Minerals yearbook 1932-33. Year 1931-32 1933

Kiessling, O. E.
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U.S. DEPARTMENT OF COMMERCE
DANIEL C. ROPER, Secretary
BUREAU OF MINES
SCOTT TURNER, Director

MINERALS YEARBOOK

1932-33

O. E. KIESSLING
Chief Economist, Division of Mineral Statistics

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1933

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FOREWORD

The Minerals Yearbook of the United States Bureau of Mines now appears for the first time. It is designed to supply timely statistical information regarding all commercially important minerals.

This new volume takes the place of various former publications, including "Mineral Resources of the United States", which has been issued annually for half a century; it also renders unnecessary various interim summaries and presents all this material in more usable form at an earlier date.

The fast pace of modern business necessitates prompt release of basic statistical information. The Bureau has been working in that direction. During recent years it has given those engaged in the mineral industry these annual services: (1) Preliminary mimeographed reviews of facts and figures pertaining to each important mineral, generally in January; (2) more complete summaries of each product, generally issued 3 to 8 months after the end of the year concerned; (3) highly accurate final figures in chapters and volumes printed 1 to 3 years later, a delay largely due to tardiness of many operators in supplying final figures.

Greater convenience to the public is a feature of the change; the yearbook is issued a relatively short time after the close of the year with which it deals, and it presents concisely in a single volume all essential data, arranged in a form well adapted to ready reference. A substantial reduction in the cost of publication will result, so the sales price set by the Superintendent of Documents should be correspondingly low.

The first volume bears the two dates 1932–33 in order that statistical records for each mineral may be carried forward unbroken; this is necessitated by the fact that no Mineral Resources volume for 1932 will be issued. Subsequent yearbooks will bear the date of the year of publication in accordance with common practice.

Virtually all copies bought by the Bureau will be distributed free to reference libraries and educational institutions; due to the necessity for economy, even this number will be small. However, copies may be purchased by anyone at moderate cost from the Superintendent of Documents, Government Printing Office, Washington, D.C., to which official is delegated the sale of all Government publications. Needless to say, that agency is in no way connected with the Bureau of Mines, and no money derived from sales reverts to the Bureau.

In most instances final statistics are given herein; where annual canvasses are not complete, figures are subject to slight revision, as indicated in footnotes. Funds permitting, all final chapters may also be printed as separate pamphlets for distribution to those whose interests are confined to single commodities. Where final figures are not available when the Minerals Yearbook goes to press, leaflets containing final statistics may be issued later.

Fifty-nine authors, all on the Bureau staff, contributed to the 61 economic and statistical surveys in this volume. There are 819 pages, divided about equally between descriptive text and charts and tables. The cloth binding is distinctive, and each year the volume should be ready for distribution by August, thus providing the mineral industries with adequate data in more convenient form at an earlier date than elsewhere or heretofore available.

It is the desire of the Bureau that the Minerals Yearbook be improved each year; criticisms and suggestions for betterment are invited.

SCOTT TURNER, *Director*.

JUNE 15, 1933.

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INTRODUCTION

One of the primary functions of the United States Bureau of Mines is the annual publication of some 60 printed economic and statistical surveys covering important branches of the mineral industry. This task had its inception in 1866 when J. Ross Browne was appointed Special Commissioner to report upon the mineral resources of the States and Territories west of the Rocky Mountains under the provision of the appropriation act of July 28, 1866, authorizing collection by the Secretary of the Treasury of "reliable statistical information concerning the gold and silver mines of the Western States and Territories." The first volume published under this congressional authorization for the year 1866 comprised 360 printed pages, was entitled "Mineral Resources of the United States", and covered minerals both west and east of the Rocky Mountains. The authors were J. Ross Browne and James W. Taylor. Approximately 21,000 copies of this volume are known to have been printed for distribution.[1]

From 1866 through 1931 the series of Mineral Resources reports has continued—since 1880 under the title of the original volume—although there are some gaps for 1876–79. Some data for these years, however, are available in other Treasury reports. The reports from 1866 to 1880 were generally on a biannual basis and attempted little in the way of commodity reviews except discussions of gold and silver. Regional mining descriptions dominated the reports, and only a small amount of space was given less-spectacular minerals mined east of the Rockies. Doubtless two men working under a limited appropriation found it difficult to carry out the instructions for a thorough survey of mining requested by Secretary of the Treasury McCullough, in a letter to J. Ross Browne, August 2, 1866.[2]

With the establishment of the United States Geological Survey by the act of March 3, 1879, Congress provided funds to carry on surveys of mineral resources and collection of statistics as closely related to studies on economic geology and classification of mineral lands. In performing this task the Survey was limited to the territory west of the one hundredth meridian. Before the collection of mineral statistics had gained much headway in the new Geological Survey a definite arrangement was made with the Bureau of the Census whereby the Survey was to conduct the mineral census of 1880 over the entire United States. Work east of the one hundredth meridian was financed by the Bureau of the Census. The following is extracted from the First Annual Report of the United States Geological Survey and explains the reasons for conducting the survey.[3]

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[1] Resolutions in the House of Representatives Jan. 29, Feb. 12, and Feb. 25, 1867; also resolutions in the Senate Feb. 6 and Feb. 27, 1867.

[2] Special Commissioners J. Ross Browne and James W. Taylor, Reports on Mineral Resources of the United States: 1867, pages 4–5.

[3] King, Clarence, First Annual Report of the United States Geological Survey to the Hon. Carl Schurz: Washington, 1880, pp. 52–53.

Foremost among all nations in the production of the precious metals, ranking first in resources of petroleum, coal, and iron, and abundantly endowed with nearly every mineral substance demanded by the civilized arts and sciences, the United States has conspicuously failed to gather and publish systematic statistical knowledge of the yearly mineral productions.

With the present rapid growth of industrial enterprise, with the complete interdependence of the arts, the least possible contribution to be made by the Federal Government should be a lucid, correct report of the production in each branch of mineral industry. Yet, legislators, economists, capitalists, and intelligent artisans are driven to scattered newspaper statements and the occasional disconnected publication of Federal and State Governments for information which should be within the reach of all.

Complete responsibility for the conduct and direction of this first annual mineral canvass of the entire United States was assumed by the United States Geological Survey. Moreover, the scope of the study was extremely broad, as indicated by the complete array of mineral substances covered in the investigation.[4]

It was not only the intention of the Survey to produce complete reliable statistics, but to "furnish full and elaborate data for the discussion of nearly all the mechanical stages of the processes which are employed in the industries of the metals" and "to report any technical local peculiarities and any interesting features in the geology and exploitation of mines" as well as to "present an account of the methods of discovery of precious metals deposits, the various legal aspects of the owners, and a review of the chief features which characterized western mining civilization."[5]

While cooperation with the Bureau of the Census permitted the Geological Survey to undertake the thorough mineral canvass of 1880, it was apparent that the work should be conducted more frequently, placed on a stable financial plane, and made a regular function of the Government. The following has been extracted from Director King's explanation of purpose of the work and his plea for funds to carry it on:[6]

Today no one knows, with the slightest approach to accuracy, the status of the mineral industry, either technically, as regards the progress and development making in methods, or statistically, as regards the sources, amounts, and valuations of the various productions.

Statesmen and economists, in whose hands rest the subjects of tariff and taxation, have no better sources of information than the guesses of newspapers and the scarcely less responsible estimates of officials who possess no adequate means of arriving at truth.

In no other intelligent nation is this so; on the contrary, mineral production is studied with the most elaborate effort. England, France, Germany, Austria, Russia, and Italy consider it essential to know, from year to year, not only the source and aggregates of amount and value of mineral yield, but many lesser facts relating to the modes and economies of the industries.

* * * As a whole it is true, and can never be refuted, that the Federal Government alone can successfully prosecute the noble work of investigating and making known the natural mineral wealth of the country, current modes of mining and metallurgy, and the industrial statistics of production. * * *

It is earnestly recommended that Congress extend this work over the whole United States, and place it on a basis of $500,000 per year. * * *

The Forty-seventh Congress responded to the need and placed the collection of mineral statistics upon a permanent basis. In an appro-

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[4] King, Clarence, work cited, p. 54.
[5] King, Clarence, work cited, p. 55; see also U.S. Geological Survey 4th Ann. Rept., 1882–83, pp. 60–63.
[6] King, Clarence, work cited, pp. 76, 78, 79.

priation act, dated August 7, 1882 (22 Stat. 329), several proposals outlined by the Geological Survey were provided for; in addition:

And not to exceed ten thousand dollars of the amount appropriated in this paragraph may be applied under the direction of the Secretary of the Interior to the procuring of statistics in relation to mines and mining other than gold and silver and in making chemical analysis of iron, coal, and oil.

The complete figures on minerals collected under this appropriation for 1882 were published in the volume entitled "Mineral Resources of the United States, 1882", which also contains the census data of 1880 and such figures as were available for 1881. This volume, completed under the first permanent annual appropriation of Congress for mineral-statistics work, began the annual series that has continued unbroken to the present.

Business men before 1900 were much like those of 1933; they wanted their figures promptly. One difficulty in publishing the volume was that the canvass for some minerals could be completed quickly, while surveys of others required much longer; hence release of information on many minerals was delayed pending completion of the most tardy canvass. This situation was remedied by publication of the chapters on the separate minerals as rapidly as completed and later assembled into the volume as required by the following provision from the act of March 2, 1895 (28 Stat. 960):

Provided, That hereafter the report of the mineral resources of the United States shall be * * * printed for each preceding calendar year as soon as compiled and transmitted for publication, and that the separate chapters on any given mineral product, such as iron, coal, building stone, and so forth, shall be printed as rapidly as transmitted for publication; that a pamphlet edition of any chapter shall be printed for distribution. * * *

Fourteen years after publication of separate chapters had been provided, users of statistical information on minerals again expressed their preference on publication of the data. The act of March 4, 1909 (35 Stat. 988) required the mineral-resources information to be published as two volumes, as follows:

The report of the mineral resources of the United States shall be published in two octavo volumes and as a distinct publication, the number of copies, printing of separate chapters, and mode of distribution of which shall be the same as of the annual report.

In the United States Geological Survey the task of collecting mineral statistics and of preparing the annual printed reports was handled by the Division of Mineral Resources. By Executive order of June 4, 1925, the personnel of this division and their duties were transferred to the Department of Commerce; then by decision of the Secretary of Commerce, they were placed in the Economics Branch, United States Bureau of Mines. This move necessitated some administrative changes that in no way affected publication of the separate chapters or hampered continuation of the annual volumes.

In glancing over the long series of Mineral Resources volumes, various additions, regroupings, and deletions in the list of subjects treated, made in response to industrial changes over 50 years, will be noted. Some minerals, given considerable space in the early volumes, ceased to deserve separate chapters. Their places were taken by newcomers, particularly by the nonmetallic building and chemical materials and by the alloying metals. Also, from 1904 on, the volumes included separate mining reviews of the important western metal-producing States, carrying forward a function very thoroughly performed in the 14-year reign (1866–80) of the Treasury reports. In fact, the Treasury Department continued its State mine reviews of metal production for many years after the first Mineral Resources volume appeared; and this task was not fully transplanted to the United States Geological Survey until 1906, following provision of funds by Congress to establish an adequate field-office staff for handling the work. Annual mine reviews of gold and silver production are now furnished the Treasury Department by the Bureau of Mines and published in the annual report of the Director of the Mint. (See Annual Report of the Director of the Mint, 1932, pp. 26–33.)

Looking over the course of mineral-resources work from its inception in 1866 and with its continuation on an annual basis for more than half a century, there is nothing spectacular to be noted. During and following the World War there was considerable expansion of many individual reports in response to war-time needs, particularly those dealing with strategic minerals. Some of this expansion was even carried over into the post-war period due to delayed completion of very ambitious research projects tackled in the stress of the war period. After publication of the war-time material the size of Mineral Resources was greatly contracted. The extent of this contraction will be appreciated when it is noted that the volume for 1929 had 827 pages less than the volume for 1918; it also was 692 pages smaller than the volume for 1913. The volume for 1931, about one half the size of the 1929 edition, was the leanest report since the days of J. Ross Browne (1866–67). Reductions in size, however, were achieved by condensations of statistical tables and discussion and by deletion of historical data carried in preceding reports that in no way impaired the essential contents.

Forty years ago the publication of the annual printed chapters and volumes represented the last word in statistical service on minerals that business interests of the period required. While completion of the annual canvasses and tabulation of the results consumed considerable time, there was apparently no complaint over delayed receipt of the data. Speeding up all business practices after the beginning of the twentieth century created a different situation. Business was conducted more on a current basis carrying with it the requirement of rapid-fire statistics. In response to this need, during the past few years the United States Bureau of Mines has exerted every effort toward early release of all annual results and toward the development of current statistical services where such moves were justifiable. Greater usefulness through earlier release of information has been achieved as follows:

I. Annual data:
   1. Publication of preliminary annual reviews on most minerals of commercial importance within 3 months following the year covered.
   2. Publication of final reviews of statistics in mimeographed form within 3 to 8 months following the year covered.
   3. Earlier publication of all printed chapters and volumes.

II. Current statistical services: Organization and development of weekly, monthly, and quarterly reports for specific minerals showing production, capacity, distribution, and stocks.

Thus viewing the program for timely service in supplying statistics, the mineral industry was relatively well served. During the first few months of the year mine operators received a preliminary review covering their specific industries. From 3 to 8 months later the preliminary statement was supplanted by final annual figures, which in turn were followed by appearance of the detailed printed chapter. For some minerals the above process was completed in less than 6 months, but for others—particularly those with large numbers of producers—the cycle may not have been completed before the latter half of the year.

The former method of publishing the volumes, Mineral Resources of the United States, has proved too cumbersome and tardy to realize the maximum benefits obtainable from cumulative improvements in both the speed and scope of statistical procedure. Hence, with this first edition of the Minerals Yearbook, the Mineral Resources series is supplanted by a new form of annual presentation for the reasons and under the program given by Director Turner in the Foreword to this volume.

In addition to drafting the discussion on fuel briquets, W. H. Young served as editorial associate, M. B. Clark supervised statistical presentation, and M. Abel supervised the preparation of graphic material. 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 J. A. Dorsey.

O. E. Kiessling.

June 10, 1933.

PART I. REVIEW OF THE MINERAL INDUSTRY

THE STATUS OF THE MINERAL INDUSTRIES

By Scott Turner

A review of our mineral industries reveals a recession during the last 3 years unprecedented in extent and duration. This condition

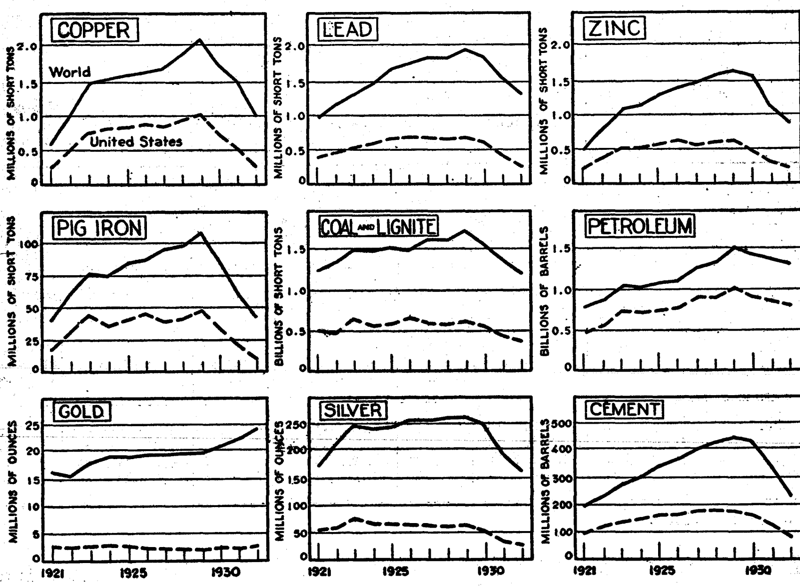

Figure 1.—Quantity-production cycles of certain important mineral commodities in the United States and the world, 1921–32.

was due to the inability of markets to absorb the output of the mills and factories that normally provide an outlet for the products of mines and smelters. Mineral producers marketed small quantities and obtained low unit prices; general disorganization was apparent in all industry. Retrenchment in the mining industry was not limited to our national boundaries, but was world-wide.

Figure 1 shows quantity-production cycles for important mineral commodities in the United States and the world, 1921–32.

Downward trend in world production.—During the 5-year period 1925–29, when world output of minerals surpassed in quantity and value that of any other equal period in history, the total value was approximately 70 billion dollars, the annual average being about 14 billion dollars. In 1930 this total annual value dropped to about 12½ billion dollars, 89 percent of the average for the preceding 5-year peak period. In 1931 the total fell to about 9 billion dollars, or 64 percent. In 1932 the value of world mineral production totaled, roughly, 7 billion dollars, one half the yearly average from 1925 to 1929.

Money-value affords the best figure by which production of all mineral commodities can be expressed, but it fails to provide useful contrast through periods wherein prices have changed greatly. For such times it is helpful to compare quantity-production figures.

The table compares with the yearly average for 1925–29 the combined tonnage during 1930, 1931, and 1932 of copper, lead, zinc, aluminum, tin, and nickel; the production of pig iron; that of gold and silver; that of coal and lignite; and that of petroleum.

Average quantity of important metals and fuels produced annually in the world, 1925–29, compared with quantities produced in 1930, 1931, and 1932

Year	Copper, lead, zinc, aluminum, tin, nickel		Pig iron		Gold	
	Short tons	Percent of 5-year average	Short tons	Percent of 5-year average	Ounces	Percent of 5-year average
1925–29	5,537,000	100	94,784,000	100	19,401,000	100
1930	5,699,000	103	88,758,000	94	20,836,000	107
1931	4,620,000	83	62,062,000	65	22,209,000	114
1932 [1]	3,462,000	63	43,211,000	46	23,900,000	123

Year	Silver		Coal and lignite		Petroleum	
	Ounces	Percent of 5-year average	Short tons	Percent of 5-year average	Barrels	Percent of 5-year average
1925–29	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	192,710,000	76	1,385,000,000	87	1,373,000,000	110
1932 [1]	160,000,000	63	1,219,000,000	76	1,306,000,000	105

[1] Subject to revision.

Declines in domestic production.—Domestic mineral production had a total value of about 29 billion dollars from 1925 to 1929, a yearly average of approximately 5.7 billion dollars. In 1930 it was 4.8 billion dollars, 17 percent less. In 1931 the total had fallen to 3.2 billion dollars, a loss of 45 percent. For 1932 our mineral production was worth about 2.4 billion dollars, a decrease of around 57 percent from the average value for the 5-year period. Of the three main groups of minerals, the general recession has affected metals most and mineral fuels least.

Index numbers showing trends of production in the three main branches of mineral production in the United States during recent years

Year	Total		Metals		Nonmetals		Fuels	
	Quantity[1]	Value	Quantity	Value	Quantity	Value	Quantity	Value
1925–29 average	100	100	100	100	100	100	100	100
1930	95	83	82	73	95	82	100	88
1931	78	55	54	42	76	58	88	60
1932 [2]	61	43	31	21	47	35	77	55

[1] Weighted averages. [2] Subject to revision.

Averages for groups as shown in this tabulation conceal fluctuations that affect individual units within the composite totals. Trends of certain minerals may be noted in the following tables showing both physical and relative production of the principal mineral commodities during 1930, 1931, and 1932, compared with the yearly average from 1925 to 1929:

Comparison of production of principal mineral commodities in the United States in 1930, 1931, and 1932 with yearly average during the 5-year period 1925–29

Commodity	Average, 1925–29	1930	1931	1932 [1]
Metals:				
Copper ... short tons	893,000	697,000	521,000	272,000
Lead ... do	661,000	574,000	390,000	255,000
Zinc ... do	590,000	489,000	292,000	207,000
Gold ... ounces	2,277,000	2,286,000	2,396,000	2,449,000
Silver ... do	61,820,000	50,748,000	30,932,000	23,981,000
Pig iron ... long tons	37,943,000	29,905,000	17,813,000	8,518,000
Aluminum ... short tons	88,000	115,000	89,000	52,000
Fuels:				
Petroleum ... barrels	869,000,000	898,000,000	851,000,000	782,000,000
Natural gas ... M cubic feet	1,487,000,000	1,943,000,000	1,686,000,000	1,518,000,000
Bituminous coal ... short tons	529,383,000	467,526,000	382,089,000	305,667,000
Anthracite ... do	75,105,000	69,385,000	59,646,000	49,900,000
Nonmetals:				
Sulphur ... long tons	1,951,000	2,559,000	2,129,000	890,000
Portland cement ... barrels	169,000,000	161,000,000	125,000,000	77,000,000
Lime ... short tons	4,457,000	3,388,000	2,708,000	1,956,000
Sand and gravel ... do	196,849,000	197,052,000	153,479,000	89,000,000
Building stone ... cubic feet	32,365,000	30,169,000	21,461,000	15,602,000
Slate ... short tons	690,000	464,000	368,000	272,000
Gypsum ... do	5,356,000	3,471,000	2,559,000	1,355,000
Crushed stone ... do	87,425,000	87,111,000	72,624,000	46,800,000
Salt ... do	7,791,000	8,054,000	7,358,000	6,447,000

[1] Subject to revision.

Index figures showing trends of quantity production of the principal mineral commodities in the United States in 1930, 1931, and 1932

[Yearly average, 1925-29=100]

Metals	1930	1931	1932 [1]	Fuels	1930	1931	1932 [1]	Nonmetals	1930	1931	1932 [1]
Gold	100	105	108	Natural gas	131	113	102	Salt	103	94	83
Aluminum	130	101	59	Petroleum	103	98	90	Crushed stone	100	83	54
Silver	82	50	39	Anthracite	92	79	66	Sand and gravel	100	78	45
Lead	87	59	39	Bituminous coal	88	72	58	Portland cement	95	74	46
Zinc	83	50	35					Sulphur	131	109	46
Copper	78	58	30					Lime	76	61	44
Pig iron	79	47	22					Slate	67	53	39
								Building stone	93	66	48
								Gypsum	65	48	25

[1] Subject to revision.

Gold and natural gas still exceed the average yearly quantity produced during the boom period; petroleum and salt have held up well. All other mineral commodities have experienced major declines, with pig iron the greatest sufferer among the important metals. This and the extreme decreases in copper and zinc production attest the severity of recession in mineral-consuming activities.

A few comparisons will indicate the low levels to which quantity production of some of these commodities fell in 1932. Pig-iron output was the lowest since 1896. Although the copper yield exceeded that of 1921, a post-war depression year, it only slightly topped the normal 1898 figure. The output of lead was the lowest since 1899 and of zinc the smallest since 1905, excluding 1921. Silver yield was the least since 1875. Bituminous-coal and anthracite production approximated the levels of 1905 and 1890, respectively.

Comparison of the trend of mineral production in the United States with that of the rest of the world will now be made. The following table will show that mineral production in the United States in 1932 dropped more than in other nations:

Comparison of trends of total mineral production, measured by value, in the world and the United States during recent years

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

Period	World total		United States		World total outside the United States	
	Value	Index	Value	Index	Value	Index
1925–29 average	14.0	100	5.7	100	8.3	100
1930	12.5	89	4.8	83	7.7	93
1931	9.0	64	3.2	55	5.8	70
1932 [1]	7.0	50	2.4	43	4.6	55

[1] Subject to revision.

Following the abrupt recession of demand in 1929, mine production abroad was not decreased as promptly as in the United States. Perhaps there was earlier realization here that reduction of output was necessary.

A review of the quantity-production records of some mineral commodities reveals pronounced diversities between the trends of output in the United States and elsewhere. The extent to which the burden of recent curtailment has fallen on America is illustrated in the following table:

Index numbers comparing trends of quantity production of some important mineral commodities during recent years in the United States with those of the rest of the world

[Index numbers based on 1925–29 average=100]

Commodity	1930		1931		1932 [1]	
	United States	Rest of world	United States	Rest of world	United States	Rest of world
Copper	78	120	58	115	30	84
Lead	87	109	59	97	39	86
Zinc	83	124	50	96	35	80
Gold	100	108	105	116	108	125
Silver	82	103	50	84	39	71
Aluminum	130	115	101	102	59	72
Pig iron	79	106	47	81	22	64
Coal and lignite	89	103	73	95	59	87
Petroleum	103	136	98	138	90	138

[1] Subject to revision.

The decline in prices.—Curtailment of operation has been accompanied by an unprecedented decline in mineral-commodity prices, some of which have fallen to the lowest levels ever recorded. The drop was more pronounced in 1930 and 1931 than in 1932, some commodities having made partial recovery during the latter half of 1932. When weighted-average prices of 20 of the most important mineral commodities are compared the 1930 price level may be represented by the index number 88, based upon 100 as the average price level from 1925 to 1929. In 1931 the index dropped to a little above 72 and in 1932 to just below 70. Thus, the general price level for the minerals considered fell 12 points in 1930, 16 more in 1931, and only 2 in 1932.

Index numbers showing price-trends of mineral commodities in the United States during 1930, 1931, and 1932

[Index numbers based on 1925–29 average=100]

Metals	1930	1931	1932[1]	Fuels	1930	1931	1932[1]	Nonmetals	1930	1931	1932[1]
Gold	100	100	100	Natural gas	96	104	105	Sulphur	102	102	[2] 102
Aluminum	93	91	91	Anthracite	96	93	83	Building stone	104	104	95
Pig iron	90	81	73	Bituminous coal	87	79	70	Sand and gravel	97	95	87
Zinc	69	56	46	Petroleum	83	45	60	Crushed stone	97	93	87
Silver	62	47	46					Gypsum	82	86	90
Lead	74	57	43					Salt	93	88	90
Copper	88	55	38					Lime	87	80	72
								Slate	92	79	69
								Portland cement	88	68	61
Weighted average	87	72	63		87	70	72		92	83	77

[1] Subject to revision. [2] Nominal price.

Some of these index numbers are derived from nominal quotations; doubtless many would have to be revised downward if all the facts were known. They are the best approximations possible with the information available.

The decline in mineral prices, though severe in some instances, has been slightly less drastic, on the whole, than the fall in the general price-level. Although the mineral price-index declined as shown above, a wholesale price-index for all commodities, adjusted from Department of Labor figures, shows recession from an average of 100 for 1925–29 to 88 in 1930, to 74 in 1931, and to 66 in 1932. The parallel between the drop of the general price-level and that of mineral commodities is striking until 1932, when the average price of mineral commodities became steady while the decline in the general average of prices continued.

In the field of minerals, metal prices have suffered most. Copper and lead particularly have been seriously affected. The price of gold, among the individual commodities, of course, has remained unchanged.

Economic outlook for minerals.—In spite of this recent record of almost uninterrupted decline, it may be that the course of deflation has been nearly completed. Prices of many mineral commodities have fallen below cost of production, and obviously such a condition cannot continue indefinitely. Three years of steadily declining consumption caused accumulation of excessive stocks, while recurring distress sales drove prices downward, a trend that has recently shown progressive abatement. With drastic curtailment of production, the increase of stocks has generally ceased, and surplus stocks are more strongly held than in the recent past.

Improvement of consumption has lately been evident, and the record of the past provides assurance for the future. The annual per capita consumption of iron in the United States advanced, in the hundred years 1831–1930, from 30 to 546 pounds and that of copper, lead, and zinc combined from less than 2 to nearly 30 pounds. The per capita consumption of iron in 1931 was 320 pounds and in 1932 probably totaled about 155 pounds; that of copper, lead, and zinc in 1931 was 21 pounds and in 1932 amounted to less than 15 pounds.

Advancing consumption has persisted through a century, which indicates a deep-lying tendency to grow, one that cannot be repressed indefinitely. The steady rise of living standards was made possible chiefly through increased utilization of minerals and metals. From 1860 to 1929 our population was multiplied by 4, the value of agricultural production by 6, that of manufactures by 22, and that of mining output by 60. Our living standards will advance further; the present low level of mineral consumption should not continue long.

STATISTICAL SUMMARY OF MINERAL PRODUCTION

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

Mineral products of the United States, 1931–32 [1]

Product	1931 Quantity	1931 Value	1932 Quantity	1932 Value
METALLIC				
Aluminum pounds	177,544,000	$37,284,000	104,885,000	$20,453,000
Antimonial lead short tons (2,000 pounds)	[2] 21,842	(2)	[2] 21,024	(2)
Antimony:				
Metal do	(3)	(3 4)	[3] 1,776	(3 4)
Ore do			900	(5)
Bauxite long tons (2,240 pounds)	195,895	1,140,629	96,349	548,168
Cadmium pounds	1,050,529	409,706	799,501	(6)
Chromite long tons	268	3,509	155	2,160
Copper, [7] sales value pounds	1,042,711,178	94,887,000	544,009,948	34,273,000
Ferro-alloys long tons	398,295	30,764,549	218,646	14,003,672
Gold [8] troy ounces	2,395,878	49,527,200	2,449,032	[9] 50,626,000
Iron:				
Ore [4] long tons	28,516,032	[4] 74,123,910	5,331,201	[4] 12,898,011
Pig do	17,812,579	285,147,156	8,518,400	126,032,714
Lead (refined), [7] sales value short tons	390,260	28,879,000	255,337	15,320,000
Manganese ore (35 percent or more Mn) long tons	39,242	699,121	17,777	377,222
Manganiferous ore (5 to 35 percent Mn) long tons	281,414	976,549	25,434	92,135
Mercury:				
Metal flasks (76 pounds net)	24,947	2,179,145	12,622	731,129
Ore short tons	(10)	(11)	(10)	(11)
Nickel do	373	202,406	195	88,515
Ores (crude), old tailings, etc.:				
Copper do	34,049,000	(11)	(12)	(11)
Copper-lead and copper-lead-zinc do	213,000	(11)	(12)	(11)
Dry and siliceous (gold and silver) do	8,329,000	(11)	(12)	(11)
Lead do	6,043,000	(11)	(12)	(11)
Lead-zinc do	5,427,000	(11)	(12)	(11)
Zinc do	4,500,000	(11)	(12)	(11)
Platinum and allied metals (value at New York City) troy ounces	36,205	1,274,029	17,616	591,849
Silver do	30,932,050	8,970,294	23,980,773	6,762,578
Tin (metallic equivalent) short tons	4	2,050	(13)	220

1 In this general statement certain of the figures represent shipments rather than quantity mined, and some of the figures for 1932 are estimates.
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; Bureau of Mines not at liberty to publish figures for 1931 and value for 1932.
4 Value not included in total value.
5 Bureau of Mines not at liberty to publish figures. Value excluded from metallic total as duplicated in content of antimonial lead.
6 Value included in total value of metallic products; Bureau of Mines not at liberty to publish figures.
7 Product from domestic ores only.
8 Value, $20.671834625323 an ounce.
9 Difference between total gold given here and total mine output ($52,113,780) given in chapter on Gold and Silver is accounted for by fact that there was a large hold-over at a smelter, which did not reach the refinery before the end of 1932.
10 Figures not available.
11 Figures showing values not available.
12 Figures for 1932 not yet available.
13 1,000 pounds.

Mineral products of the United States, 1931–32—Continued

Product	1931 Quantity	1931 Value	1932 Quantity	1932 Value
METALLIC—continued				
Titanium ore:				
Ilmenite ...short tons..	(6)	(6)	(6)	(6)
Rutile ...do...	(6)	(6)	(6)	(6)
Tungsten ore (60 percent concentrates) ...do...	1, 404	$928, 000	396	$218, 394
Uranium and vanadium ores ...do...	(6)	(6)	(6)	(6)
Zinc,[7] sales value ...do...	291, 996	22, 192, 000	207, 148	12, 429, 000
Total value of metallic products (approximate)	------------	567, 200, 000	------------	283, 700, 000
NONMETALLIC				
Arsenious oxide ...short tons..	13, 777	796, 744	12, 483	650, 902
Asbestos ...do...	3, 228	118, 967	3, 559	105, 292
Asphalt:				
Native ...do...	503, 383	2, 930, 451	340, 019	1, 942, 943
Oil (including road oil) [4] ...do...	2, 206, 568	[4] 16, 614, 594	2, 308, 785	[4] 14, 898, 492
Barite (crude) ...do...	174, 520	994, 655	129, 854	745, 955
Borates (naturally occurring sodium borates) short tons..	178, 550	4, 931, 295	181, 915	3, 023, 844
Bromine ...pounds..	8, 935, 330	1, 854, 650	5, 727, 561	1, 182, 569
Calcium-magnesium chloride ...short tons..	86, 156	1, 687, 166	66, 286	1, 163, 385
Cement ...barrels (376 pounds net)..	128, 377, 384	142, 579, 826	81, 130, 000	81, 500, 000
Clay:				
Products [14]	------------	177, 562, 025	------------	(14)
Raw [4] ...short tons..	2, 519, 495	[4] 8, 352, 185	1, 618, 380	[4] 5, 636, 302
Coal:				
Bituminous [15] ...do...	382, 089, 396	588, 895, 000	305, 667, 000	416, 000, 000
Pennsylvania anthracite ...do...	59, 645, 652	296, 354, 586	49, 900, 000	222, 000, 000
Coke [4] ...do...	33, 483, 886	[4] 161, 608, 724	21, 912, 511	[4] 105, 786, 666
Diatomite and tripoli [16] ...do...	26, 682	310, 131	14, 775	232, 700
Emery ...do...	512	5, 557	250	2, 781
Feldspar (crude) ...long tons..	147, 119	861, 059	104, 715	539, 641
Fluorspar ...short tons..	53, 484	931, 275	25, 251	392, 499
Fuller's earth ...do...	288, 400	3, 055, 570	252, 902	2, 440, 736
Garnet for abrasive purposes ...do...	2, 946	193, 015	1, 950	147, 350
Gems and precious stones	------------	(17)	------------	(17)
Graphite:				
Amorphous ...short tons..	(18)	(18)	(18)	(18)
Crystalline ...pounds..	(18)	(18)		
Grindstones and pulpstones ...short tons..	8, 724	342, 149	7, 668	247, 440
Gypsum ...do...	2, 559, 017	20, 801, 357	1, 355, 219	12, 407, 619
Lime ...do...	2, 707, 614	18, 674, 913	1, 956, 000	12, 108, 000
Magnesite (crude) ...do...	73, 602	499, 239	38, 462	283, 304
Mica:				
Scrap ...short tons..	6, 621	99, 415	7, 183	78, 648
Sheet ...pounds..	962, 953	111, 830	303, 504	40, 158
Millstones	------------	5, 330	------------	4, 450
Mineral paints:				
Natural pigments [19] ...short tons..	(19)	(19)	(19)	(19)
Zinc and lead pigments [20] ...do...	123, 963	15, 225, 300	92, 812	9, 821, 267
Mineral waters ...gallons sold..	(17)	(17)	(17)	(17)
Natural gas ...M cubic feet..	1, 686, 436, 000	392, 816, 000	1, 518, 000, 000	357, 000, 000
Natural gasoline ...gallons..	1, 831, 918, 000	63, 732, 000	1, 502, 400, 000	47, 620, 000
Oilstones, etc ...short tons..	370	81, 951	331	63, 960
Peat ...do...	(17)	(17)	(17)	(17)
Petroleum ...barrels (42 gallons)..	851, 081, 000	550, 630, 000	781, 845, 000	680, 000, 000
Phosphate rock ...long tons..	2, 534, 959	9, 288, 485	1, 700, 568	5, 504, 996
Potassium salts ...short tons..	[21] 63, 770	3, 086, 955	[21] 55, 620	2, 102, 590
Pumice ...do...	68, 819	338, 586	53, 214	235, 204
Pyrites ...long tons..	330, 848	974, 820	186, 485	492, 043
Salt ...short tons..	7, 358, 070	21, 541, 012	6, 447, 351	19, 468, 096

[4] Value not included in total value.
[6] Value included in total value of metallic products; Bureau of Mines not at liberty to publish figures.
[7] Product from domestic ores only.
[14] Figures obtained through cooperation with Bureau of the Census. Figures for 1932 not yet available; estimate of value included in total value of nonmetallic products.
[15] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.
[16] Figures represent tripoli only. Value of diatomite is 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] Canvass discontinued after 1915. Value of iron ore sold for paint included under last item ("Unspecified").
[20] Sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.
[21] Equivalent as K_2O.

Mineral products of the United States, 1931–32—Continued

Product	1931		1932	
	Quantity	Value	Quantity	Value
NONMETALLIC—continued				
Sand:				
Glass ... short tons	1,677,882	$2,779,245	89,000,000	$46,280,000
Molding, building, etc., and gravel ... do	151,801,162	83,501,075		
Sand-lime brick [22] ... thousands	143,673	1,236,825	52,853	433,118
Silica (quartz) ... short tons	7,851	69,103	7,487	59,158
Slate ... do	368,420	5,498,336	272,400	2,990,000
Stone ... do	97,933,180	135,085,627	66,233,600	84,050,000
Sulphur ... long tons	1,376,526	24,800,000	1,108,852	20,000,000
Sulphuric acid (60° Baumé) from copper and zinc smelters ... short tons	862,729	6,491,515	600,334	4,028,738
Talc and soapstone [23] ... do	163,752	1,852,472	123,221	1,361,633
Total value of nonmetallic products (approximate)		2,592,100,000		2,153,300,000
SUMMARY				
Total value of metallic products		567,200,000		283,700,000
Total value of nonmetallic products (exclusive of mineral fuels)		699,700,000		430,700,000
Total value of mineral fuels		1,892,400,000		1,722,600,000
Total value of "unspecified" (metallic and nonmetallic) products (partly estimated) [24]		7,300,000		[24] 6,000,000
Grand total approximate value of mineral products		3,166,600,000		2,443,000,000

[22] According to Bureau of the Census.

[23] Figures represent talc only. Value of soapstone is included in total value of nonmetallic products; Bureau of Mines not at liberty to publish figures.

[24] Includes for 1932 the value of bismuth, cadmium compounds, chats, columbite ($234), flint lining for tube mills and pebbles for grinding ($13,070), optical fluorspar ($59), iodine, iron ore sold for magnets, iron ore sold for paint ($10,770), lithium minerals, new ingot magnesium ($228,653), natural magnesium salts ($896,085), calcareous marl ($26,442), greensand marl ($201,173), micaceous minerals ($30,000), molybdenum ($1,186,000), selenium, silica sand and sandstone (finely ground) ($875,749), sodium salts (carbonates and sulphates) from natural sources ($1,098,394), sulphur ore, tellurium, and an estimate of the value of miscellaneous mineral products, statistics for which are not collected annually by the Bureau of Mines.

PART II. METALS

GOLD AND SILVER

By Chas. W. Henderson

Great Britain's continued abandonment of the gold standard since September 1931—a policy adopted almost immediately by several additional countries, later by others, and in April 1933 by the United States, leaving France, Switzerland, Holland, and Belgium the only nations not following their example—has occasioned much discussion throughout the world of the subject of money. It is surprising to learn that within a year 42 countries have abandoned the gold standard or are maintaining it artificially. We have witnessed variations of the British "pound sterling" between \$4.86 and \$3.20 in terms of United States money and later a drop in the value of United States dollars in terms of other countries' currency.

The literature on money is almost measureless and is exceedingly controversial. The chief functions of money are to provide a common medium by which exchanges of labor and goods are made possible, a common measure by which comparative values of the exchanges are measured, and a standard by which future obligations are determined. The result throughout the centuries of the use of various mediums of barter or exchange has been gradual elimination of all other forms but metals and finally elimination of all metals but gold and silver because these are the only substances at the same time durable, homogeneous, divisible, recognizable, and easily transportable.

The total value of goods sent from one nation to another rose to 32 billion dollars in 1929. Other money transactions raised the figure to 40 billion dollars. As the total monetary gold in the world is only about 11 billions, an auxiliary medium has been adopted—foreign bills of exchange, checks payable abroad or in foreign currency, and day-to-day claims in foreign currencies. This expedient has not met expectations.

The argument that the value of gold is determined by the cost of production is only partly true; much gold is produced at a loss, and more is produced without profit. The table following, from the report of the Director of the United States Mint, of the output of gold and silver in the world from 1493 to 1932, inclusive, gives a basis for study.

Production of gold and silver in the world since the discovery of America

[Data from 1493 to 1885 are from a table of averages for certain periods, compiled by Dr. Adolph Soetbeer; for the years since, the production is the annual estimate of the Bureau of the Mint]

Period	Gold; total for period		Silver; total for period		Ratio by weight
	Fine ounces	Value	Fine ounces	Commercial value [1]	
1493-1880	334, 030, 944	$6, 905, 033, 000	6, 207, 580, 994	$8, 361, 812, 579	1 to 18. 58
1881-90	51, 280, 184	1, 060, 056, 000	1, 004, 576, 877	1, 043, 927, 353	1 to 19. 59
1891-1900	101, 647, 521	2, 101, 241, 400	1, 616, 373, 178	1, 131, 299, 109	1 to 15. 90
1901-10	182, 891, 525	3, 780, 703, 900	1, 826, 234, 623	1, 052, 194, 838	1 to 9. 99
1911-20	206, 114, 773	4, 260, 770, 272	1, 935, 607, 379	1, 430, 510, 377	1 to 9. 39
1921-30	186, 091, 278	3, 846, 848, 092	2, 387, 189, 080	1, 481, 366, 094	1 to 12. 83
1931	22, 209, 178	459, 104, 453	192, 709, 971	55, 910, 942	1 to 8. 68
Total, 1493-1931	1, 084, 265, 403	22, 413, 757, 117	15, 170, 272, 102	14, 557, 021, 292	1 to 13. 99
1932 [2]	23, 000, 000	475, 452, 196	160, 000, 000	45, 120, 000	1 to 6. 96
Total, 1493-1932 [2]	1, 107, 265, 403	22, 889, 209, 313	15, 330, 272, 102	14, 602, 141, 292	1 to 13. 85

[1] Valued, prior to 1701, at $1.38 per fine ounce, which corresponds with a commercial ratio of silver to gold of approximately 15 to 1, the ratio that prevailed for over 100 years subsequent to 1687. From 1701 to 1840 the value corresponds with the average ratios of silver to gold. From 1841 the annual averages per fine ounce in London are used except for 1915-21 and 1931, when London prices were not equivalent to gold and New York prices were used.
[2] Subject to revision.

It is seen that world gold production recently has been increasing slightly and world silver production decreasing heavily. Official records indicate that the output in the Transvaal, the largest gold district in the world, which in 1932 produced gold valued at $238,-833,364 out of a world total of $475,452,196, averaged 971,415 ounces per month from April 1932 through December 1932 and 923,141 ounces per month from January through April 1933. A 6-month record prognosticates that United States gold output will decrease in 1933. Mexico, which produced about 100,000,000 ounces of silver of the yearly world total of 250 to 260 million ounces from 1926 to 1930, yielded 86,000,000 ounces in 1931 and 69,000,000 in 1932. Its output will fall again in 1933, owing to idleness of many mines. United States production in 1933 will be under 24,000,000 ounces, because, with the condition of mines known for the first 6 months of 1933 and with all possible factors taken into account, silver-bearing properties cannot be opened quickly enough during the last 6 months of 1933 to increase the yearly production over that of 1932.

World monetary stock.—The monetary stock of the principal countries of the world, end of calendar year 1931 (subject to revision) was: Gold, $11,940,606,000; silver, $4,110,046,000. The American Bureau of Metal Statistics is authority for the statement that on January 1, 1933, silver stocks at Shanghai were 321,930,000 fine ounces and in India 380,394,000 fine ounces.

United States monetary stock and mine production of gold and silver.—The following tables of (1) monetary stock of gold in the United States since 1873 by 10-year periods and for 1931, (2) location and ownership of United States money, June 30, 1932, and (3) gold and silver produced in the Western States, including Alaska, in terms of recovered metals, 1848-1931, make interesting comparisons. The production of gold and silver in the United States, including Philippine Islands production, since 1792 to and including 1931, as estimated by the Director of the United States Mint, is gold $4,627,-942,300, silver 3,198,115,604 fine ounces.

The Director of the Mint gives the production of the United States (Eastern States mainly) previous to 1848 as gold $24,537,000, silver 309,500 fine ounces, and the United States Bureau of Mines calculates the total production of gold for the Eastern States from 1799 to 1931 as $51,223,004. The mine production of gold in the United States proper, including Alaska from 1792 to 1931, thus was $4,700,001,251. Disregarding Philippine Islands production, the difference between the Mint total and the Bureau total is only 2 percent, and most of this difference can be accounted for in the difference between the Mint and Bureau figures for the first 5 years of California gold production.

Monetary stock of gold in the United States since 1873 [1]

[In thousands of dollars]

End of year	Coin in Treasury	Bullion in Treasury	Coin in Federal Reserve banks	Bullion in Federal Reserve banks	Coin in national banks, Comptroller's report	Other coin [2]	Total stock of gold
Fiscal year June 30, 1873	55, 519	15, 670			3, 818	30, 000	105, 007
Calendar year:							
1880	61, 481	93, 790			92, 185	150, 086	397, 542
1890	226, 220	67, 646			80, 362	274, 056	648, 284
1900	328, 453	153, 095			199, 350	307, 870	988, 768
1910	982, 586	120, 726			227, 978	378, 745	1, 710, 035
1920	238, 270	1, 999, 619	65, 979	147, 313	20, 686	453, 882	2, 925, 750
1930	735, 087	2, 783, 637	449, 916	256, 469	14, 088	354, 291	4, 593, 488
1931	976, 900	2, 580, 803	286, 082	207, 688	12, 973	395, 653	4, 460, 099

[1] Previous to 1914 (year Federal Reserve System established) figures are unrevised. Gold in the Treasury is principally held against outstanding currency and (since 1916) for the account of the Federal Reserve banks.
[2] Includes coin in State and private banks as well as coin in tills and the hands of the public.

Location and ownership of United States money, June 30, 1932

Kind of money	Money held in the Treasury	Money outside of the Treasury	Total
Gold coin and bullion	[1] $2,958, 560, 679	$960, 035, 138	$3, 918, 595, 817
Standard silver dollars	[2] 501, 022, 745	38, 985, 166	540, 007, 911
Subsidiary silver	8, 490, 556	296, 392, 440	304, 882, 996
Minor coin	4, 755, 771	121, 737, 555	126, 493, 326
United States notes	2, 279, 960	344, 401, 056	346, 681, 016
Federal Reserve notes	1, 406, 880	3, 026, 990, 335	3, 028, 397, 215
Federal Reserve bank notes	26, 298	2, 745, 742	2, 772, 040
National bank notes	16, 578, 916	720, 095, 297	736, 674, 213
Total	3, 493, 121, 805	5, 511, 382, 729	9, 004, 504, 534

[1] Of this, $1,490,698,969 is amount held in trust against $1,490,698,969 of gold certificates.
[2] Against these standard dollars are issued $487,216,201 of silver certificates and $1,222,150 of Treasury notes of 1890.

Gold and silver produced in the Western States, including Alaska, in terms of recovered metals, 1848–1931

[Compiled by Charles W. Henderson]

State	Period	Gold value	Silver, fine ounces
Arizona	1860–1931	$159, 833, 188	205, 479, 871
California	1848–1931	1, 852, 354, 387	85, 404, 568
Colorado	1858–1931	720, 301, 766	660, 127, 833
Idaho	1863–1931	137, 889, 762	333, 668, 941
Montana	1862–1931	309, 344, 425	631, 874, 414
Nevada	1859–1931	459, 717, 619	541, 191, 602
New Mexico	1848–1931	37, 629, 582	53, 055, 053
Oregon	1852–1931	103, 242, 000	4, 056, 671
South Dakota	1876–1931	298, 155, 521	7, 883, 626
Texas	1885–1931	95, 073	22, 772, 523
Utah	1865–1931	139, 657, 325	585, 475, 176
Washington	1860–1931	30, 482, 780	9, 307, 090
Wyoming	1867–1931	1, 250, 819	70, 336
Total		4, 249, 954, 247	3, 140, 367, 704
Alaska	1880–1931	398, 824, 000	17, 178, 544
Total		4, 648, 778, 247	3, 157, 546, 248

The following tables (1) the average commercial ratio of silver to gold each calendar year since 1687, and (2) the highest, lowest, and average price of silver in New York since 1874, are interesting complements to the world-production tables for gold and silver:

Highest, lowest, and average price of silver in New York, per fine ounce, since 1874, being the asked price to and including 1917, thereafter taken at the mean of the bid and asked prices

Calendar year	Quotations			Calendar year	Quotations		
	Highest	Lowest	Average		Highest	Lowest	Average
1874	$1. 29375	$1. 25500	$1. 27195	1903	$0. 62375	$0. 47500	$0. 54208
1875	1. 26125	1. 21000	1. 23883	1904	. 62500	. 53375	. 57843
1876	1. 26000	1. 03500	1. 14950	1905	. 66500	. 55625	. 61008
1877	1. 26000	1. 16000	1. 19408	1906	. 72375	. 63125	. 67379
1878	1. 20750	1. 08500	1. 15429	1907	. 71000	. 52750	. 65978
1879	1. 16750	1. 06500	1. 12088	1908	. 58875	. 48250	. 53496
1880	1. 15000	1. 11250	1. 13931	1909	. 54500	. 50750	. 52163
1881	1. 14500	1. 11000	1. 12823	1910	. 57625	. 50750	. 54245
1882	1. 15000	1. 09000	1. 13855	1911	. 57500	. 52125	. 54002
1883	1. 11750	1. 09500	1. 10874	1912	. 65625	. 55250	. 62006
1884	1. 13250	1. 08000	1. 11161	1913	. 65125	. 58000	. 61241
1885	1. 09500	1. 02750	1. 06428	1914	. 60875	. 49000	. 56331
1886	1. 03500	. 92500	. 99880	1915	. 58000	. 47750	. 51026
1887	1. 03500	. 95000	. 97899	1916	. 79125	. 57250	. 67151
1888	. 97750	. 92000	. 94300	1917	1. 16500	. 73125	. 84000
1889	. 97250	. 92500	. 93634	1918	1. 01937	. 88937	. 98445
1890	1. 20500	. 95750	1. 05329	1919	1. 38250	1. 01375	1. 12087
1891	1. 07500	. 94750	. 99033	1920	1. 37875	. 60375	1. 01940
1892	. 95250	. 83000	. 87552	1921	. 73813	. 53188	. 63096
1893	. 85000	. 65000	. 78219	1922	. 74188	. 62875	. 67934
1894	. 70000	. 59500	. 64043	1923	. 69000	. 62875	. 65239
1895	. 69000	. 60000	. 66268	1924	. 72375	. 63000	. 67111
1896	. 70250	. 65625	. 68195	1925	. 73187	. 66812	. 69406
1897	. 66125	. 52750	. 60774	1926	. 68937	. 51812	. 62428
1898	. 62250	. 55125	. 59064	1927	. 60312	. 54187	. 56680
1899	. 64750	. 58625	. 60507	1928	. 63937	. 56812	. 58488
1900	. 65750	. 59750	. 62065	1929	. 57812	. 46812	. 53306
1901	. 64500	. 54750	. 59703	1930	. 47187	. 31062	. 38466
1902	. 56875	. 47375	. 52815	1931	. 37562	. 26062	. 29013

Average commercial ratio of silver to gold each calendar year since 1687

Years	Ratio	Years	Ratio	Years	Ratio	Years	Ratio	Years	Ratio
1687	14.94	1736	15.18	1785	14.92	1834	15.73	1883	18.64
1688	14.94	1737	15.02	1786	14.96	1835	15.80	1884	18.61
1689	15.02	1738	14.91	1787	14.92	1836	15.72	1885	19.41
1690	15.02	1739	14.91	1788	14.65	1837	15.83	1886	20.78
1691	14.98	1740	14.94	1789	14.75	1838	15.85	1887	21.10
1692	14.92	1741	14.92	1790	15.04	1839	15.62	1888	22.00
1693	14.83	1742	14.85	1791	15.05	1840	15.62	1889	22.10
1694	14.87	1743	14.85	1792	15.17	1841	15.70	1890	19.75
1695	15.02	1744	14.87	1793	15.00	1842	15.87	1891	20.92
1696	15.00	1745	14.98	1794	15.37	1843	15.93	1892	23.72
1697	15.20	1746	15.13	1795	15.55	1844	15.85	1893	26.49
1698	15.07	1747	15.26	1796	15.65	1845	15.92	1894	32.56
1699	14.94	1748	15.11	1797	15.41	1846	15.90	1895	31.60
1700	14.81	1749	14.80	1798	15.59	1847	15.80	1896	30.59
1701	15.07	1750	14.55	1799	15.74	1848	15.85	1897	34.20
1702	15.52	7151	14.39	1800	15.68	1849	15.78	1898	35.03
1703	15.17	1752	14.50	1801	15.46	1850	15.70	1899	34.36
1704	15.22	1753	14.54	1802	15.26	1851	15.46	1900	33.33
1705	15.11	1754	14.48	1803	15.41	1852	15.59	1901	34.68
1706	15.27	1755	14.68	1804	15.41	1853	15.33	1902	39.15
1707	15.44	1756	14.94	1805	15.79	1854	15.33	1903	38.10
1708	15.41	1757	14.87	1806	15.52	1855	15.38	1904	35.70
1709	15.31	1758	14.85	1807	15.43	1856	15.38	1905	33.87
1710	15.22	1759	14.15	1808	16.08	1857	15.27	1906	30.54
1711	15.29	1760	14.14	1809	15.96	1858	15.38	1907	31.24
1712	15.31	1761	14.54	1810	15.77	1859	15.19	1908	38.64
1713	15.24	1762	15.27	1811	15.53	1860	15.29	1909	39.74
1714	15.13	1763	14.99	1812	16.11	1861	15.50	1910	38.22
1715	15.11	1764	14.70	1813	16.25	1862	15.35	1911	33.33
1716	15.09	1765	14.83	1814	15.04	1863	15.37	1912	33.62
1717	15.13	1766	14.80	1815	15.26	1864	15.37	1913	34.19
1718	15.11	1767	14.85	1816	15.28	1865	15.44	1914	37.37
1719	15.09	1768	14.80	1817	15.11	1866	15.43	1915	40.48
1720	15.04	1769	14.72	1818	15.35	1867	15.57	1916	30.78
1721	15.05	1770	14.62	1819	15.33	1868	15.59	1917	24.61
1722	15.17	1771	14.66	1820	15.62	1869	15.60	1918	21.00
1723	15.20	1772	14.52	1821	15.95	1870	15.57	1919	18.44
1724	15.11	1773	14.62	1822	15.80	1871	15.57	1920	20.28
1725	15.11	1774	14.62	1823	15.84	1872	15.63	1921	32.76
1726	15.15	1775	14.72	1824	15.82	1873	15.93	1922	30.43
1727	15.24	1776	14.55	1825	15.70	1874	16.16	1923	31.69
1728	15.11	1777	14.54	1826	15.76	1875	16.64	1924	30.80
1729	14.92	1778	14.68	1827	15.74	1876	17.75	1925	29.78
1730	14.81	1779	14.80	1828	15.78	1877	17.20	1926	33.11
1731	14.94	1780	14.72	1829	15.78	1878	17.92	1927	36.47
1732	15.09	1781	14.78	1830	15.82	1879	18.39	1928	35.34
1733	15.18	1782	14.42	1831	15.72	1880	18.05	1929	38.78
1734	15.39	1783	14.48	1832	15.73	1881	18.25	1930	53.74
1735	15.41	1784	14.70	1833	15.93	1882	18.20	1931	71.25

Monetary relationships.—United States coinage laws show the development of the establishment of the value of $20.671834625323 per troy ounce of gold. The following table of laws gives value of gold per troy ounce under different Congressional acts, using the eagle or $10 gold coin as a basis.

Value of gold per troy ounce under different Congressional acts

Date of law	Standard weight (grains)	Fineness (1000ths)	Fine gold content (grains)	Value per fine ounce troy (480 grains)	Value per grain
Apr. 2, 1792	270	916.6666+	247.5	$19.393939	$0.04040404
June 28, 1834	258	899.2248+	232.0	20.689656	.04310345
Jan. 18, 1837	258	900.0000	232.2	20.671835	.04306632

United States coinage laws.—In 1786 the Congress of the Confederation chose as the monetary unit of the United States the dollar of 375.64 grains of pure silver. This unit had its origin in the Spanish piaster or milled dollar, which constituted the basis of the metallic circulation of the British colonies in America. It was never coined, there being at that time no mint in the United States.

The act of April 2, 1792, established the first monetary system of the United States. The bases of the system were the gold dollar (containing 24.75 grains of pure gold and stamped in pieces of $10, $5, and $2.50, denominated, respectively, eagles, half eagles, and quarter eagles); and the silver dollar (containing 371.25 grains of pure silver). A mint was established. The coinage was unlimited, and there was no mint charge. The ratio of gold to silver in coinage was 1:15. Both gold and silver were legal tender. The standard was double.

The act of 1792 undervalued gold, which was therefore exported. The act of June 28, 1834, was passed to remedy this by changing the mint ratio between metals to 1:16.002. This latter act fixed the weight of the gold dollar at 25.8 grains but lowered the fineness from 0.916⅔ to 0.899225. The fine weight of the gold dollar was thus reduced to 23.2 grains. The act of 1834 undervalued silver as that of 1792 had undervalued gold, and silver was attracted to Europe by the more favorable ratio of 1:15½. The act of January 18, 1837, was passed to make the fineness of the gold and silver coins uniform. The legal weight of the gold dollar was fixed at 25.8 grains and its fine weight at 23.22 grains. The fineness was therefore changed by this act to 0.900 and the ratio to 1:15.988+.

Silver continued to be exported. The act of February 21, 1853, reduced the weight of the silver coins of a denomination less than $1, which the acts of 1792, 1834, and 1837 had made exactly proportional to the weight of the silver dollar, and provided that they should be legal tender to the amount of only $5. Under the acts of 1792, 1834, and 1837 they had been full legal tender. By the act of 1853 the legal weight of the half dollar was reduced to 192 grains and that of the other fractions of the dollar in proportion. Coinage of the fractional parts of the dollar was reserved to the Government.

The act of February 12, 1873, provided that the unit of value of the United States should be the gold dollar of the standard weight of 25.8 grains and that there should be coined besides the following gold coins: A quarter eagle (2½-dollar piece), a 3-dollar piece, a half eagle (5-dollar piece), an eagle (10-dollar piece), and a double eagle (20-dollar piece) all of standard weight proportional to that of the dollar piece. These coins were made legal tender in all payments at their nominal value when not below the standard weight and limit of tolerance provided in the act for the single piece, and when reduced in weight they should be legal tender at a valuation in proportion to their actual weight. The silver coins provided for by the act were a trade dollar, a half dollar (50-cent piece), a quarter dollar, and a 10-cent piece, the weight of the trade dollar to be 420 grains troy, the half dollar 12½ grams, and the quarter dollar and the dime, respectively, one half and one fifth of the weight of the half dollar. The silver coins were made legal tender at their nominal value for any amount not exceeding $5 in any one payment. The charge for converting standard gold bullion into coin was fixed at one fifth of 1 percent. Owners of silver bullion were allowed to deposit it at any mint of the United States to be formed into bars or into trade dollars, and no deposit of silver for other coinage was to be received.

Section II of the joint resolution of July 22, 1876, recited that the trade dollar should not thereafter be legal tender and that the Secretary of the Treasury should be authorized to limit its coinage to an amount sufficient to meet the export demand. The act of March 3, 1887, retired the trade dollar and prohibited its coinage; that of September 26, 1890, discontinued the coinage of the 1- and 3-dollar gold pieces.

The act of February 28, 1878, directed coinage of dollars of the weight of 412½ grains troy, standard silver, as provided in the act of January 18, 1837, and that such coins, with all silver coins theretofore coined, should be legal tender at their nominal value for all debts and dues, public and private, except where otherwise expressly stipulated in the contract.

The Secretary of the Treasury was authorized and directed by the first section of the act to purchase from time to time silver bullion at the market price thereof, not less than $2,000,000 worth nor more than $4,000,000 worth per month, and to cause the same to be coined monthly, as fast as purchased, into such dollars. A subsequent act, that of July 14, 1890, directed the Secretary of the Treasury to purchase silver bullion aggregating 4,500,000 ounces, or so much thereof as might be offered, each month at the market price thereof, not to exceed $1 for 371.25 grains of pure silver, and to issue in payment thereof Treasury notes of the United States, such notes to be redeemable by the Government on demand, in coin, and to be legal tender in payment of all debts, public and private, except where otherwise expressly stipulated in the contract. The act directed the Secretary of the Treasury to coin each month 2,000,000 ounces of the silver bullion purchased under the provisions of the act into standard silver dollars until July 1, 1891, and thereafter as much as might be necessary to provide for the redemption of the Treasury notes issued under the act. The purchasing clause of the act of July 14, 1890, was repealed by the act of November 1, 1893.

The act of June 9, 1879, made the subsidiary silver coins of the United States legal tender to the limit of $10. The minor coins are legal tender to the limit of 25 cents.

Weight, fineness, and value of the coins of the United States

Denomination	Weight (grains)	Fineness (thousandths)	Fine weight (grains)	Value
Gold				
Double eagle ($20)	516.0000	900	464.4000	$20.00
Eagle ($10)	258.0000	900	232.2000	10.00
Half eagle ($5)	129.0000	900	116.1000	5.00
Quarter eagle ($2.50) [1]	64.5000	900	58.0500	2.50
One dollar [2]	25.8000	900	23.2200	1.00
Silver				
Dollar	412.5000	900	371.2500	1.00
Half dollar	192.9000	900	173.6100	.50
Quarter dollar	96.4500	900	86.8050	.25
Dime	38.5800	900	34.7220	.10

[1] Discontinued by act of Apr. 11, 1930.
[2] Discontinued by act of Sept. 26, 1890.

CONSUMPTION

Manufactures and the arts.—The Director of the United States Mint, in his annual report for the year ended June 30, 1932, reports that gold consumption in the industrial arts in the United States during the calendar year 1931 is estimated at $29,157,865, of which $5,930,780 was new material. Silver used in the arts is estimated at 33,682,119 fine ounces, of which 24,335,838 fine ounces were new material. Compared with 1930 silver consumption was about 2,700,000 ounces less and gold consumption about $13,500,000 less. He gives the world industrial consumption of gold as $102,252,548 in 1930 and $61,204,553 in 1931; silver, 91,394,431 ounces in 1930 and 70,138,945 ounces in 1931.

UNITED STATES MINING OPERATIONS

The following table shows the production of gold and silver in 1931 and 1932 in the United States and Territories, by regions, with actual and relative increases and decreases. It is noted that the gold production of the Western States and Alaska in 1932 increased only 2.99 percent over that in 1931.

Mine production of gold and silver in the United States, by regions, 1931–32, and percent increase and decrease

[Compiled by Chas. W. Henderson]

State or Territory	Gold				Silver			
	1931	1932 [1]	Increase (+) or decrease (−)	Percent	1931 (fine ounces)	1932 (fine ounces) [1]	Increase (+) or decrease (−) (fine ounces)	Percent
Western States and Alaska:								
Alaska	$9,507,000	$9,539,000	+$32,000	+0.03	352,000	257,000	−95,000	−26.99
Arizona	2,608,495	1,319,690	−1,288,805	−49.41	3,245,311	2,057,000	−1,188,311	−36.62
California	10,814,162	11,774,677	+960,515	+8.88	867,818	486,000	−381,818	−44.00
Colorado	4,822,734	6,493,377	+1,670,643	+34.64	2,195,914	1,703,378	−492,536	−22.43
Idaho	379,563	936,434	+556,871	+146.71	7,220,923	6,700,000	−520,923	−7.21
Montana	829,192	823,773	−5,419	−.65	3,829,837	1,671,000	−2,158,837	−56.37
Nevada	2,941,473	2,695,607	−245,866	−8.36	2,562,071	1,390,100	−1,171,971	−45.74
New Mexico	644,160	494,669	−149,491	−23.21	1,041,859	1,190,451	+148,592	+14.26
Oregon	317,315	434,109	+116,794	+36.81	7,254	9,000	+1,746	+24.07
South Dakota	8,931,791	9,929,297	+997,506	+11.17	113,562	126,199	+12,637	+11.13
Texas		180	+180			1,421	+1,421	
Utah	4,108,323	2,797,726	−1,310,597	−31.90	8,290,966	6,939,545	−1,351,421	−16.30
Washington	60,035	97,158	+37,123	+61.84	22,410	17,500	−4,910	−21.91
Wyoming	1,165	5,129	+3,964	+340.26	17	195	+178	+1,047.06
Total	45,965,408	47,340,826	+1,375,418	+2.99	29,749,942	22,548,789	−7,201,153	−24.21
Eastern States:								
Alabama	407	1,423			3	10		
Georgia	1,827	5,760			12	30		
North Carolina	7,598	7,591			20,333	10,045		
Pennsylvania	5,200	1,660			2,600	830		
South Carolina	470	1,468			1	5		
Tennessee	8,325	3,315			41,000	19,300		
Virginia		637				8		
Total	23,827	21,854	−1,973	−8.28	63,949	30,228	−33,721	−52.73
Central States:								
Illinois					1,300	257		
Michigan					1,437	71,408		
Missouri					40,000	1,128		
Total					42,737	72,793	+30,056	+70.33
Philippine Islands	3,765,100	4,748,900	+983,800		110,008	149,131	+39,123	
Puerto Rico		2,200	+2,200			12	+12	
Total	3,765,100	4,751,100	+986,000	+26.19	110,008	149,143	+39,135	+35.57
Grand total	49,754,335	52,113,780	+2,359,445	+4.74	29,966,636	22,800,953	−7,165,683	−23.91

[1] Subject to revision.

Considering the heavy decrease in gold from copper ores it is remarkable that gold production made even this slight advance, and there would have been none but for the fortuitous increase from certain mines under development for many years in Alaska, California, Colorado, and South Dakota. The output of gold in the United States for 1933 will probably show a decrease compared with 1932. Silver production in the Western States and Alaska fell 24 percent compared with 1931. As with gold, the output for 1933 will probably be less than that of 1932. The following table shows the source of gold and silver from 1922 to 1931.

Gold produced in the United States, by percent of sources, as reported by mines, 1922 to 1931, and total fine ounces [1]

Year	Placers (percent)	Dry and siliceous ore (percent)	Copper ore (percent)	Lead ore (percent)	Zinc ore (percent)	Copper-lead and copper-lead-zinc ores (percent)	Lead-zinc ore (percent)	Total: Fine ounces	Total: Percent
1922	23.46	68.06	5.71	1.54	0.12	0.11	1.00	2,293,251	100.00
1923	22.95	62.79	11.30	1.58	.14	.16	1.08	2,404,913	100.00
1924	18.44	65.56	12.70	1.63	.01	.08	1.58	2,444,331	100.00
1925	18.91	61.30	15.08	2.18	.02	.24	2.27	2,307,374	100.00
1926	20.50	58.03	16.36	2.05	.05	.15	2.86	2,232,526	100.00
1927	21.42	55.17	17.45	1.97	.07	.12	3.80	2,107,032	100.00
1928	19.41	55.67	19.31	1.67	.01	.32	3.61	2,148,064	100.00
1929	19.83	52.17	22.24	1.81	.06	.19	3.70	2,058,993	100.00
1930	20.59	59.27	15.57	1.24	.02	.15	3.16	2,138,724	100.00
1931	20.36	66.16	9.65	.79	--------	.05	2.99	2,224,729	100.00

[1] Philippine Islands and Puerto Rico excluded.

Silver produced in the United States, by percentage of sources, as reported by mines, 1922 to 1931, and total fine ounces [1]

Year	Placers (percent)	Dry and siliceous ore (percent)	Copper ore (percent)	Lead ore (percent)	Zinc ore (percent)	Copper-lead and copper-lead-zinc ores (percent)	Lead-zinc ore (percent)	Total: Fine ounces	Total: Percent
1922	0.10	46.78	16.95	27.38	2.74	1.09	4.96	61,207,989	100.00
1923	.08	39.28	20.87	28.62	3.09	1.92	6.14	70,355,674	100.00
1924	.08	31.82	25.50	29.43	.04	1.86	11.27	64,070,744	100.00
1925	.08	25.63	27.06	28.15	.27	1.45	17.36	66,710,080	100.00
1926	.08	21.71	27.27	24.85	.50	2.27	23.32	62,487,219	100.00
1927	.08	19.75	24.41	26.44	2.83	3.64	22.85	59,625,682	100.00
1928	.08	19.25	25.46	23.18	.20	3.82	28.01	57,872,443	100.00
1929	.07	18.25	29.49	19.23	2.59	4.66	25.71	60,860,011	100.00
1930	.09	18.32	28.53	18.40	.94	6.39	27.33	47,724,903	100.00
1931	.15	14.63	32.07	20.48	.02	9.35	23.30	29,856,628	100.00

[1] Philippine Islands and Puerto Rico excluded.

Alaska.—According to the United States Geological Survey, in 1931 lode mines in Alaska produced $4,665,000 and placer mines $4,842,000 in gold, a total of $9,507,000. Preliminary estimates for 1932 show a total of $9,539,000; $5,312,000 was from placers and $4,227,000 from lodes. About 81 per cent of the placer gold in 1932 was recovered by dredges, chiefly the 5 modern dredges of the Fairbanks Exploration Co. in the Yukon district and the 3 modern dredges of the Hammon Consolidated Gold Fields at Nome. Including these 8 dredges, 24 were operating in Alaska in 1932. By far the largest producing gold-lode mine in Alaska is that of the Alaska Juneau Gold Mining Co. near Juneau. From 1893 to 1931 this company mined 40,524,348 tons averaging $0.95 per ton in gold content. Of this tonnage, 19,545,397 tons averaging $0.20 in gold content were rejected on picking belts, and 20,978,951 tons were milled, with an average gold recovery of $1.37 per ton and a loss in tailing of $0.29 per ton. In 1932 the company produced $3,133,122 in gold and 94,519 ounces of silver.

Silver production in Alaska is insignificant. Its principal source has been the copper ores of the Kennecott Copper Co. and adjoining properties in the Copper River district. In 1931 the total copper from Alaska was estimated at 22,614,000 pounds and silver in copper ores as 193,850 ounces, silver in gold ores as 129,800 ounces, and silver from gold placers as 28,350 ounces. The total silver output in 1931 was 352,000 ounces. In 1932 the total production of silver was 257,000 ounces and of copper 8,700,000 pounds.

Arizona.—Arizona in 1932 produced $1,319,690 in gold compared with $2,608,495 in 1931, $3,501,610 in 1930, and $4,182,287 in 1929. Copper ores yielded 89 percent of the gold in Arizona in 1929, 78 percent in 1930, and 64 percent in 1931. Copper ores yielded 87, 90, and 89 percent, respectively, of the silver of Arizona in 1929, 1930, and 1931. As an index of the decrease in gold and silver output in 1932, copper production was, respectively 415,314 tons in 1929, 288,095 tons in 1930, 200,672 tons in 1931; and 91,944 tons in 1932. There was also a large decrease in output of gold in 1932 from the Tom Reed and other gold mines near Oatman, Mohave County.

The Old Dominion mine, a large producer of copper ore for the last 40 years, was closed October 14, 1931. After the Phelps Dodge Corporation absorbed the smelting and mining assets of the Calumet and Arizona Mining Co. on October 1, 1931, the Copper Queen smelter (4 reverberatory furnaces, 883,000 tons full annual capacity) at Douglas was closed, and in 1932 the Phelps Dodge Corporation operated the adjoining smelter (4 reverberatory furnaces, 900,000 tons full annual capacity) formerly used by the Calumet and Arizona Mining Co. The Phelps Dodge Corporation closed its New Cornelia branch (15,000 tons daily) in April 1932 and its Morenci branch (flotation concentrator, 5,500 tons daily capacity, and smelter, 500 tons daily capacity) in July, leaving only the Bisbee division in active operation. The Miami Copper Co. closed its mine and mill at Miami on May 16, and the Inspiration Copper Co. closed its mine, leaching plants, and concentrator on May 9. The closing of these mines and plants resulted in the closing in June 1932 of the copper smelter (4 reverberatory furnaces, 725,000 tons full annual capacity) of the International Smelting Co. at Miami. The mine and the mill (12,000 tons daily capacity) of the Ray branch of the Nevada Consolidated Copper Co. were operated at greatly reduced rate in 1932; the Hayden copper smelter (3 reverberatory furnaces, full capacity 550,000 tons annually) was operated intermittently on concentrates from the Nevada Consolidated mill at Hayden and on crude ore and concentrates from various other operations. The mine, mill, and smelter (1 reverberatory furnace, 250,000 tons full annual capacity) of the Magma Copper Co. at Superior, Pinal County, were closed in June 1932. The smelter (6 reverberatory furnaces, 1,000,000 tons full annual capacity) of the United Verde Copper Co. at Clarkdale remained idle throughout the year. The United Verde Extension Mining Co. operated its mine at Jerome and its smelter (1 blast furnace, 180,000 tons full annual capacity and 2 reverberatories, 360,000 tons annual capacity) at Clemenceau throughout the year at an increased capacity over 1931. Only 3 of the 9 copper smelters in Arizona were active at the end of the year. Official announcement of its operating schedule for the rest of 1933 was made by Phelps Dodge Corporation on May 1, 1933, through its general manager, P. G. Beckett. The program calls for operation of its mines at Bisbee 12 days each month and a complete shut-down of the smelter at Douglas from June 1 to early in September. The Bisbee mines have been operating on a 15-day schedule for several months, and the smelter has operated continuously so far this year. With the opening of the smelter in September it is planned to run full time until about the Christmas holidays.

California.—The production of gold in California in 1932 ($11,774,677) constituted 98 percent of the calculated gross value of recovered metals from that State (gold, silver, copper, and lead). The increase ($960,515) of gold production in 1932 over 1931 was 8.88 percent. The greater part of the gold produced in California in 1932 was from old-established lode mines, such as the Empire-North Star and Idaho Maryland in Nevada County; the Original Sixteen to One and the Kate Hardy in Sierra County; the Argonaut, Central Eureka, and Kennedy in Amador County; and the Yellow Aster in Kern County. Twenty-two bucket dredges in 1932 in Amador, Butte, Calaveras, Merced, Sacramento, Shasta, Stanislaus, Trinity, and Yuba Counties produced 188,730 ounces of gold valued at $3,901,395 from 48,851,063 cubic yards of gravel, with an average recovery of 8 cents a cubic yard in gold. In 1931 the bucket-dredge gold production was $3,819,355 from 22 dredges handling 44,423,652 cubic yards of gravel. Another dredge was added to the Folsom field by the Gold Hill Dredging Co., which moved its 9-cubic-foot dredge from Dayton, Nev., for operation on the American River. The Cal-Oro Dredging Co. completed its dredge boat, which began digging early in 1933 on gravel south of Yuka, Siskiyou County. The gold output obtained from drift placers in California in 1932 was nominal. Since the beginning of floating bucket dredging in the Oroville district, $174,526,417 in gold has been produced. Of this total output of the State, the Feather River field is credited with $33,621,406, the Yuba River field with $67,049,597, and the American River field with $44,793,178. The California Debris Commission (since 1884, an organization to regulate hydraulic mining after the farming interests won their suit to prevent debris from being dumped into the rivers) in 1932 granted 44 hydraulic placer mines permission to operate; 1,062 applications for licenses are pending. Small-scale mining, taken up in 1931 in the form of panning and rocking by the unemployed in all western mining States, was more successful in 1932 in California than in any other State. Ninety-four bullion buyers in California, including banks, merchants, and private refiners, all licensed by the State mineralogist of California to purchase gold, in 1932 sold to the San Francisco Mint and other refiners 23,870 fine ounces, or $493,437, in new gold. This total compares with $162,000 in gold purchased by bullion buyers in 1931. Their reports indicate that 12,000 (out of a probable 30,000 individuals) produced 30,880 lots of new gold consisting of gold dust, nuggets, and amalgam ranging in value from

9 cents to as much as $100. The average amount received by these 12,000 amateur prospectors for their labors during the season or year was $41.12.

Colorado.—Colorado in 1932 yielded $6,493,377 in terms of recovered and recoverable gold compared with $4,822,734 in 1931, an increase of 35 percent. The Cripple Creek district in 1932 produced $2,260,507 compared with $2,385,769 in 1931. Cripple Creek ores—all sulphotelluride—were treated at the Golden Cycle 1,200-ton roast-amalgamation-cyanidation custom mill at Colorado Springs. The main part of the mill was operated at 800 to 900 tons daily. In addition, part of the 300-ton selective flotation mill, added to Golden Cycle equipment in November 1929, was used intermittently to treat gold-silver sulphide ores from Boulder, Clear Creek, Gilpin, Lake, and Park Counties (chiefly gold-[silver-lead] ores from Park County from September 10 to the end of the year), the tails from the flotation machines going direct into the cyanide circuit or to the roasters to burn the carbon from the Park County ores. Park County gold production (recoverable) increased from $871,789 in 1931 to $2,599,412 (making it the first county in gold production) as a result of greatly increased shipments from the American, London, and London Extension. These gold-silver-lead ores were shipped both to the A.V. smelter at Leadville and to the Golden Cycle mill. The third gold-producing county was San Juan—$511,092—from the output of copper-lead-silver-gold concentrates from the Shenandoah-Dives 600-ton flotation mill, treating ore from the Shenandoah-Dives Mining Co. Mayflower-North Star claims. Gilpin County was fourth with $323,252 from the Chain-O'-Mines, Perigo, and Saratoga. Lessees on the famous Camp Bird mine produced the bulk of the $256,693 credited to Ouray County. Lessees on the Ibex, Venir, and Tribune produced the bulk of the $129,312 credited to Lake County. The Little Mattie and Lincoln mines at Idaho Springs contributed the bulk of the $119,876 credited to Clear Creek County. Boulder County yielded $86,289, San Miguel County $65,705, Eagle County $61,411, and Summit County $32,856.

Silver production was 1,703,378 ounces compared with 2,195,914 ounces in 1931. The largest producing county was Eagle, with 1,110,819 ounces, mainly from iron-copper-silver fluxing ores shipped to Utah smelters and to the Leadville smelter. The next largest county was San Juan, with 339,965 ounces, chiefly in concentrates from the Shenandoah-Dives mill. Silver production in other counties was mainly a byproduct of gold ores, except 45,965 ounces from lead-silver concentrates from Aspen, Pitkin County.

Idaho.—Idaho, never a large producer of gold, increased its output of gold from $379,563 in 1931 to $936,434 in 1932. This increase came from both lode and placer mines. The new 200-ton amalgamation and flotation mill built at the Boise-Rochester-Atlanta group at Atlanta by the St. Joseph Lead Co., after several years of underground development, was placed in operation early in 1932, and its gold-bullion and concentrate shipments made it the largest producer of gold in Idaho with 42 percent of the State output. Another comparatively new company—the Yellow Pine, at Yellow Pine, Valley County—started its new 150-ton flotation mill in January 1932, and its yearly output made it the third largest producer of gold in the State. The new bucket dredge of the Idaho Gold Dredging Co.

at Warren increased its output of gold in 1932 and became the second producer of gold in the State. A new bucket dredge was constructed and installed on Warren Creek by the Warren Creek Dredging Co., the old Bailey bucket dredge on Rhodes Creek near Pierce was reconditioned and operated by the New York-Idaho Dredging Corporation, and the dredge in Owyhee County operated in 1931 by the American Gold Dredging Co. was worked under lease by the Superior Leasing Co. These four dredges yielded $170,000 in 1932 compared with $80,352 produced by four dredges in the State in 1931. The Idaho Gold Dredging Corporation, a large producer of gold since 1926, produced no gold in 1932. The Idawa Gold Mining Co., also a large producer of gold since 1926, produced no gold in 1932.

Silver production in Idaho in 1932 was 6,700,000 ounces compared with 7,220,923 ounces in 1931, a decrease for 1932 of only 520,923 ounces. Idaho remained the second largest producer of silver in the United States, following Utah as it did in 1930 and in 1931. The Coeur d'Alene district produced at least 6,500,000 ounces of silver. Of this, 45 percent came from the Sunshine (Yankee Boy) mine on Big Creek east of Kellogg. Most of the remainder came from the Bunker Hill & Sullivan, Hecla, Morning, and Crescent mines, also in the Coeur d'Alene district. The Sunshine property was not only the largest silver producer in Idaho but also in the United States in 1932. Its 500-ton flotation plant was operated steadily, and the output was 550,000 ounces greater than in 1931. Large increases in output were also made in the output of silver from the Crescent on the west side of Big Creek and from the Golconda mines east of Wallace, but decreased operations caused large declines from the output of the Morning, Hecla, Bunker Hill & Sullivan, Hall-Interstate, Page, Blackhawk, Dayrock, and Sherman mines.

Montana.—Montana in 1932 yielded $823,773 in gold compared with $829,000 in 1931. Usually the gold and silver output of Montana depends on the output of copper ore from the mines at Butte. In 1931 the value of metals recovered from copper material accounted for nearly 93 percent of the total value of the metal output of the State. In 1932, despite heavy decreases in copper ore output, the gold output of the State suffered only a small decrease because the Jardine mine at Jardine, Park County, a large producer of gold from 1918 to 1926, was again active in September 1932, and produced $28,000 in gold during the last quarter of the year from its 200-ton amalgamation-concentration mill. Also, the I. B. Mining Co., which started work at the Sleeping Princess group near Bannack, Beaverhead County, in March 1931, continued operation throughout 1932 of its 100-ton cyanide plant, and the Liberty Montana Mines Co., working its 150-ton flotation concentrator at only one third capacity, doubled its gold output in gold-copper concentrates and became the largest producer of gold in Montana. The Ohio-Keating group near Radersburg, Broadwater County, sold gold bullion valued at about $64,000 from its 100-ton cyanidation plant from the treatment of 15,000 tons of iron oxide gold ore up to September 10, when operations ceased. This property became the third producer of gold in the State. Other gold producers were the old Gold Coin mine near Southern Cross, Deer Lodge County; the August mine near Landusky, Phillips County; the Butte-Highlands 15 miles south of Butte in Silver Bow County; and the old Drumlummon property at Marysville, Lewis and Clark County.

The quantity of silver produced in Montana in 1932 decreased 56 percent from the 1931 output due almost entirely to curtailment in the output of copper ore from the properties of the Anaconda Copper Co. at Butte. The output of copper in Montana in terms of recovered metal was 184,555,735 pounds in 1931 and 84,717,000 pounds in 1932. In 1929 the copper production was 297,725,973 pounds.

Nevada.—Nevada mines yielded $2,695,607 in gold in 1932 compared with $2,941,473 in 1931. The decrease in mining activity in all parts of Nevada in 1932 affected the production of gold as well as that of other metals, but gold constituted 52 percent of the calculated total gross value of metals for the year. In the Robinson district, White Pine County, where much gold has heretofore been recovered from copper ores, a substantial decrease was recorded because of the drop in production of copper ores, but in the Goldfield district, Esmeralda County, the output of gold exceeded that of 1931. The mines of the Tonopah district produced about the same amount of gold as in 1931. The leading gold-producing companies in 1932 were the Elkoro Mines Co. at Jarbidge (which, however, exhausted all known ore in September), the Bradshaw, Inc., at Goldfield, the Nevada Consolidated Copper Co. at Ely, and the Gold Hill Development Co. (where also all available ore was virtually exhausted at the end of the year) and the Nevada Porphyry Gold Mines Co. at Round Mountain.

Silver production was 1,390,100 ounces compared with 2,562,071 ounces in 1931. The Tonopah district produced about 591,300 ounces compared with 823,872 ounces in 1931. Lessees continued to work in the properties of the Tonopah Mining, Tonopah Belmont, and Tonopah Extension mines and cleaned up all available ore and material in the mines and milling plants of these companies. The Tonopah Mining Co. "Desert" custom-cyanidation plant at Millers closed in May 1932 after 25 years' operation, and the work of dismantling the mill was well under way in October. Other important silver producers were the Nevada Consolidated Copper Co. at Ely, the Gold Hill Development Co. at Round Mountain, and the Ely Revenue at Ely. The mine production of copper and lead, both indexes of silver output, were: Copper, 31,473,600 pounds in 1932 compared with 72,634,497 in 1931; lead, 1,195,200 in 1932 compared with 15,860,634 in 1931.

New Mexico.—New Mexico in 1932 yielded $494,669 in gold compared with $644,160 in 1931. Zinc-lead-copper-silver-gold ore from the Pecos mine (operated 365 days at 538 tons a day) in San Miguel County and copper concentrates from the Chino mines (mined 6,474 tons for 180 days) at Santa Rita, and siliceous copper-gold-silver ore from Lordsburg (greatly reduced in tonnage owing to closing of Eighty-Five mine shortly after January 1, 1932) yielded the bulk of the gold ore from New Mexico in 1932. There was also some gold produced at Mogollon and at Bland. Silver production in New Mexico in 1932 was 1,190,451 ounces compared with 1,042,000 in 1931. The lead-copper-silver concentrates of the Pecos and Black Hawk flotation mills, treating complex zinc-lead-copper ores, yielded the bulk of the silver, but there was also silver production from Mogollon and Bland.

Oregon.—Oregon increased its gold output from $317,315 in 1931 to $434,109 in 1932. Silver production was nominal for both years.

Gold mining was confined chiefly to placers, including bucket dredges, hydraulicking, power shovels, rocking, and panning. Only a few lode mines were productive. The three bucket dredges operating in Baker, Grant, and Jackson Counties produced about 36 percent of the total gold, and their combined output increased about $20,000 over 1931. Gold produced from placers and lode mines in eastern Oregon was handled chiefly by banks in Baker and Grant Counties; about $58,000 was shipped to the San Francisco Mint, to the Boise assay office, and to private refiners. In western Oregon the principal banks of Grants Pass, Medford, and Ashland, including the purchases of a few merchants, handled $128,349 in new gold, mostly in small lots ranging from 10 cents to several dollars a lot. This new gold was purchased from 1,016 individuals representing prospectors and small working parties who averaged $126.32 during the year or season, chiefly from placer ground in Josephine and Jackson Counties.

South Dakota.—South Dakota in 1932 produced $9,929,297 in gold compared with $8,931,791 in 1931. Placer gold in South Dakota totaled 1,148.14 fine ounces, chiefly from the Grand Hills Mining Co. gasoline-power shovel-Ainlay bowl installation on French Creek, Custer County. Other placer production was from a gasoline shovel and sluicing at Tinton, Lawrence County, and small-scale placers on Battle, Bear, Castle, French, Spring, and Whitewood Creeks. Nearly all the remainder was from the Homestake mine at Lead, the largest gold-producing mine in the United States. The Homestake mine was operated continuously in 1932. The company report showed 1,401,593 tons mined; the proceeds (revenue) from gold-silver bullion by amalgamation followed by cyanidation of sands and slimes were $9,911,858; the dividends paid were $2,662,296. From 1876 to 1932, inclusive, this mine has produced bullion and concentrates for which $253,394,489 was received; dividends paid were $62,653,292. The output of South Dakota from 1875 to 1932, inclusive, has been $308,084,819 in gold and 8,009,825 ounces of silver.

Texas.—Texas mines produced only $180 in gold and 1,421 ounces of silver (none of either in 1931), but from 1884 to 1931, inclusive, the State output of these metals has been $95,073 in gold and 22,772,523 ounces of silver. Moreover, Texas has reserves of silver ore that can be worked when silver commands 60 cents an ounce.

Utah.—Utah in 1932 produced $2,797,726 in gold compared with $4,108,323 in 1931, with $4,309,148 in 1930, and with $4,969,915 in 1929. The gold production in 1932 decreased about 32 percent compared with 1931, owing chiefly to the curtailment in the copper ore output from Bingham and to the decrease in gold output from mines in the Tintic district. Unusually large decreases in the production of gold were apparent in the production of the Utah Copper, North Lily, Eureka Standard, Chief Consolidated, and United States Smelting, Refining & Mining Cos. There was a substantial increase in the output of the Yankee mine in the American Fork district and from mines near Gold Hill, Tooele County. Most of the gold produced in Utah is recovered from bullion from smelting copper and lead ore and concentrates in the smelters in the Salt Lake Valley or in Tooele County. The largest producers of gold in 1932 were the Eureka Standard in the Tintic district; the Utah Copper, United States Smelting, Refining & Mining Co., and the Niagara in the Bingham district; the Yankee in the American Fork district; the Utah-Delaware in the Bingham district; and the Mammoth in the Tintic district.

Silver production decreased from 8,290,966 ounces in 1931 to 6,939,545 ounces in 1932, or 16 percent. Utah has been the leading silver-producing State, and held its position in 1932, though only slightly ahead of Idaho. The increased output of silver by the Silver King Coalition and Park City Consolidated Cos. resulted in an increase of nearly 300,000 ounces in the output of silver from the Park City region, but the output from the Tintic district decreased about 900,000 ounces and the output from the Bingham district decreased nearly 600,000 ounces. The Silver King Coalition mine at Park City was the largest producer of silver in Utah in 1932, followed closely by the Tintic Standard property at Dividend in the Tintic district, which held first place in 1931. Other large silver producers were the United States Smelting Refining & Mining Co., Niagara, Park City Consolidated, Eureka Standard, Utah Copper, and Bluestone Lime & Quartzite Cos.

Copper production in Utah decreased from 151,236,505 pounds in 1931 to 65,113,000 pounds in 1932; lead decreased from 158,423,453 in 1931 to 123,149,500 pounds in 1932; and zinc decreased from 74,581,072 pounds in 1931 to 59,150,000 pounds in 1932.

Washington.—Washington increased its gold output from $60,035 in 1931 to $97,158 in 1932. The production of gold in 1932 came chiefly from the Boundary Red Mountain mine and the Azurite mine in Whatcom County and from various properties at Republic, Ferry County.

The output of silver in Washington decreased from 22,410 ounces in 1931 to 17,500 ounces in 1932. About 68 percent of the silver produced in 1932 came from the siliceous gold ore mined at Republic; most of the remainder was recovered from lead-zinc ore mined at Metaline Falls.

Wyoming.—Wyoming increased its gold production from $1,165 in 1931 to $5,129 in 1932. The bulk of the gold production in Wyoming in 1932 came from shipments of amalgamation and placer bullion from Atlantic City, Fremont County.

COPPER

By C. E. Julihn and H. M. Meyer

In 1932 the copper industry continued the decline begun in 1930 when the general disturbance of economic conditions throughout the rest of the world extended to the United States. Production, consumption, exports, imports, and price all were greatly reduced, while stocks continued to increase.

A tariff of 4 cents a pound was placed on imports to the United States effective June 21, 1932, but the domestic price of copper reached an unprecedented low, slightly under 5 cents, in December. The United Kingdom planned to reserve the British market for copper produced within the British Empire by imposing a tariff of 2 d. upon imports produced elsewhere. This tariff, however, has not been passed as yet. France likewise imposed a 4 percent ad valorem duty on copper from all countries except Belgium, to which a duty of 2 percent applies. This preference tends to reserve the French market for Katanga copper.

Copper Exporters, Inc., was disrupted by withdrawal of its foreign and some of its domestic members. Subsequent conferences for the purpose of reuniting the copper producers of the world were unsuccessful.

Great Britain is building a refinery for treatment of copper produced within the Empire.

These events signify a complete realinement in the world organization of the copper industry.

Prices.—Reports to the Bureau of Mines from copper-selling agencies in the United States indicate that 1,078,171,000 pounds of copper were delivered to domestic and foreign purchasers in 1932 at an average price of 6.3 cents per pound (2.8 cents per pound less than that in 1931 and 11.3 cents less than that in 1929). The average price indicated for the entire production for the 87 years, 1845–1931, inclusive, is 16.1 cents a pound and for the 30 years, 1902–31, inclusive, 16.3 cents a pound. The following table shows the monthly quotations for copper during the past 5 years as reported by the Engineering and Mining Journal and the American Metal Market Co. The 1932 averages are the lowest on record.

Average monthly prices at New York (refinery equivalent) per pound of electrolytic copper, 1928–32, in cents, as reported by the American Metal Market Co. and Engineering and Mining Journal

Month	American Metal Market Co.					Engineering and Mining Journal				
	1928	1929	1930	1931	1932	1928	1929	1930	1931	1932
January	13.96	16.72	17.87	9.90	7.21	13.854	16.603	17.775	9.838	7.060
February	13.97	17.92	17.87	9.83	6.12	13.823	17.727	17.775	9.724	5.965
March	13.98	21.26	17.87	10.02	5.87	13.845	21.257	17.775	9.854	5.763
April	14.10	19.80	15.74	9.57	5.66	13.986	19.500	15.621	9.392	5.565
May	14.31	17.87	12.83	8.81	5.38	14.203	17.775	12.756	8.665	5.237
June	14.62	17.87	12.24	8.18	5.26	14.527	17.775	12.049	8.025	5.145
July	14.62	17.87	11.15	7.80	5.16	14.527	17.775	11.023	7.698	5.053
August	14.62	17.87	10.79	7.40	5.31	14.526	17.775	10.693	7.292	5.219
September	14.83	17.91	10.45	7.13	6.08	14.724	17.775	10.310	6.988	5.978
October	15.31	17.87	9.70	6.89	5.85	15.202	17.775	9.597	6.775	5.733
November	15.90	17.87	10.25	6.67	5.18	15.778	17.775	10.113	6.558	5.131
December	15.94	17.87	10.49	6.72	4.91	15.844	17.775	10.300	6.580	4.813
Average	14.68	18.23	13.11	8.24	5.67	14.570	18.107	12.982	8.116	5.555

The following table shows world production and the salient domestic statistics on copper for the 5-year period, 1925–29, and for 1930, 1931, and 1932. Figure 2 shows similar details by years for the period 1910–32.

World production and salient domestic statistics of copper, 1925–32

[All tonnage figures in short tons]

	Average 1925–29	1930	1931	1932
WORLD PRODUCTION, new copper	1,761,491	1,737,241	1,518,983	[1] 990,000
Percent of 1925–29 average	100	98	86	56
UNITED STATES PRODUCTION:				
New copper—				
From domestic ores, as reported by—				
Mines	885,826	705,074	528,875	[2] 239,992
Ore produced:				
Copper ore	59,505,871	[3] 47,381,509	([4])	([4])
Average yield of copper, percent	1.44	1.43	([4])	([4])
Copper-lead and copper-lead-zinc ores	307,897	246,430	([4])	([4])
Smelters	892,730	697,195	521,356	272,005
Value of copper produced	$263,484,400	$181,271,000	$94,887,000	$34,273,000
Percent of 1925–29 average	100	69	36	13
Refineries	890,767	695,612	537,303	222,539
Percent of 1925–29 average	100	78	60	25
Percent of world production represented	50.6	40.0	35.4	22.5
Classification of product, percent:				
Electrolytic	89.8	88	88	84
Lake	9.8	10	10	12
Casting	0.4	2	2	4
From foreign ores, matte, etc., refinery reports	317,287	382,918	213,418	117,895
Percent of 1925–29 average	100	120	67	37
Total new refined, domestic and foreign	1,208,054	1,078,530	750,721	340,434
Percent of 1925–29 average	100	89	62	28
Percent of World production represented	68.6	62	49	34
Secondary copper recovered from old scrap only	347,512	342,200	261,300	180,900
Copper content of copper sulphate produced by refiners	4,601	4,710	4,492	3,173
Total production, new and old and domestic and foreign	1,560,167	1,425,440	1,016,513	524,507
Percent of 1925–29 average	100	91	65	34
IMPORTS (unmanufactured)	391,212	408,577	292,946	195,996
Refined	59,236	43,105	87,225	83,897
EXPORTS of metallic copper [5]	522,616	376,557	278,787	147,678
Refined (ingots, bars, rods, etc.)	482,868	334,626	232,114	125,029
STOCKS at end of year	307,200	532,500	636,300	691,000
Refined copper	86,100	307,500	462,300	502,000
Blister and materials in solution	221,100	225,000	174,000	189,000
WITHDRAWALS from total supply on domestic account:				
Total new copper	778,123	632,509	451,032	259,602
Percent of 1925–29 average	100	81	58	33
Total new and old copper	1,288,700	1,099,500	798,000	508,000
PRICE, average cents per pound	14.7	13.0	9.1	6.3

[1] Estimated.
[2] Subject to revision.
[3] Includes old tailings.
[4] Figures not yet available.
[5] 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.

PRODUCTION

Copper production usually occurs in three stages—mining, smelting, and refining—upon each of which an annual production record may be based. All three of these records are presented in this report to show the condition of the industry from different standpoints, but smelter

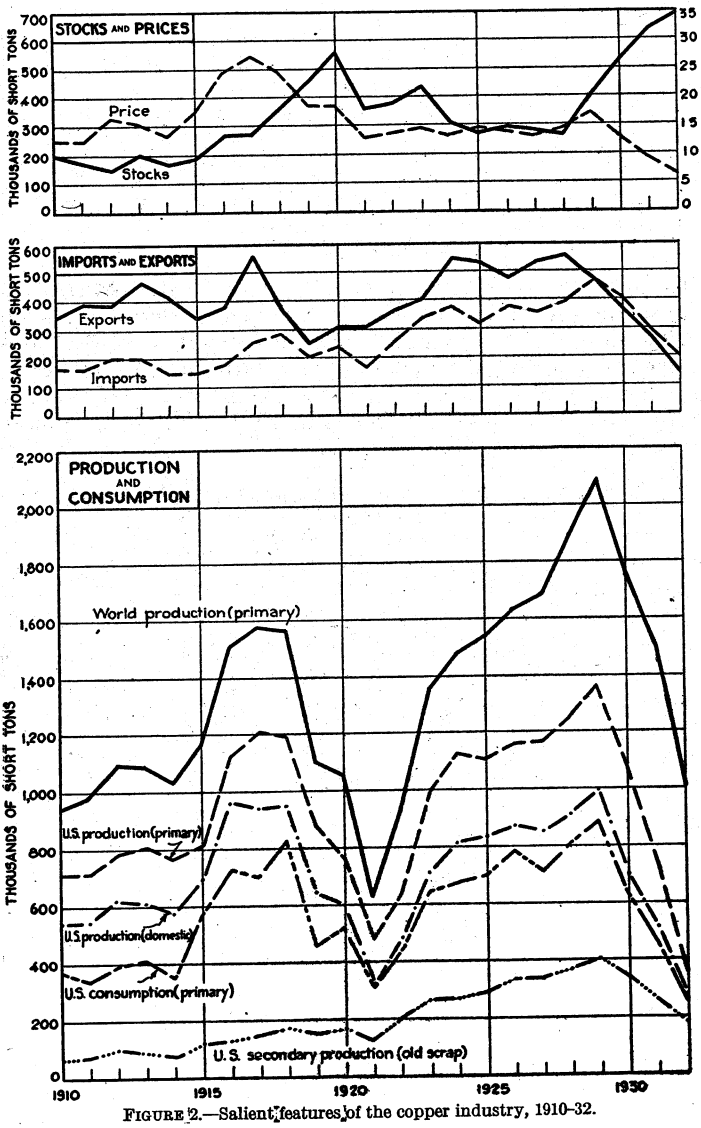

FIGURE 2.—Salient features of the copper industry, 1910–32.

production has been adopted as the official production of this country because it is more complete and less subject to error, yet indicates geographical distribution with reasonable accuracy. The significance of each of the three methods of recording copper production is discussed at length in the 1930 chapter, Mineral Resources of the United States.

In 1932 production of 479,983,000 pounds was reported by the mines of the United States, 544,009,948 pounds from domestic ores by the smelters, and 445,077,874 pounds from domestic ores by the refineries.

Copper produced from domestic ores, as reported by mines, smelters, and refineries, 1928–32, in pounds

Year	Mine	Smelter	Refinery
1928	1,809,796,907	1,825,900,393	1,791,797,387
1929	1,995,110,398	2,002,863,135	1,982,732,289
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	[1] 479,983,000	544,009,948	445,077,874

[1] Subject to revision.

PRIMARY COPPER

Smelter production.—The copper output of United States smelters from domestic ores in 1932 was 544,009,948 pounds, a decline of 498,701,230 pounds (48 percent) from the output in 1931. This production was 27 percent of world copper production, a marked decline from an average of 51 percent during the period 1925–29, from 40 percent in 1930, and from 34 percent in 1931. The origin of smelter production by States is shown below.

Copper produced in the United States from domestic ores, 1928–32

[Smelter output, in pounds fine]

State	1928	1929	1930	1931	1932
Alaska	40,541,968	39,867,940	36,380,038	23,233,034	13,297,443
Arizona	735,632,406	829,206,475	570,897,080	400,310,634	201,136,276
California	24,707,992	33,084,232	26,262,447	8,344,901	5,514,045
Colorado	10,262,083	10,519,784	12,943,857	9,028,517	8,976,169
Idaho	2,336,654	6,267,487	2,713,681	1,626,541	662,957
Michigan	179,104,311	185,300,917	142,985,522	105,222,177	63,898,656
Missouri	930	1,880	2,198	----------	----------
Montana	251,046,415	299,894,853	198,795,883	173,910,101	97,918,141
Nevada	159,332,977	138,990,247	87,475,019	71,233,352	32,616,050
New Mexico	92,777,233	100,165,206	74,187,966	66,776,267	32,914,883
North Carolina	8,207,000	(1)	(1)	(1)	(1)
Oregon	375,049	739,151	229,753	9,332	36,890
Pennsylvania	5,013,868	3,581,393	3,061,174	843,956	(1)
Tennessee	16,374,261	(1)	(1)	(1)	(1)
Texas	432,968	393,740	165,731	514	8,588
Utah	298,375,465	325,965,289	205,769,698	161,023,199	76,402,502
Vermont	----------	752,200	(1)	----------	----------
Washington	1,197,340	1,569,260	1,404,893	71,426	2,521
Wyoming	2,575	4,305	29,356	9,545	607
Undistributed	178,898	26,558,776	31,085,031	21,067,682	10,624,220
	1,825,900,393	2,002,863,135	1,394,389,327	1,042,711,178	544,009,948

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

The figures for smelter production in 1932 are based on confidential returns from all smelting companies 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 copper represent the fine-copper content. Some casting and electrolytic copper is produced direct from ore or matte, and this is included in the smelter production. Metallic and cement copper recovered by leaching also is included in smelter production. The following list names the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material produced in the United States during 1932. The list does not include lead and zinc plants that recovered copper as a byproduct from mixed ores.

Copper-reduction plants that treated materials from the United States in 1932

Location	Company	Final copper product
Arizona:		
Clemenceau	United Verde Extension Mining Co	Blister.
Clifton	Phelps Dodge Corporation	Blister and casting.
Douglas	do	Blister
Hayden	American Smelting & Refining Co	Do.
Inspiration	Inspiration Consolidated Copper Co	Electrolytic.
Miami	International Smelting Co	Blister.
Superior	Magma Copper Co	Do.
Maryland: Baltimore	American Smelting & Refining Co	Electrolytic and casting.
Michigan:		
Hancock	Quincy Mining Co	Lake.
Houghton	Michigan Smelting Co	Do.
Hubbell	Calumet & Hecla Consolidated Copper Co	Do.
Montana:		
Anaconda	Anaconda Copper Mining Co	Blister.
Great Falls	do	Electrolytic.
Nevada: McGill	Nevada Consolidated Copper Co	Blister.
New Jersey:		
Chrome	United States Metals Refining Co	Blister and electrolytic.
Maurer	American Smelting & Refining Co	Do.
Perth Amboy	Raritan Copper Works	Electrolytic.
New York: Laurel Hill	Nichols Copper Co	Blister and electrolytic.
Tennessee: Copperhill	Tennessee Copper Co	Blister.
Texas: El Paso	American Smelting & Refining Co	Do.
Utah:		
Garfield	do	Do.
International	International Smelting Co	Do.
Washington: Tacoma	American Smelting & Refining Co	Blister, electrolytic, and casting.

The precise quantity in pounds and the value of copper produced by smelters in the United States are shown by years for 1845–1930 in the Copper chapter for 1930, Mineral Resources of the United States. The data are summarized for comparison with those of 1931 and 1932 in the following table:

Copper produced (smelter output) in the United States, 1845–1932

[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
1845-1932	23,017,799	261,566	7,342,457,000

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 1930 chapter, Mineral Resources of the United States.

Mine production, although less reliable for determining total production of the country, 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 1932 was 479,983,000 pounds, a decline of 55 percent from that in 1931 and of 73 percent from the average for the period 1925–29.

Production by States and districts.—The following tables show mine and smelter production by States for 1931 and 1932 and mine production by districts 1927–31. In 1932 Arizona, Montana, Utah, and Michigan led in production with 81 percent of the smelter output. If the production of New Mexico and Nevada is added to the output of these States, 93 per cent of the output of the country is represented. Among the copper-producing districts Butte ranked first in 1931, Bingham second, Globe-Miami third, and Lake Superior fourth.

From 1845 through 1932 Arizona, Montana, Michigan, and Utah, in the order named, were the principal producers, contributing 85 percent of the total output. Butte, Lake Superior, Bingham, and Bisbee, in the order named, were the principal districts.

Copper produced in the United States, according to smelter and mine returns, by States, 1931, 1932, and 1845–1932, in short tons

	1931		1932			1845–1932	
	Smelter returns	Mine returns	Smelter returns		Mine returns [1]	Smelter output	
			Percent of total	Quantity		Total quantity	Percent of total
Alaska	11,617	11,307	2.44	6,649	4,350	615,253	2.67
Arizona	200,155	200,672	36.97	100,568	91,944	7,543,657	32.77
California	4,172	6,466	1.01	2,757	552	547,102	2.38
Colorado	4,514	4,083	1.65	4,488	3,616	185,151	.80
Idaho	813	572	.12	332	548	72,251	.31
Michigan	52,611	59,030	11.75	31,949	27,198	4,275,702	18.58
Montana	86,955	92,278	18.00	48,959	42,359	5,237,531	22.76
Nevada	35,617	36,317	6.00	16,308	15,667	956,405	4.16
New Mexico	33,388	30,752	6.05	16,458	15,352	743,448	3.23
North Carolina	(2)	(2)	(2)	(2)	(2)	(3)	(3)
Oregon	5	1	.01	18	15	10,328	.04
Pennsylvania	422	(2)	(2)	(2)	(2)	(3)	(3)
Tennessee	(2)	(2)	(2)	(2)	(2)	[4] 259,508	[4] 1.13
Texas	----------	----------	----------	4	----------	(3)	(3)
Utah	80,512	75,618	14.05	38,201	32,953	2,396,250	10.41
Washington	36	101	----------	1	2	14,208	.06
Wyoming	5	5	----------	----------	----------	15,860	.07
Undistributed	10,534	11,673	1.95	5,313	5,436	[5] 145,145	[5] .63
Total	521,356	528,875	100.00	272,005	239,992	23,017,799	100.00

[1] Subject to revision.
[2] Included under "Undistributed." Bureau of Mines not at liberty to publish figures.
[3] Included under "Undistributed." Figures not separately recorded.
[4] Approximate production through 1928. Figures for 1929–32 are confidential and are included under "Undistributed."
[5] Includes Tennessee for 1929–32.

Mine production of copper in the principal districts,[1] 1927–31, in terms of recovered copper, in short tons

District or region	State	1927	1928	1929	1930	1931 Quantity	1931 Per cent of total United States production
Butte	Montana	110,656	123,534	148,158	97,736	92,181	17.43
Bingham	Utah	124,960	143,843	155,946	87,535	73,853	13.96
Globe-Miami	Arizona	85,584	80,215	95,798	79,060	63,222	11.95
Lake Superior	Michigan	88,769	89,222	93,201	84,691	59,030	11.16
Bisbee (Warren)	Arizona	69,298	80,746	93,065	63,950	47,664	9.01
Ely (Robinson)	Nevada	53,721	70,985	65,378	52,693	35,667	6.74
Central (including Santa Rita)	New Mexico	33,486	40,120	43,723	28,622	28,159	5.32
Yavapai County (mostly Jerome district).	Arizona	70,821	82,649	104,086	58,845	22,288	4.21
Pioneer	do	14,111	18,328	19,558	16,193	14,052	2.66
Ray (Mineral Creek)	do	31,430	34,331	33,144	18,059	12,219	2.31
Plumas County	California	10,528	10,571	12,465	9,765	6,227	1.18
Battle Mountain	Colorado	45	610	1,570	2,925	3,324	.63
Lordsburg	New Mexico	1,967	2,313	2,124	2,429	1,996	.38
Banner	Arizona	904	900	2,520	3,775	1,303	.25
Tintic	Utah	1,892	1,229	1,583	1,431	785	.15
Willow Creek	New Mexico	995	1,060	1,321	719	548	.10
Park City	Utah	1,298	1,320	1,262	839	410	.08
Shasta County	California	2,263	1,528	3,017	1,981	155	.03
Battle Mountain	Nevada	657	1,538	1,216	653	70	.01
Bonanza	Colorado	1,690	2,150	1,334	617	3	
Alder Creek	Idaho	343	258	1,412	561		
Copper River [2]	Alaska	(3)	(3)	(3)	(3)	(3)	(3)
Prince William Sound [2]	do	(3)	(3)	(3)	(3)	(3)	(3)
Ajo [2]	Arizona	36,467	[4] 38,998	35,502	25,102	(3)	(3)
Morenci-Metcalf [2]	do	29,880	27,027	28,391	21,572	(3)	(3)
Silver Bell [2]	do	1,221	1,428	1,192	113	(3)	(3)
Jack Rabbit [2]	Nevada	696	1,013	1,319	998	(3)	(3)
Yerington [2]	do	4,752	5,494	1,635	(3)	(3)	(3)
Swain County [2]	North Carolina	2,722	4,104	(3)	(3)	(3)	(3)
Lebanon (Cornwall mine)[2]	Pennsylvania	868	2,489	1,727	1,430	(3)	(3)
Ducktown [2]	Tennessee	7,471	8,187	(3)	(3)	(3)	(3)

[1] Districts producing 1,000 short tons or more in any year of the period 1927-31.
[2] Not listed in order of output.
[3] Bureau of Mines not at liberty to publish figures.
[4] As shown in New Cornelia Copper Co. annual report to stockholders.

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 1930. The figures are taken from the mine reports in Mineral Resources. Detailed figures for 1931 and 1932 are not yet available. The 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. The classification of some of the complex western ores is difficult and more or less arbitrary. Under copper ores are classed 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 ores, zinc ores, pyritic sulphur ores, and ores concentrated for their content of other metals.

Copper ore, old tailings, etc., sold or treated in the United States in 1930, with copper, gold, and silver content in terms of recovered metals

State	Copper ore, old tailings, etc. (short tons)	Copper produced		Gold produced (fine ounces)	Silver produced (fine ounces)	Value of gold and silver per ton of ore
		Pounds	Percent			
Alaska	531,000	32,651,000	3.07		279,990	$0.20
Arizona	19,703,349	[1] 562,956,307	1.43	132,086.77	4,968,973	.24
California	[2] 857,786	[3] 27,007,276	1.57	23,473.31	670,398	.87
Colorado	63,915	5,953,000	4.66	4,675.33	1,484,589	10.45
Idaho	33,129	1,379,869	2.08	810.36	26,262	.81
Michigan	6,659,036	169,381,413	1.27		7,820	(4)
Montana	2,238,997	[5] 183,842,956	4.11	21,715.70	4,583,827	.99
Nevada	4,015,426	[6] 107,898,264	1.34	50,083.92	270,512	.28
New Mexico	2,636,107	61,048,300	1.16	17,138.87	228,494	.17
North Carolina	(7)	(7)	(7)	(7)	(7)	(7)
Oregon	1,033	175,427	8.49	112.00	1,050	2.63
Tennessee	[8] 915,358	[8] 35,372,356	[8] 1.93	[8] 1,218.47	[8] 117,748	.08
Texas	734	44,200	3.01		411	.22
Utah	9,696,962	[9] 168,387,871	.87	80,953.27	944,113	.21
Vermont	(7)	(7)	(7)	(7)	(7)	(7)
Washington	28,565	1,204,218	2.11	100.43	27,592	.44
Wyoming	112	11,600	5.18		25	.09
Total and average	47,381,509	1,357,314,057	1.43	332,368.43	13,611,804	.26

[1] Excludes 12,700,073 pounds of copper recovered from precipitates.
[2] Includes 51,157 tons of pyrites roasted for manufacture of sulphuric acid (residue leached) yielding 41 ounces of silver and 404,007 pounds of copper.
[3] Excludes 242,240 pounds of copper from precipitates.
[4] Only lump silver produced in 1930.
[5] Excludes 11,465,232 pounds of copper recovered from precipitates.
[6] Excludes 8,847 pounds of copper from "cyanide" precipitates.
[7] Figures included under Tennessee.
[8] Includes totals for North Carolina and Vermont.
[9] Excludes 1,141,251 pounds of copper recovered from precipitates and 2,048,369 pounds of copper from ore leached in place.

Copper ore and old tailings concentrated in the United States in 1930, 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
Alaska	521,604	42,913	21,242,961	2.04
Arizona	[1] 14,683,100	834,907	301,922,928	1.03
California	786,362	51,886	24,124,366	1.53
Idaho	30,971	2,808	1,209,193	1.95
Michigan	6,659,036	[2] 129,003	[3] 169,381,413	1.27
Montana	2,145,706	428,954	176,556,845	4.11
Nevada	3,845,476	192,244	92,502,802	1.20
New Mexico	2,513,560	91,608	54,375,000	1.08
Tennessee	[4] 520,556	[4] 51,955	[4] 11,881,125	[4] 1.14
Utah	9,592,530	261,035	162,396,675	.85
Vermont	(5)	(5)	(5)	(5)
Washington	28,336	1,837	1,136,335	2.01
Total and average	41,327,237	2,089,150	1,016,729,643	1.23

[1] Includes 154,909 tons of slimes from a leaching plant.
[2] Includes concentrates from sands.
[3] Includes copper from sands.
[4] Includes totals for Vermont.
[5] Figures included under Tennessee.

Copper ore leached and smelted in the United States in 1930, 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
Alaska				9,396	11,408,039	60.71
Arizona	[1] 3,140,566	65,615,576	1.04	2,032,680	195,166,470	4.80
California	[2] 33,389	404,007	.61	19,236	1,718,247	4.47
Colorado				63,915	5,953,000	4.65
Idaho				2,158	170,676	3.95
Montana				63,555	6,203,106	4.88
Nevada				169,950	15,395,462	4.53
New Mexico				122,547	6,673,300	2.72
North Carolina				(3)	(3)	(3)
Oregon				1,033	175,427	8.49
Tennessee				[4] 394,802	[4] 23,491,231	[4] 2.98
Texas				734	44,200	3.01
Utah	(5)	(5)	(5)	103,565	5,956,696	2.88
Washington				229	67,883	14.82
Wyoming				112	11,600	5.18
Total and average	3,173,955	66,019,583	1.04	2,983,912	272,435,337	4.57

[1] 154,909 tons of slimes from a leaching plant were concentrated.
[2] Residue from pyrites roasted for manufacture of sulphuric acid.
[3] Figures included under Tennessee.
[4] Includes totals for North Carolina.
[5] Ore leached in place yielded 2,048,369 pounds of copper; quantity of ore unknown.

Copper-lead and copper-lead-zinc ores sold or treated in the United States in 1930, with content in terms of recovered copper

State	Copper-lead and copper-lead-zinc ores (short tons)	Copper produced (pounds)	Percent of copper
Arizona	1,309	85,660	3.27
Idaho	161,863	491,468	.15
Montana	330	19,000	2.88
Nevada	30,171	1,225,225	2.03
Utah	52,757	2,204,086	2.09
Total and average	246,430	4,025,439	.82

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Copper ores, old tailings, etc., classed as copper-bearing (copper, copper-lead, and copper-lead-zinc) sold or treated in the United States in 1930 and total copper from all sources, in terms of recovered copper

State	From copper, copper-lead, and copper-lead-zinc ores, old tailings, etc.			Copper from all sources, including old slags, smelter cleanings, and precipitates (pounds)
	Ore, old tailings, etc. treated (short tons)	Copper produced (pounds)	Percent of copper	
Alaska	531,000	32,651,000	3.07	32,651,000
Arizona [1]	19,704,658	563,041,967	1.43	576,190,607
California	857,786	27,007,276	1.57	27,285,272
Colorado	63,915	5,953,000	4.66	10,514,000
Idaho	194,992	1,871,337	.48	3,111,555
Michigan	6,659,036	169,381,413	1.27	169,381,413
Missouri				176,600
Montana [1]	2,239,327	183,861,956	4.11	196,187,523
Nevada	4,045,597	109,123,489	1.35	109,203,512
New Mexico	2,636,107	61,048,300	1.16	65,150,000
North Carolina	(2)	(2)	(2)	(2)
Oregon	1,033	175,427	8.49	176,300
Pennsylvania				2,859,675
Tennessee	[3] 915,358	[3] 35,372,356	[3] 1.93	[3] 35,372,356
Texas	734	44,200	3.01	143,100
Utah [1]	9,749,719	170,591,957	.87	180,526,423
Vermont	(2)	(2)	(2)	(2)
Washington	28,565	1,204,218	2.11	1,206,438
Wyoming	112	11,600	5.18	11,600
Total and average	47,627,939	1,361,339,496	1.43	1,410,147,374

[1] Considerable copper was recovered from mine water precipitates and ores not classed as copper ores.
[2] Figures included under Tennessee.
[3] Includes totals for North Carolina and Vermont.

Copper ores produced in the United States, 1921–30, 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
1921	1,235,602	4.77	11,022,544	1.44	13,396,382	1.70	0.0039	0.357	$0.44
1922	2,278,047	5.36	23,258,970	1.43	26,893,247	1.74	.0049	.386	.49
1923	3,496,728	5.12	40,209,754	1.29	45,519,317	1.58	.0060	.321	.39
1924	3,554,915	5.08	44,427,264	1.33	49,178,315	1.59	.0063	.325	.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

[1] Includes old tailings, etc.

REVIEW BY STATES AND COMPANIES

The following details of company operations are derived from annual reports of the various companies and from the public press.

Alaska.—The Kennecott Copper Corporation produced from the Kennecott mine 31,154 tons of ore containing 9.82 percent copper and 1.73 ounces of silver per ton in 1932. The smelter production was 2,659 tons of copper and 54,966 ounces of silver. Copper produced in 1931 was 6,785 tons.

Mother Lode Coalition Mines Co., controlled by Kennecott, produced 25,710 tons containing 8.07 percent copper and 1.24 ounces of silver per ton. Smelter production was 1,716 tons of copper and 26,175 ounces of silver. Mine operations were suspended in October.

Arizona.—Phelps Dodge Corporation ceased operations of the New Cornelia branch at Ajo in April and of the Morenci branch in July 1932, but mining at Bisbee in the Junction and Campbell divisions of the Copper Queen branch were continued throughout the year. The following production from the company's mines was reported: Copper 41,544 tons, silver 873,310 ounces, and gold 20,607 ounces.

Inspiration Consolidated Copper Co. ceased operations in May after mining 463,709 tons of ore containing 1.204 percent total copper which included 0.652 percent oxide copper. Copper production was 8,512 tons compared with 30,684 tons in 1931.

Miami Copper Co. ceased operations in May after milling 1,417,810 tons containing 0.774 percent total copper, 0.595 percent sulphide. Production of copper was approximately 7,907 tons compared with 25,286 tons in 1931.

Magma Copper Co. produced 149,462 tons of ore, and 3,301 tons of other ore and concentrates were treated. The yield of copper was 10,853 tons compared with 14,420 tons in 1931. In addition, 486,036 ounces of silver and 5,152 ounces of gold were produced.

United Verde Extension Mining Co. mined 241,804 tons of ore averaging 7.81 percent copper. Copper production was 17,876 tons compared with 12,295 tons in 1931.

Iron Cap Copper Co. produced 107 tons from the Christmas mine.

United Verde Copper Co. did not operate its smelter during the year.

California.—The Walker Mining Co. produced 35,866 tons of ore, and its copper production was 535 tons compared with 6,425 tons in 1931.

Michigan.—The copper mines of the Lake Superior district in 1932 produced only 27,198 tons compared with 59,030 tons in 1931. This production was derived as follows: Calumet & Hecla Consolidated Copper Co., 16,879 tons; Copper Range, 6,094 tons; and Mohawk Mining Co., 4,225 tons.

Montana.—The Anaconda Copper Mining Co. reports production in 1932 of 48,787 tons of copper, 2,027,675 ounces of silver, and 18,551 ounces of gold. In 1931 the production of copper was 85,622 tons. During the latter part of the year operations were curtailed further.

Nevada.—The Nevada Consolidated Copper Co. combines in its report the results of operations of its Nevada mines, the Ray mines in Arizona, and the Chino mines in New Mexico. In 1932 their combined production was 2,830,755 tons of company ore of which 9,957 tons were direct smelting ore. The average grade of company material milled was 1.295 percent copper, and the average recovery of concentrates was 85.71 percent of the total copper content. The total copper production was 29,992 tons compared with 65,478 tons in 1931. Of the concentrating ore produced the Nevada mines contributed 1,073,330 tons, Chino 1,165,370 tons, and Ray 582,098 tons. The net cost of the year's production, exclusive of depreciation and depletion, was 9.14 cents a pound compared with 8.13 cents in 1931, the increased cost being due partly to a reduction in quantity of ore treated.

The Consolidated Copper Mines Corporation produced 870 tons of copper in 1932.

New Mexico.—The output of Chino mines is included with that of the Nevada Consolidated Copper Co.

Tennessee.—The copper producers of the Ducktown district do not publish details of their operations, but the Tennessee Copper Co. continued to operate on a curtailed basis during 1932. The Ducktown Chemical & Iron Co. discontinued smelting operations in 1931.

Utah.—The Utah Copper Co. mined 3,169,411 tons of ore averaging 0.973 percent copper compared with 8,147,764 tons in 1931. The net production of refined copper in 1932 was 30,006 tons compared with 71,347 tons in 1931. The Arthur plant was idle throughout the year. The cost of copper production, exclusive of Federal taxes, was 8.48 cents per pound.

REFINERY PRODUCTION

The refinery output of copper in the United States in 1932 was made by 11 plants; 7 of these employed the electrolytic method, 3 employed the furnace process on Lake Superior copper, and 1 the furnace process on Arizona ore.

Five large electrolytic refineries are on the Atlantic seaboard, the 3 lake refineries are on the Great Lakes, and 4 refineries are west of the Great Lakes—1 at Great Falls, Mont.; 1 at Tacoma, Wash.; 1 at El Paso, Tex.; and 1 at Clifton, Ariz. The plant at El Paso was idle during the year. In addition to these 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 eastern refineries, where it is melted and cast into merchant shapes, and is accounted for in the production reported from these eastern refineries. The Ajo plant was idle throughout 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 casting, lake, and electrolytic 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. The figures for refinery production include copper that was mined some 3 months earlier than the beginning of the calendar year and smelted probably 1 or 2 months earlier.

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 1930 copper chapter of Mineral Resources. 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 39.

Primary and secondary copper produced by regular refining plants in the United States and imported, 1928–32, in pounds

	1928	1929	1930	1931	1932
Primary:					
Domestic [1]—					
Electrolytic	1,607,120,026	1,785,754,654	1,228,416,733	947,065,977	[2] 373,492,550
Lake	179,104,311	185,300,917	142,985,522	105,222,177	[2] 53,815,281
Casting	5,573,050	11,676,718	19,821,950	22,317,887	17,770,043
	1,791,797,387	1,982,732,289	1,391,224,205	1,074,606,041	445,077,874
Foreign [1]—					
Electrolytic	693,787,036	756,555,087	765,189,037	426,307,093	235,240,651
Casting and best select	2,023,356	825,000	645,936	529,199	549,209
Refinery production, new copper	2,487,607,779	2,740,112,376	2,157,059,178	1,501,442,333	680,867,734
Imports refined copper	84,730,630	134,014,792	86,210,331	174,449,893	167,793,988
Total new refined copper made available	2,572,338,409	2,874,127,168	2,243,269,509	1,675,892,226	848,661,722
Secondary:					
Electrolytic	191,323,029	331,858,103	279,423,370	156,099,339	120,397,873
Casting	41,322,776	2,300,000	1,106,114	28,914	56,654
	232,645,805	334,158,103	280,529,484	156,128,253	120,454,527
Grand total	2,804,984,214	3,208,285,271	2,523,798,993	1,832,020,479	969,116,249

[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.

Copper sulphate.—The production of hydrous copper sulphate or bluestone by the copper refineries of the United States in 1932 was 24,908,525 pounds having a copper content of 6,345,000 pounds compared with 35,265,409 pounds having a copper content of 8,983,000 pounds in 1931.

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 the separation of the copper. A canvass of plants producing secondary copper has been made by J. P. Dunlop, of the Bureau of Mines, and the following figures are taken from his chapter on Secondary Metals.

Secondary copper recovered in the United States in 1932 and imports and exports of scrap brass and copper, in short tons

Copper as metal	140,500
Copper in alloys other than brass	47,200
	187,700
Copper from new scrap (not including brass)	35,000
Copper from old scrap (not including brass)	152,700
	187,700
Brass scrap remelted:	
New clean scrap	46,000
Old scrap	40,400
	86,400

Secondary copper recovered in the United States in 1932 and imports and exports of scrap brass and copper, in short tons—Continued

Copper content of brass scrap (averaging about 70 percent copper):	
New clean scrap	32, 200
Old scrap	28, 280
	60, 480
Total copper produced from secondary sources (including copper content of brass scrap):	
From new scrap	67, 280
From old scrap	180, 900
	248, 180
Imports of scrap brass	1, 259
Imports of scrap copper	1, 211
Exports of scrap brass	15, 073
Exports of scrap copper	17, 179

Refined copper from secondary sources produced in the United States, 1928–32, in pounds

1928	1,072,800,000	1931	694,000,000
1929	1,253,100,000	1932	496,400,000
1930	934,400,000		

STOCKS

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

Stocks of copper in the United States, January 1, 1929–33, 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	1932	924, 600, 000	348, 000, 000
1930	306, 000, 000	500, 000, 000	1933	1, 004, 000, 000	378, 000, 000
1931	615, 000, 000	450, 000, 000			

IMPORTS AND EXPORTS

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 for treatment of foreign raw materials and the return abroad of refined copper and manufactures of copper. Fifty-seven percent, by weight, of the copper imported in 1932 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 80 percent of the exports consisted of refined copper and primary manufactures therefrom.

Normally the exports of copper largely 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 partly made of copper, such as electrical machinery and other mechanisms.

Considering refined copper only, imports averaged 12.3 percent of exports for 1925–29, which indicates strikingly the true character of foreign trade in copper.

The imports of unmanufactured copper into the United States in 1932 amounted to 391,991,342 pounds, a decrease of 193,900,756 pounds (33 percent) from 1931 and a decrease of 60 percent from the record imports of 1929. The principal sources and the percentage of the total contributed by each in 1932 were as follows: Canada 30 percent, Chile 28 percent, Mexico 19 percent, Peru 12 percent, Africa 7 percent, and Cuba 3 percent. Imports from all of these countries decreased materially in 1932. Chile decreased its shipments of ore and blister copper but maintained its shipments of refined copper. Canada shipped less concentrates, blister copper, and refined metal, but sent more ore. A sharp decrease in imports of ore and concentrates from Africa was more than offset by an increase in blister-copper shipments. Blister copper is the principal copper import from Peru and Mexico. Imports of all classifications of unmanufactured copper except black copper declined in 1932.

Copper (unmanufactured) imported into the United States, 1932, in pounds

[General imports]

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	Composition metal, copper chief value
Africa:							
British:							
Union of South		2,081,361		6,265,737			
Mozambique	3,640	8,748,555		11,499,724			
Australia	140			2,389,860			
Canada	5,075,150	13,333,803	1,028,773	20,507,301	76,009,041	2,113,869	
Chile	7,093,259	8,650,155	200,139	2,956,041	90,540,479	20,740	
Cuba	312,168	9,784,000				113,669	
France		45,622	117,466	12,254	3,158	12,131	
Germany			216,969	5,886		73,891	
Mexico	901,609	130,359	20,800	73,117,249	1,240,060	20,660	
Peru	322,805	1,269,216	27,418	44,815,498			
Spain		10,502		63,392			
United Kingdom			105,375	31,440	1,250	74,910	
Venezuela	250,000	141,120				9,879	
Other	55,801		13,789	23,410		89,925	39,894
	14,014,572	44,194,693	1,730,729	161,687,792	167,793,988	2,529,674	39,894
Total value	$717,468	$2,567,410	$76,204	$9,215,979	$10,974,376	$101,110	[1] $1,207

[1] Value from January to June 20. Not separately classified thereafter.

Copper (unmanufactured) imported into the United States, 1928–32, in pounds

[General imports]

1928	787,073,640	1931	585,892,098
1929	974,312,201	1932	391,991,342
1930	817,154,236		

Exports of copper of all classes in 1932 totaled 328,222,700 pounds, a decrease of 229,651,044 pounds (41 percent) from those in 1931 and a decrease of 71 percent from exports in 1928.

In 1932 the United States exported more copper to France than to any other country; the United Kingdom stood second in order of importance, Germany third, and Italy fourth. The exports (in millions of pounds) from the United States to the 6 leading importers of United States copper in 1932 were as follows: France 75, United Kingdom 73, Germany 50, Italy 49, Belgium 18, and Sweden 16. Corresponding exports to the 6 leading importers in 1931 were as follows: United Kingdom 124, France 120, Germany 97, Italy 44, Belgium 36, and Netherlands 32.

Copper exported from the United States, 1932, in pounds

Country	Ore, concentrates, composition metal, and unrefined copper (copper content)	Refined [1]		Old and scrap	Pipes and tubes	Plates and sheets	Wire (except insulated)	Insulated wire and cable	Other copper manufactures
		Bars, ingots, or other forms	Rods						
Belgium	944,280	12,487,880	3,929,253	848,411	1,485	-----	233	12,988	
Canada	32,446	186,973	539,778	2,595	780,914	147,186	74,213	256,817	
China	-----	740,169	-----	76,230	1,522	4,480	187,967	48,291	
Denmark	-----	1,899,153	1,580,597	-----	-----	714	140,894	8,490	
France	5,926,225	62,367,449	2,938,829	3,196,051	2,445	79,770	7,682	24,923	
Germany	463,104	30,447,338	359,038	19,120,592	-----	-----	70	8,727	
India (British)	-----	335,761	1,201,296	89,109	336	-----	19,030	53,293	
Italy	25,293,315	23,344,238	-----	208,933	-----	336,877	400	6,545	(1)
Japan	94,979	448,041	78,563	2,715,885	1,539	530	-----	60,772	
Netherlands	-----	8,820,779	2,678,652	1,620,512	2,396	-----	4,850	19,378	
Norway	-----	246,864	2,039,233	-----	-----	-----	40,067	20,353	
Russia in Europe	-----	-----	-----	-----	-----	-----	-----	255	
Spain	-----	-----	-----	2,193,985	4,426	-----	-----	39,621	
Sweden	-----	15,590,038	-----	-----	-----	-----	-----	6,073	
United Kingdom	111,632	59,950,481	8,393,615	4,055,697	421	669,144	763	228,874	
Other	-----	5,089,383	4,365,553	230,440	400,826	432,989	1,412,560	5,387,196	
	32,865,981	221,954,547	28,104,407	34,358,440	1,196,310	1,671,690	1,888,729	6,182,596	(1)
Total value	$1,472,709	$13,537,632	$2,294,316	$2,012,729	$212,899	$232,596	$197,377	$1,038,558	$237,004

[1] Figures for quantity not recorded.

Copper [1] exported from the United States, 1928–32

Year	Pounds: Metallic [2]	Pounds: Total	Total value	Year	Pounds: Metallic [2]	Pounds: Total	Total value
1928	1,121,186,640	1,125,019,417	$168,525,383	1931	557,574,235	557,873,744	$54,230,992
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				

[1] Exclusive of "Other copper manufactures," value at $1,296,996 in 1928, $1,720,363 in 1929, $1,025,875 in 1930, $516,818 in 1931, and $237,004 in 1932; 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, 1928–32

Year	Pounds	Value	Year	Pounds	Value
1928	8,666,899	$455,023	1931	7,190,919	$276,575
1929	6,419,688	368,481	1932	4,132,529	114,579
1930	5,061,554	252,614			

Brass and bronze exported from the United States, 1931–32

	1931		1932	
	Pounds	Value	Pounds	Value
Ingots	1,169,168	$105,482	155,260	$11,113
Scrap and old	23,183,812	1,519,386	30,145,251	1,255,490
Bars and rods	2,079,981	287,073	1,255,493	154,568
Plates and sheets	646,853	132,615	432,605	76,486
Pipes and tubes	3,189,405	557,350	1,545,498	228,135
Pipe fittings and valves	1,858,827	1,014,224	827,112	485,709
Plumber's brass goods	706,060	376,309	350,870	182,819
Wire of brass or bronze	1,235,093	314,832	232,563	50,564
Brass wood screws	(1)	65,703	(1)	21,273
Hinges and butts of brass or bronze	(1)	37,797	(1)	29,180
Other hardware of brass or bronze	(1)	336,596	(1)	167,762
Other brass and bronze manufactures	(1)	1,545,875	(1)	902,074
	------------	6,293,242	------------	3,565,173

[1] Weight not recorded.

Unmanufactured brass exported from the United States, 1928–32

[Ingots,[1] bars, rods, plates, and sheets]

Year	Pounds	Value	Year	Pounds	Value
1928 [1]	4,403,726	$905,430	1931	3,896,002	$525,170
1929	7,627,717	1,597,758	1932	1,843,358	242,167
1930	6,575,452	1,230,558			

[1] Exclusive of ingots in 1928, figures for which are not separable from those for "scrap and old."

CONSUMPTION AND USES

As calculated by the method shown in the following table, the quantity of new copper consumed in a year is actually the quantity withdrawn from available supply on domestic account. This method of computation is not accurate, as figures on consumers' stocks are not available and cannot be taken into account. In addition, much copper withdrawn on domestic account is exported later in manufactured forms. The domestic withdrawals in 1932 totaled 519,202,768 pounds, a decrease of 382,862,425 pounds (42 percent) from 1931 and a decrease of 71 percent from the record year, 1929.

New refined copper withdrawn from total year's supply on domestic account, 1929–32, in pounds

	1929	1930	1931	1932
Total supply of new copper	2,874,127,168	2,243,269,509	1,675,892,226	848,661,722
Stock at beginning of year	114,000,000	306,000,000	615,000,000	924,600,000
Total available supply	2,988,127,168	2,549,269,509	2,290,892,226	1,773,261,722
Copper exported [1]	903,541,753	669,252,807	464,227,033	250,058,954
Stock at end of year	306,000,000	615,000,000	924,600,000	1,004,000,000
	1,209,541,753	1,284,252,807	1,388,827,033	1,254,058,954
Withdrawn on domestic account	1,778,585,415	1,265,016,702	902,065,193	519,202,768

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

Adding the 496,400,000 pounds of secondary copper and copper in alloys produced during the year to the 519,202,768 pounds of new refined copper withdrawn on domestic account gives a total of about 1,015,600,000 pounds of new and old copper available for domestic consumption in 1932. 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 361,800,000 pounds. The total available for consumption by this calculation would be 881,000,000 pounds.

Estimates made by others indicate distribution of consumption by uses about as follows:

	Percent
Electrical uses in manufactures and electric transmission lines	50
Wire	9
Automobiles	10
Buildings	7
Home equipment	3
Ammunition	1
Miscellaneous	12
Manufactures for export	8
Total	100

The following table shows the copper cast in different forms in 1931 and 1932. 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 1931–32

Form	1931		1932	
	Pounds	Percent	Pounds	Percent
Wire bars	1,094,000,000	66.06	418,000,000	52.18
Cathodes	162,000,000	9.78	119,000,000	14.86
Cakes	189,000,000	11.41	98,000,000	12.23
Ingots	119,000,000	7.19	90,000,000	11.24
Other forms	92,000,000	5.56	76,000,000	9.49
	1,656,000,000	100.00	801,000,000	100.00

WORLD

PRODUCTION

In 1932 world mine production was approximately 964,183 short tons compared with 1,545,439 tons in 1931, a decline of 37.6 percent. The total for 1931 is based upon official reports of the various countries of the world but for 1932 is compiled chiefly from published company records and other reports. It is accurate enough, however, to indicate trends.

The Western Hemisphere contributed 553,382 tons (57.3 percent of the total) in 1932 compared with an average of 1,410,789 tons per year for 1925–29. Production in the Western Hemisphere declined to 88.8 percent of the 5-year average in 1930, 74 percent in 1931, and 39.3 percent in 1932. The distribution of this tonnage in 1932 compared with that in 1931 follows:

Copper production of Western Hemisphere by countries, 1931–32

[Mine production]

Country	1931	1932		
	Short tons	Short tons	Percent of world total	Change, percent
United States	528,875	239,992	24.9	−55
Canada	146,150	123,839	12.8	−15
Mexico	59,758	38,815	4.0	−35
Cuba	14,888	6,533	.7	−56
Newfoundland	1,607	2,373	.2	+48
Total North America	751,278	411,552	42.6	−45
Chile	246,128	114,175	11.9	−54
Peru	48,853	25,232	2.6	−48
Bolivia	2,259	2,223	.2	−2
Venezuela	822	200		−76
Total South America	298,062	141,830	14.7	−52
Total Western Hemisphere	1,049,340	553,382	57.3	−47

Data needed to account precisely for the sources of this production are still lacking, but approximately 95 percent is accounted for specifically in the following table:

Sources of production by mines, Western Hemisphere, in 1932

	Short tons	Percent of world total		Short tons	Percent of world total
United States	239,992	24.9	Canada—Continued		
Anaconda group	57,834	6.0	Falconbridge	1,197	
Montana	48,787		Granby	19,324	
Walker	535		Hudson Bay	21,079	
Inspiration	8,512		Noranda	30,294	
Kennecott group	64,373	6.7	Sherritt Gordon	4,965	
Kennecott	2,659		Undistributed, including International Nickel	45,490	
Mother Lode Coalition	1,716		Newfoundland (includes Buchans)	2,373	0.2
Nevada Consolidated	29,992		Cuba (Matahambre)	6,533	.7
Utah Copper	30,006		Mexico	38,815	4.0
Phelps Dodge group	41,544	4.3	Boleo	11,486	
Miscellaneous Arizona	36,743	3.8	Cananea (Anaconda)	18,410	
United Verde Extension	17,876		Undistributed	8,919	
Miami	7,907		Total North America	411,552	42.6
Magma	10,853		Chile	114,175	11.9
Iron Cap	107		Andes (Anaconda)	11,619	
Lake Superior	27,198	2.8	Braden (Kennecott)	49,871	
Calumet and Hecla	16,879		Chile Copper (Anaconda)	40,685	
Copper Range	6,094		Naltalgua	6,000	
Mohawk	4,225		Undistributed	6,000	
Sundry production	12,300	1.3	Peru	25,232	2.6
Consolidated Coppermines	870		Cerro de Pasco	22,910	
Utah Delaware	314		Undistributed	2,322	
Colorado	3,616		Bolivia	2,223	.2
Idaho	548		Venezuela	200	
Utah (miscellaneous)	2,633		Total South America	141,830	14.7
Undistributed	4,319		Total Western Hemisphere	553,382	57.3
Canada	123,839	12.8			
Britannia	1,103				
Consolidated Mining & Smelting	387				

The Eastern Hemisphere contributed 411,811 tons (42.7 percent of world production). The corresponding production in the Eastern Hemisphere for 1925–29 averaged 375,161 tons per year. The present production represents an increase of about 10 percent above the 5-year average. The distribution of this tonnage in 1932 compared with that in 1931 follows.

Copper production of Eastern Hemisphere, 1931–32

[Mine production]

Country	1931	1932		
	Short tons	Short tons	Percent of world total	Change, percent
Spain-Portugal	62,832	32,638	3.4	−48.1
Union of Soviet Socialist Republics	34,282	35,300	3.7	+3.0
Germany	32,879	30,864	3.2	−6.1
Yugoslavia	23,259	33,244	3.4	+42.9
Norway	9,599	13,702	1.4	+42.7
Sweden	9,416	3,632	.4	−61.4
Finland	7,050	7,100	.7	+.1
Other Europe	4,625	1,500	.2	−67.6
Total Europe	183,942	157,980	16.4	−14.1
Belgian Congo	132,277	59,525	6.2	−55.0
Northern Rhodesia	25,353	76,034	7.9	+199.9
Southwest Africa	21,275			
Union of South Africa	11,250	10,364	1.0	−7.9
Southern Rhodesia	593	7		
French Congo	171			
Algeria		7		
Total Africa	190,919	145,937	15.1	−23.6
Japan	84,225	77,874	8.1	−7.5
British India	12,787	9,500	1.0	−2.6
Other Asia	8,377	4,000	.4	−52.3
Total Asia	105,389	91,374	9.5	−13.3
Australia	15,156	16,510	1.7	+10.0
Total Eastern Hemisphere	495,406	411,801	42.7	−16.9

Only a general indication of the important sources of production in the Eastern Hemisphere can be given.

Europe.—The production of Spain and Portugal is derived from the great low-grade pyritic belt from which Rio Tinto is the chief producer. That of Russia was probably made up about as follows: Krasnuralsk, the large new Ural smelter, 4,600 tons; Kalatinsky, 8,000; Bashkombinat, 2,400; Kosakpaisky, 4,400; Zakmekombinat, 4,500; and Korobash and Kasakstan, 11,000. Mansfeld produced 27,300 tons of Germany's mine output, the balance being from several small sources. Bor provided the whole 33,244 tons of Yugoslavia's output. Sulitelma and Roros contributed 4,409 tons of Norway's total. All production of Finland was derived from pyritic ore exported from Outokumpu. Probably all new copper produced in Sweden came from Boliden mine. These sources account for about 147,000 tons (93 percent of Europe's production).

Africa.—In Africa the entire production of Belgian Congo was made by Union Minière du Haut Katanga. In Northern Rhodesia 33,529 tons were produced by Roan Antelope and 31,977 tons by Rhokana. Otavi, formerly an important source of production in Southwest Africa, ceased operations in November 1931. Messina produced 9,158 tons in the Union of South Africa. These sources account for about 134,000 tons, or 92 percent, of Africa's production.

Asia.—For Japan 20,035 tons are attributed to Furukawa and 14,005 to Sumitomo. A balance of 43,834 may be chiefly from Nippon Sagyo, Mitsubishi, and Fujita. Of the production from India about 4,355 tons were derived from Bawdwin and 4,976 tons from Indian Copper. Taiwan and Chosen probably contributed a few thousand tons.

Australia.—Mt. Lyell contributed 12,418 tons of Australian production.

Considering world production as a whole, it is notable that in 1932 only a fourth of it was derived from the United States, although the domestic production from 1925 to 1929 averaged 49 percent of the world total. In 1930 domestic production declined to 40.7 percent of the total and in 1931 to 34.3 percent. American enterprise has been responsible, however, for a large proportion of foreign production as well. In 1932 nearly 15 percent of world production, or nearly 20 percent of foreign production, was made abroad by American companies. For the period 1925–29 American-owned foreign production was about 20 percent of world production and averaged 38.4 percent of the total foreign production.

American commercial control in 1932 embraced about 40 percent of world production compared with 68.6 percent from 1925 to 1929, but in 1930 embraced only 58 percent and in 1931, 54 percent.

American control of foreign production is attributable to four large companies or groups of related companies—Anaconda, Kennecott, Phelps Dodge, and Cerro de Pasco. All of them have important foreign mines. The first three are the chief domestic producers as well.

The Anaconda group includes the Anaconda properties at Butte, Mont., Inspiration, Ariz., and Walker, Calif. It also includes Greene-Cananea in Mexico and the Andes and Chile Copper mines in Chile.

The Kennecott group includes the Kennecott and Mother Lode mines in Alaska, Utah Copper and Nevada Consolidated, which owns Chino and Ray. In Chile this group owns Braden.

The Phelps Dodge group includes the Copper Queen, Morenci, and the Calumet and Arizona. In Mexico it owns the Moctezuma.

Cerro de Pasco owns the mine of the same name in Peru.

For the period 1925–29 the combined average annual production of these four groups was 947,052 tons, (52.4 percent of world production). It included 593,245 tons of domestic copper, (67 percent of domestic production) and 353,807 tons of foreign copper (nearly 40 percent of foreign production).

In 1932 the combined production of these four groups was 307,237 tons (32 percent of the world total). Their combined domestic production was 163,751 tons (68 percent of the total domestic production). Their combined foreign production was 143,486 tons (19.8 percent of foreign production).

Further details as to the proportions in recent years of domestic and foreign production, of American and foreign commercial control, and of production by the four chief American groups compared with that of all others, both domestic and foreign, are presented in the following table.

It should be borne in mind that American interests, in addition to actually controlling foreign production indicated, also are represented to an important extent in the ownership of Canadian and African copper companies.

Copper production—domestic and foreign origin and control, 1925–32

[Short tons; percent refers to world total]

	1925–29 average	1930	1931	1932
World	1,806,686	1,733,706	1,544,919	964,183
United States	885,826	705,074	528,875	239,992
Percent	49.0	40.7	34.3	24.9
Chief American groups	593,245	415,013	360,462	163,751
Percent	32.8	23.9	23.4	17.0
Anaconda group	178,786	139,308	121,727	57,834
Kennecott group	273,069	167,878	148,168	64,373
Phelps Dodge	141,390	107,827	90,567	41,544
Others	292,581	290,061	168,413	76,241
Percent	16.2	16.8	10.9	7.9
Foreign	920,860	1,028,632	1,016,044	724,191
Percent	51.0	59.3	65.7	75.1
Chief American groups	353,807	296,176	307,872	143,486
Percent	19.6	17.1	19.9	14.9
Anaconda group	194,541	157,831	148,605	70,705
Kennecott group	93,269	80,993	103,770	49,871
Phelps Dodge	20,068	14,352	13,497	----------
Cerro de Pasco	45,929	43,000	42,000	22,910
Others—foreign	567,053	732,456	708,172	580,705
Percent	31.4	42.2	45.8	60.2
Commercial control:				
United States	1,239,633	1,001,250	836,747	383,478
Percent	68.6	57.8	54.2	39.8
Domestic production	885,826	705,074	528,875	239,992
Percent	49.0	40.7	34.3	24.9
Foreign production	353,807	296,176	307,872	143,486
Percent	19.6	17.1	19.9	14.9
Foreign	567,053	732,456	708,172	580,705
Percent	31.4	42.2	45.8	60.2
Four chief American groups	947,052	711,189	668,334	307,237
Percent	52.4	41.0	43.3	31.9
Domestic sources	593,245	415,013	360,462	163,751
Percent	32.8	23.9	23.4	17.0
Foreign sources	353,807	296,176	307,872	143,486
Percent	19.6	17.1	19.9	14.9
Others	859,634	1,022,517	876,585	656,946
Percent	47.6	59.0	56.7	68.1
Domestic sources	292,581	290,061	168,413	76,241
Percent	16.2	16.8	10.9	7.9
Foreign sources	567,053	732,456	708,172	580,705
Percent	31.4	42.2	45.8	60.2

World mine production of copper, 1928–32, in metric tons

Country [1]	1928	1929	1930	1931	1932
North America:					
Canada	91,941	112,545	137,655	132,586	112,344
Cuba	16,546	14,982	15,693	13,507	5,927
Mexico	67,328	86,554	73,412	54,212	35,213
Newfoundland	147	936	956	1,459	2,153
United States	820,906	904,962	639,629	479,785	217,716
	996,868	1,119,979	867,345	681,549	373,353
South America:					
Bolivia [2]	8,486	7,188	3,987	2,049	2,017
Chile	286,800	320,630	220,323	223,284	(3)
Peru	[4] 56,457	[4] 56,115	[5] 48,276	[5] 44,319	22,890
Venezuela	----------	----------	96	746	(3)
	351,743	383,933	272,682	270,398	(3)

[1] In addition to the countries listed, copper is produced in Asiatic Turkey, but data of output are not available.
[2] Copper content of exports.
[3] Data not available.
[4] Figures represent output of the more important districts only; that is, those reporting production of not less than 100 tons of fine copper.
[5] Content of sales and shipments.

World mine production of copper, 1928–32, in metric tons—Continued

Country	1928	1929	1930	1931	1932
Europe:					
Austria	3,035	2,081	2,216	1,313	(3)
Bulgaria [6]	1,000	2,000	2,000	1,000	(3)
Czechoslovakia	1,627	1,359	1,790	1,252	(3)
Finland	3,410	4,565	4,986	6,396	(3)
France	265	596	422	200	(3)
Germany	26,213	28,983	26,972	29,827	(3)
Great Britain	69	69	49	67	(3)
Greece	1	(7)	----------	----------	(3)
Italy	822	883	983	364	(3)
Norway	15,779	18,890	17,317	8,708	(3)
Portugal [6]	2,000	4,000	4,000	3,000	(3)
Rumania [8]	104	143	169	(7)	----------
Russia	[9, 10] 20,200	[9, 10] 26,000	[10] 34,100	[10] 31,100	(3)
Spain	54,200	63,700	58,400	54,000	(3)
Sweden	619	1,128	5,523	8,542	(3)
Yugoslavia	15,100	15,200	22,700	21,100	(3)
	[10] 144,444	[10] 169,597	[10] 181,627	[10] 166,869	(3)
Asia:					
China [11]	4,395	3,469	1,203	157	(3)
Cyprus [3]	4,900	5,900	5,200	3,900	(3)
India, British	5,500	7,200	11,800	11,600	(3)
Japan:					
Japan proper [8]	68,233	75,469	79,033	76,408	70,646
Chosen [8]	607	547	589	[6] 600	(3)
Taiwan	1,300	6,100	3,060	[6] 3,100	(3)
Russia	(10)	(10)	(10)	(10)	(3)
	[10] 84,935	[10] 98,685	[10] 100,885	[10] 95,800	(3)
Africa:					
Algeria	230	25	1	----------	6
Belgian Congo [8]	[12] 112,456	[12] 136,992	[12] 138,949	[13] 120,000	[13] 54,000
French Congo	380	186	300	155	(3)
Morocco, French	----------	75	----------	----------	(3)
Rhodesia:					
Northern	[8] 6,026	[8] 5,553	[8] 6,370	23,000	(3)
Southern [8]	110	362	1,334	538	6
South-West Africa [14]	11,300	12,600	15,100	19,300	(3)
Union of South Africa	[8] 8,849	[8] 9,309	8,627	10,206	9,402
Volta, Upper	----------	----------	(15)	(15)	(3)
	139,351	165,102	170,681	173,199	(3)
Oceania:					
Australia	9,618	13,018	13,192	13,749	(3)
New Caledonia	----------	----------	50	(3)	(3)
Papua [16]	1	----------	(7)	----------	(3)
	9,619	13,018	13,242	13,749	(3)
	1,727,000	1,950,000	1,606,000	1,402,000	(3)

[3] Data not available.
[6] Approximate production.
[7] Less than half a ton.
[8] Smelter product.
[9] Year ended Sept. 30.
[10] Small output from Russia in Asia included under Russia in Europe.
[11] Exports of ingots and slabs.
[12] Includes copper smelted in Belgium from mattes and alloys produced in the Belgian Congo as follows: 1928, 946 tons; 1929, 1,453 tons; 1930, 2,545 tons.
[13] Fine copper content of smelter output.
[14] Year ended Mar. 31 of year following that stated.
[15] Production of copper ore reported as follows: 1930, 600 tons; 1931, 900 tons. No data on copper content available.
[16] Copper content of exports for year ended June 30 of year stated.

World smelter production of copper, 1928–32, in metric tons

Country [1]	1928	1929	1930	1931	1932
North America:					
Canada [2]	56,619	72,661	101,554	110,588	95,691
Mexico	46,865	58,997	54,025	[3] 43,000	[3] 32,000
United States [4]	911,444	998,789	729,611	537,175	278,997
	1,014,928	1,130,447	885,190	690,763	406,688
South America:					
Chile	274,900	303,188	208,011	215,696	(5)
Peru	[2] 52,292	[2] 53,962	[2] 47,287	44,395	22,531
	327,192	357,150	255,298	260,091	(5)
Europe:					
Austria	3,424	3,895	4,076	3,235	(5)
Belgium [6]	9,720	8,940	14,640	31,400	(5)
Czechoslovakia	1,010	1,694	1,521	1,215	(5)
Finland	375	235	----	----	----
France	1,142	1,010	1,207	[3] 1,000	[3] 1,000
Germany [7]	48,500	53,600	59,200	55,500	50,600
Great Britain [8]	21,400	22,000	18,000	16,000	(5)
Italy	900	539	262	721	427
Norway	788	2,400	5,149	4,352	(5)
Rumania [9]	104	143	169	(10)	----
Russia	[11] 18,996	[3] 25,000	[3] 26,000	[3] 27,000	(5)
Spain	27,758	28,455	22,996	25,734	(5)
Sweden [12]	3,396	4,748	5,523	2,854	(5)
Yugoslavia	15,086	20,675	24,463	24,351	(5)
	152,599	173,334	183,206	193,362	(5)
Asia:					
China [13]	4,395	3,469	1,203	157	(5)
Chosen	607	547	589	[3] 600	(5)
India, British	----	1,661	3,022	4,134	(5)
Japan	68,233	75,469	79,033	76,408	70,646
	73,235	81,146	83,847	81,299	(5)
Africa:					
Belgian Congo	[14] 111,510	[14] 135,539	[14] 136,404	[2] 120,000	[2] 54,000
Rhodesia:					
Northern	6,026	5,553	6,370	9,070	68,977
Southern	110	362	1,334	538	6
Union of South Africa	8,849	9,309	7,488	10,225	9,837
	126,495	150,763	151,596	139,833	132,820
Oceania: Australia	12,048	11,049	15,139	13,144	(5)
	1,706,000	1,904,000	1,574,000	1,378,000	[3] 910,000

[1] In addition to the countries listed, copper is smelted in Asiatic 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: 1928, 828,210 tons; 1929, 908,479 tons; 1930, 632,481 tons; 1931, 472,963 tons; 1932, 246,757 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 domestic ores.
[10] Less than 1 ton.
[11] Year ended Sept. 30.
[12] Exclusive of material from scrap.
[13] Exports of ingots and slabs.
[14] In addition to the crude copper smelted in the Belgian Congo, the following quantities were smelted in Belgium from matte and alloys produced in the Belgian Congo: 1928, 946 tons; 1929, 1,453 tons; 1930, 2,545 tons.

LEAD

By C. W. Wright and H. M. Meyer

Domestic production of lead in 1932 was 288,361 short tons, a decrease of 154,403 tons (35 percent) from the 1931 output. As with most metals, the lack of demand or consumption due to business conditions was the principal cause of this decline. The production of secondary pig lead—amounting to 128,000 tons, derived almost entirely from old storage batteries—did not decrease and was in part responsible for the lack of demand for primary lead. The total amount of secondary lead recovered in 1932 was 78 percent of the recovery of primary domestic lead.

The decline in consumption has been so rapid that the producers have been unable to adjust themselves to it, and this, with the reduction in the market price for lead, has been disastrous financially to even the strongest companies and has caused complete suspension of numerous important lead-producing mines. Neither the curtailment in output nor the reduction in price prevented stocks of lead from increasing to a total of 176,000 tons at the end of the year. Equilibrium of the market requires further curtailment of production for a year or more, as well as improvement in general business. It is noteworthy, however, that while domestic producers reduced their output 35 percent below that of 1931, foreign production was curtailed only 12 percent in 1932.

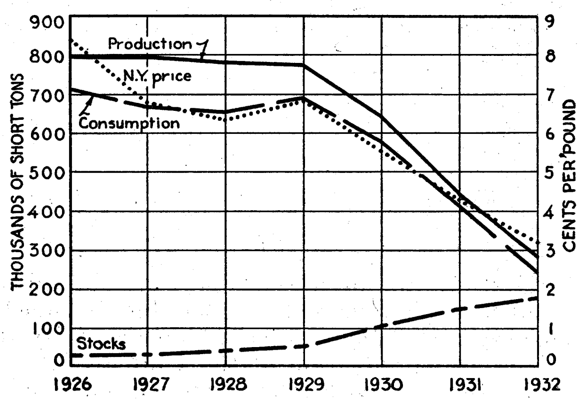

Figure 3.—Trends in production, consumption, stocks, and prices of primary lead in the United States, 1926–32.

Figure 3 shows trends in production, consumption, stocks, and prices of primary lead in the United States for the past 7 years.

The following summary table includes the salient statistics of the lead industry in the United States for 1931 and 1932.

It is evident that consumption must increase or production decline further to reduce stocks on hand.

As for the advance in mining and metallurgical practice and in research on uses of lead by producing companies and their organizations, the record of the past year offers virtually nothing of importance.

Salient statistics of the lead industry in the United States, 1931–32

	1931	1932
Production of refined primary lead:		
From domestic ores ... short tons	390,260	255,337
From foreign ores and base bullion ... do	52,504	33,024
	442,764	288,361
Recovery of secondary lead:		
As pig lead ... do	128,800	128,000
In alloys ... do	105,900	70,300
	234,700	198,300
Total production of pig lead (primary and secondary) ... do	571,564	416,361
Imports (general):		
Lead in base bullion ... do	32,320	13,462
Lead in ore ... do	20,888	21,001
Exports of refined pig lead ... do	21,665	23,516
Refined primary lead available for consumption ... do	410,606	257,669
Estimated consumption of primary and secondary lead ... do	567,700	400,000
Prices per pound of refined lead at New York:		
Highest monthly average ... cents	4.80	3.75
Lowest monthly average ... do	3.79	2.73
Average for year ... do	4.24	3.18
Quotation at end of year ... do	3.75	3.00
Mine production of recoverable lead ... short tons	404,622	[1] 290,911
Southeastern Missouri district ... percent of total	39	40
Utah ... do	20	21
Idaho ... do	25	24
Joplin (tri-State) region ... do	5	6
All other ... do	11	9
World smelter production of lead ... metric tons	1,401,000	1,157,000
United States ... percent of total	27	22
Mexico ... do	16	12
Australia ... do	11	15
Canada ... do	9	10
Spain ... do	8	9
All other ... do	29	32

[1] Subject to revision.

Capital has not been available for technical improvements in either mining or metallurgical practice due to forced economies and to the fact that most plants have a larger capacity than is needed.

The lead production of the United States, compared with world production and with that of copper and zinc, is shown in figure 1 on page 1.

The similarity of the graphs in trend and tonnage is noteworthy. A study of these and of the production tables shows a relatively greater decrease in the lead production of the United States compared with world output than in that of copper and zinc. Curtailment in lead output in foreign countries in 1932 was only 12 percent compared with a 33 percent decrease in the output of the United States exclusive of refined lead from foreign base bullion. The reason is that foreign consumption declined only 10 percent as against a decrease of 31 percent in the United States. Except the United States, Mexico shows the greatest reduction in output—84,000 metric tons—followed by Poland with a 20,000-ton decrease, while the lead production in Australia was increased 25,000 tons due to addition of the Mount Isa output. In Italy the 1932 production increased 6,800 tons.

Prices.—The average New York market price for lead in 1932 was 3.18 cents per pound compared with 4.24 in 1931 and 6.83 in 1929. There was a period of extremely low prices in July, when the quotation reached an all-time low of 2.65. Although prices rose to 3.60 in August, at the end of the year they were again down to 3 cents. St. Louis monthly prices were 0.10 to 0.21 cents below the New York quotations.

The differential between London and New York ranged from 1.12 cents in April to 1.48 cents in August, showing that a 2⅛-cent duty has never enabled the United States producers to charge this full differential. Internal competition is now keeping domestic prices much below the possible London parity.

Average monthly and yearly quoted prices of lead at St. Louis, New York, and London, 1930-32, in cents per pound [1]

Month	1930			1931			1932		
	St. Louis	New York	London	St. Louis	New York	London	St. Louis	New York	London
January	6.10	6.25	4.68	4.60	4.80	3.01	3.55	3.75	2.31
February	6.09	6.24	4.60	4.33	4.54	2.92	3.51	3.72	2.25
March	5.56	5.67	4.08	4.28	4.53	2.85	2.99	3.15	2.01
April	5.43	5.53	4.09	4.17	4.39	2.69	2.90	3.00	1.88
May	5.41	5.51	3.86	3.65	3.82	2.50	2.90	3.00	1.75
June	5.31	5.39	3.89	3.76	3.92	2.52	2.89	2.99	1.56
July	5.15	5.23	3.94	4.22	4.40	2.76	2.59	2.73	1.56
August	5.33	5.49	3.98	4.22	4.40	2.59	3.09	3.24	1.76
September	5.35	5.49	3.89	4.22	4.33	2.41	3.32	3.46	2.03
October	5.00	5.15	3.42	3.78	3.96	2.30	2.94	3.06	1.81
November	4.95	5.10	3.45	3.76	3.94	2.42	2.93	3.05	1.77
December	4.95	5.10	3.31	3.59	3.79	2.29	2.88	3.00	1.63
Average	5.38	5.52	[2] 3.92	4.05	4.24	[2] 2.64	3.04	3.18	[2] 1.83

[1] St. Louis: Metal Statistics, 1933, p. 333. 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, 1933, p. 337. 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: 1930, £18.075; 1931, £13.029; 1932, £11.913.

Consumption by uses.—The quantity of lead in all forms consumed by domestic industry is estimated by the American Bureau of Metal Statistics to be as shown in the following table:

Lead consumed in the United States,[1] *1928-32, in short tons*

Purpose	1928	1929	1930	1931	1932
White lead [2]	123,000	119,700	83,900	77,500	54,500
Red lead and litharge [3]	31,000	30,000	32,000	18,000	15,800
Storage batteries [4]	220,000	210,000	163,000	157,000	138,000
Cable covering [4]	180,000	220,000	208,000	117,000	55,000
Building [5]	96,000	96,000	67,000	40,000	22,000
Automobiles [5]	17,000	18,000	11,000	6,000	3,500
Railway equipment [5]	2,500	5,700	5,200	1,000	300
Shipbuilding [5]	100	300	500	400	200
Ammunition [4]	39,600	41,100	33,300	29,700	23,300
Terneplate [4]	4,400	4,200	2,700	2,200	1,400
Foil [4]	35,000	39,800	26,000	20,000	14,000
Bearing metal [6]	32,000	33,000	20,000	12,000	10,000
Solder [7]	37,000	37,000	27,000	20,500	14,000
Type metal [7]	17,000	18,000	16,000	14,400	10,800
Calking [7]	32,000	31,500	21,000	15,000	10,000
Castings [7]	18,000	18,000	12,000	7,000	5,000
Other uses [8]	46,000	50,000	40,000	30,000	22,200
Total	930,600	972,300	768,600	567,700	400,000

[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.
[2] From data of sales reported by U.S. Bureau of Mines for 1928. Later figures have been determined by an improved method.
[3] Exclusive of oxides for storage batteries.
[4] Based on reports from al arge proportion of manufacturers in each industry.
[5] Based on estimates of manufacture and the quantity of lead used per unit of manufacture. Under the head of building is included the lead used in chemical construction.
[6] Based on the estimated consumption of lead for this purpose by the railways.
[7] Estimates of persons engaged in the trades.
[8] Conjectural.

Lead consumed in the United States in 1932 was only approximately 400,000 tons, a decrease of 30 percent from 1931 and 59 percent from 1929, the year of record consumption. The storage-battery industries ranked first as consumers of lead, followed by its use as cable covering and as white lead in paints. The consumption in storage batteries is estimated at 138,000 tons in 1932, a reduction of 12 percent from 1931. Much of the lead used in storage batteries is of secondary origin.

Consumption in the cable industry dropped 53 percent compared with that of 1931 and 75 percent compared with 1929, reflecting the economies necessary in the communication business and lack of capital for new undertakings.

The above table shows that slightly less lead was consumed as white lead than for cable covering. An amount of lead oxide nearly equal to that indicated as white lead was consumed in storage batteries. There was a 45 percent reduction in consumption for building purposes and a 22 percent reduction in the use of lead for ammunition compared with 1931.

PRIMARY LEAD

Refinery production.—The following table traces the production of refined primary lead in the United States from 1928 to 1932.

Refined primary lead produced in the United States, 1928–32

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
1928	506,603	49,465	225,003	781,071	626,202	26,632	128,237	$0.058	$90,604,000
1929	483,622	55,666	235,345	774,633	672,498	29,675	72,460	.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

[1] The lead content of antimonial lead is excluded (see p. 57).
[2] Desilverized soft lead is excluded.

The 1932 production of refined primary lead from domestic ores in the United States was 35 percent less than in 1931 and 55 percent less than in 1930. Lead derived from smelting foreign ores declined but little, while that from foreign base bullion decreased 63 percent.

Source of ore.—The following table shows the source of foreign ores smelted and refined in the United States in 1932. The total lead production from domestic ores is added, the approximate details of its source being given in a table on mine production on page 58.

The figures for total lead produced from domestic ore include both base bullion and refined lead and thus contain a large part of the antimonial lead produced from domestic ores.

The sharp decline in production of refined lead from Mexican base bullion in recent years is ascribed to the completion of additional refining capacity in Mexico and to more favorable freight rates from smelters to points of export in Mexico.

Primary lead smelted or refined in the United States, 1928–32, by sources, in short tons

Source	1928	1929	1930	1931	1932
Domestic ore	642,697	685,992	580,013	393,599	257,041
Foreign ore:					
Australia	2	5	3		30
Canada	10,123	9,499	14,369	3,816	3,797
Europe	67	28	41	43	4,491
Mexico	14,839	16,807	14,949	6,420	334
South America	1,568	3,285	3,476	2,299	2,631
Other foreign	33	51	1,510	9,676	10,464
Foreign base bullion:					
Mexico	117,193	51,295	18,592	30,072	11,164
South America	11,044	21,165	16,353	178	113
	154,869	102,135	69,293	52,504	33,024
Grand total	797,566	788,127	649,306	446,103	290,065

Soft lead.—Soft lead is produced principally from the nonargentiferous ores of the Central States and in 1932 constituted 39 percent of the total domestic production. Most of these ores are smelted into pig lead, but a substantial quantity is used in the manufacture of lead pigments. Undesilverized soft lead often has a relatively high copper content and is resistant to corrosion by acids. It is known to the trade as chemical lead and is used chiefly in the manufacture of cable, pipe, and sheets.

Soft lead produced in the United States from domestic ores, 1928–32, 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				
1928	225,003	49,465	274,468	10,465	284,933	652,492	44
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

[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 table below).

Antimonial lead.—The principal uses of antimonial or hard lead are in the manufacture of storage batteries, bearing metals, corrosion-resistant alloys, and type metal. A large percentage of the metal so used returns as scrap, and the smelting of such scrap provides the major part of the antimonial lead used, the remainder being supplied by the refining of base bullion and by mixing metallic antimony with refined soft lead.

Antimonial lead produced at primary lead refineries, 1928–32

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
1928	17,930	15,128	12,418	45,476	4,787	10.5	(1)	(1)	(1)	40,689
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

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

Pigments.—Refined pig lead is used in the manufacture of white lead, litharge, red lead, sublimed lead, and orange mineral. Sublimed lead and leaded zinc oxide are the principal pigments derived directly from lead-zinc ores.

Lead in pigments,[1] 1928–32, 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
1928	10, 465	242, 914	654	254, 033	1931	5, 722	166, 328	710	172, 760
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					

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

The pigment industries ranked first in 1932 as consumers of primary lead. The 132,000 tons of primary lead used in the manufacture of pigments were about 50 percent of the primary lead production. The principal uses of pigments are in the manufacture of paints and storage batteries. Further details are given in the chapter on Lead and Zinc Pigments and Salts.

Mine production.—Detailed information on mining activities in the various districts of the United States can be found in the chapters dealing with the mine production of gold, silver, copper, lead, and zinc in the various States.

The following tables show the mine production of recoverable lead by States and by districts from 1928 to 1932:

Mine production of recoverable lead, 1928–32, by States, in short tons

State	1928	1929	1930	1931	1932[1]
Alaska	1, 019	1, 315	1, 365	1, 661	1, 280
Arizona	7, 190	8, 027	4, 246	982	1, 000
Arkansas	38	51	53	78	4
California	946	715	1, 780	1, 879	1, 100
Colorado	26, 751	24, 445	22, 130	6, 884	2, 060
Idaho	145, 323	148, 695	134, 058	99, 365	71, 000
Illinois	385	443	248	205	31
Kansas	25, 276	26, 596	12, 910	7, 082	6, 490
Kentucky	39	287	101		
Missouri	195, 393	198, 469	199, 632	160, 121	117, 159
Montana	16, 880	19, 607	10, 653	4, 430	1, 190
Nevada	7, 874	9, 846	11, 529	7, 930	630
New Mexico	7, 805	11, 130	10, 378	11, 269	10, 780
New York			(2)	(2)	(2)
Oklahoma	43, 687	46, 513	23, 052	13, 210	10, 634
Oregon	7	10	5	2	3
South Dakota	37				
Tennessee			(2)	(2)	(2)
Texas	348	425	198		
Utah	145, 915	149, 377	115, 495	79, 212	61, 240
Virginia	(3)	(3)	(2)	(2)	(2)
Washington	542	508	576	1, 386	940
Wisconsin	1, 698	1, 536	1, 537	952	910
Undistributed			8, 367	7, 974	4, 460
	[4] 627, 153	[4] 647, 995	558, 313	404, 622	290, 911

[1] Subject to revision.
[2] Included under "Undistributed." Bureau of Mines not at liberty to publish figures.
[3] Bureau of Mines not at liberty to publish figures.
[4] Exclusive of the output from Virginia, figures for which the Bureau of Mines is not at liberty to publish.

Of the total 1932 mine output, Missouri produced 40 percent, Idaho 24 percent, Utah 21 percent, and New Mexico and Oklahoma 4 percent each. The total mine production was 38 percent less than that for 1931.

SECONDARY LEAD

The leading consumer of lead and the source of a large and rapid return of secondary metal is the storage-battery industry. In 1932 198,300 tons of secondary lead were recovered; of this amount, over half was from storage batteries. The balance of the secondary metal was from cable piping, bearing, and type metal and other lead alloys.

This recovery of secondary lead, which in 1932 was equivalent to 78 percent of the production of primary domestic lead, is becoming a serious handicap to the lead-mining industry. Further details on secondary lead are given in the chapter on Secondary Metals.

Secondary lead recovered in the United States, 1928–32 [1]

Year	Pig lead (short tons)	Lead in alloys (short tons)	Total recovered lead		
			Short tons	Value	Ratio to domestic refined primary lead (percent)
1928	138,000	170,600	308,600	$35,797,600	49
1929	138,500	172,500	311,000	39,186,000	46
1930	129,000	126,800	255,800	25,580,000	45
1931	128,800	105,900	234,700	17,367,800	60
1932	128,000	70,300	198,300	11,898,000	78

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

IMPORTS AND EXPORTS

Imports of lead in base bullion, which come principally from Mexico, decreased 58 percent in 1932, while imports of lead in ore and matte remained virtually the same as for 1931, the receipts from Sweden offsetting in part the decrease from Mexico. Total exports of refined pig lead show a small increase in tonnage but a decrease in value.

In the following tables the lead imports are given for the past 5 years by classes and by countries. The tonnage of lead held in bonded warehouses in various forms at the end of each year is also given. The last two tables show the tonnage of refined lead exported, by classes and by destinations.

Statistics on imports for consumption, as shown in the tables that follow, include imports entered for immediate consumption and withdrawals from warehouses for domestic consumption. As most of the lead imported is smelted and refined in bond and reexported, the total imported for consumption is much less than general imports.

Lead imported into the United States, 1928–32, by classes, in short tons

[General imports]

Year	Lead in ore and matte	Lead in base bullion	Pigs, bars, sheets, and old	Total lead content
1928	25,915	128,468	661	155,044
1929	31,331	83,071	1,657	116,059
1930	39,377	38,630	209	78,216
1931	20,888	32,320	[1] 10	53,218
1932	21,001	13,462	44	34,507

[1] Reclaimed scrap, etc. No imports of pigs, bars, etc., were recorded for 1931.

Lead imported into the United States, in ore, base bullion, and refined, 1928–32, by sources, in short tons

[General imports]

Year	Canada	Mexico	South America	Europe	Other countries	Total
1928	7,177	137,592	10,204	28	43	155,044
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	2,171	----------	[1] 9,723	53,218
1932	2,459	13,545	2,811	5,053	[2] 10,639	34,507

[1] Of this total, 9,708 short tons were from Newfoundland and Labrador.
[2] Of this total, 10,598 short tons were from Newfoundland and Labrador.

Lead imported into the United States, in ore and matte, 1928–32, by countries, in short tons

[General imports]

Country	1928	1929	1930	1931	1932
Canada	7,131	3,953	17,257	2,614	2,459
Chile	504	2,295	3,313	1,866	2,211
Mexico	17,055	23,415	16,341	6,495	195
Newfoundland and Labrador	----------	(1)	----------	9,708	10,598
Peru	1,170	1,601	831	194	477
Sweden	----------	----------	----------	----------	5,024
Other countries	55	67	1,635	11	37
	25,915	31,331	39,377	20,888	21,001

[1] Less than 1 ton.

Lead imported into the United States, in base bullion, 1928–32, by countries, in short tons

[General imports]

Country	1928	1929	1930	1931	1932
Mexico	119,935	63,458	20,350	32,210	13,340
Peru	8,525	19,605	18,280	110	121
Other countries	8	8	----------	----------	1
	128,468	83,071	38,630	32,320	13,462

Lead remaining in warehouses in the United States, December 31, 1928–32, 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
1928	48,823	68,750	4,139	1931	52,849	5,343	(1)
1929	60,207	75,434	1,328	1932	42,314	3,769	(1)
1930	39,516	[1] 5,642	(1)				

[1] Pigs, bars, and old included with base bullion; not recorded separately for 1930–32.

Lead imported for consumption in the United States, 1928–32, 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		
1928	23,256	$2,626,231	6,699	$560,983	10,244	$808,359	388	$67,131	$134,995	$4,197,699
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

[1] Classification as follows: Jan. 1, 1928, to June 17, 1930, "Lead in ore and matte"; June 18, 1930, through 1932, "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, 1928–32

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
1928	938	423	$569,486	1,995	1,543	$193,177
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

Refined lead exported from the United States, 1928–32

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	
1928	116,269	$10,359,221	13,224	1931	21,665	$1,241,881	10,503
1929	73,251	7,178,337	13,086	1932	23,516	1,069,697	7,220
1930	48,307	3,904,213	12,161				

Refined pig lead exported from the United States, 1928–32, by destinations, in short tons

Destination	1928	1929	1930	1931	1932
COUNTRIES					
Argentina	1, 243	599	934	226	-------
Brazil	2, 439	1, 538	874	1, 382	759
Canada	132	141	9	58	133
France	4, 628	2, 202	3, 001	318	224
Germany	23, 552	9, 745	823	52	1, 344
Japan	21, 216	16, 416	15, 653	17, 301	20, 219
Mexico	79	83	40	171	13
Netherlands	5, 088	1, 522	22	13	112
Philippine Islands	210	111	543	400	475
Sweden	5, 316	7, 255	7, 557	392	-------
United Kingdom	43, 428	23, 732	9, 157	3	-------
Uruguay	384	448	364	145	84
Other	8, 554	9, 459	9, 330	1, 204	153
	116, 269	73, 251	48, 307	21, 665	23, 516
CONTINENTS					
North America	472	693	318	435	160
South America	4, 834	3, 852	2, 442	1, 903	863
Europe	87, 161	50, 649	27, 899	795	1, 793
Asia	23, 802	18, 055	17, 289	18, 524	20, 700
Africa and Oceania	-------	2	359	8	-------
	116, 269	73, 251	48, 307	21, 665	23, 516

WORLD PRODUCTION

World smelter production in 1932 totaled 1,157,000 metric tons, of which the United States produced 251,365 tons (22 percent) as against 27 percent in 1931.

In spite of the low price for lead in the United States production continued to exceed consumption. Mexican production shrank considerably, but there was an increased production in Australia. The total figures show only a 12 percent curtailment in the foreign production against a 33 percent reduction in the United States output exclusive of refined lead from foreign base bullion. Further curtailment is necessary both in the United States and foreign countries to reduce stocks and bring the lead output into equilibrium with its market.

For the first time in many years the United States lead mines were second on the monthly production-record list. During July and August of 1932, Australian mines were first. The world output during recent months seems to have come to a resting point at about 100,000 tons per month.

The lead situation abroad has been complicated by depreciated foreign exchange, which enables the foreign countries off the gold standard to sell their production on a more favorable exchange basis, whereas payment for labor is made in depreciated currency. Australia is a good example of this situation.

The following table shows the world smelter production of lead from 1928–32, so far as statistics are available. Official figures are used wherever possible.

Duplication in figures showing world production is always possible, as some countries sent "work lead" or base bullion to other countries for refining. Furthermore, secondary lead and antimonial lead are often included in the figures of foreign production, whereas the figures for the United States represent only refined primary lead smelted in this country, whatever the source of the ore; refined lead produced from foreign base bullion is excluded.

World production of lead, 1928–32, in metric tons [1]

Country [2]	1928	1929	1930	1931	1932
Argentina	8,291	9,020	8,882	7,609	3,481
Australia	157,565	180,358	171,248	152,850	177,900
Austria	8,135	6,569	6,935	6,117	1,906
Belgium	86,260	82,850	85,370	70,850	[3] 70,000
Canada	136,561	138,095	138,105	126,301	114,820
Chosen	719	333	130	[3] 200	[3] 200
Czechoslovakia	3,065	4,609	4,225	3,569	[3] 4,000
France	22,656	20,358	20,170	19,100	12,000
Germany [4]	87,000	97,900	110,800	101,300	95,216
Great Britain	8,638	10,839	10,383	10,723	[3] 8,000
Greece	7,306	5,361	7,329	6,707	[3] 6,000
Hungary	(5)	109	70	52	(5)
India (Burma)	79,642	81,521	81,010	75,985	72,346
Indo-China	10	17	11	5	10
Italy	21,220	22,650	24,340	24,882	31,644
Japan	3,653	3,374	3,581	4,000	[3] 4,000
Mexico	227,860	239,952	242,537	220,956	137,099
Northern Rhodesia	4,751	1,661	------	------	------
Norway	[3] 300	[3] 300	[3] 300	347	[3] 300
Peru	14,466	19,448	14,979	252	[3] 200
Poland	37,078	35,789	40,900	31,875	11,902
Portugal	84	94	89	108	[3] 100
Rumania	537	565	984	1,314	[3] 1,000
Russia	[6] 2,592	[6] 6,200	10,750	19,600	[3] 20,000
South-West Africa [7]	5,004	2,802	3,661	2,641	[3] 3,000
Spain	130,950	142,753	123,263	109,630	105,807
Tunisia	17,606	18,850	19,400	19,112	14,082
Turkey	8,062	7,324	4,664	2,767	[3] 3,000
United States (refined) [8]	592,238	636,997	551,645	374,224	251,365
Yugoslavia	13,875	9,471	10,049	7,928	[3] 8,000
	1,686,000	1,786,000	1,696,000	1,401,000	1,157,000

[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] Approximate production.
[4] Exclusive of secondary material (Metallgesellschaft, Frankfort).
[5] Data not available.
[6] Year ended Sept. 30.
[7] Year ended Mar. 31 of year following that stated.
[8] Figures cover domestic refined and lead refined from foreign ore; refined lead produced from foreign base bullion not included.

Australia.—The increase of 24,600 long tons in the Australian lead production is due largely to the increased output at the Mount Isa properties in Queensland. About 75,000 tons per month of ore averaging over 10 percent lead and 5 ounces silver are now being treated at this mine. A third blast furnace and sintering machines were installed at the smelter, raising the capacity to 6,000 tons of bullion per month. As in the past, the main lead production was derived from the lead and zinc concentrates produced in the Broken Hill district. Reduction in wage scales and favorable foreign exchange rates aided producers in this district in 1932. At the close of the year all four principal companies were operating, Sulphide Corporation having reopened in April after having been idle since December 1930. Improvements at the Port Pirie lead smelter and refinery in handling materials and the continuous softening and desilverizing operations are noteworthy.

Exports of bullion and refined lead increased 18 percent in 1932 and amounted to 172,000 tons. Europe took 98 percent of the total, Great Britain being by far the largest consumer. Exports to the latter country increased about 18 percent, due largely to shipments of Mount Isa bullion to the Northfleet refinery and to the imposition of a 10-percent tariff on non-British lead imported into Great Britain. Exports of lead ore and concentrates decreased 75 percent in 1932.

Canada.—Canada's output of lead shows a relatively small decrease for 1932. It is produced almost entirely by the Sullivan mine of the Consolidated Mining & Smelting Co. The ore is a massive sulphide averaging about 12 percent zinc, 10 percent lead, and 3 ounces silver. It is noteworthy that despite the lower price for lead this mine could continue production at about the same rate as in 1931 and that the sales of metal kept pace with the output. A total of 1,447,448 short tons was milled at this property in a flotation plant of high efficiency. Production from the Mayo district, Yukon territory, dropped from 2,227 tons in 1931 to 1,928 tons in 1932.

A large part of Canada's lead production is exported. In 1932, 107,000 short tons of pig lead or 85 percent of the total production was shipped abroad. Great Britain took 57 percent and Japan 26 percent of the total. The 27-percent increase in shipments to Great Britain may be ascribed in part to the tariff imposed on non-British lead there. About 1,857 tons of lead in the form of ore were also exported in 1932.

Germany.—Germany ranks third in consumption of lead and sixth in smelter production. In 1932 it consumed about 123,000 metric tons and smelted about 95,000 tons but mined only 43,000 tons. To meet the requirements of industry and the export trade, 51,000 tons of pig lead and 67,000 tons of lead ore were imported. There were 5,000 tons of ore and 23,000 tons of pig lead exported. Newfoundland supplied 48 percent and Yugoslavia 19 percent of the lead ore imported. The principal sources of the pig lead were Australia, which supplied 48 percent of the total, and Mexico, 17 percent. Imports of lead ore increased 36 percent, whereas exports decreased 78 percent. The pig lead exported went to neighboring European countries.

During the current depression primary production of lead in Germany has been maintained fairly well, in spite of a severe decline in consumption. Comparing 1932 with the 5-year average (1925 to 1929), it is found that consumption dropped 38 percent, whereas smelter production increased 14 percent. Mine production declined only 8 percent. During 1932 the policy of Government aid through loans was continued on a broader basis by creation of a 6,000,000-mark fund, to be advanced to privately operated lead and zinc mines.

Mexico.—Smelter production of lead in Mexico decreased 38 percent in 1932. This decline was due in part to unfavorable exchange conditions and imposition of the British tariff on lead, which greatly reduced the imports of Mexican lead into Great Britain. The change from the gold peso to the silver peso in 1931 and the decline in exchange that followed gave the Mexican producer of lead an advantage in the European markets in 1931. However, depreciation in the currencies of the lead-producing countries of the British Empire following abandonment of the gold standard by Great Britain offset this advantage gained by Mexico.

Spain.—Notwithstanding the low prices for lead and the political disturbances in Spain the decline in lead production was less severe than in many other countries. Smelter production declined from 109,630 metric tons in 1931 to 105,807 tons in 1932 (3 percent). Exports of pig lead decreased from 83,000 to 79,000 tons. Imports of Spanish lead into Great Britain were reduced 79 percent, owing to the British tariff and the exchange situation, but this loss was largely offset by increased shipments to France and Germany. France took over 50 percent of the total in 1932. In March 1933 the Government called a conference of the leading mining companies to consider ways and means of ameliorating the serious situation brought about by continued low prices and of averting increased unemployment caused by cessation of operations at the mines. Some producers requested State aid in the form of loans amounting to 4,000,000 pesetas, but apparently a final decision was not reached. The situation is complicated by the fact that some of the largest mines are operated by foreign companies.

Belgium.—Belgium ranked third in European lead production and eighth in world production in 1932, with an output estimated at 70,000 metric tons, only 1 percent under that for 1931. The lead smelted in Belgium is derived largely from foreign ores; 42,000 tons of lead ores were imported in 1932 compared with 56,000 tons in 1931. Much lead is also derived from residues from foreign zinc ores smelted in Belgium. In 1932 Belgium imported 32,000 tons of pig lead, scrap, etc., and exported 49,000 tons in the form of pigs, pipes, sheets, etc.

India.—The Bawdwin mines of the Burma Corporation are responsible for the entire output of lead from India. The average content of the ore extracted was, lead, 22.6 percent; zinc, 11.3 percent; copper, 1.48 percent; and silver, 20.1 ounces. Continued and advancing economy in the cost of production made it possible to show a substantial improvement for 1932 despite the decline in average metal prices. The total lead production declined only 5 percent. Exports of pig lead declined from 68,640 long tons in 1931 to 61,361 tons in 1932 or 11 percent. Great Britain took 75 percent and Japan 18 percent of the 1932 shipments. In contrast to Australia and Canada, which increased their exports to Great Britain in 1932, Indian exports declined 9 percent.

Great Britain.—Great Britain produces less than 1 percent of the world's lead but ranks second in consumption; in 1931 it consumed 21 percent of the total. This demand is supplied largely by importation. In 1932, 266,000 longs tons of pigs and sheets were imported, a decrease of 14 percent from 1931. A larger share of these imports was derived from the British dominions in 1932 than in 1931 owing to the imposition of a 10 percent tariff on non-British lead on March 1, 1932. In 1932 Canada, Australia, and British India supplied 86 percent of the total imports compared with 64 percent in 1931. Imports from Mexico and the United States dropped from 26 to 10 percent. There was a large increase in shipments from Australia owing to the flow of lead bullion from Mount Isa. Approximately 23,000 tons of pigs, sheets, and pipe were exported in 1932.

Lead consumption in Great Britain has held up remarkably well throughout the current depression. During the 5 years from 1925 to 1929 the yearly consumption averaged about 258,000 long tons; during 1930 it was about 266,000 tons; and in 1931, 256,000 tons, the latter being equivalent to 99 percent of the average for 1925 to 1929. The consumption in 1932 amounted to 221,000 tons, or 86 percent of the predepression average. In the British Empire as a whole production has also been well maintained. From 1925 to 1929 the yearly output averaged 361,000 tons. In 1930 the output was 398,000 tons, but in 1931 dropped to 363,000 tons. In 1932 it rose to 370,000 tons. The lead consumption of the Empire in 1931 was estimated at approximately 300,000 tons, indicating a surplus production of 63,000 tons (about 21 percent of the total consumption) in that year.

The Northfleet refinery of the Britannia Lead Co., which began operating in October 1931, produced 39,447 tons of refined lead, 1,829,947 ounces of silver, and 65 tons of antimonial lead from Mount Isa bullion during the year ended October 31, 1932.

Poland.—Due to the accumulation of large stocks, lack of demand, and low prices the lead smelters in Poland suspended operations in September. Operations were resumed in January 1933. The 1932 production was 63 percent less than in 1931. Exports declined from 20,600 metric tons in 1931 to 5,900 tons in 1932.

Yugoslavia.—Trepca Mines, Ltd., has proved to be one of the few producers able to operate profitably under the low prices prevailing in 1932. During the year ended September 30, 1932, the company treated 397,963 long tons of ore, from which 48,566 tons of 76 percent lead concentrates, containing 27 ounces of silver per ton, and 62,192 tons of 50 percent zinc concentrates were obtained. The ore mined averages 11.5 percent lead, 10.5 percent zinc, and 3 ounces silver. Mill capacity was increased nearly 50 percent during the year. Earnings permitted payment of a 10-percent dividend. Most of the concentrates produced are exported through Salonika.

ZINC

By E. W. Pehrson

Nineteen hundred and thirty-two ranks as one of the most unsatisfactory years in the history of the United States zinc industry. The average price for the year was the lowest on record. Smelter production of primary zinc was equivalent to only 34 percent of the annual

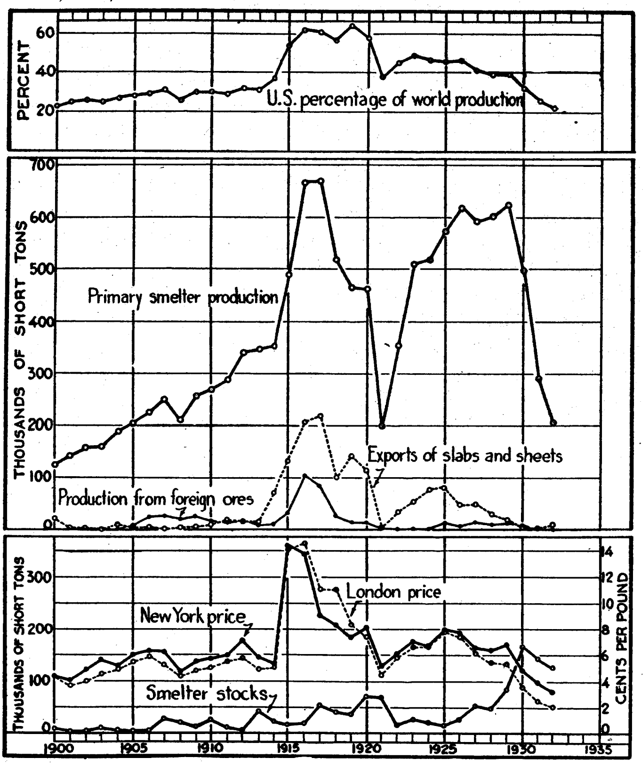

FIGURE 4.—Trends in the United States zinc industry, 1900–1932. Imports of slab and sheet zinc are not shown, since they seldom exceed 500 tons annually.

average from 1925 to 1929 and was the lowest since 1921. Mine production and consumption of primary zinc both declined to 39 percent of the 1925 to 1929 average and likewise were the lowest since 1921. Most of the principal zinc-producing companies reported large deficits in 1932.

Figure 4 shows trends in the United States zinc industry for 33 years.

The year was not without some hopeful aspects, however. The decline in price reached its lowest point in May, and during the rest of the year there was substantial recovery, so that by the end of December the quotation had regained the level of early January—the first time since 1928 that the price was not lower at the end of the year than at the beginning. The decline in the average price of zinc during the depression has been less pronounced than that of lead and copper.

During the first 7 months of 1932 the slump in production failed to keep pace with the shrinkage in demand, resulting in an increase in stocks, but during the last 5 months shipments exceeded production to such an extent that there was a net decline in stocks for the year. At the close of 1932 zinc stocks were equivalent to less than 3 months of normal consumption. The industry is thus in a relatively favorable statistical position and should be one of the first of the metal group to realize improvement should there be an increase in industrial activity.

Outside the United States the statistical position also was improved by a large and steady decline in stocks, but price increases commensurate with this improvement were not realized because of the sharp competition for markets and the hazardous existence of the International Zinc Cartel, which had controlled production and reduced stocks. The foreign situation was aggravated further by depreciated currencies, imposition of tariffs, and Government subsidies; nevertheless production, consumption, and even price suffered less severe declines abroad than in the United States.

A statistical summary follows, in which the zinc industry of the United States in 1930, 1931, and 1932 is compared with the 5 predepression years, 1925–29.

Salient statistics of the zinc industry in the United States, 1925–32

	1925–29 average	1930	1931	1932
Production of primary zinc:				
From domestic ores ... short tons	589,648	489,361	291,996	207,148
From foreign ores ... do	12,734	8,684		
	602,382	498,045	291,996	207,148
Electrolytic ... percent of total	21	26	28	11
Distilled ... do	79	74	72	89
Production of secondary slab zinc ... short tons	65,380	49,300	34,800	20,000
Stocks on hand at primary smelters Dec. 31 ... do	45,575	167,293	143,592	128,192
Primary zinc available for consumption ... do	544,016	408,469	312,592	213,280
Price—prime western at St. Louis:				
Average for year ... cents per pound	6.76	4.56	3.64	2.88
Highest quotation ... do	8.90	5.45	4.12½	3.50
Lowest quotation ... do	5.40	3.95	3.12½	2.30
Price—yearly average at London ... do	6.46	3.60	2.52	2.12
Mine production of recoverable zinc ... short tons	724,720	595,425	410,318	[1] 285,002
Tri-State district (Joplin) ... percent of total	49	36	29	32
Western States ... do	30	33	30	25
Other ... do	21	31	41	43
World smelter production of zinc ... short tons	1,435,000	1,537,000	1,102,000	887,000

[1] Subject to revision.

DOMESTIC PRODUCTION

Production of primary and secondary slab zinc.—Production of primary zinc in 1932 was the lowest since 1921, and the recovery of secondary unalloyed zinc the lowest since 1908. Compared with the

5-year period 1925–29, 1932 primary production of zinc had declined 66 percent and of secondary zinc 69 percent; the total output decreased 66 percent in quantity and 85 percent in value. As in 1931, all primary zinc was derived from domestic ores. 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, 1923–32

Year	Primary (short tons)			Secondary (short tons)			Total		
	Domestic	Foreign [1]	Total	Redistilled	Remelted	Total	Short tons	Value	Value per pound
1923	508,335	2,099	510,434	39,434	25,776	65,210	575,644	$78,288,000	$0.068
1924	515,831	1,508	517,339	35,486	23,400	58,886	576,225	74,909,000	.065
1925	555,631	17,315	572,946	39,181	22,249	61,430	634,376	96,425,000	.076
1926	611,991	6,431	618,422	40,799	23,771	64,570	682,992	102,449,000	.075
1927	576,960	15,556	592,516	42,784	22,016	64,800	657,316	84,136,000	.064
1928	591,525	11,056	602,581	48,666	22,034	70,700	673,281	82,140,000	.061
1929	612,136	13,311	625,447	47,348	18,052	65,400	690,847	91,192,000	.066
1930	489,361	8,684	498,045	[2] 34,849	14,451	49,300	547,345	52,545,000	.048
1931	291,996		291,996	[2] 21,625	13,175	34,800	326,796	24,836,000	.038
1932	207,148		207,148	14,718	5,282	20,000	227,148	13,629,000	.030

[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 it is nevertheless 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.—Production of electrolytic zinc declined more sharply in 1932 than that of distilled zinc. During the 5-year period 1925–29 electrolytic zinc accounted for 21 percent of the total primary production. In 1930 and 1931 this proportion increased, but in 1932 it fell to only 11 percent. This marked decline may be ascribed to the inability of electrolytic zinc plants to obtain raw materials due to their dependence on custom ore from the Western States where mining has been at a particularly low level as a result of the extremely low metal prices of recent years. Compared with 1929 electrolytic zinc declined 85 percent in 1932, primary distilled fell 61 percent, and redistilled secondary decreased 69 percent. The decline in production of redistilled secondary zinc was more pronounced at primary than at secondary smelters.

The sharp decline in electrolytic zinc production in 1932 is reflected in the decreased production of high-grade zinc. Compared with 1931 production of high-grade zinc declined 47 percent, whereas that of prime western fell only 27 percent.

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, 1928–32, in short tons

APPORTIONED ACCORDING TO METHOD OF REDUCTION

Year	Electrolytic primary	Distilled primary	Redistilled secondary [1]		Total
			At primary smelters	At secondary smelters	
1928	160,160	442,421	13,554	35,112	651,247
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

APPORTIONED ACCORDING TO GRADE

Year	Grade A (high grade)	Grade B (intermediate)	Grade C (brass special)	Grade D (selected)	Grade E (prime western)	Total
1928	197,675	41,779	73,957		337,836	651,247
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

[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 zinc by States.—Illinois and Pennsylvania again ranked first and second in zinc smelting in 1932; but Montana, which ranked third in 1931, fell to fifth. Oklahoma was the only State to report an increase in 1932. Kansas failed to report zinc production for the first time since 1877. West Virginia and Texas, included in "other States", showed substantial declines in 1932.

Primary zinc produced in the United States, by States, 1928–32, in short tons

Year	Arkansas	Idaho	Illinois	Kansas	Montana	Oklahoma	Pennsylvania	Other States	Total	Total value
1928	20,505	1,939	103,765	33,923	158,221	106,557	108,802	68,869	602,581	$73,515,000
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

Secondary zinc.—Besides the redistilled and remelted secondary slab zinc (unalloyed) previously mentioned 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 1932, including the unalloyed zinc, was 70,600 tons, a decrease of 31 percent from 1931 and the lowest output since 1910. 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 5 years.

Production and value [1] of sulphuric acid (60° B. basis) made at zinc-blende roasting plants in the United States, 1928–32

Year	Made from zinc blende		Made from sulphur		Total		
	Short tons	Value	Short tons	Value	Short tons	Value	Value per ton
1928	558,537	$5,523,931	546,204	$5,401,958	1,104,741	$10,925,889	$9.89
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

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

Production declined 27 percent in 1932, but notwithstanding the low rate of zinc production the quantity of acid made from blende showed a considerably smaller decrease than that made from sulphur. In 1931, 53 percent of the total was made from blende and 47 percent from sulphur, but in 1932 the percentages were 58 and 42 percent, respectively. The average price for 60° B. acid, received by producers in 1932, was 13 percent less than in 1931.

A list of acid plants using gases derived from the roasting of zinc blende was given on pages 273 and 274 of Mineral Resources of the United States, 1931, part I. The following table gives details of production from 1929 to 1932:

Details of production of byproduct sulphuric acid at zinc-blende roasting plants in the United States, 1929–32

	1929	1930	1931	1932
Number of establishments	21	21	21	20
Blende used ..... short tons	682,666	565,092	439,243	340,961
Sulphur used ..... do	176,525	125,740	[1] 100,956	65,510
Acid reported as 50°–60° B.:				
Produced (expressed as 60° B.) ..... short tons	694,990	548,660	390,278	290,237
Consumed at works (expressed as 60° B.) ..... do	33,474	28,206	16,375	13,061
Sold (expressed as 60° B.) ..... do	657,785	518,665	373,254	274,581
Value of acid sold.				
Total	$6,336,444	$4,996,275	$3,278,509	$2,085,791
Average	$9.63	$9.63	$8.78	$7.60
Acid reported as 66° B. and stronger:				
Produced (expressed as 66° B.) ..... short tons	482,507	385,038	347,964	246,456
Consumed at works (expressed as 66° B.) ..... do	67,670	51,314	46,473	36,698
Sold (expressed as 66° B.) ..... do	441,617	352,886	294,034	211,370
Value of acid sold:				
Total	$6,381,556	$4,867,536	$3,884,404	$2,525,583
Average	$14.45	$13.79	$13.21	$11.95
Total acid sold, equivalent in 60° B.:				
Quantity ..... short tons	1,187,726	942,128	726,094	528,225
Value	$12,718,000	$9,863,811	$7,162,913	$4,611,374
Total acid consumed at works (60° B.) ..... short tons	114,678	89,783	72,142	57,099

[1] Includes small quantity of pyrites.

Rolled zinc.—Statistics of production of rolled zinc for 1931–32 are reported on a different basis than previously to eliminate duplication of tonnage, caused by rolling mills including rerolled zinc made from scrap originating in their own plants in their statement of production. Since such scrap represents a revolving stock within the plant it has no effect on the market, and its inclusion in rolled-zinc production leads to erroneous conclusions on the quantity of slab zinc used each year in the zinc-sheet industry. Data needed for corrections before 1931 are not available at this time.

Production of rolled zinc and quantity available for consumption in the United States, 1931–32

	1931			1932		
	Short tons	Value		Short tons	Value	
		Total	Average per pound		Total	Average per pound
Sheet zinc not over 0.1 inch thick	15,468	$2,582,000	$0.084	12,291	$1,804,000	$0.073
Boiler plate and sheets over 0.1 inch thick	546	90,000	.082	454	58,000	.064
Strip and ribbon zinc [1]	[2] 33,290	[2] 4,475,000	.067	26,986	3,167,000	.059
Total zinc rolled	[2] 49,304	[2] 7,147,000	.072	39,731	5,029,000	.063
Imports	20	2,300		39	4,600	
Exports	2,759	461,000	.084	3,010	433,000	.072
Available for consumption	[2] 46,565			36,760		
Slab zinc (all grades)			.038			.030
Value added by rolling			.034			.033

[1] Figures represent net production. In addition 9,031 tons in 1931 and 8,066 tons in 1932 were rerolled from scrap originating in fabricating plants operated in connection with zinc-rolling mills.
[2] Revised figures.

Production of rolled zinc declined 19 percent in 1932 compared with 1931; all gages shared in the decline. The average value per pound of rolled zinc declined only 12 percent, whereas slab zinc declined 21 percent, so that the unit value added by rolling was very well maintained. The increased production of strip and ribbon zinc in 1931 due to the abnormal demand for fruit-jar covers was not maintained in 1932. Trade statistics indicate a 12-percent decline in the consumption of rolled zinc in dry-cell batteries. Normally the battery industry consumes about one third of the rolled zinc produced.

The following are the proportions of various grades of zinc used in the manufacture of 39,731 tons of rolled zinc in 1932: Brass special, 55 percent; prime western, 18 percent; high-grade spelter, 14 percent; electrolytic, 10 percent; and intermediate, 3 percent. Stocks of slab zinc at rolling mills declined from 4,863 tons on January 1 to 4,750 tons on December 31, 1932.

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 1932, 8,046 tons were produced, 24 percent less than in 1931.

Zinc dust[1] *sold by producers in the United States, 1928–32*

Year	Short tons	Value: Total	Value: Average per pound	Primary zinc recovered as zinc dust (short tons)[2]	Year	Short tons	Value: Total	Value: Average per pound	Primary zinc recovered as zinc dust (short tons)[2]
1928	9,172	$1,475,875	$0.080	2,668	1931	10,611	$1,148,152	$0.054	[3] 2,820
1929	11,050	1,864,672	.084	[3] 3,263	1932	8,046	776,189	.048	[3] 2,101
1930	9,237	1,205,740	.065	2,559					

[1] The zinc dust produced is principally "blue powder." Some "atomized" dust was produced in each of the years shown, but the Bureau of Mines is not at liberty to publish the figures separately.
[2] The amount of secondary zinc dust recovered is shown in the table on secondary zinc, p. 169.
[3] Includes a small quantity of zinc in dust made from slab zinc.

Zinc pigments and salts.—Zinc oxide, leaded zinc oxide, and lithopone are the principal pigments of zinc, and the chloride and sulphate are 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 entitled "Lead and Zinc Pigments and Salts." In 1932 the total zinc content of all zinc pigments and salts produced in the United States was 92,645 tons, 25 percent less than in 1931.

Mine production.—The following table shows the mine production of recoverable zinc in the United States, by States, from 1928 to 1932:

Mine production of recoverable zinc in the United States, 1928–32, in short tons

State	1928	1929	1930	1931	1932[1]
Western States:					
Arizona	639	1,229	815		
California				80	
Colorado	35,731	29,431	36,259	16,187	130
Idaho	31,263	45,675	37,649	19,569	10,200
Montana	82,830	68,176	26,421	6,747	2,240
Nevada	3,398	8,460	14,584	10,431	540
New Mexico	31,203	34,455	32,765	27,866	25,480
Oregon			6		6
Utah	46,929	51,510	44,495	37,291	29,080
Washington	43	1,059	352	4,974	2,290
	232,036	239,995	193,346	123,145	69,966
Central States:					
Arkansas	86	9			
Illinois	17	31	9		
Kansas	107,251	109,850	74,304	39,051	26,277
Kentucky	92				46
Missouri	12,974	11,017	10,811	3,205	986
Oklahoma	180,252	192,042	136,153	78,132	63,437
Wisconsin	18,417	16,986	12,558	10,088	7,522
	319,089	329,935	233,835	130,476	98,268
Eastern States:					
New Jersey	99,871	103,740	97,626	94,285	81,460
New York	11,257	10,250	22,471	24,100	16,794
Tennessee and Virginia[2]	32,917	40,558	48,147	38,312	18,514
	144,045	154,548	168,244	156,697	116,768
	695,170	724,478	595,425	410,318	285,002

[1] Figures for Western States production subject to revision.
[2] Bureau of Mines not at liberty to publish figures for Tennessee and Virginia separately.

The 1932 mine production of zinc declined 31 percent compared with 1931 and constituted only 39 percent of the 1929 output. All the important zinc-producing States shared in the decline in 1932, but since 1929 production has dropped over 70 percent in each of the Western and Central States areas and only 24 percent in the Eastern States. The more favorable position of the eastern mines may be ascribed to the higher zinc content of the ores, large-scale operations, the proximity to markets, and the fact that most of the eastern zinc-mining companies also manufacture the various zinc products required for the market, thus deriving all the benefits arising from the efficiency of vertically integrated industry. Another important factor is that most of the production in the Eastern States is derived from ore bodies where zinc is the principal constituent, whereas in the West zinc is largely a byproduct depending on the production of other metals such as lead and silver, which has been unprofitable in many mines in recent years.

The table that follows shows the output of the principal zinc-producing districts of the United States during the past 5 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, 1928–32, in short tons

District	State	1928	1929	1930	1931	1932
Joplin region	Kansas, Missouri, Oklahoma.	297,020	309,436	216,961	119,168	90,660
New Jersey	New Jersey	99,871	103,740	97,626	94,285	81,460
Eastern Tennessee	Tennessee	32,917	40,558	48,147	38,312	18,514
Austinville	Virginia					
Bingham	Utah	22,246	21,794	22,362	26,608	[1] 21,370
St. Lawrence County	New York	11,257	10,250	22,471	24,100	16,794
Willow Creek	New Mexico	23,205	22,865	16,638	20,817	(2)
Coeur d'Alene region	Idaho	28,665	43,046	33,145	18,934	(2)
Battle Mountain	Colorado	1,400	420	14,272	13,259	
Upper Mississippi Valley.	Iowa, northern Illinois, Wisconsin.	18,434	17,017	12,567	10,088	7,522
Park City region	Utah	23,785	27,965	19,543	9,436	[1] 7,650
Central	New Mexico	7,545	11,224	15,319	7,050	(2)
Pioche	Nevada	2,685	6,498	11,086	6,708	(2)
Leadville	Colorado	14,802	13,414	11,519	2,887	[1] 80
Southeastern Missouri region.	Missouri	3,457	3,473	4,307	1,220	40
San Juan Mountains	Colorado	17,371	14,403	10,434	41	[1] 4
Summit Valley (Butte)	Montana	73,948	50,550	13,984		(2)
Eureka	Colorado	12,714	11,429	9,839		

[1] Subject to revision.
[2] Data not available.

STOCKS

Stocks of zinc at primary reduction plants declined 11 percent more in 1932. At the end of the year they were 23 percent below the recent high at the close of 1930 but were nearly three times as large as the average from 1925 to 1929. Stocks at secondary distilling plants increased in 1932, but the total at primary and secondary plants was 10 percent under the previous year. An analysis of this decrease shows that stocks of the higher grades of zinc (grades A and B) declined 49 percent, while the lower grades (C, D, and E) increased 16 percent. At the beginning of 1932 there were on hand 58,678 tons of grades A and B and 87,411 tons of grades C, D, and E. At the close of the year the tonnages were 30,085 and 101,477, respectively.

Stocks of zinc on hand at zinc-reduction plants in the United States at end of year, 1928–32, in short tons

	1928	1929	1930	1931	1932
At primary reduction plants	47,041	85,904	167,293	143,592	128,192
At secondary distilling plants	1,391	3,549	1,909	2,497	3,370
	48,432	89,453	169,202	146,089	131,562

The decline in stocks of smelted zinc was accompanied by a large decrease in stocks of zinc in the form of ore in the Joplin district. At the beginning of 1932 over 87,000 tons of concentrates were on hand, with an estimated recoverable zinc content of 46,000 tons. By the end of the year this was reduced to only 43,000 tons of concentrates, representing about 23,000 tons of metal. This reduction was accomplished by drastic curtailment of production during the summer.

Stocks of slab zinc outside the United States, reported by the International Zinc Cartel, declined from 209,000 short tons on December 31, 1931 to 164,000 tons on December 31, 1932. World stocks may therefore be roughly estimated at 355,000 tons at the beginning of 1932 and 296,000 tons at the close, a decrease of 17 percent.

DOMESTIC CONSUMPTION

New supply.—The supply of new zinc available for consumption in 1932 was 32 percent less than in 1931 and 63 percent less than in the record year 1928 but exceeded that in 1921 by 5 percent.

The following table gives the quantity of new zinc available for consumption in the United States during the past 5 years:

Primary slab zinc available for consumption in the United States, 1928–32, in short tons

	1928	1929	1930	1931	1932
Supply:					
Stock Jan. 1:					
At smelters	53,522	[1] 48,432	85,904	167,293	143,592
Production	602,581	625,447	498,045	291,996	207,148
Imports, foreign	3	226	346	294	349
Imports, domestic, returned				3	
Total available	656,106	674,105	584,295	459,586	351,089
Withdrawn:					
Exports, foreign, from warehouse	(2)	(2)	(2)	(2)	(2)
Exports, foreign, under drawback			32		136
Exports, domestic	[2] 29,614	[2] 19,676	[2] 8,501	[2] 3,402	[2] 9,481
Stock Dec. 31:					
At smelters	[1] 48,432	85,904	167,293	143,592	128,192
Total withdrawn	78,046	105,580	175,826	146,994	137,809
Available for consumption	578,060	568,525	408,469	312,592	213,280

[1] Includes stocks at secondary distilling plants.
[2] Foreign exports included under domestic exports.

In the foregoing table an attempt has been made 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 slab 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 5 years as follows:

Estimated industrial use of zinc in the United States, 1928–32, in short tons [1]

Purpose	1928	1929	1930	1931	1932
Galvanizing:					
Sheets	144,100	142,800	103,900	77,100	52,500
Tubes	54,200	52,200	38,800	28,300	16,000
Wire	41,300	39,000	25,100	21,600	12,100
Wire cloth	8,400	10,800	9,400	6,900	4,400
Shapes [2]	43,000	45,200	39,800	34,100	24,000
	291,000	290,000	217,000	168,000	109,000
Brass and casting [3]	174,000	185,000	120,000	98,000	66,000
Rolled zinc [4]	73,500	68,300	51,400	58,300	48,000
Die castings	30,000	36,000	21,500	20,000	17,000
Other purposes [5]	58,000	55,000	41,000	34,700	27,000
	626,500	634,300	450,900	379,000	267,000

[1] Year Book, American Bureau of Metal Statistics, 1932, p. 73.
[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. 72.)
[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.

The estimated industrial use of zinc in 1932 decreased 30 percent and was equivalent to the normal consumption of about 1907. It was 2 percent above the recent low in 1921 but 56 percent below the average of the 5 years from 1925 to 1929.

While there was no startling development in the field of new uses in 1932 considerable progress was made in the direction of laying a foundation for the return of normal business. The industry continued its campaign to improve the quality and popularity of zinc-coated (galvanized) iron and steel. The success of this campaign is indicated by the fact that 75 percent of the manufacturers of galvanized sheets have been licensed to produce the heavy-coated ware sponsored by the American Zinc Institute. Heavy coatings of high-purity zinc are now being applied electrolytically to steel wire, and the increased ductility thus obtained is expected to expand greatly the market for zinc-coated wire. The increase in the use of rolled zinc for fruit-jar covers reported in 1931 was not maintained in 1932.

PRICES

The price of zinc reached new record lows during 1932 but recovered enough for the quotation at the close of the year to be the same as at the beginning. The St. Louis quotation for prime western zinc averaged 2.88 cents per pound for the year, a decline of 21 percent from 1931 and 56 percent from the average of 1929. At the beginning of 1932 the quotation stood at 3.12½ cents, and the trend was steadily downward. On April 25 the New York quotation, which averages 0.37 cent per pound above St. Louis owing to the freight differential, fell below 3.00 cents for the first time. The decline continued until May 16, when a final record low of 2.30 cents St. Louis (2.67 cents New York) was established. The previous New York low of 3.10 cents was in 1895. During the latter part of May there was an abrupt reversal of trend following an announcement of heavy curtailment of ore production in the tri-State district; but the change was of short duration, and by the middle of July the St. Louis price had declined again to 2.50 cents. During the next 2 months there was another abrupt rise resulting from the improvement in business sentiment. This brought the quotation up to a high for the year of 3.50 cents near the middle of September. From this point there was a gradual recession to 3.00 cents late in October. After another short rise the quotation settled to 3.12½ cents, where it remained steady throughout December.

The following table presents a 5-year summary of zinc price data. It will be noted that in 1932 quotations averaged 3.25 cents in New York and 2.12 cents (Gold basis)in London, making a differential of 1.13 cents per pound in favor of New York compared with 1.47 cents in 1931. The imposition of the British preferential tariff on March 1, 1932, did not have any appreciable effect on the differential, the London quotation (gold basis) having averaged 1.06 cents below New York in February and 1.11 cents in March. The more drastic decline in price in the United States compared with Europe was probably due to the more favorable statistical position abroad brought about by Cartel activities.

Prices of zinc and zinc concentrates, 1928–32

	1928	1929	1930	1931	1932
Average price of common zinc at—					
St. Louis (spot) ....cents per pound..	6.03	6.49	4.56	3.64	2.88
New York ....do....	6.38	6.84	4.91	3.99	3.25
London ....do....	5.50	5.40	3.60	2.52	2.12
Excess New York over London ....do....	.88	1.44	1.31	1.47	1.13
Joplin 60 percent zinc concentrates:					
Price per short ton ....dollars..	38.66	42.39	31.97	22.69	17.83
Price of zinc content ....cents per pound..	3.22	3.53	2.66	1.89	1.49
Smelter's margin ....do....	2.81	2.96	1.90	1.75	1.39
Price indexes (1925–29 average=100):					
Zinc (New York)	90	96	69	56	46
Lead (New York)	85	91	74	57	43
Copper (New York)	99	123	89	56	38
Nonferrous metals [1]	95	107	83	63	50
All commodities [1]	98	97	88	74	66

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

The price indexes shown in the foregoing table indicate that zinc has fared somewhat better than lead and copper during the depression. Comparing average prices in 1932 with the 5-year average from 1925 to 1929 zinc declined 54 percent, while lead and copper declined 57 and 62 percent, respectively. The nonferrous metals group declined 50 percent. The effect of these declines has been ameliorated to some extent by a 34 percent decline in the wholesale price level of all commodities.

The price of 60 percent zinc concentrates at Joplin averaged $17.83 per ton in 1932, a decline of 21 percent from 1931 and the lowest since 1894. According to the Joplin Globe weekly average prices ranged from $14 to $21 per ton in 1932. The 1932 average was equivalent to 1.49 cents per pound of zinc contained. Since the St. Louis price of zinc averaged 2.88 cents the difference of only 1.39 cents per pound covers metallurgical losses and the cost of smelting and marketing, and such smelting profits as are realized. This was less than half of of the smelter's margin of 2.96 cents per pound in 1929.

The following table shows the monthly fluctuations in the quotations of common zinc at St. Louis and London and of 60 percent zinc concentrates at Joplin during 1931 and 1932. The New York quotation for slab zinc exceeds that at St. Louis by the freight differential—0.35 cent per pound in 1931 and 0.37 cent in 1932.

Average monthly quoted prices of common zinc (prompt delivery or spot) at St. Louis and London, and of 60 percent zinc concentrates at Joplin, 1931–32 [1]

Month	1931			1932		
	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	26.00	4.03	2.76	17.40	3.02	2.21
February	26.26	4.02	2.78	17.85	2.83	2.14
March	25.00	4.01	2.64	17.57	2.79	2.05
April	23.90	3.69	2.46	17.00	2.74	1.95
May	20.00	3.31	2.28	14.55	2.53	2.04
June	21.00	3.40	2.56	19.20	2.79	1.88
July	22.53	3.90	2.66	17.47	2.55	1.84
August	23.00	3.82	2.48	18.22	2.76	2.11
September	23.00	3.74	2.34	19.83	3.30	2.40
October	20.25	3.38	2.21	18.32	3.05	2.26
November	18.35	3.20	2.30	17.75	3.10	2.23
December	18.66	3.15	2.16	18.20	3.12	2.23
Average for year	22.69	3.64	2.52	17.83	2.88	2.12

[1] All quotations from Metal Statistics, 1933. 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 5 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, 1928–32, by grades, in cents per pound

	1928	1929	1930	1931	1932
Grade A (high grade) [1] / Grade B (intermediate)	6.18	6.80	4.92	4.00	3.25
Grades C and D (select and brass special) [1]	5.99	6.44	4.71	3.63	2.95
Grade E (prime western)	6.08	6.42	4.69	3.73	2.85
All grades	6.1	6.6	4.8	3.8	3.0
Prime western; average spot quotation at St. Louis	6.0	6.5	4.6	3.6	2.9

[1] American Metal Market quotes average prices of high grade and brass special as follows: High grade (f.o.b. New York), 1928, 7.74 cents; 1929, 7.88 cents; 1930, 5.58 cents; 1931, 4.63 cents; 1932, 3.99 cents. Brass special (f.o.b. East St. Louis), 1928, 6.11 cents; 1929, 6.60 cents; 1930, 4.64 cents; 1931, 3.73 cents; 1932, 2.96 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, 1932, 12 active smelters were using 20,613 retorts, a slight increase over the 10 active plants using 19,875 retorts at the close of 1931. Only 33 percent of the regular retorts in plants operating at the end of 1932 were in use. At the end of 1932, 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 1932:

Primary zinc-smelting plants in the United States at end of 1932

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.	6,324	
Mineral Point Zinc Co. (A)[2]	Depue, Ill.	5,912	8
Grasselli Chemical Co.[2]	Terre Haute, Ind.	4,200	
American Steel & Wire Co.[2]	Cherryvale, Kans.	5,160	
Blackwell Zinc Co., Inc.[2]	Blackwell, Okla.	9,600	
Eagle-Picher Mining & Smelting Co.	Henryetta, Okla.	4,800	
National Zinc Co., Inc. (A)	Bartlesville, Okla.	4,256	
Nicholson 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.[3]	Meadowbrook, W.Va.	6,720	16
United Zinc Smelting Corporation (A)	Moundsville, W.Va.	2,368	
Total retorts		103,716	40
Number of retorts in use at end of year		20,613	(4)
Percent of total		19.9	(4)

[1] Idle since 1927.
[2] Idle throughout 1932.
[3] Horizontal-retort plant idle Dec. 31, 1932.
[4] Data not available.

The smelters of the Athletic Mining & Smelting Co. and the Eagle-Picher Mining & Smelting Co. were idle at the beginning of the year but were reopened near the close of the year. The Quinton Spelter Co. operated its plant for a few months during the year.

In addition to the primary zinc smelters listed in the foregoing table the Missouri Zinc Co. has a smelter at Beckemeyer, Ill. This plant formerly treated ores but in recent years has been operated on secondary materials exclusively. The plant contains 1,032 regular horizontal retorts and was active during 1932. Other secondary smelters which produced zinc in large graphite retorts in 1932 were the General Smelting Co., Philadelphia, Pa.; Nassau Smelting & Refining Co., Tottenville, N.Y.; Superior Zinc Corporation, Philadelphia, 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 Anaconda plant of the Anaconda Copper Mining Co. and the East St. Louis plant of the Evans-Wallower Zinc Co. were idle throughout 1932. The Sullivan Mining Co. operated its plant at Kellogg throughout the year at 29 percent of capacity. The Anaconda Copper Mining Co. shut down its Great Falls plant in June 1932 owing to its inability to get zinc concentrates. At the close of the year the rate of electrolytic zinc production in the United States was about 3 percent of rated capacity.

FOREIGN TRADE

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 1928 to 1932 and a record of bonded-warehouse inventories.

Zinc ore and old brass (fit only for remanufacture) imported into the United States, 1928–32

[General imports]

Year	Zinc content of zinc ore (short tons)				Old brass	
	Canada	Mexico	Other countries	Total	Short tons	Value
1928 [1]	18	1,646	3	1,667	6,075	$1,015,172
1929	848	13,563		14,411	7,031	1,371,655
1930	13	25,644	182	25,839	3,573	535,761
1931	(2)	778	2	780	2,212	215,430
1932		1,904		1,904	[3] 1,259	[3] 63,642

[1] Figures probably incomplete.
[2] Less than 1 ton.
[3] Jan.–June 20, 1932. None recorded after June 20.

Zinc remaining in warehouse in the United States, December 31, 1928–32

Year	Ore and calamine		Blocks, pigs, and old		Zinc sheets	
	Zinc content (pounds)	Value	Pounds	Value	Pounds	Value
1928	8,719,290	$797,923				
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

Zinc imported for consumption in the United States, 1928–32

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		
1928	(1)	$66	3	$2,556	3	$260	146	$14,147	$115,784	$132,813
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

[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 1932, 1,904 tons of zinc in ore were imported, an increase over 1931 but equivalent to only 7 percent of the 1930 imports. Domestic producers did not report the production of any zinc from foreign ores in 1931 and 1932.

The United States imports very little slab zinc, rolled zinc, and manufactured-zinc products. In 1932 the total value of these imports was $35,052, of which $9,318 represented the value of manufactured products. A considerable amount of old brass is imported, chiefly from Canada, which supplied 94 percent of the total quantity in 1932. The decrease in imports in 1932 resulted from the imposition of the copper tariff on June 21, 1932. After that date no imports of old brass were recorded.

Exports.—The total value of the 1932 exports of zinc ore and domestic and foreign manufactures of zinc (not including galvanized products, alloys, and pigments) was approximately $908,000, an increase of 23 percent from 1931 but a decrease of 95 percent from the recent high in 1925.

The following table shows the principal zinc exports of the United States during the past 5 years:

Domestic zinc ore and domestic manufactures of zinc exported from the United States, 1928–32

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
1928	4,518	$205,978	25,289	$3,013,679	4,325	$906,515	3,148	$240,613	1,008	$199,081
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

[1] Includes slab zinc made from foreign ore. Not separately recorded.

Exports of slab zinc in 1932 increased materially over those in 1931 owing to increased shipments to Japan, British India, and the United Kingdom, but were only 8.5 percent of the quantity exported in 1925. Exports of sheet zinc also increased in 1932 due largely to greater shipments to Canada. Exports of these two commodities during the past 4 years are given by destinations in the following table:

Slab and sheet zinc exported from the United States, 1929–32, by destinations, in short tons

Destination	Slabs, blocks, or pigs				Sheets, strips, etc.			
	1929	1930	1931	1932	1929	1930	1931	1932
Countries:								
Canada	974	846	7	15	2,124	1,508	1,087	1,497
Chile	565	1,115	144	4	26	7	2	2
France	2,299				13	34	13	19
Germany	1,961	564	79	35	35	20	3	
India (British)	1,681		112	1,457	340	4	1	
Japan	587			3,371	270	194	232	197
United Kingdom	4,717	640	235	1,428	1,592	1,193	957	1,029
Others	1,627	1,468	66	161	865	908	464	266
	14,411	4,633	643	6,471	5,265	3,868	2,759	3,010
Continents:								
North America	1,006	1,077	23	16	2,391	1,776	1,197	1,587
South America	626	1,186	145	5	332	314	195	89
Europe	10,502	2,350	354	1,611	1,772	1,330	1,021	1,066
Asia	2,276	20	121	4,839	726	417	339	261
Africa					1	1	1	6
Oceania	1				43	30	6	1

Considerable zinc is exported each year in the form of brass and in galvanized iron and steel, but data showing the zinc content of these products are not available. Export data on zinc pigments and chemicals are given in the chapter entitled "Lead and Zinc Pigments and Salts."

WORLD ASPECTS OF THE ZINC INDUSTRY

International (European) zinc cartel.—At the beginning of 1932 the Cartel was functioning under an agreement among virtually all important zinc-smelting countries but the United States. The total producing capacity of the members had been established by agreement at 1,125,000 metric tons of zinc per annum. Production quotas were limited to 50 percent of capacity or approximately 47,000 tons per month. Cartel stocks on January 1, including some nonmember stocks, amounted to about 189,000 tons, of which about 80,000 tons were frozen by agreement. During the latter part of 1931 and the first half of 1932 the existence of the Cartel was threatened by abandonment of the gold standard in Great Britain, the imposition of British tariffs on zinc, the demand for tariff protection in Germany, and the demand of some members for increased quotas. The continued decline of the London price of zinc led to agitation for complete cessation of zinc production for 2 months. However, rumors of the impending smash up of the Cartel were dispelled in July by statements in the press to the effect that the Cartel had agreed to continue until January 1, 1933, and that, effective August 1, production would be curtailed an additional 5 percent to 45 percent of the agreed capacity, a monthly output of about 42,000 tons. It was also reported that the Italian members of the Cartel had been permitted to increase production to meet home demands so that Italy might become self-supporting with respect to zinc, as was desired by the Government. In return for this privilege the Italians agreed not to export any metallic zinc.

During the latter part of the year discussions were begun looking toward extension of the Cartel into the new year. Wide differences of opinion developed. It was reported that some Belgian producers favored by low costs of production were anxious to expand their sales in Germany and pressed for larger production quotas. This prompted German producers to renew their demand for a protective tariff on zinc imports into Germany. Other producers, unable to meet the requirements of their customers out of current production, desired to release frozen stocks. On December 28 a provisional agreement was reached extending the Cartel for 1 month to the end of January 1933. Members were to be allowed to exceed their quota upon payment of heavy fines for excess production. At the close of 1932 Cartel stocks amounted to about 149,000 tons, a reduction of 40,000 tons for the year.

World production.—World production of zinc (smelter basis) was 805,000 metric tons in 1932, a decline of 19 percent from 1931 and 45 percent from the record output of 1929. It was the lowest since 1922 but exceeded the 1921 output by 71 percent. As in 1931, the decrease in the United States accounted for the larger part of this decline, domestic production having fallen 29 percent compared with 16 percent for the rest of the world. United States retained first rank among the zinc producers of the world but by the smallest tonnage margin since 1913. Likewise, its proportion of the world total in 1932 (23 percent) was the lowest since 1898.

Great Britain was the only producer to make an increase. Belgium, Norway, Japan, and Italy decreased less than 5 percent in production; Australia, Germany, Mexico, and the Netherlands showed declines ranging from 7 to 9 percent; while Poland, Canada, and France accounted for percentage decreases comparable with that of the United States.

The following table gives production during the past 5 years by countries:

World smelter production of zinc, 1928–32, in metric tons, by countries where smelted

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

Country	1928	1929	1930	1931	1932
Australia	51,029	52,705	55,782	54,696	50,569
Belgium	206,300	197,900	176,230	134,720	[1] 130,000
Canada	74,176	78,061	110,219	107,612	78,146
Czechoslovakia	8,039	10,675	13,472	7,947	[1] 7,000
France	92,463	87,330	86,928	62,900	48,200
Germany [2]	98,100	102,000	97,300	45,300	41,979
Great Britain	56,284	59,234	49,378	21,582	27,300
Indo-China	2,887	3,808	3,857	2,900	980
Italy	10,654	15,804	19,264	16,913	16,602
Japan	19,117	22,098	24,669	22,600	[1] 22,000
Mexico	11,220	15,099	29,431	35,248	30,349
Netherlands	26,857	25,712	23,255	19,323	15,624
Northern Rhodesia	9,751	12,316	18,194	7,038	----
Norway	----	5,516	34,611	39,472	39,300
Poland	161,815	169,029	174,362	130,756	84,953
Spain	13,549	11,825	10,697	10,094	9,504
Sweden	5,106	4,718	4,126	----	----
United States	546,649	567,393	451,816	264,893	187,921
U. S. S. R.	[3] 2,246	[3] 3,437	[3] 4,650	11,400	[1] 11,000
Yugoslavia	4,883	6,291	5,514	4,439	[1] 4,000
	1,401,000	1,451,000	1,394,000	999,800	805,000

[1] Approximate production.
[2] Exclusive of secondary material (Metallgesellschaft). The figures, published by the Stat. Reichsamt, which include secondary material, are as follows: 1928, 104,707 tons; 1929, 108,429 tons; 1930, 101,385 tons; 1931, 48,621 tons. Figures for 1932 not yet available.
[3] Year ended Sept. 30.

World consumption.—Preliminary data on production, imports, and exports of the principal zinc-consuming countries indicate that world consumption of slab zinc in 1932 totaled about 810,000 metric tons, a decrease of 23 percent from 1931 and of 39 percent from the average of the 5 years 1925 to 1929. This estimate does not consider the decline in stocks outside of the United States and Great Britain, and since it is reported that this decline has been substantial the figure given above probably understates actual consumption.

In consumption, as well as production, the decline was more pronounced in the United States than the rest of the world, as is indicated by the 32 percent decline in domestic deliveries of primary zinc compared with a decrease of about 22 percent elsewhere. Although the United States retained first place in zinc consumption in 1932, its proportion of the total was only 24 percent compared with nearly 39 percent during the 5 years from 1925 to 1929. Germany and Great Britain again ranked second and third but decreased 12 and 21 percent, respectively, in the quantity of zinc consumed. France and Belgium ranked fourth and fifth, respectively, in 1932, the former having declined only 18 percent whereas the latter decreased 45 percent. Consumption in Italy and Japan increased 6 and 7 percent, respectively.

REVIEW BY COUNTRIES

Australia.—Production of zinc was fairly well maintained in Australia during 1932 despite low prices, owing to reduction in wage scales and favorable foreign exchange rates. Smelter production declined only 8 percent. Exports of slab zinc fell from 56,000 long tons to 37,000 tons (34 percent), while shipments of zinc concentrates decreased from 88,000 to 63,000 tons. At the close of the year all four principal Broken Hill operators were producing zinc concentrates, Sulphide Corporation having reopened in April after having been idle since December 1930. North Broken Hill modernized its surface plant and completed a new mill during the year.

Belgium.—In Belgium, production of slab zinc, which is derived almost entirely from imported ores, decreased only 4 percent in 1932. Exports increased from 56,600 metric tons in 1931 to 64,100 tons in 1932. Shipments to Germany increased 28 percent and led to revival of the demand in Germany for tariff protection for the zinc smelters. Consumption, computed on a basis of production plus imports minus exports, declined 45 percent, but this appears to be excessive in view of the smaller decreases in other European countries. Evidently there was considerable liquidation of stocks in 1932, an observation substantiated by press reports that Belgian producers were pressing the cartel for increased production quotas to meet their export trade. During the year Vieille Montagne installed a Waelz plant at Moresnet to treat calamine slimes.

Canada.—Canadian zinc production (all electrolytic) amounted to 86,142 short tons in 1932, a decrease of 27 percent from 1931. Seventy-six percent of the 1932 total was produced at Trail, British Columbia, and 24 percent at Flin Flon, Manitoba. Manitoba increased its output 19 percent in 1932, whereas British Columbia decreased production 35 percent. Exports of slab zinc again exceeded production but were 26 percent below 1931. Shipments to Great Britain decreased 31 percent and were 58 percent of the total, whereas those to Japan increased 10 percent and were 17 percent of the total. No zinc ore was exported in 1931 and 1932.

Virtually all zinc production in British Columbia was derived from the Sullivan mine of the Consolidated Mining & Smelting Co. of Canada, Ltd. A total of 1,447,448 tons of lead-zinc ore was mined in 1932, a decrease of 11 percent from 1931. The grade of ore was slightly higher and recoveries somewhat lower, but the concentrates were of higher grade than in 1931. Costs of producing zinc were lower, notwithstanding the fact that operation was at 50 percent of capacity. The company reported a deficit of $2,908,000, after provision for depletion and depreciation, compared with a deficit of $713,000 in 1931.

During 1932 the Hudson Bay Mining & Smelting Co., Ltd., the only zinc producer in Manitoba, mined and milled 1,439,651 tons of ore averaging 0.085 ounce of gold, 1.13 ounces of silver, 1.98 percent of copper, and 3.7 percent of zinc from which 82,565 ounces of gold, 933,983 ounces of silver, 21,079 tons of copper and 20,868 tons of zinc were produced. All metal produced during the year was sold. An operating profit (before depreciation) of nearly $1,400,000 was reported.

France.—Production of zinc decreased 23 percent in 1932. The smelting industry depends largely on foreign ores, of which 119,000 metric tons were imported in 1932, chiefly from Spain, Mexico, and Sweden. About 47,000 tons of slab zinc were imported, Belgium supplying 57 percent. Consumption declined about 18 percent.

Germany.—The German zinc-mining industry was supported in 1932 by Government subsidies to several privately owned mines. This policy was adopted to meet the demands of zinc producers for a protective tariff and to prevent further unemployment threatened by cessation of lead and zinc mining due to extremely low prices. In principle, the Government was to advance the difference between cost of production and selling price in the form of a loan to be repaid later. No provision was made for custom-smelting plants, and during the latter part of the year they renewed agitation for a tariff. It was also reported that the Government was considering financing of the Magdeburg electrolytic zinc plant, which would provide smelting facilities for Upper Silesian ore now exported to Polish smelters. This was opposed by the sulphuric acid manufacturers and pyrite producers on the ground that creation of additional acid-producing capacity at Magdeburg would demoralize their industries. Completion of the Magdeburg plant would provide German manufacturers with a domestic supply of electrolytic zinc, which is now imported, and would therefore be a logical first step toward ultimate adoption of a zinc tariff policy. Early in 1933 it was reported that subsidies to zinc mining companies would be continued indefinitely, indicating that imposition of tariffs had been postponed.

Smelter production decreased 7 percent in 1932, and preliminary reports indicate a decline of 14 percent in mine production. Consumption totaled about 133,000 metric tons in 1932 compared with 151,000 tons in 1931. Imports were 102,000 tons, 14 percent less than in 1931; Poland, Belgium, and Australia were the the principal sources.

Great Britain.—Great Britain was the only zinc-smelting country to increase production in 1932. Consumption, however, declined 21 percent, totaling 116,000 long tons, and imports dropped from 145,000 tons in 1931 to 88,000 tons in 1932. The imposition of a 10 percent import duty on March 1, 1932, was fairly successful in excluding non-British zinc. Canada and Australia supplied 63 percent of the total of slab-zinc imports during 1931 and 87 percent during the last 9 months of 1932.

Italy.—Production, consumption, and imports of zinc in 1932 were maintained at about the same levels as in 1931. Exports of ore, however, declined over 50 percent. The mines of Sardinia operated under subsidies from the Italian Government in 1932, and Monteponi, Pertusola, and Vieille Montagne were the principal recipients. The last named exports its ore to Belgium for smelting. During the latter part of the year Italian smelting companies obtained permission from the Cartel to increase their production to meet home requirements, after agreeing not to export any zinc smelted in Italy.

Mexico.—Mine production of zinc in Mexico in 1932 totaled 57,000 metric tons, a decrease of 52 percent from 1931 and 67 percent from the record output of 1929. This decline may be attributed to unfavorable exchange conditions and to the unprofitable nature, under present conditions, of copper, lead, and silver mining, with which zinc is intimately associated in Mexico. Smelter production declined only 14 percent in 1932.

Newfoundland.—Mine production of zinc was maintained at a high rate despite low metal prices. Approximately 131,000 short tons of zinc concentrates, containing 67,500 tons of zinc and 7,000 tons of lead, and 49,500 tons of lead concentrates, containing 31,000 tons of lead and 5,300 tons of zinc, were produced in 1932 compared with 87,000 tons of zinc concentrates and 38,600 tons of lead concentrates in 1931. Virtually all the output was exported.

Poland.—The zinc industry of Poland experienced another severe decline in 1932. Mine production totaled only 22,000 metric tons, a decrease of 65 percent from 1931 and 82 percent from the record output of 1930. Smelter output declined 35 percent. Polish smelters treat large quantities of imported ores, mostly from German Upper Silesia. A large part of the Polish production of slab zinc is exported. In 1932, 73,000 tons were exported, including nearly 10,000 tons of high-grade (electrolytic) zinc. Germany took about 51 percent of the total and Russia about 11 percent.

Yugoslavia.—Trepca Mines, Ltd., has proved to be one of the few producers able to operate profitably under the low prices prevailing in 1932. During the year ended September 30, 1932, the company treated 397,963 long tons of ore, from which 48,566 tons of 76 percent lead concentrates and 62,192 tons of 50 percent zinc concentrates were obtained. Mill capacity was increased nearly 50 percent during the year. Earnings permitted payment of a 10 percent dividend. Most of the concentrates produced are exported through Salonika.

LEAD AND ZINC PIGMENTS AND ZINC SALTS

By E. W. Pehrson and H. M. Meyer

Sales of lead and zinc pigments in 1932 were affected adversely by lessened activity in the pigment-consuming industries. Dollar volume of sales in the paint industry, the largest outlet for pigments, fell 26 percent compared with 1931 due largely to the 57 percent drop in building construction. Production of pneumatic tires and storage batteries, in which large tonnages of zinc and lead pigments are used, declined 18 and 14 percent, respectively. Considering the 43 percent decrease in new automobile production in 1932, the drop in the tire and storage-battery industries was not as great as might be expected, due to replacements required by the large number of old cars still in use. The total registration of motor vehicles in the United States declined only 7 percent in 1932.

Sales of basic lead sulphate decreased the most of any pigments in 1932, falling 35 percent. Other declines were white lead, 32 percent; red lead, 27 percent; zinc oxide, 25 percent; orange mineral, 25 percent; leaded zinc oxide, 23 percent; lithopone, 20 percent; and litharge, 9 percent.

Prices of all lead and zinc pigments, as measured by average values received by producers, decreased further in 1932. Of the more important pigments leaded zinc oxide slumped the most—21 percent. Other declines were litharge, 18 percent; red lead, 14 percent; zinc oxide, 12 percent; dry white lead, 6 percent; and lithopone, 2 percent. Compared with the 5-year average from 1925 to 1929 average values in 1932 represented the following reduction: Litharge, 49 percent; red lead, 42 percent; dry white lead, 34 percent; leaded zinc oxide, 27 percent; zinc oxide, 17 percent; and lithopone, 14 percent. For the same periods the New York quotations for pig lead and zinc fell 57 and 54 percent, respectively.

Foreign trade in lead and zinc pigments was affected adversely by a sharp recession in exports of zinc pigments to Canada and the United Kingdom and an increase in imports of zinc oxide. The excess of exports over imports for the United States was only $304,000 in 1932 compared with $2,539,000 in 1930, due in part to the general ebb in consumption throughout the world; however, it may be ascribed more particularly to Canada's increasing imports from Europe and to increased production of zinc oxide in the United Kingdom, enabling it to become an exporter rather than an importer of that commodity. Another factor that may have a more pronounced effect in 1933 is the increase in preferential British tariffs on various pigments, established by Canada and the United Kingdom in 1932.

Sales of zinc chloride and zinc sulphate fell 33 and 20 percent, respectively, in 1932.

The accompanying table contrasts the salient statistics of the lead- and zinc-pigment industry in 1930, 1931, and 1932 with the yearly average from 1925 to 1929, and figure 5 traces price trends.

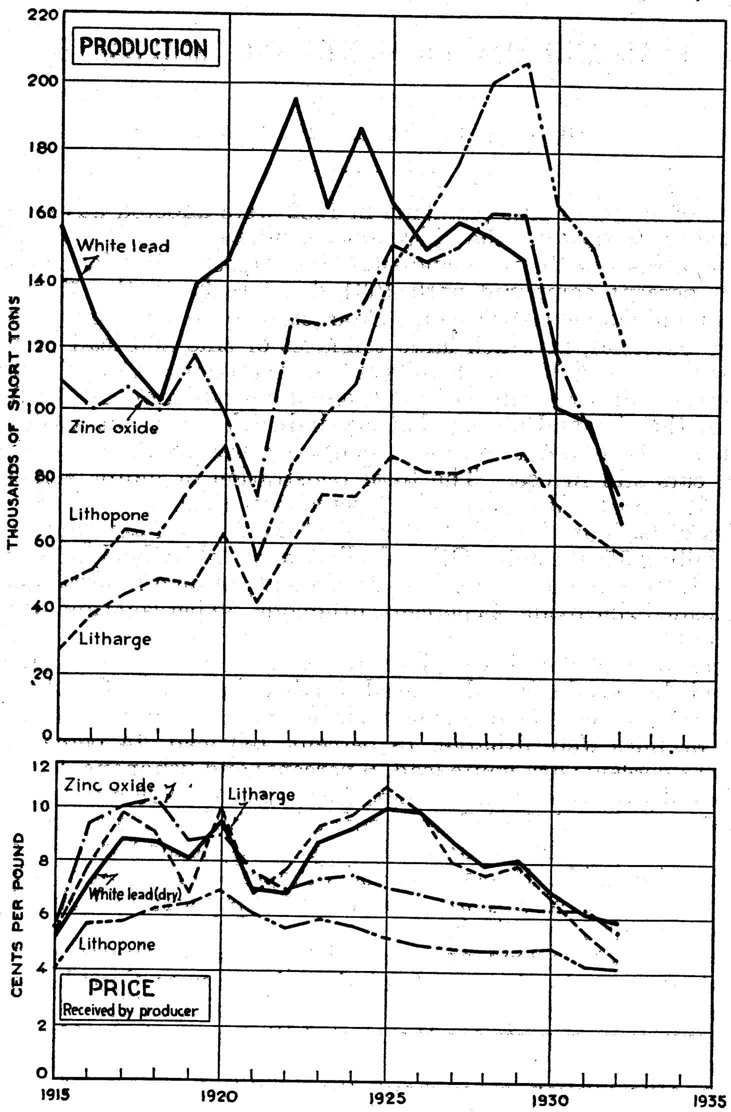

FIGURE 5.—Production and price trends of the principal lead and zinc pigments, 1915–32.

Salient statistics of the lead and zinc pigments industry of the United States, 1925–32

	1925–29 (average)	1930	1931	1932
Production (sales) of principal pigments:				
White lead (dry and in oil) short tons	154,483	102,140	97,368	66,674
Litharge do	84,845	72,578	63,890	58,096
Red lead do	41,362	32,941	25,853	18,880
Zinc oxide do	154,208	119,142	95,700	72,250
Leaded zinc oxide do	26,609	17,279	18,577	14,305
Lithopone do	177,745	164,065	151,850	121,667
Value of products:				
All lead pigments	$60,092,000	$36,386,000	$29,128,000	$19,133,000
All zinc pigments	41,314,000	32,867,000	27,139,000	19,430,000
Total	101,406,000	69,253,000	56,267,000	38,563,000
Value per ton received by producers:				
White lead (dry)	178	140	124	117
Litharge	176	134	109	89
Red lead	193	154	129	111
Zinc oxide	133	125	125	110
Leaded zinc oxide	124	120	115	91
Lithopone	98	97	86	84
Foreign trade:				
Lead pigments:				
Value of exports	1,346,000	1,514,000	947,000	365,000
Value of imports	30,000	17,000	14,000	6,000
Zinc pigments:				
Value of exports	2,150,000	1,827,000	1,058,000	466,000
Value of imports	931,000	785,000	635,000	521,000
Export balance	2,535,000	2,539,000	1,356,000	304,000

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 amounts 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 $38,563,000 in 1932 compared with $56,267,000 in 1931. The total value of all lead pigments sold was $19,132,898 and that of all zinc pigments sold $19,429,629. Sales of lead pigments decreased 34 percent in total value and 24 percent in quantity, whereas sales of zinc pigments decreased 28 percent in total value and 22 percent in quantity. The average value per ton of lead pigments sold in 1932, as reported by producers, dropped 14 percent, whereas the average New York quotation for pig lead declined 25 percent in 1932 compared with 1931. Zinc pigments were 9 percent less in value per ton compared with a 21-percent decrease in the St. Louis quotation for slab zinc.

Lead pigments.—All lead pigments shared in the tonnage decline in 1932. Production of white lead was 32 percent below 1931 and 66 percent below the peak production of 1922. Litharge production was fairly well maintained, having fallen only 9 percent below 1931 and 34 percent below the record output of 1929. Red lead production decreased 27 percent in 1932. Declines in unit values ranged from 6 percent for dry white lead to 39 percent for blue sublimed lead. Litharge and red lead unit values dropped 18 and 14 percent, respectively.

Lead pigments sold by domestic manufacturers in the United States, 1931–32

Pigment	1931			1932		
	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	8,790	$995,685	$113	5,708	$534,369	$94
Blue	896	90,755	101	549	34,125	62
Red lead	25,853	3,325,875	129	18,880	2,101,860	111
Orange mineral	282	55,254	196	212	37,691	178
Litharge	63,890	6,933,241	109	58,096	5,155,555	89
White lead:						
Dry	30,922	3,824,813	124	19,946	2,329,876	117
In oil [1]	66,446	13,902,787	209	46,728	8,939,422	191

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

Zinc pigments and salts.—Although the production of lithopone has been greatly reduced during the depression it has not fared as badly as the other principal white pigments. The 1932 output of lithopone was 20 percent below that in 1931 and 41 percent below the predepression peak, whereas that of zinc oxide fell 25 percent and 55 percent and that of white lead 32 and 66 percent for the same periods. This was not accomplished by price reductions, as lithopone producers reported smaller decreases in unit values than have white lead and zinc oxide producers.

Production of zinc chloride and zinc sulphate dropped 33 and 20 percent, respectively. The average value per ton received by zinc chloride producers increased 7 percent, whereas that received by zinc sulphate producers declined 13 percent.

Production and value of zinc pigments and salts sold by domestic manufacturers in the United States, 1931–32

Pigment or salt	1931			1932		
	Short tons	Value (at plant, exclusive of container)		Short tons	Value (at plant, exclusive of container)	
		Total	Average		Total	Average
Zinc oxide [1]	95,700	$11,997,996	$125	72,250	$7,956,697	$110
Leaded zinc oxide [1]	18,577	2,140,864	115	14,305	1,296,076	91
Lithopone	151,850	12,999,590	86	121,667	10,176,856	84
Zinc chloride, 50° B	34,885	1,417,010	41	23,524	1,033,255	44
Zinc sulphate	5,290	199,482	38	4,252	138,476	33

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

CONSUMPTION BY INDUSTRIES

White lead.—By far the principal use of white lead is in the manufacture of paint, which accounted for 95 percent of the total consumption in 1932. The tonnage used in 1932 was 31 percent below that in 1931 and 54 percent below 1929. Consumption of white lead in the ceramic industry decreased 38 percent in 1932.

Distribution of white lead (dry and in oil) sales, 1929–32, by industries

Industry	1929		1930		1931		1932	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paint	136, 526	92. 8	91, 563	89. 6	91, 832	94. 3	63, 399	95. 1
Ceramics	4, 246	2. 9	3, 366	3. 3	2, 848	2. 9	1, 761	2. 6
Other	6, 259	4. 3	7, 211	7. 1	2, 688	2. 8	1, 514	2. 3
	147, 031	100. 0	102, 140	100. 0	97, 368	100. 0	66, 674	100. 0

Basic lead sulphate.—Consumption of basic lead sulphate in paint manufacture in 1932 was 32 percent below that in 1931 and 58 percent below 1929. The use of this pigment in storage batteries has slumped 92 percent since 1929. The white variety is the whitest of the lead pigments, and the blue variety is said to be especially effective in paints used as protective coatings on metallic surfaces.

Distribution of basic lead sulphate sales, 1929–32, by industries

Industry	1929		1930		1931		1932	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paints	13, 435	79. 9	9, 573	83. 0	8, 311	85. 8	5, 689	90. 9
Storage batteries	2, 327	13. 8	1, 104	9. 6	697	7. 2	195	3. 1
Rubber	655	3. 9	394	3. 4	173	1. 8	77	1. 2
Other	397	2. 4	456	4. 0	505	5. 2	296	4. 8
	16, 814	100. 0	11, 527	100. 0	9, 686	100. 0	6, 257	100. 0

Litharge.—The principal use of litharge is in the manufacture of storage-battery plates. Sales to this industry fell off 7 percent in 1932 and were equivalent to 79 percent of the quantity used in 1929. Sales to the insecticide industry, the second largest user, have increased steadily during the past few years due to increased use of lead arsenate in the spraying of fruit trees. Recent rulings of the Department of Agriculture cutting down the permissible arsenic content of fresh foods may adversely affect the consumption of lead arsenate. The sales of litharge to the oil-refining industry have dropped steadily since 1929 as shown in the following table. Better grades of raw materials are now being used in gasoline manufacture and yield a sweeter product, requiring less litharge in the refining process. Moreover some plants have installed processes for recovering the litharge formerly discarded.

Distribution of litharge sales, 1929–32, by industries

Industry	1929		1930		1931		1932	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Storage batteries	37,160	42.2	33,173	45.7	31,605	49.5	29,365	50.5
Insecticides	(1)	(1)	6,000	8.3	7,508	11.8	11,735	20.2
Oil refining	13,615	15.5	12,028	16.6	7,351	11.5	4,793	8.3
Ceramics	8,663	9.8	4,089	5.6	4,124	6.5	2,963	5.1
Chrome pigments	8,112	9.2	3,286	4.5	3,582	5.6	2,591	4.5
Rubber	6,651	7.6	4,736	6.5	3,032	4.7	1,921	3.3
Varnish	3,124	3.6	698	1.0	641	1.0	1,360	2.3
Linoleum	322	.4	388	.5	208	.3	169	.3
Other	10,269	11.7	8,180	11.3	5,839	9.1	3,199	5.5
	87,916	100.0	72,578	100.0	63,890	100.0	58,096	100.0

[1] Included in other. Not separately reported.

Red lead.—In 1932, 22 percent less red lead was used in storage batteries than in 1931 and 59 percent less than in 1929. Compared with litharge red lead has decreased relatively more in this important use. For several years battery manufactures have been employing smaller portions of red lead in the paste that forms the battery plate. As red lead costs more than litharge this trend probably has been accelerated during the depression to reduce costs of production and meet the lower scale of storage-battery prices. It is believed that some manufacturers are substituting for red lead a substance referred to as active lead or suboxide of lead. Red lead continues to be the most effective protective paint for iron and steel, and the sharp recession in its use in paint manufacture reflects the low level of building construction.

Distribution of red-lead sales, 1929–32, by industries

Industry	1929		1930		1931		1932	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Storage batteries	25,689	59.7	18,998	57.7	13,700	53.0	10,655	56.4
Paints	11,855	27.6	10,906	33.1	9,256	35.8	6,389	33.8
Ceramics	903	2.1	835	2.5	811	3.1	467	2.5
Other	4,574	10.6	2,202	6.7	2,086	8.1	1,369	7.3
	43,021	100.0	32,941	100.0	25,853	100.0	18,880	100.0

Orange mineral.—Sales of orange mineral declined 25 percent in 1932, the major decrease being in ink manufacture.

Distribution of orange-mineral sales, 1929–32, by industries

Industry	1929		1930		1931		1932	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Ink manufacture	151	22.3	88	24.7	119	42.2	58	27.4
Color pigments	487	71.8	188	52.8	114	40.4	108	50.9
Other	40	5.9	80	22.5	49	17.4	46	21.7
	678	100.0	356	100.0	282	100.0	212	100.0

Zinc oxide and leaded zinc oxide.—Owing to the refusal of one large manufacturer to segregate its sales of the zinc oxides the Bureau of Mines is unable to report the consumption by industries. These pigments are used largely in the manufacture of rubber and paint.

The most recent source of data on the consumption of zinc oxide in the rubber industry is the Census of Manufactures for 1929. According to this report 66,838 tons of zinc oxide were used in the manufacture of rubber goods in 1929, or 42 percent of the total sales of zinc oxide reported by domestic producers in that year. Eighty-three percent of the total was used in the manufacture of tires and inner tubes, 4 percent in rubber boots and shoes, and 13 percent in miscellaneous rubber goods. The data indicate that the average zinc oxide content of all rubber goods is about 6 percent by weight.

According to the Census of Manufactures for 1929 the paint industry consumed 55,603 tons of zinc oxide in that year. This quantity probably includes leaded zinc oxide also; thus the tonnage represents 30 percent of the total sales of zinc oxide and leaded zinc oxide as reported to the Bureau of Mines for 1929.

Lithopone.—Increasing use of lithopone and other zinc sulphide pigments in the paper industry is indicated by research recently completed. Laboratory and preliminary plant tests have shown that these pigments give to paper increased opacity, whiteness, and brightness and a superior printing surface. In addition, the antiseptic properties of the zinc pigments aid in keeping down bacteria which cause the formation of troublesome slime in paper-plant pulps.

Sales of lithopone to the paint industry were 22 percent lower in 1932 than in 1931 and 38 percent below 1929. Floor coverings and textiles took 15 percent less in 1932 than in 1931 and 53 percent less than in 1929, and sales to the rubber industry were 32 percent below 1931 and 45 percent below 1929.

Lithopone producers reported the use of about 3,700 tons of lithopone in the manufacture of titanated lithopone in 1932 compared with over 4,000 tons in 1931. Sales of high-strength lithopone held up slightly better than of ordinary lithopone.

Distribution of lithopone sales, 1928–32, by industries

Industry	1928 (short tons)	1929 (short tons)	1930 (short tons)	1931 (short tons)	1932	
					Short tons	Percent of total
Paints, etc.	149,122	150,804	126,076	119,446	93,465	76.8
Floor coverings and textiles	35,416	37,506	23,656	20,780	17,601	14.5
Rubber	6,898	7,176	5,997	5,833	3,955	3.2
Other	9,032	10,829	8,336	5,791	6,646	5.5
	200,468	206,315	164,065	151,850	121,667	100.0

Zinc chloride.—The principal use of zinc chloride is as a wood preservative, and statistics indicate that it is being replaced by creosote in this field. According to the Department of Agriculture the consumption of zinc chloride by wood-treating plants rose from about 8,000 tons in 1909 to a peak of nearly 26,000 tons in 1921. Since then it has dropped to about 12,000 tons in 1928 and 5,000 tons in 1931. Meanwhile, the consumption of creosote increased from 51,000,000 gallons to a peak of 226,000,000 gallons in 1929. The consumption of creosote in 1931 was 30 percent below that of 1928, whereas that of zinc chloride fell 56 percent.

Zinc sulphate.—Sales of zinc sulphate decreased 20 percent in 1932. One principal use of zinc sulphate is as a depressant in the flotation of lead-zinc ores. In 1929, 1,425 tons were so used, but only 1,063 tons were used in 1930 and 509 tons in 1931.

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 1932, 96.1 percent of the lead in lead pigments was derived from pig lead, 3.7 percent from ore, and 0.2 percent from secondary material. For zinc pigments the proportions were 59.3 percent from ore, 21.4 percent from slab zinc, and 19.3 percent from secondary materials.

Metal content of lead pigments and zinc pigments and salts produced by domestic manufacturers, 1931–32, by sources, in short tons

Source	1931		1932	
	Lead in pigments [1]	Zinc in pigments and salts	Lead in pigments [1]	Zinc in pigments and salts
Domestic ore	5,722	74,532	4,932	54,932
Metal	166,328	26,223	127,318	19,853
Secondary material [2]	710	22,799	262	17,860
	172,760	123,554	132,512	92,645

[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 quantities of slab zinc are 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.

Lead content of lead and zinc pigments produced by domestic manufacturers, 1931–32, by sources, in short tons

Pigment	1931				1932			
	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		78, 374		78, 374		53, 784		53, 784
Red lead		23, 005		23, 005		17, 569		17, 569
Litharge		60, 446		60, 446		52, 877		52, 877
Orange mineral		256		256		147		147
Basic lead sulphate	1, 901	4, 247	569	6, 717	1, 733	2, 941	262	4, 936
Leaded zinc oxide	3, 821		141	3, 962	3, 199			3, 199
Zinc oxide								
	5, 722	166, 328	710	172, 760	4, 932	127, 318	262	132, 512

Zinc content of zinc pigments and salts produced by domestic manufacturers, 1931–32, by sources, in short tons

Pigment or salt	1931				1932			
	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	47, 460	26, 136	45	73, 641	33, 295	19, 771	325	53, 391
Leaded zinc oxide	8, 997		546	9, 543	7, 556	24		7, 580
Lithopone	[1] 17, 487		15, 111	[1] 32, 598	[1] 13, 574		11, 910	[1] 25, 484
Zinc chloride		67	6, 351	6, 418		53	5, 104	5, 157
Zinc sulphate	588	20	746	1, 354	507	5	521	1, 033
	74, 532	26, 223	22, 799	123, 554	54, 932	19, 853	17, 860	92, 645

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

PRODUCERS AND PLANTS

A list of the producers of the various lead and zinc pigments and zinc salts was given on page 220 of Mineral Resources of the United States, 1931, part I. During 1932 it was reported that the Eagle-Picher Lead Co. added 10 litharge furnaces to its Joplin plant, raising the total to 16. Early in 1933 it was stated that the Golconda Mining Co. was constructing a 50-ton mill near Kingman, Ariz., in which a new process for making zinc oxide will be used. This is the same group (Copperconda Mines Co.) that considered plans for erecting a plant at Santa Ana, Calif., in 1932.

The Ozark Smelting & Mining Co., a subsidiary of the Sherwin Williams Co., began producing zinc sulphide pigment in 1932 at its plant at Coffeyville, Kans.

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 appear in the following table:

Range of quotations on lead pigments and zinc pigments and salts at New York, 1930–32, in cents per pound

Product	1930	1931	1932 [1]
Basic lead sulphate, or sublimed lead, dry, casks	6.75– 7.75	6.00– 6.75	5.50– 6.00
White lead, or basic lead carbonate:			
Dry, casks	7.25– 8.25	6.50– 7.25	6.00– 6.50
In oil, carload lots	10.69–11.54	9.33–10.30	(2)
Litharge, American, commercial, powdered, casks	7.75– 8.75	5.75– 7.75	5.25– 6.00
Red lead, dry, casks	8.75– 9.75	6.75– 8.75	6.25– 7.00
Orange mineral, American, casks	10.75–11.75	9.50–10.75	8.75–10.75
Lead acetate, brown, broken, barrels [1]	10.50–13.00	10.00–10.50	9.00–10.50
Lead arsenate, powdered, drums [1]	13.00–16.00	10.00–16.00	9.50–14.00
Zinc oxide:			
American process, lead-free, bags, car lots	6.50	6.50	[3] 5.75 –6.50
American process, leaded, barrels, car lots	6.50	6.50	[3] 5.75– 6.50
French process, red seal, bags, car lots	9.38	9.38	[3] 8.63– 9.75
French process, green seal, bags, car lots	10.38	10.38	[3] 9.63–10.38
French process, white seal, barrels, car lots	11.63	11.63	[3] 10.88–11.63
Lithopone, American, bags, car lots	4.50– 5.25	4.50	[3] 4.50
Zinc sulphide, 500-pound barrels	16.00–32.00	13.00–16.50	13.00–13.50
Zinc chloride:			
Solution,[4] tanks	2.25– 3.50	2.25– 3.00	3.00
Fused	5.75	5.00– 5.75	5.00– 5.75
Zinc sulphate, crystals, barrels [1]	3.00– 3.50	3.00– 3.50	3.00– 3.50

[1] Compiled from weekly reports.
[2] Figures not available.
[3] Beginning with June 4, 1932, recorded as 2-ton lots.
[4] At works.

Quotations for white lead and basic lead sulphate were steady up to the latter part of December, when a decrease of one half cent per pound was announced. The lead oxides fluctuated more, following the trend of pig-lead prices more closely. Quotations were maintained at the level of the beginning of the year until the middle of July, when a drop of one half cent was recorded. During August three successive rises of one fourth cent each brought quotations above the opening, but this was followed by a ½-cent drop the first of October. A week later quotations again rose one fourth cent, where they remained until another ¼-cent cut was announced the last of December. At the close of the year oxide quotations were one fourth cent below those at the first of the year.

Zinc oxide quotations were reduced three fourths cent per pound below the year's opening levels about the middle of March and held at these levels for the rest of the year. Early in June, however, further concessions were made by reducing the tonnage requirements from carload lots to 2-ton lots. The quotation for lithopone was maintained at 4.50 cents, but the basis was changed from carload to 2-ton lots early in June.

FOREIGN TRADE

The United States continued to have an export balance in its foreign trade in lead and zinc pigments and salts in 1932. Exports were valued at $974,253 and imports at $592,245, leaving an export balance of about $382,000 compared with $1,546,000 in 1931 and $3,338,000 in 1929. In 1929 exports were valued at $4,536,000 and imports at $1,198,000. Zinc pigments and salts accounted for 53 percent of the exports and 91 percent of the imports in 1932.

The following table shows the value of the various pigments and salts imported and exported in 1931–32:

Value of foreign trade of the United States in lead and zinc pigments and salts, 1931–32

	1931		1932	
	Imports	Exports	Imports	Exports
Lead pigments:				
White lead	$12,114	$562,228	$5,073	$174,403
Red lead	44	[1] 384,929	734	[2] 58,150
Litharge	48	(1)		132,942
Orange mineral	1,937	(1)	530	(2)
Total	14,143	947,157	6,337	365,495
Zinc pigments:				
Zinc oxide	189,477	717,224	241,963	196,149
Lithopone	428,523	341,257	271,678	270,195
Zinc sulphide	16,590		7,186	
Total	634,590	1,058,481	520,827	466,344
Lead and zinc salts:				
Lead arsenate		176,212		96,199
All lead compounds [3]	47,390		46,528	
Zinc chloride	20,868		15,456	
Zinc sulphate	7,248		3,097	
All zinc compounds [3]		87,914		46,215
Total	75,506	264,126	65,081	142,414
Grand total	724,239	2,269,764	592,245	974,253

[1] Red lead includes litharge and orange mineral.
[2] Red lead includes orange mineral.
[3] Excluding pigments. Salts not classified separately.

Lead pigments and salts.—Imports of lead pigments and salts 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, 1928–32, in short tons

Year	Basic carbonate white lead	Red lead	Litharge	Orange mineral	Lead compounds	Total value
1928	83	12	1	31	118	$44,310
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

[1] Less than 1 ton.

The principal exports are white lead, litharge and red lead, and lead arsenate, all of which decreased sharply in 1932. Exports of white lead, litharge, and red lead each amounted to less than 3 percent of the domestic production of each of these pigments in 1932. Shipments of white lead to foreign countries decreased 66 percent in 1932 owing to the drop in exports to the United Kingdom. Exports of red lead and litharge fell 36 percent, as our principal customer, Canada, took 34 percent less than in 1931.

Lead pigments and salts exported from the United States, 1928–32, in short tons

Year	White lead	Red lead [1]	Litharge	Lead arsenate	Other lead compounds	Total value
1928	6,476	2,084	(2)	547	192	$1,501,950
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

[1] Includes litharge from 1928 to 1931 and an unknown quantity of orange mineral, 1928 to 1932.
[2] Included with red lead.

White lead and red lead, orange mineral, and litharge exported from the United States, by destinations, 1928–32, in short tons

Destination	White lead				Red lead, orange mineral, and litharge			
	1929	1930	1931	1932	1929	1930	1931	1932
Countries:								
Argentina	400	434	67	31	25	96	103	63
Canada	122	66	81	23	1,545	1,604	1,935	1,268
Netherlands	532	257	361	387		58	37	4
Netherland West Indies	2	3	1	3	212	901	(1)	3
Panama	568	101	1	201	77	79	76	2
Philippine Islands	228	380	112	145	133	144	86	105
United Kingdom	3,382	4,750	4,235	743	169	442	233	26
Others	674	555	150	148	729	804	617	515
Total	5,908	6,546	5,008	1,681	2,890	4,128	3,087	1,986
Continents:								
North America	940	388	152	326	2,100	2,814	2,117	1,379
South America	496	575	83	75	196	199	223	218
Europe	3,937	5,075	4,619	1,131	227	701	490	197
Asia	494	484	123	148	213	300	217	170
Africa	5	8	30	(1)	1	7	40	21
Oceania	36	16	1	1	153	107	(1)	1

[1] Less than 1 ton.

Zinc pigments and salts.—For the first time in several years the value of zinc pigments and salts imported exceeded that exported—a result of a sharp decline in exports of zinc oxide and zinc salts and a substantial increase in imports of zinc oxide. Lithopone continued to be the most important zinc import both in tonnage and value notwithstanding a 17 percent drop in tonnage. Imports of zinc oxide (dry) increased 86 percent in quantity. Nearly all the zinc pigments imported in 1932 came from Europe. The Netherlands supplied 56 percent, Germany 1 percent, and Belgium 43 percent of the lithopone. Imports of zinc oxide originated as follows: Belgium, 24 percent; France, 12 percent; United Kingdom, 55 percent; Germany, 4 percent; and other countries, 5 percent. Most of the 1932 increase was derived from the United Kingdom.

Zinc pigments and salts imported for consumption in the United States, 1928–32, in short tons

Year	Zinc oxide		Litho-pone	Zinc sulphide	Zinc chloride	Zinc sulphate	Total value
	Dry	In oil					
1928	1, 348	107	9, 885	169	563	683	$1, 165, 663
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

Exports of lithopone, zinc oxide, and zinc salts in 1932 declined 16, 75, and 70 percent in quantity, respectively, and the total export value of the three commodities declined 55 percent. Canada continued as the principal importer of United States lithopone and zinc oxide, but shipments of lithopone declined 13 percent and zinc oxide 74 percent. Canada increased its imports of zinc oxide from the United Kingdom and the Netherlands 91 percent and 70 percent, respectively, in 1932. Shipments of zinc oxide to the United Kingdom declined 94 percent in 1932. Owing to the increased production of zinc oxide at home the United Kingdom has changed from an importing to an exporting nation in this commodity.

Zinc pigments and salts exported from the United States, 1928–31, in short tons

Year	Zinc oxide	Litho-pone	Zinc salts	Total value	Year	Zinc oxide	Litho-pone	Zinc salts	Total value
1928	14, 799	3, 326	1, 688	$2, 338, 954	1931	5, 131	3, 821	1, 011	$1, 146, 395
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					

Zinc oxide and lithopone exported from the United States, by destinations, 1929–32, in short tons

Destination	Zinc oxide				Lithopone			
	1929	1930	1931	1932	1929	1930	1931	1932
Countries:								
Argentina	24	68	171	79	6	3	12	19
Canada	7, 702	4, 547	2, 818	740	3, 950	3, 217	3, 318	2, 883
Cuba	117	91	58	23	174	187	100	82
France	452	428	1	4	1	2		(1)
United Kingdom	6, 360	4, 719	1, 523	97	20	82	232	89
Others	2, 983	900	560	318	405	174	159	139
Total	17, 638	10, 753	5, 131	1, 261	4, 556	3, 665	3, 821	3, 212
Continents:								
North America	7, 997	4, 812	2, 998	904	4, 150	3, 458	3, 466	2, 983
South America	69	105	217	94	51	26	33	44
Europe	8, 025	5, 378	1, 713	116	22	85	236	95
Asia	907	176	93	61	16	40	26	1
Africa	3	14	8	5				1
Oceania	637	268	102	81	317	56	60	88

[1] Less than 1 ton.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA, IDAHO, MONTANA, UTAH, AND WASHINGTON

By C. N. Gerry and Paul Luff

ARIZONA

The value of the gold, silver, copper, and lead produced from mines in Arizona in 1932 was $13,172,871, a marked decrease from $40,144,694 in 1931. The decrease in the value of the copper output alone was more than $25,000,000, and there were also large decreases in the values of the gold and silver productions. The output of lead in 1932 was slightly more than that in 1931, but the value was less on account of the decline in the average price; no zinc was produced from mines in Arizona in 1931 or 1932.

The average price of copper in 1932 (6.1 cents a pound) was less than any annual average price from 1850 to 1932 and resulted in the closing of several mines producing copper ore that had been active operators in the last decade. After the Phelps Dodge Corporation absorbed the smelting and mining assets of the Calumet and Arizona Mining Co. on October 1, 1931 the Copper Queen smelter at Douglas was closed, and in 1932 the Phelps Dodge Corporation operated the adjoining smelter formerly used by the Calumet and Arizona Mining Co. The Phelps Dodge Corporation closed its New Cornelia branch in April 1932, and the Morenci branch was closed in July, leaving only the Bisbee division in active operation. The Miami Copper Co. closed its mine and mill at Miami on May 16, and the Inspiration Consolidated Copper Co. closed its mine, leaching plants, and concentrator on May 9. The closing of these mines and plants resulted in the closing in June of the copper smelter of the International Smelting Co. at Miami. The mine and mill of the Ray branch of the Nevada Consolidated Copper Co. were operated continuously in 1932, but at a greatly reduced rate; the Hayden copper smelter of the American Smelting & Refining Co. was operated intermittently on concentrates from the Nevada Consolidated mill at Hayden and on crude ore and concentrates received from various operators. The mine, mill, and smelter of the Magma Copper Co. at Superior, Pinal County, were closed in June 1932, and the smelter of the United Verde Copper Co. at Clarkdale remained idle throughout the year. The United Verde Extension Mining Co., however, not only operated its mine at Jerome and its smelter at Clemenceau the entire year but increased its output of gold, silver, and copper. Only 3 of the 9 copper smelters in Arizona were active at the end of the year. In normal times Arizona produces approximately 40 percent of the total copper production of the United States, and on account of the general decrease in the copper output of Utah, Montana, and Michigan, the ratio in 1932 was close to that of normal times.

Mine production of gold, silver, copper, lead, and zinc in Arizona, 1928–32, in terms of recovered metals

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1928	22,828,766	$3,967,488	6,791,351	732,276,803	14,380,964	1,278,636	$114,300,381
1929	25,860,772	4,182,287	7,543,283	830,628,411	16,054,122	2,458,580	155,567,133
1930	19,802,919	3,501,610	5,540,732	576,190,607	8,491,623	1,630,506	81,042,416
1931	13,690,610	2,608,495	3,245,311	401,344,909	1,964,112		40,144,694
1932 [1]	4,455,000	1,319,690	2,057,000	183,887,000	2,000,000		13,172,871

[1] Subject to revision.

Gold.—The gold output in 1932 decreased about 50 percent from that in 1931 due to drastic curtailment in the mining of copper ore and to the decreased output of gold ore from the Tom Reed and other mines near Oatman, Mohave County. In 1932 the output of gold in Arizona was less than half that of any other year except 1908, since detailed records were started in 1903. An exceptionally large decrease was recorded in the production of gold from the Tom Reed mine, and marked declines were also recorded from the properties of the Phelps Dodge Corporation, United Verde Copper Co., and Magma Copper Co. A large increase, however, was reported from the United Verde Extension mine at Jerome, Yavapai County. The United Verde mine, also at Jerome, the largest producer of gold in Arizona from 1924 to 1930, was idle in 1932, as were the mill and smelter at Clarkdale.

There was a decided increase in the production of gold from placer operations, particularly from Copper Basin, Big Bug Creek, Lynx Creek, and Octave in Yavapai County, Greaterville in Pima County, Dome and Quartzsite in Yuma County, San Francisco River in Greenlee County, and Gold Basin in Mohave County. There was also considerable activity in gold mining at lode mines in the Dos Cabezas district in Cochise County; Vulture district in Maricopa County; Weaver district in Mohave County; Arivaca, Cababi, and Quijotoa districts in Pima County; Old Hat district in Pinal County; Oro Blanco district in Santa Cruz County; Black Canyon, Cherry Creek, Hassayampa, and Weaver districts in Yavapai County; and Ellsworth district in Yuma County. The Copper Queen branch of the Phelps Dodge Coporation was by far the largest producer of gold in Arizona in 1932; it was followed in order by the United Verde Extension, Magma, Tom Reed, New Cornelia, and Katherine properties.

Silver.—The silver output in Arizona in 1932 decreased 1,188,311 ounces from the output in 1931, and the value from $941,140 to $580,074. Most of the silver, as well as a majority of the gold produced in Arizona, is recovered from copper ore. Since there was an unusual decrease in the output of copper material in 1932 there was a decided decline in the production of both silver and gold. In 1932 the output of silver in Arizona was the smallest since detailed records were started, and the average price (28.2 cents an ounce) was less than that of any year since 1850. The largest decrease in silver output was reported from the properties of the Phelps Dodge Corporation. The inactivity at the United Verde mine, the largest silver producer in

Arizona from 1923 to 1930, resulted in a large decrease in silver output, and there was also a large decrease from the Magma mine at Superior. The Copper Queen branch of the Phelps Dodge Corporation was the leading producer of silver in Arizona in 1932, and it was followed by the Magma and United Verde Extension mines.

Copper.—In 1932 Arizona was again the largest producer of copper in the United States, but its output decreased 54 percent from the output in 1931, and the value decreased from $36,522,387 to $11,217,107. The average price of copper in 1932 was only 6.1 cents a pound compared with 9.1 cents a pound in 1931 and 13 cents in 1930. The unusually low price in 1932 resulted in the closing of several of the large producers of copper, some of which had been in continuous operation for 30 years. The value of the copper output in 1932 was nearly 70 percent less than that in 1931, 85 percent less than that in 1930, and less than one fourth of the value of the record output of 1929.

The United Verde Extension Mining Co. was the only important copper producer in Arizona which increased its output in 1932 over 1931, but the output was considerably less than that in 1930. The largest decrease was reported by the Copper Queen branch of the Phelps Dodge Coporation, followed closely by the Inspiration property. Other large decreases were reported at the Miami and Old Dominion mines in Gila County, the New Cornelia in Pima County, the United Verde in Yavapai County, the Morenci property in Greenlee County, and the Magma and Ray mines in Pinal County. The largest copper producers in 1932 were the Copper Queen, United Verde Extension, Morenci, Magma, Miami, Inspiration, Ray, and New Cornelia properties.

Lead.—The lead production in Arizona in 1932 increased slightly over the production in 1931, but the value decreased from $72,672 to $56,000, as the average price of lead declined from 3.7 cents a pound in 1931 to 2.8 cents in 1932.

Nearly all the large producing lead mines in Arizona were idle in 1932, which resulted in an output less than that for any year since 1904. Almost all the lead ore or concentrates from Arizona in 1932 was smelted at El Paso, Tex., as the lead furnace at Douglas was idle. The Tombstone Extension property at Tombstone was the largest producer of lead in Arizona in 1932, and it was followed by the Copper Queen branch of the Phelps Dodge Corporation at Bisbee. The Montana mine of the Eagle-Picher Lead Co. at Ruby in Santa Cruz County, and the 79 mine at Hayden Junction in Gila County, each of which produced nearly 2,000,000 pounds of lead in 1930, were idle both in 1931 and in 1932. The increases from the Tombstone Extension property and from the Copper Queen branch of the Phelps Dodge Corporation in 1932 offset the decided decreases at the Grand Reef, Grand Central tailings dump, and small producers.

Zinc.—No zinc was recovered from ore mined in Arizona in either 1931 or 1932.

Review of districts and operations.—The three leading copper producing districts of Arizona are Bisbee, Cochise County; Globe, Gila County; and Jerome, Yavapai County. The output of the Bisbee or Warren district in 1931 was 1,186,213 tons of ore, which, with copper precipitates, yielded $731,888 in gold, 1,309,398 ounces of silver, 95,327,922 pounds of copper, and 503,242 pounds of lead, valued in all at $9,805,074, a decrease of $8,441,208 from the value of the output in 1930. The chief producers in the district in 1931 were the Copper Queen and Calumet and Arizona mines. In 1932 the output of the district was again distinctly decreased, and the only operator worthy of note was the Copper Queen branch of the Phelps Dodge Corporation. The output of copper from this property in 1932 was less than half that in 1931, and there was also a decrease in the output of gold and silver, but the output of lead increased. The property, however, was the largest producer of gold, silver, and copper in Arizona. In 1932 about 260,000 tons of ore, chiefly copper material, were produced from the district, which yielded gold, silver, copper, and lead valued at about $3,755,000.

The production of the Globe district in 1931 was 7,429,571 tons of ore and old tailings (chiefly copper ore), $50,869 in gold, 77,670 ounces of silver, 126,443,616 pounds of copper, and 47,065 pounds of lead, valued in all at $11,581,503, a decrease of $9,121,253 from the value of the output in 1930. In 1932 the output of ore in the Globe district was less than one third the output in 1931, as the two chief producers closed in May. The Miami mine was the largest producer of copper in the district in 1932, and the Inspiration mine was second. The Old Dominion mine, a large producer of copper ore for the last 40 years, was closed October 14, 1931, and the mine was permitted to fill with water to the twelfth level. According to the printed annual report of the Miami Copper Co. for 1932, 1,417,810 tons of ore containing 0.774 percent copper were milled during the first 4½ months of the year. Although operating costs were reduced to 6.64 cents per pound of copper, the price was too low to permit further operation. The construction of a new plant to treat 3,000 tons of tailings a day was completed, and it was put in operation in August. This plant operated intermittently until February 8, 1933, when the entire property was closed. On January 1, 1933, the estimated ore reserves consisted of 78,527,502 tons of sulphide ore containing 0.88 percent copper and 6,911,678 tons of mixed ore containing 1.83 percent copper. In 1932 the cost of mining per pound of copper was 3.08 cents, the cost of milling was 2.26 cents, and general costs 1.30 cents, a total cost of 6.64 cents.

According to the printed annual report of the Inspiration Consolidated Copper Co. for 1932, operations began at the property on June 29, 1915, and from this date to the end of 1932, 72,392,583 tons of ore were treated, which yielded 1,328,566,121 pounds of copper. The ore reserves on December 31, 1932, consisted of 41,217,769 tons of milling ore containing 1.438 percent copper and 27,793,001 tons of mixed ore containing 1.276 percent copper. The property is fully equipped to produce 130,000,000 pounds of copper annually. The mill treated 4,092 tons of sulphide ore by flotation in 1932, which yielded 124,785 pounds of copper; 537,929 tons of ore were leached, which yielded 11,061,682 pounds of copper; 28,029 tons of slimes from the leaching plant were concentrated by flotation, which yielded 172,311 pounds of copper; and 667,403 pounds of copper were recovered from slimes leached, a total production of 12,026,181 pounds of copper for the year compared with 61,368,033 pounds in 1931. The combined extraction of ore and slimes treated in 1932 was 88.926 percent of the total copper, and the cost of producing fine copper, including depreciation, but excluding depletion and Federal taxes, was 9.907 cents a pound compared with 8.429 cents a pound in 1931.

The value of the output of the Verde district in 1931 was $4,581,343. The output consisted of copper ore chiefly from the United Verde Extension and United Verde mines. From 1923 to 1930 the United Verde mine was the largest producer of silver in Arizona; during this same period, with the exception of 1923, it was the largest producer of gold in Arizona; and with the exception of 1924 and 1930 it was the largest producer of copper. In May 1931 both the mine and smelter were closed, resulting in an unusual decrease in the output of the district in 1931–32. The United Verde Extension mine was the only important producer in the district in 1932, and it increased its output over that in 1931. According to the company's printed annual report for 1932, 212,241 tons of ore and concentrates were smelted, which yielded 10,007 ounces of gold, 348,247 ounces of silver, and 35,751,326 pounds of copper. The mine ranked second in the production of gold and copper in Arizona in 1932 and third in silver. The average cost of producing 1 pound of copper was 5.45 cents. Ore reserves at the end of 1932 are estimated to be 360,000 tons. The company paid regular quarterly dividends during the year aggregating $603,750.

The Mineral Creek and Pioneer districts in Pinal County, the Ajo district in Pima County, and the Copper Mountain district in Greenlee County are also large copper-producing districts. The Ray mines of the Nevada Consolidated Copper Co. in the Mineral Creek district, Pinal County, were operated nearly the entire year, and the 12,000-ton flotation concentrator at Hayden was operated 201 days. The ore output in 1932 was less than half that in 1931 and the copper production decreased nearly 40 percent. About 33,700 tons of copper concentrates and 9,900 tons of crude copper ore were smelted at the American Smelting & Refining Co. plant at Hayden. The mine, mill, and smelter of the Magma Copper Co. in the Pioneer district, Pinal County, were closed in June, but the mine was reopened September 16 and mining resumed from November 28 to December 24. According to the company's printed annual report for 1932 the mine produced 5,151.72 ounces of gold, 486,037 ounces of silver, and 21,675,521 pounds of copper, a decrease of 2,361 ounces of gold, 215,539 ounces of silver, and 7,085,107 pounds of copper from 1931. About 117,000 tons of ore containing 6.90 percent copper and a little gold and silver, treated in 1932 by table and flotation concentration, and more than 86,000 tons of first-class copper ore, were smelted. The New Cornelia mine and 15,000-ton flotation concentrator in the Ajo district, Pima County, was operated by the Phelps Dodge Corporation until April, when all work ceased. The production of copper in 1932 was about one fourth that in 1931, and there was also a decided decrease in the production of gold and silver. The Morenci branch of the Phelps Dodge Corporation in the Copper Mountain district, Greenlee County, was operated until July, when all mining, milling, and smelting ceased. The property is equipped with a 5,500-ton flotation concentrator and a 500-ton smelter. Although the production of copper in 1932 was about 15,000,000 pounds less than that in 1931, the property ranked third as a producer of copper in Arizona.

IDAHO

The value of the gold, silver, copper, lead, and zinc produced from mines in Idaho in 1932 decreased about 34 percent from 1931. The largest decrease was in lead, by far the most important metal produced in the State. The production in 1932 was the smallest since 1902 and was valued at about $3,976,000 compared with $7,352,981 in 1931. There were also decreases in the output of zinc, silver, and copper, but the output of gold was the largest since 1916 and was more than double the output in 1931. Smelting and refining operations at the lead plant at Kellogg were conducted at a considerably lower rate, and the electrolytic zinc plant at Silver King was run on a part-time basis. Several of the large mines that had operated regularly for many years, especially those in Shoshone County near Wallace and Morning, were idle during part or all of 1932. In general, the mining industry in Idaho in 1932 was distinctly subnormal and was a continuation of the depressed conditions in 1931.

Several interesting developments, however, augmented the production of both gold and silver in Idaho during the year. Probably that attracting widest attention was the unusually large gold production made by the St. Joseph Lead Co. at its property near Atlanta, Elmore County, as the mines in this region had been virtually idle since 1917. Development at the St. Joseph property—a consolidation of the Atlanta Mines and Boise-Rochester group—had been in progress before the recent interest in reopening old gold mines, but the dredge activity at Warren in Idaho County, the work at the Mayflower mine in Boise County, and much of the activity in Valley County were new features of 1932. The increased output of silver from the Sunshine (Yankee Boy) property was also notable, not only because the production was greatly increased over that in 1931, but because the ore was mined when silver was sold at such an abnormally low price. The mine became the largest producer of silver in the United States in 1932 and produced about 44 percent of the State output of silver.

Mine production of gold, silver, copper, lead, and zinc in Idaho, 1928–32, in terms of recovered metals

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1928	2,054,329	$433,703	8,998,330	2,072,165	290,645,905	62,526,648	$26,667,706
1929	2,174,125	418,545	9,414,403	5,131,438	297,389,488	91,350,807	31,104,246
1930	1,944,900	443,309	9,420,639	3,111,555	268,115,963	75,298,172	21,494,867
1931	1,299,927	379,563	7,220,923	1,144,915	198,729,228	39,137,212	11,418,013
1932 [1]	1,031,000	936,434	6,700,000	1,097,000	142,000,000	20,400,000	7,501,151

[1] Subject to revision.

Gold.—The mine output of gold in Idaho remained close to $400,000 from 1928 to 1931 but advanced to an amount valued at $936,434 in 1932 due to the greatly increased production from both placer and lode properties. The value of the production in 1932 was the largest since 1916 when $1,115,810 in gold was produced. The increase in the output of gold in 1932 was due chiefly to the shipment of gold bullion and concentrates resulting from the operation of the mine and mill of the St. Joseph Lead Co. at Atlanta, Elmore County, the increase in the output of gold from the dredge of the Idaho Gold

Dredging Co. near Warren, Idaho County, and to the operation of the mill of the Yellow Pine Co. near Yellow Pine, Valley County. The Talache Mines, Inc., operating the Gold Hill & Iowa mine at Quartzburg, was the largest producer of gold in Idaho in 1931, but it was virtually idle in 1932 following the fire of August 1931. The mine, however, was reopened and the vein developed to a depth of 1,090 feet. The Idawa Gold Mining Co. and the Idaho Gold Dredging Corporation, both large producers of gold since 1926, produced no gold in 1932.

After spending much time and money in developing the Boise-Rochester property and the Atlanta Mines group at Atlanta and building a new 200-ton amalgamation and flotation plant in 1931 the St. Joseph Lead Co. became the largest producer of gold in Idaho in 1932. The new plant had its initial run early in the year, and gold bullion was shipped to the assay office at Boise, Idaho, and rich gold concentrates were hauled to Mountain Home and shipped to Utah for smelting. In 1932 the company produced about 42 percent of the total State output of gold or more than all the mines in the State produced in 1931.

A comparatively new company which began producing gold in 1932 was the Yellow Pine Co. at its property near Yellow Pine, Valley County. The company started operating its new 150-ton flotation plant in January and by the end of the year succeeded in becoming the third largest producer of gold in Idaho; the mill also recovered a large quantity of concentrates containing stibnite, the sulphide of antimony.

The new dredge of the Idaho Gold Dredging Co. at Warren increased its output of gold and ranked second as a producer of gold in Idaho in 1932. A new dredge was constructed on Warren Creek by the Warren Creek Dredging Co., the old Bailey dredge on Rhodes Creek near Pierce was reconditioned by the New York-Idaho Dredging Corporation, and the dredge in Owyhee County, operated in 1931 by the American Gold Dredging Co., was worked in 1932 under lease by the Superior Leasing Co. The combined output from these 4 plants was valued at about $170,000 compared with $80,352 produced by 4 dredges in 1931. Considerable gold was also produced from the Golden Anchor Mine near Burgdorf, Idaho County, and from many small mines throughout the State. There was a substantial increase in the output of siliceous gold ore in 1932 and a marked increase in deposits of gold at the assay office at Boise for the year.

Silver.—The output of silver decreased 520,923 ounces in 1932, a small quantity compared with the decreases in other States. Despite the decrease in value from $2,094,068 in 1931 to $1,889,400 in 1932 the State was the second largest producer of silver in the United States, following Utah, as it was in 1930–31.

In the Coeur d'Alene district, which produced at least 6,500,000 ounces of silver, about 45 percent of the silver was recovered from the ore of the Sunshine (Yankee Boy) Mine on Big Creek east of Kellogg; most of the remainder was produced from the Bunker Hill & Sullivan, Hecla, Morning, and Crescent Mines, which ranked in the order given. The Golconda and Page properties in Shoshone County, the St. Joseph property in Elmore County, and the Whitedelf Mine in Bonner County were also large producers of silver. The Sunshine property increased its silver output about 550,000 ounces and was not only the largest silver producer in Idaho but became the largest silver producer in the United States in 1932. The 500-ton flotation plant was worked regularly and the company paid four quarterly dividends aggregating $150,000. Large increases in the output of silver were also made from the Crescent on the west side of Big Creek and the Golconda Mines east of Wallace, but unusually large decreases were reported from the Morning, Hecla, Bunker Hill & Sullivan, Hall-Interstate, Page, Blackhawk, Dayrock, and Sherman Mines.

Copper.—The output of copper decreased about 4 percent in 1932, and the value decreased from $104,187 to $66,917 as the average price of the metal decreased 3 cents a pound.

About half the copper produced in Idaho in 1932 came from the Sunshine (Yankee Boy) property, as the chief mineral in the ore of this important producer is a variety of tetrahedrite carrying considerable silver as well as copper. It was followed by the Bunker Hill & Sullivan and Hecla properties, where a small quantity of copper is associated with lead ore. The regular copper producers in Idaho, such as the Mackay Metals Co., operating property in Custer County, and the Winder-Stillman Con, operating property in Lemhi County, have been closed since the drop in the price of copper in 1930.

Lead.—The output of lead in 1932 decreased about 28 percent from that in 1931, and the value of the output decreased from $7,352,981 to about $3,976,000 as a result of general curtailment of production caused by a continued drop in the average prices of lead and zinc.

Idaho suffered particularly from the extremely low price of lead, as the State produces about 25 percent of the lead produced in the United States. The State, however, maintained its position as the second largest producer of lead in the United States, after Missouri.

The Bunker Hill & Sullivan, Hecla, and Morning Mines were as usual the three largest producers, but the total output of these mines was 26 percent less than that in 1931; the output from the Morning Mine alone decreased more than 20,000,000 pounds, as the property was closed 5 months of the year. Other large producers of lead in 1932 were the Page, Golconda, Sidney, and Whitedelf properties. According to the annual report of the Bunker Hill & Sullivan Mining & Concentrating Co. for 1932 the company mined and treated 429,880 tons of ore compared with 460,366 tons in 1931. The Bunker Hill smelter and refinery were operated on a 1-furnace basis and produced 60,283 tons of lead, 8,528,772 ounces of silver, and 34,760 ounces of gold compared with a production of 77,687 tons of lead, 10,049,526 ounces of silver, and 44,841 ounces of gold in 1931. The sharp decreases indicate a marked reduction in both company and custom materials received at the plant. Dividends paid in 1932 amounted to only $61,637 compared with $553,246 in 1931 and $2,109,690 in 1930. Ore reserves at the end of the year were 2,118,273 tons, and mine development was limited to the new Flood-Pike-Stanly area where important new reserves of ore were opened. The electrolytic zinc plant of the Sullivan Mining Co., which is worked under the control of the Bunker Hill & Sullivan Mining & Concentrating Co., operated continuously during 1932 at about 29 percent of capacity. Although virtually all the important producers of lead in Idaho decreased their output decidedly the Golconda Lead Mines increased its output nearly 1,000,000 pounds.

Zinc.—The zinc recovered from ore and concentrates in 1932 decreased about 47 percent from that in 1931, and the value decreased from $1,487,214 to about $632,400. As the average price of zinc declined from 3.8 cents a pound in 1931 to 3.1 cents a pound in 1932, several of the large producers of lead-zinc ore remained idle throughout the year, and most of those that were active greatly curtailed production. More than 57 percent of the zinc output was recovered by roasting and leaching at the electrolytic plant at Great Falls, Mont., and the remainder was recovered at the plant of the Sullivan Mining Co. at Silver King, which was operated at less than one third capacity. The Morning Mine exceeded all others in zinc production and produced slightly more than half the total zinc of the State, but its output was 56 percent less than in 1931. Next in order were the Bunker Hill & Sullivan, Sidney, Golconda, Frisco, Star, and Page Mines. The output from each of these properties, except the Golconda and Star Mines, was considerably less than that in 1931.

Mines and mills.—According to the printed annual report of the Federal Mining & Smelting Co. for the year 1932 the Morning Mine in the Hunter district, Shoshone County, was operated on a basis of 12 days a month from January 1 to May 31 and from November 1 to December 31; the mine was closed from June 1 to October 31. The property is equipped with a 1,200-ton flotation concentrator, and in 1932 the plant treated 102,352 tons of lead-zinc ore, a decrease of 129,267 tons from 1931. The ore contained an average of 3.8 ounces of silver to the ton, 9.8 percent lead, and 6.7 percent zinc. About 12,194 tons of lead concentrates were produced containing 317,216 ounces of silver and 17,981,158 pounds of lead, and 10,086 tons of zinc concentrates were produced containing 56 ounces of gold, 41,929 ounces of silver, 537,361 pounds of lead, and 11,398,865 pounds of zinc. In 1931 a total of 48,146 tons of lead concentrates and zinc concentrates was produced containing 183 ounces of gold, 765,800 ounces of silver, 39,240,023 pounds of lead, and 25,719,970 pounds of zinc. In 1932 the mine was operated at a loss of $318,977 compared to a profit of $65,170 in 1931 and $766,091 in 1930.

Ore reserves at the end of 1932 were estimated at 1,495,000 tons of developed ore. During the year the 3,450 level was opened an additional length of 30 feet, making the total length on the ore 1,120 feet. The 3,650 level was opened an additional length of 280 feet, making a total length of 720 feet on the ore.

The Page and Blackhawk Mines in the Yreka district, Shoshone County, were also operated in 1932 on the same schedule as the Morning Mine by the Federal Mining & Smelting Co. According to the printed company report, 19,174 tons of lead-zinc ore were treated from the Page Mine and 4,428 tons of similar ore were treated from the Blackhawk Mine. The ore from both mines, which was treated in the 300-ton flotation mill at the Page property, contained an average of 4.20 ounces of silver to the ton, 11.11 percent lead, and 2.50 percent zinc. A total of 3,907 tons of lead concentrates and zinc concentrates was produced from both mines, containing 7 ounces of gold, 91,016 ounces of silver, 4,756,646 pounds of lead, and 488,009 pounds of zinc. This represents a decided decrease from the output in 1931 when 54,909 tons of lead-zinc ore were treated from both mines. A total of 9,287 tons of lead concentrates and zinc concentrates was produced containing 18 ounces of gold, 219,042 ounces of silver, 10,885,834 pounds of lead, and 1,604,781 pounds of zinc. Ore reserves in the Page-Blackhawk group are estimated at 344,400 tons at the end of 1932. Besides properties in Idaho the Federal Mining & Smelting Co. also owns properties in Kansas, Oklahoma, and Missouri, but the only mines worked in 1932 were those in Idaho. The total value of all metals sold in 1932 was $1,085,844 as compared to $3,007,304 in 1931. After $1,510,133 was deducted for cost of production, freight, treatment, and royalty the net operating loss was $424,289.

The Hercules custom-flotation plant at Wallace was operated part of the year chiefly on ore from the Tamarack & Custer Mine. The total quantity of ore treated in 1932, however, was less than 7 percent of that treated in 1931.

MONTANA

Most of the gold and silver and nearly all the copper produced in Montana depend on the output of copper ore from mines at Butte, Silver Bow County, and the value of the metals recovered from copper material in 1931 accounted for nearly 93 percent of the total value of the metal output of the State. In 1932 the value of gold, silver, copper, lead, and zinc produced from mines in Montana was $6,667,957 compared with $19,575,053 in 1931.

The large decrease of nearly $13,000,000 in the combined value of the metals resulted chiefly from curtailment in the output of copper ore by the Anaconda Copper Mining Co. and the continued drop in the average sales prices of silver, copper, lead, and zinc. The output of each metal except gold decreased to a marked degree from that in 1931—copper 54 percent, lead 73 percent, zinc 67 percent, silver 56 percent, and gold less than 1 percent.

Mine production of gold, silver, copper, lead, and zinc in Montana, 1928–32, in terms of recovered metals

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1928	4,344,279	$1,203,020	10,853,276	248,262,027	33,759,644	165,660,189	$55,365,249
1929	4,723,445	1,131,949	12,716,977	297,725,973	39,213,707	136,351,734	71,779,547
1930	2,686,669	899,001	7,052,889	196,187,523	21,306,044	52,841,108	32,720,416
1931	2,085,683	829,192	3,829,837	184,555,735	8,860,186	13,494,986	19,575,053
1932 [1]	765,000	823,773	1,671,000	84,717,000	2,375,000	4,475,000	6,667,957

[1] Subject to revision.

Gold.—The value of the gold output from both lode and placer mines was close to that of 1931, chiefly on account of the interest in the operation of lode gold mines. A feature in 1932 was the general and continued activity in gold mining which resulted in reopening mines formerly productive as well as prospecting for and developing new ones.

The Jardine Mine at Jardine, Park County, a large producer of gold from 1918 to 1926, was again active in September 1932 and produced more than $28,000 in gold during the last quarter of the year. Besides gold, part of which is free, the ore contains arsenopyrite and scheelite. The plant includes a 200-ton amalgamation and concentration mill, arsenic plant, and cyanide plant. The I. B. Mining Co., which started working the Sleeping Princess group near Bannack, Beaverhead County, in March 1931 continued to work the property throughout 1932. The property is equipped with a 100-ton cyanide plant, and slightly more gold bullion than in 1931 was sold to the mint at San Francisco. The mine ranked second as a producer of gold in Montana in 1932. The Liberty Montana Mines Co. worked its property near Jefferson Island, Madison County, throughout the year at one third of its normal capacity. The ore, containing chiefly chalcopyrite and pyrite, was treated in a 150-ton flotation concentrator, and copper concentrates rich in gold were shipped to Anaconda for smelting. The production of gold from the Liberty Montana property in 1932 was more than double that in 1931, and the mine became the largest producer of gold in Montana. The property has been a large producer of gold recovered from copper concentrates during the last 5 years. The Ohio-Keating group near Radersburg, Broadwater County, was worked by the Ohio-Keating Gold Mining Corporation until September 10 when operations ceased. More than 15,000 tons of iron oxide ore were treated in a 100-ton cyanidation plant and gold bullion valued at about $64,000 was sold. In addition, 247 tons of iron sulphide ore containing nearly 1 ounce of gold to the ton was shipped for smelting. The property not only increased its output of gold in 1932 but ranked third as a producer of gold in Montana. About 2,800 tons of gold ore from the old Gold Coin Mine near Southern Cross, Deer Lodge County, were treated by amalgamation, and exceptionally rich gold ore of smelting grade was shipped from the August Mine near Landusky, Phillips County.

Mines in the Highlands district 15 miles south of Butte in Silver Bow County received more attention in 1932 than in previous years, and the Butte Highlands Mining Co. shipped 600 tons of first-class ore containing more than 1 ounce of gold to the ton. The Spring Hill mine of the Montana Mines Corporation, a large producer of gold since 1928, was idle in 1932. The decrease in gold from this property and from the Anaconda group represented a combined decrease of 14,600 ounces of gold; but the large increases in gold output from the Liberty Montana, Ohio-Keating, Jardine, Gold Coin, Drumlummon, and Butte Highlands properties, and the continued production from the I. B. Mine and from many small producers from various parts of the State nearly offset the decrease.

The largest gold producers in the State in 1932 were the Liberty Montana, I. B., Ohio-Keating, Anaconda, Jardine, August, Gold Coin, and Drumlummon properties.

Silver.—The output of silver in 1932 was less than half that in 1931 and was the smallest since detailed production figures have been recorded. The decrease in silver output was due almost entirely to the curtailment in the output of copper ore from the property of the Anaconda Copper Mining Co., as most of the silver produced in Montana is recovered from copper ore mined at Butte. With a better price for silver, however, much silver-bearing ore may again be mined at Kila, Flathead County; Philipsburg, Granite County; and Neihart, Cascade County.

Copper.—The copper output decreased nearly 100,000,000 pounds in 1932, and the value of the output decreased from $16,794,572 to $5,167,737, the lowest value in the last 30 years. The enormous decrease in the size of the copper output, combined with the decline in the average sales price from 9.1 cents a pound in 1931 to 6.1 cents a pound in 1932 and the decrease in the value of the silver output, accounted for nearly 95 percent of the total decrease in the value of the metal output of the State.

Despite the large decline in the output of copper the State retained its position as the second largest producer of copper in the United States. In 1932 the Anaconda Copper Mining Co. produced nearly all the State's copper from its mines at Butte, which were kept in operation despite the exceptional drop in the price of copper. The production was less than half that in 1931.

Lead.—The production of lead decreased 73 percent in quantity and 80 percent in value; it was the smallest output since 1903. The decrease of nearly 6,500,000 pounds in the production of lead was due chiefly to the closing of the Jack Waite Mine and mill in March. The property, however, was the largest producer of lead in Montana in 1932, as it was in 1931.

Nearly all the large producers of lead in Montana, especially those at Butte, have been closed since the drop in metal prices. The Block P Mine near Monarch, Judith Basin County, was the largest producer of lead in Montana in 1929 and 1930, but the property was closed during the latter part of 1930 as a result of low metal prices. In 1929 and 1930 considerable lead was also produced from mines near Basin, Jefferson County; Philipsburg, Granite County; Radersburg, Broadwater County; and Melrose, Madison County. The lead smelter at East Helena was operated until June 16 when it was closed for an indefinite period. The receipts in 1932 consisted chiefly of lead concentrates from Idaho and residues from the electrolytic zinc plant at Great Falls.

Zinc.—Nearly all the zinc produced in Montana in 1932 was recovered from treating current slag in the fuming plant of the Anaconda Copper Mining Co. at East Helena. The total output of zinc decreased 67 percent in quantity in 1932 and was the lowest since 1908. The value decreased from $512,809 in 1931 to $138,725 in 1932. This large decrease was due to the fact that the production of zinc from current slag at East Helena was suspended when the lead smelter closed in June. The Jack Waite property in Sanders County produced a little zinc, recovered from zinc concentrates shipped to the electrolytic zinc plant at Silver King, Idaho. The electrolytic zinc plant near Great Falls was operated at less than one half capacity, treating chiefly custom material from Utah and Idaho; the electrolytic zinc plant at Anaconda was idle. The custom flotation plants for the treatment of lead-zinc ore at Aanconda and Butte, owned by the Anaconda Copper Mining Co., remained inactive the entire year. In 1929 nearly 74 percent of the zinc produced in Montana was recovered from zinc ore and lead-zinc ore from the mines at Butte, Silver Bow County, but the mines were closed in 1930 as a result of the drop in metal prices. In 1929–30 considerable zinc was also produced from the Block P Mine near Monarch, Judith Basin County, from current slag at East Helena and from mines near Philipsburg, Granite County.

Butte district and Silver Bow County.—The Butte district, by far the most important mining region of Montana, produced 1,869,330 tons of ore and old tailings in 1931 from which $206,268 in gold, 3,698,676 ounces of silver, and 184,361,564 pounds of copper were recovered, or metals valued at $18,055,786, a decrease from $29,300,026 in 1930.

The production of gold, silver, and copper from ore, old tailings, and precipitates from the Butte mines in 1932 was valued at only $5,831,736.

The Anaconda Copper Mining Co. was virtually the only producer in the Butte district in 1932. According to the printed annual company report for 1932 the mines continued to produce copper ore but at a greatly reduced rate. In 1932 the Anaconda smelting plant produced 97,573,887 pounds of copper, 2,027,675 ounces of silver, and 18,551.5 ounces of gold; nearly all the copper and silver came from mines at Butte, but about 83 percent of the gold came from shipments from mines outside of Silver Bow County. In 1931 the smelter produced 173,440,855 pounds of copper, 3,640,066 ounces of silver, and 19,486.2 ounces of gold. The electrolytic zinc plant of the Anaconda Copper Mining Co. at Great Falls was operated until May 6, 1932, and the plant at Anaconda has been idle since June 1931. During the time the plant at Great Falls was operated a total production of 33,904,565 pounds of zinc was made, chiefly from zinc concentrates received from mills in Idaho and Utah. In 1931 the two plants produced 125,983,883 pounds of zinc.

The gross sales and earnings of the Anaconda Copper Mining Co. and its subsidiaries in 1932 were $52,295,611. The cost of sales, including all operating expenses, current development, maintenance charges, repairs, selling and general expenses, and taxes amounted to $57,240,906, resulting in an operating loss of $4,945,295 compared with an operating income of $6,409,427 in 1931. After depreciation, interest, and expense of carrying nonoperating units were deducted and $610,063 was allowed for miscellaneous income, the net loss to surplus was $16,893,240. The company paid no dividends in 1932 and the reported surplus at the end of the year was $42,061,546 compared to a reported surplus of $69,613,562 at the end of 1931.

No lead or zinc has been produced from the Butte district since 1930 on account of low metal prices. The North Butte Mining Co., a large producer of copper in 1930, was closed in May 1931 and remained nonproductive throughout 1932.

From 1882 to the end of 1932 Silver Bow County, which includes the Butte district, yielded gold, silver, copper, lead, and zinc valued at $2,172,616,484, as follows: Gold, $37,367,104; silver, $329,440,735; copper, $1,577,522,736; lead, $21,016,091; and zinc, $207,269,818. These values represent 1,807,633.58 ounces of gold, 462,084,047 ounces of silver, 10,371,575,359 pounds of copper, 314,289,223 pounds of lead, and 2,567,395,925 pounds of zinc.

UTAH

The mines of Utah produced gold, silver, copper, lead, and zinc valued at $14,325,782 in 1932, a value less than for any year since 1899 and a decrease of $14,645,192 from the output in 1931. Metal production declined so rapidly in the last 3 years that the value of the five metals in 1932 was only 15 percent of that in 1929, the record year in the history of metal mining in Utah.

The curtailed output of copper ore, chiefly from the Utah Copper property at Bingham, and the decline in metal prices accounted for 41 percent of the total decrease in the value of the metal output of the State. There was also a large decrease in the output of lead-zinc ore from mines at Bingham and Park City and in lead ore from mines in the Tintic district.

The smelting plants at Murray and Tooele were operated at greatly reduced capacity and for only part of the year, but the lead smelter at Midvale was worked throughout the year on a 1-furnace basis, and the copper plant at Garfield continued to operate at reduced capacity.

Utah remained first in the United States in the production of silver followed by Idaho and Montana, ranked third in copper after Arizona and Montana, and third in lead after Missouri and Idaho.

The fact that the average price of copper dropped to an unprecedented low of 6.3 cents a pound, resulting in the closing of the Utah Copper mine part of the year after the capacity had been greatly reduced, was a severe blow to the mining industry in Utah. Three features of the year, however, were most encouraging for the future of the industry. The Eureka Standard mine continued to be an important producer of gold from ore of smelting grade and surpassed all other mines in Utah in gold production at a time when the Utah Copper Co. was seriously curtailing its output. The high-grade gold ore shipped in 1932 contained the telluride minerals hessite and petzite and gives the mine a unique place mineralogically compared with other active gold mines in Utah. While the Park Utah Consolidated Co. property at Keetley and Park City was virtually idle, the Park City Consolidated Mines Co. resumed operations in March after being idle since June 1, 1931. The company shipped about 21,000 tons of ore containing more than 400,000 ounces of silver, which was sufficient to prevent Utah from losing its lead in silver. The third feature of the year was the continued operation and interesting development in the various properties of the United States Smelting, Refining & Mining Co. at Lark and Bingham.

Mine production of gold, silver, copper, lead, and zinc in Utah, 1928–32, in terms of recovered metals

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1928	18,427,117	$4,394,001	17,072,852	293,235,039	291,830,021	93,857,352	$79,258,904
1929	19,831,975	4,969,915	17,592,396	318,282,523	298,754,429	103,019,485	95,985,201
1930	11,041,841	4,309,148	13,129,421	180,526,423	230,989,780	88,990,938	48,653,464
1931	8,954,617	4,108,323	8,290,966	151,236,505	158,423,453	74,581,072	28,970,974
1932 [1]	3,776,800	2,797,726	6,939,545	65,113,000	123,149,500	59,150,000	14,325,782

[1] Subject to revision.

Gold.—The gold production decreased about 32 percent in 1932, due chiefly to curtailment in output of copper ore from Bingham and to the decrease in the output of gold from mines in the Tintic district. The output of gold from mines in the Bingham district decreased more than 36,000 ounces compared with that of 1931; the output of gold from mines in the Tintic district decreased more than 27,000 ounces; and there was also a decrease in the output of gold from mines in the Park City region. Unusually large decreases in the production of gold were made by the Utah Copper, North Lily, Eureka Standard, Chief Consolidated, and United States Smelting, Refining & Mining companies. A substantial increase in the output of gold was made at the Yankee Mine in the American Fork district, Utah County, by the American Smelting & Refining Co. and from mines near Gold Hill, Tooele County.

Although the gold recovered in the past from placers in Utah has been relatively small, more gold was recovered in 1932 from placer operations in Grand, Garfield, and San Juan Counties than in recent years. Most of the gold produced in Utah, however, is recovered from bullion after smelting copper and lead ore and concentrates in furnaces in the Salt Lake Valley or in Tooele County near Tooele.

An effort was made in 1932 to rejuvenate old lode gold mines in the State, particularly in Park Valley district, Box Elder County; at Mercur and Gold Hill, Tooele County; in the Fortuna district, Beaver County; and in the Gold Mountain district, Piute and Sevier Counties.

The largest producers of gold were the Eureka Standard Mine in the Tintic district, the Utah Copper, United States, and Niagara properties in the Bingham district; the Yankee (American Smelting & Refining Co.) Mine in the American Fork district; the Utah-Delaware property in the Bingham district; and the Mammoth Mine in the Tintic district.

Silver.—The production of silver in Utah has decreased decidedly in the last 3 years, and the value of the silver output decreased from $2,404,380 in 1931 to $1,956,952 in 1932. The average price of the metal dropped slightly from 29 cents an ounce in 1931 to 28.2 cents in 1932.

Utah has been the leading silver producer of the United States since 1920. The State retained its position in 1932 but was only slightly ahead of Idaho. The increased output of silver by the Silver King Coalition and Park City Consolidated companies resulted in an increase of nearly 300,000 ounces in the output of silver from the Park City region, but the output of silver from the Tintic district decreased more than 900,000 ounces, and the output from the Bingham district decreased nearly 600,000 ounces. The Silver King Coalition mine at Park City was the largest producer of silver in Utah in 1932, followed closely by the Tintic Standard property at Dividend in the Tintic district, which held first place in 1931. Other large silver producers were the United States, Niagara, Park City Consolidated, Eureka Standard, Utah Copper, and Bluestone Lime & Quartzite properties.

Copper.—Copper has decreased in Utah from more than 318,000,000 pounds in 1929 to 65,113,000 pounds in 1932. The value of the copper output decreased from $13,762,522 in 1931 to about $4,102,119 in 1932. The output in 1932 was the smallest since 1921, and the average price of copper declined from 9.1 cents a pound in 1931 to 6.3 cents a pound in 1932. The decrease of 57 percent in the total copper production of the State was due almost entirely to the curtailment in the output of copper ore by the Utah Copper Co. at Bingham. Following the Utah Copper Co., the leading copper producers were the Silver King Coalition, United States, Utah-Delaware, and Yankee properties.

Lead.—The lead output was valued at $3,694,485, a decrease from $5,861,668 in 1931. The output in 1932 was the smallest since 1921 as the average sales price of lead declined from 3.7 cents a pound in 1931 to 3 cents a pound in 1932. A substantial increase in lead was reported from the Niagara property, controlled by the United States

Smelting, Refining & Mining Co. at Bingham, and smaller increases were made at the United States and Lark properties of the same company. Unusually large decreases were reported at the Tintic Standard, Park Utah Consolidated, North Lily, Utah-Apex, Bullion Coalition (Combined Metals Reduction Co.), Chief Consolidated, Plutus, and Utah-Delaware properties. A decrease of nearly 19,000,000 pounds was recorded in the Tintic district, more than 9,400,000 pounds in the Park City region, and more than 4,400,000 pounds in the Bingham district. The largest producers of lead in order of output were the United States, Silver King Coalition, Tintic Standard, Bluestone Lime & Quartzite, and Niagara properties.

Zinc.—The zinc, recovered entirely from milling lead-zinc ore, decreased from $2,834,081 in 1931 to about $1,774,500 in 1932. The average sales price of the various grades declined from 3.8 cents a pound in 1931 to 3 cents a pound in 1932, which resulted in a large decrease in the output of lead-zinc ore from mines at Bingham and Park City. The production of zinc in 1932 from the United States mine at Bingham, the largest producer of lead-zinc ore in the State, was much less than that in 1931, and there was also a large decrease in the production of zinc from the Park Utah Consolidated properties near Park City. The Silver King Coalition Mines Co. at Park City, which ranked second as a producer of lead-zinc ore in the State, increased its production of zinc. Most of the zinc concentrate made from ore mined in Utah in 1932 was stock-piled to await a rise in the price of zinc. The largest zinc producers in Utah in 1932 were the United States, Silver King Coalition, and Niagara properties.

Review of districts and operations.—According to estimates made early in 1933 the mines of Utah produced 3,776,800 tons of ore and old tailings in 1932, a decrease from 8,954,617 tons in 1931, chiefly in copper ore. The Bingham district produced about 3,450,000 tons compared with 8,485,873 tons in 1931, and the metal output of the West Mountain or Bingham district was estimated at 70,490 ounces of gold, 1,909,800 ounces of silver, 62,526,000 pounds of copper, 62,720,000 pounds of lead, and 43,740,000 pounds of zinc. The output from Bingham, the most important district of Utah, represented a marked decrease from 106,867.66 ounces of gold, 2,502,057 ounces of silver, 147,706,141 pounds of copper, 67,193,735 pounds of lead, and 53,215,489 pounds of zinc produced in 1931.

According to the printed annual report of the Utah Copper Co. for 1932, the total output for the year dropped to about 42 percent of that in 1931 and was about one third the average annual output for the last 5 years. A total of 3,169,411 dry tons of ore containing 0.973 percent copper was mined and milled. The average recovery of copper in the mill concentrates was 93.15 percent. Mining costs were 45.78 cents a ton and milling costs 59.01 cents a ton. The average cost per pound of net copper was 8.48 cents in 1932 compared with 6.99 cents in 1931. Concentrates shipped to the smelter contained 57,477,385 gross pounds of copper and mine-water precipitates contained 4,484,298 pounds of copper. Metals sold during the year consisted of 55,991,783 pounds of copper, 25,398.63 ounces of gold, and 222,417 ounces of silver which had a sales value of $3,489,572. The net cost of the metals sold was $4,595,590 and after miscellaneous income was added and depreciation and metal price adjustments were deducted the net loss for the year to surplus account was $3,218,887. The company paid no dividends during 1932.

In the annual report of the United States Smelting, Refining & Mining Co. for 1932 the company states that most of the lead and zinc it produced came from the United States mine at Bingham, which was operated continuously during the year. The company Lark unit was nonproductive during the year, but active development was carried on at both properties, resulting in an increase in the known ore reserves.

The mines of the Tintic district produced about 120,000 tons of ore and old tailings compared with 216,698 tons in 1931. The estimated production of the district was 50,000 ounces of gold, 2,324,000 ounces of silver, 980,000 pounds of copper, 18,430,000 pounds of lead, and 115,000 pounds of zinc. The production in 1931 was 77,110.74 ounces of gold, 3,286,748 ounces of silver, 1,568,747 pounds of copper, 36,853,599 pounds of lead, and 791,130 pounds of zinc.

The annual report of the Tintic Standard Mining Co. for 1932 gives the output from the Tintic Standard mine as 44,527 tons of lead ore and 8,828 tons of siliceous ore which contained 2,280.20 ounces of gold, 1,843,612 ounces of silver, 361,561 pounds of copper, and 18,163,057 pounds of lead. The net profit to surplus after all charges were paid was $253,666, and four quarterly dividends aggregating $230,663 were paid in 1932. The Tintic Standard Mining Co. owns 64.45 percent of the issued stock of the Eureka Standard Consolidated Mining Co. The Eureka Standard mine produced 36,478 tons of siliceous ore during 1932 containing 39,274.38 ounces of gold, 337,251 ounces of silver, 345,083 pounds of copper, and 842,189 pounds of lead. The ore had a gross sales value of $950,570 and after all charges were deducted the net profit for the year was $232,703. The company paid four quarterly dividends in 1932, aggregating $179,951.

The important output in the section near Eureka came from the Mammoth mine, which produced more than 16,000 tons of ore containing gold, silver, copper, and lead, but valuable chiefly for its gold. Production from the North Lily mine in 1932 was unusually small, as it consisted of 832 tons of ore containing 283.29 ounces of gold, 2,872 ounces of silver, and 96,273 pounds of lead. Production from the Chief mine was also small compared with past years. It consisted of 1,351 tons of ore for which the net smelter returns were $8,611. The Grand Central mine, owned by the Chief Consolidated Mining Co., produced 5,948 tons of smelting ore in 1932 containing 796 ounces of gold, 23,348 ounces of silver, and 87,374 pounds of copper.

Mill ore and first-class ore produced by mines in the Park City region amounted to about 151,500 tons in 1932 compared with 186,521 tons in 1931. The estimated output of the region was 2,800.00 ounces of gold, 2,430,000 ounces of silver, 980,000 pounds of copper, 25,260,000 pounds of lead, and 15,300,000 pounds of zinc. In 1931 the Park City region produced 5,041.06 ounces of gold, 2,124,177 ounces of silver, 818,545 pounds of copper, 34,736,616 pounds of lead, and 18,871,329 pounds of zinc.

The Silver King Coalition Mines Co. was the chief producer in the Park City region in 1932 and according to the printed annual company report 97,496 tons of ore was mined and milled which yielded 19,506 tons of lead concentrates and 13,574 tons of zinc concentrates. All of the lead concentrates were sold but 10,364 tons of zinc concentrates were placed in storage. The company gives the metal contents of the concentrates and lease ore sold in 1932 as follows: 2,157.82 ounces of gold, 1,816,671 ounces of silver, 1,022,883 pounds of copper, 25,545,861 pounds of lead, and 4,002,672 pounds of zinc. The income from the sale of ore and concentrates was $975,081 and after other income was added and all charges were deducted the net profit to surplus was $2,323. The company paid no dividends in 1932.

WASHINGTON

Due to the interest in gold mining and the operation of the mill at Metaline Falls the value of the gold, silver, copper, lead, and zinc produced from mines in Washington in 1932 was approximately $297,543 compared with $565,498 in 1931. Previous to 1931, when the Pend Oreille Mines & Metals Co. increased the output of lead and zinc in Washington, there was a gradual decrease in the value of the metal output of the State, which was continued in 1932. Marked decreases in the production of copper, lead, and zinc in 1932 resulted from the continued drop in the sales prices of these metals, but there was a fair increase in the gold output, amounting to about $37,000.

The Pend Oreille Mines & Metals Co., an important producer of lead-zinc ore at Metaline Falls in 1931, operated its milling plant and produced both lead and zinc concentrates during the first 4 months of 1932. The production of gold, chiefly from the Boundary Red Mountain mine and the Azurite mine in Whatcom County and from various properties at Republic, Ferry County, was more than the output of 1931 but less than the average annual output of the last decade.

Mine production of gold, silver, copper, lead, and zinc in Washington, 1928–32, in terms of recovered metals

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1928	64, 554	$337, 167	99, 738	1, 177, 246	1, 084, 739	85, 318	$633, 156
1929	93, 527	76, 898	47, 182	1, 400, 489	1, 015, 190	2, 117, 344	552, 233
1930	45, 456	87, 748	32, 816	1, 206, 438	1, 152, 585	703, 782	348, 630
1931	92, 049	60, 035	22, 410	202, 503	2, 771, 116	9, 947, 495	565, 498
1932 [1]	42, 200	97, 158	17, 500	5, 000	1, 879, 000	4, 588, 000	297, 543

[1] Subject to revision.

Gold.—The production of gold increased nearly 62 percent in 1932 and was larger than in any year since 1928. The Boundary Red Mountain mine south of Sardis, British Columbia, was the largest gold producer in the State in 1932; its output was more than double that in 1931. Mines in the Republic district, chiefly the Knob Hill, Mountain Lion, Morning Glory, and Ben Hur, produced gold valued at more than $46,000. The mines were operated by lessees who shipped about 4,300 tons of siliceous gold ore to the Consolidated Mining & Smelting Co. of Canada, Ltd., of Trail, British Columbia, and to Tacoma, Wash. The Boundary Red Mountain mine, the largest producer of gold in Washington in 1929 and 1930, was active most of 1932, and its gold output was valued at about $29,500 compared with $12,465 in 1931.

During the decade 1923 to 1932 mines in Washington produced $2,137,468 in gold. More than 71 percent of this total was produced from siliceous gold ore from mines in the Republic district, and 13 percent was produced from gold ore from the Boundary Red Mountain mine in Whatcom County.

Silver.—The output of silver in the State decreased 22 percent, and the value decreased from $6,499 in 1931 to $4,935 in 1932. More than 68 percent of the silver produced in 1932 came from siliceous gold ore mined at Republic; most of the remainder was recovered from lead-zinc ore mined at Metaline Falls. In the last decade mines in Washington have produced 1,154,500 ounces of silver. About 30.5 percent of the total output was produced from gold ore from mines at Republic, 25 percent from copper ore and concentrates shipped from Chewelah and Index, and more than 21 percent from lead ore shipped from the Colville district. Silver was also produced from the Springdale and Palmer Mountain districts.

Copper.—The output of copper decreased decidedly in 1932, and the value decreased from $18,428 in 1931 to only about $305 in 1932. The Sunset Copper Co. near Index, the largest producer of copper in the State since 1923, was idle throughout 1932, and shipments of silver-copper ore from Chewelah were suspended.

Lead.—Lead decreased from a production valued at $102,531 in 1931 to an output valued at $52,917 in 1932, due to declines in the quantity of ore mined and in the price of the metal. The largest producer of lead in Washington in both 1931 and 1932 was the Pend Oreille property at Metaline Falls, but the mill was closed on May 8 as a result of the continued drop in the sales prices of lead and zinc. Several cars of high-grade lead ore were shipped from the Electric Point and Gladstone properties near Leadpoint, but the Grandview mine at Metaline Falls, a large producer of lead-zinc ore in 1929, has been idle since January 1930.

During the decade 1923–32, 25,872,957 pounds of lead were produced from mines in Washington. More than half of this output was produced from lead ore from the Gladstone mine in the Northport district, Stevens County, and 28 percent was produced from mines in the Metaline district, Pend Oreille County, chiefly from lead-zinc ore from the property of the Pend Oreille Mines & Metals Co. during the last 3 years. Considerable lead was also produced from the Springdale, Colville, and Bossburg districts, all in Stevens County.

Zinc.—The production of zinc decreased about 55 percent in quantity in 1932, as the mill at the property of the Pend Oreille Mines & Metals Co. was idle 8 months in 1932. The value of the output decreased from $378,005 in 1931 to $142,228 in 1932, and the average price of zinc decreased from 3.8 cents a pound to 3.1 cents a pound. About 33,400 tons of ore containing lead and zinc were treated in the plant during the first 4 months of the year; lead concentrates were shipped to the Bunker Hill smelter at Bradley, Idaho, and zinc concentrates were shipped chiefly to the electrolytic plant of the Sullivan Mining Co. at Silver King, Idaho.

During the last decade a total of about 24,919,000 pounds of zinc has been recovered from ore mined in Washington. More than 61 percent of the total production was recovered from lead-zinc ore from the Josephine mine of the Pend Oreille Mines & Metals Co. at Metaline Falls, and about 25 percent was recovered from zinc ore from the Black Rock mine near Northport. Most of the zinc from the Black Rock mine was produced from 1922 to 1926, and nearly all the zinc from the Josephine mine was produced in 1931 and 1932. Virtually all the zinc produced in 1928 was recovered from lead-zinc ore from the Grandview property at Metaline Falls.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA, NEVADA, AND OREGON

By V. C. Heikes

CALIFORNIA

The total production of gold, silver, copper, and lead from placer and lode mines in California in 1932, in terms of recovered metals, was valued at $12,053,677, a decrease of approximately $334,057 from 1931. Gold was the only metal which showed an increase, its value representing nearly 98 percent of the total value of metals recorded for 1932. Silver decreased 44 percent in quantity, lead 38 percent, and copper 91 percent compared with 1931, with large losses in values. The recovery of some zinc was reported in 1931 but none in 1932. Continued low prices of the base metals were a factor in the decreased production of silver, copper, and lead, but the stable price of gold and the decrease in cost of its production resulting from cheaper supplies and labor helped to stimulate the mining industry. Gold production in 1932 was the largest since 1926.

The approximate value of the metals produced in 1932 brought the total value of gold, silver, copper, lead, and zinc produced in the State since 1848 to $2,144,957,862.

Mine production of gold, silver, copper, lead, and zinc in California, 1928–32, in terms of recovered metals

Year	Gold	Silver	Copper	Lead	Zinc	Total value
		Fine ounces	*Pounds*	*Pounds*	*Pounds*	
1928	$10,785,315	1,478,771	25,150,743	1,891,037		$15,381,783
1929	8,526,703	1,176,895	33,218,994	1,429,489		15,090,589
1930	9,451,162	1,622,803	27,285,272	3,559,564		13,801,004
1931	10,814,162	867,818	12,931,995	3,757,256	159,865	12,387,734
1932 [1]	11,774,677	486,000	1,136,000	2,346,000		12,053,677

[1] Subject to revision.

Gold.—California again maintained its lead as a gold-producing State with its lode and placer mines yielding 569,600 fine ounces of gold, valued at $11,774,677, an increase of 9 percent or 46,465 ounces in quantity and $960,515 in value over 1931.

Most of the gold in 1932 was produced from old-established lode mines, such as the Empire-North Star and Idaho Maryland in Nevada County; the Original Sixteen to One and the Kate Hardy in Sierra County; the Argonaut, Central Eureka, and Kennedy in Amador County; and the Yellow Aster in Kern County. The reduced output of gold from mines on the Mother Lode belt in Eldorado, Amador, Calaveras, Tuolumne, and Mariposa Counties was offset partly by increases in gold from pocket operations in the East belt mines in Tuolumne and Mariposa Counties. Three of the principal mines of the Mother Lode belt produced $235,266 less gold in 1932 than in 1931, but part of this decrease was offset by the gain of $110,833 in gold from six important lode mines in Nevada and Sierra Counties. Thirty-two companies, each with an output of more than 1,000 ounces, produced about 83 percent of the total gold yield of the State in 1932. The 10 largest lode and placer gold producers were the Empire Star Mines Co., Ltd. (gold lode); Natomas Co. (6 dredges); Idaho Maryland Mines Co. (gold lode); Yuba Consolidated Gold Fields in Yuba County (3 dredges); Capital Dredging Co. (3 dredges); Argonaut Mining Co. (gold lode); The Mountain Copper Co., Ltd. (gold lode); Original Sixteen to One Mine, Inc. (gold lode); Kennedy Mining & Milling Co. (gold lode); and the Merced unit of the Yuba Consolidated Gold Fields (1 dredge). Much gold has been recovered in the past from copper ores mined in the State, but in 1932 the output from this source was small.

As the gold-dredging fields of the State become exhausted the production of gold from lode mining is steadily exceeding that from the placers. According to a report of the California Debris Commission for 1932, issued by the War Department, 44 hydraulic placer mines were granted permission to operate, and 1,062 applications for licenses were pending. Surveys have been made in the area under the jurisdiction of the commission of those portions of the Yuba, Feather, Bear, and American Rivers containing great deposits of mining debris. Hydraulic mining is opposed by the agricultural interests in the valley counties, and in some parts of northern California placer mining is restricted 3 months of the year. Since the beginning of dredging in the Oroville district $174,526,417 in gold has been produced, and of this output the Feather River field is credited with $33,621,406, the Yuba River field with $67,049,597, and the American River field with $44,793,178. Various estimates of the future life of the remaining dredging ground have been made, but no definite figures are available. Yuba County, formerly one of the largest gold-dredging areas in the State, is now supplanted by Sacramento County, where the dredge gold output from the Folsom field has increased the last 2 years. Twenty-two dredges in Amador, Butte, Calaveras, Merced, Sacramento, Shasta, Stanislaus, Trinity, and Yuba Counties produced 188,730 ounces of gold, valued at $3,901,395, from 48,851,063 cubic yards of gravel, with an average recovery of 8 cents a cubic yard in gold. In 1931 the dredge gold production was $3,619,355 from 22 boats handling 44,423,652 cubic yards of gravel. Another dredge was added to the Folsom field by the Gold Hill Dredging Co., which moved its 9-cubic-foot dredge from Dayton, Nev., for operation on the American River. The Cal-Oro Dredging Co. completed its boat, which began digging early in 1933 on gravel south of Yreka, Siskiyou County. The gold obtained from drift placers in California is nominal, and the largest output from this method of mining in 1932 was from Calaveras County. The Calaveras Central drift mine near Angels Camp was an important producer, and late in 1932 the Tonopah Belmont Mining Co. took control of the Vallecito-Western drift mine near Angels Camp, a producer of gold for several years. Production was continued by the new company.

Small-scale gold mining.—Increasing interest in small-scale gold mining lured many people to the foothill counties of the Sierras and other gold regions in northern and southern California. Many recovered enough precious metal to pay their living expenses. The experienced prospector also joined in exploring for new gold-bearing quartz veins and reopening old prospects and abandoned veins. The results of the gold rush of 1932, in which the working season was terminated in some places in about 90 days, were disappointing. High water or snow restricted work and hampered the gold seeker in certain regions, while in a few places the work was continuous the entire year.

The records of those who bought gold from the general prospector, miner, and layman in compliance with the California "high-grade" law, administered by the State mineralogist, were reviewed and compiled with the following results, which are of interest to those seeking a livelihood from small-scale gold mining.

Ninety-four bullion dealers in California, including banks, merchants, and private refiners, all licensed by the State mineralogist of California to purchase gold in 1932, sold to the San Francisco Mint and other refiners 23,870 fine ounces or $493,437 in new gold. This total compares with $162,000 in gold purchased by bullion buyers in 1931. The reports of the bullion buyers indicate that 12,000 individuals produced 30,880 lots of new gold consisting of gold dust, nuggets, and amalgam with a range in value from 9 cents to as much as $100. The average value of each lot sold was $16, and the average amount received by the prospectors for their labors during the season or year was $41.12.

The licensed bullion buyers located in 17 counties served prospectors working in all known mineral areas of California. The bulk of this gold and that of established mines was deposited at the San Francisco Mint, which issued 19,265 deposit certificates, chiefly for gold, compared with 8,153 settlement certificates in 1931. Most of the gold deposited was from California, with important lots from Alaska, the Philippine Islands, and Arizona. Other States represented were Nevada, Oregon, New Mexico, Montana, Utah, and Washington. The minimum amount of gold received at the offices of the Bureau of the Mint was 2 ounces, equivalent to about $40; any amount under this was returned to the sender whose only recourse was to sell the gold to a bullion dealer.

The nearest bullion dealer in California paid full value for gold, and the prospectors have discovered the saving in express and melting charges on each lot sold and the added advantage of getting immediate cash or merchandise.

Amador County bullion buyers at Plymouth and Jackson handled 315.35 fine ounces of gold valued at $6,519 for 580 individuals whose average deposit was $9.73 or $11.24 for the season. Most of the gold originated from the Consumnes River in Eldorado and Amador Counties. Gold was also reported from Sutter, Jackson, Flat, Dry, and Scott Creeks, and a little gold was recovered from gravel at 49 Flat.

In Butte County 6 bullion buyers bought 2,760.28 fine ounces of gold valued at $57,060 from 2,052 individuals, whose lots of gold averaged $12.83 per deposit, or $27.81 for the season. The gold was recovered chiefly from placer gravel of the Feather River in Butte and Plumas Counties and in more than 50 other localities.

Calaveras County bullion buyers at Angels Camp, Mountain Ranch, and Camanche handled 484.62 fine ounces or $10,018 in gold. There were 488 individuals who sold 610 lots of gold dust averaging $16.32 a deposit, or $20.53 for the season. Most of the gold was from the Mokelumne River in Amador and Calaveras Counties. Particular localities mentioned in the reports received from buyers were Rich, Hicks, Wet, and Adobe Gulches and the O'Neil, McKinney, Murray, Jesus Maria, Martins, and Chile Creeks.

Del Norte County gold producers sold most of the gold recovered from beach sands to private refiners of platinum metals. The gold produced in the interior districts was shipped to banks at Grants Pass, Oreg., and to the San Francisco Mint. The burlap table continued to be the popular method for recovering gold from beach sands in Del Norte County.

Eldorado County bullion dealers at Volcanoville, Placerville, Pilot Hill, and Georgetown purchased 648.76 fine ounces or $13,411 in gold, representing 1,059 lots of gold dust from 654 individuals. The average of each lot was $12.66, and $20.51 was the average result of a season's work for each person. Most of the gold was produced from the vicinity of Placerville, Webber Creek, and Big Canyon Creek.

In Fresno and Madera Counties bullion dealers at Fresno, Friant, Orange Cove, Selma, and Coarsegold purchased 414.67 fine ounces or $8,572 in gold, representing 833 lots from 634 individuals. The average lot amounted to $10.29, and the result of the season's work amounted to $13.52 for each individual. Most of the gold was from the abandoned gravel pits near Friant. Many white families and a few Indians were camped near the gravel pits and along the San Joaquin River during the year and made a scanty living from their labors. In the vicinity of Coarsegold most of the gold was from Deadwood, Cabin, Coarsegold Gulch, and the Fresno River.

Humboldt County prospectors sold small lots of gold to a bank at Eureka and shipped bullion direct to the San Francisco Mint. Gold was produced from the beach sands at Gold Bluff and from the bench gravel on the Klamath and Salmon Rivers, most of it originating near Orleans, and sold to a buyer at that point.

Kern and San Bernardino County dealers in gold dust at Cantil, Bakersfield, and Hobo Hot Springs and various Los Angeles refiners of gold bullion handled gold produced by about 200 individuals, whose total output for the season could not be learned, but judging from gold sold at Cantil the average for the season was about $20. Most of the gold came from the vicinity of Randsburg, Goler, Oro Fino, Summit Diggings, Black Mountain, and Boulder Gulch. Other localities in San Bernardino and Kern Counties mentioned frequently were Atolia, Panamint, Lytle Creek, and the Goldstone district.

Mariposa County bullion dealers at Mariposa, Bagby, Hornitos, Coulterville handled 265 small lots of gold for 209 individuals, whose combined output amounted to 160.84 fine ounces, or $3,325 in gold. An average of $12.55 in gold was sold, and the prospector received $15.91 for the season. Most of the gold was from Saxon, Agua Fria, Mariposa, Chispia, Sherlock, and Solomon Creeks; Australian Gulch and Merced River also furnished some gold.

In Nevada County 8 bullion buyers at Nevada City, French Corral, North San Juan, and Bridgeport purchased 3,636.72 fine ounces of gold valued at $75,178 from 1,346 individuals whose gold lots averaged $27.00 a lot, or $55.85 for the season. Most of the gold was reported from placers on Deer Creek and Yuba River; some of it came from small lots of crushed quartz originating from mine dumps in the Grass Valley region.

Placer County bullion buyers at Auburn, Iowa Hill, Dutch Flat, Colfax, Foresthill, Gold Run, and Sheridan bought 2,277.69 fine ounces or $47,084 in gold from 1,293 individuals whose lots of gold dust averaged $15.08 a lot, or $36.41 for the work of the season. Most of the gold was from the North, South, and Middle Forks of the American River and Buckeye, Blue Canyon, and Indian Creeks. The localities frequently mentioned were Steep Hollow, Dutch Flat, Baltimore, Shirt Tail Canyon, Georgia Hill, and Yankee Jims.

Plumas County bullion buyers representing seven establishments at Quincy, La Porte, Belden, Virgilia, Keddie, and Crescent Mills purchased 1,800.04 fine ounces of gold valued at $37,210 from 1,109 individuals whose work for the season totaled $33.55, or an average of $12.60 for each lot of gold sold. Most of the gold was from Spanish, Nelson, Squirrel, Rush, Black Hawk, and Sloat Creeks. Frequent mention was made of the Middle and North Forks of the Feather River and streams and tributaries in Plumas and Sierra Counties in the vicinity of La Porte.

In Sacramento County three bullion dealers at Sacramento handled 553.41 fine ounces of gold, chiefly from the foothills of Sacramento, Placer, and Eldorado Counties. A total of 676 individuals averaged $14.69 in gold for each lot sold and $16.92 for the entire season.

Siskiyou County was the most favorable of any county in the State for the small prospector who averaged $57.46 for the work of the season. From records of 10 bullion buyers at Yreka, Etna, Happy Camp, Sawyers Bar, Forks of Salmon, and Hornbrook, 1,550 individuals sold 4,308.49 fine ounces of gold or $89,064, averaging $21.81 per lot. The placers of the Salmon River and its tributaries and of the North Central region were most frequently mentioned by gold seekers.

Shasta County prospectors sold most of their gold to one establishment in Redding, which handled some gold from Trinity and other counties. Altogether, 3,271 small lots of gold dust, nuggets, and retorted material ranging from 9 cents to about $100 was purchased from 1,258 individuals, whose average gold deposit was $7.98 and whose average for the season or year amounted to $20.75. Most of the gold was from French Gulch, Whiskeytown, Churntown, Buckeye, Clear Creek, Squaw Creek, Beegum Creek, Motion Creek, Cottonwood Creek, and the Sacramento River and its tributaries.

In Trinity County producers of gold sold to four licensed bullion buyers at Denny, Lewiston, Hayfork, and Weaverville and at Redding in Shasta County 1,609 lots of gold averaging $15.64 per lot from 628 individuals whose work for the season averaged $40.07. Most of the gold was from the Trinity River and its tributaries.

In Tuolumne County 1,046 individuals sold to four bullion buyers at Sonora and Jamestown 1,152.15 fine ounces of gold, valued at $23,817, or an average of $22.77 for the season. Most of the gold was recovered from placers, but some came from pocket lode mines in the East Belt region and on the Mother Lode. The placer gold was reported from various creeks (Turnback, Woods, Bull, Sullivan, Mormon, and Eagle) and from the Stanislaus and Tuolumne Rivers.

Yuba County, with five bullion buyers at Marysville, Smartsville, and Strawberry, handled gold from various points in Yuba, Sierra, and Plumas Counties amounting to 1,068.44 fine ounces, valued at $22,087. This represents the output of 711 individuals, who averaged $25.27 a lot or $31.06 for the season.

Gold was recovered from beach sands near Santa Cruz and Monterey.

Several districts, formerly old producers in San Diego and Imperial Counties, and all the old diggings, worked before the '49 discovery, in Los Angeles County were again productive, especially near Saugus and Azusa and in the San Gabriel and San Francisquito Canyons.

Silver.—The production of silver in California is largely a by-product of gold mining, although silver ores and lead-silver ores have been mined for silver alone in Inyo, Mono, Napa, and San Bernardino Counties. The output of silver in 1932 was approximately 486,000 fine ounces valued at $137,052. The average price was 28.2 cents a fine ounce compared with 29 cents in 1931. San Bernardino County had the largest yield of silver, due to operations at the Kelly Rand silver property, discovered in 1918 and a large producer during succeeding years. The county was the only one with an output of over 100,000 ounces in 1932. Nevada County, second in output, derives its silver from gold-bearing ores mined in the Grass Valley-Nevada City district.

In Inyo County, the Estelle and Cerro Gordo properties, operated as one unit by the American Smelting & Refining Co., have long been important silver-lead producers, and in 1932 these properties and the Santa Rosa property in the same region contributed largely to the silver output of the State. Due to the low prices of silver and lead, shipments of small lots of lead-silver ore from mines in Inyo and San Bernardino Counties decreased. The yield of silver in Plumas County was chiefly from copper ore, but due to curtailed mining operations the output fell below 50,000 ounces in 1932. Silver ore from the Comanche group in the Blind Springs Hill district, Mono County, was shipped to a smelter in Utah. The Treadwell Yukon Co. did much exploratory work in the Bodie district for about 2 years but withdrew from the field late in 1931, and the district, except for leasing operations, was practically dormant. Nevada and Inyo were the only counties with a yield of silver between 50,000 and 100,000 ounces; Plumas was the only county with a yield between 20,000 and 50,000 ounces. Four counties, Mono, Shasta, Amador, and Kern, named in order of production, produced between 10,000 and 20,000 ounces, and the other producing counties fell below 5,000 ounces each.

Copper.—The production of copper in California in 1932 was approximately 1,360,000 pounds, valued at $71,568. This is a decided decrease in both quantity and value compared with 1931, when 12,931,995 pounds, valued at $1,176,812, was recorded. The average price of copper in 1932 was 6.3 cents a pound compared with 9.1 cents in 1931 and 17.6 cents in 1929 when the production was 33,218,994 pounds. Although Plumas, Shasta, Trinity, and Calaveras Counties have been large producers of copper only one mine in Plumas County, that of the Walker Mining Co., continued production in 1932. The company, however, closed its mine and mill the end of February, retaining a small force to make repairs and improvements. According to the printed annual report of the company 30,774 tons of ore were broken, and 35,866 tons were produced. The flotation mill treated 34,741 tons, yielding 1,770.84 tons of concentrate. There were also produced 60 tons of copper precipitates averaging 60 to 63 percent of copper. The company sold 2,114 tons of concentrates containing 1,543.70 ounces of gold, 28,674 ounces of silver, and 1,070,057 pounds of copper. In Shasta County, the Mountain Copper Co., Ltd., long recognized as a copper producer, discontinued mining copper ores in 1931 and turned to gold mining. The company now devotes its activity to mining gold-bearing gossan overcapping its copper-ore deposit and treating it in a 500-ton cyanidation plant.

Lead.—The mine production of lead in California in 1932 was 2,346,000 pounds (partly estimated) valued at $70,380, a decrease of 1,411,256 pounds in quantity and $68,638 in value compared with 1931. The average price of the metal in 1932 was 3 cents a pound compared with 3.7 cents in 1931. Lead ores were mined chiefly in Inyo and San Bernardino Counties, and the important producers were the Estelle and Cerro Gordo and the Santa Rosa mines in the Cerro Gordo district of Inyo County. The American Smelting & Refining Co. took over the Estelle and Cerro Gordo mines in 1929 and has since been operating them as one unit, shipping the ore to the Selby smelter on San Francisco Bay where most of the California lead ores are treated. Some ore from eastern San Bernardino County, chiefly from the Panamint, Shadow, and Providence Mountains, is sold to Utah smelters and to the Selby smelter.

Review of mines and mills.—New construction work at milling plants in California in 1932 included the enlargement of several old plants by replacing gravity concentration with flotation equipment. Installations replacing vanner and table concentration were noted in Amador County at the Kennedy mill near Jackson, and an experimental flotation plant was constructed at the Amador Star mine near Plymouth. In Nevada County the Idaho Maryland Mines Co. operated its two amalgamation-flotation mills continuously. Six flotation cells were added to the Golden Center 20-stamp mill. In the same county are four other mills, the Murchie, Hoge, Empress, and Spanish, which used the flotation process during part of 1932. In Eldorado County a new departure from the regular crushing device was made at the Beebe mine near Georgetown where a Hadsell mill with steel-shod wheels 24 feet in diameter was constructed. The Beebe ore is an altered silicified schist averaging $3.50 a ton in gold. During a test of the Hadsell mill lasting several months an average of 208 tons of ore a day was crushed at a low cost per ton, yielding a product of which 2 percent was plus 60 mesh and 65 percent minus 200 mesh. The mill is designed to separate the sands and slimes and recover the gold from the sands by cyanidation. The slimes are fed to a 6-cell Kraut machine, and the flotation concentrate is mixed continuously with the sands for cyanidation. Bullion 0.639 to 0.849 fine in gold was shipped to the San Francisco Mint. At the Sliger mine near Garden Valley a 100-ton flotation plant supplemented the 25-stamp amalgamation mill in December. In Calaveras County the flotation process proved successful at the Mar John property near Sheepranch, where the ore was crushed to 2½ inches through jaw crushers and to 80 mesh through 10 stamps to a ball mill in closed circuit with a Dorr classifier. The flotation concentrate was sold to a custom cyanidation plant.

The deepest producing properties in California are the Argonaut and Kennedy mines in Amador County, each with workings at a vertical depth of over 5,000 feet. Nevada County mines, chiefly in the Grass Valley-Nevada City region, are developed to a vertical depth of over 4,000 feet; some of the richest ore is mined in the upper levels at a depth of about 2,000 feet. The five leading mines produced more gold in the last 2 years than any district in California. In 1932 the output was $3,395,000 in gold compared with $3,191,820 in 1931.

The Empire Star Mines Co., Ltd., at the end of the year had put the Murchie mine on a profit-earning basis after an expenditure of about $500,000. The flotation mill and mine equipment were materially improved; the shaft was also reconditioned and sunk an additional 300 feet. Operating costs were lower for the Murchie than for any mine in the Grass Valley-Nevada City district. According to the annual report of the Empire Star Mines Co., Ltd., for the calendar year 1932, the North Star and Pennsylvania properties were practically without pay ore by midsummer, but by making a 10 percent cut in all wages and salaries paid by the company and with the reduced cost of powder all mines continued in operation although the North Star mine remained unprofitable. During 1932 underground development totaled 22,757 feet and diamond drilling 1,787 feet. The company mined 207,322 tons of ore, including lease ore, compared with 267,500 tons in 1931. The mills reduced 228,156 tons of ore with a 95.96 percent extraction compared with 214,534 tons milled and an extraction of 95.90 percent in 1931. The average gold recovery per ton of ore was $8.789 compared with $9.435 in 1931 and $9.442 in 1930. This drop in mill heads was slightly compensated by a further drop in total costs to $6.92 a ton compared with $7.08 in 1931.

The Idaho Maryland mine according to the annual report of its holding company, the Idaho Maryland Consolidated Mines, Inc., produced 58,245 tons of ore in 1932. Of this quantity 36,805 tons were treated in the Brunswick flotation plant and 21,440 tons in the Idaho Maryland amalgamation-flotation mill. The total gold and silver recovered from ore milled amounted to $979,420, an average of $16.82 a ton compared with $13.84 in 1931. The average loss in the tailings at both plants was $1.14 a ton compared with $2.13 in 1931. With bullion and smelter charges deducted the net value of the year's output was $954,712. Total expenditures amounted to $485,936.94, including compensation insurance, local and State taxes, mine development, metallurgical experiments, and alterations but without interest or smelter charges. The total cost was $8.34 a ton of ore milled.

The Hoge Development Co. continued development work in 1932 by adding 1,000 feet of drifts and 1,500 feet of raises to its property. About 6,000 tons of ore were treated at the Murchie mill of the Empire Star Mines Co., Ltd., and a similar quantity was treated at the Hoge flotation plant after its completion in September. The property of the Golden Center Mines Co. is opened by a 1,300-foot inclined shaft and 10,472 feet of drifts. The gold associated with sulphide minerals carrying silver, copper, and lead was recovered in a 20-stamp amalgamation gravity concentration mill until September when flotation cells replaced table concentration. Gold bullion was shipped to the San Francisco Mint and lead concentrate to the Selby smelter and to a metallurgical plant in South San Francisco.

NEVADA

The value of the mine production of gold, silver, copper, lead, and zinc in Nevada, in terms of recovered metals, decreased from $11,673,787 in 1931 to about $5,135,792 in 1932. Compared with the 1931 production there were decreases in the output and value of all metals, substantial ones being recorded in the output and value of copper, lead, and zinc. Silver decreased 46 percent in both quantity and value compared with 1931.

Mine production of gold, silver, copper, lead, and zinc in Nevada, 1928–1932, in terms of recovered metals

Year	Gold	Silver	Copper	Lead	Zinc	Total value
		Fine ounces	*Pounds*	*Pounds*	*Pounds*	
1928	$3,620,833	5,481,574	158,876,883	15,747,444	6,796,713	$31,033,776
1929	3,384,211	4,923,526	140,138,809	19,692,568	16,920,083	33,030,237
1930	3,081,436	4,219,832	109,203,512	23,058,381	29,168,117	21,455,517
1931	2,941,473	2,562,071	72,634,497	15,860,634	20,861,348	11,673,787
1932 [1]	2,695,607	1,390,100	31,473,600	1,195,200	982,800	5,135,792

[1] Subject to revision.

Gold.—The gold from mines in Nevada decreased from $2,941,473 in 1931 to about $2,695,607 in 1932. The decline in gold production in 1932 recalls the period from 1892 to 1895 when the output dropped below $2,000,000 a year, reaching the lowest point in 1893 with a production of $985,700. Mine production was revived in 1896 by the gold discoveries at Delamar, which again promises to become an important gold-producing district. Gold contributed over 52 percent of the total gross value of metals produced in the State in 1932. Five companies, each producing between 10,000 and 20,000 ounces, yielded 52 percent of the State total; these 5 companies combined with 6 other companies, each producing between 1,000 and 10,000 ounces, yielded over 71 percent of the total gold output of the State. Due to the decrease in mining activity in all parts of Nevada, the yield of gold did not increase as it did in some other gold-producing States. In the Robinson district, White Pine County, where considerable gold has been recovered heretofore from the mining of copper ores, a substantial decrease was recorded; but in the Goldfield district, Esmeralda County, the output of gold exceeded that in 1931. The mines of the Tonopah district produced about the same amount of gold as in 1931. The leading gold-producing companies in Nevada in 1932 were the Elkoro Mines Co. at Jarbidge; the Bradshaw, Inc., at Goldfield; the Nevada Consolidated Copper Co. at Ely; and the Gold Hill Development Co. and the Nevada Porphyry Gold Mines, Inc., both at Round Mountain.

A record of the exact number of people prospecting in Nevada for placer gold during 1932 is not available, but engineers of the Nevada State Bureau of Mines estimate that 600 to 700 men were at work in placer areas. The gold produced in regularly worked placer districts increased over that of the previous year, but just how much was produced by small-scale mines was not determined. The principal placer areas producing in 1932, named in order of production, were Round Mountain, Battle Mountain, Manhattan, Osceola, and Lynn.

Silver.—The silver production from mines in Nevada decreased from 2,562,071 fine ounces in 1931 to about 1,390,100 ounces in 1932 and the value from $743,001 to about $392,008. The Tonopah district produced about 591,300 ounces, a decrease of 232,572 ounces compared with 1931. Lessees continued to work in the properties of the Tonopah Mining, Tonopah Belmont, and Tonopah Extension mines and cleaned up ore and material in the mines and milling plants of these companies. The Desert cyanidation custom plant of the Tonopah Mining Co. at Millers closed in May after 25 years of operation, and dismantling of the mill was well under way in October. Other important silver producers were the Nevada Consolidated Copper Co. at Ely, the Gold Hill Development Co. at Round Mountain, and the Ely Revenue at Ely.

Any revival in the price of silver will benefit mining as it is a by-product in almost all of the copper, lead, and zinc ores mined in Nevada.

The ores of the Tonopah, Tybo, Pioche, Cortez, Comstock, Rochester, Eureka, and 60 or more other districts past producers of silver promise much activity, but at present no large-scale silver mines are operating. The principal mines in many districts are ready to resume operations whenever it becomes possible to do so, but the continued low prices of silver and the possible disruption of railroad service may cause a long shut-down. The mines are fully equipped with modern operating facilities including reduction plants.

Copper.—In 1932 the mine production of copper in Nevada was 31,473,600 pounds, a decrease of 41,160,897 pounds or 57 percent from 1931. The total value decreased 70 percent or $4,626,902. Concentrates yielded most of the copper in 1932, as the low price of the metal cut down shipments of crude ore. Most of the copper was produced in the Robinson district, White Pine County, by the Nevada Consolidated Copper Co. and the Consolidated Coppermines Corporation, both companies suffering heavy losses. The operations of both mines and reduction works were on a part-time basis. Some blister copper was shipped to Italy during the year.

Lead and zinc.—The lead output from mines in Nevada decreased from 15,860,634 pounds in 1931 to about 1,195,200 pounds in 1932, and the value decreased from $586,843 to about $35,856. The largest producer was the Combined Metals Reduction Co., in Lincoln County. Zinc-lead ore was shipped from the Yellow Pine district in Clark County to eastern oxide plants. Nevada's zinc output in 1932 was estimated at 982,800 pounds valued at $29,484 compared with 20,861,348 pounds valued at $792,731 in 1931.

Review of mines and mills.—Production in Churchill County in 1932 was confined to a mill clean-up and to small lots of gold ore mined in the Fireball district and treated by amalgamation at Olinghouse. Gold-silver ore was shipped to a smelter from the Fairview district.

In Clark County the Crescent, Eldorado Canyon, and Searchlight districts produced gold chiefly from the Eldorado-Rand, Quartette, and Duplex mines. Oxidized zinc-lead ore from the Yellow Pine district, aggregating 600 tons, was reduced at the Ozark works in Kansas. The ore was principally from the Yellow Pine, Bullion, and Anchor mines. A new discovery of gold was made in the Chiquita claim adjoining the Keystone, a former gold-producing mine, and gold bullion was shipped to the San Francisco Mint.

The production of molybdate of lead and vanadium minerals attracted attention to the Shenandoah property at Goodsprings. Some molybdate of lead was forwarded to Wilmington, Calif., for the foreign market, and arrangements were made to equip a mill at Kingman, Ariz., for future treatment.

Elko County mines produced gold, silver, and a little copper in 1932. Jarbidge and Gold Circle were the two largest district producers of gold.

The Elkoro Mines Co. at Jarbidge, according to the annual report of its holding company for 1932, had exhausted all known ore on the property in September. The mine and 100-ton cyanidation plant have produced about 20,000 ounces of gold annually since 1918. In 1932, the company treated 40,517 tons of ore with a net operating profit of $138,878.

At Midas in the Gold Circle district lessees at the Missing Link and Elko Prince holdings of the Gold Circle Consolidated and the Buena Gold Mines Co. made important shipments of gold and silver bullion recovered by amalgamation and cyanidation. Some siliceous ore was also shipped to smelters in Utah.

The outstanding development in Elko County was the opening of a large deposit of copper ore in the Rio Tinto property at Mountain City. The first car of ore shipped to a smelter in June assayed 47 percent of copper, a little silver, and a trace of gold.

Esmeralda County produced chiefly gold and silver ore from mines at Goldfield, Gold Mountain, Silver Peak, Gilbert, and the western part of the Tonopah district. The mineral output of the latter is mentioned under Nye County.

Goldfield district production in 1932 was confined to the Goldfield Consolidated mine and the property of the Goldfield Deep Mines Co., each worked by lessees who shipped ore to the smelters. The Bradshaw, Inc., continued to treat the old Goldfield mill tailing by cyanidation and handled 281,000 tons of tailing during 1932. The district output amounted to $360,951 in gold, 9,257 ounces of silver, and 6,054 pounds of copper.

At Silver Peak various leasing interests of the Lucky Boy and Black Mammoth companies and the Calumet Gold Mining Co. produced about 1,800 tons of ore from the Mary mine. The ore was treated in the Black Mammoth and Liberty Divide or Oromonte amalgamation-flotation mills and the old Mary mine tailing in the Fanchini cyanidation plant. The total output of the district amounted to approximately $91,000 in gold, and some silver was shipped as crude ore, bullion, and concentrate.

Production in Eureka County was confined chiefly to the Eureka district, from which lessees shipped lead ore mined from the Richmond-Eureka property and the Bear, Cyanide, and Diamond-Excelsior groups to Utah smelters. The Buckhorn mine near Blackburn produced and shipped gold and silver ore to a smelter. In the Lynn district about 50 men worked placers, and one enterprising company found good pay gravel after removing considerable overburden.

In Humboldt County the production consisted of gold and silver from Buckskin mine in the National district and from small lode mines near Ten Mile, Daveytown, and Paradise. The Basque mine produced milling ore yielding a little gold bullion. Some placer gold was reported from the Sawtooth and Leonard Creek districts.

Lander County mines were important producers of copper until 2 years ago. Now copper ore is held in reserve for better prices, and gold ore discovered by lessees of the Copper Canyon Mining Co. near Battle Mountain has been worked since 1931. The output of over $100,000 in gold from the lode and placer properties in the county was greatly in excess of that in 1931.

Production in Lincoln County in 1932 was greatly reduced due to the restricted operation of copper and lead-zinc mines. In the Pioche district the Combined Metals Reduction Co. produced from its no. 2 or Caselton shaft silver-lead ore containing a little copper and zinc, which was shipped to a smelter in Utah. A little lead-zinc ore of milling grade from the no. 1 shaft of the company was shipped to its flotation mill at Stockton, Utah, for treatment when metal prices recover. At Delamar in the Ferguson district new discoveries of gold ore were made in the Magnolia and April Fool mines. The gold output of the county was chiefly from Delamar and amounted to $47,500 in gold compared with $18,783 in 1931.

In Lyon and Storey Counties at Silver City and in the Comstock district mining was active but was done principally by lessees on various properties. Engineers investigating some of the old mines carried on extensive examinations. The output of the region was chiefly gold and silver, and in 1932 approximately $75,000 in gold and 140,000 ounces of silver were reported compared with $115,000 in gold and 27,000 ounces of silver in 1931. The Donovan custom mill operated its amalgamation and cyanide units to full capacity, treating chiefly ore from Silver Hill mine where 20 sets of lessees worked during most of 1932.

At the Overland mine and 10-stamp mill, owned by the Comstock Silver Mining Co., some gold-silver bullion was produced by lessees. At the close of 1932 a new flotation mill of 150 tons capacity was nearing completion at the portal of the Hale and Norcross tunnel for the Arizona Comstock Corporation. This flotation mill was designed to mill ores from the Chollar-Potosi, Hale and Norcross, and Savage mines.

Several shipments of gold ore were made from the Milwaukee mine, and many small lots of ore from other mining claims in the region were treated by the miners at the Trimble amalgamation plant. A shaft was sunk on the Woodville-Justice property, and the Teddy O'Neal mine near the Milwaukee mine was operated by lessees. The McTigue amalgamation plant at Silver City was overhauled and completely equipped for treating ores by flotation. Most of the lessee ore produced from the Santiago and Haywood group was treated in the Trimble mill. In the Palmyra district the Stone Cabin Consolidated near Como started operation of its flotation mill built originally to treat ore from the Pony Meadow property.

In Mineral County most of the ore in 1932 was mined in the vicinity of Mina in the Gold Range, Omco, Summit Springs, and Pilot Range districts. The Sunnyside mines in the Silver Star district and the Olympic lease were the most important producers of gold. The Simon Silver-lead Mines property at Simon was idle.

Nye County produced more gold in 1932 than any other county in Nevada. Gold amounted to about $728,000 and silver to about

500,000 ounces compared with $682,246 in gold and 1,352,509 ounces of silver in 1931. Mines in the Tonopah, Manhattan, and Round Mountain districts were operated by lessees. In the Manhattan district the White Caps Gold Mining Co. was the principal producer of ore, and lessees shipped about 5,000 tons of gold ore to smelters in Utah. Ore from the Nevada Coalition Gold Mines Co. property and various other lode claims worked by lessees was treated in the War Eagle stamp-amalgamation mill. The placer output was much larger than in 1931. At Tybo no new ore was produced, but (according to the annual report of the Treadwell Yukon Co. for 1932) 4,491 tons of zinc concentrate were in storage at the end of the year. The concentrate assayed 0.037 ounce of gold, 12.75 ounces of silver, 1.94 percent of lead, and 49.23 percent of zinc to the ton. The company discontinued development at Tybo and other properties in Nevada on October 1.

At Round Mountain, lode mines and placers produced gold and silver valued at $518,386 in 1932 compared with $408,910 in 1931 and $203,159 in 1930. The Gold Hill Development Co., according to its annual report for 1932, opened up its property with an additional 3,503 feet, part of which was on the deepest level of the mine. Further progress in sinking or crosscutting to the Gold Hill vein was brought to a halt at a depth of 645 feet owing to an excessive flow of water. All available commercial ore, except portions of the shaft pillars, was practically exhausted at the end of the year. Due to conditions requiring additional pumping facilities the company recommended discontinuance of operations in the mine and closed the mill. The output of the Gold Hill mine for 1932 was 38,050 dry tons of ore, which was milled in the company cyanidation plant and averaged 0.337 ounce of gold and 1.91 ounces of silver, valued at $7.494, a ton. The recovered bullion contained 11,755.02 ounces of gold and 34,898 ounces of silver, representing 91.59 percent of the total gold and 47.87 percent of the silver. The average cost of milling was $2.196 a ton and that of mining $3.94 a ton, which includes a stoping cost of $3.15 a ton and a development cost of $0.787 a ton.

During repairs to its Sunnyside stamp-amalgamation mill the Nevada Porphyry Gold Mines, Inc., at Round Mountain slowed down operations, but its placers were worked continuously. Water for placer mining was piped 9 miles from the Toyabe Range. Some gold was recovered by amalgamation from ore of the Monte Cristo Mine, the owner of which operated a small tube mill. About 300 feet of development work was done in the mine.

In Pershing County most of the mine production was from the Seven Troughs and adjoining districts. The Seven Troughs mine and large cyanidation plant remained closed. Some placer gold was reported from small dry-washing operations in the Humboldt district near Imlay. Placer ground also was worked in the Rosebud and Sierra districts but with indifferent success.

In Washoe County the White Horse district was the largest producer of gold from the operations of many lessees who worked in various properties of the district, chiefly the Springfield mine. The ore was treated in the Springfield amalgamation mill.

In White Pine County the value and quantity of the mine production of metals was substantially less than in 1931, but the total value exceeded that of any other county in Nevada. Ten lode mines in the county in 1932 produced 1,375,100 tons of ore and tailings from which were recovered $339,847 in gold, 104,400 ounces of silver, 30,864,500 pounds of copper, and 2,000 pounds of lead. This compares with $778,464 in gold, 184,842 ounces of silver, 71,350,587 pounds of copper, and 77,874 pounds of lead produced in 1931. The placer production, chiefly from Osceola, was valued at $3,543 in 1931 and $10,467 in 1932. The Nevada Consolidated mill and smelter near McGill treated all the ore of milling and smelting grade produced from mines in White Pine County. In the Cherry Creek district a continued demand for convertor lining material caused increased shipments of low-grade siliceous ore and tailings. Most of the material was from the Nevada Standard property.

OREGON

The total value of gold, silver, copper, lead, and zinc from lode and placer mines in Oregon in 1932, in terms of recovered metals, was approximately $439,295 compared with $319,703 in 1931, an increase of about $119,592. Gold was the chief metal produced, with an output of approximately 21,000 ounces valued at $434,109 compared with 15,350 ounces valued at $317,315 in 1931. The silver yield was incidental to the production of gold and increased from 7,254 ounces valued at $2,104 in 1931 to about 9,000 ounces valued at $2,538 in 1932. The production of copper increased from 1,700 pounds valued at $155 in 1931 to approximately 32,500 pounds valued at $2,048 in 1932. Lead increased from 3,497 pounds valued at $129 in 1931 to about 8,000 pounds valued at $240 in 1932. The recovered zinc was entirely from the experimental treatment of ores and amounted to about 12,000 pounds valued at $360.

Mine production of gold, silver, copper, lead, and zinc, in Oregon, 1928–32, in terms of recovered metals

Year	Gold	Silver	Copper	Lead	Zinc	Total value
		Fine ounces	*Pounds*	*Pounds*	*Pounds*	
1928	$225,968	30,924	358,463	13,246		$296,446
1929	353,323	30,009	655,746	20,180		486,000
1930	297,702	9,000	176,300	9,113	12,528	325,143
1931	317,315	7,254	1,700	3,497		319,703
1932[1]	434,109	9,000	32,500	8,000	12,000	439,295

[1] Subject to revision.

Gold mining was confined principally to the placers, although a few lode mines in the State were productive. The three dredges operating in Baker, Grant, and Jackson Counties produced slightly more than 36 percent of the total gold, their combined output increasing about $20,000 over that of the preceding year. Shortage of water prevented continuous operation of the dredge in Jackson County. Gold produced from placers and lode mines in eastern Oregon was handled chiefly by banks in Baker and Grant Counties. About $58,000 in gold was shipped to the offices of the Bureau of the Mint at Boise and San Francisco and to private refiners. Most of the gold of the small producers was purchased by mine operators or merchants. Small placers throughout the State were active, and their production contributed substantially to the gold output in 1932. In eastern Oregon the Empire dredge in Grant County was the largest gold producer, followed by the Superior dredge in Baker County. A placer on Salmon Creek above the old Nelson mine northwest of Baker was operated with a power shovel. Pine Creek gravel deposits east of Hereford have produced gold for 34 years, but water has not been available for large-scale mining. At the Yellow Nugget placer near the mouth of Pine Creek gravel was handled with a power shovel and hauled a quarter of a mile in trucks to water pumped from Burnt River. At Harper's placer, 3 miles from the mouth of Pine Creek, a power shovel handled about 300 yards of material a day. Most of the gold was very coarse, and one nugget found during the season weighed 12 ounces. The Elliott drift placer in the same region was developed and worked when water was available. In Stice's Gulch a power shovel worked to bedrock and obtained pay gravel. Seven miles west of Baker in Washington Gulch water was available during a short season to permit the operation of hydraulic giants. A shaft was sunk 50 feet to the original bedrock. Two hydraulic giants were operated in Rye Valley on the Silbaugh property. In Grant County hydraulic giants washed gravel on the Marysville property near Canyon City; at Vinegar, Olive, and Vincent Creeks; and in the Susanville district.

The Macy and Virginia 10-stamp mills were rehabilitated. The Cornucopia mill near the portal of the Union-Companion adit was rebuilt. New mills were added to the Evans mine on Ruby Creek, the Pedro Mountain mine 13 miles west of Durkee, and the Shoestring property in the Rye Valley region. A small mill was erected at the Crystal Palace mine in the Sparta district. Some milling equipment was added to the plant on the Bull Run mine, and eight men were employed in developing the Record lode mine north of Hereford. At the Sanger mine some specimen quartz of free gold was mined during development. Men working on Elkhorn Mountain, 16 miles west of Baker, on the Hurdy Gurdy and Denny Fraction claims reduced rich gold quartz in hand mortars; the lower-grade ore was shipped. The Imperial mine in the Cable Cove district was worked with a crew of 14 to 18 men, and some high-grade ore was developed. At the Columbia and Taber Fraction properties the old tunnels were retimbered and 3 car lots of ore shipped to Tacoma. The Twin Baby Mining Co. or Vindicator property on the Baker-Union County line near Medical Springs was under new management, and the shaft was sunk 100 feet to the 350 level. Development of the White Swan property was continued, and some gold ore was milled from the Banzette property.

In Grant County the Rabbit mine and 5-stamp mill were operated continuously, and the shaft was deepened. At the Buffalo mine a little ore was treated by flotation, and concentrate containing gold, silver, and lead was shipped with small lots of crude ore to the Bunker Hill smelter in Idaho. In Malheur County the Golden Eagle lode claim was under development. A 200-foot shaft was sunk on the Sunday Hill mine, and a little gold ore was milled.

In western Oregon the principal banks at Grants Pass, Medford, and Ashland handled $128,349 in new gold (including the purchases of five merchants), of which most was in small lots ranging from 10 cents to several dollars. This new gold was purchased from 1,016 individuals representing prospectors and small working parties who averaged $126.32 in gold during the year or season, chiefly from placer ground in Josephine and Jackson Counties. Most of the gold was reported from Evans, Foots, and Sterling Creeks in Jackson County and Grave and Althouse Creeks in Josephine County. Gold producers in Coos, Curry, Douglas, and Linn Counties also sold gold in Grants Pass.

Next to dredging, hydraulic gravel mining had special interest. The Flynn placer mine on the Illinois River, 3 miles from Takilma, the Plataurica hydraulic property in Fry Gulch, and the Llano de Oro hydraulic placer near Waldo were all producers. In the Althouse Creek region many small-scale producers of gold added to the regular output of the Ramsey claims, 12 miles from Holland. The Tigertown hydraulic mine was worked on a small scale, and the John Apple hydraulic mine, 7 miles south of Holland, produced gold. Placers on Sucker Creek were active; the Barnett was hydraulicked to full capacity. Small-scale placer mining progressed on California Bar, and some gold was sold to the local storekeepers. Hydraulic placers were worked on Jump-Off Joe Creek and tributaries. The chief gold producers were the Weymouth and placers on Jack's, Briggs, Hogum, Starveout, and Silver Creeks. A power shovel and trucks to transport gravel to a washing plant were placed on Louse Creek at the Lindar gravel property. Sardine Creek had the largest mechanical placer outfit in southern Oregon, a 1¼-yard power shovel handling 100 yards of gravel hourly. On the banks of the Rogue River in Josephine and Jackson Counties small groups were at work. Drift placers were worked in 12 places within the city limits of Jacksonville, by shafts 12 feet in gravel to bedrock, and very few large wash boulders were encountered. Some beach mining was carried on in Coos and Curry Counties, and the Mule Mountain district in Curry County was actively prospected.

Lode mining was productive in few instances in southwestern Oregon, but plans for financing several mines were under way. A Straub mill was installed on the Brady mine at Whiskey Creek, and the Mead property on Jones Creek was opened with a crosscut drift. A new mill was ready to operate in December on ore from the Towne mine at Jacksonville, and the Opp mine enlarged its reserve of milling ore. A 20-ton mill was constructed at the Sunbeam mine, 15 miles south of Grants Pass. At the head of Louse Creek gold ore averaging $75 a ton was developed in the Granite Hill mine. The Humdinger mine, actively developed in 1931, was turned back to the owner, and no production was reported for 1932. In Jackson County the Ashland mine was developed, and some bullion was sold to the San Francisco Mint. Bullion was shipped from the American Boy mine southwest of Medford. The Chieftain and Continental lode mines in Douglas County and the quartz property of the Bartels Mining Co. in Lane County were producers of gold. Considerable development work was done at the Continental, and at the Chieftain the 15-ton floatation mill was operated. In Marion County the Amalgamated Mining Corporation operated a mill and shipped lead-zinc concentrate to Midvale, Utah.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO, NEW MEXICO, TEXAS, SOUTH DAKOTA, AND WYOMING

By CHAS. W. HENDERSON

COLORADO

In 1932 the output of gold, silver, copper, lead, and zinc from Colorado ores and gravels, in terms of recovered and estimtated recoverable metal, was 314,117 ounces of gold, 1,703,378 ounces of silver, 7,165,000 pounds of copper, 4,116,800 pounds of lead, and 218,000 pounds of zinc. Compared with 1931 gold increased $1,670,643, silver decreased 492,536 ounces, copper decreased 1,000,000 pounds, lead decreased 9,651,200 pounds, and zinc decreased 32,155,000 pounds. The approximate gross value of the output of metals in Colorado in 1932 was as follows: Gold $6,493,377, silver $480,353, copper $451,395, lead $123,504, and zinc $6,540, a total of $7,555,169 compared with $7,942,154 in 1931.

Mine production of gold, silver, copper, lead, and zinc in Colorado, 1928–32, in terms of recovered metals

Year	Gold (lode and placer)	Silver (lode and placer)		Copper	
		Fine ounces	Value	Pounds	Value
1928	$5,304,876	4,052,253	$2,370,568	8,594,646	$1,237,629
1929	4,417,358	4,397,377	2,343,802	8,905,074	1,567,293
1930	4,517,619	4,382,852	1,687,398	10,514,000	1,366,820
1931	4,822,734	2,195,914	636,815	8,165,000	743,015
1932 [1]	6,493,377	1,703,378	480,353	7,165,000	451,395

Year	Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	
1928	53,501,723	$3,103,100	71,462,000	$4,359,182	$16,375,355
1929	48,889,906	3,080,064	58,861,000	3,884,826	15,293,343
1930	44,260,000	2,213,000	72,518,000	3,480,864	13,265,701
1931	13,768,000	509,416	32,373,000	1,230,174	7,942,154
1932 [1]	4,116,800	123,504	218,000	6,540	7,555,169

[1] Subject to revision.

The value of metal production herein reported for Colorado, New Mexico, Texas, South Dakota, and Wyoming has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, $20.671835 an ounce. The silver price is the average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1928–32

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per pound*	*Per pound*	*Per pound*		*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1928	$0.585	$0.144	$0.058	$0.061	1931	$0.290	$0.091	$0.037	$0.038
1929	.533	.176	.063	.066	1932	.282	.063	.030	.030
1930	.385	.130	.050	.048					

Review by counties and districts.—The Cripple Creek district in 1932 produced $2,260,507 in gold compared with $2,385,769 in 1931. The Golden Cycle 1,200-ton roast-amalgamation-cyanidation custom mill at Colorado Springs was operated at the rate of 800 to 900 tons daily, principally on Cripple Creek sulphotelluride ores. All Cripple Creek ores are treated at this mill. During 1932 part of the 300-ton selective flotation mill added to the Golden Cycle equipment in November 1929 was used intermittently to treat custom gold-silver ores from Boulder, Clear Creek, Gilpin, Lake, and Park Counties, chiefly gold (silver-lead) ores from Park County from September 10 to the end of the year; the tails from the flotation machines went direct into the cyanide circuit or to the roasters to burn the carbon in the American ore. Producing mines and dumps in the Cripple Creek district included the Acacia, Atlas, Buckeye, Cresson, Doctor-Jack Pot, El Paso, Elkton, Empire Lee, Gold Dollar, Gold Pinnacle, Granite, Jerry Johnson, Pharmacist, Portland, School Section, Stratton Estate, Strong, and United Gold Mines. The Cripple Creek district has yielded $354,022,394 in gold from its discovery in 1891 to 1932, inclusive.

San Juan County in 1932 produced $511,092 in gold, 339,965 ounces of silver, 1,031,000 pounds of lead, and 1,367,000 pounds of copper compared with $647,208 in gold, 430,793 ounces of silver, 1,250,505 pounds of copper, and 1,134,000 pounds of lead in 1931. The Sunnyside Mining & Milling Co. 1,000-ton selective flotation mill at Eureka continued idle. The 550-ton Shenandoah-Dives selective flotation mill operated throughout the year on gold-copper-silver-lead ore from the Mayflower group.

The Durango lead bullion-copper matte smelter which closed November 1, 1930, remained idle.

No ores were marketed from Rico, Dolores County, but the St. Louis Smelting & Refining Co. completed its 6,000-foot adit.

In San Miguel County a small production was made from the mines at Ophir, and lessees continued gouging operations in the Smuggler-Union mine at Telluride, sold in 1929 for its salvage value. Clean-ups were made at abandoned mills in the Telluride district. The Cimarron mine at Telluride was reopened.

The King Lease on the upper workings of the Camp Bird mine, Ouray County, continued to extract gold ore which was treated in the amalgamation-concentration mill built by the leasing company at the upper adit, in Imogene Basin. Production of small lots of high-grade gold-silver ore from the Trust-Ruby property at Sneffels was continued. Other small producers in Ouray County were the American, Banner American, Governor, and Valley View.

Gold, silver, copper, lead, and zinc mined in Colorado in 1932, by counties, in terms of recovered metals [1]

County	Gold [2] (lode and placer)		Silver [2] (lode and placer)		Copper		Lead		Zinc		Total value
	Fine ounces	Value	Fine unces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Adams	10.02	$207									$207
Arapahoe	1.56	32									32
Boulder	4,174.23	86,289	11,737	$3,310			15,000	$450			90,049
Chaffee	165.84	3,428	745	210			6,000	180			3,818
Clear Creek	5,798.98	119,876	26,153	7,375	6,000	$378	72,000	2,160			129,789
Costilla	7.63	158									158
Custer	1.18	24	11	3							27
Denver	18.64	385	4	1							386
Dolores	4.60	95	2	1							96
Douglas	32.38	669	6	2							671
Eagle	2,970.75	61,411	1,110,819	313,251	5,620,000	354,060	440,000	13,200			741,922
Elbert	27.58	570									570
Fremont	42.42	877	568	160	1,000	63	5,000	150			1,250
Gilpin	15,637.32	323,252	24,451	6,895	51,000	3,213	187,000	5,610	84,000	$2,520	341,490
Grand	1.77	37									37
Gunnison	154.88	3,202	67	19							3,221
Hinsdale	69.19	1,430	871	246			1,800	54			1,730
Huerfano	1.81	37									37
Jackson	5.64	117									117
Jefferson	9.04	187									187
Lake	6,255.47	129,312	16,768	4,729	6,000	378	152,000	4,560	126,000	3,780	142,759
La Plata	1,467.89	30,344	6,966	1,964			7,000	210			32,518
Larimer	.84	17									17
Mesa	1.74	36									36
Moffat	54.40	1,125	4	1							1,126
Montezuma	1.87	39									39
Montrose	93.68	1,937	30	8							1,945
Ouray	12,417.54	256,693	48,050	13,550	97,000	6,111	316,000	9,480	8,000	240	286,074
Park	125,746.54	2,599,412	63,236	17,833	16,000	1,008	1,634,000	49,020			2,667,273
Pitkin	52.82	1,092	45,965	12,962			228,000	6,840			20,894
Rio Grande	7.00	145	3	1							146
Routt	20.31	420	9	3							423
Saguache	17.52	362	21	6							368
San Juan	24,724.06	511,092	339,965	95,870	1,367,000	86,121	1,031,000	30,930			724,013
San Miguel	3,178.50	65,705	4,645	1,310	1,000	63	21,000	630			67,708
Summit	1,589.42	32,856	1,511	426			1,000	30			33,312
Teller	109,352.03	2,260,507	771	217							2,260,724
Total, 1932	314,117.09	6,493,377	1,703,378	480,353	7,165,000	451,395	4,116,800	123,504	218,000	6,540	7,555,169

[1] Subject to revision.
[2] Includes placer production of $45,435, of which $23,192 was from dredging in 1932, compared with $21,581 in 1931, of which $8,786 was from dredging.

Small but slightly increased shipments of gold ore were made from the May Day and other mines at Hesperus, La Plata County. The La Plata Mines Co. continued development work at the Gold King mine above La Plata and operated its mill intermittently.

Eagle County continued in 1932 as one of the principal producing counties in Colorado through the production of the Empire Zinc Co. Eagle mine from ore bodies in the Leadville limestone formation, dipping northeastward under Battle Mountain near Redcliff. Since 1912 this company has been opening and developing its holdings, always with some regular annual production; from November 1929 to December 1, 1931, the company ran its new 600-ton flotation mill on zinc-lead-silver-iron sulphide ore. This mill is built in an excavation cut into the granite face of Eagle Canyon and therefore is mostly underground. In 1931, in addition to milling zinc-lead ore from its large reserves, the company continued to ship copper-iron-silver-gold ore to Utah smelters. In 1932 this smelting ore was shipped both to Utah smelters and to the Arkansas Valley smelter at Leadville, which was equipped to handle copper ores. Several cars of gold ore were shipped to Leadville from the reopened Champion mine on Battle Mountain, many years ago a prominent gold producer from ore bodies in the Cambrian quartzite formation.

Lake County (Leadville) in 1932 produced 6,255 ounces of gold, 16,768 ounces of silver, 152,000 pounds of lead, 6,000 pounds of copper, and 126,000 pounds of zinc compared with 5,055 ounces of gold, 81,183 ounces of silver, 33,308 pounds of copper, 2,940,514 pounds of lead, and 5,773,000 pounds of zinc in 1931. The Leadville district produced no iron-manganese ore in 1932. The Leadville Deep Mines Co. properties remained idle. Gold ore was shipped from the Ibex, Tribune, and Venir mines. Development was continued at the Resurrection group. The Arkansas Valley smelter was idle during January and October. It ran as a lead-bullion smelter in February and March, as a copper-matte smelter from April through August, and again as a lead furnace in September, November, and December.

The Climax Molybdenum Co. at Climax, 14 miles north of Leadville, continued to mill at the rate of 44,000 tons a month to August 1, then 8,000 tons a month to December 1, and 15,000 tons in December, making a total for the year of 354,030 tons treated, which yielded 1,797 tons of molybdenite concentrate containing 1,913,375 pounds of elemental molybdenum.

Aspen (Pitkin County) continued to show the effect of the low prices of silver and lead; in 1931 its production was 37,169 ounces of silver and 282,000 pounds of lead and in 1932, 45,965 ounces and 228,000 pounds, respectively. Several cars of gold smelting ore from the old Independence district gave Pitkin County a gold production of $1,092.

The silver mines of Mineral County (Creede), which ceased to operate after July 1930, remained idle in 1932.

The United States Vanadium Co. 140-ton roasting, leaching, and precipitation mill at Rifle was operated continuously to July 1, 1932, on ore from its vanadium mines 12 miles from Rifle; the mine was then abandoned.

In Gunnison County small shipments of gold bullion were made to the Denver Mint from the Maple Leaf mine near Parlin and from the Carter mine, at Ohio City; development work only was done at White Pine; some new development work was done at Powderhorn.

Production in Summit County in 1932 was confined to small shipments of lead-silver smelting ore from Breckenridge and Montezuma, gold-silver bullion from the Tiger Amalgamation mill at Breckenridge, and placer gold-silver bullion from the Continental Dredging Co. dredge on Blue River, below Breckenridge, and from small hydraulicking and sluicing operations on Blue and Swan Rivers.

Gold production (recoverable) in Park County increased from $871,789 in 1931 to $2,599,412 in 1932 as the result of greatly increased shipments of gold ore from the American, London, and London Extension. Other producers were the "North London," Great West, Hock Hocking (silver-gold), Magnolia, Orphan Boy, Pacific, and "West London." Development work was done at the Butte, London Mountain, Ophir, and Weber groups.

Clear Creek County yielded $119,876 in gold and 26,153 ounces of silver, chiefly from the operations of the Little Mattie and Lincoln Mines near Idaho Springs. Gilpin County produced $323,252 in gold, principally from the operations of the Chain O'Mines at Central City. Other producers in Gilpin County were the Pittsburg, Saratoga, and Perigo. Small lots of bullion, concentrates, and ore marketed from Boulder County mines in 1932 yielded $86,289 in gold and 11,737 ounces of silver.

NEW MEXICO

In 1932 the output of gold, silver, copper, lead, and zinc from New Mexico ores and gravels, in terms of recovered and estimated recoverable metal, was 23,930 ounces of gold, 1,190,451 ounces of silver, 28,899,000 pounds of copper, 20,951,000 pounds of lead, and 51,108,000 pounds of zinc. Compared with 1931 these figures show a decrease of 7,231 ounces of gold, an increase of 148,592 ounces of silver, a decrease of 32,604,100 pounds of copper, a decrease of 1,586,000 pounds of lead, and a decrease of 4,624,000 pounds of zinc. The gross value of the New Mexico metal production in 1932 was as follows: Gold $494,669, silver $335,707, copper $1,820,637, lead $628,530, and zinc $1,533,240, a total of $4,812,783 compared with $9,494,766 in 1931.

Mine production of gold, silver, copper, lead, and zinc in New Mexico, 1928–32, in terms of recovered metals

Year	Gold (lode and placer)		Silver (lode and placer)		Copper	
	Fine ounces	Value	Fine ounces	Value	Pounds	Value
1928	32,912.41	$680,360	827,793	$484,259	89,854,646	$12,939,069
1929	35,176.46	727,162	1,121,546	597,784	97,717,262	17,198,238
1930	32,370.42	669,156	1,107,335	426,324	65,150,000	8,469,500
1931	31,161.24	644,160	1,041,859	302,139	61,503,100	5,596,782
1932 [1]	23,929.62	494,669	1,190,451	335,707	28,899,000	1,820,637

Year	Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	
1928	15,610,501	$905,409	62,406,000	$3,806,766	$18,815,863
1929	22,260,811	1,402,431	68,910,000	4,548,060	24,473,675
1930	20,756,900	1,037,845	65,529,000	3,145,392	13,748,217
1931	22,537,000	833,869	55,732,000	2,117,816	9,494,766
1932 [1]	20,951,000	628,530	51,108,000	1,533,240	4,812,783

[1] Subject to revision.

The large low-grade porphyry copper deposit of the Chino Mines of the Nevada Consolidated Copper Co. at Santa Rita was mined at the rate of 6,474 tons daily for 180 days in 1932 compared with 7,178 tons in 1931 (actually 8,852 tons for 296 days). The deposit is mined by open-pit methods, using steam and electric shovels, and the ore is concentrated at the company flotation mill at Hurley, which has a daily capacity of 15,000 tons in all seven units. The Lordsburg district, the second largest gold and copper producer in the State in 1931, in 1932 shipped 16,608 tons of siliceous copper-gold-silver ores, containing 1,404 ounces of gold, 37,561 ounces of silver, 936,100 pounds of copper, and 59,284 pounds of lead, compared with 96,032 tons in 1931, which contained 11,287 ounces of gold, 137,731 ounces of silver, 4,725,223 pounds of copper, and 186,196 pounds of lead. As usual, the ore was shipped to Douglas, Ariz., and El Paso, Tex. The largest producing mine in this district, the Eighty-Five, was closed soon after January 1, 1932. The only other producer in 1932 was the Bonney mine.

The Pecos mine of the American Metal Co. on Willow Creek, San Miguel County, in its sixth year of production, continued to produce at the rate of 538 tons a day. The ore minerals in this complex sulphide ore body are sphalerite, galena, chalcopyrite, and pyrite, and the gangue is a sheared micaceous diorite. The ore bodies are mined both by the cut-and-fill system and by square-set stopes. The mine and mill are connected by a 12-mile aerial tramway. The capacity of the mill, a selective flotation plant, is 600 tons a day. In 1932 the mill produced 44,681 tons of zinc concentrates and 17,665 tons of lead-copper concentrates compared with 44,780 tons and 18,911 tons, respectively, in 1931. The actual heads of ore into the mill in 1932 averaged 0.112 ounce of gold, 4.24 ounces of silver, 0.89 percent copper (wet assay), 4.89 percent lead (wet assay), and 15.50 percent zinc. This mine is the largest single producer of gold, silver, lead, and zinc in New Mexico. Other producers of zinc concentrates were the Black Hawk (or Combination) selective flotation mill at Hanover, which was operated continuously, and the Peru selective flotation mill at Wemple, near Deming, which was operated the last 3 months only. Zinc concentrates produced in New Mexico in 1932 amounted to 55,870 tons containing 61,576,492 pounds of zinc and averaging 55 percent zinc.

Several cars of silver-gold ore were shipped to the El Paso smelter from the Cochiti or Bland district, Sandoval County; several shipments of gold-silver concentrate were made from the Mogollon district, Catron County; and several small shipments of gold-silver ore were made from Tres Piedras and from Red River, Taos County. Small lots of placer gold bullion were shipped from the Mt. Baldy district, Colfax County; the Pinos Altos district, Grant County; the Jicarilla district, Lincoln County; the Hillsboro district, Sierra County; the Orogrande district, Otero County; and the Golden district, Santa Fe County.

TEXAS

Although no output of gold, silver, copper, or lead was recorded for Texas in 1931 a small output of each of these metals was reported in 1932. As shown in the accompanying table $180 in gold, 1,421 ounces of silver, 7,000 pounds of copper, and 34,000 pounds of lead were recovered, with a combined gross value of $2,042.

Mine production of gold, silver, copper, and lead in Texas, 1928–32, in terms of recovered metals

Year	Ore (short tons)	Gold	Silver		Copper		Lead		Total value
			Fine ounces	Value	Pounds	Value	Pounds	Value	
1928	76,915	$10,115	1,340,622	$784,264	447,792	$64,482	695,570	$40,343	$899,204
1929	63,872	26,439	1,020,516	543,935	341,000	60,016	849,683	53,530	683,920
1930	31,147	3,648	389,239	149,857	143,100	18,603	396,820	19,841	191,949
1932 [1]	185	180	1,421	401	7,000	441	34,000	1,020	2,042

[1] No production was recorded for 1931; figures for 1932 subject to revision.

The metals produced in Texas in 1932 were from Shafter, Presidio County, and Allamoore, Culbertson County.

SOUTH DAKOTA

The metal mines in South Dakota in 1932 produced $9,929,297 in gold, 126,199 ounces of silver, and 7,000 pounds of lead, increases for each of the three metals over 1931.

The Homestake mine at Lead, Lawrence County, the largest producing gold mine in the United States, was operated continuously in 1932. The company report showed 1,401,593 tons mined; the proceeds from gold-silver bullion treated by amalgamation followed by cyanidation of sands and slimes were $9,911,858; the dividends paid were $2,662,296. From 1876 to 1932, inclusive, this mine has yielded bullion and concentrates which brought $253,394,489 and has paid $62,653,292 in dividends.

Mine production of gold, silver, and lead in South Dakota, 1928–32, in terms of recovered metals

Year	Ore (short tons)	Gold (lode and placer)		Silver (lode and placer)		Lead		Total value
		Fine ounces	Value	Fine ounces	Value	Pounds	Value	
1928	1,422,233	317,378.94	$6,560,805	90,547	$52,970	74,000	$4,292	$6,618,067
1929	1,463,159	316,836.85	6,549,599	85,182	45,402			6,595,001
1930	1,365,156	407,221.14	8,418,008	105,236	40,516			8,458,524
1931	1,404,153	432,075.39	8,931,791	113,562	32,933			8,964,724
1932 [1]	1,401,664	480,329.74	9,929,297	126,199	35,588	7,000	210	9,965,095

[1] Subject to revision.

Ore milled, receipts, and dividends, Homestake mine, 1928–32

Year	Ore milled	Receipts for bullion product		Dividends
		Total	Per ton	
	Short tons			
1928	1,416,949	$6,566,784.69	$4.6345	$1,758,120
1929	1,437,935	6,517,837.95	4.5328	1,758,120
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]	1,401,593	9,911,858.40	7.0718	2,662,296

[1] Subject to revision.

In 1932 placer gold production in South Dakota totaled 1,148.14 fine ounces, chiefly from the Grand Hills Mining Co. steam shovel Ainlay bowl installation on French Creek near Custer, the scene of the first discovery of gold in South Dakota in 1874. Other placer production was from a gasoline shovel and sluicing at Tinton and small-scale placers on Battle, Bear, Castle, French, Spring, and Whitewood Creeks. From 1875 to 1932, inclusive, South Dakota has yielded $308,084,819 in gold and 8,009,825 ounces of silver.

In 1932 the production of lead in South Dakota, in terms of recovered metal, was 7,000 pounds, from a car of concentrates from the Sitting Bull-Richmond mill.

WYOMING

Metal mines in Wyoming in 1932 reported production of $5,129 in gold, 195 ounces of silver, and 9,000 pounds of lead. These metals had a gross value of $5,454 compared with $1,989 for the State in 1931.

The bulk of the gold production of Wyoming in 1932 was from shipments of amalgamation and placer bullion from Atlantic City, Fremont County. One car of lead-silver ore was shipped from Encampment, Carbon County.

Mine production of gold, silver, copper, and lead in Wyoming, 1928–32, in terms of recovered metals

Year	Ore (short tons)	Gold	Silver		Copper		Lead		Total value
			Fine ounces	Value	Pounds	Value	Pounds	Value	
1928	129	$677	53	$31	2,604	$375			$1,083
1929	143	995	26	14	4,301	757			1,766
1930	1,285	9,158	122	47	11,600	1,508			10,713
1931	23	1,165	17	5	9,000	819			1,989
1932 [1]	80	5,129	195	55			9,000	$270	5,454

[1] Subject to revision.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN AND CENTRAL STATES

(MINE REPORT)

By J. P. Dunlop and H. M. Meyer

Mines of the Eastern and Central States yielded metals in 1932 valued as follows: Gold, $21,854; silver, $29,052; copper, $4,111,903; lead, $8, 381,280; and zinc, $16,008,210. There were decreases in both quantity and value of all these metals. The output of gold was only about $2,000 less than in 1931; the decrease was due solely to the smaller quantity of copper ore mined.

The value of metal production herein reported has been calculated at the figures given in the table on page 146. Gold is figured at the mint value for fine gold; that is, $20.671835 an ounce. Silver is valued at the average buying price at New York for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Salient statistics of mine production of gold, silver, copper, lead, and zinc in the Eastern and Central States in 1932, 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*	*Pounds*	*Short tons*	*Short tons*	
Eastern States:							
Alabama	800	$1, 423	10				$1, 426
Georgia	440	5, 760	30				5, 769
New Jersey	559, 651					81, 460	[1] 7, 993, 650
New York	189, 679				(2)	16, 794	[3] 1, 007, 640
North Carolina	20, 660	7, 591	10, 045	(4)			[5] 10, 423
Pennsylvania	69, 811	1, 660	830	(4)			[5] 1, 894
South Carolina	150	1, 468	5				1, 469
Tennessee	852, 885	3, 315	19, 300	[4] 10,872, 200	[2] 4, 460	[6] 18, 514	[7] 2, 072, 147
Virginia	304, 773	637	8		(2)	(6)	[8] 639
	1, 998, 849	21, 854	30, 228	10, 872, 200	4, 460	116, 768	11, 095, 057
Total, 1931	3, 255, 518	23, 827	63, 949	23, 346, 000	7, 974	156, 697	18, 179, 046
Central States:							
Arkansas	(9)				4		240
Illinois	(9)		257		31		1, 932
Kansas	750, 500				6, 490	26, 277	1, 966, 020
Kentucky	(9)					46	2, 760
Michigan	1, 142, 775		71, 408	54, 396, 108			3, 447, 092
Missouri	3, 786, 600		1, 128		117, 159	986	7, 089, 018
Oklahoma	1, 587, 700				10, 634	63, 437	4, 444, 260
Wisconsin	310, 300				910	7, 522	505, 920
	7, 577, 875		72, 793	54, 396, 108	135, 228	98, 268	17, 457, 242
Total, 1931	14, 871, 948		42, 737	118, 059, 491	181, 648	130, 476	34, 113, 936

[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] No estimates available for small quantity of ore treated in Arkansas, Illinois, or Kentucky.

Prices of silver, copper, lead, and zinc, 1928–32

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per pound*	*Per pound*	*Per pound*		*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1928	$0.585	$0.144	$0.058	$0.061	1931	$0.290	$0.091	$0.037	$0.038
1929	.533	.176	.063	.066	1932	.282	.063	.030	.030
1930	.385	.130	.050	.048					

Gold and silver.—The output of gold in the Eastern States was valued at $21,854 in 1932, or $1,973 less than in 1931. Placer mines yielded 226.88 fine ounces of gold in 1932 compared with 166.12 ounces in 1931. Gold derived from siliceous ores increased from 90.36 ounces in 1931 to 459.04 ounces in 1932. Gold derived from the refining of copper bullion decreased from 896.15 ounces in 1931 to 371.27 ounces in 1932. More than twice as many placer and lode gold mines were operated in 1932 as there were in 1931. Small yields of gold were reported in 1932 by 15 lode gold mines and 20 placers. Numerous other properties were being prospected, old mines were reopened, and experimental mills were built, indicating a considerable increase in gold from the Southern Appalachian States in 1933. In 1932 about 2,200 tons of siliceous ore were treated at mills in Alabama, Georgia, North Carolina, South Carolina, and Virginia; in 1931 lode mines were productive only in Georgia and North Carolina. The value of the estimated output of gold in the Southern Appalachian States from 1799 to 1932, inclusive, is recorded as $51,243,198.

Mines in the Central States yielded no gold.

Of the silver (30,228 ounces) produced in the Eastern States in 1932 all except 21 ounces from placer bullion and 77 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. As the copper output in the Eastern States decreased in 1932 the silver output was less than half that in 1931.

Production of silver in the Central States in 1932 was 72,793 ounces. The output of Illinois was from lead concentrates recovered in mining fluorspar, that of Missouri was from zinc concentrates derived from milling lead ore, and that of Michigan was from copper ore. Lead, zinc, and lead-zinc ores mined in Kansas, Oklahoma, and Wisconsin contain no appreciable quantity of silver.

Copper.—The mine production of copper in the Eastern States in 1932 was 10,872,200 pounds, valued at $684,949, a decrease of 12,573,800 pounds from that in 1931; each of the producing States showed a decrease. The output was derived from copper ore mined in North Carolina and Tennessee and from copper concentrates recovered from Pennsylvania pyritiferous magnetite ore mined for its iron content. The copper ore yielded $0.06 to the ton in gold and silver. The copper concentrates from magnetite ore contained about 20.1 percent copper and $2.42 to the ton in gold and silver.

All the copper produced in 1932 in the Central States was from mines in Michigan; no copper ore or residues containing copper were shipped from mines or smelters in Missouri. The output of refined copper in Michigan was 54,396,108 pounds in 1932 compared with 118,059,491 pounds in 1931. The average recovery of copper per ton of rock treated increased from 33.1 pounds in 1931 to 47.6 pounds in 1932.

Lead.—The output of lead from mines in the Eastern States was all from lead-zinc ores from the Austinville mine in Virginia, the Balmat mine in New York, and the Embree mine in Tennessee. Lead concentrates shipped amounted to 7,291 tons.

The lead recovered from mine shipments of lead ore and concentrates in the Central States decreased from 181,648 tons in 1931 to 135,228 tons in 1932. Missouri shipments yielded 117,159 tons of lead, of which 116,152 tons were from mines in southeastern Missouri. Production of lead in Oklahoma, as measured by recovered metal in concentrates shipped, decreased from 13,210 tons in 1931 to 10,634 tons in 1932. Shipments from Kansas mines decreased from 7,082 tons in 1931 to 6,490 tons in 1932. Wisconsin lead-zinc mines produced ore yielding 952 tons of lead in 1931 and 910 tons in 1932. Only a few cars of lead concentrates were shipped from mines in Illinois. The output of lead from Arkansas mines decreased from 78 tons in 1931 to 4 tons in 1932. Mines in the Tri-State or Joplin region shipped 23,523 tons of lead concentrates in 1932 containing 18,131 tons of recoverable lead.

Zinc.—The recoverable zinc in ore and concentrates shipped from mines in the Eastern States was 116,768 tons, valued at $10,112,130, in 1932, compared with 156,697 tons, valued at $15,422,112, in 1931. Mines in New Jersey yielded 81,460 tons, as metal or in oxide, valued at $7,993,650.

[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, partly from zinc ore and partly from lead-zinc ore, from which 16,794 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 18,514 tons, less than 50 percent of that recovered in 1931. Some of the zinc concentrates made in 1932 were stocked at the mines. The zinc concentrates shipped from mines in the Eastern States in 1932 totaled 580,352 tons, including about 1,100 tons of zinc carbonate from Tennessee and Virginia and the large shipments from New Jersey.

Shipments in the Central States had a recovered zinc content of 98,268 tons in 1932 compared with 130,476 tons in 1931. Mines in the Tri-State or Joplin region shipped ore and concentrates yielding 90,660 tons of zinc in 1932 compared with 119,168 tons in 1931. A considerable part of the zinc concentrates shipped in 1932 were milled in 1931. Mines in Oklahoma contributed 70 percent and mines in Kansas 29 percent of the zinc from the Tri-State region in 1932. The zinc recovered from mines in Wisconsin decreased from 10,088 tons in 1931 to 7,522 tons in 1932, and that from mines in Missouri decreased from 3,205 tons in 1931 to 986 tons in 1932. A few cars of zinc carbonate and silicates yielding 46 tons of zinc were shipped from mines in Kentucky. No ore or concentrates containing zinc were shipped from mines in Arkansas or Illinois in 1932.

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REVIEW OF MINE PRODUCTION IN THE EASTERN AND APPALACHIAN STATES

Alabama.—The value of the gold produced in Alabama from 1830 to 1932, inclusive, is recorded as $769,229. In 1932 there was a revival of lode mining, and the mines yielded $1,423 in gold and 10 ounces of silver. Most of this was from the W. F. Pasley mine near Alexander City, Tallapoosa County; the mine is equipped with a cyanide plant.

Georgia.—The value of the gold produced in Georgia from 1830 to 1932, inclusive, is recorded as $17,859,439. In 1932, 11 small placer mines and 3 lode mines yielded $5,760 in gold and 30 ounces of silver; in 1931, 2 mines produced $1,827 in gold and 12 ounces of silver. Placer mines near Dahlonega and Auraria in Lumpkin County yielded nearly 80 percent of the State output of placer gold ($3,720) in 1932; the remainder was produced by small mines operating in Cherokee, Dawson, Douglas, Gwinnett, and Hall Counties. The lode gold mines producing in 1932 were the Russell near Cleveland in White County, the Arnold near Lexington in Oglethorpe County, and the Hamilton at Thomson in McDuffie County. The Hamilton mine and mill were operated by W. H. Fluker, who sank two shallow shafts and did considerable drifting. The ore milled was taken out during development and treated at a 5-stamp mill. It is stated that amalgamation recovered only 60 percent of the gold content of the ore, whereas tests showed that cyanidation would recover a much larger proportion. The Hamilton mine adjoins the old Parks and Columbia mines which have yielded considerable gold and are now being reopened. The Russell mine was operated by Telford and Kenimer, and the gold ore was treated at a small mill. The Arnold mine is opened by a shaft and drifts, and the small quantity of ore mined yielded about $9 a ton in gold. The Chestatee placer mines and the Barlow, Findley, and other properties of Craig R. Arnold in the Dahlonega district are optioned and are to be developed in 1933.

Maine, Maryland, New Hampshire, and Vermont.—There was no production of gold, silver, copper, lead, or zinc in these States in 1932.

New Jersey (see also note on p. 147).—The production of zinc ore in New Jersey in 1932 was 559,651 tons containing 162,920,000 pounds of recoverable zinc. The only producing properties were the Mine Hill and Sterling Hill mines of the New Jersey Zinc Co.

New York.—The quantity of zinc ore and old tailings milled in New York in 1932 was 72,615 tons, and the quantity of lead-zinc ore was 117,064 tons; the concentrates shipped yielded 16,794 tons of zinc. The mines were not operated at capacity in 1932, and the shipments of concentrates were only about two thirds of those in 1931. The old Edwards mine yields sulphide zinc ore and is equipped with a 450-ton all-flotation plant. The Balmat mine near Sylvan Lake yields sulphide lead-zinc ore with a recovery of about 1 ton of lead concentrates to 10 tons of zinc concentrates and has a 600-ton flotation plant.

North Carolina.—The value of the gold produced in North Carolina from 1799 to 1932, inclusive, is recorded as $23,698,278. The yield of gold in 1932 was $7,591 and that of silver 10,045 ounces. Six placer mines yielded $449 in gold and nine lode mines $7,142. The placer mines were worked on a small scale. The Fontana copper mine was the largest producer of gold from lode mining. The placer gold was recovered in Burke, Gaston, Halifax, and Rutherford Counties. Lode mines were productive in Cabarrus, Guilford, Jackson, Montgomery, Randolph, Stanly, Swain, and Union Counties. The lode gold mines were all small producers, and less than 1,000 tons of gold ore were milled in 1932; properties that produced in 1932 were the Hearne and Sibley in Cabarrus County, operated by W. L. Cotton; the Crayton, also in Cabarrus County; the Zachary near Sylva in Jackson County, where rich gold ore was mortared and panned; the Lindsey in Guilford County, operated by J. A. Allred; the Black Ankle in Montgomery County near Seagrove, worked by means of a vertical shaft and open cuts and where a 100-ton cyanide plant is under construction; the Kindley near Fullers in Randolph County, equipped with a ball mill; the Whitley near Albemarle in Stanly County, equipped with a 10-stamp mill using amalgamation; and the Rogers near Waxhaw in Union County, operated by G. H. Strother, from which ore was shipped to Gold Hill for treatment. Terry & Holler are erecting a new 10-stamp mill near Charlotte in Mecklenburg County, and H. H. Green has rebuilt a 10-stamp mill at Gold Hill in Rowan 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. The crude ore assays 0.01 ounce of gold and 0.73 ounce of silver to the ton. The Fontana mine is opened by a 1,200-foot incline shaft.

Pennsylvania.—The Cornwall mines in Lebanon County were operated at a much reduced rate in 1932, and only one third as much copper concentrates was shipped as in 1931. The ore mined is pyritiferous magnetite, and the tailings from the iron concentrates go to the flotation plant. The copper concentrates, which contained about 20.1 percent copper and $2.42 to the ton in gold and silver, were shipped to the Nichols Copper Co.

South Carolina.—From 1829 to 1932, inclusive, mines in South Carolina yielded $5,184,753 in gold. The output in 1932 was $1,468, of which $947 came from lode gold mines. The most productive placer in 1932 was the Brewer near Jefferson in Chesterfield County, operated by J. F. Hartman. Smaller yields were reported by W. P. Bogan and by E. C. Young. Some gold was also recovered at the old Haile mine in Lancaster County near Kershaw, but the largest output was from the Notts mine in Union County near Pauline. This old mine, idle since 1900, was reopened in March 1932 by J. P. Cannon. The 10-stamp mill was operated for about 10 days mainly on ore from old dumps, but some good ore was mined through the 80-foot shaft.

Tennessee.—Mines in Tennessee produced $361,021 in gold from 1831 to 1932, inclusive. Almost the entire output since 1906 has been from copper ores. There were large decreases in the quantity of copper, zinc, gold, and silver from mines in Tennessee. The output of gold decreased from $8,325 in 1931 to $3,315 in 1932 and that of silver from 41,000 to 19,300 ounces. Tennessee produces only a little lead, but the quantity recovered in 1932 was double that in 1931. The total lead recovered from mines in Virginia, New York, and Tennessee in 1932 was 4,460 tons, and the total zinc recovered from mines in Tennessee and Virginia (for which separate figures may not be given) was 18,514 tons. The output of copper from mines in North Carolina, Tennessee, and Pennsylvania was 10,872,200 pounds, a decrease of nearly 12,474,000 pounds from 1931. The Tennessee Copper Co. ran its flotation plant and smelter on ore from the Polk County, Burra-Burra, and Eureka mines in Tennessee and on crude sulphide ore from the Fontana mine in Swain County, N.C.; the company mines were operated 191 days, the flotation plant was operated 173 days, and the smelter was operated full time on reduced tonnage. The Ducktown Chemical & Iron Co. operated its Isabella and East Tennessee mines and its flotation plant part of the year; it did not operate its smelter but stored the copper concentrates. The Mascot mine and mill of the American Zinc Co. of Tennessee were operated at about 80 percent of the 1931 rate. The Universal Exploration Co. did not mine any zinc carbonate ore in 1932 but kept its 800-ton all-flotation plant running on zinc sulphide ore at a lower rate than in 1931; the blende concentrates shipped had an average zinc content of 64.83 percent—the highest grade zinc concentrates reported in 1932. The Embree Iron Co. in Washington County shipped much less high-grade zinc carbonate than in 1931 but more lead carbonate.

Virginia.—The value of gold produced from mines in Virginia from 1828 to 1932, inclusive, is recorded as $3,299,073, of which only about $9,800 was produced during the last 22 years. In 1932 Virginia produced $637 in gold and 8 ounces of silver—the first output of gold since 1926. Shipments of lead and zinc concentrates decreased sharply in 1932. As there were only two producers of zinc and one of lead the Bureau of Mines is not at liberty to publish the figures. Sulphide lead-zinc ore was mined at the Austinville mine of the Bertha Mineral Co. The Ivanhoe Mining & Smelting Co. mined some oxidized zinc ore from shallow shafts. The gold and silver came from the Moss mine near Tabscott, Goochland County, operated by J. C. Williams and others. A 150-foot shaft was completed in July 1932, and a small stamp mill was operated for a few days on ore taken out during development. Part of the ore developed probably is not amenable to treatment by amalgamation and must be shipped to a smelter. Development work was continued in 1932 by Leo Faust on the Waller mine near Tabscott. The vertical shaft is down more than 300 feet. Some good ore is reported at the 150-foot level, but no effort will be made to mill the ore until drifts are run at the 300-foot level to cut other veins and until tests are made to indicate the proper method of treatment. The Moss and Waller mines are only 2 miles apart, in the James River area about 40 miles from Richmond.

REVIEW OF MINE PRODUCTION IN THE CENTRAL STATES

Tenor of ores.—The only fair basis for comparison of the relative magnitude of mining operations in different States is that of quantity of crude ore or "dirt." There are, however, marked differences in the metal content of the ores of the several mining regions and States; therefore, comparison of tenor of the ores is of interest and significance. All but a very small part of the ore from the Central States is of such tenor that it requires concentration. In Kentucky and southern Illinois most of the lead and zinc concentrates are recovered as by-products in the concentration of the fluorspar that they accompany, and it is not possible to calculate the metal content of the crude ore raised. 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 present an accurate comparison with the tenor during a period of active mining.

Quantity and tenor of copper, lead, and zinc ores, old tailings, etc., produced in the Central States, 1930-32, by States

State	1930		1931		1932	
	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	3,517,300	2.86	1,913,200	3.04	750,500	3.92
Michigan	6,659,036	1.27	3,570,748	1.65	1,142,775	2.38
Missouri	7,010,100	3.08	5,240,400	3.17	3,786,600	3.19
Oklahoma	7,213,600	2.61	3,828,900	3.06	1,587,700	3.70
Wisconsin	486,400	3.66	318,700	3.99	310,300	3.28
	24,886,436		14,871,948		7,577,875	

[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, the relative proportions of which are shown in the table on p. 145 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 gives the areas included in the seven lead- and zinc-producing regions of the Central States. Mineral Resources for 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.

Mine production of lead and zinc in the Central States in 1932, by regions

Region	Lead [1]		Zinc [2]		Total value
	Short tons	Value	Short tons	Value	
Concentrates:					
Joplin	23,523	$836,563	169,705	$3,096,428	$3,932,991
Southeastern Missouri	162,989	4,891,978	80	1,300	4,893,278
Upper Mississippi Valley [3]	1,312	38,493	28,133	178,326	216,819
Kentucky-southern Illinois	56	1,340	137	1,886	3,226
Northern Arkansas	6	180			180
	187,886	5,768,554	198,055	3,277,940	9,046,494
Total, 1931	253,588	11,166,717	262,387	5,637,359	16,804,076
Metal:					
Joplin	18,131	1,087,860	90,660	5,439,600	6,527,460
Southeastern Missouri	116,152	6,969,120	40	2,400	6,971,520
Upper Mississippi Valley [3]	910	54,600	7,522	451,320	505,920
Kentucky-southern Illinois	31	1,860	46	2,760	4,620
Northern Arkansas	4	240			240
	135,228	8,113,680	98,268	5,896,080	14,009,760
Total, 1931	181,648	13,441,952	130,476	9,916,176	23,358,128

[1] Includes both 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.

Arkansas.—No zinc ore or concentrates were shipped by mines in Arkansas in 1932, and shipments of galena concentrates were only 6 tons, yielding about 4 tons of lead. In 1931 the lead output was 78 tons. No zinc mines were operated in 1932, and all the lead ore shipped was from the Brewer land in Newton County.

Illinois.—None of the zinc or lead mines in northern Illinois were operated in 1932, and the only shipments from mines in southern Illinois were 56 tons of galena concentrates having an average lead content of 55.4 percent. The recoveries from these shipments were 31 tons of lead and 257 ounces of silver. The output in 1931 was 205 tons of lead and 1,300 ounces of silver. The Hillside Fluor Spar Mines was the largest shipper of galena concentrates in 1932, and all the concentrates were sold to the St. Louis Smelting & Refining Co. plant of the National Lead Co. The Rosiclare and Franklin mines, producing mainly fluorspar, did not sell any lead concentrates in 1932.

Kansas.—The output of recovered lead and zinc in Kansas in 1932 was much less than in 1931, although considerable quantities of concentrates milled in 1931 were shipped in 1932. The recovered lead in concentrates shipped decreased from 7,082 tons in 1931 to 6,490 tons in 1932 and recovered zinc from 39,051 to 26,277 tons.

The total quantity of zinc and lead-zinc ore and old tailings milled in Kansas in 1932 was 750,500 tons (1,913,200 tons in 1931), and the total shipments were 8,300 tons of galena concentrates, 79 tons of lead carbonate, and 49,487 tons of sphalerite concentrates. The galena concentrates had an average lead content of 79.3 percent, and the sphalerite concentrates had an average zinc content of 60.3 percent. The following average prices were received by sellers of concentrates: Galena concentrates $39.20 a ton, and sphalerite concentrates $17.97 a ton. The 507,100 tons of crude ore milled yielded 0.91 percent in galena concentrates assaying 79.3 percent lead and 7.03 percent in sphalerite concentrates averaging 60.4 percent zinc. The 243,400 tons of old tailings re-treated yielded only 4 tons of galena concentrates but contained 2.01 percent in sphalerite concentrates with an average assay of 59.5 percent zinc.

The total concentrates made by flotation in 1932 were 13,400 tons of sphalerite and 290 tons of galena.

Of the total shipments of sphalerite (49,487 tons), mines near Crestline contributed 11 tons and mines near Galena 27 tons; the remaining 49,449 tons were shipped from mines in the Blue Mound-Baxter Springs area. This area also contributed 7,529 tons of galena concentrates. Mines at Galena shipped 547 tons of galena and 79 tons of lead carbonate concentrates, and mines at Crestline shipped 224 tons of galena.

In the Crestline area all the large mills were idle in 1932, and most of the galena shipped was from stocks at mines. In the Galena camp most of the concentrates shipped were produced by small gougers on leases of the Eagle-Picher Mining & Smelting Co.

Mine production of lead and zinc in Kansas, 1931–32

Year	Lead concentrates [1]		Zinc concentrates		Metal content [2]			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1931	9,283	$404,231	73,690	$1,651,992	7,082	$524,068	39,051	$2,967,876
1932	8,379	327,344	49,487	889,066	6,490	389,400	26,277	1,576,620

[1] Includes 79 tons of lead carbonate, containing 56 percent lead, from Galena in 1932 and 270 tons of lead carbonate, containing 57 percent lead, in 1931.
[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, 1931–32

	1931		1932	
	Crude ore	Old tailings	Crude ore	Old tailings
Total ore and old tailings milled......short tons	1,040,800	872,400	507,100	243,400
Total concentrates shipped:				
Galena......do	8,882	401	8,375	4
Sphalerite......do	55,537	18,153	44,168	5,319
Ratio of concentrates to ore, etc.:				
Lead......percent	0.94	0.05	0.91	....
Zinc......do	6.30	2.09	7.03	2.01
Metal content of ore, etc.:				
Lead......do	.73	.03	.72	....
Zinc......do	3.80	1.24	4.24	1.17
Average lead content of galena concentrates......do	79.3	61.1	79.3	75.0
Average zinc content of sphalerite concentrates..do	60.4	59.8	60.4	59.5
Average value per ton:				
Galena concentrates	$44.99	$24.81	$39.21	$16.50
Sphalerite concentrates	$23.26	$19.86	$18.11	$16.73

The mines near Baxter Springs shipped 1,225 tons of galena and 6,112 tons of sphalerite. Of this quantity, about 25 percent was milled in 1931. Little prospecting was done in this area, and the only new mill erected was a 100-ton plant of the Lucky O. K. Mining Co. The principal shippers in the area in 1932 were the Rupe Milling Co. (tailing mill), Lucky O. K. Mining Co., Vinegar Hill Zinc Co. (Hartley-Grantham mine), H & B Mining Co., Childress Raymond Mining Co. (Hartley mine), and Lowther & Co. (Peru mine).

The mines in the Blue Mound area, which in 1931 shipped 5,998 tons of galena and 60,304 tons of sphalerite, had a much smaller output in 1932; shipments, including a large quantity of galena and a smaller proportion of sphalerite from mine bins, aggregated 6,304 tons of galena and 43,337 tons of sphalerite in 1932. The larger shippers in this area were the Jay Hawk Mining Co., Tri-State Zinc, Inc. (tailings), Black Eagle Mining Co. (ore and tailings), Commerce Mining & Royalty Co. (Webber, West Side, and Wilbur mines), Eagle-Picher Mining & Smelting Co. (Bendelari mine), Mid Continent Lead & Zinc Corporation and Vinegar Hill Zinc Co. (Barr mine).

The Waco district (in Kansas) shipped 2,063 tons of sphalerite in 1931; all mines and mills were idle in 1932, and no shipments were made from stocked concentrates.

Kentucky.—The fluorspar mines in Kentucky made no shipments of lead concentrates in 1931 or 1932. Shipments in 1930 were 184 tons having a recoverable content of 101 tons of lead.

Shipments of 137 tons of zinc carbonate and silicates were made in 1932 from mines near Marion, by Roberts & Frazer and Avery H. Reed; the recovered zinc content was 46 tons. The ore mined by Avery H. Reed is a mixed zinc carbonate and lead carbonate.

Michigan.—In 1932 the mines of Michigan produced 1,142,775 tons of rock yielding 79,753,030 pounds of mineral, from which 54,396,108 pounds of refined copper were obtained. The production was less than half that recorded for 1931. Adverse industrial conditions throughout the world caused a severe contraction in demand for copper, and an unfavorable balance between supply and demand resulted. A new low price for copper was established in 1932, and virtually all copper mines in the country were operated at a loss. Owing to these conditions the Michigan State Tax Commission reduced the assessed valuation of the mines in Houghton and Keweenaw Counties during the year from $28,562,661 to $19,992,470; Houghton County mines were valued at $14,132,470 compared with $20,347,661 in 1931 and Keweenaw County mines at $5,860,000 compared with $8,215,000 in 1931. The assessed valuation of Calumet & Hecla properties in Houghton County was reduced from $14,650,000 to $10,580,000 and in Keweenaw County from $5,575,000 to $4,040,000. Copper Range was reduced from $2,765,000 to $1,900,000; Isle Royale from $950,000 to $645,000; Quincy from $900,000 to $435,000; Arcadian from $50,000 to $25,000; La Salle from $80,000 to $25,000; Superior from $20,000 to $10,000; Mohawk from $1,850,000 to $1,380,000; Seneca from $700,000 to $350,000; and Douglass Copper from $40,000 to $30,000.

Mining companies in Michigan made every effort to reduce the cost of production by selective mining, abandonment of exploration and construction work, reduction in salaries and wages, etc. The grade of rock mined increased from 1.27 percent in 1930 to 1.65 percent in 1931 and to 2.38 percent in 1932. Selective mining and the failure of the Calumet & Hecla Consolidated Copper Co. to treat copper sands in 1931 and 1932 were responsible for this increase. The average grade of rock for the district in 1932 was considerably higher than in any previous year since the compilation of mine figures was begun by the U.S. Geological Survey in 1906, due principally to the mining of high-grade rock from shaft pillars and old backs in the conglomerate branch of Calumet & Hecla. According to Butler and Burbank,[1] who recorded the grade of rock produced by individual mines in the Lake Superior district from 1845 through 1925, this mine produced rock yielding 66.6 pounds of copper to the ton in 1897 (slightly higher than the 65.53 pounds reported for it in 1932) and produced no rock of such high grade after that time.

[1] Butler, B. S., and Burbank, W. S., The Copper Deposits of Michigan: U.S. Geol. Survey Prof. Paper 144, 1929, p. 80.

Mine production of silver and copper in Michigan, 1928–32 [1]

Year	Silver (fine ounces)	Copper [2]			Concentrate ("mineral") [3]		Ore [4] ("rock") (short tons)
		Pounds	Yield		Pounds	Yield (percent)	
			Pounds per ton of ore ("rock")	Percent			
1928	17,153	178,442,704	24.2	1.21	283,405,073	63.0	7,361,658
1929	20,795	186,402,218	24.5	1.23	286,583,602	65.0	7,598,180
1930	7,820	169,381,413	25.4	1.27	258,005,986	65.7	6,659,036
1931	1,437	[5] 118,059,491	[5] 33.1	[5] 1.65	[5] 172,431,815	[5] 68.5	[5] 3,570,748
1932	71,408	[5] 54,396,108	[5] 47.6	[5] 2.38	[5] 79,753,030	[5] 68.2	[5] 1,142,775

[1] The figures are based on the actual recovery of copper from "mineral" smelted and the estimated recovery from "mineral" that was not smelted during the year.
[2] Includes copper from sands.
[3] Includes "mineral" from sands.
[4] Includes sands.
[5] No sands reported for 1931 or 1932.

Value of silver and copper produced in Michigan mines, 1928–32

Year	Silver	Copper		Total	Year	Silver	Copper		Total
		Total	Per ton of ore ("rock")				Total	Per ton of ore ("rock")	
1928	$10,035	$25,695,749	$3.49	$25,705,784	1931	$417	$10,743,414	$3.01	$10,743,831
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					

During 1932 the mines of the Calumet & Hecla Consolidated Copper Co. produced 32,354,000 pounds of copper at an average cost sold (not including depreciation and depletion) of 10.64 cents a pound compared with 72,367,000 pounds of copper in 1931 at an average cost sold of 9.77 cents a pound. The reclamation plants at Lake Linden and Hubbell were both idle in 1931 and 1932. In the conglomerate branch, mining of shaft pillars and old backs extending into the higher zones of the mine where the rock is of richer quality was continued and raised the grade of rock for the entire branch from 51.48 pounds to the ton in 1931 to 65.53 pounds in 1932. In 1930 the grade was 48.69 pounds per ton. Because of the low price for copper, early in January 1933 production was confined to the shaft pillars and old backs, and the lower part of the mine was permitted to fill with water. Closer selection in the stopes of the Ahmeek mine raised the grade of rock from that mine slightly; operations were suspended in April 1932. The Osceola amygdaloid branch was closed May 31, 1931, and remained idle throughout 1932. At the Calumet mill 425,175 tons of conglomerate rock were stamped, and at the Ahmeek 151,436 tons of amygdaloid rock were treated. Reconstruction of a third stamp unit at the Ahmeek mill to permit fine grinding and flotation was well under way when the mine and mill were closed April 30. The smelter treated 22,000 tons of concentrates and mass from the Calumet & Hecla mines and 106 tons from the Isle Royale property. A total of 30,560,000 pounds of refined copper was produced compared with

71,100,000 pounds in 1931. Plants of the Lake Milling, Smelting & Refining Co. were idle throughout 1931 and 1932.

Operations at the property of the Isle Royale Copper Co. were continued on a curtailed basis until the latter part of April when the mine and mill were closed. Late in December the mine was allowed to fill with water.

Copper produced by the Isle Royale Copper Co., 1929–32

	1929	1930	1931	1932
Rock hoisted short tons	669,049	668,700	450,682	74,189
Rock-house discard do	154,025	158,438	97,607	15,878
Rock treated do	515,024	510,262	353,075	58,311
Cost of mining, transportation, stamping, and taxes per ton of rock	$2.67	$2.44	$2.24	$2.63
Refined copper produced pounds	10,864,085	10,659,413	7,731,418	1,403,142
Refined copper per ton of rock treated do	21.09	20.89	21.90	24.06

Production at the Champion mine of the Copper Range Co. was maintained at approximately 1,000,000 pounds a month in 1932, most of which came from the south end of the property. Operations at the north end were discontinued March 1, 1932. A total of 12,188,578 pounds of copper was produced at an average cost delivered, exclusive of depreciation and depletion, of 8.646 cents a pound. The Baltic and Trimountain mines were idle throughout the year. A total of 291,265 tons was stamped at the Champion mill in 1932. Work on electrical crushing to replace steam stamps was begun late in the year. The new crusher will have operating advantages over the steam stamps, and a substantial reduction in costs is anticipated.

Copper produced by the Champion mine of the Copper Range Co., 1928–32

Year	Rock stamped	Copper produced	Yield per ton	Cost per pound [1]	Price received	Net profit
	Short tons	*Pounds*	*Pounds*	*Cents*	*Cents*	
1928	427,240	19,563,535	45.79	11.10	15.01	$829,357.45
1929	446,804	20,660,701	46.24	11.76	17.94	1,267,685.97
1930	(2)	19,999,564	44.57	11.60	11.43	[3] 32,955.04
1931	[4] 404,830	[4] 17,721,270	[4] 43.77	[4] 9.754	[4] 8.2	[5] 451,450.25
1932	291,265	12,188,578	41.847	8.646	6.0	[5] 690,105.09

[1] Excludes depreciation and depletion.
[2] Figures not given.
[3] Deficit.
[4] Includes Baltic mine.
[5] Deficit for the Copper Range Co.

Copper produced by the Baltic mine, 1928–32 [1]

Year	Rock stamped	Copper produced	Yield per ton	Cost per pound [2]	Price received	Net loss
	Short tons	*Pounds*	*Pounds*	*Cents*	*Cents*	
1928	92,742	3,415,082	36.82	14.54	15.01	[3] $16,085.53
1929	53,833	2,127,926	39.53	21.27	17.94	62,339.97
1930	(4)	3,251,705	49.72	11.82	11.43	(4)
1931	(5)	(5)	(5)	(5)	(5)	(5)

[1] No production recorded for 1932.
[2] Excludes depreciation and depletion.
[3] Net profit.
[4] Figures not given.
[5] Included with Champion mine in preceding table.

Copper produced by the Trimountain mine, 1928–32 [1]

Year	Rock stamped	Copper produced	Yield per ton	Cost per pound [2]	Price received	Net loss
	Short tons	*Pounds*	*Pounds*	*Cents*	*Cents*	
1928	38,950	1,275,515	32.74	16.90	15.01	$24,100.34
1929	42,763	1,408,689	32.94	22.92	17.94	57,968.20
1930	(3)	542,649	37.81	16.38	11.43	(3)

[1] No production recorded for 1931 and 1932.
[2] Excludes depreciation and depletion.
[3] Figures not given.

At the property of the Mohawk Mining Co. 216,588 tons of rock were stamped and yielded 8,450,388 pounds of copper. The average cost of copper produced in 1932 was 5.163 cents a pound compared with 7.038 cents in 1931. With the exhaustion of the mine in prospect, this record low cost was obtained by maintaining maximum production with freedom from development and construction expenses. Mining operations were continued on the basis of a 2-shift day and 6-day week until September 12, 1932. Owing to the small reserves and the increasing pressure of the surrounding ground on no. 6 shaft, the only one in operation, the mine was then closed. Mineral and mass from current production and storage smelted during the year totaled 27,055,350 pounds and yielded 19,784,167 pounds of copper. The 18,049,750 pounds of mineral in storage at the end of 1932 were estimated to contain 12,600,000 pounds of recoverable copper. At a stockholders' meeting on March 28, 1933, it was voted to proceed with liquidation of the company. Dividends paid in 1932 totaled $1,120,750.

Copper produced by the Mohawk Mining Co. in 1932

Rock hoisted ... short tons	217,460
Rock stamped ... do	216,588
Product of mineral ... pounds	11,223,000
Copper in mineral produced ... do	8,450,388
Yield per ton of rock treated ... do	39.016
Cost per ton of rock hoisted [2]	$1.428
Cost per ton of rock stamped [2]	$1.434
Operating cost per pound of refined copper [2] ... cents	3.675
Cost of taxes [2] ... do	.328
Cost of smelting, freight, and marketing product, including eastern offices' expenses ... cents	1.160
Total	5.163

Operations at the mine of the Quincy Mining Co. were suspended September 22, 1931, and the mine remained idle throughout 1932.

Copper produced by the Quincy Mining Co., 1928–32 [a]

Year	Copper rock and mass	Mineral	Copper	Yield of copper per ton of rock
	Short tons	*Pounds*	*Pounds*	*Pounds*
1928	60,834	1,891,200	1,220,536	20.06
1929	207,833	7,088,500	4,459,426	21.46
1930	[b] 450,800	18,042,927	10,939,787	24.27
1931	(c)	(c)	(c)	(c)

[a] No production in 1932.
[b] Not given in company report but indicated by other figures.
[c] No report issued by company, but production of copper, as indicated by other sources, 7,466,000 pounds.

[2] Based on actual production costs from Jan. 1, 1932, to date of shut-down, Sept. 12, 1932.

Missouri.—The following tables show the production of lead and zinc in southwestern Missouri and the tenor of ore ("dirt") and concentrates from Missouri.

Mine production of lead and zinc in southwestern Missouri, 1931–32

Year	Lead concentrates				Zinc concentrates				Metal content [1]			
	Galena		Carbonate		Sphalerite		Silicate and carbonate		Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1931	1,254	$51,673	440	$13,985	3,600	$79,371	377	$4,760	1,171	$86,654	1,985	$150,860
1932	849	25,837	646	14,491	1,538	25,180	404	4,248	1,007	60,420	946	56,760

[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 concentrates produced in southwestern Missouri, 1929–32

	1929	1930	1931	1932
Total ore short tons	428,400	328,800	104,800	46,400
Total concentrates in ore:				
Lead percent	0.33	0.40	1.63	3.61
Zinc do	3.80	3.89	3.76	4.69
Metal content of ore:				
Lead do	.25	.31	1.15	2.48
Zinc do	2.26	2.25	2.15	2.60
Average lead content of galena concentrates do	76.3	76.0	74.6	75.6
Average lead content of lead carbonate concentrates do	60.0	60.0	59.1	59.6
Average zinc content of sphalerite concentrates do	60.3	60.0	58.6	59.5
Average zinc content of silicates and carbonates do	40.2	40.1	39.0	39.8
Average value per ton:				
Galena concentrates	$82.31	$59.39	$41.21	$30.43
Lead carbonate concentrates	61.36	53.42	31.78	22.43
Sphalerite concentrates	40.53	33.55	22.05	16.37
Zinc silicates and carbonates	21.24	24.00	12.63	10.51

Tenor of lead ore and concentrates in southeastern Missouri disseminated-lead district, 1929–32

	1929	1930	1931	1932
Total lead ore short tons	6,439,600	6,681,300	5,135,600	3,740,200
Galena concentrates in ore percent	4.31	4.15	4.36	4.36
Zinc content of ore do	.11	.13	.04	.01
Average lead content of galena concentrates do	72.7	73.0	72.4	72.7
Average value per ton of galena concentrates	$75.61	$59.60	$43.93	$30.01
Average zinc content of sphalerite concentrates percent	58.1	58.2	57.6	57.15
Average value per ton of sphalerite concentrates	$39.44	$18.80	$17.86	$16.25

Mine shipments of lead and zinc concentrates in southeastern and central Missouri, 1907–32

Year	Lead concentrates (galena)		Zinc concentrates			
			Sphalerite		Carbonate and silicate	
	Short tons	Value	Short tons	Value	Short tons	Value
1907–1929	5,853,746	$382,041,252	25,335	$948,639	10,285	$233,534
1930	277,520	16,558,920	8,411	158,116		
1931	223,853	9,833,045	2,408	43,000		
1932	162,989	4,891,978	80	1,300		

The value of the silver, lead, and zinc shipped from Missouri mines was $7,089,018 in 1932 compared with $12,104,134 in 1931. The quantity of silver recovered from ore and concentrates sold and treated declined from 40,000 ounces in 1931 to 1,128 ounces in 1932. The quantity of recovered lead declined from 160,121 tons in 1931 to 117,159 tons in 1932 and that of recovered zinc from 3,205 to 986 tons. The silver recovered came from residues from zinc concentrates derived from lead ore mined in southeastern Missouri. Shipments of lead concentrates (of which only 646 tons were lead carbonate) were 164,484 tons compared with 225,547 tons in 1931. Of the total in 1932, 162,989 tons were shipped from mines in southeastern Missouri and averaged 72.7 percent lead; the recovered lead content was 116,152 tons in 1932 compared with 158,950 tons in 1931.

Shipments of lead concentrates from mines in southwestern Missouri comprised 849 tons of galena and 646 tons of lead carbonate. The average lead content of the galena from southwestern Missouri in 1932 was 75.6 percent, and the average price for the concentrates, sold mainly in small lots, was about $30. The quoted weekly prices of galena concentrates in the Tri-State or Joplin region in 1932, although indicating the trend of prices, did not govern the prices paid to sellers of galena concentrates. Sellers of small lots were paid the quoted price or less, whereas sellers of carload lots, or quantities totaling several hundred tons, were paid $2.50 to $5 above quoted prices.

Practically all the zinc concentrates shipped from Missouri mines in 1932 were from properties in southwestern Missouri, as only about 2 cars of blende concentrates were sold from southeastern Missouri mines. The total quantity of blende concentrates shipped from Missouri in 1932 was 1,618 tons, a decrease of 4,390 tons from 1931. The blende concentrates from southwestern Missouri had an average zinc content of 59.5 percent and brought an average price of $16.37 a ton.

The shipments of zinc silicate in 1932 came entirely from southwestern Missouri; they amounted to 404 tons (27 tons more than in 1931) and averaged about 39.8 percent in zinc content. All the zinc silicate was a milled product as there was no demand for lump ore, and all was purchased at a flat price as there were no quoted prices in 1932. The total value of lead and zinc concentrates shipped from southwestern Missouri decreased from $149,789 in 1931 to $69,756 in 1932. The total value assigned for the 162,989 tons of galena concentrates shipped from southeastern Missouri was $4,891,978 ($4,941,067 less than in 1931).

The quantity of crude ore and old tailings treated in Missouri in 1932 totaled 3,786,600 tons. The total amount received for all classes of lead and zinc concentrates sold in 1932 was $4,963,034, an average of $1.31 per ton of crude ore and old tailings treated (60 cents less than in 1931).

There was a very small demand for high-grade sphalerite concentrates in 1932, and no premium was paid for them; moreover, smelters did not desire to purchase lead-free zinc concentrates or concentrates containing more than 60 to 60.5 percent zinc. Flotation concentrates were purchased more eagerly than jig or table concentrates. This change in preference of ore buyers is due to the fact that most smelters are equipped to re-treat the concentrates that they can purchase at lower prices and also save much of the lead contained in such zinc concentrates. The new and more efficient milling plants usually can make sphalerite concentrates averaging as high as 63+ percent in zinc content. The general average zinc content of the concentrates sold in the Tri-State region in 1932 was about 1 percent more than in 1931, notwithstanding the fact that a considerable part of the 1932 shipments were concentrates made in 1931. Several large mills which were producing 61 to 63 percent sphalerite concentrates are keeping the content at 60 percent or less, and the concentrates now held in mine bins include very little flotation products or low-grade jig and table concentrates. Prices quoted in 1932 were not paid for some of the zinc concentrates shipped in 1932, as they were sold under special contract, and a large quantity was shipped to smelters for smelting with the proviso that the metal recovered was to be held subject to control of the shipper of the concentrates.

Only a few small mines and mills were operated in southwestern Missouri in 1932. Most of the lead concentrates were produced by small lessees and sold in small lots. The zinc carbonate sold in 1932 was mainly from the Aurora and Wentworth camps. Two thirds of the sphalerite was shipped by operators in the Waco camp who leased the properties formerly worked by the Missouri-Kansas Zinc Corporation. Small shipments were also made from mines near Granby, Joplin, Oronogo, Fidelity, and Webb City.

The lead ore (3,740,200 tons) mined in the disseminated-lead district in southeastern Missouri yielded 4.36 percent of galena concentrates averaging 72.7 percent lead. As the operators mine and smelt their lead concentrates the assigned value of $30.01 a ton is more or less arbitrary. Of the 227 tons of galena produced by operators of shallow diggings most was purchased and shipped by T. F. Blount of Potosi. The Annapolis mine and mill in Iron County were idle; the remainder of the galena shipped was produced by the National Lead Co. (St. Louis) and the St. Joseph Lead Co. The five mills of the St. Joseph Lead Co., which have a daily capacity of 17,000 tons, milled about 3,056,000 tons of crude ore—about 75 percent of the quantity treated in 1931. From about March 1 to December 31 the mines were operated at about 50 percent of capacity. The National Lead Co. (St. Louis Smelting & Refining Co.) operated its 3,500-ton mill in 1932 at about 73 percent of its 1931 rate.

Oklahoma.—The average zinc content of sphalerite from Oklahoma increased from 59.9 percent in 1931 to 60.9 percent in 1932. The zinc content of the concentrates made from crude ore averaged 61 percent, and some of the concentrates assayed 63 percent. The zinc content of sphalerite made from old tailings increased from 59.5 percent in 1931 to 60.3 percent in 1932. Many mills were idle in 1932; others were operated part of the year. Very little profit could be made by operators even when high-grade crude ore was treated. Generally the work was distributed among as many employees as possible; in some instances miners were permitted to work upper levels on a restricted weekly output basis, and the output was purchased by the owner of the mine. The wrecking of many old plants and the erection of the largest mill in the district by the Eagle-Picher Mining & Smelting Co. provided an unexpected use of labor and supplies which partly mitigated the idleness in the district. The new mill was put in operation early in the fall of 1932 (although not run at capacity) on ore mined at various properties and transported in standard railway cars. A considerable part of the tailings made daily are loaded direct on cars for railway and commercial uses.

About 40 mines and tailing mills and many small scrappers were operating at different times during 1932, and shipments of stored concentrates were made from several idle properties.

About 1,000 tons of the galena and 27,000 tons of the sphalerite were flotation products. It is estimated that as much as 35 percent of the concentrates made in 1933 will be flotation concentrates.

Mine shipments of lead and zinc in Oklahoma in 1932, by districts

District	Lead concentrates (galena)		Zinc concentrates (sphalerite)		Metal content [1]			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Miami	13,544	$465,411	111,830	$2,075,114	10,554	$633,240	60,053	$3,603,180
Peoria	48	1,600			37	2,220		
Quapaw and Sunnyside	57	1,880	6,446	102,820	43	2,580	3,384	203,040
	13,649	468,891	118,276	2,177,934	10,634	638,040	63,437	3,806,220
Total, 1931	17,005	786,719	148,112	3,540,964	13,210	977,540	78,132	5,938,032

[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, old tailings, and slimes milled and concentrates produced in Oklahoma, 1931–32

	1931		1932	
	Crude ore	Old tailings and slimes	Crude ore	Old tailings and slimes
Total ore, etc., milled ... short tons	2,208,100	1,620,800	1,262,200	325,500
Total concentrates shipped:				
Galena ... do	16,793	212	13,437	212
Sphalerite ... do	123,680	24,432	108,332	9,944
Ratio of concentrates to ore, etc.:				
Lead ... percent	0.85	0.01	0.79	0.05
Zinc ... do	6.56	1.74	6.01	2.28
Metal content of ore, etc.:				
Lead ... do	.68	.01	.63	.04
Zinc ... do	3.94	1.07	3.66	1.37
Average lead content of galena concentrates ... do	79.3	71.2	79.6	73.1
Average zinc content of sphalerite concentrates ... do	60.3	59.5	61.0	60.3
Average value per ton:				
Galena concentrates	$46.21	$50.21	$34.47	$26.75
Sphalerite concentrates	$24.30	$21.90	$18.50	$17.48

Mine production of lead and zinc concentrates in Oklahoma, 1891–1932, 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	1,037,707	$90,408,208	5,529,459	226,868,125		
Peoria	2,254	110,763	220	8,289	2,944	76,787
Quapaw and Sunnyside	25,055	2,239,226	220,512	9,027,710	164	2,692
	1,065,016	92,758,197	5,750,749	235,931,523	4,007	104,071

The larger shippers of concentrates from mines near Commerce were the Lost Trail Mining Co. and the Covert Mining Co. The Quapaw and Sunnyside area had numerous small operators and shippers; its shipments of galena were only 57 tons, and 84 percent of the sphalerite shipped was concentrates made in 1931. Shipments of 1,369 tons of galena and 11,519 tons of sphalerite from the Douthat area were largely those of the Admiralty Zinc Co.; smaller shipments came from the Beck Mining & Milling Co. and the Continental Mining & Development Co., both of which were idle most of 1932. Mines near Hockerville shipped 480 tons of galena and 18,182 tons of sphalerite. Most of the sphalerite was from ore or tailings milled in 1930 or 1931 by the St. Louis Smelting & Refining Co. Other shippers were C. Y. Semple (Brewster tailings), Jager Mining Co., Blue Bonnet Mining Co., Roberts Mining Co., Thurston Mining Co., and Smith Davis Co. The mines and mills in Picher made a much smaller output in 1932 than in 1931, and a large part of the sphalerite sold was from old tailings. The large shippers were the Eagle-Picher Mining & Smelting Co. and its sublessees, the Retriever Milling Co. (tailing mill), Just Right Milling Co. (tailing mill), Midway Mining Co., and Davis Big Chief Mining Co. Mines in the Cardin-Tar River area shipped 8,411 tons of galena and 63,839 tons of sphalerite in 1932, a considerable part of which was concentrates made in 1931. The larger shippers were the Myers Milling Co., Interstate Zinc & Lead Co., and W. H. Aul & Co. from old tailings milled and from mines of the Commerce Mining & Royalty Co. (3 mines), Evans Wallower Lead Co. (2 mines), Velie Mining Corporation, Vinegar Hill Zinc Co., Dines Mining Co., Rialto Mining Corporation, and Eagle-Picher Mining & Smelting Co. (Central and Domado mills).

Wisconsin.—The National Zinc Separating Co. at Cuba City was the only roasting plant operated in Wisconsin in 1932 and treated practically all the zinc concentrates except the high-grade flotation concentrates made by the Badger Zinc Co. Only four mines had an appreciable output. The total value of the concentrates shipped in 1932 was about 60 percent of that in 1931. Very little prospecting was done, and no new mills were built. The larger shipments came from the Badger Zinc Co. at Linden and from the Vinegar Hill Zinc Co. which operated 2 mines at Hazel Green and 1 at Shullsburg.

Mine production of lead and zinc in Wisconsin, 1931–32

Year	Lead concentrates		Zinc concentrates		Metal content [1]			
			Sphalerite		Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1931	1,307	$59,277	34,200	$317,272	952	$70,448	10,088	$766,688
1932	1,312	38,493	28,133	178,326	910	54,600	7,522	451,320

[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 metals 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, 1929–32

	1929	1930	1931	1932
Total ore short tons	607, 100	486, 400	318, 700	310, 300
Total concentrates in ore:				
Lead percent	0. 36	0. 44	0. 41	0. 42
Zinc do	11. 5	10. 6	10. 7	9. 07
Metal content of ore:				
Lead do	. 26	. 32	. 30	. 30
Zinc do	3. 53	3. 34	3. 69	2. 98
Average lead content of galena concentrates do	72. 2	73. 5	74. 3	70. 7
Average zinc content of sphalerite concentrates do	30. 6	31. 6	34. 3	32. 9
Average zinc content of zinc carbonate concentrates percent	41. 6	43. 0		
Average value per ton:				
Galena concentrates	$76. 61	$60. 91	$45. 35	$29. 34
Sphalerite concentrates	17. 28	13. 00	9. 28	6. 34
Zinc carbonate concentrates	24. 60	27. 77		

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SECONDARY METALS

By J. P. Dunlop

The total value of certain nonferrous metals, for which the quantity recovered from secondary sources is reported to the Bureau of Mines, was $65,022,800 in 1932, $45,651,800 less than in 1931; the total quantity decreased 175,420 short tons. The drop in total value was due partly to lower average prices for the metals other than nickel and aluminum, but the output of each secondary metal declined. Secondary copper recovered and brass remelted decreased nearly 110,000 tons, and the calculated value was less than half that in 1931.

Rural collections of scrap metals were comparatively small, as prices were unattractive to junk dealers. There was much less metallic waste than usual in large industrial centers, and most of it was marketed. Frequently there was active demand from both primary and secondary smelters for brass and copper scrap and old batteries, and they brought relatively high prices. Probably there are no large accumulations of scrap metals because of the low rate of industrial operations and poor collections. Naturally improvement in the price of new metals will bring in old metals not now being collected.

Secondary metals of certain classes recovered in the United States, 1931–32

	1931		1932	
	Short tons	Value	Short tons	Value
Copper, including that in alloys other than brass	261,000	$47,502,000	187,700	$23,650,200
Brass scrap remelted	122,800	17,932,000	86,400	8,916,500
Lead as metal	128,800	17,367,800	128,000	11,898,000
Lead in alloys	105,900		70,300	
Zinc as metal	34,800	3,207,200	20,000	1,578,000
Zinc in alloys other than brass	7,400		6,300	
Tin as metal	5,500	9,428,800	4,650	6,248,100
Tin in alloys and chemical compounds	14,300		10,100	
Aluminum as metal	15,200	12,726,000	12,200	10,992,000
Aluminum in alloys	15,100		11,800	
Antimony as metal and in alloys	7,900	1,061,800	6,450	725,000
Nickel as metal	270	1,449,000	200	1,015,000
Nickel in nonferrous alloys and salts	1,800		1,250	
	720,770	110,674,600	545,350	65,022,800

The quantity of zinc used for zincking (galvanizing) declined greatly so that zinc drosses were scarce, redistilled zinc produced decreased about 6,900 tons, and smaller quantities of skimmings were available for zinc chloride, lithopone, etc.

Detinning plants treated about 47,800 long tons less clean tin-plate clippings in 1932 than in 1931.

The trend of prices of primary metals was steadily downward, so that scrap metals, alloys, drosses, and residues bought by dealers could not be sold at a profit. Foundry purchases of scrap metals and composition ingot were at a minimum, for many such establishments were idle and others only purchased material to fill spasmodic orders. In 1932 few foundries stocked any new or old metals, even at the very low prices prevailing. The average weekly quotations for many scrap metals and alloys can be obtained from the Waste Trade Review, Waste Trade Journal, and Metal Industry.

An appreciable number of the larger secondary metal plants have been acquired by the large smelting companies that normally produce primary metals and by others that produce both primary and secondary metals and alloys. There is a general tendency to eliminate small plants and to concentrate the secondary metal industry in larger units. New plants have been erected or old ones purchased by the National Lead Co., American Smelting & Refining Co., Eagle-Picher Lead Co., and Western Electric Co.

Plans have been made for the formation of a new trade association to be known as the Secondary Metals Institute. Some of the objects of the proposed Institute will be to maintain standard metal classifications; clarify nomenclature, definitions, impurities, and penalties relating to scrap metals, drosses, etc.; and standardize insurance and contract forms.

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, aluminum, 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 addition to the figures in the general reports on the primary metals, and will become more valuable in 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.

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 7,262,710 fine ounces of silver and $22,214,263 in gold from waste or discarded material in 1932. The increase in gold was nearly $2,300,000. Jewelry and dental waste furnish the largest quantity of secondary gold,[1] and

[1] Hoke, C. M., The Buying and Selling of Old Gold: Metal Ind., February 1933, pp. 55–59.

silverware and photographic waste supply the largest quantity of secondary silver. The consumption of silver in the photographic industry in the United States is estimated at 5,182,380 fine ounces in 1932 compared with 6,605,623 ounces in 1931. It is stated that about a million feet of old film yield 1,600 fine ounces of silver.

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 publication shows that an enormous quantity of such ferrous material is salvaged and reused.

Secondary copper.—The copper produced by smelters of secondary materials in 1932 includes 80,273 tons of pig copper (part of which was electrolytically refined), 47,200 tons of copper in alloys other than brass, and 60,480 tons of copper in remelted brass; these figures indicate decreases from 1931 of 29,963 tons in pig copper, 25,500 tons in copper in alloys other than brass, and 25,520 tons in copper contained in brass. Regular copper smelters produced about 18,000 tons less secondary copper in 1932 than in 1931; the ratio of decrease was much lower than that shown by smelters treating only secondary material.

The total value of secondary copper as metal and in brass and other alloys computed at 6.3 cents a pound—the average price in 1932 of all merchantable grades of new metal—was $31,270,680, about $31,883,300 less than in 1931.

Imports of scrap copper decreased more than half and those of scrap brass 43 percent.

Exports of scrap copper decreased 16,410 tons, but those of scrap brass increased 3,481 tons.

Secondary copper recovered in the United States, 1931–32, and imports and exports of brass and copper scrap, in short tons

	1931	1932
Copper as metal	[1] 188,300	[1] 140,500
Copper in alloys other than brass	72,700	47,200
	261,000	187,700
Copper from new scrap (not including brass)	45,000	35,000
Copper from old scrap (not including brass)	216,000	152,700
	261,000	187,700
Brass scrap remelted:		
New clean scrap	58,100	46,000
Old scrap	64,700	40,400
	122,800	86,400
Copper content of brass scrap (averaging 70 percent copper):		
New scrap	40,700	32,200
Old scrap	45,300	28,280
	86,000	60,480

	1931	1932
Total secondary copper (including copper content of brass scrap):		
From new scrap	85,700	67,200
From old scrap	261,300	180,980
	347,000	248,180
As metal	188,300	140,500
In brass and other alloys	158,700	107,680
	347,000	248,180
Brass scrap imported	2,212	1,259
Scrap copper imported	2,550	1,211
Brass scrap exported	11,592	15,073
Scrap copper exported	33,589	17,179

[1] Of these totals secondary copper reported by smelters and refiners that treat mainly primary metal comprised 78,064 tons in 1931 and 60,227 tons in 1932.

Railroads were again large producers of scrap metals, although their sales of such materials in 1932 were greatly curtailed. Reports for 1932 show that the railroad reused at their shops and foundries the following quantities of scrap metals: 5,700 tons of brass; 400 tons of copper; 7,500 tons of copper in alloys other than brass; 1,200 tons of tin in babbitt, solder, and bronze; and 3,600 tons of lead in various alloys.

Secondary lead.—The output of secondary lead equaled 69 percent of the total output of refined primary lead in the United States in 1932 compared with 53 percent in 1931, as the primary lead output was curtailed radically in 1932.

Much recovered lead is derived from old batteries, pipe, and sheet lead. The curse of rebuilt batteries continued to be felt in 1932; a few were worth the selling price, but most of those sold were worthless. Metal-trade associations urge battery and scrap dealers to break up all batteries so that only smelters can use them.

The American Bureau of Metal Statistics estimates that 10,000,000 automobile batteries were made in 1932—1,000,000 less than in 1931 and about 6,000,000 less than in 1929. The total lead (as oxide or metal) and antimony content of automobile batteries is figured at 138,000 tons in 1932 compared with 157,000 tons in 1931.

Secondary lead recovered in the United States, 1931–32, in short tons

	1931	1932
Secondary lead recovered by smelters that treat mainly ore	43,774	33,611
Secondary lead recovered by smelters that treat only scrap and drosses	85,026	94,389
	128,800	128,000
Secondary lead recovered in remelted alloys:		
Estimated secondary lead content of antimonial lead produced at regular lead smelters	14,173	13,486
Lead content of drosses and scrap alloys treated at secondary smelters	91,727	56,814
	105,900	70,300
Total secondary lead recovered	234,700	198,300

Refined primary lead produced in the United States, 1931–32, in short tons

	1931	1932
From domestic ore	390,260	255,337
From foreign ore and base bullion	52,504	33,024

The collection of old discarded batteries kept up remarkably well in 1932, although undoubtedly it declined greatly in rural areas. There was active demand from smelters all year, either as outright purchase or for treatment on a toll basis. At least 75 percent of the discarded automobile batteries are returned as scrap after about 21 to 22 months' use. Other types of discarded batteries swell the quantity of lead and antimony although radio batteries have decreased sharply. It is estimated that about 10,000 tons a month of battery plates, etc., were available in 1932 and that the average lead and antimony content of each automobile battery has declined from 28.9 pounds in 1928 to 24.6 pounds in 1932.

A number of secondary smelters treating old batteries 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. In this manner such smelters cut their output of antimonial lead, which has a more limited and seasonal market than pig lead.

Secondary lead, recovered by smelters whose product is mainly primary metal, decreased 10,163 tons in 1932. The output of pig lead by secondary smelters increased 9,363 tons, and lead in scrap alloys decreased 34,913 tons.

Secondary zinc.—Secondary zinc recovered as pig metal and in alloys (including brass) dropped 24,300 tons in 1932, largely in redistilled zinc from drosses, which were comparatively scarce due to the decided decrease in galvanizing. The quantity of remelted brass was also much smaller and the recovered zinc content of brass 8,400 tons less in 1932 than in 1931.

The total recovery of secondary zinc (including that in brass) in 1932 equaled 23 percent of the total output of primary slab zinc in the United States (207,148 tons).

Zinc recovered by redistillation decreased from 21,625 tons in 1931 to 14,718 tons in 1932. Of the 1932 total, 6,383 tons were recovered at retort smelters that use mainly ore and concentrates and 8,335 tons (a decrease of 4,548 tons) by redistillation of zinc drosses at five plants that employ large graphite retorts instead of small clay retorts, such as are used by smelters treating zinc concentrates or mixed concentrates and drosses. One smelter using clay retorts treated only dross and residues in 1932, and one smelter equipped with graphite retorts was idle in 1932.

Secondary zinc [1] recovered in the United States, 1931–32, and products made from zinc dross, skimmings, and ashes, in short tons

	1931	1932
Secondary zinc recovered by redistillation	[2] 21,625	14,718
Secondary zinc recovered by sweating, remelting, etc	13,175	5,282
Total zinc recovered unalloyed	34,800	20,000
Zinc recovered in alloys other than brass	7,400	6,300
Zinc recovered in brass (estimated)	30,000	21,600
Zinc dust made from zinc dross	7,478	5,713
Zinc dross used for zinc dust (estimated)	8,700	6,700
Zinc concentrates and ore exported	13	----------
Zinc dross exported	382	178
Lithopone made from zinc skimmings and ashes	73,564	58,225
Secondary zinc content of lithopone	15,111	11,910
Zinc chloride made from zinc skimmings, ashes, etc	28,872	23,193
Zinc content of zinc chloride made from zinc skimmings, etc	6,351	5,104
Zinc content of zinc sulphate made from zinc skimmings, ashes, etc	746	521

[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 quite large.
[2] Includes 312 tons of secondary electrolytic zinc.

The five active zinc smelters using large graphite retorts in 1932 were:

Federated Metals Corporation, Trenton, N.J.
General Smelting Co., Philadelphia, Pa.
Nassau Smelting & Refining Co., Tottenville, N.Y.
Superior Zinc Corporation, Philadelphia, Pa.
Wheeling Steel Corporation, Wheeling, W.Va.

Of the total output of 122,766 tons of lithopone in 1932, 58,225 tons were made from zinc skimmings and ashes.

The quantity of zinc chloride made in 1932 was 23,430 tons (a decrease of 5,745 tons), 23,193 tons containing 5,104 tons of zinc being from zinc residues.

The American Bureau of Metal Statistics estimates that 109,000 short tons of zinc—59,000 tons less than in 1931 and 108,000 tons less than in 1930—were used in 1932 for zincking (galvanizing) sheets, forms, tubes, wire, etc.

Secondary tin.—Secondary tin recovered amounted to 14,750 short tons valued at $6,248,100 in 1932 compared with 19,800 tons valued at $9,428,800 in 1931. The total value assigned is based on the yearly average price (21.18 cents a pound in 1932 and 23.81 cents in 1931) given by the American Metal Market for 99 percent metal, prompt delivery at New York. The total recovered decreased 5,050 tons, mainly in tin in alloys; recovery of tin from scruff and drosses declined from 4,300 to 3,400 tons.

The secondary tin recovered in 1932 was equivalent to nearly 38 percent of the tin imported into the United States as pig metal.

According to the American Iron and Steel Institute the quantity of tin plate and terneplate made in 1932 was 1,032,507 long tons (426,436 tons less than in 1931.) It is estimated that 16,300 long tons of tin were used in these products.

Nearly all detinning in the United States is done by the electrolytic process or by the chlorine process. Many earlier chapters of this series contain data relating to plants and to 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).

Secondary tin recovered in the United States, 1931–32

	1931	1932
Tin recovered as pig tin.....short tons..	5,500	4,650
Tin recovered in alloys and chemical compounds.....do....	14,300	10,100
	19,800	14,750
Clean tin-plate scrap treated at detinning plants.....long tons..	180,659	132,894
Metallic tin recovered at detinning plants.....pounds..	2,206,219	1,406,675
Tin content of tin tetrachloride, tin bichloride, tin crystals, and tin oxide made at detinning plants.....pounds..	4,282,631	3,536,107
Total tin recovered at detinning plants.....do....	6,488,850	4,942,782
Tin tetrachloride, tin bichloride, tin crystals, and tin oxide made at detinning plants pounds..	9,051,189	7,540,318
Average quantity of tin recovered per long ton of clean tin-plate scrap.....do....	35.9	37.2

Tin (metal) and tin concentrates (tin content) imported into the United States, 1931–32, in short tons

	1931	1932
Tin imported as metal.....	73,992	38,998
Tin concentrates (tin content) imported.....	34	19

Tin-plate clippings imported in 1932 totaled 6,094 long tons, 1,219 tons less than in 1931. The average cost of all clean tin-plate clippings delivered at the plants decreased from $6.74 a long ton in 1931 to $5.60 in 1932. These clippings were treated at plants of the Vulcan Detinning Co. at Sewaren, N.J., Neville Island, Pa., and Streator, Ill.; by the Johnson & 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.

The tin reported recovered in alloys and compounds in 1932 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 tetrachloride, and tin oxide.

The total recovery of tin as metal or in compounds from clean tin-plate scrap in 1932 was 2,471 short tons, whereas it is estimated that makers of tin plate and terneplate consumed more than 18,250 short tons of tin.

Apparently no old tin-coated containers were used in 1932 to make window weights. 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 value of primary aluminum produced in the United States dropped from $37,284,000 in 1931 to $20,453,000 in 1932, due to a decline of 41 percent in output.

The recovery of secondary aluminum (including that in alloys) totaled 24,000 tons valued at $10,992,000 compared with 30,300 tons valued at $12,726,000 in 1931. The value in 1932 is computed at 22.9 cents a pound, the average yearly quotation for 98–99 percent ingot aluminum.

Secondary aluminum recovered in the United States, 1931–32, in short tons

	1931	1932
Secondary aluminum recovered unalloyed	15,200	12,200
Aluminum recovered in alloys (mainly no. 12)	15,100	11,800
	30,300	24,000

Primary aluminum produced in the United States and imported and exported, 1931–32, in pounds

	1931	1932
Primary aluminum produced in the United States	177,544,000	104,885,000
Aluminum (crude and semicrude) imported for consumption	14,832,807	8,184,713
Aluminum (crude and semicrude) exported	4,700,878	4,436,690

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 much 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[2] by Anderson is interesting to smelters and users of secondary aluminum.

The market for mixed cast-aluminum alloys was generally weak and the demand spasmodic, although the price for primary aluminum with a greatly reduced output was steady and unchanged from that of 1931.

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.

The production of secondary antimony in the United States, nearly all of which was recovered in alloys, decreased 18.4 percent from 1931 to 1932. The average price for ordinary brands of antimony, as stated by the American Metal Market, was 5.62 cents a pound in 1932 compared with 6.72 cents in 1931. Smelters that ordinarily use primary ores, concentrates, or metals reported 2,495 tons of antimony as contained in 21,024 tons of antimonial lead. The recovery of secondary antimony by secondary smelters decreased 1,386 tons in 1932.

Secondary antimony recovered in and antimony imported into and exported from the United States, 1931–32, in short tons

	1931	1932
Secondary antimony in antimonial lead scrap smelted at regular smelters	1,474	1,410
Secondary antimony recovered at secondary smelters	6,426	5,040
	7,900	6,450
Antimony imported in ore, as metal, or as oxide or salts	10,099	3,742
Foreign antimony exported	697	123

Most of the old batteries are collected by dealers and sold to smelters at a price based on that of pig lead at St. Louis, the antimony content being paid for at the price of lead. In 1932 lead averaged 3 cents a pound, 2.62 cents less than the average for ordinary brands of antimony. The effect of the much smaller number of batteries made in 1932 is shown by the substantial decline (6,357 tons) in imports of antimony, as the decrease in secondary antimony recovered was only about 1,450 tons.

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 rapidly in 1931 and 1932.

The secondary nickel reported as recovered in 1932 came mainly from scrap-nickel anodes, nickel silver, copper-nickel alloys, and

[2] Anderson, R. J., Secondary Aluminum: The Sherwood Press, Inc., Cleveland, Ohio, 1931, 563 pp.

Monel metal. In addition 1,030 tons (142 tons more than in 1931) of nickel and alloys containing nickel were purchased on the east coast and exported to Europe, mostly from the Port of New York. The quantity of nickel produced as a byproduct from the electrolytic refining of copper was 178 tons less in 1932 than in 1931.

Secondary nickel recovered in the United States, 1931–32, in short tons

	1931	1932
Nickel recovered as metal	270	200
Nickel recovered in nonferrous alloys and salts	1,800	1,250
	2,070	1,450

Primary nickel produced in the United States and imported and exported, 1931–32, in short tons

	1931	1932
Nickel produced as a byproduct from the electrolytic refining of copper at domestic refineries	373	195
Nickel imported for consumption in the United States as nickel or in nickel ores and matte, oxide, and alloys	17,784	10,815
Nickel, Monel metal, and other alloys exported	888	1,030

Analyses of various nickel alloys were published in Mineral Resources, 1915.[3] Considerable information as to the uses of nickel, Monel metal, and other nickel alloys is given in Inco, the publication 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 terri-

[3] Hess, F. L., Nickel: Mineral Resources of the United States, 1915, pt. I, pp. 763–765.

tory 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.

(*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 ¼ 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 specification 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 aeroplane 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 1930 report of this series.

IRON ORE, PIG IRON, FERRO-ALLOYS, AND STEEL

By O. E. Kiessling and H. W. Davis

In 1932 the American iron and steel industry experienced one of the most disastrous years in its history, and the production of steel and of pig iron required only 19 and 17 percent, respectively, of the potential productive capacities of steel mills and blast furnaces. The abnormally low rate of operation reflected a small volume of business which was accompanied by declining prices for iron and steel products. Wedged between sharply decreased total returns and the continuation of heavy fixed charges, producers effected drastic economies and rigorously checked controllable expenses. Savings achieved through this procedure, however, softened only in part the full effect of unfavorable market conditions, and at the end of the year the balance sheets of most companies showed large financial losses.

The main reason for depressed activity at iron and steel plants in 1932 can be understood from a brief review of the curtailed demand affecting the larger outlets for the principal iron and steel products. For example, railroad purchases, representing both steel rails and rolling stock, were at the lowest level in the present century. The automobile industry, which had enjoyed a steady growth for almost a decade and a half, produced the smallest number of cars since 1918. The overseas movement of goods was greatly curtailed due to uncertain world economic conditions, and shipping was sharply reduced; most shipyards were inactive, and there was little demand for steel to meet usual naval requirements.

Figure 6 shows trends in production of iron ore, pig iron, and steel in the United States for more than half a century.

The demand for pipe for long-distance transmission of both gas and oil was an important market factor in the 5 years prior to 1932; however, many of these long-distance lines have been completed, and work on lines under construction as well as on those projected was delayed pending improvement in the business situation. Farm-implement manufacturers required less metal as the reduced income of the farmer was directly reflected in his inability to purchase new farm machinery. The demand for steel forms and beams for buildings declined as the total volume of construction decreased. The sharp drop in the construction of large apartments and office buildings, the principal users of building steel, was particularly acute. Thus, all of the large users of iron and steel greatly reduced their purchases as part of the process of meeting their own severe business problems; in the same manner less iron and steel were required for most minor uses. This situation brought about an exceedingly weak market—a condition accentuated by stocks in the hands of consumers that had to be reduced before even small purchase commitments could be made.

In addition to low demand and production, generally lower prices prevailed than in 1931. The price of tin plate was dropped to $4.25 a base box in November, a reduction of 50 cents per box or $10 a ton; rails were quoted at $40 a ton in the last quarter of 1932, a reduction of $3. Although quotations on bars, plates, and shapes were advanced $2 a ton during the second quarter of 1932 the average quotation for the entire year was less than in 1931.

The prices for pig iron, ferromanganese, iron and steel scrap, and fluorspar reflected the downward trend in steel quotations. Compared with 1931 the average price of pig iron declined $1.21 per gross ton (from $16.01); ferromanganese dropped $9.80 a ton (from $81.67); heavy melting steel scrap at Pittsburgh, $1.86 a ton (from $11.28)s and fluorspar, $1.81 a ton (from $12.64). Spiegeleisen was an exception, and showed a small increase in price. General price decline; also were recorded for raw materials used in blast-furnace burdens.

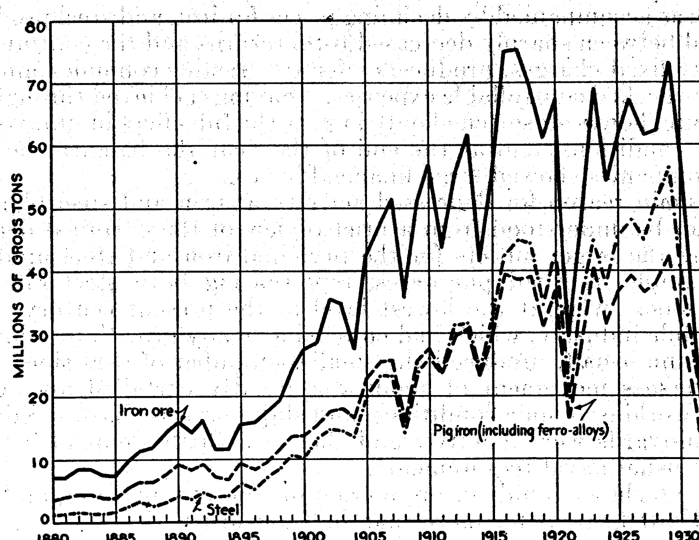

FIGURE 6.—Trends in production of iron ore, pig iron, and steel in the United States, 1880–1932.

Figure 7 shows trends in prices of iron ore, pig iron, finished steel, and steel scrap.

While exports of iron and steel products slumped sharply in 1932 imports compared more favorably with 1931 although substantially smaller in volume than in other recent years. Sheets, tin and terne plate, wire rods, and rails were imported in larger quantities than in 1931. Imports of pig iron increased 55 percent to 130,630 tons in 1932, this material coming chiefly from Netherlands, India, and the United Kingdom.

The pronounced curtailment in pig iron and steel outputs reacted to the detriment of several branches of the mining industry that depend upon the iron and steel furnaces as their principal market. Thus, in response to reduced demand, the shipments of iron ore, manganese ore, and fluorspar were the smallest since 1880, 1922, and 1901, respectively. The output of other materials, such as fluxing stone and coke, was similarly affected.

With iron mines and furnaces and steel plants utilizing less than one fifth of their potential capacity in 1932 the efforts of operators to ameliorate the effect of the business depression on labor are of interest. Many companies made a definite endeavor to distribute available work among as large a number of employees as practical, even though such a program resulted in some inefficiency, and production schedules were kept at levels somewhat above what was warranted by current market trends. Activity at Lake Superior iron-ore mines, for example, resulted in the production of 4,562,000 tons of ore in excess of shipments at a time when stocks at lower lake ports and furnaces were adequate to supply blast furnaces for about 7 months, even

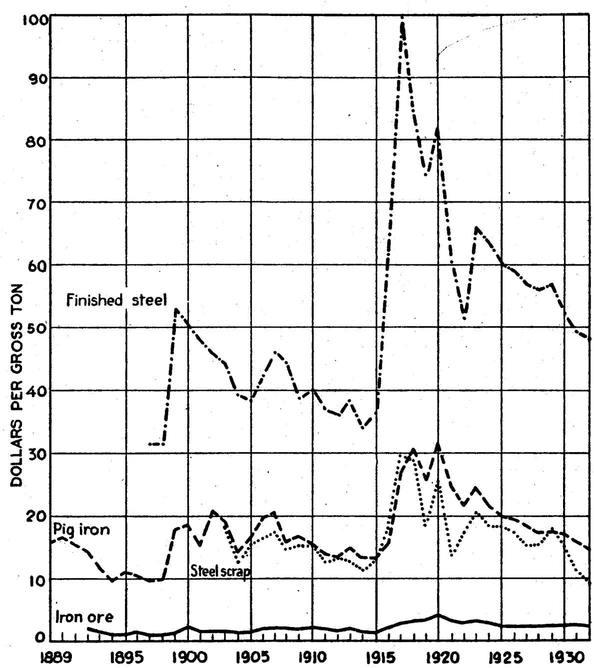

FIGURE 7.—Trends in prices of iron ore, pig iron, finished steel, and steel scrap. The prices of iron ore and pig iron are the averages f.o.b. mines and furnaces, respectively, as reported to the U.S. Bureau of Mines; the price of finished steel is an average composite computed by American Metal Market; that of steel scrap is an average at Pittsburgh of no. 1 heavy melting computed by Iron Age.

though the latter operated at 75 percent of capacity. Work at certain ore mines, blast furnaces, and steel plants was distributed by alternating employees. While the earnings per worker necessarily dropped sharply, according to Charles M. Schwab,[1] approximately 200,000 more men were at work in the iron and steel industry than would have been required under a policy of discharging all excess personnel and retaining only full-time employees. While the staggering of available work seems to have been at best a temporary expedient and its full economic effects are uncertain, the response of the iron and steel industry to requests for participation in the "share the work" movement is noteworthy.

[1] Iron Age, vol. 131, June 1, 1933, p. 852.

Salient statistics of iron ore, pig iron, ferro-alloys, and steel in the United States, 1931–32

	1931		1932	
	Gross tons	Value	Gross tons	Value
Iron ore:				
Production:				
Hematite	[1] 29,665,475		[1] 9,621,808	
Brown ore	359,960		61,739	
Magnetite	[1] 1,105,249		[1] 162,892	
Carbonate	818		477	
	31,131,502		9,846,916	
Open pit	[2] 13,830,165		3,413,486	
Underground	[2] 17,279,424		6,432,673	
Undistributed	21,913		757	
	31,131,502		9,846,916	
Shipments (exclusive of ore for paint)	28,516,032	$74,123,910	5,331,201	$12,898,011
Average value per ton at mines		2.60		2.42
Stocks at mines	13,063,708		17,603,873	
Imported	1,465,613	3,901,775	582,498	1,539,374
Exported	435,665	1,657,832	83,449	219,852
Pig iron:				
Production	17,952,613		8,549,649	
Shipments	17,812,579	285,147,156	8,518,400	126,032,714
Average value per ton at furnaces		16.01		14.80
Imported	84,411	978,683	130,630	1,301,625
Exported	6,719	150,658	2,324	53,966
Ferro-alloys:				
Production	466,969		230,311	
Shipments:				
Ferromanganese	159,168	12,999,329	70,417	5,061,029
Spiegeleisen	55,327	1,313,068	31,071	745,966
Ferrosilicon	153,063	7,213,265	97,224	3,517,268
Other varieties	30,737	9,238,887	19,934	4,679,409
	398,295	30,764,549	218,646	14,003,672
Imported for consumption:				
Ferromanganese	24,664	1,751,646	18,470	1,091,026
Spiegeleisen	9,482	247,788	8,364	192,037
Ferrosilicon	3,783	128,397	864	38,200
Steel production:				
Open hearth:				
Basic	22,130,398		11,742,682	
Acid	379,168		164,648	
Bessemer	3,023,446		1,532,076	
Crucible	1,547		645	
Electric	410,942		241,111	
	25,945,501		13,681,162	

[1] Some hematite included with magnetite.
[2] Some open pit included with underground.

IRON ORE

Production and shipments.—Iron-ore mining was again drastically curtailed in all producing States, only 129 mines in 10 States being worked in 1932 compared with 186 mines in 15 States in 1931. No iron-ore mine produced a million tons in 1932, and only 27 yielded 100,000 tons or more, whereas 4 mines produced a million tons or more in 1931, and 79 had an output of 100,000 tons or more. The production of iron ore in 1932 was 9,846,916 gross tons, a decrease of 68 percent from 1931 and 17 percent of the average for the 5-year period 1927–31. Shipments, however, were about 4,516,000 tons less than production, indicating the extent the mines were worked to provide employment for some of the many thousand men usually employed. The greater part of the iron ore mined in the United States is sold for use in the manufacture of iron and steel; but some ore produced in 1932 in New York, Pennsylvania, and Utah was sold for use in making paint and some from Pennsylvania was also sold for use in purifying gas.

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 not requiring treatment. Although included in the figures on production the iron ore sold for the manufacture of paint (1,567 gross tons in 1932 valued at $10,770—$6.87 a ton—compared with 5,514 tons in 1931 valued at $29,759—$5.40 a ton) is not included in the figures on shipments from mines. The output of manganiferous ore that contained 5 percent or more manganese is also not included; 25,434 gross tons valued at $92,135 were shipped in 1932 compared with 281,414 tons valued at $976,549 in 1931. In Arkansas one producer shipped 2 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 1932, 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	8	1,332,975	41,559			1,374,534
Georgia	1		925			925
Michigan	44	2,554,996				2,554,996
Minnesota	42	5,154,291				5,154,291
Missouri	[1] 24	12,532	17,265			29,797
New Jersey	1			30,844		30,844
New York	2	(2)		[2] 31,327		31,327
Pennsylvania	3		1,640	100,721	477	102,838
Utah	2	136,874	350			137,224
Wisconsin	2	430,140				430,140
Total, 1932	[1] 129	[2] 9,621,808	61,739	[2] 162,892	477	9,846,916
Total, 1931	[1] 186	[2] 29,665,475	359,960	[2] 1,105,249	818	31,131,502

[1] In addition, an undetermined number of small pits was worked in Missouri. The output from these pits is included in the figures given.
[2] Some hematite included with magnetite.

Iron ore mined in the United States in 1932, by States and mining methods, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	Open pit	Underground	Undistributed	Total
Alabama	41,559	1,332,975		1,374,534
Georgia	925			925
Michigan	215,291	2,339,705		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
Total, 1932	3,413,486	6,432,673	757	9,846,916
Total, 1931	[1] 13,830,165	[1] 17,279,424	21,913	31,131,502

[1] Some open pit included with underground.

Iron ore mined in the United States, 1931–32, by States and counties

[Exclusive of ore containing 5 percent or more manganese]

State and county	1931 Active mines	1931 Gross tons	1932 Active mines	1932 Gross tons
Alabama:				
Blount	2	54,692		
Cherokee	1	35,993	1	6,977
Franklin	1	83,837	1	31,218
Jefferson	5	3,369,481	4	1,332,975
Shelby	1	24,197		
Talladega	1	391	1	34
Tuscaloosa	3	46,553	1	3,330
	14	3,615,144	8	1,374,534
Colorado: Saguache	1	26,202		
Georgia:				
Floyd	1	6,874	1	925
Polk	2	13,871		
	3	20,745	1	925
Michigan:				
Baraga	1	88,967	1	28,326
Dickinson	5	676,624	3	187,002
Gogebic	15	2,818,428	12	994,903
Iron	20	1,406,533	16	622,399
Marquette	14	2,562,029	12	722,366
	55	7,552,581	44	2,554,996
Minnesota:				
Crow Wing	8	665,012	6	536,659
Itasca	22	4,156,637	11	1,890,681
St. Louis	37	12,623,354	25	2,726,951
	67	17,445,003	42	5,154,291
Missouri:				
Bollinger	(1)	244	(1)	43
Butler	[2] 1	7,778	(1)	1,394
Carter	(1)	3,562	(1)	1,067
Crawford	3	15,994	2	2,311
Dent	[2] 1	3,399	1	740
Franklin	[2] 2	23,667	3	2,219
Gasconade	(1)	30		
Greene			(1)	80
Howell	(1)	2,480	(1)	221
Iron	(1)	352	[2] 3	371
Madison	[2] 1	6,939	[2] 1	1,163
Oregon	(1)	195		
Osage	(1)	1,513		
Phelps	2	4,997	2	773
Pulaski	1	2,740		
Reynolds	(1)	330	[2] 8	4,352
Ripley	(1)	1,058	(1)	248
St. Francois	[2] 2	2,758	[2] 1	6,118
Shannon	[2] 2	2,738	[2] 1	2,516
Texas	1	266		
Washington	(1)	70		
Wayne	(1)	31,262	[2] 2	6,181
	[2] 16	112,372	[2] 24	29,797
New Jersey:				
Morris	3	232,071	1	30,844
Passaic	1			
Warren	1	61,697		
	5	293,768	1	30,844
New Mexico: Grant	10	168,075		

[1] An undetermined number of small pits.
[2] In addition, an undetermined number of small pits was worked. The output from these pits is included in the figures given.

Iron ore mined in the United States, 1931–32, by States and counties—Continued

[Exclusive of ore containing 5 percent or more manganese]

State and county	1931		1932	
	Active mines	Gross tons	Active mines	Gross tons
New York:				
Essex	1	205,376		
Clinton	1	44,904	1	31,327
Oneida	1	24,795	1	
Orange	1			
Wayne	1			
	5	275,075	2	31,327
Pennsylvania:				
Carbon	1	818	1	477
Lebanon	1	367,299	1	100,721
Venango			1	1,640
	2	368,117	3	102,838
Tennessee: Lawrence	1	8,717		
Utah:				
Box Elder	1	400	1	350
Iron	1	183,668	1	136,874
	2	184,068	2	137,224
Washington: Stevens	1	1,032		
Wisconsin:				
Dodge	1	31		
Iron	2	879,801	2	430,140
	3	879,832	2	430,140
Wyoming: Platte	1	180,771		
Total for United States	[3] 186	31,131,502	[3] 129	9,846,916

[3] In addition, an undetermined number of small pits was worked in Missouri. The output from these pits is included in the figures given.

Iron ore mined in the United States, by mining districts and varieties, in 1932, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

District	Hematite	Brown ore	Magnetite	Carbonate	Total
Lake Superior [1]	8,139,427				8,139,427
Birmingham	1,332,975	3,330			1,336,305
Chattanooga		7,936			7,936
Adirondack			[2] 31,327		[2] 31,327
Northern New Jersey and southeastern New York			30,844		30,844
Other districts	[2] 149,406	50,473	100,721	477	[2] 301,077
Total, 1932	[2] 9,621,808	61,739	[2] 162,892	477	9,846,916
Total, 1931	[3] 29,665,475	359,960	[3] 1,105,249	818	31,131,502

[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.
[3] Some hematite included with magnetite.

Iron ore shipped from mines in the United States, 1931–32, by States

[Exclusive of ore containing 5 percent or more manganese and ore sold for paint]

State	1931		1932	
	Gross tons	Value	Gross tons	Value
Alabama	3,629,997	$6,155,995	1,470,445	$2,428,227
Colorado	26,202	(1)		
Georgia	20,745	51,513	925	(1)
Michigan	5,555,376	15,986,273	968,789	2,703,900
Minnesota	17,063,591	46,020,269	2,248,727	6,263,181
Missouri	112,055	337,144	25,418	72,144
New Jersey	239,722	984,021	14,966	(1)
New Mexico	168,075	(1)		
New York	259,184	1,067,489	30,600	(1)
Pennsylvania	436,920	913,163	74,420	157,400
Tennessee	8,717	36,156		
Utah	183,668	(1)	136,874	(1)
Washington	1,032	(1)		
Wisconsin	629,977	1,658,670	360,037	905,601
Wyoming	180,771	(1)		
Undistributed		2 913,217		2 367,558
	28,516,032	74,123,910	5,331,201	12,898,011

1 Included under "Undistributed."
2 This figure includes value for States entered as "(1)" above.

Beneficiated iron ore.—Beneficiation of iron ore was reported at 17 mines in 5 States in 1932 and at 48 mines in 9 States in 1931. 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 1932 amounted to 407,486 gross tons valued at $1,119,804, a decrease of 91 percent in both quantity and value compared with 1931.

The quantity of crude ore beneficiated in the Lake Superior district in 1932 amounted to 2,477,163 gross tons and the beneficiated ore recovered to 1,455,848—a ratio of 1.702:1. In 1931 the crude lake ore treated amounted to 5,923,349 tons and the beneficiated ore recovered therefrom to 3,612,244 tons—a ratio of 1.64:1.

Beneficiated iron ore shipped from mines in the United States, 1931–32

[Exclusive of ore containing 5 percent or more manganese and of ore sold for paint]

State	Variety	1931		1932	
		Gross tons	Value	Gross tons	Value
Alabama	Brown ore	209,279	$523,515	31,218	$70,241
Georgia	do	13,871	40,023		
Minnesota	Hematite	3,574,309	9,187,883	292,458	782,323
Missouri	Brown ore	4,914	(1)		
New Jersey	Magnetite	239,722	984,021	14,966	(1)
New Mexico	do	91,073	(1)		
New York	do	259,184	1,067,489	30,600	(1)
Pennsylvania	do	275,295	964,000	38,244	72,663
Tennessee	Brown ore	8,717	36,156		
Undistributed			239,522		194,577
		4,676,364	13,042,609	407,486	1,119,804

1 Included under "Undistributed."

The accompanying table gives the shipments of beneficiated iron ore and the percentage of beneficiated ore to the total ore shipped from 1928–32. Corresponding figures for 1914 (the first year for which statistics were gathered) to 1927 are given in Mineral Resources for 1930.

Iron ore shipped from mines in the United States, 1928–32, in gross tons, and percentage of beneficiated ore 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
1928	8,621,331	63,432,826	13.6	1931	4,676,364	28,516,032	16.4
1929	9,424,445	75,602,734	12.5	1932	407,486	5,331,201	7.6
1930	8,973,888	55,201,221	16.3				

Average value of ore.—The average value per ton of iron ore at the mines in 1932 was $2.42 compared with $2.60 in 1931.

The table that follows gives the average value at the mines of the different classes of iron ore in 1931–32 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 of 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, 1931–32

[Exclusive of ore containing 5 percent or more manganese and of ore sold for paint]

State	Hematite		Brown ore		Magnetite	
	1931	1932	1931	1932	1931	1932
Alabama	$1.65	$1.64	$2.38	$2.10		
Georgia			2.48	(1)		
Michigan	2.88	2.79				
Minnesota	2.70	2.79				
Missouri	2.92	3.21	3.09	2.65		
New Jersey					$4.10	(1)
New York					4.12	(1)
Pennsylvania				(1)	2.09	$1.99
Tennessee			4.15			
Wisconsin	2.63	2.52				
Other States [2]	1.22	(1)	1.35		2.55	
	2.58	2.41	2.47	2.39	3.07	2.87

[1] Less than 3 producers; permission to publish not given, therefore value may not be shown.
[2] 1931: Colorado, New Mexico, Utah, Washington, and Wyoming; 1932: Utah.

Iron ore consumed.—The production of 8,549,649 gross tons of pig iron in 1932 required 13,181,238 gross tons of iron ore and 1,954,710 tons of cinder, scale, and scrap, an average of 1.77 tons of metalliferous materials per ton of iron made. The average consumption of ore per ton of pig iron made declined from 1.70 in 1931 to 1.54 in 1932. The much lower consumption of ore in 1932 was due chiefly to the use of relatively larger quantities of flue dust in a year of exceedingly subnormal operations.

The greater part of the iron ore used in Alabama furnaces in 1932 was hematite from mines in Jefferson County, Ala.; small quantities of imported ore and of iron sinter from Tennessee were also used. The brown ore used was chiefly from mines in the Birmingham and Russellville districts, Alabama; the manganiferous iron ore was chiefly from mines in Alabama, Arkansas, and Georgia. The furnaces in Alabama in making 1 ton of pig iron consumed in 1932 an average of 2.538 tons of ore, the highest average for any State.

In 1932 the furnaces in Maryland used foreign ores obtained from Australia, Chile, Cuba, Russia, and Sweden. The Maryland furnaces consumed an average of only 1.168 tons of ore in making 1 ton of pig iron in 1932; however, they used proportionately more cinder, scale, and scrap than the furnaces in any other State.

The blast furnaces in Indiana, Kentucky, Michigan, Ohio, and West Virginia used Lake Superior iron ore and manganiferous iron ore exclusively in 1932. The consumption of ores per ton of iron made in this group of States ranged from 1.238 tons in Kentucky to 1.598 tons in Michigan.

The furnaces in the Chicago district, including Joliet, Ill., used iron ore and manganiferous iron ore from mines in the Lake Superior district; those at Granite City, Ill., used ore chiefly from mines in the Lake Superior district but also ore from various properties in Missouri. An average of 1.412 tons of ore was used to make 1 ton of pig iron in Illinois in 1932.

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., and a small quantity of manganese cinder from Canada; and the furnace at Standish used magnetite from the Chateaugay mine at Lyon Mountain, N.Y., and a small quantity of ferruginous manganese ore from Canada. In making 1 ton of pig iron the furnaces in New York used an average of 1.583 tons of ore in 1932.

The furnaces in western Pennsylvania used ore from the Lake Superior district. Those in the eastern part of the State used, in addition to some Lake ores, magnetite from the Cornwall mine in Pennsylvania, magnetites from mines in New Jersey and New York, and considerable quantities of ores from Africa, Australia, Chile, and Cuba. An average of 1.37 tons of ore was used to make 1 ton of pig iron in Pennsylvania in 1932.

The blast furnaces at Pueblo, Colo., used chiefly hematite from the Sunrise mine in Wyoming, brown ore from the Orient mine in Colorado, 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 and Utah.

Iron ore and other metallic materials consumed and pig iron produced in 1932, by States, in gross tons

State	Metalliferous materials consumed				Pig iron produced, exclusive of ferro-alloys	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	1,648,938	8,205	44,817	1,701,960	652,898	2.538	0.069	2.607
Illinois	1,297,571		128,737	1,426,308	919,247	1.412	.140	1.552
Indiana	1,162,145		203,207	1,365,352	852,276	1.364	.238	1.602
Kentucky	90,211		37,968	128,179	72,855	1.238	.521	1.759
Maryland		442,115	209,192	651,307	378,739	1.168	.552	1.720
Michigan	291,610		49,731	341,341	182,525	1.598	.272	1.870
New York	987,743	143	140,259	1,128,145	624,169	1.583	.224	1.807
Ohio	3,737,513		505,620	4,243,133	2,387,028	1.566	.212	1.778
Pennsylvania	2,679,286	201,889	608,180	3,489,355	2,103,170	1.370	.289	1.659
West Virginia	357,487		21,780	379,267	224,032	1.596	.097	1.693
Undistributed [1]	276,382		5,219	281,601	152,710	1.810	.034	1.844
	12,528,886	652,352	1,954,710	15,135,948	8,549,649	1.542	.228	1.770

[1] Includes Colorado, Iowa, Tennessee, and Utah.

Foreign iron and manganiferous iron ore consumed in the manufacture of pig iron in the United States, 1931–32, by sources of ore, in gross tons

Source of ore	1931	1932	Source of ore	1931	1932
Africa	89,496	13,898	Russia	216,825	71,426
Asia	276		Spain	13,044	
Australia	66,718	39,423	Sweden		31,157
Canada	4,473	143	Undistributed	17,977	8,066
Chile	680,042	395,732			
Cuba	105,699	92,507		1,231,587	652,352
Newfoundland	37,037				

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 1932 amounted to 17,603,873 gross tons, an increase of 35 percent over 1931. These stocks (the largest ever accumulated) were about 7,642,000 tons above the average for the 5-year period 1927–31.

Stocks of iron ore at mines, December 31, 1931–32, by States, in gross tons

State	1931	1932	State	1931	1932
Alabama	894,645	798,734	New York	178,899	180,790
Iowa	12,165	12,165	North Carolina	200	200
Michigan	8,669,145	10,260,532	Pennsylvania	33,254	60,635
Minnesota	2,600,852	5,516,724	Virginia	3,473	3,473
Missouri	317	4,702	Wisconsin	551,649	630,930
New Jersey	119,109	134,988			
				13,063,708	17,603,873

Foreign trade in iron ore.—The iron ore imported into the United States amounted to 582,498 gross tons valued at $1,539,374 in 1932, a decrease of 60 percent in quantity and 61 percent in total value from 1931. Chile continued to be the chief source of imports, furnishing 38 percent of the total, while Cuba supplied 13 percent, Norway 17 percent, and Russia 28 percent.

Iron ore imported into the United States, 1930–32, by countries

Country	1930		1931		1932	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Africa:						
Algeria and Tunisia	232,265	$836,333	70,471	$276,752	10,000	$25,632
Morocco	5,170	15,054	15,509	53,643		
Mozambique	1	15				
Australia	219,926	659,236	39,979	147,584		
Belgium			115	781	5,012	12,605
Brazil	24,507	93,768	25	416		
Canada	395	2,767	1,490	4,913	807	2,584
Chile	1,689,071	4,051,301	750,702	1,819,355	218,492	517,725
Cuba	190,654	781,301	89,000	212,386	77,000	184,143
Egypt	6,925	44,885				
Germany	295	5,748	25	730	150	2,111
India, British	7,170	24,425				
Kwantung			8	41		
Mexico	157	286	1,456	3,150	281	622
Netherlands			1	19		
Newfoundland and Labrador	48,771	202,006	22,920	77,939		
Norway			73,082	262,527	99,911	399,943
Persia	2,500	48,665				
Philippine Islands			3	20		
Soviet Russia in Europe	63,412	136,228	278,612	571,290	162,740	356,775
Spain	81,012	255,041	38,191	121,179	245	1,952
Sweden	202,748	952,925	83,554	341,404	7,037	27,938
United Kingdom	145	3,055	470	7,646	822	7,324
Venezuela					1	20
	2,775,124	8,113,039	1,465,613	3,901,775	582,498	1,539,374

Exports of iron ore from the United States amounted to 83,449 gross tons valued at $219,852 ($2.63 a ton) in 1932 compared with 435,665 tons valued at $1,657,832 ($3.81 a ton) in 1931. Except for 30 tons shipped to Japan, all the iron ore exported in 1932 went to Canada.

Iron-ore mining in Cuba.—Shipments of iron ore from Cuba to the United States amounted to 81,305 gross tons in 1932, a decrease of 11 percent from 1931, and were the smallest since 1885. They consisted of 20,893 tons of hematite carrying 56.07 percent iron (dried) and 48,977 tons of siliceous ore carrying 29.23 percent iron from the Daiquiri and Juragua mines on the southern coast, and 11,435 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 684,933 gross tons at the end of 1932 compared with 577,899 tons at the end of 1931.

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, 1884–1932, 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
1884–1930	[1] 20,289,454		20,438	3,662,466	41,241	903,103	24,916,702
1931	82,899			8,048			90,947
1932	69,870			11,435			81,305
	20,442,223		20,438	3,681,949	41,241	903,103	25,088,954

[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 amounted to 8,139,427 gross tons in 1932, a decrease of 69 percent compared with 1931. 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 of manganese. The Mesabi Range produced 52 percent of the iron-ore output of the Lake Superior district (60 percent in 1931) and 43 percent of the total output of the United States (50 percent in 1931). The proportion contributed by this range has been 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.

Iron ore mined in the Lake Superior district, 1854–1932, in gross tons

[Exclusive after 1905 of ore containing 5 percent or more manganese]

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854–1930	175, 296, 700	172, 587, 132	186, 110, 713	58, 764, 191	890, 027, 602	22, 281, 958	1, 505, 068, 296
1931	2, 650, 996	2, 083, 157	3, 698, 229	1, 181, 224	15, 598, 767	665, 012	25, 877, 385
1932	750, 692	809, 401	1, 425, 043	362, 137	4, 255, 495	536, 659	8, 139, 427
	178, 698, 388	175, 479, 690	191, 233, 985	60, 307, 552	909, 881, 864	23, 483, 629	1, 539, 085, 108

The average number of men employed in iron-ore mines in the Lake Superior district declined from about 15,200 in 1931 to about 8,000 in 1932.

The average daily wage in Michigan declined from $4.96 in 1931 to $4.29 in 1932, and in St. Louis and Itasca Counties, Minn., it declined from about $5.29 in 1931 to about $4.55 in 1932.

The operators' gross loss at underground mines in Michigan, acaccording to the State mine appraiser, was $1.89 a ton in 1932 (6 cents gross profit in 1931). According to the Minnesota Tax Commission, the average cost per ton of developing and mining iron ore at open-pit operations in Minnesota in 1931 was $1.135 and at underground or mixed operations $1.971.

Shipments.—The shipments of ore from the Lake Superior district amounted to 3,588,534 gross tons (3,577,553 tons of iron ore and 10,981 tons of manganiferous iron ore containing 5 percent or more manganese) in 1932, compared with 23,495,348 tons (23,249,212 tons of iron ore and 246,136 tons of manganiferous iron ore) in 1931.

Iron-ore analyses.—The iron content of the ore shipped from the Lake Superior district in 1932 averaged 52.16 percent (natural) compared with 51.53 percent in 1931 and 51.33 percent in 1930, 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 iron 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, 1928–32

Year	Gross tons	Iron (natural)	Phosphorus	Silica	Manganese	Moisture
		Percent	*Percent*	*Percent*	*Percent*	*Percent*
1928	54,045,941	51.15	0.099	8.43	0.85	11.37
1929	65,443,546	51.18	.100	8.48	.80	11.24
1930	46,698,554	51.33	.095	8.70	.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

Stocks of ore at Lake Erie ports.—According to the Lake Superior Iron Ore Association, at the close of navigation in 1932, 5,191,114 gross tons of iron ore were in stock at Lake Erie ports compared with 6,048,327 tons on the corresponding date in 1931. At the opening of navigation in May 1933, 4,969,363 tons were in stock at these ports, indicating a withdrawal of only 221,751 tons during the winter of 1932–33. The average quantity withdrawn each winter during the preceding 5 years was about 1,658,000 tons.

Prices of Lake Superior ore.—The unit prices established June 3, 1932 for the four standard grades of Lake Superior ore are the same as those for 1929–31, 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 1925–32 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 51.5 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 an increase from the previous year of 29,910,000 in Minnesota but a decrease of 2,437,000 tons in Michigan.

Iron-ore reserves in Minnesota May 1, 1928–32, in gross tons

Range	1928	1929	1930	1931	1932
Mesabi	1,190,480,901	1,178,855,601	1,154,434,031	1,162,776,979	1,190,295,183
Vermilion	14,483,285	14,939,704	14,250,540	14,789,137	14,237,637
Cuyuna	53,268,438	48,264,579	66,542,939	66,756,610	69,699,960
	1,258,232,624	1,242,059,884	1,235,227,510	1,244,322,726	1,274,232,780

Iron-ore reserves in Michigan Jan. 1, 1929–33, in gross tons

Range	1929	1930	1931	1932	1933
Gogebic	48,587,126	51,347,176	51,143,511	50,793,057	50,473,546
Marquette	57,920,862	55,655,383	57,665,510	56,335,788	55,894,039
Menominee (including Iron River and Crystal Falls districts)	62,922,419	61,347,264	62,178,324	59,940,058	58,264,532
	169,430,407	168,349,823	170,987,345	167,068,903	164,632,117

IRON-ORE MINING, BY STATES

Alabama.—The production of iron ore in Alabama in 1932 was 1,374,534 gross tons (1,332,975 tons of hematite and 41,559 tons of brown ore), a decrease of 62 percent from 1931. The hematite, much of which contains enough lime to make it self-fluxing or nearly so, was produced at the Sloss nos. 1 & 2, Raimund nos. 1 & 2, Red Mountain group, and Woodward nos. 1 & 3 mines, all in Jefferson County. The iron content of that shipped in 1932 ranged from 33.1 to 40.31 percent (natural) and averaged 37.19 percent; the manganese content averaged 0.14 percent and the phosphorus content 0.31 percent. As in 1931, the Red Mountain group (819,299 tons) was the largest producing mine in the United States. The brown ore was obtained chiefly from the Russellville mine in Franklin County, the Tecumseh mine in Cherokee County, and the Docray mine in Tuscaloosa County. The content (dried) averaged 50.7 percent iron, 0.75 percent manganese, and 0.62 percent phosphorus.

Georgia.—Brown ore amounting to 925 gross tons was produced in Georgia from the Tecumseh mine in Floyd County, Ga., and Cherokee County, Ala. The ore averaged 50.5 percent iron (dried), 1.5 percent manganese, and 0.61 percent phosphorus.

Michigan.—Mining activity on the Michigan ranges in 1932 was again sharply curtailed, as is shown by a production of 2,554,996 gross tons compared with 7,552,581 tons in 1931. Of the 44 active mines in Michigan in 1932 (55 in 1931), only 6 (27 in 1931) yielded more than 100,000 tons each. The Norrie-Aurora mine in Gogebic County again had the largest output of any mine in Michigan in 1932—177,869 tons. The average production per mine in Michigan was 58,068 tons in 1932 compared with 137,320 tons in 1931.

The ore reserves in Michigan on January 1, 1933, amounted to 164,632,117 gross tons, a decrease of 2,436,786 tons from the previous year.

A report on the iron-ore mines of Michigan for 1932, published by the geological survey division of the Michigan Department of Conservation,[2] shows that the average number of men employed per day was 3,529 (6,112 in 1931), the average number of days worked 88 (170 in 1931), the average daily wage \$4.294 (\$4.963 in 1931), the average yearly earning \$377.89 (\$843.71 in 1931), and the average tons of ore mined per man per day 4.06 (5.3 in 1931).

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: Geol. Survey Div., Michigan Dept. of Conservation (Lansing), 1933.

Average per-ton costs of mining iron ore at underground mines in Michigan in 1932, by counties

Item	Gogebic	Marquette	Dickinson and Iron	Total
Cost of mining	$2.1316	$2.2490	$1.9760	$2.1107
Deferred mining cost	.1607	.1128	.0564	.1111
Taxes	1.5945	1.0631	.8125	1.1743
General overhead	.4040	.6111	.4755	.4869
Transportation	1.7193	1.4474	1.5565	1.6044
Marketing	.0191	.0703	.0715	.0513
Idle mine cost (excluding royalty)	.4206	.1943	.5329	.3959
Royalty	.3340	.5438	.3277	.3955
Interest on borrowed money	.3992	.0523	.1287	.2080
Total ore cost	7.1830	6.3441	5.9377	6.5381
Lake Erie value per ton	4.7960	4.7022	4.4337	4.6487
Gross ore loss [1]	2.3870	1.6419	1.5040	1.8894

[1] This figure does not represent true loss, as much ore is sold below the Lake Erie price.

Minnesota.—Mining in Minnesota was more sharply curtailed than in Michigan in 1932. The production of 5,154,291 represented a decrease of 70 percent from 1931. Of the 42 active mines in Minnesota in 1932 (67 in 1931), only 15 (41 in 1931) yielded more than 100,000 tons each. The Orwell mine, an open-pit operation in St. Louis County, which yielded 798,787 tons, was the largest producing mine in Minnesota; it was the only mine in the Lake Superior district that yielded over half a million tons in 1932. The average production per mine in Minnesota was 122,721 tons in 1932 compared with 260,373 tons in 1931.

The reserves of ore in Minnesota on May 1, 1932 amounted to 1,274,232,780 gross tons, an increase of 29,910,054 tons over the previous year.

According to the annual report of the mine inspector of St. Louis County an average of 2,243 men was employed in iron-ore mines in 1932 (4,824 in 1931), and the average daily wage was $4.53 ($5.31 in 1931).

According to the annual report of the mine inspector of Itasca County an average of 1,201 men was employed in iron-ore mines in 1932 (2,940 in 1931), and the average daily wage was $4.59 ($5.26 in 1931).

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, 1927–31

Year	Developing	Mining			Royalty	Total
		Labor	Supplies	Other items		
Open-pit operations:						
1927	$0.305	$0.146	$0.148	$0.165	$0.438	$1.202
1928	.276	.121	.126	.135	.456	1.114
1929	.260	.112	.124	.113	.456	1.065
1930	.270	.113	.122	.154	.459	1.118
1931	.254	.111	.121	.221	.428	1.135
Underground operations (including two milling operations):						
1927	.089	.947	.428	.220	.466	2.150
1928	.068	.896	.424	.190	.447	2.025
1929	.055	.862	.416	.189	.447	1.969
1930	.056	.852	.429	.201	.452	1.990
1931	.051	.747	.410	.303	.460	1.971

Missouri.—The production of iron ore in Missouri dropped to 29,797 gross tons in 1932 from 112,372 tons in 1931. The output in 1932 consisted of 12,532 tons of hematite chiefly from the Iron Mountain, Rueppele, Christy, Wiggins, Hinch, St. James, Silver Hollow, and Crisp mines, and 17,265 tons of brown ore chiefly from properties in Butler, Carter, Madison, Reynolds, Shannon, and Wayne Counties. The iron content (natural) of the ore shipped in 1932 averaged 53.44 percent.

New Jersey.—The only active mine in New Jersey in 1932 was the Mt. Hope mine in Morris County, which yielded 30,844 gross tons of magnetite concentrates averaging about 62 percent iron. The production in New Jersey in 1931 was 293,768 tons.

New York.—The production of iron ore in New York declined to 31,327 tons gross in 1932 from 275,075 tons in 1931. The output in 1932 was chiefly from the Chateaugay mine in Clinton County. Shipments from stock were made from the Old Bed, Harmony, and New Bed mines in Essex County in 1932. Shipments from New York in 1932 consisted of 17,950 tons of sinter and concentrates averaging 67.88 percent iron, 0.074 percent manganese, and 0.048 percent phosphorus; and 12,650 tons of lump ore averaging 62.25 percent iron, 0.1 percent manganese, and 0.85 percent phosphorus.

Pennsylvania.—Pennsylvania, the most important source of magnetite in the United States, produced 102,838 gross tons of ore in 1932 compared with 368,117 tons in 1931. The production consisted chiefly of 100,721 tons of magnetite from the Cornwall mines in Lebanon County; it averaged 37.83 percent iron (natural). Some hydrated iron ore for use in gas purification was mined in Venango County, and some carbonate ore for use in paint was mined in Carbon County in 1932.

Utah.—The production of iron ore in Utah in 1932 was 137,224 tons compared with 184,068 tons in 1931. It was chiefly hematite, averaging 52.6 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.

Wisconsin.—The production of iron ore in Wisconsin declined to 430,140 gross tons in 1932 from 879,832 tons in 1931. The Montreal mine (402,732 tons) and Cary mine (27,408 tons), both in Iron County, were the only productive operations. The stock pile of ore at the Plumer mine, also in Iron County, was shipped during 1932.

WORLD PRODUCTION

The following table shows the production of iron ore by countries from 1928 to 1932, so far as figures are obtainable. Figures for preceding years appear in earlier volumes of Mineral Resources. Complete returns for 1932 are not yet available, but the world production of pig iron suggests a total of about 83 million metric tons, of which the United States furnished about one eighth. In 1931 the United States contributed a little more than one fourth of the world total, which was almost 120,000,000 metric tons.

Iron ore produced, 1928–32, by countries, in metric tons

Country	1928	1929	1930	1931	1932
North America:					
Cuba [1]	400,750	682,095	190,270	92,407	82,610
Mexico	80,293	112,749	106,979	(2)	(2)
Newfoundland [3]	1,572,725	1,541,334	1,196,856	716,579	150,867
United States	63,195,351	74,199,815	59,346,123	31,631,163	10,004,959
South America:					
Brazil [4]	30,000	30,000	30,000	30,000	30,000
Chile [5]	1,515,203	1,812,343	1,695,089	741,650	172,681
Europe:					
Austria	1,928,182	1,891,381	1,180,451	511,945	(2)
Belgium	164,420	155,670	130,990	125,820	(2)
Czechoslovakia	1,779,176	1,807,663	1,652,920	1,235,078	(2)
France	49,191,300	50,731,100	48,570,980	38,784,209	(2)
Germany [6]	6,296,261	6,191,232	5,658,574	2,574,049	(2)
Greece	166,868	253,025	256,161	235,967	(2)
Hungary	199,547	251,711	157,421	84,033	(2)
Italy	625,488	715,171	718,124	560,853	458,362
Luxemburg	7,026,832	7,571,206	6,649,372	4,764,926	(2)
Netherlands	1,100	900	----------	----------	(2)
Norway	530,508	746,112	772,423	574,887	(2)
Poland	736,755	659,568	476,846	284,653	(2)
Portugal	14,000	8,507	(7)	(7)	(2)
Rumania	83,869	90,014	92,517	61,907	(2)
Russia	[8] 5,911,456	[9] 7,849,000	[9] 10,425,000	[9] 10,612,000	(2)
Spain	5,771,207	6,546,648	5,517,211	3,190,203	1,847,000
Sweden	4,668,801	11,467,551	11,236,428	7,070,868	(2)
Switzerland [10]	65,702	88,445	101,925	34,239	(2)
United Kingdom:					
Great Britain [11]	11,443,083	13,427,043	11,813,850	7,748,255	(2)
Northern Ireland	819	700	----------	----------	(2)
Yugoslavia	439,481	427,946	431,189	133,112	(2)
Asia:					
China	[4] 2,000,000	2,672,400	2,261,200	2,242,200	(2)
Chosen	504,375	551,814	532,497	(2)	(2)
India, British	2,088,991	2,467,533	1,879,311	1,650,962	(2)
Japan	157,706	177,557	245,992	(2)	(2)
Russia	[8] 12,970	(9)	(9)	(9)	(2)
Unfederated Malay States:					
Johore	654,981	755,138	714,081	496,723	(2)
Trengganu	26,343	55,693	76,187	206,369	(2)
Africa:					
Algeria	1,985,626	2,196,182	2,231,868	1,016,957	(2)
Belgian Congo	51,000	50,000	14,000	19,000	(2)
Morocco, Spanish [10]	1,060,709	1,061,424	752,715	500,650	171,182
Rhodesia:					
Northern	4,538	3,613	10	771	722
Southern	3,112	3,406	2,524	535	----------
South-West Africa	29,929	28,697	39,969	22,214	(2)
Tunisia	909,000	977,000	828,000	446,600	209,000
Union of South Africa [1]	20,898	38,270	51,662	15,447	16,024
Oceania:					
Australia:					
New South Wales [12]	85,558	[13] 6,580	----------	----------	(2)
Queensland	----------	1,256	2,456	4,629	(2)
South Australia	628,240	861,420	943,293	293,820	546,562
New Zealand [13]	12,929	8,172	16,409	7,031	(2)
	174,076,000	201,175,000	179,000,000	119,523,000	(2)

[1] Shipments.
[2] Data not available; estimate included in total for 1931.
[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] Year ended Sept. 30.
[9] Russia in Asia included with Russia in Europe.
[10] Exports.
[11] Exclusive of bog ore, which is used mainly for the purification of gas.
[12] Exclusive of iron oxide used for paint.
[13] 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 8,549,649 gross tons in 1932 compared with 17,952,613 tons in 1931. The production in 1932 consisted of 8,534,594 tons made with coke as fuel and 15,055 tons made with charcoal. Of the pig iron manufactured in 1932, it is calculated that 391,522 gross tons valued at $5,255,688 were made from 652,352 gross tons of foreign ore from Africa, Australia, Canada, Chile, Cuba, Russia, and Sweden, indicating an average pig-iron yield of 60.02 percent from imported ore. Domestic ore and 1,954,710 gross tons of cinder, scale, and scrap, amounting in all to 14,483,596 tons, were reported as used in making 8,158,127 tons of pig iron, indicating an average pig-iron yield of 56.33 percent from domestic materials.

Pig iron manufactured in the United States, 1931–32, by States, in gross tons

State	1931	1932	State	1931	1932
Alabama	1,640,851	652,898	New York	1,060,935	624,169
Illinois	1,965,469	919,247	Ohio	4,117,384	2,387,028
Indiana	1,790,489	852,276	Pennsylvania	5,036,305	2,103,170
Kentucky	130,990	72,855	West Virginia	605,634	224,032
Maryland	676,536	378,739	Undistributed [1]	389,001	152,710
Michigan	537,350	182,525			
Minnesota	1,669			17,952,613	8,549,649

[1] 1931: Colorado, Iowa, Massachusetts, Tennessee, and Utah; 1932: Colorado, Iowa, Tennessee, and Utah.

The number of furnaces in blast on June 30 and December 31 and the total number of stacks recorded for 1931 and 1932, exclusive of electric reduction furnaces, were as follows:

Blast furnaces (including ferro-alloy blast furnaces) in the United States, 1931–32 [1]

State	In blast June 30, 1931	Dec. 31, 1931			In blast June 30, 1932	Dec. 31, 1932		
		In	Out	Total		In	Out	Total
Alabama	12	6	19	25	4	3	22	25
Colorado	1		5	5			3	3
Illinois	7	7	18	25	6	3	22	25
Indiana	6	5	13	18	5	4	14	18
Kentucky	1		2	2		1	1	2
Maryland	3	2	3	5	2	2	4	6
Massachusetts	1		1	1			1	1
Michigan	4	3	5	8	2	2	6	8
Minnesota			3	3			3	3
Mississippi			1	1				
Missouri			1	1			1	1
New Jersey			2	2				
New York	5	6	13	19	3	1	18	19
Ohio	23	12	46	58	13	12	45	57
Pennsylvania	27	17	81	98	12	14	81	95
Tennessee			6	6			6	6
Utah	1	1		1	1	1		1
Virginia			7	7			6	6
West Virginia	2	2	1	3	1	1	2	3
	93	61	227	288	49	44	235	279

[1] American Iron and Steel Institute.

The total shipments of pig iron, exclusive of ferro-alloys, reported by manufacturers to the Bureau of Mines, amounted to 8,518,400 gross tons in 1932, valued at $126,032,714, a decrease of 52 percent in quantity and 56 percent in total value from 1931. 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, 1931–32, by States

State	1931		1932	
	Gross tons	Value	Gross tons	Value
Alabama	1,617,331	$20,024,541	733,774	$8,076,727
Colorado	(1)	(1)	(1)	(1)
Illinois	1,727,834	29,178,510	731,872	11,544,298
Indiana	1,721,925	28,458,099	713,415	11,019,875
Iowa	(1)	(1)	(1)	(1)
Kentucky	128,194	(1)	74,431	(1)
Maryland	677,076	(1)	367,614	(1)
Massachusetts	(1)	(1)	(1)	(1)
Michigan	519,643	8,964,439	280,536	4,269,528
Minnesota	17,878	(1)	1,571	(1)
New York	1,014,320	15,568,275	594,350	8,546,837
Ohio	4,290,669	69,001,692	2,505,268	37,886,811
Pennsylvania	5,099,016	86,877,965	2,069,553	32,764,148
Tennessee	13,094	293,111	4,623	(1)
Utah	(1)	(1)	(1)	(1)
Virginia	26,519	(1)	1,710	(1)
West Virginia	593,831	(1)	245,869	(1)
Undistributed	[2] 365,249	[2] 26,780,524	[2] 193,814	[2] 11,924,490
	17,812,579	285,147,156	8,518,400	126,032,714

[1] Included under "Undistributed."
[2] Includes figures for States entered as "(1)" above.

Pig iron shipped from blast furnaces in the United States, 1931–32, by grades

Grade	1931			1932		
	Gross tons	Value		Gross tons	Value	
		Total	Average		Total	Average
Charcoal	62,195	$1,260,496	$20.27	23,852	$437,591	$18.35
Foundry	2,021,859	28,812,509	14.25	972,630	12,524,358	12.88
Basic	10,367,377	162,890,061	15.71	5,144,905	73,973,005	14.38
Bessemer	4,371,268	74,996,006	17.16	1,919,325	31,834,238	16.59
Low-phosphorus	130,858	2,851,989	21.79	67,584	1,387,267	20.53
Malleable	778,359	12,779,283	16.42	364,234	5,397,057	14.82
Forge	47,729	763,992	16.01	8,426	99,762	11.84
All other (not ferro-alloys)	32,934	792,820	24.07	17,444	379,436	21.75
	17,812,579	285,147,156	16.01	8,518,400	126,032,714	14.80

Values 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 $14.80 a gross ton in 1932—$1.21 less than in 1931 and $2.66 less than the average for 1927–31.

Average value per gross ton of pig iron at blast furnaces in the United States, 1928–32

State	1928	1929	1930	1931	1932
Alabama	$16.71	$16.19	$13.55	$12.38	$11.01
Illinois	17.96	18.46	17.80	16.89	15.77
Indiana	16.56	16.69	16.54	16.53	15.45
Michigan	19.00	16.76	18.08	17.25	15.22
New York	16.85	17.88	17.80	15.35	14.38
Ohio	16.93	17.30	17.05	16.08	15.12
Pennsylvania	17.61	18.29	18.13	17.04	15.83
Tennessee	18.70	18.46	19.64	22.39	(1)
Virginia	19.72	(1)	(1)	(1)	(1)
Wisconsin	(1)				
Other States [2]	17.10	16.83	15.85	14.81	13.40
Average for United States	17.27	17.61	17.13	16.01	14.80

[1] Included under "Other States."
[2] 1928: Colorado, Kentucky, Maryland, Massachusetts, Minnesota, Utah, West Virginia, and Wisconsin; 1929–30: 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: 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, 1931–32 [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	
	1931	1932	1931	1932	1931	1932	1931	1932
January	$17.00	$15.50	$13.96	$11.64	$17.50	$16.00	$17.00	$15.00
February	16.79	15.18	13.00	11.00	17.29	15.68	16.79	14.68
March	16.50	15.00	12.67	11.00	17.00	15.50	16.50	14.50
April	16.50	15.00	12.10	11.00	17.00	15.50	16.50	14.50
May	16.44	14.78	12.00	11.00	17.00	15.28	16.38	14.28
June	16.00	14.50	12.00	11.00	17.00	15.00	15.50	14.00
July	16.00	14.50	12.00	11.00	17.00	15.00	15.50	14.00
August	16.00	14.50	12.00	11.00	17.00	15.00	15.50	14.00
September	16.00	14.50	12.00	11.00	17.00	15.00	15.50	14.00
October	16.00	14.50	12.00	11.00	16.93	15.00	15.43	14.00
November	16.00	14.50	12.00	11.00	16.50	15.00	15.00	14.00
December	15.75	14.50	12.00	11.00	16.25	15.00	15.00	14.00
Average	16.25	14.75	12.31	11.05	16.96	15.25	15.88	14.25

[1] Metal Statistics, 1933.

Foreign trade in pig iron.—Imports of pig iron into the United States in 1932 were 130,630 gross tons—55 percent more than in 1931 and 2 percent more than the average for 1927–31. Netherlands (74,372 tons), India (28,820 tons), and the United Kingdom (23,378 tons) were the chief sources of supply.

Pig iron imported into the United States, 1928–32, by countries, in gross tons

Country	1928	1929	1930	1931	1932
North America:					
Canada	1,015	7,382	664	2,789	2,113
Mexico	423	387	41		
Europe:					
Belgium	272	284	669	300	200
France	30	101		25	97
Germany	695	103	50	202	361
Netherlands	26,989	24,189	6,243	7,209	74,372
Norway	1,186	3,400	2,610	227	140
Sweden	2,720	3,534	4,092	1,900	561
United Kingdom	50,944	39,140	14,239	2,656	23,378
Asia:					
Hong Kong				2	
India, British	56,420	69,243	108,261	67,930	28,820
Japan			102	20	279
Kwantung			60	1,098	309
Oceania: Australia				53	
	140,694	147,763	137,031	84,411	130,630
Value	$2,232,094	$2,398,488	$1,806,754	$978,683	$1,301,625

Exports of pig iron from the United States in 1932 were 2,324 gross tons—65 percent less than in 1931 and 94 percent below the average for 1927–31. Exports to Canada declined from 3,408 tons in 1931 to 322 tons in 1932.

Pig iron exported from the United States, 1931–32, by countries, in gross tons

Country	1931	1932	Country	1931	1932
North America:			Europe—Continued		
Canada	3,408	322	Italy	27	26
Cuba	250	65	United Kingdom	714	136
Mexico	192	323	Asia:		
Panama	161	60	China	142	100
Other countries	32	1	Japan	637	200
South America:			Philippine Islands	48	233
Chile	56	15	Oceania:		
Colombia	88	96	Australia	12	
Peru	350	203	New Zealand	15	
Other countries	50	135			
Europe:				6,719	2,324
Belgium	261	398	Value	$150,658	$53,966
France	206	11			
Germany	70				

World production of pig iron.—World production of pig iron (including ferro-alloys) in 1932 was approximately 39,200,000 metric tons, a decrease of 30 percent from 1931 and 52 percent below the average for 1927–31. In 1932 the output of the United States represented about 23 percent (33 percent in 1931) of the world output, and it was about 67 percent (44 percent in 1931) less than that of the producing countries of Europe combined. The production of pig iron decreased 21 percent in Europe in 1932 compared with a decrease of 52 percent in the United States.

Pig iron (including ferro-alloys) produced, 1928–32, by countries, in metric tons

Country	1928	1929	1930	1931	1932
Australia	417,468	337,975	[1] 447,000	[1] 386,000	[1] 400,000
Austria	458,451	458,973	296,824	145,016	94,466
Belgium	3,856,990	4,040,530	3,365,240	3,197,790	2,782,800
Brazil	25,763	33,708	34,974	[1] 35,000	[1] 35,000
Canada	1,099,578	1,189,037	825,440	474,294	162,179
China	[1] 300,000	[1] 300,000	[1] 300,000	[1] 300,000	[1] 300,000
Chosen	148,652	155,514	151,378	[1] 150,000	[1] 150,000
Czechoslovakia	1,569,264	1,644,515	1,437,089	1,164,726	450,000
Finland	8,470	6,608	3,444	12,329	[1] 10,000
France	10,072,100	10,362,072	10,071,980	8,300,000	5,519,000
Germany (exclusive of the Saar)	11,803,565	13,239,455	9,698,421	6,061,068	3,933,026
Saar	1,936,184	2,104,940	1,912,444	1,515,429	1,349,493
Great Britain	6,717,400	7,701,200	6,296,259	3,818,418	3,630,000
Hungary	285,461	367,951	257,226	159,630	[1] 150,000
India, British	1,072,052	1,417,563	1,198,802	1,089,919	[1] 1,100,000
Italy	554,113	726,544	587,594	552,852	488,391
Japan [2]	1,540,465	1,561,448	1,687,435	1,408,204	[1] 1,400,000
Luxemburg	2,770,066	2,906,093	2,473,714	2,053,158	1,958,930
Mexico	49,442	60,230	57,826	[1] 60,000	[1] 60,000
Netherlands	258,224	253,776	272,718	256,717	236,426
New Zealand	6,464	4,464	8,205	3,516	[1] 4,000
Norway	126,598	153,395	144,836	118,837	[1] 119,000
Philippine Islands	209	166	173	163	[1] 150
Poland	683,951	705,532	477,949	347,114	198,700
Rumania	70,123	72,346	68,843	25,894	[1] 26,000
Russia	[3] 3,281,977	[3] 4,018,700	[3] 4,982,200	5,007,000	[1] 5,000,000
Spain	562,821	752,618	621,891	479,215	[1] 289,000
Sweden	437,512	523,829	496,410	417,506	[1] 400,000
Union of South Africa	9,057	16,510	29,726	8,940	[1] 9,000
United States	38,780,625	43,315,279	32,279,283	18,715,216	8,920,878
Yugoslavia	29,303	30,885	35,011	37,733	[1] 38,000
	88,932,000	98,462,000	80,520,000	56,302,000	39,200,000

[1] Approximate production.
[2] Includes pig iron produced at Government and other steel works for conversion into steel.
[3] Year ended Sept. 30.

FERRO-ALLOYS

Production and shipments.—The production of ferro-alloys was 230,311 gross tons in 1932 compared with 466,969 tons in 1931, a decrease of 51 percent. Ferro-alloys were made in 1932 at 9 blast furnaces, 12 electric furnaces, and 2 alumino-thermic plants; in addition, 1 plant made ferrophosphorus as a byproduct.

The shipments of ferro-alloys of all classes in 1932 were 218,646 gross tons valued at $14,003,672, a decrease of 45 percent in quantity and 54 percent in total value compared with 1931.

Ferro-alloys shipped from furnaces in the United States, 1931–32, by varieties

Variety of alloy	1931		1932	
	Gross tons	Value	Gross tons	Value
Ferromanganese	159,168	$12,999,329	70,417	$5,061,029
Spiegeleisen	55,327	1,313,068	31,071	745,966
Ferrosilicon (7 percent or more silicon)	153,063	7,213,265	97,224	3,517,268
Ferrotungsten	870	1,690,298	295	525,239
Ferrovanadium	616	1,613,381	283	704,038
Other varieties [1]	29,251	5,935,208	19,356	3,450,132
	398,295	30,764,549	218,646	14,003,672

[1] Ferrochromium, ferromolybdenum and calcium-molybdenum compounds, ferrophosphorus, ferrotitanium, ferrozirconium, silicomanganese and silicospiegeleisen, and zirconium-ferrosilicon.

Ferromanganese.—The shipments of ferromanganese in 1932 were 70,417 gross tons, a decrease of 56 percent from 1931. The average value per ton f.o.b. furnaces reported for ferromanganese was $71.87 in 1932 compared with $81.67 in 1931.

Ferromanganese was made at 5 furnaces by 5 producers in both 1931 and 1932.

The production of ferromanganese in 1932 was 56,350 gross tons containing 43,760 tons of manganese (metal), an average of 77.66 percent manganese. In the production of ferromanganese in 1932 there were used 90,677 gross tons of foreign manganese ore, 91 tons of foreign ferruginous manganese ore, 10,666 tons of domestic manganese ore, 1,642 tons of domestic ferruginous manganese ore, 3,537 tons of iron ore, and 1,499 tons of cinder, scale, and scrap. The quantity of manganese ore used per ton of ferromanganese made in 1932 was 1.798 tons; in 1931 it was 1.799 tons; and in 1930 it was 1.792 tons. Of the foreign manganese ore used in 1932, Russia supplied 46,596 gross tons; Brazil, 25,279 tons; India, 11,541 tons; Africa, 5,135 tons; and Cuba, 2,126 tons. The quantity of domestic manganese ore used in the manufacture of ferromanganese in 1932 represented 10.5 percent of the total manganese ore used, compared with 4.1 percent in 1931.

Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture, 1928–32

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			
1928	319,770	78.62	251,400	566,859	37,827	23,159	8,395	1.891
1929	339,205	79.30	269,000	614,763	27,558	47,735	7,811	1.894
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

Quantity and tenor of manganese ore used in manufacture of ferromanganese in the United States, 1931–32

Source of ores	1931		1932	
	Gross tons	Manganese content (percent, natural)	Gross tons	Manganese content (percent, natural)
Africa	26,133	49.79	5,135	49.44
Brazil	62,630	43.42	25,279	44.19
Chile	4,363	46.64		
Cuba			2,126	54.26
India	26,267	50.75	11,541	51.04
Russia	168,580	49.29	46,596	49.45
United States	12,277	39.21	10,666	44.84
	300,250	47.79	101,343	47.94

Spiegeleisen.—The shipments of spiegeleisen in 1932 amounted to 31,071 gross tons (44 percent less than in 1931). The average value per ton at the furnaces was $24.01 in 1932 and $23.73 in 1931.

The production of spiegeleisen in 1932 was 37,317 tons, averaging about 20 percent manganese. Spiegeleisen was made at 4 furnaces by 3 producers in 1932.

Ferrosilicon.—The shipments of ferrosilicon were 97,224 gross tons containing 21,255 tons of silicon in 1932 compared with 153,063 tons containing 38,520 tons of silicon in 1931.

The production of ferrosilicon amounted to 116,593 gross tons in 1932, of which 65,084 tons were made by the blast-furnace process and 51,509 tons by the electric-furnace process.

Ferrotungsten.—The shipments of ferrotungsten in 1932 were 295 gross tons containing 527,356 pounds of tungsten, and the average value per pound of contained tungsten was $1 f.o.b. furnaces ($1.10 in 1931).

The production of ferrotungsten in 1932 was 246 gross tons averaging 79.88 percent tungsten. The ferrotungsten produced in 1932 was made chiefly from ores from China and Nevada.

Ferrovanadium.—The shipments of ferrovanadium in 1932 were 283 gross tons containing 235,118 pounds of vanadium and were valued at the furnaces at an average of $2.99 per pound of contained vanadium compared with $3.13 in 1931.

The production of ferrovanadium in 1932 was 109 gross tons averaging 36.73 percent vanadium. It was reduced chiefly from vanadium oxide made from roscoelite-carnotite ores mined in Colorado and Utah.

Other ferro-alloys.—Although substantially less than in 1931 the shipments of silicomanganese, silicospiegel, ferrophosphorus, ferrochromium, and ferromolybdenum in 1932 did not decline as much as the shipments of ferromanganese, spiegeleisen, ferrotungsten, and ferrovanadium. The shipments of silicomanganese and silicospiegel decreased 39 percent from 1931; ferrophosphorus 36 per cent; ferrochromium 33 percent; and ferromolybdenum and calcium-molybdenum compounds 43 percent. The shipments of ferrotitanium in 1932, however, increased 5 percent over those in 1931.

Foreign trade in ferro-alloys.—Imports of all alloys of the rarer metals are not recorded separately but are grouped as shown in the next table. Ferromanganese and spiegeleisen constituted the bulk of the imports in 1932.

The imports for consumption of ferromanganese in 1932 (chiefly from Canada and Norway) were 18,470 gross tons, a decrease of 25 percent from 1931. The imports from Norway in 1932 increased about 67 percent and those from the United Kingdom decreased about 73 percent compared with 1931.

The imports for consumption of spiegeleisen in 1932 (chiefly from Canada and the United Kingdom) were 8,364 gross tons, a decrease of 12 per cent from 1931.

Ferro-alloys and ferro-alloy metals imported for consumption in the United States, 1931–32, by varieties

Variety of alloy	1931 Gross weight (gross tons)	1931 Content (gross tons)	1931 Value	1932 Gross weight (gross tons)	1932 Content (gross tons)	1932 Value
Ferromanganese:						
Containing over 1 percent carbon	24, 234	19, 488	$1, 713, 287	18, 443	14, 756	$1, 085, 691
Containing not over 1 percent carbon	430	348	38, 359	27	23	5, 335
Manganese boron, manganese silicon, manganese metal, and spiegeleisen, n.e.s.	(1)	431	44, 929	(1)	329	31, 451
Spiegeleisen	9, 482	(1)	247, 788	8, 364	(1)	192, 037
Ferrochrome or ferrochromium containing less than 3 percent carbon	135	91	21, 463	159	106	30, 984
Ferrophosphorus	1, 839	(1)	134, 773	711	(1)	48, 251
Ferrosilicon:						
Containing 8 percent and less than 60 percent silicon	3, 758	924	126, 509	864	312	38, 200
Containing 60 percent and less than 80 percent silicon	25	20	1, 888			
Chrome or chromium metal				(1)	20	19, 289
Chromium and zirconium silicon and calcium silicide	40	(1)	6, 629	79	(1)	11, 511
Silicon aluminum, aluminum silicon	13	(1)	1, 800			
Ferrosilicon aluminum and ferroaluminum silicon and alsimin	16	(1)	2, 149			
Ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum	(1)	94	213, 660	(1)	(2)	89
Ferrotitanium	1	(1)	379	2	(1)	718
Tungsten and combinations, in lump, grains, or powder:						
Tungsten metal	(1)	9	11, 716	(1)	6	5, 882
Combinations containing tungsten or tungsten carbide	(1)	(3)	24	(1)	(4)	332
Tungstic acid and other compounds of tungsten, n.s.p.f.	(1)	1	3, 819	(1)	1	2, 629
Ferrozirconium and zirconium-ferrosilicon	(5)	(1)	312			

1 Not recorded.
2 44 pounds.
3 3 pounds of tungsten.
4 131 pounds.
5 496 pounds.

Ferromanganese and ferrosilicon imported into the United States, 1931–32, by countries

[General imports]

Country	Ferromanganese (manganese content)[1] 1931 Gross tons	1931 Value	1932 Gross tons	1932 Value	Ferrosilicon (silicon content)[2] 1931 Gross tons	1931 Value	1932 Gross tons	1932 Value
Canada	8, 331	$865, 891	6, 747	$603, 934	442	$71, 924	54	$9, 969
France	180	21, 970	500	26, 689				
Germany	410	20, 611	675	23, 948	9	1, 867	3	1, 105
Italy	590	82, 312	327	33, 831	30	4, 658	46	6, 317
Japan					13	809		
Norway	2, 712	285, 963	4, 542	235, 746	244	26, 800	65	9, 366
United Kingdom	5, 105	315, 842	1, 402	72, 618				
Yugoslavia and Albania	436	14, 580	393	14, 452				
	[1] 17, 764	[1] 1, 607, 169	[1] 14, 586	[1] 1, 011, 218	[2] 738	[2] 106, 058	[2] 168	[2] 26, 757

1 Includes small quantities of other manganese alloys.
2 Includes small quantities of chromium and zirconium-silicon and calcium silicide.

The exports of ferro-alloys are relatively unimportant. Ferromanganese and spiegeleisen usually constitute the greater part of the total exports, but in 1932 only 33 gross tons (probably ferromanganese) were exported compared with 1,306 tons in 1931. Tungsten and ferrotungsten, the exports of which increased from 13 gross tons in 1930 to 472 tons in 1931, amounted to 63 tons in 1932.

Ferro-alloys and ferro-alloy metals exported from the United States, 1930–32, by varieties

Variety of alloy	1930		1931		1932	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Ferromanganese [1] / Spiegeleisen [1]	6,189	$145,629	1,306	$38,506	33	$2,369
Tungsten and ferrotungsten (including tungsten wire)	13	221,934	472	624,412	63	172,585

[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 both open-hearth and Bessemer steel billets at Pittsburgh in 1932 ranged from $26 to $27.75 a gross ton; in 1931 it ranged from $28.80 to $30 a ton. Tank plates at Pittsburgh ranged from 1.5 to 1.6 cents a pound in 1932 and from 1.54 to 1.65 cents a pound in 1931. Structural shapes at Pittsburgh ranged from 1.5 to 1.6 cents a pound in 1932 and from 1.5 to 1.65 cents a pound in 1931. Hot-rolled annealed sheets, no. 24 gage, at Pittsburgh ranged from 2.1 to 2.22 cents a pound in 1932 and from 2.15 to 2.4 cents a pound in 1931.

The production of steel in 1932 was 13,681,162 gross tons, of which 11,907,330 tons were open-hearth, 1,532,076 tons Bessemer, 645 tons crucible, and 241,111 tons electric steel. In 1931 the production was 25,945,501 tons, of which 22,509,566 tons were open-hearth, 3,023,446 tons Bessemer, 1,547 tons crucible, and 410,942 tons electric steel.

Bessemer steel ingots and castings manufactured in the United States, 1928–32 by States, in gross tons

State	1928	1929	1930	1931	1932
Ohio	2,577,728	2,724,864	1,892,021	1,393,875	939,228
Pennsylvania	2,293,085	2,427,490	1,732,545	786,767	233,215
Illinois	978,511	1,073,790	718,104	420,569	250,983
Other States	770,871	896,365	692,789	422,235	108,650
	6,620,195	7,122,509	5,035,459	3,023,446	1,532,076

Open-hearth steel ingots and castings manufactured in the United States, 1928–32 by States, in gross tons

State	1928	1929	1930	1931	1932
New England States	285,767	325,232	214,425	175,673	128,227
New York and New Jersey	2,323,333	2,541,856	1,764,976	1,144,839	589,945
Pennsylvania	15,261,713	17,504,807	12,488,175	7,384,091	3,506,451
Ohio	10,179,096	10,241,579	7,152,526	4,954,069	2,849,170
Indiana	5,971,416	6,235,333	4,742,297	2,746,899	1,428,091
Illinois	3,239,669	3,607,810	2,514,799	1,450,637	695,936
Other States	6,852,962	7,896,271	6,171,974	4,653,358	2,709,510
	44,113,956	48,352,888	35,049,172	22,509,566	11,907,330

According to these tables there was a decrease of 49 percent in the production of Bessemer steel and of 47 percent in that of open-hearth steel in 1932 compared with 1931; the total production of steel decreased 47 percent also. Of the total output in 1932, 87.03 percent was open-hearth, 11.2 percent Bessemer, and 1.77 percent other classes of steel.

Of the total output of open-hearth steel 11,742,682 gross tons were made by the basic process and 164,648 tons by the acid process compared with 22,130,398 tons of basic steel and 379,168 tons of acid steel in 1931.

The production of steel by the electric process decreased 41 percent compared with 1931.

Steel electrically manufactured in the United States, 1928–32, in gross tons

Year	Ingots	Castings	Total	Year	Ingots	Castings	Total
1928	453,692	348,568	802,260	1931	235,376	175,566	410,942
1929	532,392	419,039	951,431	1932	141,328	99,783	241,111
1930	307,418	305,181	612,599				

Figures for the total production of electric steel in 1932 include 140,877 tons of alloy-steel ingots and castings that were alloyed with nickel, vanadium, tungsten, chromium, molybdenum, and other metals (116,765 tons of ingots and 24,112 tons of castings) compared with 232,113 tons (186,027 tons of ingots and 46,086 tons of castings) so alloyed in 1931.

The number of completed plants equipped for the manufacture of steel by the electric process was 247 on December 31, 1932 compared with 250 at the end of 1931.

Foreign trade in steel.—The imports of steel, though substantially smaller than in 1931, declined relatively less than exports. The imports of some steel products (rails, sheets, tin and terne plates, nails, and wire rods) in 1932 were larger than in 1931. The imports of steel ingots declined from 20,023 tons in 1931 to 2,396 tons in 1932.

Iron and steel imported into the United States, 1930–32

Article	1930 Gross tons	1930 Value	1931 Gross tons	1931 Value	1932 Gross tons	1932 Value
Bar iron	1,376	$101,624	854	$48,323	505	$25,713
Boiler and other plate of iron and steel	1,892	59,837	755	33,249	421	10,623
Castings and forgings	1,526	244,095	1,775	238,472	981	105,233
Cast-iron pipe and fittings	11,874	319,294	6,641	183,010	250	6,212
Other pipes and tubes	21,453	2,395,012	15,791	1,721,624	6,937	673,297
Hoop, or band iron or steel, cut to length	5,278	189,555	8,620	251,181	12,694	347,837
Hoop, band, or scroll iron and steel	9,779	396,492	19,371	657,811	19,284	459,317
Iron and steel scrap	27,482	395,161	16,279	117,954	9,775	59,210
Nails	6,014	544,454	8,106	633,032	10,876	721,296
Rails for railways	8,307	240,331	5,007	99,607	5,662	196,342
Sheets of iron or steel, skelp, saw plates, and steel, n.e.s.	26,594	1,247,891	16,152	600,637	21,831	441,862
Steel bars:						
Reinforcement bars	48,365	2,302,594	38,832	812,766	27,176	406,066
Other bars			51,540	1,748,620	31,997	834,105
Steel ingots, blooms, slabs, etc.	22,313	749,010	20,023	518,563	2,396	74,941
Structural iron and steel	120,333	4,094,425	72,329	2,226,454	36,547	642,217
Tin and terne plates	261	67,102	196	42,704	7,245	471,939
Wire and articles made from wire		2,850,389		1,925,673		2,149,159
Wire rods	8,843	585,191	7,114	472,240	7,933	397,354
Other advanced manufactures		2,216,581		989,908		461,218

The export trade in steel slumped greatly in 1932, and except for a few items all products were affected more or less. Some of the larger decreases in tonnage were recorded for steel bars, wire rods, both galvanized and black sheets, tin and terne plates, unfabricated plates, structural shapes, and rails.

Iron and steel exported from the United States, 1931–32

Article	1931 Gross tons	1931 Value	1932 Gross tons	1932 Value
Semimanufactures:				
Steel ingots, blooms, billets, slabs, and sheet bars	7,965	$331,707	1,627	$63,889
Iron and steel bars and rods:				
Iron bars	1,017	95,954	617	42,906
Steel bars	42,513	2,328,632	15,548	827,251
Alloy-steel bars	2,968	498,606	1,622	250,958
Wire rods	32,125	1,297,110	14,818	583,451
Iron and steel plates, sheets, skelp, and strips—				
Boiler plates	500	32,468	818	45,692
Other plates, not fabricated	41,973	1,878,230	9,477	478,112
Skelp iron or steel	56,498	2,369,366	25,486	910,162
Iron or steel sheets, galvanized	51,523	4,294,442	26,924	1,982,002
Steel sheets, black	91,786	6,917,787	38,277	2,844,285
Iron sheets, black	5,523	446,589	2,461	175,995
Strip steel, cold rolled	8,897	739,545	5,558	500,170
Hoop, band, and scroll iron or steel	19,333	1,094,930	12,219	626,881
Tin plate, terne plate, and taggers tin	84,433	7,841,193	39,603	3,272,566
Manufactures—steel-mill products:				
Structural iron and steel:				
Structural shapes:				
Not fabricated	88,710	3,436,880	14,885	589,847
Fabricated	24,862	2,327,063	8,639	628,713
Ship and tank plates, punched or shaped	1,525	84,269	1,072	64,396
Metal lath	2,408	350,046	1,471	182,931
Other structural shapes	5,745	358,140	7,365	335,924
Railway track material:				
Rails for railways	33,108	1,288,811	11,320	427,924
Rail joints, splice bars, fishplates, and tie-plates	4,897	377,723	1,969	121,006
Switches, frogs, and crossings	1,265	269,837	745	96,494
Railroad spikes	1,158	74,387	693	38,641
Railroad bolts, nuts, washers, and nut locks	769	154,634	336	43,156

Iron and steel exported from the United States, 1931–32—Continued

Article	1931		1932	
	Gross tons	Value	Gross tons	Value
Manufactures—steel-mill products—Continued				
Tubular products:				
Boiler tubes	7,070	$885,816	3,677	$566,830
Casing and oil-line pipe	21,973	2,468,798	17,274	1,791,968
Welded black pipe	34,309	2,805,851	14,805	1,157,130
Welded galvanized pipe	26,129	2,371,674	16,082	1,305,992
Malleable-iron screwed pipe fittings	4,510	1,400,764	1,678	485,337
Cast-iron screwed pipe fittings	2,142	526,544	752	180,574
Cast-iron pressure pipe and fittings	12,995	653,796	4,723	217,736
Cast-iron soil pipe and fittings	6,049	480,678	2,940	191,997
Wire and manufactures:				
Barbed	21,459	1,049,148	1,675	791,283
All other	25,114	3,394,517	13,754	1,864,744
Nails and bolts (except railroad):				
Cut nails	137	16,186	158	21,481
Horseshoe nails	619	147,331	676	159,722
Wire nails	8,838	484,860	7,550	369,717
All other nails, including tacks and staples	3,059	444,559	2,543	274,619
Bolts, nuts, rivets, and washers (except railroad)	4,855	1,048,532	2,715	625,223
Castings and forgings:				
Horseshoes	153	21,128	100	13,935
Iron and steel, including car wheels and axles	21,141	2,858,663	11,145	1,394,614
Advanced manufactures:				
House-heating boilers and radiators		485,201		246,561
Tools:				
Axes		263,776		177,259
Hammers and hatchets		100,118		41,202
Saws, wood and metal cutting		1,141,696		673,013
Shovels and spades		113,372		67,736
All other tools		6,456,128		2,998,265

BAUXITE AND ALUMINUM

By C. E. Julihn

Although aluminum and bauxite, the ore from which it is derived, continued to decline in production and consumption during 1932, they fared better than many other metals and minerals. The quoted price of aluminum remained unchanged, and that of bauxite decline only slightly. Research on new uses was maintained, and satisfactory progress was reported. The Aluminum Cartel of Europe was strengthened by new agreements. The Soviets continued construction of plants, one of which is nearly completed. The aluminum output of Italy increased. In Great Britain developments in the electrical industry absorbed substantial quantities of aluminum for transmission lines. There has been rapid expansion in the use of aluminum foil for heat insulation.

Early in 1933 an interesting publication appeared,[1] which included abstracts from 150 papers bearing upon the suitability of aluminum for use in cooking, with a large amount of tabulated data derived from them.

Trends of bauxite production for the United States and for the world over two decades compared with shipments into the United States and domestic exports are shown in figure 8.

Primary aluminum produced in the United States and in the world, 1913–32, compared with imports into the United States and with domestic consumption, exports, secondary production, and the trend of the average New York quoted price (no. 1 virgin 98–99 percent) are shown in figure 9.

Salient statistics of the bauxite and aluminum industries, 1931–32

	1931	1932	Decrease, percent
Bauxite:			
World production ... metric tons	1,071,000	[a] 800,000	[a] 25.3
United States:			
Production ... do	199,039	97,895	50.8
Do ... long tons	195,895	96,349	50.8
Value ... dollars	1,140,629	548,168	51.9
Price per ton ... do	5.82	5.69	-------
Imports ... long tons	306,490	205,620	32.9
Exports ... do	88,370	28,474	67.8
Aluminum:			
World production ... metric tons	230,000	153,000	33.5
United States:			
Production ... do	80,532	47,575	40.9
Do ... short tons	88,772	52,443	40.9
Value ... dollars	37,284,000	20,453,000	45.1
Price per pound, new, 98-99 percent ... cents	22.9	22.9	-------
Secondary production ... short tons	30,300	24,000	20.7
Imports, value ... dollars	3,210,745	1,822,202	43.2
Exports, value ... do	2,854,745	1,451,375	49.2

[a] Estimated.

[1] Weidlein, Edward R., and Beal, George D., A Select Annotated Bibliography of the Hygienic Aspects of Aluminum and Aluminum Utensils: Mellon Inst. Indust. Research, Bibliog. Ser., Bull. 3, 69 pp.

BAUXITE

In 1932 the bauxite output of the United States was 96,349 long tons valued at $548,168 compared with 195,895 long tons valued at $1,140,629 in 1931. The decrease thus amounted to 99,546 tons (about 51 percent). The total decline since 1928 is about 74 percent. The percentage declines in total value are virtually the same as those in quantity.

Bauxite is now the only commercial ore of aluminum, and the quantity known to exist throughout the world is limited. There is,

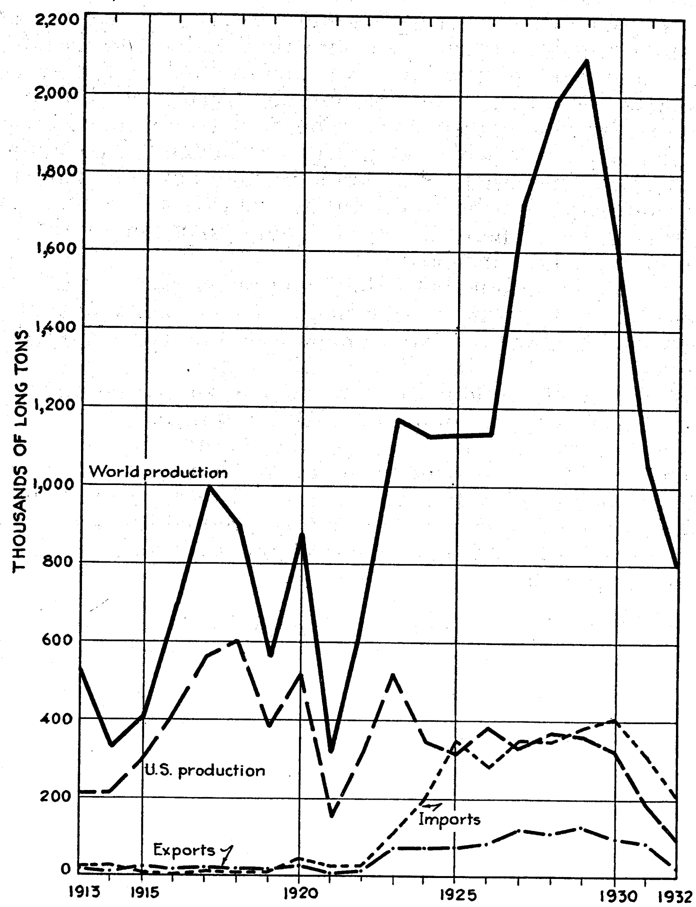

FIGURE 8.—Trends of bauxite production for the United States and for the world over two decades compared with shipments into the United States and domestic exports.

however, a vast amount of other aluminous material, such as clays and feldspathic rocks, containing as much as 20 to 35 percent of aluminum oxide. Due to this, aluminum is estimated to be the most abundant metal of the earth's crust and to be exceeded in quantity only by two other elements, oxygen and silicon. Although it is possible to extract aluminum oxide from low-grade aluminous material the cost of doing so commercially would greatly exceed that of its extraction from bauxites containing a much larger proportion of aluminum oxide.

Typical bauxites now worked throughout the world contain less than 2 percent silica, 10 to 30 percent combined water, 55 to 65 percent alumina, and 25 per cent to less than 1 percent ferric oxide, together with 1 to 2 percent titanium oxide. Bauxites of the United States and the Guianas are characterized by very high percentages of water, usually about 30 percent; by a low percentage of ferric oxide, usually about 1 percent; and by relatively high silica, usually about

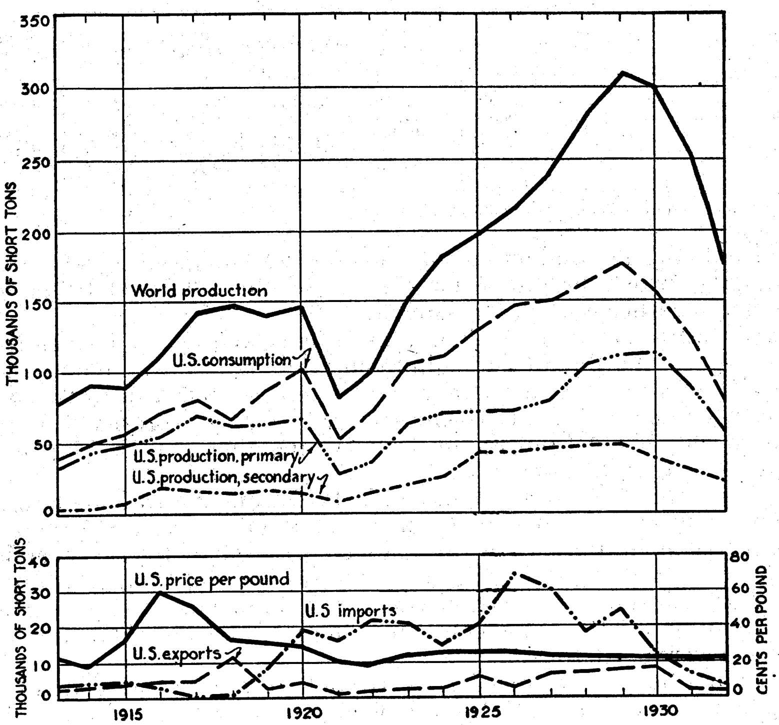

FIGURE 9.—Primary aluminum produced in the United States and in the world, 1913–32, compared with imports into the United States and with domestic consumption, exports, secondary production, and the trend of the average New York quoted price (no. 1 virgin 98–99 percent).

2 percent. The alumina averages about 60 percent in the ores of the United States and somewhat higher in the ores of Guiana.

Approximately one fourth of the bauxite produced is usually consumed in the manufacture of chemicals, refractories, abrasives, and cement and for the filtering of oil; the balance is consumed in production of aluminum.

Aluminum is not made directly from bauxite, but from alumina (Al_2O_3), which is extracted from bauxite by chemical processes; the alumina is then 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 alumnia, and 2 tons of alumina yield about 1 ton of aluminum.

At East St. Louis alumina is extracted from the bauxites of Arkansas and Dutch Guiana, but it is shipped to reduction plants established where cheap water power is available. Such plants are located at Niagara Falls and at Messina, N.Y.; at Alcoa, near Knoxville, Tenn.; and at 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, 1928–32

Year	Georgia, Alabama, and Tennessee[1]		Arkansas		Total	
	Long tons	Value f.o.b. mine	Long tons	Value f.o.b.mine	Long tons	Value f.o.b. mine
1928	14,190	$80,668	361,236	$2,193,230	375,426	$2,273,898
1929	14,723	84,480	351,054	2,181,158	365,777	2,265,638
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

[1] No production from Tennessee in 1929–32.

The domestic production of bauxite was derived chiefly from Arkansas, which produced 93 percent of the total; Alabama and Georgia together provided 7 percent.

Arkansas shipped 89,779 long tons of bauxite in 1932, derived from three mines, the Bauxite mine in Saline County; the Dixie no. 2, and the England in Pulaski County. This represented a decrease of 52 percent compared with 1931 and resulted from a decrease of 65 percent in shipments from Saline County, together with a 14 percent increase in Pulaski County.

In Alabama bauxite was shipped in 1932 from the Eufaula and the Lennig mines in Barbour County. Shipments were 15 percent greater than in 1931. All ore shipped was taken by the chemical industry. In Georgia bauxite was shipped in 1932 from the Hatton and Easterlin mines in Sumter County. Shipments were 57 percent less than in 1931. The combined shipments from Alabama and Georgia were 6,570 tons.

The first bauxite produced in the United States was obtained in 1889 from deposits in the north Georgia field, and in 1891 bauxite was first 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 bauxite from the Tennessee deposits was first shipped. The total production of bauxite recorded in Mineral Resources from 1889 to 1932, inclusive, is 8,122,643 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 is therefore narrow, and prices are quoted through a wide range. Producers of domestic bauxite reported sales during 1932 at prices ranging from $4 to $12.11 a long ton. The average for Arkansas bauxite was $5.65 a ton, for Alabama and Georgia $6.16, and for the United States $5.69. The quoted prices [2] 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 $8 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 $6.50; and French, 56 to 59 percent Al_2O_3 and 2 to 4 percent SiO_2, $5.50 to $7 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 are now used in the manufacture of refractories and are sold according to their alumina content; three grades, containing 55, 65, and 70 percent of alumina (Al_2O_3), are regularly handled. 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 1932 were made to chemical industries, which took 61,838 tons, or 64 percent of the total. For making aluminum 28,899 tons, or 30 percent, were shipped and 5,612 tons (nearly 6 percent) were for use in abrasives. This represents 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. Since that year the quantity of domestic bauxite taken by the aluminum industry has declined 87 percent; that by chemical industries 26 percent; and that by abrasive industries 92 percent. In 1932 the consumption for aluminum declined 65 percent from that of 1931; consumption for chemicals increased 6 percent; and for abrasives it declined 90 percent.

Domestic bauxite sold by producers to industries in the United States, 1928–32, in long tons

Year	Aluminum	Chemical	Abrasive [1]	Cement and refractory [1]	Total	Year	Aluminum	Chemical	Abrasive [1]	Cement and refractory [1]	Total
1928	218,398	83,992	72,931	105	375,426	1931	83,340	58,424	53,631	500	195,895
1929	172,807	86,419	99,925	6,626	365,777	1932	28,899	61,838	5,612		96,349
1930	179,869	67,690	82,116	937	330,612						

[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, 1928–32

Year	New aluminum	Aluminum salts	Year	New aluminum	Aluminum salts
1928	$47,899,000	$13,990,264	1931	$37,284,000	$8,736,030
1929	51,864,000	11,677,728	1932	20,453,000	7,626,575
1930	50,961,000	10,245,063			

[2] Metal and Mineral Markets, vol. 3, 1932.

Aluminum salts.—Manufacturers of aluminum salts reported a consumption of 100,386 long tons of bauxite in 1932, with an average value of $10.89 a ton at the plant compared with 112,102 tons in 1931, with an average value of $11.55 a ton. An unrecorded quantity of high-alumina clay, 2,713 short tons of alumina hydrate, and some aluminum sulphate were also 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 table 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 1931–32

Salt	1931				1932			
	Number of producers reporting	Short tons	Value: Total	Value: Average	Number of producers reporting	Short tons	Value: Total	Value: Average
Alum:								
Ammonia	5	4,668	$251,066	$54	5	3,889	$202,216	$52
Potash	3	2,086	111,168	53	3	2,098	108,345	52
Sodium-aluminum sulphate	3	15,907	905,184	57	3	16,341	888,607	54
Aluminum chloride:								
Liquid	4	1,588	60,685	38	5	1,829	105,669	58
Crystal	2	5,533	560,175	101	2	2,070	222,443	107
Anhydrous	3				4			
Aluminum sulphate:								
Commercial:								
General	10	291,875	5,951,392	20	11	261,254	5,309,149	20
Municipal	10	11,509	193,450	17	10	10,954	165,905	15
Iron-free	7	15,108	483,060	32	7	14,017	428,523	31
Other aluminum salts and hydrate	[1] 4	2,797	219,850	--------	[1] 4	2,497	195,718	--------
	--------	351,071	8,736,030	--------	--------	314,949	7,626,575	--------

[1] Two producers each of alumina and sodium aluminate.

Aluminum salts produced in, imported into, and exported from the United States, 1928–32

Year	Domestic production		Imports		Exports (aluminum sulphate) [1]	
	Short tons	Value	Short tons	Value	Short tons	Value
1928	386,905	$13,990,264	1,425	$68,096	[1] 22,713	[1] $552,342
1929	394,093	11,677,728	1,912	86,411	[1] 26,588	[1] 607,757
1930	373,051	10,245,063	2,058	90,472	[1] 25,255	[1] 573,234
1931	351,071	8,736,030	1,770	82,337	[1] 27,668	[1] 568,490
1932	314,949	7,626,575	1,505	65,859	[1] 21,550	[1] 462,954

[1] Also "other aluminum compounds" as follows: 1928, 418 short tons, valued at $85,809; 1929, 275 tons, $65,458; 1930, 1,009 tons, $194,503; 1931, 875 tons, $170,585; 1932, 326 tons, $58,789.

Aluminous abrasives and refractories.—The use of aluminous abrasives and high-alumina refractories continued to decline in 1932. Makers of artificial abrasives took only 5,612 long tons of domestic bauxite in 1932 compared with 53,631 long tons in 1931. Makers of refractories took 6,789 short tons of high-alumina (diaspore) clay in 1932.

The aluminous abrasives are used largely in the form of grinding wheels and "sandpaper", in powdered and granulated material.

Bauxite producers in the United States in 1932

Dixie Bauxite Co., Inc., Sweet Home, Ark.
Benjamin Easterlin, Americus, Ga.
General Abrasive Co., Inc., Niagara Falls, N.Y.
American Cyanamid & Chemical Corporation, 535 Fifth Avenue, New York, N.Y.
Charles Lennig & Co., Inc., 222 West Washington Square, Philadelphia, Pa.
Republic Mining & Manufacturing Co., 230 Park Avenue, New York, N.Y.

Consumers of bauxite in the United States in 1932

Alcoa Ore Co., East St. Louis, Ill.
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.
American Cyanamid & Chemical Corporation, 535 Fifth Avenue, New York, N.Y.
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.
Passaic Valley Water Commission, 158 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 declined in 1932. Imports fell from 306,490 long tons in 1931 to 205,620 tons in 1932, a decline of 100,870 tons (33 percent). Exports fell from 88,370 tons in 1931 to 28,474 tons in 1932, a decline of 59,896 tons (68 percent). Total supply, including domestic production and the excess of imports over exports, fell from 414,015 tons in 1931 to 273,495 tons in 1932, a decline of 140,520 tons (34 percent). The supply in 1932 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 is shipped, chiefly to Canada, for reduction to aluminum.

The principal source of imports was Dutch Guiana, from which 131,943 long tons of bauxite were imported in 1932.

Bauxite imported into and exported from the United States, 1928–32

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
1928	350,111	$1,534,498	112,984	$5,210,912	1931	306,490	$1,495,577	88,370	$3,309,208
1929	380,812	1,753,840	133,551	3,926,283	1932	205,620	1,042,829	28,474	1,162,238
1930	409,678	1,995,941	104,504	3,776,774					

ALUMINUM

New aluminum produced in the United States in 1932 amounted to 104,885,000 pounds (52,443 short tons) valued at $20,453,000, representing decreases of 41 percent in quantity and 45 percent in total value compared with 1931. The total decline from maximum domestic production of aluminum, attained in 1930, was 54 percent. According to statistics collected by J. P. Dunlop, of the Bureau of Mines, 24,000 short tons of secondary aluminum were recovered in 1932, 12,200 tons as metal and 11,800 tons as the aluminum content of casting alloys. Thus, in 1932 the combined domestic production of the new aluminum and of secondary aluminum recovered as metal and in alloys amounted to 76,443 tons, 68.6 percent of the total being new metal and 31.4 percent secondary or recovered material.

Aluminum produced in the United States, 1928–32

Year	Primary metal		Secondary metal		Year	Primary metal		Secondary metal	
	Pounds	Value	Pounds	Value [1]		Pounds	Value	Pounds	Value [1]
1928	210,000,000	$47,899,000	95,600,000	$22,848,400	1931	177,544,000	$37,284,000	60,600,000	$12,726,000
1929	225,000,000	51,864,000	96,800,000	23,135,200	1932	104,885,000	20,453,000	48,000,000	10,992,000
1930	229,035,000	50,961,000	77,200,000	17,177,000					

[1] 1928–29: Value of secondary aluminum based on average price at New York as given by American Metal Market; 1930–31: Based on average price as reported to Bureau of Mines; 1932: Based on average price of 22.9 cents a pound.

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 the year. The open-market quotation at New York for virgin metal, 98 to 99 percent pure, was held at 22.9 cents a pound.

Consumption and uses.—Consumption of aluminum declined further in 1932, but precise data indicating the extent of the recession are not available. It is reported, nevertheless, that industrial research directed toward extending the use of the metal has continued and that this has produced satisfactory results in several directions.

The choice of any metal for a particular use is determined largely by its chemical and physical properties, and the outstanding property of aluminum is its lightness. This was a factor in the early use of aluminum for kitchen utensils and in its subsequent use in automobiles, airplanes, airships, and other means of transportation. Aluminum competes with copper as an electrical conductor; it is a noteworthy adjunct to the metallurgy of steel. Lately it has become important as a light structural material made strong by alloying and heat treatment. It is marketed in die castings; sand castings; permanent structural shapes; foil; paints; powder; round, square, flat, and hexagonal wire; rivets; bolts; nuts; screen; perforated sheets; bottle caps; drums; barrels; collapsible tubes; tanks and tank cars; pans; shingles; corrugated sheets; and many other forms.

When the weight of transportation equipment is reduced by the use of aluminum a corresponding increase in the weight of the pay load is permitted; or, if the pay load is not increased, lighter equipment decreases the inertia to be overcome in starting into motion and the momentum to be overcome in stopping. Reduction in operating costs and maintenance expense therefore results. Because of these advantages there has been an increasing trend toward the use of aluminum in motor trucks and the rolling stock of railroads and street railways. It is reported that in 1932 transportation continued to account for the largest percentage of aluminum consumption.

Aluminum alloys are now employed in the chassis frames of motor trucks as well as in the body and the cab, in trucks of the heavy-duty dump type having 25 tons capacity, and in rapid delivery vans. For the latter class of vehicles there was an innovation in 1932 of trucks having pressed aluminum-alloy frames that were especially light.

In recent years there has been a decline in the use of aluminum for pleasure cars, except those of the higher price range, and for pistons. In the past year a new design of aluminum piston called the T-slot piston, so named because of the shape of a slot cut in its edge, was placed on the market. It is said to permit close clearance due to a tendency of this piston to conform to the cylinder. Likewise the more extensive use of high-compression motors led in the past year to the adoption of aluminum cylinder heads by some motor-car manufacturers. In this use the thermal conductivity of aluminum is said to be an advantage.

For several years past there has been gradual extension in the use of aluminum in the construction of railroad passenger cars, by which 5 or 6 tons of weight are saved in an ordinary car. Tank cars for chemicals, saving 4 tons of weight, have also been built. In 1931, experiments were made in building Pullman cars in which aluminum was used as extensively as possible, and the success of this experiment led in 1932 to the development of a light, stream-line railway car for main-line service. It is constructed almost entirely of light, strong aluminum alloys and is motored by a 16-cylinder gasoline engine.

It is doubtful whether the present development of aircraft would have been possible but for aluminum and its alloys. Until recently the demand for aluminum in this field showed rapid increase. With a marked curtailment in the production of aircraft, the consumption of aluminum by the various aviation industries has diminished. The building of the U.S.S. *Macon*, sister ship of the U.S.S. *Akron*, has, however, held the tonnage of aluminum employed in lighter-than-air craft at approximately the same level for the past 2 years.

Requirements of aluminum for building construction amounted to 10 percent of consumption in 1932. The advantage of aluminum in the design of buildings is its resistance to acid atmospheric corrosion and its ability to reduce the load to be carried by steel structures when it is substituted for steel, brick, or concrete or used as a fireproofing material. In the Rockefeller Center, New York, recently completed, aluminum was used very extensively for spandrels, window sills, rails, grills, and other decorative features.

Duraluminum was the first strong aluminum alloy developed, but there is now a large variety of such alloys, some for casting and others more suitable for forging and rolled shapes. Plates and all structural shapes are now available in strong aluminum alloys. They are suitable for use in the construction of large moving parts, such as those of cranes and derrick booms in which aluminum is said to make possible a longer reach and more rapid action. Used to some extent in such equipment as buckets of drag-line scrapers, mine skips, and mine cars, larger capacity is possible with a given weight.

Aluminum foil has been used as an insulating material in several fields, either as a backing of wallboard or as a crumpled filler. It has been applied not only for wall insulation of buildings and refrigerator cars but on shipboard for insulating bulkheads, hulls, and steam systems. The use of foil for milk-bottle caps and for other food containers has grown, and ornamental foil—including that which is colored—is employed in the confectionery trade.

The coloring of aluminum has been well developed recently, and virtually any color combination is now available for uses requiring color finishes resistant to abrasion. Colored aluminum is being employed to some extent in household decoration and in the manufacture of household and office appliances.

Collapsible tubes for shaving creams, cosmetics, and greases are also increasing in use. Aluminum is particularly valuable for use in packing many drugs. It is also reported that a trial of aluminum instead of other metals during the past 12 years has shown higher resistance to certain types of corrosive conditions in sewage-disposal plants.

Aluminum equipment is used in chemical industries due to resistance of the metal to certain types of corrosion; it possesses, as well, a valuable combination of physical properties that permit its casting and working with comparative ease. Its lightness often proves a determining factor in selection, as most other metals suitable for the manufacture of equipment are several times as heavy as aluminum. Alloys of aluminum with silicon make good castings for chemical equipment and resist corrosion. For the manufacture of wrought products manganese-aluminum alloys prove resistant to corrosion and satisfactory for casting and provide mechanical strength as well. An alloy containing 1.25 percent manganese is frequently used.

In processes where aluminum is subjected to attack by alkalies it is found that addition of a very small amount of sodium silicate inhibits such attack.

IMPORTS AND EXPORTS

Aluminum imports decreased 43 percent in total value—from \$3,210,745 in 1931 to \$1,822,202 in 1932. Imports of aluminum metal, scrap, alloy, etc., decreased 45 percent in quantity in 1932 compared with 1931; imports of plates, sheets, bars, circles, disks, etc., decreased 29 percent in quantity; imports of hollow ware increased 11 percent in quantity and 222 percent in value; and imports of aluminum powders and foil decreased 20 percent in quantity.

Aluminum exports decreased 49 percent in value—from \$2,854,745 in 1931 to \$1,452,375 in 1932. Exports of crude and semicrude aluminum decreased 6 percent in quantity in 1932 compared with 1931; exports of tubes, moldings, castings, and other shapes decreased 35 percent in quantity.

Aluminum imported for consumption in the United States, 1931–32, by classes

Class	1931 Pounds	1931 Value	1932 Pounds	1932 Value
Crude and semicrude:				
Crude form, scrap, alloy, etc	14,664,195	\$2,497,314	8,064,830	\$1,310,228
Plates, sheets, bars, rods, circles, squares, etc	168,612	42,442	119,883	29,227
	14,832,807	2,539,756	8,184,713	1,339,455
Manufactures:				
Leaf (5½ by 5½ inches)	(1)	59,049	(1)	16,669
Bronze powder and powdered foil	591,684	175,981	598,417	159,831
Foil less than 0.006 inch thick	1,070,119	322,865	722,762	53,084
Table, kitchen, and hospital utensils and other similar hollow ware	117,649	61,711	130,792	198,460
Other manufactures	(2)	51,383	(2)	54,703
		670,989		482,747
Grand total		3,210,745		1,822,202

[1] 1931: 39,699,868 leaves; 1932: 13,723,695 leaves; equivalent in pounds not recorded.
[2] Quantity not recorded.

Aluminum imported for consumption in the United States, 1928–32

Year	Crude and semicrude [1] Pounds	Crude and semicrude [1] Value	Manufactures of [2]	Total value
1928	38,847,007	\$8,057,107	\$816,368	\$8,873,475
1929	50,880,823	9,934,723	925,286	10,860,009
1930	25,461,179	4,689,521	596,063	5,285,584
1931	14,832,807	\$2,539,756	\$670,989	\$3,210,745
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, 1931–32, by classes

Class	1931 Pounds	1931 Value	1932 Pounds	1932 Value
Crude and semicrude:				
Ingots, scrap, and alloys	1,510,688	\$132,484	3,904,802	\$317,571
Plates, sheets, bars, strips, and rods	3,190,190	853,386	531,888	151,221
	4,700,878	985,870	4,436,690	468,792
Manufactures:				
Tubes, moldings, castings, and other shapes	1,292,400	551,606	839,043	336,766
Table, kitchen, and hospital utensils	(1)	386,744	(1)	201,979
Other manufactures of aluminum	(1)	930,525	(1)	444,838
	(1)	1,868,875	(1)	983,583
Grand total	(1)	2,854,745	(1)	1,452,375

[1] Quantity not recorded for table, kitchen, and hospital utensils and other manufactures.

Aluminum and manufactures of aluminum exported from the United States, 1928–32

Year	Crude and semi-crude [1]		Manufactures	Total value	Year	Crude and semi-crude [1]		Manufactures	Total value
	Pounds	Value				Pounds	Value		
1928	15,728,281	$3,758,728	[2] $3,132,762	$6,891,490	1931	4,700,878	$985,870	[2] $1,868,875	$2,854,745
1929	17,032,117	4,149,539	[2] 3,821,546	7,971,085	1932	4,436,690	468,792	[2] 983,583	1,452,375
1930	17,329,511	3,915,582	[2] 3,206,272	7,121,854					

[1] Includes ingots, metal and alloys, plates and sheets, etc.
[2] Tubes, moldings, castings, and other shapes exported amounted to 1,003,957 pounds in 1928, 2,466,508 pounds in 1929, 1,864,308 pounds in 1930, 1,292,400 pounds in 1931, and 839,043 pounds in 1932; figures for quantity of table, kitchen, or hospital utensils and other manufactures exported are not recorded.

From the preceding tables of imports and exports in 1932 it appears that the total imports for which the weights are recorded were 4,818 short tons and the total exports 2,638 tons. The excess of imports over exports thus accounted for amounts to 2,180 tons, indicating an approximate total supply of 54,623 tons of aluminum, other than domestic secondary, for domestic consumption.

FOREIGN BAUXITE AND ALUMINUM INDUSTRIES

World production of bauxite.—World production of bauxite in 1931 was 1,071,000 metric tons, a decline of 34 percent from the production of the previous year. This included 347,947 tons (32.5 percent) produced by France, 199,039 tons (18.6 percent) by the United States, 173,154 tons (16.2 percent) by Dutch Guiana, 127,103 tons (11.9 percent) by British Guiana, 89,556 tons (8.3 percent) by Hungary, 67,369 tons (6.3 percent) by Italy, and 62,018 tons (5.8 percent) by Yugoslavia. These seven countries thus account for 99.6 percent of the total; and the balance is credited to Northern Ireland (3,394 tons), Greece, Rumania, Spain, and Australia. Europe thus supplied 53 percent of the total, South America 28 percent, and North America about 19 percent. In 1930 the respective percentage productions of these continents were about 55 percent, 24 percent, and 21 percent.

The corresponding production for 1932 is not known as yet, but it is certain to represent a further severe decline, because production of the United States fell about 51 percent and that of Dutch Guiana about 30 percent, although production of some countries of Europe is reported to have been maintained fairly well. Production of Hungary is unofficially reported as 84,000 metric tons, a decline of only 6 percent. The limited data available suggest that the world total for 1932 may approximate 800,000 metric tons.

World production of aluminum.—World production of aluminum in 1932 is estimated at 153,000 metric tons, a decline of 33.5 percent from that of 1931 (230,000 metric tons). This is less than the production of 1924 but greater than that of any year previous to 1924. Of the total, North America produced 42.7 percent compared with 48.4 percent in 1931. All other production was from Europe.

Production of the United States (47,575 metric tons, equivalent to 31 percent of world production) exceeded by a large margin that of any other country. Norway, with 19,310 metric tons (12.6 percent) was second; and Canada, with 17.960 tons (11.7 percent) was third. Other producers were France, 14,160 tons (9.2 percent); Germany, 14,110 tons (9.2 percent); Switzerland, 13,780 tons (9 percent); Italy, 13,413 tons (8.7 percent); Great Britain, 8,860 tons; Austria Hungary, 3,200 tons; and Spain, 1,000 tons.

The production of the United States and Great Britain declined 41 and 38 percent, respectively, in 1932 as compared with 1931, that of Canada, 39 percent; France, 41 percent; and Germany, 44 percent. Production of Switzerland and Norway declined only 14 percent and 10 percent, respectively. Italy alone made an increase in production in 1932 compared with 1931 (21 percent).

World production of bauxite, 1928–32, by countries, in metric tons

Country	1928	1929	1930	1931	1932
Australia:					
New South Wales	------	------	------	199	(1)
Victoria	196	555	(1)	(1)	(1)
British Guiana [2]	168,077	188,123	121,536	127,103	(1)
France	636,000	666,348	609,180	347,947	(1)
Germany	6,860	7,256	1,391	------	(1)
Greece	300	6,280	2,280	1,150	(1)
Hungary	395,974	389,152	31,696	89,556	84,000
India, British	14,902	9,189	2,554	------	(1)
Italy	162,229	192,774	161,187	67,369	(1)
Rumania	653	926	678	381	(1)
Spain	181	975	323	(1)	(1)
Surinam (Dutch Guiana)	213,869	209,998	264,556	173,154	[3] 134,061
United Kingdom: Northern Ireland	2,322	2,359	2,070	3,394	(1)
United States	381,452	371,648	335,918	199,039	97,895
Yugoslvaia	49,264	103,366	94,700	62,018	(1)
	2,032,000	2,149,000	1,628,000	1,071,000	(1)

[1] Data not available. [2] Exports. [3] Imports into United States.

NORTH AMERICA

Canada.—Canada has no production of bauxite, but its cheap water power led to the establishment of aluminum reduction works at Shawinigan Falls and Arvida, in Quebec, which have operated chiefly upon alumina imported from the United States. They are now owned by the Aluminum Co. of Canada, a subsidiary of Aluminium, Ltd. The latter was created in 1928 to take over practically all foreign interests of the Aluminum Co. of America. Canada produced 17,960 metric tons of aluminum in 1932, compared with 29,500 metric tons in 1931 and 34,900 tons in 1930. Exports in 1932 were 9,172 short tons, compared with 10,769 tons in 1931 and 21,663 tons in 1930.

In 1932 Canada agreed with the U.S.S.R. to exchange aluminum for mineral oil.

Greenland.—Greenland is the only source of natural cryolite, annual exports of which recently averaged about 30,000 tons. The production goes to Denmark for refining and reexport to other countries of Europe.

SOUTH AMERICA

British Guiana.—British Guiana is an important source of high-grade bauxite, produced chiefly by the Demerara Bauxite Co., Ltd., a subsidiary of Aluminium, Ltd. Annual production recently averaged about 200,000 tons, but it had fallen to 127,000 metric tons in 1931. The deposits occur in small hills 60 to 80 miles from the coast. They are similar to the deposits of Dutch Guiana.

Dutch Guiana.—Dutch Guiana has important deposits of bauxite similar to those of British Guiana. They extend 15 to 100 miles from the coast in the region of Paramaribo. In thickness they range from 50 feet in the north to 10 feet in the south. The chief production is made by Surinaamsche Bauxite Maatschappij, a subsidiary of the Aluminum Co. of America, but minor production is made by the Kalbfleisch Corporation. In 1932 the Surinaamsche Bauxite Maatschappij exported to the United States 122,550 metric tons compared with 179,107 tons in 1931.

EUROPE

The European Aluminum Cartel was reorganized and was joined by Canada in 1932. It also includes the producers of Great Britain, Germany, France, and Switzerland, together with the subsidiary plants of German and Swiss companies in Italy, Austria, and Spain. It is called Alliance Aluminium Cie. A fixed price and export quotas apply to aluminum but not to manufactures of it. The price first established in 1926 was £105 a ton; it was reduced later to £95 and to £80 in 1932. Recent fluctuations in exchange values of currency are said to have disturbed the balance aimed at by the cartel, but the details of the situation have not been published.

Austria.—Austria recently produced between 3,000 and 4,000 tons of aluminum a year, most of which was exported. One of its two reduction plants, located at Lend-Gastein is owned by Aluminium Industrie, of Switzerland; the other, Aluminiumwerke Steeg, is located at Gmunden.

France.—France produces more bauxite than any other country—more than 600,000 tons a year until recently. Nearly half of this is usually exported as bauxite or as alumina made from it in France. The exports go chiefly to Great Britain, Switzerland, Germany, and Norway and in 1932 they exceeded 210,000 metric tons. A considerable part of the balance is used in France for abrasives, chemicals, and refractories.

French production of aluminum recently averaged between 25,000 and 30,000 tons, most of which was consumed in France, exports having amounted to about 3,000 tons a year.

Four fifths of French bauxite production originates in the Department of the Var and most of the balance in Hérault; both are located between the Rhône and the Alps. The streams from the latter furnish the hydroelectric power for a number of small aluminum reduction plants.

These plants have been gradually consolidated into a large company, producing about 90 percent of the French output, and a smaller company that produces the balance. The former is L'Aluminium Français, which has alumina works at St. Auban, Salindres, and Gardanne; its subsidiary, popularly known as Péchiney, because of its extravagantly long official name, owns reduction plants at 10 different points. The other company, the Société d'Electrochimie, d'Electrométallurgie et des Aciéries Electriques d'Ugine, extracts alumina at La Barasse and has three small aluminum reduction works.

Germany.—As it has only a small production of low-grade bauxite, Germany depends upon imports for its supply and has found difficulty in endeavoring to obtain control of deposits in Hungary, Yugoslavia, and Italy. These imports totaled more than 400,000 metric tons in

1928 but have since been reduced by half. In 1932 about 201,000 metric tons were imported. In 1931 total imports amounted to 211,000 tons, of which 83,000 tons were derived from France, 64,000 tons from Hungary, 46,000 tons from Yugoslavia, and 16,000 tons from Italy.

Germany has 5 aluminum reduction plants, 3 of which are owned by the Government, through the Vereinigte Aluminiumwerke. Another, at Rheinfelden, is owned by the Neuhausen concern of Switzerland. The total capacity, since recent improvement of the Rheinfelden plant, is 45,000 tons. Actual production, however, has ranged between 25,000 metric tons (produced in 1931) and 30,000 metric tons. Production in 1932 was only 14,110 metric tons. The 25 rolling mills in Germany use about half the aluminum produced there. Germany has specialized in the manufacture of aluminum foil, for which the market is rapidly improving, due to the new use of foil for insulation.

Greece.—Greece has some bauxite from which sporadic production in small amounts is made.

Hungary.—Hungary has enormous reserves of bauxite and in 1928 produced nearly 400,000 metric tons, largely for export, but by 1932 production had fallen to 84,000 metric tons. Although aluminous cements are manufactured, aluminum is not produced by Hungary. Exports go to Germany, Austria, Czechoslovakia, and Rumania.

Italy.—Italy has not only substantial reserves of bauxite but has established production of alumina from leucite by the Blanc process. Recent endeavors have resulted in a well integrated industry with steadily expanding production of aluminum.

Italy produced 67,400 tons of bauxite in 1931, compared with 161,000 tons in 1930, 192,800 tons in 1929, 162,200 tons in 1928, and 95,300 tons in 1927.

Bauxite deposits are found chiefly at Lecce di Marsi and Pescolido, Abruzzi, and in Istria, and the reserves have been estimated at 13,600,000 tons, having a content of 40 to 63 percent alumina. Of these reserves 8,100,000 tons are in Istria and 5,500,000 in Abruzzi. Reserves of aluminum in the leucite of Naples and Orvieto are estimated at about 30,000,000 tons. Production of aluminum in 1932 was 13,413 metric tons, compared with 11,109 tons in 1931; 8,000 tons in 1930; 7,400 tons in 1929; 3,500 tons in 1928; and less than 2,000 tons in 1926.

It appears to be the policy of Italy to cooperate with the cartel, while refusing to be diverted from its policy of increasing output and reducing the price of aluminum. Electrification of Italian state railways in the coming year is expected to increase further—by approximately 20 percent—the domestic demand for aluminum.

Italian plant capacity is now estimated at 13,500 metric tons, 6,000 tons being that of the Mori works of the Montecatini group. Further extension of plant to treat leucite is discouraged by surplus domestic output and by the existence of large world stocks of aluminum.

Norway.—Norway produces no bauxite, but its water power has made it an important producer of aluminum from imported bauxite and alumina. These imports recently averaged about 60,000 tons; production of aluminum exceeded 20,000 tons, and virtually all that was produced was exported. This constitutes an interesting example of international utilization of natural resources of water power.

Production of aluminum in 1932 was 19,310 metric tons, compared with 21,421 tons in 1931. Imports of alumina in 1932, aside from those of bauxite, were 23,619 metric tons; exports of aluminum were about 14,000 tons.

The principal companies operating aluminum-reduction works include the following:

Aktieselskapet Stangfjordens Elektrokemiske Fabriker, at Standfjord (owned by the British Aluminium Co.); annual capacity, 400 tons.

Aktieselskapet Vigelands Brug, at Vigelands (owned by the British Aluminium Co.); annual capacity, 3,000 tons.

Det. Norske Nitridaktieselskab, at Eydehan and Tyssedal (owned by Compagnie A.F.C., British Aluminium Co., and Aluminium, Ltd.); annual capacity in 1929, 15,000 tons.

Norske Aluminium Co., at Höyanger (owned jointly by Norwegian interests and Aluminium, Ltd.); annual capacity, 6,500 tons.

A. S. Haugvik Smelteverk, at Glomfjord; annual capacity, 8,000 tons.

The first production of aluminum was made in 1908. The total rated annual capacity in 1930 was about 36,000 tons, of which the subsidiaries of Aluminium, Ltd., produced a considerable part. Norway is fortunate in possessing hydroelectric power sites on excellent harbors.

Spain.—Spain is the most recent country to enter the aluminum-producing field. The only works are at Sabiñanigo, Province of Huesca, where the plant is operated by the Aluminio Español, S. A.; it has a rated capacity of 1,200 tons a year. Production of aluminum amounts to about 1,000 metric tons and imports of alumina to about 2,000 metric tons.

Switzerland.—Water power of the Alps enables Switzerland to produce aluminum from imported alumina. About three fourths of the aluminum produced is then exported. The industrial situation in Switzerland thus closely resembles that in Norway. Swiss production of aluminum was about 13,800 tons in 1932 compared with 16,000 tons in 1931. Imports of alumina recently averaged about 40,000 tons, production of aluminum about 20,000 tons, and exports about 15,000 tons, a third of which went to Germany.

The principal Swiss company is L'Aluminium Industrie, often called the Neuhausen concern. It has two plants in Switzerland, at Neuhausen and at Chippis; another at Rheinfelden, Germany; and a fourth at Lend, Austria. It also has an Italian subsidiary, Societa Alluminio Veneto Anonima, with a plant capacity of 6,000 tons, at Porto Marghera, Italy.

The other company is Fabrique d'Aluminium Martigny, S. A., at Martigny-Bourg, in the Canton of Valais (on the French border west and south of the Chippis works). Its annual production is about 1,800 tons.

United Kingdom.—The only bauxite produced in the United Kingdom comes from near Belfast, Northern Ireland, at Larne Harbor, County Antrim. Bauxite from this source, however, has not been able to compete successfully with foreign ores. The average annual production amounts to about 3,000 tons, the output in 1931 having been 3,394 metric tons.

Production of aluminum in 1932 amounted to 8,860 metric tons, compared with 14,300 metric tons in 1931, 14,000 tons in 1930, 13,900 tons in 1929, and 10,700 tons in 1928.

Early in 1932 the United Kingdom exported to Germany for the first time, particularly to points where freight rates favored British shippers over German producers. Evidently the exchange favored the British since they went off the gold standard.

The following quotation indicates the effect of the new British tariff act on the Norwegian aluminum industry:

> Although since the opening of the North British Aluminium Co.'s plant at Kinlochleven last year the output capacity in the British Isles is ample for home trade requirements, the tariff will not be without some effect on the aluminium market here. A substantial proportion of the imports of raw aluminium has come from Norway where the British producers' subsidiaries have reduction plants, and presumably all this metal will now find a market on the Continent rather than pay a 10 percent import duty. Against this, however, practically all the bauxite used for the production of the metal here is imported from abroad and consequently will have to pay duty, to say nothing of the petroleum coke and other substances needed for the electrodes, which constitute no small proportion of the expenses of aluminium production.

The British Aluminium Co., Ltd., the chief producer, has two reduction works, both in Scotland. The North British Aluminium Co., Ltd., has another plant in Scotland. A fourth plant is that of Aluminium Corporation, Ltd., in Wales. Imports of bauxite are derived chiefly from France.

U.S.S.R.—The Soviet plan for creation of an aluminum industry includes construction of three plants. The first to be completed is that at Volkhov, on the banks of the River Volkhov about 75 miles from Leningrad, where production at a rate of 5,000 tons per annum will start in May 1933; the plant is expected to be increased to a capacity of 12,000 tons by 1935. This plant will use Volkhov bauxite (Tikhvinsky) and will also manufacture bauxitic cement.

A second plant is established near the great Dnieper hydroelectric plant and is expected to come into production in 1934 with a capacity of 40,000 tons. A third plant is proposed at Sverdlovsk, with an annual capacity of 50,000 tons of aluminum by 1935. It is said, however, that construction of this plant has not yet begun, so that the near prospect of Soviet production appears to be limited to something like 50,000 tons; in contrast, it has been pointed out that Soviet imports of aluminum in 1932 amounted to only 14,000 tons, of which Norway supplied nearly 8,000 tons and France nearly 5,000 tons.

Intensive search for bauxite has been conducted by the Soviets for several years past, and many discoveries have been reported, but as yet adequate details for their evaluation are lacking.

Last year the Soviets obtained the services of engineers of the French Péchiney concern for technical assistance in construction of aluminum works but were recently recalled to France because of difficulties that arose.

Yugoslavia.—Yugoslavia has deposits of high-grade bauxite, providing very large reserves, but it has only one small reduction plant. Production of bauxite in 1931 was 62,000 metric tons compared with 95,000 tons in 1930 and 103,000 tons in 1929.

The principal deposits occur in northern and central Dalmatia, Bosnia, and Herzegovina, Slovenia, and western Croatia, those of Dalmatia being the most important. The richest ores are along the Adriatic coast; the ore contains 50 to 60 percent alumina and 0.25 to 3 percent silica.

The deposits along the valleys of the Drave and Save Rivers have been estimated to contain 80,000,000 to 100,000,000 tons, much of which averages 60 percent alumina and less than 1 percent silica.

ASIA

India.—India is said to have extensive deposits of bauxite, from which only a small production has been made as yet; it was less than 10,000 tons in 1929, and has since declined severely.

Japan.—Japan produces no bauxite but imports crude aluminum for manufacture in domestic plants. An endeavor is being made to obtain bauxite from Pacific islands. Imports of aluminum were nearly 12,000 tons in 1929 but since declined to as little as 2,500 tons in 1931. Larger purchases have recently been made, so that Japanese stocks are said to amount to 10,000 tons, a year's supply.

AUSTRALIA

Bauxite occurs in Australia, but only small production has occurred, chiefly from Victoria.

MERCURY

By Charles F. Jackson and H. M. Meyer

During 1932 production of mercury here and abroad was curtailed drastically in the face of large stocks abroad and continuation of the drop in world prices which began in June 1931. Production of mercury in the United States decreased to 12,622 flasks with a calculated value of $731,129 in 1932 from 24,947 flasks with a calculated value of $2,179,145 in 1931. The number of producing mines was 95 in 1932 compared to 77 in 1931. A considerable number of the mines reporting production in 1932 produced only 1 to 20 flasks each. The sharp decline in prices which began in 1931 forced many mines to close in the fall of that year. The brief rise in price in March and April 1932 encouraged resumption of operations at some mines, but a later slump to 70 percent of the lowest 1931 price prostrated the domestic producing industry. The domestic price stiffened in March and April, advancing from $66.30 per flask in February to $72.54 in March. In May, however, the price again dropped to February levels and continued to fall until September, after which it remained fairly steady at around $47 to $49 per flask until the end of the year. The low prices prevailing during most of the year forced suspension of operations at most domestic mines, and the production for the year was approximately half that during 1931. The European price, which had been maintained by the Spanish-Italian cartel until June 1931 and which had made it possible for American producers to export considerable of their excess production in that year, broke sharply in January 1932 and continued to decline. The European price in New York broke to $52 per flask, duty paid, in October. Consequently, exports from this country dropped from 4,984 flasks in 1931 to 214 flasks in 1932, most of the 1932 exports going to countries in the Western Hemisphere. On the other hand, general imports increased from 356 flasks in 1931 to 8,114 flasks in 1932. Thus the position occupied by the United States as an exporter of mercury in 1931 was only transitory, and in 1932 the United States returned to its previous status as an importer. In comparing statistics of consumption and imports for 1932 with those of previous years it should be borne in mind that in 1932 some 530,000 pounds (7,000 flasks) were imported for use in two mercury-vapor boiler installations at electric power-generating plants. This quantity of mercury represents about 30 percent of the total consumption in this country in an average year, and it is unlikely that further such quantities will be required for a similar purpose in the near future.

At the end of the year stocks of mercury in the United States in producers' hands were low, and domestic production had been curtailed to match consumptive demand. It is believed that considerably higher prices will be necessary before it will be profitable to resume operations at many mines in the United States that were closed in 1931 and 1932. Pending considerable price increases it is therefore probable that consumers' requirements will continue to be filled in part by imported mercury.

Reports were current during the middle of the year that the Italian interests, dissatisfied with the price situation, were about to withdraw from the cartel, Mercurio Europeo. This cartel, organized in 1928, had been able to maintain prices up to the middle of 1931 but apparently could never control the production of its members, with the result that large stocks accumulated. When price control was lost also and prices dropped precipitously in 1932 the effectiveness of the cartel was lost, at least temporarily. It was later reported that legal difficulties stood in the way of immediate withdrawal of the Italian interests, that differences had been patched up, and that dissolution of the cartel had been avoided.

Salient statistics of the mercury industry in the United States, 1930–32

[Flasks of 76 pounds]

	1930	1931	1932
Production flasks	21,553	24,947	12,622
Number of producing mines	75	77	95
Average price per flask:			
New York	$115.01	$87.35	$57.925
London	£21 15s. 8d	£19 15s. 10d	£13 15s. 2d
Imports for consumption:			
Pounds	283,086	41,733	295,348
Equivalent flasks	3,725	549	3,886
Apparent supply flasks	25,200	20,512	16,294
From domestic mines percent	85	97	76
Stocks in warehouses (bonded) at end of year flasks	305	88	[1] 3,840

[1] Probably includes about 3,550 flasks imported late in the year on 1 large contract.

Prices.—During most of 1931 the quotations on imported mercury were well above the prices at which the product of domestic mines was being sold. Much of the time the New York price was approximately the same as the European, not including the duty of $19 per flask, and the latter was sometimes higher, thus enabling the United States to enter the foreign market. With the almost vertical drop in European prices in 1932 foreign mercury could be imported into the United States for less than the cost of production at most American mines.

On January 8 the American Metal Market reported that it had been announced in London that metal from Mercurio Europeo was available at $65 f.a.s. European port of shipment, although it had previously been reported that the trust had disposed of 30,000 flasks to a syndicate in London which would market the metal at $75. The London price had fallen to £16 10s. or $60 at the prevailing rate of exchange by the end of April, and by the middle of July mercury was quoted in London at £11 10s. A low price of £9 18s. 6d. was obtained late in July, but by December first the price had increased to £11.

The trend of domestic prices during 1931 and 1932 is shown in the following table.

Trend of domestic prices of mercury, 1931 and 1932 (New York) [1]

[Per flask of 76 pounds]

	1931	1932		1931	1932
January	$103.000	$64.900	August	$80.115	$47.444
February	100.205	66.304	September	76.300	47.500
March	100.423	72.537	October	72.385	47.600
April	102.077	72.125	November	68.587	48.750
May	101.140	66.380	December	66.115	48.500
June	92.058	59.481			
July	85.808	53.580	Year	87.351	57.925

[1] Eng. and Min. Jour., New York.

Average yearly prices of mercury in the United States and the United Kingdom, 1928–32

[Per flask of 76 pounds, except as indicated]

Year	San Francisco (domestic) [1]	New York [1]	London [2]	Year	San Francisco (domestic) [1]	New York [1]	London [2]
			£. s. d.				£. s. d.
1928	[3] $125.34	$123.51	22 6 1	1931	(4)	$87.35	19 15 10
1929	[3] 124.00	122.15	22 5 2	1932	(4)	57.925	13 15 2
1930	(4)	115.01	21 15 8				

[1] Eng. and Min. Jour., New York.
[2] Mining Journal (London).
[3] Beginning Oct. 27, 1928, quotations for San Francisco are on basis of "retail and small wholesale lots".
[4] Not given.

Consumption and uses.—The following table shows the supply of mercury in the United States from 1922 to 1932.

Supply of mercury in the United States, 1922–32

[Flasks of 76 pounds]

Year	Production (flasks)	Imports for consumption (flasks)	Exports (flasks)	Apparent supply: Total (flasks)	Apparent supply: From domestic mines (percent)	Apparent supply: Imported (percent)
1922	6,291	16,697	287	22,701	26.4	73.6
1923	7,833	17,836	314	25,355	29.7	70.3
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

[1] Not separately classified, 1927–30.
[2] Estimated by Bureau of Mines.
[3] From a special compilation by the customs statistics section, Bureau of Foreign and Domestic Commerce.

Statistics covering the distribution of domestic consumption for 1928 were presented in Mineral Resources, 1929, part I, pages 118–119, and so far as is known similar figures have not been compiled for later years. These statistics showed that of a total domestic consumption of 34,482 flasks in 1928 drugs and chemicals accounted for about 39 percent and fulminate used in detonators and ammunition for 19 percent. Next in importance was the use of mercury for scientific instruments and electrical apparatus, followed in turn by vermilion, felt, and caustic soda and glacial acetic acid.

This order of importance probably has remained substantially the same since 1928, if the large amount of mercury used in 1932 for mercury-boiler plants is not considered, although the proportionate use for electrical apparatus may have increased somewhat.

No new uses for mercury that might be expected to result in greatly increased consumptive demand were reported during the year. There is no reason to expect additional large orders to be placed soon for mercury to be used in mercury-boiler installations, like those reported in 1932. It is stated that there is virtually no loss of mercury in these plants, and thus they do not constitute a source of continuing demand. Some time in the future electric generating plants probably will be installed which will require important amounts of mercury. Gradual increase in the requirements of the electrical industry may be anticipated.

The following abstracts from the technical press indicate that research on the hardening effect of mercury in base bearing alloys may eventually result in increased use of mercury with such alloys.

It is reported [1] that the addition of 5 percent of tin, mercury, bismuth, or cadmium to lead has a hardening effect. The Brinell hardness of pure lead is 5.7; with the addition of 5 percent of tin it is 9.7; of mercury, 10.1; of bismuth, 6.7; and of cadmium, 19.2. Additions of mercury to lead-base bearing metals have little influence on the hardness; the elastic limit of compression is increased, but the wearing properties are lowered. According to Rolfe,[2] information on the best alloys for use in cases where metal-to-metal contact is likely to occur is best obtained by making tests in a dry or slightly lubricated condition. Hard bearing metals usually consist of a somewhat plastic matrix in which hard grains are embedded. This will squeeze down to a better surface. Lead-base alloys can be used for rather high temperatures if the heat is frictional, but in automobile bearings, affected by heat from sources other than the bearing itself, the softer alloys do not serve so well. Unusual compositions used in a vessel of the German Navy contain copper 1.7–2.3 percent; lead, 0.6 percent; mercury, 3.5–6.5 percent; and tin, the balance. The mercury is in solid solution in the tin matrix.

The invention of a new mercury coin collector for prepayment telephones is reported. It is said that this collector eliminates about 100 parts essential in the type of prepayment telephones now in use.

A new mercury arc lamp of glass or quartz is described by Harries and Hippel.[3] The new lamp operates automatically and gives a linear source of light of high intrinsic brightness. The lamp uses little power in operation and develops little heat.

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[1] Ackermann, K. L., Low-Melting Heavy Metals in Lead-Base Bearing Metals: Metallwirtschaft, vol. 11, 1932, pp. 292–293; Chem. Abs., vol. 26, No. 18, Sept. 20, 1932, p. 4780.

[2] Rolfe, R. T., Bearing Alloys: Trans. Manchester Assoc. Eng., 1929–30, pp. 14–97; Metals and Alloys, vol. 2, p. 205; Chem. Abs., vol. 26, July 20, 1932, p. 3764.

[3] Harries, W., and Hippel, A. V., A New Mercury Arc Lamp of Glass or Quartz for Laboratory and Commercial Use: Physikal. Ztschr., vol. 33, 1932, pp. 81–85; Chem. Abs., vol. 26, Apr. 20, 1932, p. 2126.

REVIEW BY STATES

California retained first place among the mercury-producing States, although the gap between California production and the combined production of Texas, Arizona, Arkansas, and Alaska decreased considerably. The California production decreased to 5,172 flasks from 13,448 flasks in 1931, while there were increases in production

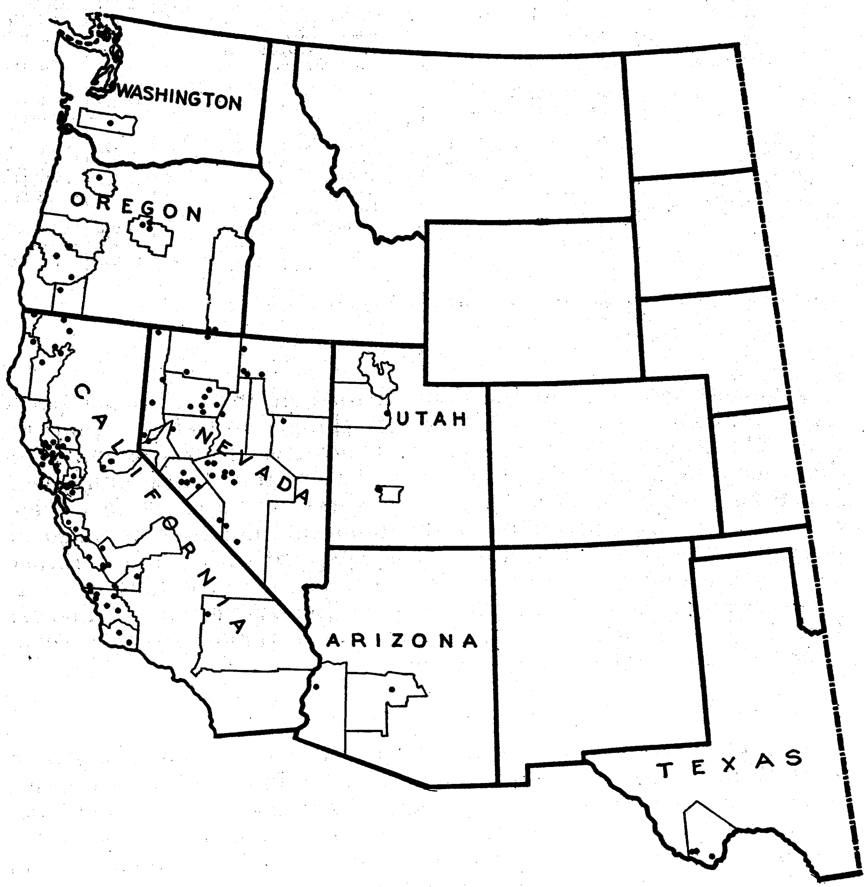

FIGURE 10.—Location of mercury mines and prospects, western United States.

from Arkansas and Texas. The increase in the number of producing mines in California from 45 in 1931 to 63 in 1932 was due to sporadic operations at a number of small properties by leasers and caretakers who would otherwise have been without employment, and the individual and aggregate output from such operations was small. A decrease in production was recorded by all States but Arkansas and Texas. Figure 10 shows the location of all mercury mines and prospects in the Western States.

Mercury produced in the United States, 1929–32

	Producing mines	Flasks of 76 pounds	Value [1]
1929:			
California	29	10,139	$1,238,428
Nevada	19	4,764	581,899
Oregon	5	3,657	446,684
Washington	2	1,397	170,637
Texas, Arizona, and Alaska	8	3,725	454,990
	63	23,682	2,892,638
1930:			
California	40	11,451	1,316,968
Nevada	20	3,282	377,460
Oregon	7	2,919	335,711
Washington	1	1,079	124,095
Texas, Arizona, and Alaska	7	2,822	324,555
	75	21,553	2,478,789
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

[1] Value calculated at average price for quicksilver at New York.

ARIZONA

Little mercury was produced in Arizona in 1932. Press reports stated that 14 flasks of quicksilver were shipped in October from the Tonto Basin property of the Arizona Quicksilver Corporation. The Empire State Mining Co. took over the Dreamy Draw mine near Phoenix in Maricopa County, and the shaft, which is 300 feet deep, was retimbered. Operations at this mine had not been resumed at the end of the year. The property is equipped with a 35-ton rotary kiln. According to press reports, a good grade of milling ore was struck early in the year in a tunnel at the Boardman mine, Sunflower district, 55 miles northeast of Phoenix. The tunnel was to be continued 40 feet to cut a high-grade ledge.

ARKANSAS

In May 1932 the State geologist [4] issued a report on cinnabar in southwestern Arkansas. This report, containing 38 illustrations, deals with topography and drainage, distribution of the deposits, geology and mineralogy of the ores, and development, discusses commercial possibilities, methods of prospecting, and development, and gives a number of descriptions of cinnabar in place. Branner states that the areal and structural geology of about 21 square miles had been mapped and a quantity of valuable detailed geological data accumulated. With regard to the commercial possibilities, Branner is quoted as follows:

> With the knowledge available at this time, it is impossible to form any clear idea of the commercial values to be expected in the cinnabar area as it is now defined. On the Parnell-Carroll tract in the Little Missouri River area, erratically mineralized zones, having an areal extent of 250 by 50 feet and a known depth of possibly 20 feet, exist, and cinnabar has been found on that tract through a maximum vertical range of 120 feet. In the Antoine Creek area mineralized zones, having an areal extent of about 15 feet along the strike and about 8 feet across the strike, have been found. One of these mineralized zones has a known vertical range of about 90 feet, and cinnabar has been found through a maximum

[4] Branner, George C., Cinnabar in Southwestern Arkansas: Arkansas Geol. Survey Inf. Circ. 2, 1932, 51 pp.

vertical range of 275 feet. Shale and sandstone contact deposits are also present in both of the above areas but little is known of their extent, either horizontally or vertically. Concerning the depth to which deposition may be expected to continue, no dependable estimate can be made. . . . At the present time it may be said that the situation appears to be distinctly encouraging for careful and systematic prospecting. The number of mineralized areas along the Cowhide Creek anticline and the Amity fault tend to bear out the belief that at least a few deposits, in the order of a few acres in extent each, will be found which will prove to be of sufficient size and richness to justify long term operation. Judging wholly from information now available, indications are that the metallic content of the ore within the minable areas will approximate that within the majority of the minable areas of western United States, although there apparently are no facts to demonstrate that areas of exceptional richness and size may not be discovered.

The Arkansas Quicksilver Co. installed a 2-tube, type "D", Gould retort at Graysonia late in 1931. On April 26, 1932, 25 flasks of mercury, constituting the first Arkansas shipment in bulk, were shipped. The C. Mining Corporation installed a 10-ton custom quicksilver-reduction plant near Kirby, which started operation in March but was soon shut down.

According to press reports the Southwestern Quicksilver Co. exposed a low-grade mineralized zone and a high-grade cinnabar vein 1 to 3 inches thick. Associated with this vein was an occurrence of native quicksilver in cavities. A semiportable rotary furnace was put in operation April 21 and handled an average of 12 tons per day. The ore is hand-sorted to yield about 10 pounds of quicksilver per ton.

CALIFORNIA

The output of mercury from California in 1932 was 5,172 flasks compared to 13,448 flasks in 1931. Most of the California mines must receive $60 to $70 per flask to operate, and the low prices prevailing in 1932 forced suspension of operations at many mines. Only a few operated continuously, others treated stock-pile ore and discontinued mining operations, while others did only development work. In spite of the large decrease in total output production was reported from 63 mines compared to 45 mines in 1931.

Colusa County.—The Cherry Hill mine treated a small tonnage of concentrates recovered from old dumps from which some mercury and gold were recovered. It was reported that the Western Merger Mines Co. has acquired the Manzanita property in Colusa County.

Fresno County.—At the Archer mine some road work was done, and a 3-pipe Johnson and McKay retort was installed; no mining was carried on although a small quantity of mercury was produced.

Kings County.—The Fredanna mine in the Parkersville district was sold to E. K. Anderson and J. W. McBride; a small retort handling 1 ton per day was operated both before and after transfer of the property, and some mercury was produced and sold.

Lake County.—Production was reported in 1932 by the Sulphur Bank, Great Western, Anderson-Schwartz, Konocti, Big Chief, Mirabel, Wilkinson, and several other mines. Only five mines in the county reported production of 20 flasks or more. The Sulphur Bank mine operated only a few days. The Great Western mine operated 315 days. E. J. Bumsted, president of the Bumsted Mining Co., operating the Great Western mine, has furnished the following interesting figures and kindly granted permission to publish them:

Tons treated, 6,063; quicksilver produced, 607 flasks; average recovery per ton, 7.6 pounds. Production costs were as follows:

Distribution:	Cost per ton	
Mining:		
Labor	$1.23	
Supplies	.17	
		$1.40
Treatment:		
Labor	.74	
Supplies	.06	
Maintenance	.04	
Fuel oil	.49	
Power	.14	
Lights	.03	
Flasks	.08	
Total treatment		1.59
Fixed and general charges:		
Audit and legal	.06	
Insurance, general	.04	
Insurance, compensation	.22	
Interest and taxes	.19	
Assaying	.02	
Auto and truck	.13	
Road repairs	.02	
Camp maintenance	.03	
Office and management	.62	
Depreciation	.30	
Depletion	.07	
Miscellaneous	.10	
Total fixed and general		1.80
Total cost per ton		4.79
Total cost per flask		47.82

Napa County.—Mercury was produced at the Aetna, Ivanhoe, Knoxville, La Joya, and Oat Hill, and other mines in 1932.

At the Mt. St. Helena mine 600 feet of drifting and 48 feet of raising were done. Press reports in October stated that an entirely new vein had been opened in the Aetna mine at St. Helena. Plans were made to do enough development work to have the ground ready for operation as soon as the price of quicksilver should justify it.

San Benito County.—Mines reporting some production of mercury in 1932 were Alpine, Aurora, New Idria, Stayton, Wonder, and a number of others, but only one produced an appreciable amount.

It was reported in the Engineering and Mining Journal December 1932 that the Alpine mine had resumed operations to develop a strike of cinnabar discovered while cleaning out old workings. The new vein was said to assay 4 percent mercury, but only enough ore was being treated to keep three retorts in operation. The New Idria mine near Mendota was closed in January, although during the first 5 months of 1932 the flotation plant was operated and the concentrates were retorted.

It was reported early in the year that H. V. Underwood and E. A. Matthews had installed three 12-foot flumes with riffles at the Bitter-water mine near Llanada for treating ore from the dumps and were carrying on sluicing and retorting operations. Drifting was stated to be under way, opening up ore of high enough grade to require no concentrating.

San Luis Obispo County.—Ten mines—the Carson, Deer Trail, Oceanic, Rinconada, and others—reported production of mercury during 1932.

Operations at the Deer Trail mine were suspended on August 1. The Cambria mine was closed all year, but a small amount of mercury was produced from clean-ups. Sporadic operations were conducted at the Carson (Klaŭ) mine. The Oceanic mine was operated by the Consolidated Metals Co.; the mining method was reported to have been changed to top slicing, effecting considerable reduction in mining cost. The Rinconada mine, equipped with a 50-ton rotary furnace and "D" retorts, produced considerable mercury. At the Bagby mine shafts were sunk on two veins of medium-grade ore 5 to 8 feet wide; very little ore was retorted.

Santa Barbara County.—Four mines, including the Extention and Los Prietos, reported production in 1932. The lease on the Extention was surrendered during the year. The ownership of Los Prietos mine passed to Edgar R. Larsen, who was reported in June to be repairing the roads and the 25-ton reduction plant and to be doing considerable underground development. It was stated that plans embraced the installation of two new 50-ton rotary furnaces and later a 200-ton concentrating plant.

Sonoma County.—The Culver-Baer, Cloverdale, and Contact mines each reported production in 1932. In October B. I. Potter and James G. Cortelyou were reported to have purchased the Cloverdale mine. The property was equipped with a 75-ton rotary kiln by the former operators.

Trinity County.—The Altoona mine was operated from April 15 to November 1 and produced considerable mercury.

NEVADA

The production of mercury in Nevada fell from 2,217 flasks in 1931 to 474 flasks in 1932. Most of the mines were idle during the greater part of 1932, although production was reported from 15 mines compared to 16 mines in 1931.

Elko County.—The Mayflower mine did not operate during 1932, except that some development work was done which yielded a small tonnage of ore. F. M. Williams reported 300 feet of development work at the Rimrock property 39 miles from Redhouse.

Esmeralda County.—A small production was reported from the Red Rock group of claims.

Humboldt County.—At the Buckskin mine, 75 miles north of Winnemucca, 1 mile of road was constructed, and a compressor and 1,500-pound retort were installed.

Mineral County.—The B and B, Spring, Crystal Quick, Stevens, Cardinal Quick, and Drew (Red Devil) mines each reported a small production in 1932. A somewhat larger production was reported from the Reward No. 4 and No. 5 mines, where the best ore is said to occur in chert and calcareous sandstone.

Nye County.—A few flasks of mercury were produced at the Flower mine from the retorting of screenings from the mine dumps.

Pershing County.—The Nevada Quicksilver Mines, Inc., was reported to have placed its rotary furnace in operation in May to treat ore accumulated during the winter from the Hunley-Forge lease. This property is 21 miles east of Lovelock in the Antelope Springs district. Northwest of it O. H. Oleson and J. H. Henry cut two veins of milling-grade ore, according to press reports.

Storey County.—The Castle Peak mine, 19 miles south of Reno, reported production in 1932. During the year a winze was sunk 135 feet below the mill-tunnel level, and a 20-horsepower hoist and a 12 by 10 air compressor were installed; the mine and plant have not operated since July 15, 1932.

Washoe County.—The Steamboat Springs Mining Co. reported a small output from its mine 1 mile from Steamboat Springs.

OREGON

The output of mercury from Oregon in 1932 was 2,523 flasks, about one half the production in 1931; 7 mines reported production in 1932, whereas only 5 reported in 1931.

Clackamas County.—A small quantity of mercury was produced at the Oak Grove prospect from ore reported to average about 15 pounds per ton.

Crook County.—The Maury Mountain Mining Co. placed its 25-ton Herreshoff furnace in operation May 31. The plant is operated by a 60-horsepower Diesel engine belted to a 260 cubic foot compressor and a 25-horsepower Diesel engine belted to a 20-kilowatt generator. In August it was reported that the company had found another promising cinnabar deposit. After some mercury had been produced operations were suspended pending higher prices for mercury. Some development work was done at the Mother Lode mine 37 miles from Prineville, and a few flasks of quicksilver were retorted.

Jackson County.—A small quantity of mercury was recovered from the Little Jean prospect 18 miles from Gold Hill.

Lane County.—The Black Butte mine, operated by the Quicksilver Syndicate and equipped with a 150-ton rotary furnace, accounted for a considerable output of mercury in 1932, derived from the treatment of 28,667 tons of ore. At the end of the year it was reported that the company was employing a few men to develop the 1,100-foot level of its mine and to keep the organization intact. In 1932, as in every year since 1928, this mine was one of the largest producers of mercury in the country.

Malheur County.—The Bradley Mining Co. suspended operations at the Opalite and Bretz mines in October after producing a considerable quantity of mercury earlier in the year.

TEXAS

The Terlingua district, Brewster County, Tex., continued to supply an important percentage of the mercury production in the United States.

The Big Bend mine of the Brewster Quicksilver Co. mined about 24,000 tons of ore and treated 8,582 tons in its furnaces, from which a considerable amount of mercury was recovered. Ore treated averaged 0.35 percent mercury. At the Fat-and-Forty mine installation of a 30-ton rotary furnace was begun.

Press reports at the end of October stated that the Chisos Mining Co. had operated continuously for 30 years. The Rainbow mine was active in 1932.

UTAH

In September it was announced in the press that the Sacramento Gold & Quicksilver property at Mercur would be developed by the company, following cessation of work by the International Smelting Co.

WASHINGTON

The State of Washington produced 407 flasks of mercury from 3 mines in 1932 against 560 flasks from 4 mines in 1931. The production was made by the Consolidated Mercury Mining Co., the Washington Cinnabar Co., and the Charlotte Ann Mercury Co., from mines near Morton, Lewis County. Some development work was reported at the property of the Shoshone Mercury Co. 12 miles from Dryden, Chelan County.

IMPROVEMENTS IN METALLURGY

During 1932 references appeared in the technical and trade journals to a few improvements in ore reduction and metal purification. C. N. Schuette has discussed the increased dust-collecting efficiency at the rebuilt reduction plant of the Brewster Consolidated Quicksilver Co., Terlingua, Tex., and has given comparative cost figures of the old and new plants.[5] In the old plant, of 91 flasks of quicksilver produced per month by a 33-ton furnace 23 were recovered as free quicksilver and 68 were in the dust; operating costs, including mining and treatment, averaged $246.60 per day. In the new plant the cost was $219.85 or $54.96 per flask, when 4 flasks were produced per day.

Experiments show that the separation of antimony and mercury from concentrates containing both metals is possible both technically and economically.[6]

The material is roasted first at 400° to 425° C. to separate mercury and then is transferred to a second furnace, where antimony oxides are separated at 500° to 550° C.

Moore [7] has discussed a method of mercury purification. An apparatus wholly of glass or silica is described in which purification is accomplished by washing the fine droplets of mercury, drying, and filtering to remove traces of copper, bismuth, lead, and iron.

U.S. Patent 1855901 covers introduction of mercury into discharge tubes. A body containing mercury as mercury sulphide is inserted within the envelope of an electrical discharge device and treated to effect reduction of the mercury (as by the action of iron, on heating).[8]

Colman describes a vacuum retort for cinnabar ores.[9] A small amount of air proportioned to the amount of sulphur in the charge is admitted to the vacuum retort. The value of the vacuum is stated to be as follows: Lower temperature requirement; force exerted on every particle of material under treatment; dusting reduced to a minimum; no danger of salivation to the workmen; fumes and condenser under full control at all times; loss of mercury can only be at the exhaust point of the vacuum, which is on the ground and alongside the operator.

[5] Schuette, C. N., Dust-Collecting Efficiency Increased in Quicksilver Reduction Plants: Eng. and Min. Jour., vol. 133, No. 4, April 1932, pp. 236-237.
[6] Shakhov, G. A., and Slobodska, Y. Y., Roasting of Concentrates Containing Quicksilver and Antimony and Their Separation by Successive Roasting: Tzvetnuie Metal, 1932, no. 1, pp. 23-28; Chem. Abs., vol. 26, Nov. 20, 1932, p. 5885.
[7] Moore, Burrows, Ind. Chemist, vol. 8, 1932, pp. 63-64; Chem. Abs., vol. 26, Apr. 20, 1932, p. 2093.
[8] Bareiss, Max, and Wiegand, Erick, Chem. Abs., vol. 26, June 20, 1932, p. 3147.
[9] Colman, Murray N., A Vacuum Retort for Cinnabar Ores: Min. Jour. (Arizona), Aug. 30, 1932, pp. 3-4.

FOREIGN TRADE

Imports.—General imports rose to 616,649 pounds (8,114 flasks) in 1932 from 27,054 pounds (356 flasks) in 1931, the largest part being in fulfillment of one contract reported to cover about 530,000 pounds (7,000 flasks) for use in two mercury-vapor boiler-plant installations. Shipments on this contract may have exceeded this amount. Imports from Spain totaled 346,090 pounds (4,554 flasks) and those from Italy 261,972 pounds (3,447 flasks). These large shipments contrast with shipments of only 26,609 pounds (350 flasks) from Spain and none from Italy in 1931. Belgium, which had not shipped to the United States since 1929, supplied 7,606 pounds (100 flasks) in 1932, while imports from Mexico shrank to 221 pounds (3 flasks) from 445 pounds in 1931 and 10,716 pounds (141 flasks) in 1930. Imports of 760 pounds from the United Kingdom were reported.

Mercury imported into the United States, 1928–32, by countries

[General imports]

Country	1928		1929		1930		1931		1932	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Belgium	68,454	$93,823	94,969	$129,083					7,606	$3,100
Canada	5	10	37,500	52,195	5	$9				
France			24,587	33,966						
Germany	40,954	57,414	53,259	70,677						
Hong Kong			3	4						
Italy	428,821	558,622	67,778	90,532					261,972	98,907
Mexico	136,208	176,968	91,854	122,229	10,716	13,747	445	$622	221	199
Peru			960	700						
Spain	464,206	643,621	715,311	947,756	212,965	282,073	26,609	32,027	346,090	128,637
United Kingdom	30,100	41,559							760	571
	1,168,748	1,572,017	1,086,221	1,447,142	223,686	295,829	27,054	32,649	616,649	231,414

Mercury compounds imported for consumption in the United States, 1931–32

Compound	1931		1932	
	Pounds	Value	Pounds	Value
Chloride (mercuric) (corrosive sublimate)	100	$75		
Chloride (mercurous) (calomel)	2,021	3,138	1,302	$1,352
Oxide (red precipitate)			7	19
Mercury preparations (not specifically provided for)	1,472	2,209	870	1,177
Vermilion reds (containing quicksilver)	25,365	30,463	15,620	15,301
		35,885		17,849

Exports.—In 1932 the United States exported 16,281 pounds of mercury (214 flasks) valued at $13,121, compared to 378,769 pounds (4,984 flasks) valued at $433,596 in 1931. Over 75 percent of the exports went to countries in the Western Hemisphere, and the balance was shipped to the Far East. No mercury was shipped to Europe in 1932, whereas in 1931 approximately half the mercury exported (189,465 pounds) went to Europe.

The accompanying table shows the exports of mercury in 1931 and 1932 and the countries of destination. Shipments to Canada were made from the following customs districts: St. Lawrence (2,161 pounds), Vermont (1,098 pounds), Buffalo, Michigan, Washington, and North Dakota. Exports to South and Central America, Cuba, and other islands in the Caribbean amounted to 8,168 pounds, of which 7,845 pounds were shipped from New York. Exports from San Francisco totaled 2,722 pounds, of which 2,420 pounds went to Australia. Exports to the Philippine Islands totaled 1,136 pounds, of which 986 pounds were exported from New York and 150 pounds from San Francisco.

Mercury exported from the United States, by destination, 1931–32

Destination	1931		1932	
	Pounds	Value	Pounds	Value
North America:				
Canada	61,522	$83,151	4,488	$3,746
Costa Rica	302	374	2,041	1,471
Cuba	1,481	1,941	156	148
Nicaragua	377	460	228	189
Other	1,394	1,585	1,633	1,171
	65,076	87,511	8,546	6,725
South America:				
Argentina	1,230	1,735	111	157
Colombia	1,273	1,898	2,270	2,007
Peru	3,465	3,986	210	250
Venezuela	1,056	1,435	1,071	1,085
Other	463	641	448	394
	7,487	9,695	4,110	3,893
Europe:				
Belgium	24,650	29,200		
Germany	102,173	121,013		
Netherlands	8,800	11,000		
United Kingdom	53,842	58,900		
	189,465	220,113		
Asia:				
Hong Kong	83,010	84,560		
India (British)	1,140	1,500		
Japan	29,440	26,507		
Philippine Islands	1,802	2,225	1,136	787
Other	1,129	1,268	69	107
	116,521	116,060	1,205	894
Oceania	220	217	2,420	1,609
	378,769	433,596	16,281	13,121

WORLD PRODUCTION

The following table shows the world production of mercury by countries for 1928–32:

World production of mercury, 1928–32, by countries

[1 metric ton=29.008 flasks of 76 pounds]

Country [1]	1928		1929		1930		1931		1932	
	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons
Algeria	--------	--------	122	4.2	325	11.2	1,073	37.0	1,184	40.8
Austria	133	4.6	113	3.9	72	2.4	72	2.5	(2)	(2)
Bolivia [3]	46	1.6	49	1.7	--------	--------	1,021	35.2	(2)	(2)
China [4]	1,973	68.0	580	20.0	725	25.0	638	22.0	(2)	(2)
Chosen	--------	--------	15	.5	26	.9	(2)	(2)	(2)	(2)
Czechoslovakia	2,086	71.9	1,897	65.4	2,060	71.0	2,222	76.6	1,305	45.0
Italy	57,677	1,988.3	57,966	1,998.3	56,069	1,932.9	37,652	1,298.0	27,740	956.3
Japan	14	.5	41	1.4	121	4.2	101	3.5	(2)	(2)
Mexico	2,535	87.4	2,396	82.6	4,946	170.5	7,292	251.4	7,350	252.7
New Zealand	--------	--------	--------	--------	52	1.8	450	15.5	(2)	(2)
Rumania	--------	--------	--------	--------	--------	--------	8	.3	(2)	(2)
Russia [5]	2,950	101.7	3,771	130.0	3,278	113.0	(2)	(2)	(2)	(2)
Spain	63,675	2,195.1	71,832	2,476.3	19,221	662.6	19,786	682.1	(2)	(2)
Turkey	124	4.3	235	8.1	537	18.5	235	8.1	(2)	(2)
United States	17,870	616.0	23,682	816.4	21,553	743.0	24,947	860.0	12,622	435.1
Total	149,083	5,139.4	162,699	5,608.8	108,985	3,757.0	98,600	3,400	(2)	(2)

[1] In addition to the countries listed, Taiwan reported production of 27,979 kilograms of cinnabar in 1929, mercury content not stated; and Chile reported 69 kilograms of metallic mercury produced in 1930.
[2] Data not available.
[3] Exports.
[4] Approximate production (Imp. Inst., London).
[5] Year ended Sept. 30.

Algeria.—Production in 1932 was 1,184 flasks compared to 1,073 flasks in 1931. Metal and Mineral Markets reported in the issue of April 14, 1932 that France had imposed import quotas on mercury from March 1 to June 30, this action probably being due to the close connection between the French Government and the Société dés Mines de Ras-el-Ma in Algeria and the desire to expand the output of these mines. The capacity of this property was said to be 2,500 flasks per year; it was proposed to increase this to 4,500 flasks.

The deposits of Ras-el-Ma in the Department of Constantine and of Taghit in Mount Aurès are the only ones of note discovered in Algeria, although cinnabar has been noted at many other places.

Australia.—No appreciable production has been reported from Australia as yet; however, Metal and Mineral Markets reported on August 18, 1932, that with suspension of operations by the New Zealand producer the only properties in the British Empire remaining in operation were those near Kilkivan, Queensland. On May 16, 1932 the Queensland Government Mining Journal reported that the Queensland Quicksilver Development Co., Ltd., had officially opened its retorts and treatment plant on April 23. The company property consists of 160 acres near Kilkivan, on which the plant is situated. It is developed by three shafts, from which alluvial stone (wash sand and pebbles) and ore are taken. Later in the year it was reported that this company had changed its name to Queensland Quicksilver, Ltd., and had increased its capital from £6,000 to £20,000. At a meeting of the company on August 12 it was stated that there were extensive alluvial deposits and that there was ample opportunity to work the property as a sluicing proposition on account of the proximity of water. It was decided to carry on both sluicing operations and development of the lode deposits.

Africa.—The Mining Journal (London), October 24, 1931 reported that following discovery of a rich deposit of cinnabar in Nkandhla (Zululand, Natal), there was a rush of prospectors into the district.

Czechoslovakia.—Production in 1932 was 1,305 flasks compared to 2,222 flasks in 1931. On October 7, 1932 Metal Industry (London) reported that the French-owned Société le Cinabre, which has a mercury mine at Mernik, Czechoslovakia, had commenced operations and that during the first half of the year production was estimated at 587 flasks. Output in 1931 was 366 flasks. Virtually all of the output is taken by France.

Italy.—Production in 1932 is reported to have been 956.3 metric tons (27,740 flasks) compared to 1,298 tons (37,652 flasks) in 1931.

The threatened withdrawal of the Italian producers from the cartel did not materialize. It was apparently found that the low price did not justify dissolution of the cartel; according to the Mining Journal (London), it has now been strengthened and consolidated. It is reported that under the agreement, the cartel will continue in force until its date of expiration in 1934.

In a summary of the quicksilver situation the Metal Bulletin (London) stated in its issue of May 19, 1932 as follows:

> The Italian Government has granted permission to the Monte Amiata concern to shut down its chief mine, Abbadia San Salvatore, and the whole labor force will be dismissed by September next, following which the mine will be closed for at least 3 months. During the last financial year, the stocks of this concern expanded from 30,000 flasks to 50,000 flasks. The important producer, Stabilimento Minerario del Siele (Leghorn), has also asked permission to close. This concern holds stocks amounting to fully 27,000 flasks. Meanwhile the Mercurifera Italiana has also closed down.

Under date of November 2, 1932, the Bureau of Foreign and Domestic Commerce reported that despite a decided drop in exports from Italy during the second quarter the exports for the first half amounted to 2,688 quintals (1 quintal equals 220.46 pounds) compared to 2,241 quintals during the first half of 1931. Preliminary figures for July and August indicated increases in foreign sales in those months also. Valuations were considerably reduced, however; in the first half of 1932 the average valuation was $0.84 per pound compared with $1.35 per pound in the first half of 1931, and quotations later dropped to an average of $0.50 per pound in August 1932. Increased exports were principally to Germany, British India, and Japan.

Mexico.—Production of mercury in Mexico amounted to 7,350 flasks in 1932 compared to 7,292 flasks in 1931.

According to the Arizona Mining Journal, May 30, 1932, indications of rich deposits of mercury have been located covering a considerable portion of Guerrero State and extending into southern sections of Michoacan State. The Mining Journal later reported (August 15, 1932) that the Compañia Minera de Mercurio, S. A., which operates mercury mines near Huahuaxtla, Taxco municipality, Guerrero State, had asked the federal board of conciliation and arbitration for authority to suspend activities temporarily, contending that the price of its metal had dropped to such an extent operations were unprofitable. The application applied to the company's eight mines—La Estrella, San Luis, San Antonio, La Provedencia, El Porvenir, Maria Eugenia, La Aurora, and La Esperanza.

On September 15, 1932, the Arizona Mining Journal reported the discovery of what appeared to be one of the largest mercury deposits in northern Mexico. It was stated that this was being developed by Cia. Minera Mercuriocrom, S. A., Santa Maria del Oro, Durango. This deposit is 40 kilometers from Santa Maria del Oro, between the Rosario end of the railroad and Santa Maria on the Sestin River, northern Durango. The main exposure is opened at Porvenir, where it was said 3,000 tons of 2 percent mercury ore were ready for the furnace. It was stated further that the company planned to install a 10-ton rotary furnace.

In October 1932 Chemical Markets stated that ore assaying as high as 2 percent had been reported from Cerro de Cuarenta, San Bernardino municipality, Durango.

It was reported late in 1932 that, to insure the mineral resources of the country being considered national reserves, the Mexican Government had passed a presidential decree nationalizing the deposits of gold, copper, antimony, mercury, aluminum, phosphates, nitrates, coal, platinum, iron, and bismuth.

Spain.—The Spanish mercury industry has undoubtedly been affected severely by developments of the past few years. The situation was discussed in an article published by the Metal Bulletin (London), October 4, 1932. The following is abstracted from this article:

> Although the United States output rose from 310 tons in 1925 to 770 tons in 1931, and Italy maintained hers at over 1,900 tons, Spain, which exported 2,470 tons in 1929, only exported 468 tons in 1931. * * * The crisis in the Spanish quicksilver industry has provoked both labor and political tension, and the authorities have conducted lengthy investigations with a view of locating the causes and applying remedies. * * * Particular dissatisfaction is felt with the fact that reductions in prices have not stimulated exports.

In its issue of December 14, 1932, Minerals and Metals reported that the Spanish Chamber of Deputies had approved a new law governing the operation of the Almadén mercury mines. Administration will continue under a council of administration responsible to the Treasury Ministry; its jurisdiction continues to extend also over Las Arrayanes lead mines at Linares. Projects, installations, and contracts involving more than 250,000 pesetas require the approval of the Minister of the Treasury. Sums left over after obligations are met are to be deposited in the Treasury as state property.

Under date of January 11, 1933, it was reported that Spanish production of mercury was at an exceptionally low rate,[10] due to large stocks on hand and dull business, although actual figures on current production and stocks had not been released by the administration of the Almadén mines. The latest figures available on the output of Almadén are for 1931 and show production of 19,496 flasks of 76 pounds each. The high record for 10 years was made in 1927, with 72,232 flasks. Exports have been declining; their high point for recent years was reached with 48,637 flasks in 1926, from which they declined steadily to 13,565 flasks in 1931. During the first 9 months of 1932 there was some recovery, exports of 12,696 flasks being almost equal to those for all the preceding year. More than half of the 1932 exports so far reported went to the United Kingdom, the principal purchaser for the past 4 years.

[10] Bureau of Foreign and Domestic Commerce, Foreign Trade Notes—Minerals and Metals: vol. 2, no. 1, Jan. 11, 1933, pp. 6–7.

Mercury produced in Spain, 1930–31

Province	Ore mined						Metal produced				
	Number of mines	Number of workmen	Metric tons	Tenor (percent)	Value [1]	Tons per man	Number of plants	Number of workmen	Flasks (76 pounds)	Value	Flasks per man
1930											
Ciudad Real	1	480	18,000	4.52	$359,110	37.50	1	410	18,937	$1,104,429	46.19
Granada	3	30	1,740	.95	11,369	58.00	1	21	284	20,503	13.52
	4	510	19,740	4.21	370,479	38.71	2	431	19,221	1,124,932	44.60
1931											
Ciudad Real	1	1,584	27,497	(2)	448,819	17.36	1	418	19,496	930,221	46.64
Granada	3	30	2,179	(2)	7,223	72.63	1	24	290	18,835	12.08
	4	1,614	29,676	(2)	456,042	18.39	2	442	19,786	949,056	44.76

[1] Pesetas converted to dollars at the average annual rate of exchange, as published by the U.S. Federal Reserve Board.
[2] Data not available.

Russia.—Results of exploration of the deposits and geological, petrographic, and metallographic characteristics of the Nikitovka mercury deposits in South Russia are given by S. N. Danilov and F. A. Abranov in Svutloe Metal, 1931. The ore is mainly cinnabar, and the quantity available is estimated at 4.8 million tons containing about 13,000 tons of mercury.

MANGANESE AND MANGANIFEROUS ORES

By R. H. Ridgway

Continued recession in the iron and steel industry throughout the world caused further declines in the production and consumption of manganese ore in 1932. Although the figures for the world production of manganese ore are not yet available it is estimated that they dropped below those for the preceding year and were very low compared with normal output. With greatly reduced demand, prices weakened further as the year progressed. Competition from Russia was felt keenly in other producing localities, resulting in drastic curtailment in India and the Gold Coast, while operations virtually ceased in Brazil, Union of South Africa, and Egypt. An expanding production is noted in Cuba, now a minor source.

In the United States 1932 was characterized by decreased consumption, greatly reduced imports, falling prices, and decreased production. The low prices of manganese ore again brought the question of dumping to the fore. Late in the year (October 24) the Treasury Department requested the withholding of appraisements of manganese ore pending investigation to determine the facts relative to dumping.

The following table outlines the principal statistics for the domestic manganese industry during the last 2 years.

Salient statistics of the manganese industry in the United States, 1931–32, in long ton

	1931	1932
Manganese ore:		
Total shipments containing 35 percent or more manganese	39,242	17,777
Shipments of metallurgical ore	29,874	9,963
Shipments of battery ore	7,952	7,012
Imports	502,518	110,634
Stocks in bonded warehouses at end of year	613,814	622,489
Ferro-alloys:		
Production of ferromanganese	166,937	56,350
Imports of ferromanganese [1] (manganese content)	19,836	14,779
Production of spiegeleisen	67,800	37,317
Imports of spiegeleisen [1]	9,482	8,364
Exports of spiegeleisen and ferromanganese	1,306	33
Stocks of ferromanganese in bonded warehouses	6,745	6,173

[1] Imports for consumption.

The use of manganese metal as an alloying element continued to make steady progress during the year. Plants and personnel were relieved of the pressure of production, and attention was turned to research problems. Although manganese is one of the most important alloying elements its principal function is that of a deoxidizer. Modern rigid specifications for cleaner steel have resulted in research to determine other methods or materials for the removal of inclusions.

New deoxidizers, however, developed slowly. The deoxidation of open-hearth steel with manganese-silicon alloys has been described by C. H. Herty, Jr., and others.[1]

DOMESTIC PRODUCTION

The production of manganese ore in 1932 totaled 17,777 long tons containing 42 percent manganese and was the lowest since 1922. Curtailed operations in the domestic steel industry resulted in a decided drop in the demand for metallurgical grade ore, both foreign and domestic. Shipments of domestic metallurgical grade ore were only 9,963 tons in 1932. Battery-grade ores (concentrates) held up better, and shipments totaled 7,012 tons, a decrease of 12 percent from the preceding year. The following table covers the shipments of manganese-bearing ores for the past 5 years.

Manganiferous raw materials shipped in the United States, 1928–32, in long tons

Year	Metallurgical ore [1]				Battery ore [2]	Miscellaneous manganese ore	Fluxing ore [3]
	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			
1928	[4] 31, 430	90, 581	1, 085, 401	171, 107	15, 430	(4)	1, 650
1929	[4] 47, 597	78, 191	1, 110, 067	168, 363	12, 782	(4)	------
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	------

[1] Ferrous metallurgy only.
[2] Recorded as "chemical manganese ore" in reports of this series prior to 1930.
[3] Nonferrous smelters.
[4] Small quantities of miscellaneous ore included with metallurgical ore.

Shipments of the various grades during the last 5 years are given by States in the following tables: [2]

Metallurgical manganese ore (exclusive of fluxing ore) shipped from mines in the United States, 1928–32, by States, in long tons [a]

State	1928	1929	1930	1931	1932	State	1928	1929	1930	1931	1932
Alabama	(b)	------	------	------	267	North Carolina	10	------	60	------	------
Arizona	3, 507	2, 655	364	------	------	Tennessee	55	523	471	70	------
Arkansas	3, 623	4, 308	3, 276	4, 028	1, 306	Texas	------	42	247	155	------
California	------	569	162	40	------	Utah	------	88	------	------	------
Georgia	4, 727	2, 521	18, 897	6, 491	200	Virginia	3, 071	2, 651	3, 055	901	------
Idaho	(b)	1, 326	------	------	------	West Virginia	------	------	------	29	------
Montana	12, 044	29, 945	22, 731	17, 088	8, 190	Undistributed	1, 766	------	------	------	------
Nevada	------	------	1, 489	------	------						
New Mexico	2, 627	2, 969	2, 574	1, 072	------		31, 430	47, 597	53, 326	29, 874	9, 963

[a] Includes small quantities of miscellaneous ore, 1928–29.
[b] Included under "Undistributed."

[1] Herty, C. H., Jr., Christopher, C. F., Lightner, M. W., and Freeman, Hyman, The Physical Chemistry of Steel Making; Deoxidation of Open-Hearth Steel with Manganese-Silicon Alloys: Min. and Met. Investigations, Coop. Bull. 58, Min. and Met. Adv. Board, Pittsburgh, 1932, pp. 1–73.
[2] In addition manganiferous zinc residuum was produced in New Jersey; miscellaneous ore came from Arizona, Montana, Tennessee, and Virginia; fluxing ore in 1928 came from Nevada and Colorado.

Ferruginous manganese ore (exclusive of fluxing ore) shipped from mines in the United States, 1928–32, by States, in long tons

State	1928	1929	1930	1931	1932	State	1928	1929	1930	1931	1932
Alabama		475	321	1,321	4,328	Montana	11,156	15,665	11,875	14,311	
Arizona	214	45	48			Nevada		2,407	3,363		
Arkansas	7,136	13,774	12,645	2,230	208	New Mexico	36,250				
Colorado	18,599	17,770	19,730	3,685		Tennessee	718	241	113		
Georgia	4,687	5,310	12,009	11,652	9,700	Utah	286	5,942	10,972	1,501	
Idaho		38	1,450	578		Virginia	105	80	193		
Michigan	7,943	11,023		2,217							
Minnesota	3,487	5,421	4,698	26,567	1,399		90,581	78,191	77,417	64,062	15,635

Manganiferous iron ore (exclusive of fluxing ore) shipped from mines in the United States, 1928–32, by States, in long tons

State	1928	1929	1930	1931	1932
Alabama					217
Michigan	41,261	38,089			9,582
Minnesota	1,025,014	1,004,420	693,546	217,352	
New Mexico	19,081	67,558	14,427		
Tennessee	45				
	1,085,401	1,110,067	707,973	217,352	9,799

Battery ore[1] shipped from mines in the United States, 1928–32, by States

Year	Montana (long tons)	Virginia (long tons)	Total		Year	Montana (long tons)	Virginia (long tons)	Total	
			Long tons	Value				Long tons	Value
1928	14,689	741	15,430	$621,292	1931	7,802	150	7,952	$281,523
1929	12,382	400	12,782	576,158	1932	7,012		7,012	239,267
1930	11,451	306	11,757	432,668					

[1] Recorded as "chemical manganese ore" in reports of this series prior to 1930.

IMPORTS OF MANGANESE ORE

Imports of manganese ore into the United States in 1932 decreased materially and amounted to only 110,634 long tons, a decline of 78 percent from the preceding year. Manganese ore imported in 1932 contained 48.4 percent manganese. Imports from all principal supplying countries decreased substantially, while imports from Cuba, a smaller source, increased 77 percent to 6,749 tons. Russia was again the largest supplier, furnishing 50 percent of the total in 1932. The following table shows the imports of manganese ore into the United States from 1930 to 1932, by countries.

Manganese ore imported into the United States, 1930–32, by countries

[General imports]

Country	Manganese ore (long tons)			Manganese content (long tons)			Value		
	1930	1931	1932	1930	1931	1932	1930	1931	1932
Brazil	185,048	133,927	21,500	79,849	59,174	9,494	$1,484,039	$947,549	$199,382
Canada	15,998	18,832	27	7,706	9,958	13	343,437	251,679	1,000
Chile	3,485	1,748	-------	1,544	822	------	33,488	17,484	--------
Cuba	2,071	3,804	6,749	899	1,199	3,417	32,317	19,891	111,770
Germany	66	30	25	33	17	13	3,583	1,951	1,380
Gold Coast	93,142	87,439	24,592	44,892	43,908	12,204	1,253,742	1,228,707	349,648
Greece	9	-------	-------	4	-------	------	487	--------	--------
India (British)	58,150	47,850	1,750	29,989	24,646	909	839,621	550,515	18,200
Java and Madura [1]	1,602	1,754	-------	917	972	------	30,906	34,961	--------
Netherland East Indies	-------	-------	529	-------	-------	282	--------	--------	14,817
Soviet Russia in Europe	225,888	195,834	55,437	112,174	99,335	27,206	2,445,871	1,896,538	521,868
Union of South Africa	-------	5,002	-------	-------	2,601	------	--------	67,627	--------
United Kingdom	109	6,298	25	63	3,278	15	9,311	87,688	1,318
	585,568	502,518	110,634	278,070	245,910	53,553	6,476,802	5,104,590	1,219,383

[1] Included in Netherland East Indies beginning January 1932.

Stocks.—Stocks of manganese ore in bonded warehouses increased slightly and at the end of the year totaled 622,489 long tons containing 299,504 tons of manganese metal compared with 613,814 tons containing 300,410 tons of manganese metal at the close of 1931.

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 1932.

On October 22, 1932, hearings were held in Washington, D.C., on the question of dumping manganese ore into the United States from the Union of Soviet Socialist Republics, Brazil, British India, and the Gold Coast. As a result of these hearings, collectors of customs at various ports were requested on October 24 to withhold appraisements of manganese ore (metallic) pending investigation to determine the facts.

The decade ended December 31, 1932, includes virtually all the period during which there has been a tariff on manganese ore. During this period the marketed production of domestic manganese ore containing 35 percent or more manganese (excluding fluxing ore) was 508,631 long tons. Of this total 158,900 tons (31 percent) were produced for consumption in the battery trade. Virtually all the remaining 349,731 tons were used by the metallurgical industries, 264,769 tons (52 percent of the total) being consumed in the manufacture of ferromanganese. Nineteen States contributed the total production; Montana alone furnished 65 percent, and Georgia, the second largest source, 8 percent.

For the same period 4,705,000 tons of foreign ore were used by domestic furnaces in the manufacture of ferromanganese. Thus since the tariff act of 1922 approximately 95 percent of the manganese ore consumed in the United States in the manufacture of ferromanganese came from foreign sources and 5 percent from domestic mines.

Price of manganese ore.—Prices of manganese ore according to grade and origin, as quoted by 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.

According to the Engineering and Mining Journal the trend of prices for imported metallurgical grade ore (quotations given per long-ton unit of manganese, c.i.f. North Atlantic ports, exclusive of duty) were as follows during 1932.

Brazilian ore containing 46 to 48 percent manganese, which was quoted at 23 cents at the beginning of the year, dropped to 21 cents in the latter part of February. Further declines in June and July brought the price down to 18 cents, where it remained for the rest of the year.

Indian ore containing 48 to 50 percent manganese opened the year at 25 to 26 cents but dropped to 24 cents in the latter part of February. At the end of March the price dropped to 23 cents and was given at 23 to 24 cents until the end of June, when a drop to 22 cents was noted. The price showed further weakness and was quoted at 20 to 21 cents when the year ended.

Caucasian (Russian) ore containing 52 to 55 percent manganese, which was quoted at 26 cents at the beginning of the year, dropped to 24 cents at the end of February, dropped further to 23 cents at the end of June, and was quoted at 22 cents at the end of December.

Prices of Chilean ore containing a minimum of 47 percent manganese opened the year at 29 cents and declined to 24 cents in Feburary; a further decline brought the price down to 20 cents for the later months.

The price of South African ore containing 52 to 54 percent manganese was 23 to 25 cents at the beginning of the year but declined to 22 to 23 cents in May, where it remained until late in December, when it was quoted at 20 to 21 cents. Second-grade ore containing 50 to 52 percent manganese was quoted at 1 cent per unit lower than first-grade. Lower-grade material (44 to 46 percent manganese) was quoted at 21½ cents at the beginning of the year, but decreases brought the quotations down to 18 and 19 cents at the close of the year.

According to the Engineering and Mining Journal the trend of prices per long ton for chemical (battery) ores was as follows during 1932: Domestic chemical ores containing 70 to 72 percent manganese dioxide were quoted at $43 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 $50 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.

Steel production, the principal use of manganese ore, was lower in 1932 than in any year since 1901, and steel plants operated at only 19 percent of the available capacity. The greatly reduced activities in steel manufacture, coupled with the curtailment in other outlets, caused a severe drop in the consumption of all grades of manganese ore. Consumption of ores containing 35 percent or more manganese declined 67 percent from the preceding year, while ferruginous manganese ores and manganiferous iron ores showed even greater declines.

The indicated consumption of manganiferous raw materials in the United States in 1931–32 appears in the following table. The table does not take into account the difference 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, 1931–32

	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)
1931						
Domestic shipments	[1] 41,616	[2] 41	161,052	16	217,352	7.5
Imports for consumption	293,137	54	[3] 34,000	25	[3] 65,000	6.8
Total available for consumption	334,753	52	195,052	17	282,352	7.4
1932						
Domestic shipments	[1] 20,079	[2] 43	40,955	18	9,799	9.0
Imports for consumption	90,782	49	[3] 14,367	21	[3] 42,028	6.8
Total available for consumption	110,861	48	55,322	18	51,827	7.18

[1] Includes shipments from Puerto Rico. [2] Partly estimated. [3] Estimated.

Besides the material shown in the foregoing table 91,700 long tons of iron ore containing 2 to 5 percent manganese were presumably used in the manufacture of manganiferous pig iron in 1932 compared with 612,000 long tons in 1931. Figures for imports of this class of ore are not available.

A list of the consumers of domestic ores is given on page 169 of the Mineral Resources chapter on Manganese and Manganiferous Ores for 1931.

METALLURGICAL INDUSTRY

Although manganese ore is used in both the ferrous and nonferrous metallurgical industries, the bulk of the consumption is 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 is usually added to steel. The following table shows the critical data on manganese alloys imported into and produced in the United States:

Chief manganese alloys imported into and made from domestic and imported ores in the United States, 1931–32, in long tons

	1931		1932	
	Alloy	Manganese	Alloy	Manganese
Ferromanganese:				
Imported	24,664	19,836	18,470	14,779
Domestic production	166,937	131,200	56,350	43,760
From domestic ore [1]	5,578	4,141	5,535	4,054
From imported ore [1]	161,359	127,059	50,815	39,706
Total	191,601	151,036	74,820	58,539
Ratio (percent) of manganese in ferromanganese of domestic origin to total manganese in ferromanganese made and imported		2.74		6.93
Number of plants making ferromanganese	5		5	
Spiegeleisen:				
Imported	9,482	1,896	8,364	1,673
Domestic production	[2] 67,800	[1] 13,560	37,317	7,461
From domestic ore [1]	(3)	(3)	28,545	5,718
From imported ore [1]	(3)	(3)	8,772	1,743
Total	77,282	15,456	45,681	9,134
Ratio (percent) of manganese in spiegeleisen of domestic origin to total manganese in spiegeleisen made and imported		(3)		62.60
Number of plants making spiegeleisen	2		4	
Total available supply of metallic manganese as alloys		166,492		67,673
Percentage of available supply of manganese in—				
Ferromanganese and spiegeleisen imported		13.05		24.31
Ferromanganese made from imported ore		76.32		58.67
Spiegeleisen made from imported ore		(3)		2.58
Ferromanganese made from domestic ore		2.49		5.99
Spiegeleisen made from domestic ore		(3)		8.45
Ferromanganese and spiegeleisen made from domestic ore		(3)		14.44
Spiegeleisen made and imported		9.28		13.50
Total open-hearth and Bessemer steel	25,533,012		13,439,406	

[1] Estimated.
[2] Steel, Manganese Ore and Alloy Statistics: Vol. 90, no. 1, Jan. 4, 1932, p. 198.
[3] Bureau of Mines not at liberty to publish figures.

Ferromanganese.—Production of ferromanganese in 1932 amounted to 56,350 long tons compared with 166,937 tons in 1931 and was made at 5 furnaces by 5 different operators. The bulk of the output was made at blast-furnace plants, only a small portion coming from one electric furnace at Niagara Falls. The following plants manufactured ferromanganese in 1932:

Bethlehem Steel Co., Johnstown, Pa.
Colorado Fuel & Iron Co., Pueblo, Colo.
Pittsburgh Metallurgical Co., Niagara Falls, N.Y.
Republic Steel Corporation, Thomas, Ala.
United States Steel Corporation, Etna, Pa.

In the production of ferromanganese there were used 90,677 long tons of foreign manganese ore, 10,666 tons of domestic manganese ore, 1,642 tons of domestic ferruginous manganese ore, 91 tons of foreign ferruginous manganese ore, 3,537 tons of domestic iron ore, and 1,499 tons of cinder, scale, and scrap. The table following shows the production of ferromanganese during the past 5 years and the metalliferous materials consumed in its manufacture.

Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture, 1928–32

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			
1928	319,770	78.62	251,400	566,859	37,827	23,159	8,395	1.891
1929	339,205	79.30	269,000	614,763	27,558	47,735	7,811	1.894
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

The following table shows by sources the foreign manganese ore consumed in the manufacture of ferromanganese from 1928 to 1932.

Foreign manganese ore used in manufacture of ferromanganese in the United States, 1928–32, in long tons

Source of ore	1928	1929	1930	1931	1932
Africa	25,039	28,592	62,913	26,133	5,135
Brazil	218,181	228,737	138,757	62,630	25,279
Chile	5,118	1,187	1,705	4,363	
Cuba	14,280	2,050			2,126
India	96,232	86,547	44,667	26,267	11,541
Russia	208,009	267,600	211,436	168,580	46,596
Turkey		50			
Total	566,859	614,763	459,478	287,973	90,677

Shipments of ferromanganese in 1932 were 70,417 long tons valued at $5,061,029. The trend of shipments during the last 5 years has been as follows:

Ferromanganese shipped from furnaces in the United States, 1928–32

Year	Long tons	Value	Year	Long tons	Value
1928	310,122	$29,199,990	1931	159,168	$12,999,329
1929	334,162	33,184,012	1932	70,417	5,061,029
1930	273,640	25,865,783			

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 1932 included 27 tons containing not over 1 percent carbon. Imports of ferromanganese for consumption in the United States and exports of ferromanganese and spiegeleisen, 1928–32, are given in the following table.

Ferromanganese imported into and exported from the United States, 1928–32

Year	Imports for consumption [1]		Exports [2]	
	Manganese content (long tons)	Value	Gross weight (long tons)	Value
1928	[1] 48,844	[1] $4,899,374	9,440	$232,990
1929	[1] 56,969	[1] 6,126,056	1,574	59,036
1930	[3] 44,037	[3] 4,021,040	6,189	145,629
1931	[3] 19,836	[3] 1,751,646	1,306	38,506
1932	[3] 14,779	[3] 1,091,026	33	2,369

[1] Figures for 1928–29 include small quantities of other manganese alloys.
[2] Include spiegeleisen; not separately classified.
[3] Excludes other manganese alloys as follows: 1930, 964 tons, $107,025; 1931, 431 tons, $44,929; 1932, 329 tons, $31,451.

Canada, Norway, and the United Kingdom furnish the bulk of the imports into the United States, as the following table shows.

Ferromanganese [1] imported into the United States, 1931–32, by countries

[General imports]

Country	1931		1932	
	Manganese content (long tons)	Value	Manganese content (long tons)	Value
Canada	8,331	$865,891	6,747	$603,934
France	180	21,970	500	26,689
Germany	410	20,611	675	23,948
Italy	590	82,312	327	33,831
Norway	2,712	285,963	4,542	235,746
United Kingdom	5,105	315,842	1,402	72,618
Yugoslavia and Albania	436	14,580	393	14,452
	17,764	1,607,169	14,586	1,011,218

[1] Includes small quantities of other manganese alloys.

Ports into which imported ferromanganese entered in 1931–32 were as follows:

Manganese content of ferromanganese [1] imported into the United States, 1931–32 by ports of entry, in long tons

[General imports]

Port of entry	1931	1932	Port of entry	1931	1932
Buffalo	4,163	5,252	Ohio	1,716	530
Galveston	24		Oregon	39	
Los Angeles	474		Philadelphia	745	1,485
Maryland	5,251	4,987	San Francisco	690	
Michigan	2,601	1,024	Washington (State)	21	
New Orleans	1,175	963			
New York	865	345		17,764	14,586

[1] Includes small quantities of other manganese alloys.

Stocks of ferromanganese in bonded warehouses totaled 6,173 long tons, containing 5,299 tons of manganese metal, at the end of 1932.

The status of ferromanganese in the tariff bill in 1930 is given on page 321 of the Mineral Resources chapter on Manganese and Manganiferous Ores for 1930. The tariff was not changed in 1932.

The price of ferromanganese declined during the first half of the year, and for the last half it was quoted at $73.24 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, 1930–32 [1]

[80 percent—delivered at Pittsburgh]

Month	1930	1931	1932	Month	1930	1931	1932
January	$104.79	$89.79	$79.85	July	$103.79	89.79	73.24
February	103.79	89.79	80.24	August	103.79	89.79	73.24
March	103.79	89.79	80.24	September	103.79	89.79	73.24
April	103.79	89.79	80.24	October	103.79	89.79	73.24
May	103.79	89.79	80.24	November	103.79	89.79	73.24
June	103.79	89.79	74.99	December	93.25	79.79	73.24

[1] Steel: Vol. 92, Jan. 2, 1933.

Spiegeleisen.—The production of spiegeleisen in 1932 was 37,317 long tons; shipments were 31,071 tons. Figures for the production and shipments for the last 5 years are shown in the following table:

Spiegeleisen produced and shipped in the United States, 1928–32

Year	Produced (long tons)	Shipped from furnaces		Year	Produced (long tons)	Shipped from furnaces	
		Long tons	Value			Long tons	Value
1928	99,517	116,911	$2,802,108	1931	[1] 67,800	55,327	$1,313,068
1929	137,143	123,146	3,336,703	1932	37,317	31,071	745,966
1930	87,059	94,918	2,469,861				

[1] Steel, Manganese Ore and Alloy Statistics: Vol. 90, no. 1, Jan. 4, 1932, p. 198.

Spiegeleisen was manufactured at the following plants in 1932:

New Jersey Zinc Co., Palmerton, Pa.
Republic Steel Corporation, Thomas, Ala.
United States Steel Corporation, Etna and Rankin, Pa.

Most of the spiegeleisen produced in the United States is made from domestic raw materials, although 7,781 long tons of foreign ferruginous manganese ore were consumed in the manufacture of spiegeleisen in 1932.

Imports of spiegeleisen for consumption were 8,364 long tons in 1932.

Spiegeleisen imported for consumption in the United States, 1928–32

Year	Long tons	Value	Year	Long tons	Value
1928	5,260	$147,406	1931	9,482	$247,788
1929	13,828	403,853	1932	8,364	192,037
1930	13,406	381,197			

The following table shows the price quotations of spiegeleisen by months for the past 3 years:

Prices per long ton of spiegeleisen in the United States, 1930–32 [1]

[20 percent—at producers' furnaces]

Month	1930	1931	1932	Month	1930	1931	1932
January	$34.00	$30.00	$27.00	July	$33.00	$30.00	$25.00
February	34.00	30.00	27.00	August	33.00	30.00	25.00
March	34.00	30.00	27.00	September	33.00	30.00	25.00
April	34.00	30.00	27.00	October	33.00	30.00	25.00
May	34.00	30.00	27.00	November	33.00	30.00	24.25
June	34.00	30.00	26.50	December	30.00	27.00	24.00

[1] Steel: Vol. 92, Jan. 2, 1933.

Manganiferous pig iron.—Precise data on the consumption of manganiferous ores in the production of manganiferous pig iron are not available; however, 9,799 long tons of domestic ore containing 5 to 10 percent manganese and 91,700 tons of domestic ore containing 2 to 5 percent were shipped in 1932. Foreign manganiferous iron ore amounting to 42,028 tons and foreign ferruginous manganese ore amounting to 6,495 tons were also consumed in the manufacture of manganiferous pig iron. The sources of the foreign ores for the last 3 years appear in the following table. The ferruginous manganese ore contains material consumed in the manufacture of ferromanganese and spiegeleisen. Import figures for iron ore containing 2 to 5 percent manganese are not available.

Foreign ferruginous manganese ore and manganiferous iron ore consumed in the United States, 1930–32, in long tons

Source of ore	Ferruginous manganese ore			Manganiferous iron ore		
	1930	1931	1932	1930	1931	1932
Africa	72		91	29,546	5,962	8,818
Australia	41,773	7,949	6,213	1,804	59,421	33,210
Brazil	61,872	7,034				
Canada	919	4,473	143			
Cuba		2,438	1,215			
India	4,903	3,259				
Palestine	979	276				
Spain				12,520		
Undistributed		8,623	6,705			
Total	110,518	34,052	14,367	43,870	65,383	42,028

BATTERY INDUSTRY

Shipments of manganese ore by domestic producers to battery makers in 1932 totaled 7,012 long tons and shipments from Puerto Rico 2,302 tons. These figures indicate a consumption of 9,314 tons of domestic materials in battery manufacture. Imported manganese ore was also consumed in the battery industry, but no figures for such imports are available.

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 domestic manganese ore shipped to these industries totaled 802 long tons in 1932.

REVIEW BY STATES

The following table shows shipments of manganese-bearing ore in 1932 by States.

Manganese and manganiferous ore (exclusive of fluxing ore) shipped by mines in the United States in 1932, 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
Metallurgical:									
Alabama	2	267	$2,834	11	4,328	$16,709	1	217	$190
Arkansas	1	1,306	(1)	1	208	(1)	-	-	-
Georgia	1	200	2,400	1	9,700	(1)	-	-	-
Michigan	-	-	-	-	-	-	1	9,582	29,356
Minnesota	-	-	-	1	1,399	4,030	-	-	-
Montana	[2] 1	8,190	(1)	-	-	-	-	-	-
Undistributed	-	-	118,269	-	-	41,850	-	-	-
Total metallurgical	5	9,963	123,503	14	15,635	62,589	2	9,799	29,546
Battery:									
Montana	[3] 2	7,012	239,267	-	-	-	-	-	-
Total battery	2	7,012	239,267	-	-	-	-	-	-
Miscellaneous:									
Montana	[2] 1	277	14,452						
Virginia	3	525		-	-	-	-	-	-
Total miscellaneous	4	802	14,452	-	-	-	-	-	-
	10	17,777	377,222	14	15,635	62,589	2	9,799	29,546

[1] Included under "Undistributed."
[2] 1 producer in Montana shipped both metallurgical and miscellaneous ore.
[3] Mills through which all ore was shipped; producers not counted.

Alabama.—Shipments of metallurgical manganese ore from Alabama in 1932 totaled 267 long tons, valued at $2,834. Collier & Edge, mine operators in Etowah County, shipped 184 tons averaging (nat.) 38.62 percent manganese. The remaining shipments came from the Rock Run mine in Cherokee County (operated by the Margemma Mining Co.) and contained (dried) 40.61 percent manganese, 2.82 percent iron, and 18.81 percent silica. Shipments of ferruginous manganese ore were 4,328 long tons, containing (nat.) 18.28 percent manganese in 1932. The output came from several producers in Calhoun, Cherokee, Etowah, and Talladega Counties. Alabama also produced 217 tons of manganiferous iron ore in 1932.

Arkansas.—Shipments of manganese ore from Arkansas were 1,306 tons, containing (dried) 52.4 percent manganese. Walter H. Denison in Independence County was the only shipper in 1932. He also shipped 208 tons of ferruginous manganese ore containing (dried) 29.7 percent manganese.

Georgia.—The only output of manganese ore from Georgia in 1932 came from Bartow County, where J. T. Thomasson shipped 200 tons of ore containing (nat.) 35–40 percent manganese. All shipments of ferruginous manganese ore came from Bartow County, where the Manganese Corporation of America operates; the shipments were 9,700 tons containing (dried) 31.2 percent manganese.

Michigan.—Shipments of manganiferous iron ore from Michigan in 1932 came from the Rogers mine on the Menominee range and contained (nat.) 9.03 percent manganese, 43.05 percent iron, and 3.44 percent silica.

Minnesota.—Shipments of ferruginous manganese ore from Minnesota in 1932 totaled 1,399 tons and came from the Louise and Merritt mines on the Cuyuna range. There was a considerable production of manganiferous iron ore in 1932 on the Cuyuna range, but no shipments were made.

Montana.—Shipments of metallurgical manganese ore from Montana in 1932 totaled 8,190 tons. These shipments and 277 tons shipped for miscellaneous purposes came from the Emma mine at Butte. Shipments of battery-grade ore amounted to 7,012 tons and came from the Philipsburg district where the Trout Mining Co. and the Moorlight Mining Co. produce battery-grade concentrates by magnetic separation. The sintering plant of the Domestic Manganese & Development Co. at Butte was not operated during the year.

Virginia.—Three producers in Virginia shipped 525 tons of manganese ore for miscellaneous uses in 1932. The shipments came from Bland, Page, and Shenandoah Counties. It was reported during the year that the Crimora mine in Augusta County had been acquired by western interests that are planning to develop the property.

Puerto Rico.—The manganese ore produced in Puerto Rico comes from the mine of the Atlantic Ore Co., about 3 miles from Juana Diaz. The entire output is shipped to the United States; shipments in 1932 totaled 2,302 long tons, vauled at $65,509, compared with 2,374 long tons, valued at $87,356, in 1931.

Producers of domestic manganese ore.—The following list comprises producers and shippers of domestic manganese ore (35 percent or more manganese) in 1932.

Producers and shippers of domestic manganese ore in 1932

Alabama:
- Collier & Edge, Walnut Grove.
- Margemma Mining Co., 1517 Comer Bldg., Birmingham.

Arkansas:
- Walter H. Denison, Cushman.

Georgia:
- J. T. Thomasson, Chattanooga, Tenn.

Montana:
- Anaconda Copper Mining Co., Butte.
- Moorlight Mining Co., Philipsburg.
- Trout Mining Co., Philipsburg.

Virginia:
- O. W. Danner, Crandon.
- Hy-Grade Manganese Co., Inc., Woodstock.
- Stanley Manganese Mines, 1817 Thirty-seventh Street NW., Washington, D.C.

WORLD PRODUCTION

The following table shows, so far as statistics are available, the World production of manganese ores from 1928 to 1932 and the 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, 1928–32, in metric tons

Country [1]	Percentage of manganese	1928	1929	1930	1931	1932
North America:						
Canada (shipments)	----------	349	273	497	176	----------
Cuba	36–48	2,440	972	762	96	9,800
Mexico	40+	661	650	732	----------	(2)
United States:						
Continental (exclusive of fluxing ore)	35+	47,612	61,348	68,111	39,872	18,062
Puerto Rico [3]	48–58	1,547	2,353	2,577	2,412	2,339
South America:						
Argentina [4]	----------	141	208	239	221	(2)
Brazil	38–50	359,651	316,172	206,831	147,349	20,300
Chile [3]	40–50	9,192	3,104	6,137	383	(2)
Europe:						
France	30+	----------	1,095	1,000	(5)	(2)
Germany	30+	210	475	2,349	----------	(2)
Great Britain	30+	239	----------	----------	----------	(2)
Greece	30+	1,080	1,600	655	356	(2)
Hungary	30	22,167	19,044	9,090	1,132	(2)
Italy	30–50	10,274	9,917	10,633	6,421	2,347
Rumania	42	31,267	35,038	33,528	18,787	(2)
Russia	41–48	[6] 673,398	[6] 1,183,880	[6] 1,444,166	(5)	(2)
Spain	29+	13,704	17,872	16,819	17,916	(2)
Sweden	35–45+	12,617	13,674	4,907	4,140	(2)
Yugoslavia	42–45	2,660	3,072	1,539	2,453	(2)
Asia:						
China [3]	50–55	43,332	41,881	54,854	22,051	(2)
India:						
British	47–52	994,153	1,010,237	843,267	546,476	(2)
Portuguese	42–50+	6,654	5,092	5,476	3,547	(2)
Japan	50+	17,693	18,446	19,588	(5)	(2)
Netherland India	45–56	24,452	20,892	16,690	14,541	8,400
Portuguese East Indies (Timor)	----------	----------	3,300	----------	----------	(2)
Turkey	40	61	151	900	1,000	(2)
Africa:						
Algeria [3]	----------	1,476	450	1,583	498	689
Egypt	30+	137,502	191,477	121,211	101,781	(2)
Gold Coast [3]	50+	348,755	465,282	453,773	226,889	(2)
Morocco (French)	40–50+	2,300	13,150	16,200	11,502	4,000
Northern Rhodesia	41–50	1,821	1,879	887	1,491	----------
Tunisia	30–43	2,200	200	----------	----------	----------
Union of South Africa	40–60	----------	9,349	147,321	101,899	[7] 3,116
Oceania:						
Australia:						
New South Wales	----------	170	237	127	----------	(2)
South Australia	----------	----------	----------	----------	13	----------
Western Australia [3]	47+	----------	81	----------	----------	(2)
New Zealand [3]	52+	----------	----------	2	----------	(2)
	----------	2,770,000	3,453,000	3,492,000	2,260,000	(2)

[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] Data not available.
[3] Exports.
[4] Shipments by rail and river.
[5] Estimate included in total.
[6] Year ended Sept. 30.
[7] Sales and shipments.

Brazil.—Production of manganese ore in Brazil in 1932 amounted to 20,300 metric tons. Manganese-mining operations in Brazil were further reduced in 1932, and in June the Cia. Meridional de Mineração closed its operations in Minas Geraes. Because of the unemployment resulting from the closing down of the mines the State of Minas Geraes agreed to purchase 10,000 tons to be mined in a stipulated time so that manganese miners might earn some money while looking for other employment.

A Brazilian decree (No. 21418) dated May 17 provides for the abolition of state export duties within a 5-year period from January 1933. No new export taxes may be created, and those in force must be reduced by 20 percent each year until the export taxes are eliminated.

Russia.—Figures on the production of manganese ore in Russia in 1932 are not available, but exports amounted to 400,928 metric tons, a decrease of 46 percent from the preceding year. France, United States, Germany, and Italy were the principal markets for Russian manganese in 1932.

Exploitation of a new deposit a few miles south of Achinsk on the Trans-Siberian Railway was begun during 1932. The ore is found in horizontal beds and can be worked through opencuts. Reserves of more than a million tons have been reported. A branch line is being built to the deposits, and plans call for construction of a concentrating plant in 1933. The ore will be shipped to the Stalinsk steel plant at Kuznetsk, which has been using Chiaturi ores.

It was reported [3] during the year that the U.S.S.R. had concluded an agreement with Belgian interests to purchase manganese ore through a new concern known as Intenhanko. The new company will maintain a stock of 100,000 tons of washed Caucasian ore in Belgium for use in the steel works. The reported price was 7¾ pence per unit c.i.f., considerably below world-market quotations.

The Russian ferromanganese works at Sestafoni were scheduled for completion late in the year.

India.—Manganese mining in India, normally the World's second largest producer, has declined sharply. Many mines have closed, and in the last quarter of the year operations in the Central Provinces—the principal producing area—had virtually ceased. The cost of transporting the ore from the mines to the ports is a vital factor in placing Indian ore on the market, and on September 15 the Indian railways granted a reduction of 16 percent in the the cost of transporting the ore from the mines to Calcutta. Further reduction in transport costs is expected by use of the new harbor at Vizagapatam and the new connecting railroads, which will shorten the rail haul 182 miles. The first cargo from the new port at Vizagapatam was loaded in December.

The Central Provinces Manganese Ore Co., the principal producing company in India, obtained a renewal of its leases in 1932 for 60 years.

Gold Coast.—During the fiscal year ended March 31, 1932, exports of manganese ore from the Gold Coast were 222,145 metric tons compared with 402,399 tons in the preceding fiscal year. The only producing mine in the Gold Coast is the Nsuta mine of the African Manganese Co., Ltd.

Union of South Africa.—Shipments of manganese ore from the Union of South Africa were 3,116 metric tons in 1932. The shipments were made from stocks as the mines were idle since the shut-down in September 1931. The suspension of production was due to curtailed

[3] Metal Bulletin, London, Manganese: No. 1679, Apr. 1, 1932, p. 9.

consumption and the low prices at which other ores were being offered. The rail haul is an important factor in the cost of placing Postmasburg ore on the market. As far as South Africa is concerned, 1s. 1d.[4] per unit is the minimum price at which the ore can be produced at a profit.

Egypt.—Early in 1932 the mines suspended operations until the accumulated production of the past several years has been disposed of. The plant at Abu Zenima has been described in Mechanical Handling.[5]

Cuba.—The production of manganese ore in Cuba in 1932 totaled 9,800 metric tons. It was reported that the Cuban-American Manganese Corporation had produced 50,000 short tons of crude ore during the year. The concentrating plant of this company at Isabelita was completed and operated at part capacity.

Other countries.—During the year the Polish State Geological Institute verified the discovery of promising deposits of manganese ore in Southern Galicia not far from the Polish-Rumanian frontier. It was also reported that extensive deposits of manganese ore exist near Pasaje, El Oro Province, western Ecuador. The manganese deposits of Canada have been described by Hanson.[6]

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[4] Mining Journal, London, The Manganese Industry: vol. 179, no. 5067, Oct. 1, 1932, p. 657.

[5] Omega, Conveying Manganiferous Ore; Mechanical Handling: vol. 19, no. 12, December 1932, pp. 393–397.

[6] Hanson, G., Manganese Deposits of Canada: Canada Dep. Mines, Geol. Survey, Econ. Geol. Ser., no. 12, Ottawa, 1932, pp. 1–120.

MOLYBDENUM

By Frank L. Hess

The production of molybdenum concentrate in the United States during 1932 showed a decrease from 1931 and was about two thirds of the production during the peak year of 1929.

The mine production in 1932 amounted to 363,400 short tons of ore which yielded 2,387 short tons of concentrates averaging 84.89 percent (4,052,000 pounds) of molybdenum sulphide (MoS_2), equivalent to 2,431,000 pounds of metallic molybdenum. In 1931 the production was 434,400 tons of ore which yielded 3,038 tons of concentrates averaging 85.93 percent (5,221,000 pounds) of molybdenum sulphide (equivalent to 3,132,700 pounds of metallic molybdenum). Concentrates shipped from mines in 1932 contained an equivalent of 2,373,000 pounds of metallic molybdenum with an estimated value of \$1,186,000, compared with 3,157,000 pounds in 1931 valued at \$1,577,000.

In 1932, as in other recent years, the Climax Molybdenum Co. at Climax, Lake County, Colo., and the Molybdenum Corporation of America at Questa, Taos County, N.Mex., were the principal producers and shippers. In addition, a small quantity of high-grade concentrates was recovered and shipped by Hugo W. Miller who concentrated some crude ore from the Santo Niño Mine at Patagonia, Santa Cruz County, Ariz.

Salient statistics of the molybdenum industry in the United States, 1931–32 [1]

	1931	1932
Shipments .... pounds	3,157,000	[2] 2,373,000
Value	\$1,577,000	\$1,186,000
Imports:		
Tons	210,766	44
Value	\$213,660	\$89

[1] Figures for molybdenum products exported are not specially classified.
[2] Includes some molybdenum temporarily stocked at mines.

The two American mines and the Knaben mine in Norway produce 97 to 98 percent of the world's molybdenum.

Prices.—Molybdenum for use in steel containing not more than 1½ percent of molybdenum is usually sold as calcium molybdate (called by one firm "molyte"). For steel containing larger percentages, ferromolybdenum is used.

During 1932 prices were quoted by the Engineering and Mining Journal as follows:

Molybdenum, chemically pure powder, 10- to 50-pound lots: \$9 per pound.
Molybdenum, 97 percent Mo, 10- to 50-pound lots: \$4.50 per pound.
Molybdenite concentrates, 75 to 85 percent MoS_2, per pound MoS_2: 45 cents in January, 42 cents the remainder of the year.
Calcium molybdate, molyte: 85 cents per pound of contained Mo.
Ferromolybdenum, 50 to 60 percent Mo: January, \$1 per pound for contained Mo; remainder of the year, 95 cents.

General information and uses.—Molybdenum is one of the scarcer elements of the earth and is considered by Washington [1] to be about thirty-sixth in quantity among the elements found in the lithosphere. According to this estimate it is scarcer than the metals cerium, beryllium, cobalt, or cadmium; is of about the same order of plentitude as tin, mercury, or antimony; and is more plentiful than tungsten, bismuth, or the precious metals.

Molybdenum forms few minerals, of which the two commonest and the only minerals that have been utilized commercially, are molybdenite and wulfenite.

Molybdenite is a lead-colored sulphide, MoS_2, which usually is found in flakes but sometimes in crystals which cleave readily into flexible leaves.

Wulfenite is lead molybdate ($PbMoO_3$) and is found only in the oxidized parts of lead-bearing veins. It is usually in thin, flat, translucent plates, which commonly are yellow but may be orange, brown, or red in various tints. Wulfenite is occasionally found in octahedra with curved outlines. The mineral is purely an oxidation product, but the original form in which the molybdenum occurs in the vein has never been identified. Wulfenite is found widely spread through the Southwestern States, but most deposits are small.

The other known molybdenum minerals are:

Achrematite.—A very rare arseno-chlor-molybdate of lead ($3PbO.3PbCl_2.9As_2O_5.4MoO_3$).

Belonesite.—Reported as a magnesium molybdate, but its existence seems more or less questionable.

Chillagite.—A very rare molybdate and tungstate of lead ($3PbWO_4.PbMoO_4$). It resembles wulfenite in appearance and has been found only at Chillago, Queensland.

Eosite.—A questionable molybdate and vanadate of lead.

Ilsemannite.—A deep blue, very soluble molybdenum mineral. The composition is given in the textbooks as $MoO_2.4MoO_3$, but it is probably a molybdenum sulphate.[2] It is found in small quantity at many places.

Jordisite.—A questionable colloidal molybdenum sulphide. Only one occurrence has been noted.

Koechlinite.—Bismuth molybdate ($Bi_2O_3.MoO_3$). Known only as tiny plates on a single specimen from Schneeberg, Saxony.

Molybo-sodalite.—A sodium aluminum chlor-silicate ($3NaAlSiO_4.NaCl$), containing 2 percent MoO_3, has been reported as a single specimen from Mount Vesuvius, Italy.

Powellite.—Calcium molybdate ($CaMoO_4$). Frequently found as a white mineral replacing molybdenite; has been found also as individual crystals which contain more or less tungsten.

Molybdenum has been reported as having been found in small quantity in bravoite (iron-nickel sulphide), coronadite [$(Mn, Pb)Mn_3O_7$], scheelite (calcium tungstate, $CaWO_4$), aluminite ($Al_2O_3.SO_3.9H_2O$, with some iron), copiapite ($2Fe_2O_3.5SO_3.18H_2O$), and halotrichite ($FeSO_4.Al_2(SO_4)_3+24H_2O$). The last three compounds are sulphates and are colored blue by the molybdenum, which may be present as the blue ilsemannite molecule.

Molybdenum occurs in small quantity with the more basic rocks but like tungsten and tin it is found in large quantity only with the more quartzose rocks, such as granite. It is deposited at much lower temperatures than tin, so that it is also found in contact metamorphic deposits. Although the element is one of lesser quantity in the rocks of the earth it concentrates in the solutions given off by freezing masses

[1] Washington, H. S., The Chemistry of the Earth's Crust: Jour. Franklin Inst., vol. 190, 1920, p. 777.
[2] Hess, Frank L., Ilsemannite near Ouray, Utah: U.S. Geol. Survey Bull. 750, 1923, pp. 1–16.

of molten deep-seated rocks and remains in solution until the fluids have cooled noticeably, and so may be carried to a considerable distance to be deposited in quartz veins or as a replacement of already cooled rocks. Thus, molybdenite is very wide-spread and is probably found, at least as a mineralogical curiosity, in every country and State having granitic rocks the upper parts of which have not been entirely eroded away. Its striking metallic appearance, the comparatively broad thin plates in which it usually occurs, and its contrast with quartz and other light-colored minerals with which it is found attract attention and are likely to give an exaggerated idea of the quantity of molybdenum present.

In the great development of chemistry that took place in the late seventeen hundreds such a cleanly segregated and noticeable mineral was necessarily investigated. The metal was isolated by P. J. Hjelm in Sweden in 1782. Owing to their likeness in color galena, flaky graphite, molybdenite, and other substances had always been confused and were all referred to as "molybdæna" or by some closely related term, and from that word, there used for molybdenite, that Hjelm formed his name for the new element.

Successful utilization of the metal in metallurgy required a long time and great advance in knowledge of that science. Tungsten, which was discovered at about the same time, found at least some use in steel 75 years later and became a standard component of tool steels just after the beginning of the twentieth century. Efforts to use molybdenum in a similar manner had enthusiastic supporters, but the use was comparatively small until 20 years later when it had been demonstrated that molybdenum might be made to function in an entirely different way from tungsten—small quantities toughening steel whereas tungsten hardens and tends to embrittle steel.

The development of the use of molybdenum in metallurgy in the United States was due largely to the work of Wills and Phillipson. After the companies with which Phillipson was connected had put a very large sum of money into a molybdenum mine and mill the demand was too small to pay for the investment. Phillipson, working with the steel companies and following the earlier work of Wills, developed and advertised the value of molybdenum in quantities of 0.2 or 0.3 percent in machine steels until his company's plant had to be greatly enlarged and molybdenum steels have become commonly quoted. Others also have worked effectively along the same line during this time.

Molybdenum-bearing tool steels were patented, and a considerable quantity was employed about 30 years ago, but their use declined as the use of tungsten steels increased. Since the Great War extensive experiments by the United States Naval Establishments have developed a molybdenum high-speed steel which, it is said, can be made satisfactorily and used in case of a shortage of tungsten.

The use of a few tenths of 1 percent of molybdenum in cast steels and gray cast irons has also been developed in recent years and seems to be growing.

While efforts were being made to make desirable molybdenum steels Elwood Haynes found that an excellent tool for cutting steel could be make from an alloy—which he called "stellite"—of cobalt, chromium, molybdenum, and/or tungsten.

For many years molybdenum in the form of ammonium molybdate has been the universal reagent for determining phosphorus in iron, steel, and other substances.

As has been said, the most important use of molybdenum is in steel. During 1932 J. L. Gregg and H. W. Gillett published a review of this use in an article entitled "Molybdenum—Today and Tomorrow" in Metals and Alloys (vol. 3, April 1932, pp. 98–104). Later in the year a volume by J. L. Gregg appeared under the title "The Alloys of Iron and Molybdenum" as a monograph of the Battelle Memorial Institute.[3]

According to Gregg, molybdenum when used alone apparently has little effect on "un-heat-treated" steel. In heat-treated wrought or cast steels with more than 0.3 percent carbon, less than 1 percent molybdenum substantially increases the tensile strength. The effect is reduced with less than 0.3 percent carbon. Several tenths of 1 percent of molybdenum increase the strength of low-carbon steel at high temperatures but may increase susceptibility to chemical attack. One half of 1 percent of molybdenum increases the tensile and transverse strength, endurance limit, and hardness, improves the high-temperature properties of gray cast iron, and apparently does not lower machinability. The use of molybdenum in cast iron is growing. Such iron is used for brake drums on automobiles.

Steels containing 0.15 to 0.25 percent of molybdenum and 0.50 to 1.10 percent of chromium, with or without 0.40 to 0.70 percent of manganese are used extensively in automobiles; steels containing 2 to 3 percent of nickel in place of the manganese are used in smaller quantity.

The place of molybdenum in high-speed tool steels has been a matter of dispute for more than 30 years. For a while its use ebbed, but it is now receiving favorable consideration by military engineers and others. Of the 18 or 20 percent of tungsten contained in high-speed tool steels molybdenum may be used to replace from 1 or 2 percent to the entire quantity. In such a substitution molybdenum replaces twice the percentage of tungsten owing to their difference in atomic volumes. Considerable has been said about "nitriding steels" for bearing or wearing surfaces, although the volume of such steels is small. Molybdenum (0.20 to 1.0 percent) seems to be used generally in such steels as it makes the extremely hard skin of iron nitride less brittle. Many other types of molybdenum steel that are not so well standardized have been made.

Molybdenum sheet has been employed for the plate in radio and Roentgen tubes; the wire is used as a support in radio tubes and incandescent lamps, and wire and ribbon are used as heating elements in small furnaces. Ammonium molybdate is used in large quantity to determine phosphorus in ores, iron, and steel. It is said that high-speed tools are made with a molybdenum shank and a tantalum carbide tip.

The interest now shown in molybdenum is remarkable. About 60 patents dealing with molybdenum as a component of alloys were noted in 1932. In most of them the molybdenum content is comparatively small, and in some molybdenum seems to have been introduced with the idea of not missing anything rather than with a definite idea of its having a specific function, for it is given as one of

[3] Published by the McGraw-Hill Book Co., Inc., New York, 507 pp.

a half dozen or more elements that "may be added" in very small quantity. In some 25 patents it forms part of corrosion-resistant alloys. In 14 patents it forms part of hard alloys or other tool materials, and 14 patents cover its use for electrical purposes—in magnets, filaments and filament supports, resistances, heating elements, electrodes for spot welding, the cathode in radio tubes, a thermocouple with tungsten, etc. Other patents cover the use of molybdenum in armor plate, copper turbine blades, and a "strong light alloy" of beryllium and aluminum and of aluminum with small quantities of other metals. The use of molybdenum salts for coloring other metals and the use of the metal as eyelets are patented.

A high-molybdenum alloy with tungsten, iron, cobalt, nickel, or manganese [4] and molybdenum alone [5] are used as catalysts.

A small group of patents covers the recovery of molybdenum from scrap-welding electrodes [6] and from catalysts [7] and the formation of molybdic oxide from molybdenite.[8] Other patents cover the making of molybdates of the alkaline-earth metals; [9] the carbonyls of molybdenum and tungsten [10] from which to obtain pure metals by thermal decomposition, as in the Mond nickel process; and methods of adding molybdenum to blast-furnace charges [11] and to cast iron.[12] The British Chemical Standards added a molybdenum-bearing high-speed steel to its analyzed standards.[13]

Yntema [14] described the electrodeposition of molybdenum, and Henderson [15] described the effects of molybdenum on the malleabilization of white cast iron.

REVIEW OF INDUSTRY, BY STATES

Colorado.—Alan Kissock, vice president of the Climax Molybdenum Co., says [16] that the company has developed at Climax, Colo., about 80,000,000 tons of ore containing an average of approximately 9 pounds of recoverable molybdenum per short ton which, based on the consumption in 1929, is sufficient to meet world demands for 200 years. The world output in 1929 was probably about 2,300 tons of contained molybdenum. Kissock's figures indicate a use of 1,800 tons for the year. A concentrate carrying about 90 percent MoS_2

4 Mittarch, — and Keunecke, —, Molybdenum as a Catalyst: Ztschr. physik. Chem., Bodenstein Fest Band, p. 574; Foote-Prints, vol. 5, no. 1, May 1932, p. 33.

5 Industrial and Engineering Chemistry (news edition), Molybdenum Sulphide Found to Be Good Catalyst: vol. 10, no. 23, Dec. 10, 1932, p. 292.

6 McCarroll, R. H. and Vennerholm, G. (assr. to Ford Motor Co., Ltd.), Treating Metals Such as Scrap-welding Electrodes of the Copper-Molybdenum or Copper-Tungsten Type: British Patent 353377, Feb. 4, 1930; Ford Motor Co., Ltd., 88 Regent Street, London. Improvements in a Method of Reclaiming and Reusing Metallic Scrap Mixtures: British Patent 353377, July 23, 1931.

7 Johnson, J. Y. (from I. G. Farbenind., A.G.), Recovery of Molybdenum, Tungsten, and Vanadium from Ores or the Like: British Patent 374250, May 26, 1931.

8 Iredell, C. V. (assr. to Westinghouse Lamp Co.), Recovery of Molybdenum [Oxide from Molybdenite]: U.S. Patent 1838767, Dec. 29, 1931.

9 I. G. Farbenindustrie, A.G., Germany, Process for preparation of Molybdate of the Alkaline-Earth Metals and of Magnesium: French Patent 685410, Mar. 31, 1930; Pokorny, Ernst (assr. to I. G. Farbenind. A.G.), Calcium Molybdate: U.S. Patent 1873475, Aug. 23, 1932.

10 Johnson, J. Y. (assr. to I. G. Farbenindustrie, A.G.), Manufacture of the Carbonyls of Molybdenum and Tungsten: British Patent 367481, Dec. 3, 1930; Improvements in the Manufacture and Production of Molybdenum Carbonyl: British Patent 370894, Apr. 4, 1932.

11 Kissock, Alan, Molybdenum-Bearing Iron: Canadian Patent 322595, May 24, 1932.

12 Kissock, Alan, Cast Iron Containing Molybdenum: U.S. Patent 1857595, May 10, 1932.

13 Chemistry and Industry (London), British Chemical Standard Alloy Steel "W 2": vol. 51, no. 15, Apr. 8, 1932, p. 324.

14 Yntema, L. F., The Electrodeposition of Chromium, Molybdenum, and Tungsten: Jour. Am. Chem. Soc., vol. 54, no. 9, September 1932, pp. 3775, 3776.

15 Henderson, Everett L., The Effects of Molybdenum and Chromium on the Malleabilization of White Cast Iron: Iowa State College Jour. Sci., vol. 6, 1932, pp. 435–437; Chem. Abs., vol. 26, Nov. 20, 1932, p. 5887.

16 Kissock, Alan. Molybdenum: Its Mining, Milling, and Uses: Min. and Met., vol. 14, 1933, pp. 181–182.

is produced in the mill and exported without further processing, or is shipped to the company's plant at Langeloth, Pa., where it is converted into ferromolybdenum, calcium molybdate, or metallic molybdenum. About three times as much is exported as is used in this country.

The deposit is in a huge mass of finely brecciated granite, in the cracks of which tiny veinlets of quartz and molybdenite have been deposited. The mine is 1 mile east of the village of Climax (altitude 11,300 feet) at an altitude of 12,000 feet. The climate is severe. From June 1 to October 1 there are many rains and on many afternoons light snowfalls. In October there may be bad blizzards, and during the long winter heavy winds blow the fine dry snow so that outside work is difficult.

The locality is a rough, bare mountain ridge running nearly north and south. A glacial cirque a mile long and half a mile wide is cut in the west side of the ridge and opens to the northwest at Fremont Pass in which Climax is located. Bartlett Mountain is on the northeast side of the cirque and Ceresco Mountain on the southwest side. A small stream drains the cirque, and on both sides, especially on the slope of Ceresco Mountain, is a great accumulation of heavy debris. Within the cirque on the lower slopes of both Bartlett and Ceresco Mountains is the great mass of brecciated granite with more or less quartz porphyry in which the Climax deposit is located; outcrops range from 11,500 to 13,000 feet in altitude.

Originally the Climax Molybdenum Co. owned the property only on Bartlett Mountain, but it has since acquired the extension of the deposit on Ceresco Mountain. Alan Kissock [17] says:

The molybdenite deposit has the form of a pipe or stock of silicified granite which enlarges downward. In the central part or core of this stock the granite has been highly silicified and in most places is massive white quartz. Around this core is an intermediate zone of moderately silicified rock cut in all directions by intersecting quartz veinlets which carry molybdenite. The ore zone surrounds the barren and more highly silicified core, at places penetrating it and gradually decreasing both in molybdenum content and silicification in the opposite direction. The ore limits are therefore indefinite and determined only by metallurgical and commercial considerations. This ore body may be likened to a doughnut, though it is really elliptical in shape with the present commercial grade of ore varying from 250 to over 400 ft. wide and having a known vertical depth of 1,300 ft. around a central core which has approximate diameters of 900 ft. at the 300-ft. level and 1,300 ft. at the 740-ft. level.

In an ore body of as low a grade as Climax it is necessary to use low-cost mining methods. * * * Mining costs are comparable with many well-known operations which are handling much greater daily tonnages. * * *

It required 100-mesh grinding to free the finely divided molybdenite from the quartz. To eliminate this cost on the tonnage that must be handled the ore is first ground to 25 percent on 100 mesh. The flotation pulp from the classifiers is pulled heavily in rougher cells resulting in a froth carrying about 15 percent molybdenum sulfide. Rougher tailing is put through scavenger cells in a series, and thus the great bulk of tonnage is quickly eliminated from the circuit. Rougher froth goes to a bowl classifier where the middling settles out and is reground in a small 4-ft. ball mill in closed circuit with the bowl. Thus relatively coarse grinding of an ore requiring fine grinding is made possible, and the middling is entirely removed from the main mill circuit. Bowl classifier overflow is refined through a series of cleaner cells, washed in thickeners, filtered, dried, and packed in the usual manner.

There is more pyrite than molybdenite in the feed, and yet with about a 130 to 1 concentration ratio the final concentrate carries approximately 90 percent molybdenum sulfide and only a fractional percentage of iron. With feed averaging only 0.8 to 0.9 percent molybdenum sulfide a recovery of 90 percent is

[17] Kissock, Alan. Molybdenum: Its Mining, Milling, and Uses: Min. and Met., vol. 14, 1933, pp. 181-182.

made, which is a performance that may be considered a tribute to the flotation process and to the men in charge of this operation.

Concentrate is packed in oak kegs for shipment through Galveston to European ports, and in heavy jute bags for shipment to the company's conversion plant near Pittsburgh. It is necessary to ship nothing but concentrate abroad which goes in duty free because conversion there provides work in the countries involved.

Molybdenite concentrate carries about 35 percent sulfur. Conversion includes roasting to remove this sulfur and combination in the same furnace of the resulting oxide with lime to form calcium molybdate. The discovery that calcium molybdate could be used directly to introduce molybdenum into iron and steel eliminated the costly step of reduction to a ferro-alloy and by thus lowering the ultimate price greatly widened the application and increased the use of molybdenum. Fully 90 percent of all molybdenum steel made in this country is now produced from calcium molybdate.

Ferromolybdenum is produced from roasted molybdenite either by the electric furnace or thermit process. It is necessary to use this product for alloying molybdenum in excess of 1½ percent or whenever it is required to make addition to the ladle. * * *

For a time the United States was the largest consumer of molybdenum, but during the past few years European countries have far outstripped us. Export demand to England, France, Germany, Russia, Japan, and other lands has grown remarkably.

The following reports give information on the property:

EMMONS, S. F. Geology and Mining Industry of Leadville, Colo. U.S. Geol. Survey Mon. 12, 1886, 770 pp.

EMMONS, S. F., IRVING, J. D., AND LOUGHLIN, G. F. Geology and Ore Deposits of the Leadville District, Colo. U.S. Geol. Survey Prof. Paper 148, 1927, 368 pp.

EMMONS, S. F. Ten-Mile Folio. U.S. Geol. Survey Folio 48, 1898.

(The two preceding reports cover only the geology of the area but do not describe the deposit. The Ten Mile Folio carries geology to the north.)

BROWN, H. L., AND HAYWARD, M. W. Molybdenum Mining at Climax, Colo. Eng. and Min. Jour., vol. 105, 1918, pp. 905–907.

HOLLAND, L. F. S. Recent Developments in Molybdenum. Min. and Sci. Press, vol. 117, 1918, pp. 529–531.

HALEY, D. F. Molybdenite Operations at Climax, Colo. Trans. Am. Inst. Min. and Met. Eng., vol. 61, 1919, pp. 71–76.

WORCESTER, P. G. Molybdenum Deposits of Colorado. Colorado Geol. Survey Bull. 14, 1919, pp. 87–94.

HESS, F. L. Molybdenum Deposits—Short Review. U.S. Geol. Survey Bull. 761, 1924, pp. 4, 9–12, pl. 2.

COULTER, W. J. Mining Molybdenum Ore at Climax, Colo. Eng. and Min. Jour., vol. 127, 1929, pp. 394–400; Crushing and Concentrating Molybdenum Ore at Climax, Colo., pp. 476–480.

STAPLES, L. W., AND COOK, C. W. Microscopic Investigation of Molybdenite Ores from Climax, Colo. Am. Mineral., vol. 16, 1931, pp. 1–17.

BUTLER, B. S., VANDERWILT, J. W., AND HENDERSON, CHAS. W. The Climax Molybdenum Deposit of Colorado. Proc. Colorado Sci. Soc., vol. 12, 1931, pp. 309–353.

New Mexico.—The molybdenite mine of the Molybdenum Corporation of America is situated in Sulphur Gulch on the north side of Red River 7 miles east of Questa, Taos County, N.Mex. The mill and camp are in Red River Valley 1¼ miles away. The mine is at an altitude of 8,700 feet, and the mill is 600 feet lower. The winters are cold but not so stormy as at higher and more exposed localities. The country is very rough and precipitous around the mine, and on some mountain sides the rock is so broken that the slopes are merely bare fragmental debris.

The veins are narrow and irregular and cut granodiorite. Besides molybdenite the ore contains quartz, pyrite, feldspar, biotite, fluorite, a little rhodochrosite, calcite, and inclusions of the country rock. The ore is friable, requires little power for crushing, is comparatively rich (ranging from 4.5 to 7.5 percent MoS_2), and averages about 5 percent. About 40 tons per day are mined, and about 65 men are employed.

The ore is concentrated by flotation in a mill operated largely by water power. To obtain as much head as practicable the mill is located in the bottom of the canyon of the Red River, and the ore flows by gravity supplemented by an elevator and pumps. A Diesel engine gives needed extra power but costs 10 times as much as water power. About 80 percent of the crushed ore passes through a 40-mesh screen.

Mining and milling have been described by J. B. Carman, manager of the property, in two papers published by the United States Bureau of Mines.[18]

Data for 10 months of operation in 1930 are given below.

Metallurgical data of the Questa mill of the Molybdenum Corporation of America, Feb. 1 to Nov. 30, 1930[19]

Ore treated	wet tons	11, 239
Days operated		289
Hours operated per day		23. 80
Average ore treated per day	tons	38. 9
Concentrates produced	do	673
Average concentrates produced per day	do	2. 33
Ratio of concentration, tons into 1		16. 7
Feed	percent of MoS_2	5. 08
Concentrates	do	71. 13
Tailings	do	. 68
Recovery of MoS_2	percent	86. 8
New water consumption per ton of ore treated	tons	2. 5
Ball consumption per ton of ore	pounds	1. 5
Liner consumption per ton of ore	do	. 934
Cyanide used per ton of ore treated	do	. 08
Flotation oil per ton of ore treated	do	1. 00

The geology of the mine was described by E. S. Larsen and C. S. Ross under the title "R. & S. Molybdenum Mine, Taos County, N.Mex." in Economic Geology (vol. 15, 1920, pp. 567–573).

Arizona.—Ore carrying 7.75 percent MoS_2 was produced from the Santo Niño mine near Helvetia, Ariz. This mine has produced high-grade ore in connection with copper ore for many years.[20]

Walter X. Osborn and associates were engaged in developing the Rowley mine at Gila Bend for wulfenite for which a foreign market was said to be open.

It was reported that the Mammoth-Arizona Gold Mining Co. spent a considerable sum in developing the old Mammoth and other mines at Shultz for wulfenite, but no production was made.

The "Edward Smith Exploration" reported that it was developing a molybdenite property 6 miles from Miami.

Idaho.—At Porthill the International Molybdenum Co. mined a small quantity of molybdenite during the year.

Utah.—In Utah a little work was done on the ilsemannite deposit near Ouray.[21]

Nevada.—Development work was done by the California Molybdenum Co. on a wulfenite-bearing property at Goodsprings, Nev., but no production was made.

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[18] Carman, J. B., Mining Methods of the Molybdenum Corporation of America at Questa, N.Mex.: Inf. Circ. 6514, Bureau of Mines, 1931, 15 pp.; Milling Methods at the Questa Concentrator of the Molybdenum Corporation of America, Questa, N.Mex.: Inf. Circ. 6551, Bureau of Mines, 1932, 14 pp.

[19] Inf. Circ. 6551, p. 13.

[20] On the occurrence of molybdenite in the Leader and Ridley Mines at Helvetia, Ariz., see Schrader, F. C., and Hill, J. M., Some Occurrences of Molybdenite in the Santa Rita and Patagonia Mountains, Ariz.: U.S. Geol Surv. Bull. 430, 1910, pp. 154–163; also Mineral deposits of the Santa Rita and Patagonia Mountains, Ariz.: U.S. Geol. Surv. Bull. 582, 1915, pp. 106–108 and 126–127.

[21] For a description of this deposit see Hess, Frank L., Ilsemannite at Ouray, Utah, U.S. Geol. Surv. Bull. 750, 1923, pp. 1–16.

FOREIGN TRADE

The United States, being by far the largest producer, is an exporter of molybdenum ores, but figures showing the quantity shipped are not available.

The only importation recorded during 1932 was 44 pounds of ferromolybdenum, valued at $89, from Germany.

Ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum imported for consumption in the United States, 1923–32

Year	Molybdenum content, pounds	Value	Year	Molybdenum content, pounds	Value
1923	4	$5	1928	576	$1,385
1924	431	802	1929	1,627	2,384
1925	274	1,184	1930	144,963	[1] 283,846
1926	604	987	1931	210,766	[2] 213,660
1927	1,657	5,712	1932	44	89

[1] Average value 1930, $1.96. [2] Average value 1931, $1.01.

In 1931 molybdenum oxide containing 200,000 pounds of molybdenum was imported presumably for use in the hydrogenation of vegetable oils. The bulk of the imports in 1930 was molybdenum in bars to be drawn into wire.

Tariff.—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.

WORLD PRODUCTION

The world production of molybdenum during 1930–32 is shown in the following table.

World production of molybdenum ores and concentrates, 1930–32

Country	Mineral	Concentrates	Percent MoS_2	Contained molybdenum	Value
1930		*Metric tons*		*Metric tons*	
Australia:					
New South Wales	Molybdenite	3	(1)	(1)	$2,115
Queensland	do	2	(1)	(1)	1,935
Austria	Wulfenite	(1)	(1)	0.2	(1)
China	Molybdenite	5	(1)	(1)	(1)
Chosen	do	26	(1)	(1)	14,313
Morocco, French [2]	do	.8	(1)	(1)	785
Norway	do	284	75	128	227,993
United States	do	3,282	85.75	1,688	2,048,000
1931					
Australia:					
New South Wales	do	.3	(1)	(1)	245
Queensland	do	.3	(1)	(1)	218
Canada	do	(1)	(1)	.6	270
China	do	(1)	(1)	(1)	(1)
Chosen	do	(1)	(1)	(1)	(1)
Mexico	do	(1)	(1)	3.4	6,789
Morocco, French [2]	do	5	(1)	(1)	3,136
Norway	do	223	77	108	134,000
Peru	do	(1)	(1)	4.6	4,550
United States	do	2,756	85.93	1,421	1,566,000
1932					
Australia:					
New South Wales	do	(1)	(1)	(1)	(1)
Queensland	do	(1)	(1)	(1)	(1)
China	do	(1)	(1)	(1)	(1)
Chosen	do	(1)	(1)	(1)	(1)
Mexico	do	(1)	(1)	3.1	4,342
Morocco, French [2]	do	.1	(1)	(1)	4
Norway	do	[2] 369	[2] 80	[2] 221.4	(1)
Peru	do	(1)	(1)	(1)	(1)
United States	do	2,165	84.89	1,103	1,216,000

[1] Data not available. [2] Exports.

Norway.—The largest foreign molybdenum deposit now in operation is the Knaben mine in Norway. The Knaben mine, in southern Norway about 25 miles a little east of north from Flekkefjord and 38 miles N. 60° E. from Ekersund, has been producing molybdenite since 1901, except in 1910, 1920, 1921, and 1922. The total quantity produced to the close of 1932 was 3,012 metric tons[22] of molybdenite concentrates averaging 80 percent MoS_2, of which 369 metric tons were produced in 1932, as shown by exports.[23]

Woakes[24] divides the deposits into (1) quartz lodes; (2) fissured granite, more or less decomposed, carrying molybdenite with a small quantity of quartz, having a flat dip and little depth; (3) impregnated granite or norite. Some pyrite, chalcopyrite, a little pyrrhotite, feldspar, mica, and hornblende are found with the deposits.

In the Knaben mine some of the stopes are 10 meters wide, and although in general the molybdenite is finely disseminated some large rich masses have been mined. In many places the ore disappears at

[22] A metric ton equals 2,204.6 pounds or 1.1023 short tons.
[23] From figures compiled by H. H. Smith, Oslo, Norway.
[24] Woakes, E. R., Molybdenum in Norway: Inst. Min. and Met. (London), Bull. 160, 1918, p. 5.

shallow depths, either pinching out or leaving a barren vein. The ore in the Knaben No. 1 mine contained about 0.56 percent MoS_2 and in the Knaben No. 2 mine 0.5 percent.

The mine was described by Sv. Blekum, technical director, under the title "A./S. Knaben Molybdaengruber" in the Tidsskrift for Kemi og Bergvesen (vol. 12, 1932, pp. 184–190). An aerial tramway was installed between the mine and mill with a capacity of 50 tons per hour.[25]

Australia.—At Everton, Victoria, Myrtleford Molybdenite, Ltd., was said to be reopening the molybdenite deposits of that locality (near long. 146°30′ E., lat. 36°20′ S.). The deposits are in granite intruded into slate and sandstone. The granite is cut by pegmatites, few of which carry molybdenite, and in these it is associated with quartz. It is also associated with comparatively narrow quartz veins where found in the granite.

Mexico.—A considerable number of deposits of molybdenum minerals are known in Mexico, and it is reported that during 1932 ore containing 3.1 metric tons of molybdenum was produced by Frank Fast from his San Julian mine near Tonichi, Sonora.

A decree issued by the President of Mexico permitted lowering taxes on mineral lands, and a second decree authorized the Ministry of Industry, Commerce, and Labor to create national mineral reserves on free land on which is found molybdenum and most other commercial minerals.[26]

Other countries.—Discoveries of molybdenite of unknown importance have been reported from Sierra Leone.[27] There have also been indefinite reports of large deposits in Peru.

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[25] Metal Bulletin, Jan. 24, 1933, p. 15.
[26] Mining Journal (Phoenix, Ariz.), vol. 16, 1932, p. 10.
[27] Mining Journal (London), vol. 179, 1932, p. 718.

TUNGSTEN

By Frank L. Hess

The relative economic position of the tungsten industry has followed closely the course of the business depression, and the industry declined much more in 1932 than in the 2 preceding years. So serious were the difficulties that some tungsten ore sold for less than the duty levied on tungsten ore.

The production of tungsten concentrates in the United States during the past 5 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 1928–32, and average price per unit

Year	Short tons	Value	Average price per unit	Year	Short tons	Value	Average price per unit
1928	1,208	$753,900	$10.40	1931	1,404	$928,000	$11.02
1929	830	654,000	13.13	1932	396	218,394	9.20
1930	702	509,000	12.09				

Prices.—According to the Engineering and Mining Journal domestic scheelite carrying 65 percent, or more, tungsten trioxide (WO_3), was quoted from January through May as $10 to $11.50 per short-ton unit (20 pounds of WO_3). The price gradually slid downward until it reached $7.50 to $9 per unit in November and $8 to $10 in December. Bolivian scheelite, duty paid, was quoted in the early part of the year at $10.75 per unit, gradually dropping to "9.50 nominal" at the close of the year. Chinese wolframite, duty paid, was quoted at $10.75 to $11 per unit in January to $9.50 in December. Tungsten powder containing 98 percent tungsten (W) was quoted at $1.45 per pound throughout the year, and ferrotungsten carrying 75 to 80 percent (W) was quoted at $1 to $1.10 for the contained tungsten until December, when it fell to 94 cents to $1, f.o.b. shipper's works.

At $9.50 duty paid per short-ton unit $1.57 is left per unit for the wolframite, c.i.f. New York, making the duty ($7.931) 505 percent.

Published European quotations are said to be rather unreliable.

The cost of reducing wolframite, ferberite, or scheelite concentrates to ferrotungsten was quoted during the year as 15 cents per pound of tungsten contained in the ferro, and a recovery above 92 percent of the tungsten in the concentrate was guaranteed.

Imports, exports, and apparent consumption.—The tungsten imports for consumption during 1931 and 1932 have been as follows:

Tungsten imported for consumption in the United States, 1931–32

	1931		1932	
	Pounds	Value	Pounds	Value
Tungsten ore and concentrates (W content)	167,352	$48,288	92,284	$21,857
Tungsten metal and alloys	20,126	11,716	12,472	5,882
Combinations containing tungsten or tungsten carbide (W content)	3	24	131	332
Tungstic acid and other compounds of tungsten, not specially provided for (W content)	1,795	3,819	1,315	2,629
	189,276	63,847	106,202	30,700

No tungsten ores are exported from the United States, but ferrotungsten, tungsten wire, and some other tungsten products are exported. The shipments during 1932 amounted to 140,783 pounds valued at $172,585. Of this quantity 118,943 pounds containing about 90,000 pounds of tungsten [1] were exported to Russia.

The apparent consumption of new tungsten in the United States in the past 10 years is shown in the following table:

Apparent consumption of new tungsten in the United States, 1923–32, 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 in short tons of 60 percent WO_3 concentrates
1923	79,021	229,359	308,380	4,032	304,348	320
1924	141,858	537,711	679,569	3,435	676,134	710
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] [2] 846,200	[1] 679,291	[1] 714
1932	106,202	376,881	483,083	[2] 112,626	370,457	389

[1] Revised figures.
[2] Of these quantities, in 1931, 802,609 pounds and, in 1932, 90,000 pounds were shipped to Russia as ferrotungsten.

Tungsten stocks in bonded warehouses December 31, 1931 and 1932, were as follows:

[1] Information from David Taylor Co.

Tungsten stocks in bonded warehouses on Dec. 31, 1931 and 1932, by customs districts

Customs district	Ore: Tungsten content (pounds) Dec. 31, 1931	Ore: Tungsten content (pounds) Dec. 31, 1932	Ore: Value Dec. 31, 1931	Ore: Value Dec. 31, 1932
New York	916,736	827,116	$209,692	$168,713
Pittsburgh	710,579	36,930	188,623	7,135
Buffalo	170,876	172,583	57,379	57,379
Philadelphia	29,387	32,280	7,361	3,743
Ohio	6,816	5,276	2,052	1,583
Total	1,834,394	1,074,185	465,107	238,553
	Tungsten (metal)			
Los Angeles	62,921	43,647	$28,800	$18,594
Galveston	39,218	35,490	16,155	14,615
New York	280	240	387	516
Total	102,419	79,377	45,342	33,725

Duties.—Import duties on tungsten in ore and other forms as provided by the Tariff Act of 1930 are as follows:

Par. 302 (*c*).—Tungsten ore or concentrates, 50 cents per pound on the metallic tungsten contained therein. (As a short-ton unit, 20 pounds of tungsten trioxide (WO_3) contains 15.862 pounds of metallic tungsten, the duty is equivalent to $7.931 per short-ton unit or $8.883 per long-ton unit.)

Par. 302 (*g*).—Tungsten metal, tungsten carbide, and mixtures or combinations containing tungsten metal or tungsten carbide, all the foregoing, in lumps, grains, or powder, 60 cents per pound on the tungsten contained therein and 50 per centum ad valorem; tungstic acid, and all other compounds of tungsten, not specially provided for, 60 cents per pound on the tungsten contained therein and 40 per centum ad valorem.

Par. 302 (*h*).—Ferrotungsten, ferrochromium tungsten, chromium tungsten, chromium-cobalt tungsten, tungsten nickel, and all other alloys of tungsten not specially provided for, 60 cents per pound on the tungsten contained therein and 25 per centum ad valorem.

Par. 305 provides that besides the duties levied in some other paragraphs extra duties shall be collected as follows:

(1) A duty of 8 per centum ad valorem if such steel or iron contains more than one-tenth of 1 per centum of vanadium, or more than two tenths of 1 per centum of tungsten, molybdenum, or chromium, or more than six tenths of 1 per centum of nickel, cobalt, or any other metallic element used in alloying steel or iron: *Provided*, That phosphorus shall not be considered as alloying material unless present in the steel or iron in excess of 5 per centum, nor shall manganese or silicon be so considered unless either is present in the steel in excess of 1 per centum, or unless either is present in the iron in excess of 3 per centum; and

(2) An additional cumulative duty of $1 per pound on the vanadium content in excess of one tenth of 1 per centum, 72 cents per pound on the tungsten content in excess of two tenths of 1 per centum, 65 cents per pound on the molybdenum content in excess of two tenths of 1 per centum, and 3 cents per pound on the chromium content in excess of two tenths of 1 per centum.

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.

Uses and metallurgy.—The principal use of tungsten is in the making of high-speed tool steels—steels that will hold their temper when raised almost to red heat, thus allowing much faster cutting of metals. It is used in smaller quantity in numerous other types of cutting steels and in alloys such as valves in explosion engines which must stand considerable heat. Tungsten carbide cemented with cobalt is the hardest artificial cutting material. Saws tipped with it are used for cutting asbestos manufactured products and other gritty materials and "remain sharp from 25 to hundreds of times as long as steel saws."[2] A new type of the material made by the General Electric Co. contains crushed diamonds ranging from dust to 0.1 carat or larger. The principal use is for dressing grinding wheels.

In a new tool material, Vascoloy, made by the Vanadium-Alloys Steel Co., tantalum carbide is held in a matrix of tungsten.

The use of tungsten which touches most people is that in incandescent lights, in which it has no rival for general purposes and in which it has made enormous saving in power with increased quality of the light.

Tungsten is used extensively in intermittent electrical contacts, as in automobile-engine timers. A steel containing 2 percent tungsten is used as a core for small armor-piercing projectiles, especially those for airplane rifles. Tungsten is used as the filament in radio tubes. Sodium tungstate and oxide are used in making lakes, mordants, and some other chemicals.

A process for obtaining very pure tungsten by making carbonyl from impure metal and then reducing the carbonyl was patented during the year by J. Y. Johnson.[3] Further patents on plating objects with tungsten were issued during the year to Colin G. Fink [4] and to Fink and Jones.[5]

A review of tungsten plating was published by Holt and Kahlenberg.[6]

REVIEW BY STATES

Arizona.—The Boriana Mining Co. in the Hualpai Mountains northeast of Yucca, Ariz., shipped 11 short tons of wolframite carrying 66.36 percent WO_3 that had been mined in 1931. Development work was carried on during the first 8 months of 1932, and there are said to have been blocked out: Positive ore, 15,549 tons, 2.383 percent WO_3; probable ore, 16,146 tons, 2.07 per cent WO_3; possible ore, 31,685 tons, 2 percent WO_3. Five thousand feet of drifts, 1,000 feet of ladder raises, and numerous ore raises and crosscuts have been run. Control of the property passed from the Stoody Co. to J. P. Sievers and associates.

Lawler & Wood mined through lessees and shipped 4.35 short tons of wolframite from Camp Wood, northwest of Prescott.

The Tungsten Alloys Corporation in the Las Guigas Mountains, west of Amado, did no mining during the year but shipped 42.7 short tons of huebnerite carrying 63.43 percent WO_3.

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[2] Asbestos, Two Million Feet of Asbestos Pipe Covering Cut by a Disston-Carboloy Saw: Vol. 14, December 1932, pp. 15–16.

[3] Johnson, J. Y. (I. G. Farbenindustrie A.-G.), Manufacture of the Carbonyls of Molybdenum and Tungsten: British Patent 367481, Dec. 3, 1930; Improvements in the Manufacture and Production of Molybdenum Carbonyl: British Patent 370894, Apr. 4, 1932.

[4] Fink, Colin G., Electroplating and Process of Producing Same: U.S. Patent 1885700, Nov. 1, 1932.

[5] Fink, Colin G., and Jones, Frank L., Tungsten Plating and Method of Producing Same: U.S. Patent 1885701, Nov. 1, 1932.

[6] Holt, M. Leslie, and Kahlenberg, Louis, The Electrodeposition of Tungsten from Aqueous Alkaline Solutions: Metal Ind., vol. 31, 1933, pp. 94–97.

California.—The Atolia Mining Co. at Atolia, which began work in 1905 on what has been, with the possible exception of the Easley & Inslee Mine, near Oruro, Bolivia, the greatest tungsten mine known, did not operate during 1932, although it did ship some scheelite that had been concentrated in 1931. Some scheelite concentrate was shipped by Magee & Wolf at Georgetown; lots were still held by the Atolia Mining Co. at Atolia, the Tonopah Mining Co. from work done at Round Valley, near Bishop, by A. E. Beauregard at Laws, and by the estate of J. H. Kennedy at Posey.

Colorado.—The only miners of tungsten in the Boulder County ferberite field were George Cowdery and the Wolf Tongue Mining Co. Mr. Cowdery mined 60 short tons of ore carrying about 2 percent WO_3, from which 1¾ tons of concentrates carrying 65 percent WO_3 were made and added to stock on hand. A new ore body was discovered.

The Wolf Tongue Mining Co. mined a newly discovered ore body during the year and had a stock of concentrates on hand at the close of the year. Prospecting was carried on by core-drilling, in which firthite, a cemented tungsten carbide, was used instead of diamonds. William Loach, manager, says that in hard gneiss the cost was about equal to diamond drilling, but in the softer rocks it was much less. On account of the smaller cost of firthite there is not the loss through loosening or breakage that there is with diamonds, and he has found the aggregate cost to be less. At the close of the year the company did some geophysical prospecting, hoping that, as the veins are vuggy and carry a great deal of water, by locating water-bearing channels, veins might be found. Results have not yet been confirmed by mining.

The United States Bureau of Mines published in December 1932 Information Circular 6673 by William O. Vanderburg, Methods and Costs of Mining Ferberite Ore at the Cold Springs mine, Nederland, Boulder County, Colo. Information Circular 6685, Methods and Costs of Milling Ferberite Ore at the Wolf Tongue Concentrator, Nederland, Boulder County, Colo., was published in January 1933. These were made possible through the cooperation of William Loach, manager of the company, William T. Todd, mine superintendent, and W. G. Roseborough, mill superintendent. They are for free distribution from the Section of Publications, U.S. Bureau of Mines, Washington, D.C., as long as the supply lasts.

Montana.—The Jardine Mining Co. of Jardine, Mont. shipped 25.9 short tons of scheelite carrying 68.93 percent WO_3 that had been mined and milled in 1931.

The Spokane-Idaho Copper Co. discovered in its Midas claim, 25 miles (36 miles by road) south of Libby, Mont., a rich lens of scheelite-bearing ore in a gold-silver vein. A part analysis of scheelite concentrate gave: Tungsten trioxide, 72.09; lime, 17.44; silica, 7.83; iron and aluminum oxides, 0.98; phosphorus, 0.014; copper, none. The scheelite is said to carry also \$6 to \$25 per ton in gold and a few ounces of silver.

Nevada.—The Nevada-Massachusetts Co. operated its mine and mill in the Eugene Mountains 10 miles north of Mill City, Nev., only part of the year. The mill was shut down from May to December. During that time new ore bodies were developed, some of which were thought to carry 3 to 3½ percent WO_3.

Sixteen thousand tons of ore were mined and milled, from which were made 230 short tons of concentrates containing 14,410 units, an equivalent of 240 tons carrying 60 percent WO_3. It was sold at an average price of $9.77 per unit. Charles H. Segerstrom estimates that should the demand for tungsten return to the average of the last few years before 1929 and under the present tariff he could produce 2,000 tons of concentrates per year, with the employment of 200 men. (The United States uses an average of about 4,500 tons of 60 percent WO_3 per normal year.) A new shaft was completed at the Humboldt mine. The mill was repaired and enlarged to a capacity of 250 to 300 tons per day. The company further developed its Silver Dyke mine at Mina and increased the milling capacity to 100 tons per day. It did no work at its Ragged Top mine about 20 miles by road southwest of Lovelock, or at its Cottonwood mine near Quartz Mountain about 45 miles north and a little east of Luning.

During the year the Bureau of Mines published Information Circular 6604, Methods and Costs of Concentrating Scheelite Ore at the Silver Dyke Mill, Mineral County, Nev., by William O. Vanderburg, and a paper on The Tungsten Deposit at Mill City, Nev., was read by Prof. P. F. Kerr at the meeting of the Geological Society of America at Cambridge, Mass., the last of December.

Washington.—During the first 6 months of 1932 Tungsten Producers, Inc., of Chehalis, Wash., operated the old Germania wolframite mine worked before the Great War by William Scheck at Deer Trail, Stevens County, 9 miles southeast of Fruitland. About 1,000 feet of adit were driven in 1931 and 250 feet more in 1932. Some concentrate was shipped during the year.

James Keeth also produced some wolframite by hand sorting and jigging from a claim on the Spokane Indian Reservation about a mile from the Tungsten Producers, Inc., which is just outside of the reservation.

FOREIGN PRODUCTION

Little data concerning the foreign production of tungsten ore in 1932 are at hand. Such figures as could be obtained for the output in 1932 are shown in the following table.

World production of tungsten ore, 1928–32, in metric tons of concentrates containing 60 percent WO_3

Country [1]	1928	1929	1930	1931	1932
North America:					
Mexico	----------	11	28	([2])	([2])
United States	1,096	753	637	1,274	359
	1,096	764	665	1,300	([2])
South America:					
Argentina	24	63	98	20	([2])
Bolivia [3]	29	1,630	888	410	1,000
	53	1,693	986	430	([2])

[1] In addition to the countries listed, Ethiopia reports an experimental production of 100 tons of tungsten ore in 1928; content of WO_3 not stated. No further development of deposit reported.
[2] Data not available.
[3] Exports.

World production of tungsten ore, 1928–32, in metric tons of concentrates containing 60 percent WO_3—Continued

Country	1928	1929	1930	1931	1932
Europe:					
Czechoslovakia	73	75	74	17	(2)
France		1			(2)
Germany (Saxony)				5	(2)
Great Britain (Cornwall)	96	27	153	121	(2)
Portugal	151	358	499	274	(2)
Spain	193	257	254	135	(2)
	513	718	980	552	(2)
Asia:					
China [3]	8,283	9,978	9,454	7,492	2,249
Chosen	161	15	13	(2)	(2)
India (Burma)	843	1,484	2,699	2,474	(2)
Indo-China (Tonkin)	175	198	220	248	(2)
Japan	54	61	81	(2)	(2)
Malay States:					
Federated Malay States	5	356	1,054	462	378
Unfederated Malay States	139	157	178	241	(2)
Netherland India	8	10	15	1	(2)
Russia [3]	[4] 58	(2)	(2)	(2)	(2)
Siam		62	7	12	(2)
	9,726	12,321	13,721	11,000	(2)
Africa:					
Southern Rhodesia	15	28	38	24	14
Union of South Africa				2	(2)
	15	28	38	26	(2)
Oceania:					
Australia:					
New South Wales		25	17	62	(2)
Northern territory:					
Central Australia		20	67	29 (Central and North Australia)	(2) (Central and North Australia)
North Australia		1	(5)		
Queensland	29	22	24	3	(2)
Tasmania	209	180	133	(5)	
New Zealand [3]	6	39	21	6	(2)
	244	287	262	100	(2)
	11,600	15,800	16,700	13,400	(2)

[2] Data not available.
[3] Exports.
[4] Year ended Sept. 30.
[5] Less than 1 ton.

Africa.—Africa has never produced much tungsten, although tungsten minerals are found at widespread points. During 1932 the only known production was 14 metric tons (15 short tons) of scheelite concentrates, apparently from the Scheelite Queen mine in the Gevelo district of Southern Rhodesia.

It was reported that wolframite was found in gold concentrates from the Kigez district of Uganda.[7]

Bolivia.—Easley [8] and Inslee produced and shipped from their Conde Auque mine about 45 kilometers (28 miles) northeast of Oruro, Bolivia, about 1,000 metric tons of scheelite concentrates which went to Italy, Germany, and England. In other years the concentrate has averaged about 60 percent WO_3, ranging from 55 to 65 percent WO_3. No data are at hand concerning other possible output from Bolivia, but it was probably negligible.

Burma.—Little information concerning details of current production in Burma is at hand.

[7] South Africa Mining and Engineering Review, Minerals in Uganda: Vol. 43, part 1, 1932, p. 444.
[8] Information from George A. Easley.

The principal producing properties are the Hermingyi mine near Tavoy and the Mawchi mine in Bawlake. From Rangoon the mouth of the Tavoy River is reached by fortnightly steamer in a little less than 24 hours. Tavoy is between 20 and 30 miles up the river, and the tungsten mines are about 40 miles farther in a very rough jungle-covered country. The rainfall, mostly falling during three and one half months of the monsoon, is said to average 240 inches and reaches 400 inches per year,[9] but the remainder of the year is so dry that water must be stored for mining purposes. The wolframite concentrates contain considerable tin and are separated magnetically at Tavoy before export.

At Mawchi, in the southern part of the Karenni state of Bawlake, east of the Salween River, veins carrying wolframite and cassiterite are mined yielding a concentrate that carries approximately 57 percent cassiterite and 43 percent wolframite,[10] including some scheelite, which is shipped to Murex, Ltd., London, a stockholder in the mine, for separation.

Recent assays of Burmese concentrates are given below.

Burmese wolframite concentrates [1]

	Symbol	Tavoy	Mawchi	District not given	
Tungsten trioxide	WO_3	70.70	69.36	60.2	68.7
Tin	Sn	.69	.69	.40	.72
Arsenic	As	.03	.20	.14	None
Phosphorus	P	.02	.02	[2] .03	Trace
Copper	Cu	.03	.05	.47	.04
Manganese	Mn	8.21	10.30	4.95	12.2
Iron	Fe			17.25	6.74
Molybdenum	Mo	Nil	Trace		
Antimony	Sb	do	Nil	Trace	
Lead	Pb			do	.38
Lime	CaO			.69	.05
Bismuth	Bi			1.41	.10

[1] Courtesy of J. J. Haesler.
[2] P_2O_5.

China.—China has remained the principal producer of tungsten ore since the Great War, although its exports of 2,249 metric tons (2,479 short tons) in 1932 were the smallest since 1917. Like the rest of the world, China has been affected by depressed business conditions, moreover, it has had internal troubles, so that the tungsten industry has suffered severely.

The tungsten output apparently is still centered in southern Kiang Si, with a smaller quantity from Hunan and still smaller quantities from Kwang Tung and Kwang Si.

Shipments through Shanghai have now practically ceased. Some concentrates are said to be shipped through Swatow and Amoy, but most go through Canton and Hong Kong. Companies that had been handling tungsten ore for many years are said to have been ruined by the various adverse conditions, including official charges.

The small price received by the miners is shown by the fact that ore delivered in New York sold as low as $1.40 per short ton unit after the long carry from the mines to the rivers, thence to Canton and Hong Kong, across the Pacific, and from Panama to New York, or else around the world to the west.

[9] Griffiths, Harry D., The Wolframite Industry of Lower Burma: Min. Mag., vol. 14, 1914, pp. 440–451.
[10] Mining Journal (London), vol. 175, 1931, p. 955.

Little Chinese concentrate came to the United States, the bulk going to Germany, Great Britain, France, Belgium, and Russia.

Malay States.—The Malay States have only one known good tungsten mine, that of the Kramat Pulai Tin, Ltd., at Kramat Pulai, Perak. The deposit is an intergrowth of fluorite and scheelite carrying a little cassiterite and chalcopyrite and is one of the finest scheelite deposits now worked.[11]

The mine was apparently operated only through April, May, and June [12] of 1932, and during that time produced 5,076 pikuls (338 short tons, 307 metric tons) of concentrates. Concentrates shipped to the United States have carried 74 percent WO_3, and on that basis the output would be equivalent to 417 short tons (378 metric tons) of concentrates carrying 60 percent WO_3.

Portugal.—Portugal is the most important of the three European countries producing a significant quantity of tungsten ore, but production figures are not at hand. Beralt Tin and Wolfram, Ltd., having tin and tungsten properties at Panasqueira, Cabeço da Piao, about 5 miles from Silvares in the Province of Beira Baixa, District of Castelo Branco, and an alluvial area near Viseu, has its own tin smelter [13] and acquired land near the Thames for a ferrotungsten plant.[14]

[11] The mine was described Nov. 23, 1932, by E. S. Willbourn and F. T. Ingham, Scheelite at Kramat Pulai. Mining Magazine vol. 48, 1933, pp. 60–61.
[12] Senior Warden of Mines, F.M.S., Monthly Bulletin of Statistics Relating to the Mining Industry, 1932, table 7.
[13] Mining Journal (London), vol. 179, 1932, p. 707.
[14] Mining Magazine (London), vol. 47, 1932, p. 72.

TIN

By Charles White Merrill

Tin has been for many years the most valuable mineral product furnished United States industry almost exclusively from foreign mines. Imports of tin in 1932 exceeded $16,000,000, but domestic mine production was valued at less than $250. The importance of tin in the foreign commerce of the United States is emphasized by the fact that it stands twenty-second in value among imports. Maintenance of a steady flow of tin into the United States is imperative, because tin is indispensable to two of the largest domestic industries—automobile manufacture and food packing.

United States production.—The domestic production of tin in 1932 was 0.4 long ton, valued at approximately $220, all came from South Dakota. However, recovery of secondary tin—that is, production of tin from sources other than ore—provides more than one fourth of the United States supply of tin.

Salient statistics for tin in the United States, 1923–32

	1923–27 average	1928	1929	1930	1931	1932
Production:						
From domestic mines……long tons..	10	42	35	15	3.7	0.4
From secondary sources……do….	29,064	31,964	30,625	23,393	17,679	13,170
Imports for consumption……do….	71,788	77,970	87,127	80,734	66,064	34,819
Exports (domestic and foreign)……do….	1,431	1,617	1,930	2,233	[1] 1,661	[1] 1,116
Monthly price of Straits tin at New York:						
Highest……cents per pound..	70.67	55.64	49.37	38.91	27.07	24.76
Lowest……do….	38.48	47.10	39.79	25.27	21.35	19.24
Average……do….	56.10	50.46	45.19	31.70	24.46	22.01

[1] Foreign only. Domestic not separately recorded.

World output, price, and stocks.—The world production of tin (tin content of ores) in 1932 was 95,000 long tons, a decrease of 34 percent from the 145,000 tons produced in 1931 and of 51 percent from the 193,000 tons produced in the record year 1929. Thus the world output dropped below that for any year since 1904. The output of the four leading producing countries was 73,720 tons (78 percent of the world total), as follows: Federated Malay States, 27,091 tons (28 percent); Bolivia, 20,589 tons (22 percent); Netherland India, 16,779 tons (18 percent); and Siam, 9,261 tons (10 percent). The smelter production of tin was even more localized than the mine output, as the three leading tin-smelting countries—the Straits Settlements, the United Kingdom, and Netherland India—produced approximately nine tenths of the world total.

The principal supply to consumers in the United States enters the domestic market as imported refined pig tin, and most of it comes from four countries. The Straits Settlements furnished 63 percent of the 1932 total, the United Kingdom 16 percent, Hong Kong 10 percent, and the Netherlands 8 percent. Imports of tin in 1932 totaled 34,819 long tons, a decline of 47 percent from the 66,064 tons imported in 1931 and the smallest quantity since 1921. There was a decline of 55 percent in value from 1931 to 1932, which carried it below that for any year since 1898, decreasing from $104,793,396 in 1926 to $16,473,-998 in 1932 (84 percent).

The fall in total value of tin imports resulted not only from a decreased quantity of tin but also from a decline in price. The average price for Straits tin at New York was 22.01 cents a pound in 1932, compared with 24.46 cents in 1931 and 65.30 cents in 1926, the year of recent peak price; the 1932 price represents a 10 percent decrease from 1931 and a 66 percent decrease from 1926. Although the 1932 average price was lower than that for any year since 1898, it remained well above the low levels prevailing during much of the nineteenth century.

During the early months of 1932 the world "visible" stocks (in Government warehouses and in transit) continued at the record high level established about the middle of 1931. At midyear, however, a decline started that carried the world visible stocks to 45,796 long tons at the end of the year, the low point since January 1931. The high point for 1932 was 51,300 tons at the end of February, little below the all-time high of 51,707 tons at the end of July 1931. These large stocks proved a very depressing factor in the tin market. Data concerning changes in stocks held by consumers, merchants, brokers, and others are not available.

The accompanying graph (fig. 11) illustrates some of the salient features of the tin industry since 1900. World mine production follows, during most of this period, an upward slope of low inclination compared with that of many other metals. The effects of the post-World-War depression and the boom of the late twenties are clearly seen. In 1932, however, the production equaled approximately that for 1901. The most significant feature of the graph, however, is the parallelism between the price curve and the United States tin-imports curve. The importance to tin miners of industrial activity in the United States can be seen at a glance. The curve for world visible stocks shows a strong tendency to rise with falling prices 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.

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 is subject to wide variation in the number of units produced and the proportion of high-tin-content to low-tin-content cars. The continued recession in the productivity of the automobile industry was the most important factor in the decreased consumption of tin in the United States in 1932. The general depression continued to be 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 the equipment of new buildings.

The decreased consumption in the United States during 1932 was a very depressing factor on the tin market; nevertheless, much curtailment during the period since 1929 has been for needs that ultimately will be supplied. Consequently tin producers can look forward with some degree of optimism, because much business, particularly in the building trades, is not lost but postponed.

International production control.—The high tin prices of 1926–27 caused a boom in the development of tin mines that led to over production 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, Netherlands, India, and Nigeria finally agreed to a production-curtailment plan that went

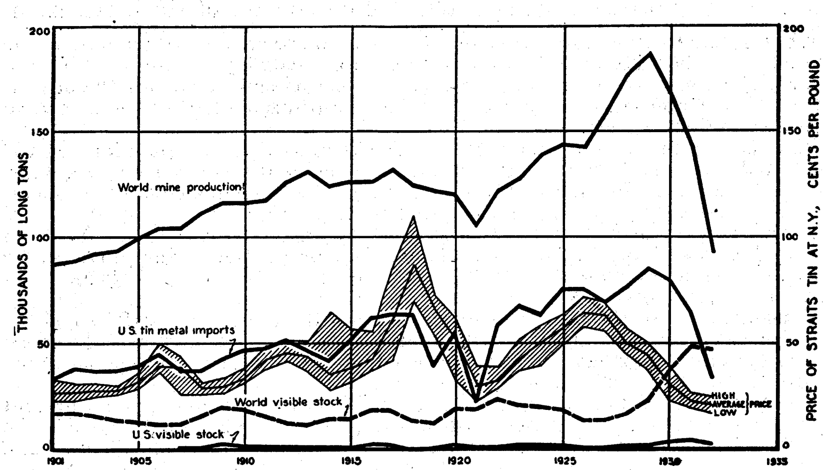

FIGURE 11.—Trends in production, imports, stocks, and prices of tin, 1901–32.

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 Netherlands. This committee assigned an export quota to each of the four signatory countries with the understanding that each would translate this quota into controlled production by assigning output quotas to its respective producers. Each Government, supported by the necessary legislation, issued individual production permits; disregard of these made the offender subject to heavy penalties. Siam joined the plan later, on a basis of accepting a quota of 10,000 long tons a year effective from September 1, 1931. All the countries but Siam subsequently accepted several reductions in their quotas, the last being agreed to on July 1, 1932. The table on p. 295 summarizes the quota data.

Another development was the Tin Pool, an international organization for carrying surplus stocks of tin. This organization was formed during August 1931 and acquired 19,000 long tons of tin before the end of that year. During the early part of 1932 the pool's holdings were increased to 21,000 tons. It has been announced that the holdings of the pool are to be liquidated at a minimum price of £165 per ton and released in small monthly installments. All the pool's holdings are said to appear in current statistics as "visible" stocks. Another pool was formed during 1932, but its holdings have been relatively small and its methods apparently speculative.

The members of the production-control group planned to foster better tin statistics and more research to stimulate consumption of tin. Although these activities have not been carried on very long some valuable research results have been announced.

In spite of the fact that the tin consumers of the United States form one of the most important factors in the world tin industry, no representation has been given them on the International Tin Committee. During 1932 these consumers had little to complain of with respect to supplies and prices, but the rapidly rising prices of the early months of 1933 lessened confidence in the prediction made by proponents of tin-mining rationalization that controlled production would stabilize the tin market. An article by James [1] from which the following is quoted discusses international control of tin production.

> What are the future prospects for tin restriction from the standpoint of the producers? They intend to retain the plan for several years and possibly to renew it. It may, therefore, be examined as a permanent device for the organization of an international industry. When scrutinized on this basis, several favorable factors emerge.
>
> First of all, the tin-restriction plan is likely to remain in operation for the stipulated period and even longer. It was preceded and accompanied by a widespread financial integration of the tin industry which insures effective cooperation among the participating international groups. * * *
>
> In the second place, tin restriction as a permanent plan for the industry offers the producers an opportunity to rationalize their production. The provision for the collection of adequate statistics and research as to the uses of tin is an excellent initial step. * * *
>
> Consumers of tin should not be neglected in a discussion of restriction plans. A world tin monopoly might benefit producers to the detriment of consumers. At present consumers have no cause for complaint, since tin restriction, as stated above, had little effect on price. * * *
>
> The future interests of consumers under a permanent tin-control plan present a different problem. On a rising price level a control plan might be used to extort monopoly prices from consumers. But is serious extortion likely? No. Industrial users, as well as ultimate consumers, could shift their demand to substitute products and could utilize more tin scrap. But equally important as a protection against price extortion is the fact that producers themselves would find excessive prices ruinous to their control plan. Such prices would not only stimulate the few outside producers to expand their output, but also they would probably cause low-cost participating producers to withdraw from the plan. A price policy, therefore, which proved permanently successful for a world tin monopoly, would not unduly burden the consumers * * *
>
> The interests of consumers in tin restriction do not end with the statement that price extortion is unlikely. A permanent control plan offers the possibility of positive gains to consumers through a more moderate exploitation of tin resources. Although authorities disagree as to the total accessible tin deposits, many believe that two or three decades of utilization at the present rate will leave them nearly depleted. * * *
>
> Another possible gain for consumers from controlled tin production appears in the prospects for greater efficiency through more rational contraction and expansion of production. Unrestricted competition is assumed to promote the highest efficiency, since only the fittest enterprises are thought to be able to survive. But business survival may result from technical superiority of production, more effective selling methods, or merely influential financial connections. * * * Additional capacity saved by restriction during a depression will militate against excessive prices later and thus subdue the stimulus to recurring overexpansion.

[1] James, Clifford L., International Control of Tin Ore: Harvard Business Rev., vol. 11, no. 1, Oct. 1932, pp. 67–75.

Aside from the organization of Government forces for the benefit of tin miners the present period is one of consolidation of producers, of diminished prospecting and development, and of less urgent need for replacing tin with substitutes. The control over supplies by the International Tin Committee and the rising prices of 1933 undoubtedly will increase interest in substitutes for tin and in undeveloped tin-bearing areas that lie outside the control of the signatories to the production-control program.

DOMESTIC PRODUCTION

Primary tin.—Although the United States has never been an important producer of tin it does not lack producing deposits; 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.

Tin mined in the United States (including Alaska), 1923–32, in long tons

[Metallic tin obtainable from concentrates produced in tin mining]

1923–27 (average)	10	1930	15
1928	42	1931	3.7
1929	35	1932	.4

Alaska has been the chief source of tin for many years, but no output was reported for 1932. South Dakota produced concentrates containing 0.4 long ton of tin valued at approximately $220. 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.

Secondary tin.—During 1932, 13,170 long tons of secondary tin were recovered in the United States, a decline of 26 percent from that recovered in 1931 and equivalent to 38 percent of the virgin tin imported in 1932. If the recovery of secondary tin were included with primary production the United States would rank fourth among tin-producing countries.

Tin content and value of secondary tin recovered in the United States, 1923–32 [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	Value
1923–27 (average)	930	1,859	2,789	7,516	21,548	29,064	$36,071,400
1928	783	1,979	2,762	7,321	24,643	31,964	35,678,300
1929	763	2,402	3,165	6,607	24,618	30,625	30,513,300
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

[1] Figures compiled by J. P. Dunlop of the Bureau of Mines.

The quantity of secondary tin recovered fluctuates with industrial activity and the price of virgin tin. Depression of both these factors accounted for the decreased quantity of tin recovered during 1932. The principal source of secondary tin is the scrap that results from the manufacture of tin-bearing articles, but junk also provides large quantities of secondary tin. The value of this type of scrap and of reclaimed junk depends upon the prices offered for the metals contained. With metal prices at present levels the recovery of tin from much scrap, ordinarily valuable, is unprofitable.

Tin-bearing alloys, tin plate, clippings, and melting-pot drosses are the most important materials from which tin is reclaimed. Most tin recovered from alloys does not pass through a refined-tin stage but is used in making alloys brought to the required specifications by adding virgin metals. Virtually all the tin plate entering the reclaiming processes is composed of trimmings incident to the fabrication of tin cans. Some used tin cans have entered the detining plants, but at the present prices for reclaimed metals the recovery of tin from this source is unprofitable in the United States. Used cans, however, recently have been exported from the United States to Japan, where their reclamation apparently pays.

IMPORTS AND EXPORTS

Metal and ore.—Imported tin concentrates were first smelted in the United States in 1916, following the first imports in 1915. These imports reached the high point in both quantity and value in 1920 and virtually ceased in 1924. The tin content of concentrates imported since 1924 has ranged from 17 long tons in 1932 to 303 tons in 1926. Inability to obtain clean concentrates to mix with refractory Bolivian concentrates was an important factor in ending the United States tin-smelting industry. Another serious disadvantage faced by the domestic industry was the high wage scale compared with that in Great Britain and continental Europe. The export tariff policy of Great Britain continues to make clean concentrates economically unavailable. Nevertheless, the enormous local market, coupled with the proximity of Bolivia, should permit the building up of a large tin-smelting industry in the United States if a process for handling Bolivian concentrates economically, without admixture of clean ore, could be devised.

Foreign trade of the United States in tin and tin concentrates, 1923–32

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]
1923–27 (average)	71,788	$86,165,052	(5)	$521,025	643	788
1928	77,970	86,983,174	130	69,227	349	1,268
1929	87,127	91,838,781	128	66,609	790	1,140
1930	80,734	60,233,644	289	177,120	84	2,149
1931	66,064	36,723,656	30	7,117	(6)	1,661
1932	34,819	16,473,998	17	4,364	(6)	1,116

[1] Imports for consumption.
[2] General imports.
[3] Imported as ore and exported as pigs, bars, etc.
[4] Imported as pigs, bars, etc., and exported as such.
[5] Recorded as gross weight of concentrates for 1923 and as tin content for 1924–27.
[6] Not separately recorded.

In 1932, 34,819 long tons of tin (bars, pigs, blocks, grains, and granulated) were imported into the United States compared with 66,064 tons in 1931 and 80,734 tons in 1930. The quantity of tin imported in 1932 was the smallest since 1921 and its value the lowest since 1898. The Straits Settlements supplied 63 percent of the tin imported in 1932, the United Kingdom 16 percent, Hong Kong 10 percent, the Netherlands 8 percent, and all others 3 percent. In 1931 the proportion furnished by the Straits Settlements (75 percent) was much larger, but the proportions furnished by the United Kingdom (12 percent), Hong Kong (6 percent), and the Netherlands (3 percent) were smaller.

Metallic tin (bars, pigs, blocks, grains, and granulated) imported into the United States, 1931–32, by countries

[General imports]

Country	1931		1932	
	Long tons	Value	Long tons	Value
Australia	400	$218,624	240	$114,906
Belgium			50	23,040
Canada	32	8,494	42	8,181
China	130	65,938	476	220,141
Dominican Republic	(1)	71		
France	40	23,080		
Germany	851	441,970	176	61,165
Hong Kong	4,196	2,282,543	3,376	1,536,078
Japan	25	15,850	25	10,855
Malaya (British) (Straits Settlements)	49,741	27,680,221	21,784	10,352,863
Netherlands	2,008	1,198,402	2,680	1,297,140
Netherland India	891	483,363	524	261,160
Panama			1	319
United Kingdom	7,750	4,305,100	5,445	2,588,150
	66,064	36,723,656	34,819	16,473,998

[1] Less than 1 ton.

Exports of metallic tin continued small; tin exported in the form in which it was imported decreased from 1,661 long tons in 1931 to 1,116 tons in 1932.

Tin manufactures.—Imports of tin plate, terneplate, and taggers tin amounted to 7,246 long tons valued at $471,939 in 1932 compared with 196 tons valued at $42,704 in 1931. Of the total quantity in 1932, 99.9 percent came from the United Kingdom. Over 90 percent of these imports were made during March and April, when monthly imports exceeded exports for the first time in many years. During succeeding months tin-plate imports virtually ceased, but exports showed a small increase.

For the year 1932 the exports of tin plate, terneplate, and taggers tin totaled 39,603 long tons valued at $3,272,566 compared with 84,433 long tons valued at $7,841,193 for 1931, a decrease of 53 percent in quantity and 58 percent in value. The world export market for tin plate appears to have expanded during 1932, as increased exports by the United Kingdom and Germany more than offset the decrease from the United States.

Tin plate, terneplate, and taggers tin exported from the United States, 1923–32

Year	Long tons	Value	Year	Long tons	Value
1923–27 (average)	190, 310	$22, 127, 599	1930	216, 516	$24, 201, 977
1928	249, 642	26, 345, 576	1931	84, 433	7, 841, 193
1929	258, 964	28, 566, 189	1932	39, 603	3, 272, 566

In both quantity and value the 1932 tin-plate exports fell below those for any year since 1910. In comparing the 1932 exports to principal countries with those of 1931 it is seen that the value declined in every instance. Exports to the Orient, except those to Japan, have remained near the 1931 level, but those to other parts of the world have decreased very sharply. The tremendous decrease in exports from New York permitted Maryland to advance to first place as port of export for tin plate.

Exports of tin plate, terneplate, and taggers tin from the United States, by principal countries and districts, 1931–32

	1931		1932	
	Long tons	Value	Long tons	Value
Country				
Argentina	8, 715	$724, 754	2, 326	$188, 917
Brazil	3, 913	320, 674	304	24, 086
Canada	2, 605	258, 453	765	69, 482
China	10, 563	997, 962	9, 855	826, 928
Cuba	2, 395	255, 434	1, 456	123, 464
Hong Kong	4, 923	476, 447	4, 428	334, 016
Japan	18, 028	1, 610, 807	7, 058	580, 292
Mexico	8, 873	906, 114	2, 830	245, 212
Peru	4, 404	416, 140	780	57, 671
Philippine Islands	4, 433	439, 182	4, 555	375, 071
Uruguay	5, 022	432, 485	911	71, 150
Others [1]	10, 559	1, 002, 741	4, 335	376, 277
Total	84, 433	7, 841, 193	39, 603	3, 272, 566
District				
Maryland	31, 502	2, 835, 369	24, 561	1, 991, 836
New York	42, 955	4, 008, 311	11, 302	925, 909
Philadelphia	4, 377	411, 497	842	65, 566
Others [1]	5, 599	586, 016	2, 898	289, 255
Total	84, 433	7, 841, 193	39, 603	3, 272, 566

[1] Includes all exports not exceeding $250,000 in 1931 or 1932.

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.[2] The results of this work are presented in the

[2] Umhau, J. B., Consumption of Primary Tin in the United States during 1930: Inf. Circ. 6564, Bureau of Mines, 1932, 7 pp.

following table. As the earlier estimates of the War Industries Board (1917) and the Bureau of Mines (1925)[3] include secondary tin they are not comparable with the following figures.

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.

The consumption of virgin tin can be approximated by calculations based upon 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, however, the figure for apparent consumption is useful, particularly when it includes an item for consumers' stocks, the chief component of domestic invisible stocks.

Apparent consumption of virgin tin in the United States, 1928–32, in long tons

	1928	1929	1930	1931	1932
Supply:					
Domestic production	42	35	15	4	----------
Imports of tin as metal	77,970	87,127	80,734	66,064	34,819
Imports of tin in concentrates	130	128	289	30	17
Visible stocks, Jan. 1	1,573	2,428	2,820	4,693	6,254
Consumers' stocks, Jan. 1	9,215	8,534	10,606	15,500	[a] 15,500
Total available	88,930	98,252	94,464	86,291	56,590
Withdrawals:					
Exports of tin as metal	1,617	1,930	2,233	[b] 1,661	[b] 1,116
Exports of tin in concentrates	36	35	15	4	----------
Visible stocks, Dec. 31	2,428	2,820	4,693	6,254	4,496
Consumers' stocks, Dec. 31	8,534	10,606	15,500	[a] 15,500	[a] 15,500
Total withdrawn	12,615	15,391	22,441	23,419	21,112
Apparent consumption	76,315	82,861	72,023	62,872	35,478
Consumption accounted for in Bureau of Mines canvass	74,369	([c])	65,448	([c])	([c])

[a] 1930 figure repeated in absence of more recent data.
[b] Foreign exports only for 1931–32.
[c] No canvass by Bureau of Mines for 1929, 1931, and 1932.

[3] Furness, J. W., Consumption of Tin in the United States, 1925: Inf. Circ. 6019, Bureau of Mines, 1927, 3pp.

The apparent consumption of virgin tin in the United States was 35,478 long tons in 1932 compared with 62,872 tons in 1931 and 72,023 tons in 1930. The 1932 consumption represents a 44 percent decrease from 1931 and a 57 percent decrease from the peak year 1929. The 1932 figure may be questioned because of the lack of current data on consumers' stocks. It seems reasonable to assume, however, that changes in this item have not been large enough to impair greatly the usefulness of the apparent consumption figure.

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, having consumed more than one third of the total virgin tin used in 1927 and 1928 and having increased its requirements to 42 percent of the total used in 1930, the last year for which figures are available.

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. One 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. 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, 1923–32, in long tons [1]

Year	Tin plate	Terneplate	Total	Year	Tin plate	Terneplate	Total
1923–27 (average)	1,508,869	101,944	1,610,813	1930	1,660,325	103,118	1,763,443
1928	1,714,990	124,215	1,839,205	1931	1,392,227	66,716	1,458,943
1929	1,816,223	152,057	1,968,280	1932	986,217	46,290	1.032,507

[1] From Annual Report of American Iron and Steel Institute.

In 1932 tin was used in the manufacture of 986,217 long tons of tin plate and 46,290 tons of terneplate in the United States compared with 1,392,227 and 66,716 tons, respectively, in 1931. Exports of tin plate, terneplate, and taggers tin were 39,603 long tons in 1932, a decline of 53 percent from 1931. Imports of tin plate, terneplate, and taggers tin increased tremendously but still remained small compared with exports and negligible compared with domestic production. The United States produced approximately one third more tin plate and terneplate than Great Britain but exported less than one tenth as much.

Automobile manufacture.—The automobile industry is one of the principal consumers of tin. The chief uses are in babbitt for engine bearings, solder for radiators, and bronzes for bearings and bushings. The tin plating of pistons to reduce friction is a new development already adopted by the makers of several models of engines.

Production, registration, and exports of motor vehicles in the United States, 1923–32

Year	Production [1]			Registration [2] (all classes)	Exports [3] (all classes)
	Passenger cars	Trucks and busses	Total		
1923–27 (average)	[4] 3,453,258	467,670	3,920,928	[5] 19,695,000	264,634
1928	3,815,417	543,342	4,358,759	24,611,000	507,097
1929	4,587,400	771,020	5,358,420	26,616,000	536,207
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	24,228,000	66,404

[1] Bureau of the Census.
[2] Bureau of Public Roads.
[3] Bureau of Foreign and Domesgic Commerce.
[4] Taxicabs not included prior to 1924.
[5] Road tractors not included prior to 1924.

The number of automobiles manufactured during 1932, the smallest since 1918, shows a 43 percent decrease from 1931 and a 74 percent decrease from the peak year 1929. Moreover, there was a decrease in the number of automobiles registered in 1932; registration, however, exceeded 18 times the number of new cars manufactured. The maintenance and repair of these cars are a substantial item in the consumption of tin.

Other manufactures.—In spite of the depressed condition of most manufacturing industries there has been constant expansion in the number of airplanes and mechanical refrigerators in use. The manufacture and maintenance of these machines are becoming an important outlet for tin. The legalization of beer in the United States early in 1933 probably will increase the demand for tin because of its extensive use in breweries and in beer-dispensing equipment. Pipes, valves, and other fixtures of pure tin are used in handling beer. Moreover, much tin will be consumed in the refrigerating equipment that will be needed by the retail beer trade.

SUBSTITUTES

A few years ago, when the price of tin was more than double what it averaged during 1932, the opinion was widely expressed that the reserves of tin marketable at the prices than current were very limited. Intensive research for substitutes resulted. The field for making important substitutions seemed very promising, because at that time tin was the highest-priced metal in the common base-metal group. Since then the fall in the price of tin and the growing tin stocks have diminished the intensity of the search for substitutes. Nevertheless, many of those concerned with the supply of tin in the more distant future cannot escape the conclusion that adequate supplies will require payment of prices much higher than those current during 1932. Moreover, domestic consumers must depend upon substitutes as one of their most effective means for maintaining reasonable tin prices as well as one of their principal means for continued production if war should curtail the flow of tin to the United States.

The finding of a substitute for tin plate in the canning industry has been studied in detail, but to date no tin-free container has been developed that can compete seriously with the tin can. Glass containers have been used successfully where the advantage of display of contents has outweighed higher initial cost and difficulties of transportation. Research to develop a practical aluminum can continues. So far aluminum products have not only been costly but have failed to withstand the rough handling to which ordinary cans are subjected. Some progress appears to have been made in the development of a lacquer highly resistant to chemicals, which is baked onto steel sheets.

Aluminum is being substituted for tin in the manufacture of foils and collapsible tubes and is invading the fields where lead is excluded because of its toxic properties. Because of its low specific gravity a given weight of aluminum will make much more foil of a given gage than an equal weight of tin, but this advantage is offset in some tin foils by rolling from bars containing a lead core. Tin foil is also meeting severe competition as a food and cigar wrapper in "cellophane", a transparent cellulose product, and in various waxed papers. The manufacture of zinc foil in important quantities, reported for the first time in 1931, continued in 1932.

PRICES AND STOCKS

Prices.[4]—The break in the tin market that started in April 1927 continued with only minor recoveries until a low monthly average of 19.24 cents a pound was reached in April 1932; thus, the average monthly price recorded for April 1932 represented a decline of 73 percent from the high monthly average of 70.67 cents recorded for November 1926. The price record of tin in 1932 includes a high monthly average of 24.76 cents for September, a low monthly average of 19.24 cents for April, and an average of 22.01 cents for the year compared with the 1931 record of a high average monthly price of 27.07 cents for March, a low of 21.35 cents for December, and an average of 24.46 cents for the year. The average price for 1932 was thus 2.45 cents (10 percent) less than that for 1931. The average price for December 1932, however, was 1.34 cents (6 percent) above that for the closing month of 1931.

[4] Prices used in this discussion refer to Straits tin at New York, as quoted in the American Metal Market and published in Metal Statistics, 1933, pp. 295–299.

Monthly price of Straits tin for prompt delivery in New York, 1930–32, in cents per pound [1]

	1930			1931			1932		
	High	Low	Average	High	Low	Average	High	Low	Average
January	39.75	37.80	38.91	27.25	25.40	26.10	22.37½	20.75	21.84
February	39.20	37.75	38.67	27.20	25.25	26.31	22.30	21.50	22.03
March	37.90	35.85	36.81	27.50	26.50	27.07	22.35	20.80	21.86
April	37.20	34.00	36.07	26.62½	23.35	25.12	20.25	18.35	19.24
May	33.25	31.25	32.13	24.15	22.50	23.20	22.12½	20.00	20.95
June	31.12½	29.50	30.30	26.00	22.30	23.41	20.75	18.65	19.64
July	30.37½	29.15	29.81	26.75	24.12½	25.02	21.37½	20.40	20.93
August	30.35	29.60	30.02	27.15	24.30	25.75	24.37½	21.50	22.96
September	30.00	28.70	29.64	26.75	22.25	24.68	25.62½	23.87½	24.76
October	28.00	24.75	26.86	23.37½	22.12½	22.76	24.50	23.25	23.92
November	26.75	25.20	25.89	23.55	21.40	22.80	24.15	22.00	23.32
December	26.87½	23.75	25.27	21.95	20.60	21.35	22.85	22.45	22.69
Year	39.75	23.75	31.70	27.50	20.60	24.46	25.62½	18.35	22.01

[1] Metal Statistics, 1933, pp. 297 and 299.

Unlike copper, lead, zinc, and silver, tin did not establish a new low price in 1932. Nevertheless, the 1932 average price was the lowest since 1898. During the decade ended in 1898 the yearly average price never exceeded that for 1932. The early months of 1933 have shown a steady improvement in the price of tin.

Prices of tin plate and sheet bars at Pittsburgh and pig tin at New York on dates of principal price changes of tin plate, 1927–32 [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*
1927: Nov. 30	$5.25	$34.00	58.62½	1930: Oct. 1	$5.00	$31.00	28.00
1928: Nov. 15	5.35	34.00	50.12½	1931: Oct. 1	4.75	29.00	22.12½
1929: Dec. 31	5.25	34.00	39.75	1932: Nov. 17	4.25	26.00	23.35

[1] Metal Statistics, 1933, p. 131.

Stocks.—The monthly average of the world "visible supply" of tin was 48,892 long tons in 1932, compared with 49,900 tons in 1931 and 38,621 tons in 1930. The supply followed a fairly regular decline from the high yearly average of 24,682 tons for 1922 to the low yearly average of 14,925 tons for 1927. At the close of 1927 the monthly average of visible supplies started to mount; its climb was arrested during most of 1929 and again during the latter months of 1930, but the high point was not reached until July 1931, when an all-time record high of 51,707 tons was established. This was followed by a period of minor fluctuation until June 1932, when a period of decline commenced that carried the world's visible supplies to 45,796 tons at the end of December 1932. The early months of 1933 have witnessed continuance of this decline.

Visible stocks of tin in the world and in the United States at end of each month, 1923–32, in long tons [1]

Month	1923–27 (average)		1928		1929		1930		1931		1932	
	World	U.S.	World	U.S.	World	U.S.	World	U.S.	World	U.S.	World	U.S.
January	21,043	3,194	15,244	2,518	24,237	2,611	29,032	3,081	43,619	4,904	50,043	5,342
February	20,209	3,038	17,645	1,998	26,402	3,307	33,581	3,626	49,339	5,862	51,300	4,578
March	19,448	3,051	15,586	2,078	26,632	2,550	32,972	3,566	48,607	7,917	50,780	3,841
April	17,722	2,653	15,001	1,973	26,353	3,603	36,595	5,687	48,462	6,212	50,716	3,546
May	19,099	2,389	17,064	3,708	24,765	3,464	39,771	6,767	51,231	5,698	[2] 50,562	3,981
June	18,531	2,410	16,231	2,148	23,751	3,830	42,611	7,728	51,626	5,633	[2] 48,945	3,759
July	17,838	2,689	18,022	2,878	23,789	3,087	41,950	6,786	51,707	5,838	49,125	4,559
August	17,579	2,803	18,456	1,718	26,400	2,858	43,805	7,533	50,987	6,213	47,177	4,459
September	17,440	2,494	19,924	3,508	24,556	2,479	40,150	6,323	50,722	5,868	47,739	4,191
October	16,967	2,654	20,907	4,598	25,580	2,720	39,676	4,823	50,602	6,773	47,048	4,291
November	17,709	1,874	22,067	3,603	25,171	2,050	40,811	5,372	50,583	7,458	47,471	3,441
December	19,236	2,126	24,563	2,428	28,140	2,820	42,498	4,693	51,313	6,254	45,796	4,496
Average	18,568	2,615	18,392	2,763	25,481	2,947	38,621	5,499	49,900	6,219	48,892	4,207

[1] Metal Statistics, 1933, pp. 289 and 291.
[2] Shipments of Chinese tin not included.

Visible stocks of tin held in the United States have averaged approximately 2,500 tons for many years, seldom dropping below 1,500 tons and seldom exceeding 7,000 tons. During the last 3 years the average has been higher than it was formerly, but the 1932 average is lower than that for 1931 or 1930. In 1932 stocks at the close of the month recorded a high point of 5,342 tons in January and a low of 3,441 tons in November; the average for the year was 4,207 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 lower price of tin and the metal required for the increasing trading in the National Metal Exchange probably are the principal factors accounting for the increased domestic tin stocks during recent years.

The so-called "invisible stocks" of tin are exceedingly difficult to estimate, as they consist largely of stocks held by consuming manufacturing companies and by metal merchants and speculators. The questionnaires that have formed the basis of the Bureau of Mines studies of tin consumption since 1928 indicate that manufacturing requirements rather than current price of the metal determine the stocks carried by consumers of virgin tin in the United States.

WORLD PRODUCTION AND RESOURCES

The world production of tin in 1932 was 95,000 long tons, compared with 145,000 tons in 1931, 176,000 tons in 1930, and 193,000 tons in 1929. The production in 1932 was 34 percent less than that in 1931 and was smaller than that for any year since 1904. The Bureau of Mines has made available recently a detailed record [5] of tin production since the beginning of the nineteenth century. The annual increase in production brought out in this study, although at a geometrical rate, indicates that the output of tin has expanded 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 probably will resume its slow expansion as soon as the present dislocation of industry and trade is overcome.

[5] Umhau, J. B., Summarized Data of Tin Production: Econ. Paper 13, Bureau of Mines, 1932, 34 pp.

World production of tin (content of ore), 1923–32, by countries, in long tons

Country	1923–27 (average)	1928	1929	1930	1931	1932
Australia	3,074	2,890	2,239	1,451	1,750	1,400
Belgian Congo	1,012	785	971	652	(1)	(1)
Bolivia [2]	31,898	41,409	46,343	38,161	31,137	20,589
China [2]	7,308	7,033	6,778	6,483	3,478	[3] 6,000
India (British)	1,854	1,946	2,649	2,990	2,979	[3] 2,900
Indo-China	551	796	829	992	874	600
Japan	(1)	(1)	1,092	1,496	[3] 1,500	[3] 1,500
Malay States:						
Federated [2]	45,149	61,935	67,042	62,065	51,250	27,091
Unfederated	1,952	2,680	2,326	1,699	1,365	1,273
Mexico	(1)	(1)	(1)	(1)	761	751
Netherland India	31,278	34,837	35,236	34,590	27,375	16,779
Nigeria	6,758	9,132	10,734	8,331	7,556	[2] 3,965
Portugal	500	678	(1)	(1)	(1)	(1)
Siam	7,702	7,572	10,517	11,526	[2] 12,497	[2] 9,261
Union of South Africa	1,097	1,249	1,218	930	(1)	541
United Kingdom (England)	2,053	2,761	3,271	2,488	598	1,346
Other countries [4]	700	1,100	1,500	1,900	1,900	1,100
	143,000	177,000	193,000	176,000	145,000	95,000

[1] Less than 500 tons; included under "Other countries."
[2] Exports.
[3] Estimated.
[4] Includes countries producing less than 500 tons.

Reduction in output of tin 1932 is very largely the result of the legislative tin-production curtailment program. The countries that signed the curtailment plan produced the following percentages of tin in 1932 compared to their respective productions of 1931: Nigeria, 52 percent; British Malaya, 54 percent; Netherland India, 61 percent; Bolivia, 66 percent; and Siam, 74 percent. In the countries where output was not subject to compulsory restriction there was little or no curtailment in production. In the United Kingdom and China there was a large increase in output in 1932, while in Japan, Mexico, India, and the Union of South Africa the output remained virtually constant. Voluntary curtailment reduced the output of Australia and Indo-China 20 percent and 31 percent, respectively.

Tin-production quotas (annual) for countries signatory to the tin-production curtailment plan, in long tons

Country	Production (1929): Reported by Bureau of Mines	Production (1929): Agreed upon as quota basis	Quota 1931: Mar. 1	Quota 1931: June 1	Quota 1932: Jan. 1	Quota 1932: June 1	Quota 1932: July 1	Net excess or deficiency, production over quota to Dec. 31, 1932
British Malaya	69,371	69,366	53,928	45,375	38,960	30,406	23,115	−381
Bolivia	46,343	} 92,480	34,260	28,826	24,751	19,317	14,687	+1,453
Netherland East Indies	35,236		29,916	25,171	21,612	16,867	12,823	−1,380
Nigeria	10,734		7,992	6,724	5,773	4,506	3,431	−292
Siam	10,517	} 24,672	(1)	[2] 10,000	10,000	10,000	10,000	−564
Other countries	19,452		(1)	(1)	(1)	(1)	(1)	
Total production	192,000	186,518						−1,164
Reduction			36,000	20,000	15,000	20,000	17,040	
Cumulative reduction			36,000	56,000	71,000	91,000	108,040	

[1] No restriction of output.
[2] Not effective until Sept. 1, 1931.

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 27,091 long tons of metallic tin in 1932 compared with 51,250 tons in 1931 and 62,065 tons in 1930. The legally enforced curtailment program was the principal factor in the reduction of output. Of the 119 dredges in use 91 were temporarily idle at the end of 1932. Employment in the mining industry in the last month of the year has been as follows: 1932, 42,556; 1931, 57,418; and 1929, 104,468. As many of the unemployed Chinese have been repatriated, some predict a labor shortage in the event of a rapid rise in the demand for tin.

There was much difficulty in keeping Malaya within the quota during 1931, but administration of the curtailment plan appears to have run smoothly during 1932. The mine operators, however, seem to be growing more and more discontented with the national allotment, resulting in a movement for reconsideration of Malaya's share in world tin production as soon as the present agreements terminate in August 1934.

The Straits Settlements, the world's leading producer of smelted tin, decreased its output in 1932 because of smaller mine production in the countries supplying the bulk of the tin concentrates to its smelters.

The Unfederated Malay States together produced concentrates containing 1,273 long tons of metallic tin in 1932, compared with 1,365 tons in 1931 and 1,699 tons in 1930.

Bolivia.—Bolivia, the second largest producer of tin and the largest producer of lode tin, exported concentrates and ore containing 20,589 long tons of tin in 1932, compared with 31,137 tons in 1931 and 38,161 tons in 1930. The Patiño Mines & Enterprises Consolidated, Inc., which produced almost one half of Bolivia's tin in 1932, increased its importance in Bolivia's tin industry by acquiring the Sociedad Empresa de Estaño de Araca, a company having large reserves and producing over 1,000 tons of tin a year.

Bolivia could not curtail the production of its mines enough to keep within the national quota during 1932. Further curtailment during 1933 is planned, however, with the object of offsetting former excesses. Military operations against Paraguay in the Gran Chaco area, though not directly interfering with the tin industry, have added to the difficulties of the tin producers because of the added taxation required and the enlistment of many of the best workmen in the army.

Netherland India.—Netherland India produced concentrates containing 16,779 long tons of tin in 1932, compared with 27,375 tons in 1931 and 34,590 tons in 1930. As in the past, virtually all the production came from mines operated by the Government, the Billiton Mining Co., and the Singkep Tin Co. Part of the concentrates were smelted locally, and the remainder were exported to the Straits Settlements for reduction. It is reported that plans are now under way to divert Billiton Mining Co. concentrates from the Strait Settlements to the company smelter at Arnhem, the Netherlands. The Arnhem smelter, which has been operating principally on Bolivian concentrates, is being enlarged to handle the added supply of material.

Siam.—Siam produced concentrates containing 9,261 long tons of tin in 1932, compared with 12,497 tons in 1931 and 11,526 tons in 1930. Siam's acceptance of an annual quota of 10,000 tons ended the steady climb in production that had continued through 1931.

Nigeria.—Nigeria produced concentrates containing 3,965 long tons of tin in 1932 compared with 7,556 tons in 1931 and 8,331 tons in 1930; all the concentrates were exported for smelting. The Anglo-Oriental Mining Corporation, Ltd., working through its associated companies—the London Tin Corporation, Ltd., and the Associated Tin Mines of Nigeria, Ltd.—has brought under its control almost one half of the Nigerian tin production.

China.—Shipments from China in 1932 were reported as 6,000 long tons of tin compared with 3,478 tons in 1931 and 6,483 tons in 1930. It has been reported recently that a modern tin refinery is to be built and operated in conjunction with the present tin smelter at Kotchiu in the tin-mining area of southern Yunnan. It is stated that the several low-grade brands now produced in small refineries at Hong Kong will be displaced by but two grades, which are to be equal in quality to the pig tin now marketed as Straits and Banka. There has been some doubt raised, however, as to whether this program can be financed in the next few years.

United Kingdom.—The production of tin (content of domestic ores) in the United Kingdom was 1,346 long tons in 1932, compared with 598 tons in 1931 and 2,488 tons in 1930. The increase of production in 1932 appears to have resulted largely from the cutting of costs made possible by Britain's abandonment of the gold standard. 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.

Other countries.—The countries separately discussed account for 86,000 long tons (91 percent of the total production) in 1932. The remaining 9,000 tons were produced largely by India, Japan, Australia, Mexico, Indo-China, and Union of South Africa; but a rise in the price of tin undoubtedly would increase activity in the Belgian Congo, Portugal, Spain, Russia, Tanganyika, Uganda, Southwest Africa, Swaziland, Gold Coast, French Morocco, Portugese East Africa, Rhodesia, Argentina, and Canada.

CHROMITE

By L. A. Smith

The sharp decline in the consumption of chromite reflected the low level of industrial activity in the United States in 1932, especially in the steel and automobile industries. The supply available for consumption was 58 percent below that in 1931, 73 percent below the

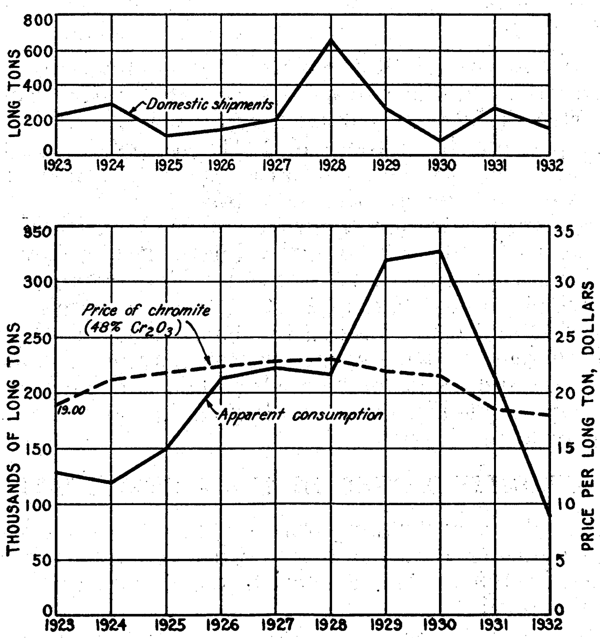

Figure 12.—Trends in consumption, price, and domestic shipments of chromite in the United States, 1923–32.

peak in 1930, and the lowest since 1921. As the domestic shipments of chromite again were negligible, virtually the entire demand was supplied by imports. Shipments from countries which were the most important centers of supply in 1931 decreased sharply in 1932, as follows: Southern Rhodesia 77 percent, New Caledonia 71 percent, Greece 43 percent, and Russia 73 percent. Cuba, which supplied 7 percent of the total in 1931, did not export any chromite to the United States in 1932. Shipments from Turkey ranked first in 1932, having increased from 1 percent of the total in 1931 to 20 percent in 1932.

The following table compares salient statistics of the chromite industry of the United States in 1930, 1931, and 1932 with the yearly average from 1925–29, and figure 12, shows the trend of domestic consumption and prices during the last decade.

Salient statistics of the chromite industry of the United States, 1925–32

	1925–29 average	1930	1931	1932
Production ... long tons..	262	310	762	200
Consumption:				
Imports ... do....	224, 357	326, 617	212, 528	89, 143
Domestic shipments ... do....	276	80	268	155
Apparent available supply ... do....	224, 633	326, 697	212, 796	89, 298
Prices per ton at New York, approximate average of all grades..	$22.46	$21.50	$18.50	$18.00
Origin of imports:				
Southern Rhodesia ... percent of total..	52	45	32	17
New Caledonia ... do....	6	10	19	13
Turkey ... do....	----------	1	1	20
Greece (largely transshipments from Yugoslavia) ... do....	9	14	14	18
Russia ... do....	----------	4	8	5
Cuba ... do....	15	13	7	----------
Others ... do....	18	13	19	27
World production ... long tons..	428, 000	550, 000	366, 000	(1)

1 Data not available.

Outside of the United States consumption apparently was maintained better than in the United States. It is estimated that total world imports in 1932 were 190,000 long tons, a drop of about 105,000 tons, or 36 percent, from those in 1931. Imports into the United States declined over 123,000 tons, so that the rest of the world actually increased its imports several thousand tons.

World production decreased further in 1932. Although data are not available to justify a tonnage estimate, it is believed that the reduction will approximate 25 percent. The output of Southern Rhodesia, which ranked first in 1931 by a large margin, declined 81 percent in 1932 and was exceeded by that of several other countries. A probable increase in Russian production may place it first in 1932, as decreases are indicated for New Caledonia and Yugoslavia. Turkey more than doubled its output in 1932 and probably ranked second or third in world production.

CHROMITE MINING IN THE UNITED STATES

In the United States 200 long tons of chromite were mined and 155 tons shipped during 1932, compared with 762 tons mined and 268 tons shipped in 1931. All production and shipments in both years were from California.

A new chromite deposit is reported near San Antonio, Tex. An analysis of the ore shows 49.4 percent Cr_2O_3, 12 percent Fe_2O_3, 6 percent FeO, 17.4 percent Al_2O_3, and 8.4 percent SiO_2. Other activities during 1932 included prospecting in the Beartooth deposits near Red Lodge, Mont., and near South Pass City, Wyo.

The following table shows the production and shipments of chromite in the United States, 1929–32, inclusive:

Crude chromite mined and shipped from mines in the United States (all from California), 1929–32

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	
1929	383	182	$2, 712	160	87	$1, 264	$3, 976
1930	235	80	1, 905	75	----------	----------	1, 905
1931	612	268	3, 509	150	----------	----------	3, 509
1932	200	155	2, 160	----------	----------	----------	2, 160

IMPORTS

The United States imported 89,143 long tons of chromite in 1932, a decrease of 123,385 tons or over 58 percent from 1931 and a decrease of about 73 percent from 1930, the peak year. Imports from the countries usually furnishing ores of refractory grade declined more than imports from countries supplying the other grades.

Of the imports of chromite into the United States in 1932 Turkey furnished 19.7 percent, Greece (probably transshipments from Yugoslavia) 18.4 percent, Southern Rhodesia 17.4 percent, United Kingdom (transshipments) 14.8 percent, New Caledonia 13 percent, India 8.8 percent, Russia 5.4 percent, and Algeria and Tunisia 2.5 percent. It is noteworthy that for the first time since the war no chromite was imported from the countries of the Western Hemisphere. Imports from Southern Rhodesia, Greece, India, New Caledonia, Russia, and the United Kingdom decreased 77 percent, 43 percent, 9 percent, 71 percent, 73 percent, and 45 percent, respectively. Some countries, notably Cuba and the Union of South Africa, that shipped chromite to the United States in 1931 sent none in 1932. Imports from Turkey in 1932 increased to approximately eight times those in 1931. The average grade of the ore imported in 1932 was nearly the same as that of the ore imported in 1931.

The following table shows the imports of crude chromite into the United States by countries, 1928–32, inclusive.

Crude chromite imported into the United States, 1928–32, by countries

[General imports]

Country	1928 (long tons)	1929 (long tons)	1930 (long tons)	1931 (long tons)	1932 Long tons: Gross weight	1932 Long tons: Chromium content	1932 Value
Africa:							
British—Union of South	15,745	17,545	24,376	5,379			
French—Algeria and Tunisia				[a]	2,206	1,303	$52,944
Portuguese:							
Mozambique	112,073	167,381	145,709	68,291	15,496	7,324	309,678
Other	4,000		2,000	2,000			
Belgium		1,367	1,595	482			
Brazil	320	462	10				
Cuba	33,707	52,949	40,982	14,957			
Germany		1,700					
Greece	17,152	26,647	45,822	28,893	16,395	7,852	370,811
Guatemala			89	91			
India (British)	17,591	21,033	14,542	8,664	7,857	3,780	76,743
Malta, Gozo, and Cyprus	600						
Netherlands	50						
Oceania (French)	15,154	26,846	31,022	39,579	11,550	5,198	86,316
Soviet Russia in Europe			13,878	17,736	4,800	2,257	51,710
Turkey in Asia	200	1,700	2,591	2,198	17,602	9,079	360,820
United Kingdom			4,001	24,258	13,237	7,037	316,711
	216,592	317,630	326,617	212,528	89,143	43,830	1,625,733

The following tables show the imports of chromium alloys and compounds into the United States, 1928–32.

Ferrochrome or ferrochromium and chrome or chromium metal imported for consumption in the United States, 1928–32, in long tons

	1928	1929	1930	1931	1932
Ferrochrome or ferrochromium:					
Containing 3 percent or more carbon (chromium content)	69	37			
Containing less than 3 percent carbon, gross weight	611	638	153	135	159
Chrome or chromium metal	10	21			20

Chromium compounds imported for consumption in the United States, 1928–32

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
1928	99,617	$24,547	6,866	$1,112	1,752	$287	110	$33
1929	462,486	84,683	8,880	1,537	350	80	3,823	509
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		

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 decreased from 326,697 long tons in 1930 to 89,298 long tons in 1932 (73 percent). Since stocks held by consumers on December 31, 1932 probably were larger than those on December 31, 1931, the available supply in 1932 appears to have exceeded actual consumption.

Almost all of this decline may be ascribed either directly or indirectly to the slump in the steel industry, the principal consumer of chromite. Production of steel ingots and castings in 1932 was 66 percent below that in 1930, while production of stainless steel declined 55 percent. The output of the automobile industry, one of the principal users of chromium-alloy steels as well as chromium plating, declined nearly 60 percent for the same period. The low rate of steel production also affected the consumption of chromite refractories, as the steel plants were operating at only 19 percent of capacity in 1932. Another contributing factor to the drop in chromite consumption was the sharp decline in building construction, in which large quantities of chromium-plated plumbing fixtures are used.

The following table shows the apparent available supply of chromite in the United States from 1928 to 1932:

Domestic sales, imports, and supply of crude chromite in the United States, 1928–32, in long tons

Year	Sales from domestic mines	Imports (general)	Apparent available supply	Year	Sales from domestic mines	Imports (general)	Apparent available supply
1928	660	216,592	217,252	1931	268	212,528	212,796
1929	269	317,630	317,899	1932	155	89,143	89,298
1930	80	326,617	326,697				

USES

METALLURGICAL

A recent survey by E. F. Cone [1] of the production of stainless-steel-alloy ingots and castings indicates a total output of 47,580 gross tons in 1929, 53,080 tons in 1930, 30,280 tons in 1931, and 23,770 tons in 1932. (Over 60 firms were canvassed, and the results were estimated to be 90 percent of the actual production of ingots and 75 percent of that of castings.) The actual figures for ingots, as reported by the firms canvassed, were 39,287 tons in 1929, 44,156 tons in 1930, 24,670 tons in 1931, and 19,150 tons in 1932 and those for castings were 2,949 tons in 1929, 3,015 tons in 1930, 2,157 tons in 1931, and 1,866 tons in 1932—a total of 42,236 tons in 1929, 47,171 tons in 1930, 26,827 tons in 1931, and 21,016 tons in 1932. Thus the decrease in production of stainless-steel ingots from the peak in 1930 to 1932 was about 57 percent, whereas castings decreased only 38 percent. Since steel ingots and castings of all sorts declined 66 percent from 1930 to 1932, it would appear that the high-chromium steels fared better than the lower-chromium alloys. This was due partly to expansion in the use of high-chromium, corrosion-resisting steels in many lines, particularly in the chemical and petroleum-refining industries, where high temperatures and pressures are met. In one oil refinery stainless steels were used to construct a petroleum hydrogenation chamber which is required to resist 3,600 pounds of pressure per square inch and a temperature of 1,000° F. Since the estimated annual cost of corrosion in the petroleum industry normally exceeds $100,000,000, there appears to be a large field for expansion of high-chromium alloys in this industry.

In the paper industry such alloys as 18 percent chromium–8 percent nickel–4 percent molybdenum and 25 percent chromium–12 percent nickel have tended to supplant straight 18–8 for certain uses, but 18–8 still has an excellent field for future application. In this industry sulphur and small quantities of sulphuric acid are the main corrosive agents. Other applications in the food, architectural, laundry, telephone, automotive, mining, utensil, and other industries were discussed in an article by W. M. Mitchell in Iron Age (vol. 131, no. 19, May 11, 1933, p. 743).

The prices of 18–8 alloys range from 45 to 68 cents a pound, depending upon the degree of primary or secondary fabrication. Ordinary stainless chromium steels are sold for 22 to 27 cents per pound.

Most stainless steels are produced by companies that are licensees of the American Stainless Steel Co. of Pittsburgh and the Krupp Nirosta Co. of Watervliet, N.Y.

A table of the chemical, physical, and mechanical properties of some corrosion- and heat-resisting chromium steels was given in Iron Age (vol. 131, no. 18, May 4, 1933, p. 707e).

Selenium to increase the machinability of stainless steels was applied commercially in 1932.

Ferrochromium delivered in carload lots and containing 65 to 70 percent chromium and 4 to 6 percent carbon was quoted at 10 cents per pound of contained chromium during 1932. Ferrochromium containing 1 percent carbon was quoted at 19 to 20 cents, ferro-

[1] Cone, E. F., American Production of Rustless Steels: Iron Age, vol. 131, no. 7, Feb. 16, 1933, p. 288.

chromium containing 0.1 percent carbon at 23 to 25 cents, and ferrochromium containing 0.06 percent carbon at 25 to 27 cents.

REFRACTORIES

Estimates of the consumption of chromite in refractories (bricks cements, grogs, and patch) totaled roughly 30,000 to 32,000 net ton, in 1932 compared with 130,000 to 135,000 tons in 1930 a decrease of 78 percent. In 1930 about 46 percent of the total chromite used in the United States was refractory ore compared with 44 percent for metallurgical purposes and about 10 percent for chemicals. The importance of the steel industry as a market for chromite refractories is illustrated by the 78-percent decline in the consumption of chromite of refractory grade from 1930 to 1932 following a 66-percent decline in steel production for the same period.

After considerable research, a chromite brick capable of withstanding temperatures over 3,000° F. without serious spalling or sagging has been developed. One steel company is planning to build an open-hearth furnace entirely of this new brick, and the performance of this furnace doubtless will be watched with interest by both the steel companies and refractory manufacturers.

Some manufacturers of chromite refractories now treat the crude chromite to remove deleterious gangue before crushing and screening. This permits mixing ores of various chemical and physical characteristics in the desired proportions. The ground material then is sized carefully, the size being determined by the use to which the finished refractory will be put. Cements generally require relatively smaller grain size than brick. Some firms use ores running 45 to 47 percent Cr_2O_3, others use ore running 33 to 40 percent, while still others mix all grades and types.

In 1932 the quoted price of chromite brick opened at $45 per long ton, f.o.b. shipping point, but by January 28 had dropped to $42.50, where it remained throughout the rest of the year. The price of magnesite brick opened at $65, but by February had dropped to $61.50, where it remained until the end of December.

CHROMIUM CHEMICALS

Chromates and bichromates.—According to the Bureau of the Census the production of sodium bichromate and chromate was 24,745 short tons valued at $3,162,482 in 1931 compared with 39,301 short tons valued at $5,137,346 in 1929, a decrease of 37 percent in quantity. Figures on the production of potassium bichromates and chromate are not available.

Exports of chromates and bichromates were 4,407,460 pounds valued at $287,794 in 1931 and 6,177,956 pounds valued at $328,656 in 1932, an increase of about 40 percent in quantity and 14 percent in value.

Imports of chromates, bichromates, and other chemicals into the United States are shown on page 302.

The quoted price of potassium bichromate decreased from 8¼ to 8½ cents per pound in January to 7 to 8 cents in December, but potassium chromate remained steady at 23 to 32 cents throughout the year. Sodium bichromate opened at 5 to 5¼ cents per pound and dropped to 4⅝ to 4¾ cents in December.

Chromium plating.—According to the latest figures of the Bureau of the Census the production of chromic acid in 1931 was 3,024,854 pounds valued at $423,069 compared with 4,211,605 pounds valued at $710,272 in 1929, a decrease of 28 percent in quantity and 40 percent in value. During 1927 production was 898,093 pounds valued at $241,965. These figures illustrate the relatively favorable position of chromium electroplating compared with chromium refractories and steels. The 1932 quoted price of chromic acid ranged from 14 to 15½ cents per pound in January to 11½ to 14 cents in December.

Chromium plating has become standard practice for decoration of household and plumbing fixtures and the bright parts of automobiles. Therefore, the decline in the number of automobiles manufactured during 1930–31 and the sharp decline in building construction undoubtedly caused a decrease in the use of chromium plating, as reflected by the decrease in chromic-acid production and sales for the same period.

Much research has been directed toward increasing the current efficiency of chromium-plating processes. At present current efficiency rarely exceeds 15 percent, leaving a wide field for future research. Any material increase in plating efficiency would lead to a reduced cost.

Chromium pigments.—According to the Bureau of the Census the production of chromium-yellow pigments was 13,349,000 pounds valued at $2,019,000 in 1931 compared with 16,399,268 pounds valued at $2,392,790 in 1929 and 14,334,423 pounds valued at $2,351,111 in 1927. The average value of chromium yellow, based on the foregoing totals, was 15.12 cents per pound in 1931, 14.59 cents in 1929, and 16.40 cents in 1927. The 1932 quoted price of chrome yellow was steady at 16 cents per pound on spot and 15 to 16 cents per pound on contract deliveries.

The production of chromium green pigments was 16,907,000 pounds valued at $2,550,000 in 1931, 16,351,788 pounds valued at $2,603,225 in 1929, and 14,114,248 pounds valued at $2,460,276 in 1927.

The average value of chromium green was 15.08 cents per pound in 1931, 15.92 cents in 1929, and 17.43 cents in 1927. During 1932 the price of c.p. light chrome green was 23 to 25½ cents, that of dark green 28 to 33 cents, and that of medium green 26 to 27½ cents. Domestic oxide green was quoted at 23 to 26 cents per pound in January and 19 to 21 cents in December. The production of chromium-orange pigments was 8,330,000 pounds valued at $1,267,000 in 1931 compared with 9,954,493 pounds valued at $1,449,929 in 1929 and 4,652,209 pounds valued at $751,468 in 1927. The average value of chromium orange was 15.21 cents per pound in 1931, 14.56 cents in 1929, and 16.15 cents in 1927.

Thus the total production of chromium pigments was 38,586,000 pounds valued at $5,836,000 in 1931 compared with 42,705,549 pounds valued at $6,445,944 in 1929, a decrease of about 10 percent in quantity and nearly 10 percent in value. The average value in 1931 was 15.12 cents per pound compared with 15.09 cents per pound in 1929.

PRICES

According to Metal and Mineral Markets quotations for chromite were reduced three times during 1932. At the beginning of the year Indian ores containing 46 to 48 percent Cr_2O_3 were quoted at $17.50

per long ton c.i.f. Atlantic ports. Ores containing 50 to 51 percent Cr_2O_3 were quoted at $19.50 to $20. These levels held until May, when all quotations were reduced 50 cents per ton. Toward the latter part of July another reduction was made to $16.50 for the lower-grade ore and $19 for the higher-grade ore. At the close of October and early in November, quotations fluctuated somewhat but settled at $14 to $15 for 46 to 48 percent ore and $17 to $18.50 for 50 to 51 percent ore.

The same authority reported the London quotation for 48 percent Rhodesian ore at 80s. per long ton up to the end of May when it rose to 85s. From the end of June to the close of the year the price was steady at 80 to 85s.

WORLD PRODUCTION

The following table shows the available statistics on world production from 1928 to 1932, inclusive.

Production of crude chromite, 1928–32, by countries, in metric tons

Country	1928	1929	1930	1931	1932
Australia		131	171	26	(1)
Brazil [2]	20	70	10		
Canada (shipments)		114			49
Cuba [3]	34,248	53,799	41,640	15,197	
Cyprus (shipments)		2,483	1,569	203	(1)
Greece	20,953	24,214	23,402	5,634	(1)
Guatemala [3]			90	92	
India (British)	46,185	50,361	51,497	20,233	(1)
Indo-China		11	1,451	2,800	(1)
Japan	9,808	9,163	11,348	[4] 8,846	(1)
New Caledonia	56,902	52,594	61,894	63,000	(1)
Russia [5]	29,536	52,889	66,720	[6] 67,000	(1)
Southern Rhodesia	199,060	265,909	205,631	81,623	15,692
Turkey (Asia Minor)	11,849	16,178	28,195	25,382	55,196
Union of South Africa	31,756	63,974	13,726	23,335	[7] 21,547
United States (shipments)	671	273	81	272	157
Yugoslavia	16,678	43,022	51,576	57,871	(1)
	457,700	635,200	559,000	371,500	(1)

[1] Data not available.
[2] Exports.
[3] Imports into the United States.
[4] Output of principal mines.
[5] Year ended Sept. 30.
[6] Approximate production.
[7] Shipments.

Complete data are not yet available regarding world output in 1932, but from a study of the trend of exports and steel production in countries that supplied about 75 percent of the total output in 1931 it is estimated roughly that world production in 1932 declined about 25 percent.

The principal producing countries in 1931 and the proportion of the total supplied by each were: Southern Rhodesia 22 percent, Russia 18 percent, New Caledonia 17 percent, Yugoslavia 16 percent, Turkey 7 percent, Union of South Africa 6 percent, India 5 percent, and Cuba 4 percent. Production data available for 1932 show decreases of 81 and 8 percent, respectively, in Southern Rhodesia and the Union of South Africa. Cuba, which supplied 7 percent of the United States imports in 1931, neither produced nor shipped any chromite in 1932. Turkey increased its output 117 percent, and increased exports and steel production in Russia suggest a substantial rise in the latter's chromite production. Press reports indicate that production in New Caledonia declined in 1932. Thus, Russia, Turkey, and New Caledonia probably ranked first, second, and third in chromite production in 1932. The trend of production in Yugoslavia and India probably was downward.

WORLD TRADE

Chromite is an important commodity in world trade, as the main producing countries consume only small quantities while the main consuming countries produce only a small fraction of their requirements. In 1931, the latest year for which final data are available, world exports were 238,000 metric tons compared with 427,000 metric tons in 1930, a decrease of 44 percent. Southern Rhodesia supplied 37 percent of the 1931 total, New Caledonia 16 percent, Yugoslavia 12 percent, Russia 10 percent, Union of South Africa 9 percent, Cuba 6 percent, Turkey about 4 percent, and India 3 percent. Incomplete data indicate a decline of about 15 percent in world exports for 1932. Shipments from Southern Rhodesia, which showed the largest tonnage decline, amounted to 60 percent of the 1931 total. Other decreases were Cuba 100 percent and Yugoslavia 31 percent. While data on the exports from New Caledonia in 1932 are not yet available, a substantial decline is indicated by the fall in shipments of ore from New Caledonia into the United States in 1932. Exports from the Union of South Africa were maintained at about the same level as in 1931. Russia and British India increased their shipments 52 and 167 percent, respectively, and Turkey appears to have tripled or quadrupled its shipments.

The principal importing countries and the proportion of world imports each took in 1931 were: United States 73 percent, Germany 9 percent, Sweden 5 percent, United Kingdom 4 percent, France 4 percent, and Norway 3 percent. In 1932 the 58-percent decline in imports into the United States was in striking contrast to imports into the principal European consuming countries. Germany increased its imports 55 percent, Norway about 50 percent, and France 5 percent. While Sweden showed a decline of 47 percent shipments into the United Kingdom appear to have been maintained well so that Europe as a whole increased its imports about one fifth.

A brief summary of activities in the principal chromite producing and consuming countries in the world follows.

Cuba.—Cuba neither produced nor shipped any chromite in 1932. In 1931, 15,197 metric tons were shipped to the United States. Cuban ores are of low grade and are used primarily for refractories. The decline in production in recent years probably reflects the decline in refractory-ore consumption in the United States due to the low level of steel production and the inability of the Cuban deposits to compete under the lower scale of prices.

France.—France is an important consumer of chromite. Imports increased from 12,772 metric tons in 1931 to 13,394 tons in 1932. Russia supplies most French imports. The ore is used chiefly in the manufacture of ferrochrome for the French steel industry, but the domestic production of the alloy does not quite meet home requirements. Imports of ferrochrome increased from 754 tons in 1931 to 1,115 tons in 1932; exports increased from 381 to 681 tons.

Germany.—Germany formerly ranked second in chromite consumption but during the past few years has dropped to third, Russia apparently having moved into second place. All of Germany's needs are supplied by importation, 42,653 metric tons having been brought in in 1932 compared with 27,530 tons in 1931. In 1932

British South Africa shipped 42 percent of the total, Turkey 27 percent, New Caledonia 16 percent, and British India and Yugoslavia 6 percent each. Industrial application of chromium alloys is said to be making good progress in Germany.

Germany manufactures an excess of chromates and bichromates, of which 7,066 tons were exported in 1931 and 6,186 tons in 1930.

Greece.—Exports of chromite were 1,102 metric tons in 1932 and 1,034 tons in 1931. The average annual exports prior to 1931 were about 20,000 tons, the decrease being due largely to a recession of demand from the United States. Advance estimates indicate a slight increase in production in 1932 over that in 1931.

India (*British*).—Production of chromite in India reached a peak of 58,000 metric tons in 1927, from which it declined to 20,000 tons in 1931 and probably dropped further in 1932. Exports rose from 7,832 tons in 1931 to 20,920 tons in 1932. This increase does not necessarily reflect an advance in production, as the excess of production over exports prior to 1932 indicates the accumulation of considerable stocks. The principal customers in 1932 were the United Kingdom, which took 39 percent, and Germany, which took 24 percent. These countries accounted for most of the increase in exports.

Japan.—Japan's production was 8,846 metric tons in 1931 and 11,348 tons in 1930. In addition, a few hundred tons of imported ore were consumed at home. Since steel production in Japan in 1932 was about 10 percent above that in 1931 it is believed that production and consumption of chromite in 1932 approximated 1931 levels.

New Caledonia.—New Caledonia ranked third in chromite production in 1931, with an output of 63,000 metric tons. According to press reports mining was continued on a reduced scale in 1932. At the close of the year stocks totaled about 90,000 tons. Exports in 1931 amounted to 38,271 tons, of which the United States took about 78 percent. A large decrease in exports is indicated for 1932, as receipts of ore reported by the United States declined 71 percent.

Norway.—Norway imports chromite to supply its metallurgical industry, principally for use in the manufacture of ferrochromium. During the first 7 months of 1932 imports were about 8,600 metric tons compared with 9,206 tons for all of 1931. This indicates an increase of over 50 percent in imports for the year. The chief sources have been Africa and India. Exports of ferrochromium dropped from 4,856 tons in 1931 to 4,248 tons in 1932.

According to press reports the Feragen mine near Roros has been reopened and a new concentrating plant constructed capable of treating 30 tons of ore per day. Details of production are not available.

Russia.—Russia probably ranked first in chromite production and second in consumption in 1932. From 1928 to 1931 production and exports increased steadily. In 1932 exports were 36,125 metric tons, an increase of 52 percent over 1931. Since preliminary figures indicate an increase in steel production, in which the largest part of the chromite is used, consumption probably was well maintained. Thus a substantial increase in production is indicated for 1932.

Southern Rhodesia.—From 1921 to 1931 this country ranked first in chromite production by a wide margin, the yearly output having increased from less than 46,000 metric tons in 1921 to a peak of 266,000 tons in 1929. During the depression, however, Southern Rhodesia apparently has been unable to compete successfully in the world market under the lower scale of prices. As a result production dropped to only 15,692 tons in 1932, a decrease of 81 percent from that in 1931 and 94 percent from the peak in 1929. Exports in 1932 also were lower, amounting to 35,384 tons compared with 88,132 tons in 1931 and 255,173 tons in 1929. Exports exceeded production, as in 1931, causing further reduction in producers' stocks accumulated before 1931. The decrease in exports since 1929 is attributable largely to decreased exports to the United States and the United Kingdom. These countries took 234,000 tons in 1929 and about 20,000 tons in 1932.

Producers in 1932 were seeking a reduction in railway rates from mines to seaports so that they might compete more effectively in the world markets.

Sweden.—Sweden consumes a large quantity of chromite, chiefly in the manufacture of ferrochromium. This demand is supplied by imports which were 8,533 metric tons in 1932, a decrease of 47 percent from those in 1931. Germany was credited with 70 percent of the 1931 imports, Turkey with 15.4 percent, Belgium with 6.3 percent, and the United Kingdom with 8.3 percent, all but those from Turkey being transshipments.

Turkey.—The production in 1932 was 55,196 metric tons compared with 25,382 tons in 1931, an increase of 117 percent. Figures for exports in 1932 are not yet available, but imports of Turkish ore into the United States, Germany, and Sweden totaled 32,000 tons in 1932 and 8,400 tons in 1931, indicating that stocks of ore in Turkey have mounted rapidly in the past 2 years.

Union of South Africa.—This country ranked second in chromite production in 1929, but since then there has been a large decline in output. In 1932 shipments from the mines totaled 21,547 metric tons, a decrease of 52 percent from the shipments reported in 1929. Exports were 20,614 tons in 1932 and 20,715 tons in 1931. The control of the chief chrome interests in the Transvaal Province was sold in 1932 to the African Chrome Mines, Ltd. (Edmund Davis group). This company and its subsidiaries are said to control roughly 85 percent of the world output. The principal centers of operation are in Southern Rhodesia, India, New Caledonia, and Transvaal.

United Kingdom.—The steel industry of the United Kingdom consumes considerable chromite. In 1931, 12,845 long tons were imported, of which Southern Rhodesia supplied 45 percent, Portuguese East Africa (probably transshipments from Southern Rhodesia) 30 percent, Union of South Africa 14 percent, and British India 10 percent. Imports in 1932 probably approximated those in 1931, as there was a small increase in steel production.

Yugoslavia.—From 1927 to 1931 production increased steadily, reaching a peak of 57,871 metric tons in the latter year. The trend of production probably was downward in 1932, exports having declined to 20,123 tons, compared with 29,291 tons in 1931. The United States took 67 percent of the 1932 total, France 12 percent, and Germany 12 percent. Shipments to the United States are routed through Greece and are credited to that country in the official United States import statistics.

ANTIMONY

By F. M. Shore

The antimony trade was characterized by dullness throughout most of 1932, reflecting conditions in the principal consuming industries. The demand situation is indicated by the United States production of automobile passenger cars and trucks, which declined 43 percent in 1932, and the production of babbitt metal which dropped about one third. Bearing metals and storage batteries normally account for almost half the domestic consumption of antimony. Supplies of antimony available for consumption in the United States were substantially less from all sources in 1932, except in the production of domestic ores and of antimonial lead. Imports of all classes of antimony for consumption registered drastic declines, and there was likewise a smaller recovery of secondary antimony. The 1932 average price of ordinary brands at New York was again substantially below that of the preceding year. The year also witnessed a decided reduction in the percentage of the available supply that came from foreign sources, with a corresponding proportionate increase in the supply of antimony from domestic sources.

Salient statistics for antimony in the United States, 1928–32

	1928	1929	1930	1931	1932
Average price for year of antimony at New York [1] cents per pound	10.30	8.94	7.67	6.72	5.62
Imports for consumption:					
Antimony in ore short tons	2,185	1,865	863	4,863	1,328
Liquated antimony sulphide do	1,208	1,803	713	650	435
Metal do	9,684	11,073	7,700	3,753	1,508
Oxide do	2,268	1,892	690	746	403
Exports of foreign antimony do	599	509	493	697	123
Stocks of antimony in bonded warehouse at end of year do	1,471	1,461	705	702	705
Production of antimony ore do	86				900
Antimony contained do	42				419
Antimony contained in antimonial lead produced from domestic and foreign ores short tons	3,432	3,052	1,685	964	1,085
Recovery of secondary antimony do	11,900	11,131	8,082	7,900	6,450

[1] According to the American Metal Market.

Prices.—The general trend of prices of ordinary brands of antimony metal at New York was downward in 1932, conforming to the general industrial trend and movement of commodity prices. The downward trend exhibited throughout January was reversed at the beginning of February, at a time when military activities threatened outlets for Chinese production, and the high point of the year was reached at 7 cents per pound. The downward trend was resumed almost at once, however, and continued to the low point of the year—5 cents—which was reached in the early part of June and persisted several weeks.

The price of antimony showed some improvement in August, along with prices of a number of other metals, and continued a moderate and fairly steady gain into November. Prices receded in December, however, and the year closed substantially below the level at which it opened. The movement of prices throughout the year is outlined by the monthly averages of 5.976 cents per pound in January, 6.489 in February, 5.000 in July, 5.771 in November, and 5.400 in December. The yearly average of 5.592 cents per pound was more than 16 percent below that for 1931 and the lowest since 1922.

The weekly average price of needle antimony (powdered), as quoted by Oil, Paint and Drug Reporter, opened the year at 6–6½ cents per pound, reached a high of 8 cents in March, and closed the year at 7–8 cents. Oxide opened at 6½–8 cents, reached the high point of 7½–10 in March, and was quoted at that figure for the remainder of the year.

London prices of foreign antimony, as quoted by Metal Industry, opened the year at £28 per long ton, reached the year's high point of £32 in the week of February 26, receded to £24 in the early part of July, and recovered to £28 in early November to finish the year at that figure.

New York prices for recent years are shown in the following table.

Prices of antimony (Chinese brands) per 100 pounds at New York City, 1928–32[1]

Year	High	Low	Average	Year	High	Low	Average
1928	$11.375	$9.500	$10.305	1931	$7.625	$6.050	$6.720
1929	9.750	8.250	8.956	1932	7.000	5.000	5.592
1930	8.875	6.750	7.667				

[1] Compiled from Engineering and Mining Journal.

Stocks.—Stocks in bonded warehouses, which were 1,573,778 pounds at the end of January, rose to 2,018,089 at the end of February and gradually declined to the low figure of the year—1,409,174 pounds—at the end of December compared with 1,404,538 pounds at the end of 1931. The monthly average of bonded stocks in 1932 was 1,754,149 pounds.

DOMESTIC CONSUMPTION AND USES

In recent normal years the annual consumption of all forms of antimony in the United States has closely approached the World's yearly output of new antimony exclusive of that contained in antimonial lead ores. A large percentage of the domestic consumption, however, comes from the accumulated revolving fund of secondary antimony. The average annual domestic consumption of antimony (antimony content of the various forms in which the element enters trade) for the 5-year period 1926–30, inclusive, has been estimated by Paul M. Tyler at 28,955 short tons.[1]

Of this amount imports represented approximately one half, and secondary antimony recovered in United States plants accounted for slightly over 40 percent of the total. The separate items, in short tons of antimony content, are as follows:

[1] Tyler, Paul M., Consumption of Antimony in the United States: Bureau of Mines Office Memo. 211, 1932; reprinted in Am. Metal Market, vol. 39, no. 230, Dec. 1, 1932, pp. 3–6.

Ore (mainly imported)	1,715
Crudum (imported)	1,100
Oxides and compounds (imported)	1,500
Regulus (imported)	9,970
Antimonial lead (United States and foreign)	2,720
Secondary (United States)	11,950

Pre-war consumption (1910–14, inclusive), on the same basis, was about 11,940 tons, of which about 25 percent was of secondary origin.

On a comparable basis, supplies made available for consumption in 1931 were approximately 18,600 tons, representing a decline of about 5 percent from the previous year and 36 percent from the 1926–30 average. In 1932 the supply available for consumption registered a further decline of approximately 38 percent from 1931.

Tyler estimates the percentages of the total consumed by principal uses in a year of fairly large consumption, such as 1928, as follows:

Product:	Percent	Product—Continued	Percent
Bearings	18.0	Ammunition	5.5
Batteries	28.0	Enamels, chemicals, and paints	15.0
Cable coverings	3.5	Miscellaneous	10.0
Soft-metal alloys and solder	5.0		
Hard lead	3.5		
Type metal, etc	11.5		100.0

DOMESTIC PRODUCTION

Domestic antimony ore again entered the records in 1932, for the first time since 1928, with a total production of 900 tons having an antimony content of 419 tons—the largest production of domestic ore recorded since 1917 and the largest antimony content since 1916. Of the 1932 production 858 tons, with an antimony content in dry ore of 48.47 percent, came from operations of the Yellow Pine Co. in Valley County, Idaho, and the remainder from Nevada.

The output of the plant of the Texas Mining & Smelting Co. at Laredo, Tex., is another new factor in the domestic market and correspondingly affects the total supply of antimony products made available for consumption. This plant, reported to have an annual capacity of 3,600 tons of metal and oxide and using ore imported from Mexico, began operations December 31, 1930. In 1932 it produced 1,776 short tons of metallic antimony and 100 tons of oxide and other compounds.

Primary antimony produced in antimonial lead in 1932 amounted to 1,085 short tons, an increase of 12.6 percent over the quantity produced in 1931. In the total production of 21,024 tons of antimonial lead at primary plants, 1,410 tons of the antimony content were secondary antimony, leaving 1,085 tons of primary antimony produced in antimonial lead.

These figures compare with a production of 21,842 tons of antimonial lead in 1931 containing a total of 2,438 tons of antimony, of which 964 tons were primary and 1,474 tons secondary antimony. Of the new antimony recovered in antimonial lead in 1932, 19.1 percent was of foreign origin compared with 20.3 percent in 1931.

No antimony production was reported from Alaska in 1932. The annual review of the United States Geological Survey for 1931 contains the following notes on antimony in Alaska: [2]

[2] Smith, Philip S., Mineral Industry of Alaska in 1931: U.S. Geol. Survey Bull. 844-A, 1933, p. 80.

Antimony ores are widely distributed throughout Alaska, and in the past considerable quantities were produced and shipped from the Territory. In 1931, 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 newspaper reports a test shipment of about 1 ton of antimony ore was made to a smelter in California from the 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 places some of the larger masses of stibnite are laid aside until enough has accumulated to be worth shipping. The present low price of antimony of 6 to 7 cents a pound and the remoteness of most of these deposits in interior Alaska do not encourage their development at this time.

Mine production of antimony ores in the United States, 1928–32, in short tons [1]

Year	Ore	Antimony content	Year	Ore	Antimony content
1928	86	42	1932	900	419

[1] No production reported for 1929–31.

Byproduct antimonial lead produced in the United States from both foreign and domestic ores, 1928–32

Year	Short tons	Antimony content		Year	Short tons	Antimony content	
		Short tons	Value [1]			Short tons	Value [1]
1928	33, 058	3, 432	$707, 000	1931	(2)	964	$129, 600
1929	25, 669	3, 052	545, 700	1932	(2)	1, 085	122, 000
1930	13, 711	1, 685	258, 500				

[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, and in 1932, 21,024 tons.

Recovery of secondary antimony.—The recovery of antimony from old alloys, scrap, and dross in 1932 amounted to 6,450 short tons, according to J. P. Dunlop, of the Bureau of Mines. This quantity, nearly all of which was recovered in the form of alloys, represents a decrease of 18.4 percent from the production in 1931 and was the smallest output since 1921. Of the total secondary antimony recovered in 1932, 1,410 tons came from antimonial lead scrap treated at regular smelters, and 5,040 tons 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, 1928–32

Year	Short tons	Value [1]	Year	Short tons	Value [1]
1928	11, 900	$2, 451, 400	1931	7, 900	$1, 061, 800
1929	11, 131	1, 990, 200	1932	6, 450	725, 000
1930	8, 082	1, 239, 800			

[1] Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

IMPORTS, EXPORTS, AND WORLD PRODUCTION

Imports and exports.—All classes of antimony imported for consumption in 1932 showed marked declines from the preceding year. Imports of ore (antimony content) fell off 73 percent, liquated sulphide 33 percent, metallic 60 percent, and oxides and other compounds 43 percent.

The total tonnage of antimony imported for consumption in 1932, including antimony content of ore, liquated sulphide, metallic antimony, and oxides and other compounds, was 62.9 percent less than in 1931, while the total value declined 68.5 percent.

Of the general imports of ore and metal marked decreases from the figures of the preceding year were shown in the imports of ore from Mexico, which declined 75 percent, and in antimony metal from China, which fell off 61 percent. Imports of antimony metal from China have declined steadily—from 10,524 short tons in 1929 to 1,895 tons in 1932.

Imports of type metal and antimonial lead virtually disappeared in 1932, amounting to only 6 short tons, with an antimony content of 1 ton.

Exports of foreign antimony from the United States—never of important volume—declined 82 percent in 1932 compared with the preceding year.

Antimony imported for consumption in the United States, 1928–32

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						
1928	3,912	2,185	$313,127	1,208	$158,231	9,684	$1,641,265	2,643	$448,156
1929	3,161	1,865	231,086	1,803	174,104	11,073	1,622,182	2,222	359,247
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

Antimony imported into the United States, 1931–32 [1]

[General imports]

Country	Antimony ore			Antimony metal [2]	
	Gross weight (short tons)	Antimony content		Short tons	Value
		Short tons	Value		
1931					
Argentina	556	184	$21,801		
Belgium				3	$504
China [3]				4,836	396,558
Germany				(4)	27
Mexico	13,459	4,679	238,151	243	27,656
United Kingdom				113	20,624
	14,015	4,863	259,952	5,195	445,369
1932					
Argentina	278	115	11,869		
Belgium				2	174
Bolivia	39	10	1,636		
Chile [5]	7	2	237		
China [3]				1,895	106,882
Germany				(4)	45
Mexico	3,355	1,201	60,655	38	4,904
United Kingdom				69	9,844
	3,679	1,328	74,397	2,004	121,849

[1] Includes large quantities of antimony metal that went into bonded warehouse and that are not included in the table of imports for consumption.
[2] Includes small quantities of liquated antimony sulphide, known in the trade as "crude antimony", "antimony matte", or "needle antimony."
[3] Some of the material credited to other countries is possibly of Chinese origin, having been transshipped in a foreign port.
[4] Less than 1 ton.
[5] Imports credited to Chile originated mainly in Bolivia.

Type metal imported for consumption in the United States, 1928–32 [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
1928	1,995	$193,177	452	22.6	1930	328	$32,934	53	16.2
1929	2,720	180,679	295	10.8	1932	6	479	1	16.7

[1] No imports reported for 1931.

Foreign antimony (matte, regulus, or metal) exported from the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	599	$90,975	1931	697	$74,668
1929	509	71,415	1932	123	11,820
1930	493	54,634			

World sources and production.—Antimony ores are widely distributed throughout the world, being found in many countries and in each of the continents. The amount, quality, and accessibility of reserves vary to some extent in each country, and many of them apparently cannot compete successfully in the world market, except in periods of high prices. The potential productive capacity of the world is vastly above normal requirements, as is indicated by the war-time peak production of approximately 80,000 metric tons in 1916 compared with an average annual production of 28,500 tons from 1925 to 1929, inclusive. In recent years antimony has been produced with considerable regularity in about a dozen countries, but in most of them the output was relatively small. The ample deposits of China, available at low production costs, have enabled that country to maintain consistently its position as the leading source of supply.

Figures of world production in 1932 are as yet incomplete. Production in 1931 was about 25 percent below that of the previous year. For the 5-year period 1926–30 the annual average of world production (approximate recoverable metal content of ore produced, exclusive of antimonial lead ores) was 28,100 metric tons, of which China produced approximately 70 percent. During the past 4 years Mexico has ranked second in world production of antimony, a position held by Bolivia in the 3 preceding years. France, Czechoslovakia, and Italy have also been among consistent producers of recent years. China is the chief source of new antimony metal imported by the United States, while Mexico has supplied the bulk of the ore imported during the past 2 years.

Exports of antimony from China in 1932 went chiefly to Great Britain, United States, Japan, and Germany, in the order named. While shipments to Great Britain predominated in 1932, China's exports of antimony to Great Britain and the United States were approximately equal in 1931.[3] Exports of antimony from China in 1932 were 77.0 percent regulus, 14.4 percent crude, and 8.6 percent "refuse and oxide."[4]

Consular advices from Hankow reported the formation of the Antimony Trade Association for Hunan, designed to control the production and export price of antimony and scheduled to begin operations January 1, 1933. The association is under the control of the Hunan Provincial Government and will collect a fee of 10 percent of the selling price of all exports from Hunan. The minimum purchase price at Changsha is said to have been initially established at 280 silver dollars a long ton, making the selling price 308 silver dollars per ton when the association fee is included.[5]

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[3] Statistical Department of the Inspectorate General of Customs, Monthly Return of the Foreign Trade of China, December 1932, The Maritime Customs, China. I: Statistical Series No. 8. Shanghai, 1933, p. 84.

[4] Statistical Department of Inspectorate General of Customs, The Trade of China, 1932. Vol. II, Foreign Trade—Abstract of Import and Export Statistics. The Maritime Customs, China. I: Statistical Series, No. 1, Shanghai, 1933, pp. 98, 99, 100, 101.

[5] Bureau of Foreign and Domestic Commerce, Foreign Trade Notes: Vol. 2, no. 2, Jan. 25, 1933, p. 1.

World production of antimony, 1928–32, in metric tons [1]

Country	1928	1929	1930	1931	1932
North America:					
Canada	----	----	----	6	----
Mexico	2,297	3,096	3,042	4,354	1,393
United States	30	----	----	----	304
South America:					
Bolivia [2]	2,834	3,023	927	1,078	1,176
Peru	112	[2] 86	[2] 47	[2] 24	(3)
Europe:					
Austria	914	560	----	----	(3)
Czechoslovakia	967	556	307	513	(3)
France	925	1,021	992	516	(3)
Greece	----	55	54	217	(3)
Italy	230	306	330	269	(3)
Spain	6	----	----	----	(3)
Yugoslavia	258	210	3	68	(3)
Asia:					
China [2]	19,324	22,401	17,419	9,842	12,300
India, British	181	38	1	----	(3)
Japan	21	22	----	(3)	(3)
Turkey (Asia Minor)	78	6	26	34	(3)
Africa:					
Algeria [2]	21	114	----	282	(3)
Morocco:					
French	4	----	----	----	(3)
Spanish	[2] 225	[2] 180	----	80	(3)
Southern Rhodesia	40	----	27	----	(3)
Oceania:					
Australia:					
New South Wales	48	25	42	38	(3)
Queensland	1	----	----	----	(3)
Victoria	1	1	(3)	(3)	(3)
	28,500	31,700	23,200	17,300	(3)

[1] Approximate recoverable metal content of ore produced (80 percent of reported content), exclusive of antimonial lead ores.
[2] Exports.
[3] Data not available.

ARSENIC

By Paul M. Tyler and C. N. Gerry

The decline in the consumption of arsenic in 1932 was much smaller than might have been anticipated in view of the depressed state of agriculture and general industry. The price likewise was well maintained, there being no change in the nominal quotations and such concessions as were made being explained in large measure by eliminating the cost of barrels and packing as a result of bulk shipments to carload-lot consumers. The apparent supply of white arsenic as represented by domestic sales plus imports was 19,365 short tons, only 10 percent less than in 1931 and still well ahead of any year before 1923. Stocks of crude and refined arsenic in producers' hands dropped substantially during the summer season, and visible supplies at the end of the year made a net increase of only 221 tons. There was actually a further slight decrease in stocks of refined arsenic at the end of 1932, and the total quantity carried by producers scarcely exceeded 2 months' normal demand. It is reasonable to suppose that stocks in consumers' hands tended to diminish; in any event the atter have shrunk to rather small proportions during the last 2 or 3 years.

Salient statistics for arsenic in the United States, 1928–32

	1928	1929	1930	1931	1932
WHITE ARSENIC					
Domestic sales:[1]					
Crude .... short tons	3,652	4,723	2,771	1,795	1,975
Refined .... do	8,115	9,823	14,654	11,982	10,508
Imports for consumption .... do	11,153	13,157	10,471	7,791	6,882
Apparent supply[1] .... do	22,920	27,703	27,896	21,568	19,365
Average reported value:					
Domestic, crude .... cents per pound	2.70	2.51	2.09	2.18	2.28
Domestic, refined .... do	3.32	3.29	3.05	3.00	2.67
OTHER ARSENICALS					
Imports for consumption:					
Metallic arsenic .... pounds	186,622	287,545	113,440	28,661	45,474
Sulphide (orpiment and realgar) .... do	525,060	424,426	554,902	598,194	502,531
Arsenic acid (H_3AsO_4) .... do	75	247	201	12,061	1,703
Calcium arsenate .... do	1,323	----------	6,359	40,950	4,500
Lead arsenate .... do	----------	200	800	----------	----------
Sheep dip .... do	175,055	208,770	174,215	154,530	62,509
Paris green and London purple .... do	13,279	1,102	19,024	2,340	2,364
Exports:					
Calcium arsenate .... do	1,178,702	3,139,633	3,177,335	2,145,653	2,533,599
Lead arsenate .... do	1,093,673	1,563,982	2,270,980	1,788,345	1,189,629

[1] Includes sales by domestic producers for export.

Domestic production and sales.—Production of arsenic as arsenious oxide in the United States in 1932 amounted to 12,704 short tons, of which most (10,489 tons) was refined and the remainder (2,215 tons) crude. The entire output in 1932, as in recent years, was a byproduct from smelting copper and lead ores. The products for the market were refined white arsenic, crude white arsenic, "black" dust, and "treater" dust. No production of red or yellow arsenic sulphide or elemental arsenic was reported in 1932.

The Jardine Mining Co. resumed operation of its mine and mill at Jardine, Mont., late in 1932. Gold and arsenic are recovered from arsenopyrite. The arsenic kitchens have been idle since 1927, and it is reported that the output of arsenical material is being stored.

Virtually all the arsenic made at the copper smelter of the Anaconda Copper Mining Co., Anaconda, Mont.—by far the largest producer of domestic white arsenic—resulted from the smelting of copper concentrates, chiefly from the Butte mines, where arsenic occurs as enargite. In Utah the arsenic deposits (chiefly arsenopyrite and scorodite) of Gold Hill, Tooele County, remained idle. There are several deposits in Utah, Colorado, Washington, and other Western States that could be operated as arsenic mines if the demand justified. With an increased price due to a demand for insecticides or weed killer it would be possible to increase the arsenic content of the charge of the lead smelters at Midvale and Murray, Utah, by shipments of arsenic ore from the Gold Hill or Western Utah mines at Gold Hill, Utah.

The smelting plants at Anaconda, Mont., and Murray and Midvale, Utah, were operated on a part-time basis or at a greatly curtailed rate in 1932. On the other hand, production of arsenic at Tacoma, Wash., partly from foreign ores, was decidedly increased.

A total of 12,483 short tons of refined and crude arsenic was sold; it was valued at $650,902. The refined white arsenic (10,508 tons) was sold for $560,707; the crude arsenic (1,975 tons) was sold for $90,195.

Prices.—A price of 4 cents a pound for white arsenic, with the usual increases for small lots, became virtually established in 1927. Experience indicates that this figure encourages the recovery of byproduct arsenic by the large smelting companies and that it is too low to allow arsenic to be made in the United States as a main product. This New York quotation includes freight from refinery to buyers' works, which averages about one half cent a pound, and also a further cost of about one half cent for barreling. Tank-car shipments are therefore cheaper.

The average receipts actually obtained from sales by producers in 1932, as reported to the Bureau of Mines, were 2.67 cents per pound for refined and 2.28 cents per pound for crude arsenic. These prices, of course, do not include freight. The averages reported in 1931 were 3.00 and 2.18 cents, respectively.

The British market value in the year was firm, due to scarcity of Cornish white and the reluctance of Mexican producers to quote in sterling. Until late in the summer Cornish white was quotable at £24 or more a ton, but meanwhile Mexican arsenic was available at substantial discounts. In October, due to reported offerings from the Continent, the latter was cut to £21. By the end of the year Mexican arsenic was freely offered at £20 a ton, equivalent (with the exchange at \$3.28) to under 3 cents a pound, and the nominal premium for Cornish white had virtually disappeared.

In general, quotations for arsenic compounds were lower than at any time during the past 10 years. As in 1931, red arsenic was quoted at 9⅜ to 10 cents per pound. Throughout most of the year lead arsenate was quoted at 9½ to 13½ cents and calcium arsenate at 5½ to 6½ cents. Sodium arsenate was quoted at 25 to 35 cents per pound until October, when the quotation was sharply reduced to 7¾ to 8¾ cents. At the end of February the price of arsenic metal receded from the 1931 level of 30 to 35 cents, to 27 to 29 cents, where it remained for the rest of the year.

Prices of white arsenic, red arsenic, lead arsenate, calcium arsenate, sodium arsenate, and arsenic metal, New York, 1922–32,[1] in cents per pound

Year	White arsenic		Red arsenic		Calcium arsenate		Lead arsenate [2]	Sodium arsenate [2]	Arsenic metal [2]
	High	Low	High	Low	High	Low			
1922	15½	5½	13	11	16	10	22 –24	----------	17–20
1923	16	9¾	15½	13	18	12	20 –24	----------	50–55
1924	13½	6	15	15	13	8	18½–24	----------	50–55
1925	6¼	3½	15	12	8	7	14½–15½	----------	50–55
1926	3½	3½	12	10½	8	7	15 ---	----------	50–55
1927	4	3¼	10½	9	7½	6½	13½–15	18 –19	50–55
1928	4	4	9½	9	7	6	13 –13½	18 –19	50–55
1929	4	4	9½	9	8	6½	14 –15	18 –19	30–35
1930	4	4	9½	8¾	8	7	13 –16	18 –19	30–35
1931	4	4	10	9⅜	9	6	10 –14	25 –35	30–35
1932	5	4	10	9⅜	6½	5½	9½–13½	7¾– 8¾	27–29

[1] Oil, Paint and Drug Reporter.
[2] December quotations.

Uses.—Arsenic is used in medicinal preparations; in lead alloys for bullets and shot; in pyrotechnic and boiler compositions; as a depilatory agent; in the manufacture of paint pigments, opal glass, and enamels; in textile dyeing and calico printing; as a bronzing agent or decolorizing agent for glass; and for insecticides, vermin poisons, and sheep dips.

The arsenic of commerce is arsenious oxide (white arsenic). Of the domestic output of this product in 1932, 71 percent was used in the manufacture of insecticides, which requires arsenic of the highest grade; 11 percent for weed killers (used principally by railroads), fungicides, and wood preservatives; about 2 percent in glass manufacture; and the balance (about 16 percent) sold for export. Most of the crude arsenic produced at Midvale was made directly into sodium arsenite, a liquid used in the West for sheep dip or insecticides.

Due to its extensive use for boll-weevil control in the cotton fields of the South calcium arsenate has become the leading product made from white arsenic, more important even than lead arsenate, which finds its chief use in poison sprays and dusts for destruction of the codling moth, plum curculio, cabbage worm, potato bug, tobacco hornworm, and other pests that attack fruits and vegetables. The former contains more arsenic, about 45 percent of the weight being As_2O_3. Lead arsenate is available in two forms: (1) Acid lead arsenate, the principal compound, which contains the equivalent of over 28 percent As_2O_3 (33 percent As_2O_5); and (2) basic lead arsenate (used for certain trees on the Pacific coast because of climatic conditions), which contains the equivalent of about 20 percent As_2O_3 (23 percent As_2O_5). A colloidal lead arsenate was placed upon the market in 1931.[1] Paris green (copper acetoarsenite), magnesium arsenate, and manganese arsenate are also used as insecticides.

The removal of arsenical spray residues from fruits and other food products for human consumption is receiving a great deal of consideration both in the United States and abroad. According to various recent papers, washing with quite dilute hydrochloric acid successfully removes all danger of poisoning and does not impair the keeping qualities if reasonable care is employed. Another problem that may rise to trouble manufacturers of arsenical insecticides is the effect of successive heavy applications of calcium arsenate on soil fertility; this is less serious on red soils than on iron-poor soils, consequently treatment with sulphate of iron greatly reduces this injury.[2] Arsenic is an effective wood preservative, and both in Germany and in British India considerable attention is currently given to new processes utilizing chromates or chromic acid to fix the arsenic in the wood. The use of arsenic as a concrete admixture, expecially to inhibit lime liberation and to improve water resistance, is advocated, especially in Sweden, but the use of any poisonous material is deplored by various commentators in the German press.

Arsenic is generally considered a deleterious element in alloys. In ordinary (60–40) brass, as little as 0.12 percent halves the ductility, and in steel amounts above 0.20 percent result in cold-shortness similar to that produced by phosphorus. In bearing metals, however, it appears to be finding a useful place. According to Wegner,[3] for example, the effect of arsenic in lead-base alloys is to form needle-shaped crystals with an arsenic-rich core consisting probably of arsenic, antimony, and tin. The interlocking of these needles prevents segregation. A method for introducing arsenic into antimonial lead has been patented by Betterton.[4] A British patent [5] describes arsenic additions (0.1 to 2 percent) in conjunction with silicon (0.25 to 4 percent) and copper (0.1 to 2 percent) in the open hearth for making corrosion-resistant steel.

FOREIGN TRADE

Imports.—Imports of white arsenic (arsenious acid) dropped to 6,882 short tons valued at $357,991 in 1932, compared with 7,791 tons valued at $451,468 in 1931 and 10,471 tons valued at $725,991 in 1930. The decline resulted in part from further reduction in imports from American-owned plants in Mexico from 8,234 tons in 1930 and 4,298 tons in 1931 to 3,325 tons in 1932. Mexico continued to be the principal foreign source of supply, although imports from Japan rose to 1,643 tons, compared with 1,546 tons in 1931 and 674 tons in 1930. Canada, formerly the second source of supply, furnished only 841 tons compared with 1,532 tons in 1931. Imports from Europe more than doubled as a result of increased shipments from France and Germany.

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[1] Chemical Age (London), vol. 25, no. 644, Oct. 31, 1931, p. 381.

[2] Cooper, H. P., Effect of Calcium Arsenate on the Productivity of Certain Soil Types: South Carolina Agr. Expr. Sta. Ann. Rept., 1931, pp. 28–37.

[3] Wegner, K. H., Arsenic in Ternary Lead-Base Bearing Alloys: Metals and Alloys, vol. 3, no. 5, May 1932, pp. 116–119.

[4] Betterton, Jesse O., Introducing Arsenic into Antimonial Lead: U.S. Patent 1882749, Oct. 18, 1932.

[5] Hall & Pickles, Ltd., and Smith, J., Corrosion-Resisting Iron and Steel Alloys: British Patent 351532, Mar. 26, 1930; Chem. Abs., vol. 26, May 20, 1932, p. 2695.

Imports of arsenical compounds other than white arsenic were generally smaller in 1932 than in 1931.

Exports.—Exports of white arsenic are not reported, and ordinarily are insignificant, as domestic requirements are supplied in part by imports. In 1932, however, they rose to nearly 2,000 tons, an increase of almost 50 percent as compared with the previous year. American insecticides and arsenical disinfectants are sold all over the world, although separate statistics are available only for calcium arsenate and lead arsenate.

WORLD PRODUCTION

Prior to the World War the apparent production of white arsenic rose gradually to about 10,000 tons annually. Germany was the leading producer, but the United States and Canada were becoming increasingly important. England, which in the heyday of Cornish tin mining had produced even more arsenic than Germany, also was a factor, as was Portugal. Other countries, including Japan and Australia, had scarcely entered the field. Due especially to the increasing demand for insecticides world production expanded to more than 25,000 tons in 1920 and subsequently to 45,000 tons.

In recent years the United States has been by far the leading producing country and Mexico second. Sweden, however, has now forged ahead, and before the end of 1933 is expected to be producing arsenic at an annual rate variously estimated up to more than 52,000 tons, or substantially in excess of the maximum quantity the world has hitherto consumed in any single year. Australia is another new source of considerable importance. Germany, although actually producing more arsenic now than before the World War, is a relatively minor producer, and the decline of tin mining in Cornwall has reduced the British supply of refined white arsenic to the point where substantial imports are required to balance consumption.

World production of arsenic ore and white arsenic, 1927–31, in metric tons

Country and product	1927	1928	1929	1930	1931
Algeria: Arsenate of lead—					
Gross weight	2,482	1,201	2,541	1,175	----------
Arsenic content	546	144	305	353	----------
Australia:					
New South Wales—					
Ore and concentrates [1]	755	5,924	2,814	6,809	3,977
White arsenic	(2)	50	255	809	672
Queensland—Ore	71	----------	----------	----------	----------
Western Australia—White arsenic	----------	----------	----------	----------	416
Austria: Arsenic content of gold ores	155	14	----------	----------	----------
Belgium: Luxemburg Economic Union: White arsenic [3]	2,201	2,659	3,717	3,111	2,502
Brazil: White arsenic	----------	----------	----------	----------	179
Canada:					
White arsenic	2,220	1,821	1,678	1,248	(2)
Arsenic content of ores and concentrates exported	605	643	694	804	(2)
China: White arsenic	(2)	(2)	2,387	983	500
Czechoslovakia: Ore—					
Gross weight	13	6	38	----------	----------
Arsenic content	3	1	8	----------	----------
France:					
Ore [4]—					
Gross weight	56,822	69,362	43,263	48,795	91,964
Arsenic content [5]	4,984	3,703	3,622	4,970	(2)
White arsenic	2,456	2,947	3,372	3,950	(2)

See footnotes at end of table

World production of arsenic ore and white arsenic, 1927–31, in metric tons—Con.

Country and product	1927	1928	1929	1930	1931
Germany:					
Ore—					
Gross weight	23,783	25,710	27,866	29,437	27,935
Arsenic content	1,498	1,619	1,756	1,858	1,850
White arsenic[3]	2,745	2,711	2,578	4,614	4,425
Great Britain:					
Ore[1]	81	--------	20	--------	--------
White arsenic and arsenic soot	1,358	1,314	968	588	180
Greece: White arsenic	1,036	709	763	841	659
Italy: Ore—					
Gross weight	81	--------	--------	--------	--------
Arsenic content	20	--------	--------	--------	--------
Japan: White arsenic	1,713	1,829	1,963	1,654	(2)
Mexico: White arsenic	11,332	12,933	12,785	9,476	6,508
Portugal:					
Ore[1]	47	(2)	9	(2)	(2)
White arsenic	(2)	134	105	176	159
Southern Rhodesia: White arsenic	38	102	52	50	--------
Spain: Ore—					
Gross weight	186	--------	--------	--------	--------
Arsenic content	28	--------	--------	--------	--------
Sweden: Ore—					
Gross weight	22,100	22,728	22,919	21,649	53,668
Arsenic content	4,420	4,546	4,584	4,350	11,182
Turkey: Ore—					
Gross weight	--------	10	14	55	54
Arsenic content	--------	(2)	6	22	22
Union of South Africa: White arsenic	53	17	33	15	9
United States: White arsenic	10,487	10,675	13,196	15,808	12,498
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: 1927, 471 tons; 1928, 359 tons; 1929, 410 tons; 1930, 137 tons. Data not available for 1931.

Australia.—Much of the arsenic consumed in Australia goes into compounds for destruction of the prickly pear. Domestic requirements have been supplied mainly from New South Wales, but Queensland has also furnished considerable output in the past. New developments in the Wiluna gold fields in Western Australia now provide a large exportable surplus. The arsenic plant of A. Victor Leggo & Co. on the property of the Wiluna Gold Corporation, Ltd., in this district, which was producing at the rate of 3,000 tons annually, is to be improved in 1933 by the installation of Cottrell precipitating equipment. The crude arsenic is shipped to Bendigo, Victoria, for refining; the refinery when in full working order can produce 75 to 80 tons a month.[6]

Belgium.—Arsenical residues from the furnaces of the Société Générale Métallurgique de Hoboken in addition to various foreign materials are worked up at the arsenic works at Reppel. The products include white arsenic, red arsenic, arsenic acid, arsenite and arsenate of soda, and calcium arsenate.

Canada.—The output of arsenic in Canada declined in 1932. Figures covering the quantity of white arsenic produced are not available, but the value ($99,008) was substantially less than in 1931 ($135,170) or in 1930 when the output was 1,375 short tons valued at $109, 928. In recent years the only producer of white arsenic has been the Deloro Smelting & Refining Co., which treats arsenical ores from Cobalt and neighboring districts of northern Ontario. Imports

[6] Industrial Australian and Mining Standard, Wiluna Arsenic: Vol. 87, no. 2229, Mar. 31, 1932, p. 113.

of arsenicals into Canada, consisting principally of lead arsenate and calcium arsenate, declined although there was a slight increase (from 83.5 short tons in 1931 to 213 tons in 1932) in the imports of white arsenic and an even larger relative increase in the imports of sulphide of arsenic. The decrease in exports of arsenic was from 1,546 short tons valued at $116,044 in 1931 to 894 tons valued at $65,287 in 1932.

Germany.[7]—Approximately 4,500 tons of arsenic are produced annually in Germany from domestic and imported ores. At least 15 German firms are engaged in the manufacture of arsenic compounds, the output of which ranges from 8,000 to 10,000 tons a year, calcium arsenate comprising about 75 percent. The exports of arsenates from Germany were 4,425 metric tons in 1931 compared with 2,578 tons in 1929.

Mexico.—Since 1925 the United States has obtained more arsenic from Mexico than from any other foreign country. The Mexican output all comes as a byproduct from the plant of the Cia. Minera de Peñoles S.A. (American Metal Co.) at Mapimí, Durango, and the American Smelting & Refining Co. smelter in San Luis Potosí, the latter furnishing by far the major portion. Most of this arsenic is exported, chiefly to the United States. About one half of the shipments to the United States are by water from Tampico; the remainder enters by rail, principally at Laredo but also at El Paso.

In 1932 the Mexican output receded to 3,947 metric tons, less than one third the average in 1927–29.

Sweden.—By the end of 1932 the smelting works and housing accommodations of the Bolidens Gruvaktiebolag at Rönnskär were virtually completed, with a view to coming into full production at the rate of 400,000 tons of ore a year in 1933. The shares of this company, formerly included in the ill-fated Kreuger financial network, are now held mainly by Riksgaelds-Konteret as guaranty for a loan. This great gold mine was discovered in 1925 by electrical prospecting methods (which date back to 1918), and smelting has been conducted on a steadily expanding scale since 1930. The ore is a mixture of arsenopyrite, chalcopyrite, and iron pyrite with minor amounts of other minerals containing gold, silver, lead, zinc, and antimony. The arsenic (As) content averages nearly 11 percent and has represented a problem of prime importance both from a metallurgical and an economic viewpoint.

At first the crude arsenic fume was mixed with cement [8] or placed in large concrete cylinders and sunk in deep water of the Gulf of Bothnia. This proved expensive, and a concrete storage structure 110 feet long and capable of holding 120,000 tons of crude arsenic was built. Since this huge warehouse is already more than half full the company is making strenuous efforts to create new uses so as eventually to dispose of its output without dislocating the market. Attention has been given to employing arsenic as a means of waterproofing cement. Potential markets for insecticides in the newly opened agricultural areas beyond the Caucasus, in Egypt, Ethiopia, and the Sudan are being investigated. Close at hand are extensive

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[7] Daugherty, W. T., German Exports of Arsenates: Bureau For. and Dom. Comm., World Trade Notes on Chemicals, etc., vol. 6, no. 50, Dec. 12, 1932, p. 2.

[8] Lindblad, A. R., Treatment of Arsenious Ore: U. S. Patent 1822103, Sept. 9, 1931. (Fume from roasting is rendered innocuous by mixing with cement and water and allowing mixture to harden before dumping.)

timber supplies and arsenic. Treated timbers and lumber may be exported for mine props in Great Britain and for other purposes.

The arsenic is almost completely removed from the ore in the preliminary roast; only 0.5 to 0.9 percent remains in the calcines. As no similar experience on a large scale was known, the methods for removal of such great quantities of arsenic from the roaster gases are of special interest. The practice is described by Palén [9] as follows:

> * * * The gases must first be cooled below the condensation point of arsenious oxide (218° C.). Later experience has shown that cooling must be carried below 150° C. to secure good efficiency in the Cottrell treaters. The first coolers were large chambers of sheet iron, equipped with air-cooled jackets to provide sufficient cooling surface. An experiment with water cooling did not prove successful. On the later coolers several improvements have been made, and the cooling problem may be considered satisfactorily solved. About one third of the arsenious oxide is recovered in the coolers, the rest being precipitated in the Cottrell treaters, which are of the plate type, of Lurgi construction.
>
> At present the arsenic precipitated in the coolers and Cottrell treaters is drawn into closed cars and dumped on a belt conveyor running in an underground tunnel to one of two elevators, which carry the powder to the top of the arsenic storage, where another belt conveyor discharges it through slots in the roof. Transportation from coolers and Cottrells to the belt conveyor, however, will soon be effected by screw conveyors instead of cars.

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[9] Palén, A. G. Paul, Smelting at Rönnskär, Sweden: Eng. and Min. Jour., vol. 133, no. 6, June 1932, pp. 339–342.

RADIUM, URANIUM, AND VANADIUM

By Frank L. Hess

The demand for radium, uranium, and vanadium, like that for most other substances, was small in 1932. During the year 61 short tons of carnotite-bearing ores were sold carrying 481 milligrams of radium and 3,755 pounds of uranium oxide, U_3O_8 (3,186 pounds of elemental uranium), also concentrates, both chemical and mechanical, carrying 231,461 pounds of vanadium pentoxide (109,092 pounds of elemental vanadium). The uranium ores were valued at $6,150, and the vanadium concentrates at $102,527.

No exports of uranium or radium are known to have been made, and records of vanadium concentrates, salts, or ferrovanadium were not kept separately. Imports are shown in the following tables.

Vanadium ore (steel-hardening) imported for consumption in the United States, 1928–32 [1]

Year	Pounds	Value
1928	1,104,320	$49,771
1929	19,519,360	794,734
1930	11,576,320	491,633

[1] No imports reported for 1931–32.

Uranium and radium salts imported for consumption in the United States, 1929–32

Class	1929		1930		1931		1932	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Uranium oxide and salts of pounds	272,913	$344,548	231,194	$306,566	180,049	$233,601	122,229	$146,051
Radium salts grams [1]	10.69	579,085	16.86	924,852	13.41	731,204	9.14	479,028
Radioactive substitutes	(2)	183	(2)	971	(2)	267	(2)	2,513
		923,816		1,232,389		965,072		627,592

[1] Bureau of Foreign and Domestic Commerce publishes quantities as follows: 1929, 165 grains; 1930, 260 grains; 1931, 207 grains; 1932, 141 grains.
[2] Weight not recorded.

The production of ferrovanadium in 1932 was 109 gross tons containing 89,624 pounds or an average of 36.73 percent of vanadium (metal). The shipments of ferrovanadium in 1932, amounting to 283 tons, contained 235,118 pounds of vanadium, and the average value per pound of contained vanadium was $2.99 f.o.b. furnaces compared with $3.13 in 1931.

Prices.—During 1932 prices were largely a matter of bargaining—entirely so as far as uranium ores were concerned. Vanadium ore was quoted by the Engineering and Mining Journal through the year at about 26 cents per pound for the V_2O_5 contained, f.o.b. shipping point, but this quotation was nominal.

Ferrovanadium was quoted at $3.05 to $3.30 per pound of contained vanadium, delivered, the price depending upon the quality. In December the quotations were $2.60 to $2.80. Fused vanadium oxide containing 86 to 92 percent V_2O_5 was nominally priced at 65 cents to $1.25 per pound of contained V_2O_5.

USES

Radium.—The uses of radium are few, but the value of radium for these uses is largely determined not in the ordinary terms of dollars and cents but in terms of human misery saved and human knowledge acquired. From such a viewpoint radium has been invaluable.

The principal use of radium is therapeutic. It has become a standard remedy for the removal of birthmarks, the cure of fibroid tumors, and the alleviation or cure of certain cancers. It has also been used successfully in certain cases of leukemia, tubercular glands of the neck, and other diseases.

In a hearing before a subcommittee of the Committee on Mines and Mining in 1930, Dr. Howard A. Kelly[1] said that if radium had no more value than as a palliative "it would be well worth all our efforts", and it has also been said that radium would be worth its whole cost as a cure for fibroid tumors.

The service that the discovery of radium has rendered science and through science the electrical industry (including the radio industry), by the new conceptions of the constitution of matter that it has given, cannot be valued in dollars but is very great.

Radium has been used recently in the examination of steel for flaws. Radium in a tube is placed on one side of the metal, and a photographic plate in a holder is held on the other side. After developing the plate, flaws in the metal will be shown by differences in exposure.

The use of radium for ionizing air, thus making it a conductor that prevents the accumulation of static charges of electricity in rolling or molding rubber, has been reported.

Uranium.—There are few if any practical uses for uranium as a metal. In the form of various salts it is used for coloring ceramic glazes. Large quantities are used to give a creamy tint to heavy glazed building tile for facing large structures, cornices, etc. A small quantity of salts is used in chemistry.

Vanadium.—Vanadium is used for making tough steels, but its use undoubtedly would increase much faster if the price could be lowered. As an illustration, it has been said that in the highly competitive manufacture of automobiles makers of one machine refused to use certain steel because the added cost was 11 cents per car.

In high-speed steels there is apparently a tendency to increase the vanadium content. One such steel contains tungsten, 17 percent; chromium, 4 percent; vanadium, 1.75 to 2.3 percent; carbon, 0.8 percent; remainder, iron.

[1] Manufacture of One Gram of Radium, Hearing before a Subcommitte of the Committee on Mines and Mining, House of Representatives, 71st Cong., 2d sess., on H.R. 4811, Feb. 11 and 25 and Mar. 4, 11, and 25, 1930, p. 54.

In adding vanadium to steel the practice is usually to introduce it in the form of ferrovanadium, but steel makers have added some vanadium to steel by adding vanadium oxide to the molten slag.

In the contact process of manufacturing sulphuric acid and in the making of certain organic chemicals the use of vanadium is apparently increasing.

THE DOMESTIC SITUATION

The largest American operator, the United States Vanadium Corporation, exhausted its roscoelite (vanadium mica) mine on East Rifle Creek 11 miles north and a little east of Rifle, Colo., and closed both the mine and the reduction plant at Rifle about July 1, 1932. The ore deposit had been measured so carefully that the approximate date of stopping operations had been known for a considerable time. The company owns many of the claims formerly held by the Standard Chemical Co. in and near Long Park, Montrose County, and by the Radium Co. of Colorado near Gateway, Mesa County, but no mining was done on them during 1932. The claims of the Vanadium Corporation of America at Long Park also remained idle. All of these claims carry carnotite (hydrous potassium uranium vanadate, $K_2O.2UO_3.$-$V_2O_5 3.H_2O$), roscoelite, and a group of less-common vanadium minerals, and it seems probable that when they are worked it will be desirable to save radium as a byproduct. During the year only one company mined ore for the isolation of radium. The Shattuck Chemical Co. of Denver mined ore from claims along Dolores River in the McIntyre district (Colo.) for radium and uranium and for vanadium. Some radium was made in the form of high-grade bromide and some in the form of low-grade chloride. The work was largely experimental in an endeavor to save all three products—radium, uranium, and vanadium.

The following shipped small quantities of carnotite ore in 1932: Sullivan Bros. at Nucla, Colo.; H. W. Balsley (Yellow Circle Mining Co.), Moab, Utah, with deposits on the southwest side of La Sal Mountains, about 16 miles east of Moab; Shumway Bros., Blanding, Utah; and R. E. Adams, 331 Pitkin Avenue, Grand Junction, Colo.

Shumway Bros. claims in the Blue (Abajo) Mountains were discovered during the year, surprisingly late after so many years of prospecting in the general area.

About the close of the year the property of the International Vanadium Corporation on the south side of Dry Valley 55 miles southeast of Moab, Utah, was acquired by the Molybdenum Corporation of America, and a quantity of fused vanadium oxide made in 1931 was taken over. The ore on these claims is of lower grade than the roscoelite deposits exhausted on East Rifle Creek and carry some carnotite, of which rich pockets are found here and there.

The Garfield Vanadium Co. did some development work on its roscoelite property on the west side of East Rifle Creek opposite the United States Vanadium Corporation property. The United Vanadium Corporation reported the mining and concentration of a considerable tonnage of low-grade vanadinite-bearing rock at Dripping Springs northwest of Christmas, Ariz.

The Kingman Refining & Smelting Corporation mined and concentrated some higher-grade ore at Good Springs, near Kingman, Ariz.

No vanadinite is known to have been sold during the year.

FOREIGN COUNTRIES

Canada.—Although not yet a formidable competitor of the Belgian company, Union Minière du Haut Katanga, the pitchblende deposits discovered early in 1930 by Gilbert LaBine of the Eldorado Gold Mines, Ltd., on the east side of Great Bear Lake, Mackenzie district, Northwest Territories, Canada, have such a dramatic appeal that they attracted considerable attention.

The Arctic Circle crosses the lake a short distance north of the deposits. The country has been heavily glaciated and is exceedingly inhospitable, but it has the lure of potential wealth reached with great difficulty.

The area is reached from Edmonton by a train that runs to Waterways (285 miles), and the trip requires about a day. Thence an airplane trip of 850 miles lands one at LaBine Point or other places in the vicinity in another day.

The climate is severe. Airplanes fitted with skis can make the trip during about 3 winter months. Darkness at Great Bear Lake makes landing bad during part of the winter. Ordinarily, the ice breaks up on the bays about the last of June, but the lake is not free of ice until the second half of July. Freezing begins after August 15.

In 1931 the Canadian Government dispatched topographers, a geologist, and a representative from the Mines Branch to the area, and all have issued valuable reports. The Mines Branch investigated the isolation of radium from the ores and made flotation tests for removing the sulphides but did not find the process very satisfactory. Analyses of two samples gave:

Part analyses of pitchblende ore from LaBine Point, Great Bear Lake, Mackenzie district, Canada

	A	B		A	B
U_3O_8 .... percent..	56.91	63.94	Bi .... percent..	0.18	Trace
Th .... do....	Nil	Nil	As .... do....	.15	.14
V_2O_5 .... do....	Trace	Nil	Fe .... do....	1.01	.77
Cu .... do....	.70	.66	S .... do....	2.08	.90
Ni .... do....	Trace	Trace	Ag ...... ounces per ton..	1.41	1.72
Co .... do....	.13	.10	Au .... do....	.19	Trace
PbO .... do....	12.00	12.13			

An analysis by J. P. Marble[2] of carefully selected material from the deposit of the Eldorado Gold Mines, Ltd., gave the following data: Average results of five analyses, percent: Lead, 10.48; uranium, 52.06; thorium, none; approximate age, 1,375,000,000 years.

The age is therefore pre-Cambrian. These data are valuable in that they show the age of mineralization which otherwise could not be determined even approximately owing to the absence of fossils, and it places it at a definite time in the pre-Cambrian.

The following papers deal with the Great Bear Lake pitchblende area:

Broadfoot, W. C. Possibilities of Natural Radiations from the Great Bear Lake Pitchblende Deposits on Gene Mutations. Sci., vol. 75, 1932, pp. 334–335.

Campbell, E. E. Facts vs. Fiction about Great Bear Lake. Eng. and Min. Jour., vol. 132, 1932, p. 500.

Cooper, Courtney R. The Trail of '32. Saturday Evening Post, Nov. 12, 1932, pp. 8, 9, 47–49. A popular account of the country.

[2] Marble, J. P., Paper delivered before the Geological Society of Washington, 1933 (unpublished).

DAY, MAJOR BERNHARD. Prospecting and Mining for Gold, Silver, and Radium at Great Bear Lake, Northwest Territories, Canada. Inst. Min. and Met., Bull. 339, London, 1932, pp. 33–45.

KIDD, D. F. A Pitchblende-Silver Deposit, Great Bear Lake, Canada. Econ. Geol., vol. 27, 1932, pp. 145–159; Great Bear Lake Developments, 1932. Geol. Surv. Canada, multigraphed, 1932, 12 pp.

McDONALD, RODERICK C. Surveys at Great Bear Lake, 1931. Canadian Min. and Met. Soc. Bull. 240, Apr., 1932, pp. 209–223.

REID, J. A. The Minerals of Great Bear Lake. Note on the Geology and Mineralization of the Echo Bay Region, Great Bear Lake. Canadian Min. Jour., vol. 53, 1932, pp. 61–66.

SPENCE, H. S. Great Bear Lake Finds Look Good to Government Expert: Northern Miner, vol. 17, 1931, pp. 1 and 3; Radium and Silver at Great Bear Lake. Min. and Met., vol. 13, 1932, pp. 147–151; Radium-Bearing Minerals from Great Bear Lake, Northwest Territories. Canadian Mines Branch Mem., ser. 48, 1931, 4 pp.; Occurrences of Pitchblende and Silver Ores at Great Bear Lake, Northwest Territories. Canadian Mines Branch Mem., ser. 51, 1931, 6 pp.; Character of the Pitchblende Ore from Great Bear Lake, Northwest Territories. Canadian Min. Jour., vol. 53, 1932, pp. 483–487.

THOMSON, ELLIS. Mineralogy of the Eldorado Mine, Great Bear Lake, Northwest Territories. Contributions to Can. Mineralogy, 1932. Dept. of Min. and Pet., Univ. of Toronto, pp. 43–50.

By the summer of 1932 more than 2,000 claims had been staked and filed. According to Kidd 35 tons of pitchblende were shipped in 1932 and 20 tons in 1931. Both lots were awaiting treatment. Ten tons of rich silver ore were also shipped by the Eldorado Gold Mines, Ltd. The geology of the district was studied by Kidd.[3]

Concerning the pitchblende deposits, Kidd says: [4]

> 1. Eldorado deposit, LaBine Point. This is the original discovery and has received most development to date and the most study. The pitchblende has been found in three shear and shatter zones cutting altered sedimentary and volcanic rocks near their contact with intrusive granite. The zones trend east-northeast and are several hundred feet apart. In the middle one pitchblende and native silver have been found at intervals for 1,400 feet from the lake shore back to a small pond. In the northernmost zone pitchblende only has been found. It has been mined from two lenses 350 feet apart. Two lenses of pitchblende have been found in the northernmost zone, but no mining has been done. The mineralization, particularly in the middle zone, is highly complex, some 27 metallic minerals, exclusive of surface alteration products, having been found so far. Preliminary studies indicate that pitchblende is one of the earliest formed minerals of the deposit and that the silver is fairly late in the mineral sequence.
>
> During 1932, surface mining was done, and between April and August 35 tons of pitchblende ore and 10 tons of silver ore were obtained from open pits. This was shipped out by boat. Little more exploration was done except in the autumn of 1931 when at a point approximately 3,800 feet from the easternmost discoveries, in the edge of a pronounced gully, silver mineralization was reported to have been found over a width of 22 feet with values from 30 to 150 ounces of silver.
>
> In the latter part of August a mining plant arrived by boat, and a crosscut tunnel has been commenced to intersect the north end of the middle zone at a depth of 80 feet.
>
> 2. Bear Exploration and Radium, Ltd. This company is developing the discovery made by N.A.M.E. in 1931 at Contact Lake.
>
> A zone of fracturing and some shearing, striking northeast with a steep dip and 1½ to 3 feet wide, cuts massive diorite. At one point in it a lense of pitchblende, possibly containing several tons, is present together with native silver which at one place is visible as scattered wires across a width of 1 foot. In a pit further along the zone more silver is present, in spots abundantly, and at this place an adit has been started along the zone into the base of a hill.

It is remarkable that only the two discoveries of pitchblende have been made.

[3] Kidd, D. F., Great Bear Lake Developments, 1932: Geol. Surv. Canada, multigraphed, 1932, pp. 2–3.
[4] Work cited, pp. 5–6.

During the year the Eldorado Gold Mines, Ltd., erected a plant for the isolation of radium at Port Hope, Ontario. It is estimated that 1 gram of radium will be produced from each 10 tons of ore.

R. J. Traill and W. R. McClelland, of the Mines Branch at Ottawa, devised a system for the extraction of radium from the ore, but to what extent the system is used in the new plant is unknown. No radium had been produced by the end of the year.

News items stated that the Canada Radium Mines, Ltd.,[5] and International Radium and Resources, Ltd.,[6] made preparations to concentrate uraninite from pegmatite at Wilberforce, Haliburton Township, Ontario.

Another news item[7] states that the University of Toronto had installed apparatus for the gathering and sale of radium emanation (radon).

The discovery of carnotite on Quadra Island was reported, and the announcement was made that it would be exploited.[8] More information is desirable.

Belgian Congo.—The Belgian Congo has dominated radium production and marketing since 1923 and still holds the leading position. Throughout these years it has owned the largest and richest uranium deposits in the world and has had the Belgian Government as a partner in the enterprise,[9] giving it all possible advantages as to Government contacts.

The principal uranium workings are at Chinkolobwe, but apparently there are a number of smaller deposits.

The company radium plant at Oolen, Belgium, began work in 1922 and turned out its first radium (2.7 grams) in December of that year. Sales began in 1933 when 20 grams were marketed, and by the end of 1931, 315 grams had been sold. Besides the sales various quantities had been loaned or given to Government agencies or institutions and the output by the end of 1932 probably had exceeded 400 grams.

Kenya.—Pitchblende is reported to have been found in the Loldaiga Hills 30 miles from Nanyuki,[10] but no details are at hand.

Czechoslovakia.—The first radium isolated—that extracted by the Curies in 1898—was produced from pitchblende mined at St. Joachimsthal, Austria, known since the Great War as Jachymov in the newly formed country of Czechoslovakia. The making of uranium pigments and other salts had been carried on there for many years, and the production of radium was begun by the Austrian Government in 1906; the first recorded production—0.7217 gram—was made in 1909. The production to 1930,[11] had been 39.039 grams. In 1932 the production of elemental radium contained in salts was about 4 grams, and 3.750 grams (in 8.650 grams of salts) had been produced in 1931,[12] so that a total of about 46.789 grams (approximately 1⅔ avoirdupois ounces) had been produced to the end of 1932. In 1932 1.876 grams and in 1931 0.797 gram were sold. In 1931, 15 grams of radium had been retained by the Ministry of Public Works and 7.4337 grams by physical laboratories, the Ministry of Health, and various state, university, and municipal hospitals—a total of

[5] Engineering and Mining Journal, vol. 133, 1932, p. 303.
[6] Toronto Mail and Empire, Mar. 19, 1932, p. 19.
[7] Mining Review, Salt Lake City, vol. 34, 1932, p. 8.
[8] Mining Truth (Spokane), Nov. 15, 1932, p. 9; Dec. 15, p. 4.
[9] Cullen, William, The Northern Rhodesina Copper Fields: Min. Mag., vol. 48, 1933, p. 211.
[10] Mining Journal (London), vol. 179, 1932, p. 826.
[11] Bailey, John W., Jr., Report of American Consul General: Prague, Aug. 28, 1931.
[12] Bliss, Don C., commercial attaché, Prague: Econ. and Trade Notes No. 204, Mar. 9, 1933.

22.4337 grams. As only 2.673 grams were exported of the 7.750 grams produced in 1931 and 1932 the quantity now in the country is apparently more than 27 grams.

In 1931 the ore required for the 3.750 grams of radium produced was 232 metric tons,[13] which apparently was hand-picked to 28.65 metric tons. If similar ore was produced in 1932 about 248 tons would have been required. In 1930, 20.267 metric tons and in 1931, 19.063 metric tons of uranium pigments were made. Export sales are said to be made through a sales office at Frankfurt am Main, Germany "jointly with the Belgian products, on a quota scheme. The Belgian production contingent for ore is twice the amount of the Czechoslovak quota." [14]

Australia.—Efforts are still being made to work the uncertain radium deposits on Mount Painter in the desert of South Australia. The Australian Radium Products, Ltd., was to take over the assets of the older Australian Radium Corporation, N.L.

Six tons of concentrates were made and sent to a reduction plant at Dry Creek, and "70 milligrams of radium salt" have been extracted and sold.[15] The concentrates are said to carry 8 percent U_3O_8.

Before the end of the year another reorganization was proposed after which the company was to be called Radium Products, Ltd., with a capital of £300,000 and to which the leases on the Mount Painter property were to be sold for £110,000 in paid-up shares.

The uranium minerals are autunite and torbernite. Little is known of the unoxidized minerals.

Germany.—A report from Consul Sydney B. Redecker, Frankfurt am Main, dated March 29, 1933, gives the following information:

> Germany has a small output of radium salts, which is secured entirely from radioactive mineral springs rather than ore deposits.
>
> The entire German output of radium from springs is furnished by the mineral springs at Kreuznach, in southwestern Germany, well known for their curative waters. These springs yield a deposit of silt or mud, and it is from this deposit that the radium salts are secured. On an average of around 20 tons of silt, or radio-barium, accumulate each year, and this deposit yields around 1.75 milligrams of radium per ton and in addition certain quantities of thorium and actinium.
>
> Inasmuch as the deposits must in any case be removed from the curative waters, no special costs are involved in procuring them so far as radium recovery is concerned. It is profitable, therefore, despite the low yield, to work the deposits for the securing of radium salts and radium preparations. It is stated that other radioactive substances are not removed since they enhance the value of the medicinal preparation.
>
> A second mineral spring containing radioactive substances is known to exist at Baden-Baden, the "Kloster" Spring, but the exploitation of radium has not been found profitable in the case of these springs due to their restricted flow and insufficient deposits of the radium-containing mud.

Russia.—It was announced that the "Moscow rare-metals plant has succeeded in producing radium on a factory scale" and that "the Commissariat for Heavy Industry has passed a resolution providing for further scientific research work in the field of rare metals." [16]

The ore is tyuyamunite ($CaO.2UO_3.V_2O_5+H_2O$)-bearing material from Tyuya Muyun Mountain, Fergana, Russian Turkestan.

[13] 1 metric ton equals 2,204.6 pounds or 1.1023 short tons.
[14] Don C. Bliss, commercial attaché, Prague, Quotation from "Narodin Listy", Mar. 7, 1933.
[15] Winton, L. J., The Mount Painter Radium Field: South Australian Min. Rev., half year ended June 30, 1932, pp. 58–59.
[16] Economic Review of the Soviet Union, Mar. 1, 1932, p. 115.

It is also said [17] that 5 tons of vanadium were produced in November at a plant in Kertch, Crimea by a process worked out by the Institute of Applied Mineralogy. The vanadium is extracted from titaniferous magnetite used in blast furnaces. The deposits in the Urals and in the Kuznetzk Basin are said to be very large. Titanium also is extracted from the ores.

Nothing is known of the production of vanadium from the tyuyamunite ores of Fergana.

Northern Rhodesia.—At Broken Hill, Northern Rhodesia, the Rhodesia Broken Hill Development Co., Ltd., late in 1930, completed a plant with a capacity of 50 tons per month for the production of fused vanadium oxide. The ore mineral used is mostly descloizite, but there is also some vanadinite; these minerals are found in the oxidized parts of the great lead-zinc deposits. Large stock piles of high-grade vanadium ore had been accumulated before the vanadium plant started operation. Operation began in January 1931 [18] with an output of 10 long tons of fused oxide for the month. In July the output had increased to 25 long tons (28 short tons) per month [19] and by January 1932 to 51 short tons of fused vanadium oxide carrying 90 percent V_2O_5.[20] A monthly output of 100 tons of concentrates carrying 16 percent V_2O_5 was reached in the second half of the year.

The fused vanadium oxide and vanadium concentrates are sold in Germany and France and have furnished sufficient profit to carry the expense (£6,000 per month) of caring for the entire lead and zinc plant and to leave a small surplus.[21]

The output for the year 1932 [22] was 676,806 pounds of contained vanadium in fused vanadium oxide carrying 90 percent V_2O_5 (about 671 short tons of fused oxide), nominally valued at 13s. ($2.28) a pound. In 1931, the output was 335,971 pounds of vanadium contained in 333 tons of fused oxide valued at £226,000.

Southwest Africa.—No data are at hand on the production of vanadium in Southwest Africa during 1932. In 1931 the production of concentrates amounted to 4,602 long tons (5,154 short tons) containing 17 percent vanadium pentoxide (V_2O_5). Exports of vanadium concentrates were 3,940 long tons in 1931 and 3,835 long tons in 1930.

Peru.—No shipments of vanadium ores are known to have been made from Peru either in 1931 or 1932.

RADIUM MEDICAMENTS

Almost since the discovery of radium efforts have been made to use it in the treatment of disease, and many radium-bearing substances have been placed on the market for the treatment of bodily ills, for use as cosmetics, and particularly for use in drinking water.

During 1932 considerable public attention was attracted by a newspaper account of a wealthy man who died from drinking water into which a radioactive element had been introduced, and the tragedy focused attention on the fact that comparatively little is known either of the value or the danger of such preparations.

[17] Economic Review of the Soviet Union, New Products of Soviet Metallurgy: Vol. 7, December 1932, p. 419.
[18] Mining Magazine (London), vol. 45, 1931, p. 128.
[19] Engineering and Mining Journal, vol. 132, 1931, p. 136.
[20] Rhodesian Mining Journal (Johannesburg), vol. 6, 1932, p. 159.
[21] Mining Journal (London), vol. 174, 1931, p. 606.
[22] Rhodesian Mining Journal, vol. 7, 1933, p. 113.

Schlundt, Fulton, and Bruner[23] published the results of a study of three radium-water generators from which they concluded that the risk was "rather remote." No statement was made of any possible benefit to be derived from the use of radioactive water.

No experiments on the quantity of radium that might be beneficial or harmful are known to have been made on large animals, but Dr. Schlundt is now experimenting with white rats.

During 1932 prosecutions initiated by the Federal Trade Commission against makers of allegedly radioactive medicaments caused 2 or 3 companies to go out of business, and 2 cases were pending.

Dr. R. R. Sayers, former chief surgeon of the Bureau of Mines, canvassed the hospitals and physicians of the United States to learn how much radium was in use and how much more was thought to be needed.[24] He found "710 individuals, companies, and hospitals, owning 124.7 grams of radium, estimate that they need 117.4 grams more. From the reports it is estimated that approximately 80,000 patients are treated annually with radium."

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[23] Schlundt, Herman, Fulton, Ralph G., and Bruner, Frank, Radium-water Generators: Jour. Chem. Education, vol. 10, 1933, pp. 185–187.

[24] Sayers, R. R., Radium in Medical Use in the United States: Information Circ. 6667, Bureau of Mines, October 1932, 6 pp.

PLATINUM AND ALLIED METALS

By C. W. Davis and H. W. Davis

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 is almost negligible in the world supply, averaging about 500 ounces for the past 10 years. Much larger quantities of platinum metals are obtained in the United States as byproducts of gold and other metals (about 7,200 ounces annually during the past 10 years), 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, furnishing about 50,000 ounces annually for the past 10 years. The bulk of this output is from crude platinum imported from foreign sources, notably Colombia.

Salient statistics of platinum and allied metals in the United States, 1931–32, in troy ounces

	1931	1932
Production:		
Crude platinum from placers	885	1,074
New metals:		
Platinum	[1] 31,274	[1] 14,666
Palladium	2,742	1,252
Other	2,189	1,698
	36,205	17,616
Secondary metals:		
Platinum	33,837	21,635
Palladium	6,331	5,783
Other	3,566	5,170
	43,734	32,588
Stocks in hands of refiners, Dec. 31:		
Platinum	51,231	37,976
Palladium	17,553	19,707
Other	19,701	18,228
	88,485	75,911
Imports for consumption:		
Platinum	91,728	33,218
Palladium	28,070	15,445
Other	9,834	7,384
	129,632	56,047
Exports:		
Unmanufactured	1,209	20,106
Manufactures (except jewelry)	1,190	2,032

[1] In 1931 includes 5,595 ounces of new platinum from domestic sources comprising 198 ounces derived from crude placer platinum and 5,397 ounces obtained from domestic gold and copper ores as a byproduct of refining; in 1932 includes 1,912 ounces of new platinum from domestic sources comprising 218 ounces derived from crude placer platinum and 1,694 ounces obtained from domestic gold and copper ores as a byproduct of refining.

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. Canada can furnish 60,000 to 70,000 troy ounces of platinum, Colombia 40,000 ounces, Russia 100,000 ounces, South Africa 30,000 to 40,000 ounces, and the rest of the world 5,000 ounces. Canada also can produce about 60,000 troy ounces of palladium annually and the remainder of the world about 10,000 ounces.

CRUDE PLATINUM

Production.—Mine returns for 1932 indicate a production of 720 troy ounces of crude platinum in Alaska, 280 ounces in California, and 74 ounces in Oregon—a total of 1,074 ounces (885 ounces in 1931). The greater part of the production in Alaska was from placers in the Goodnews Bay district south of the mouth of the Kuskokwim River, but a small quantity was recovered in placer gold mining on Dime Creek, Seward Peninsula. In California most of the platinum produced was a byproduct of dredges working the gold placers in Merced, Sacramento, and Stanislaus Counties. The production in Oregon was chiefly from 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 1932, 1,694 ounces of platinum were recovered as a byproduct of refining gold and copper ores compared with 5,397 ounces in 1931.

Purchases.—Platinum refiners in the United States reported purchases of domestic crude platinum from the following sources in 1932: Alaska, 33 ounces; California, 327 ounces; Oregon, 116 ounces; and unspecified, 5 ounces—a total of 481 ounces (446 ounces in 1931). Refiners in the United States also reported purchases of 19,043 ounces (34,933 ounces in 1931) of foreign crude platinum in 1932—250 ounces from Australia, 11 ounces from Canada, 14,767 ounces from Colombia, 9 ounces from the Philippine Islands, and 4,006 ounces from South Africa.

Markets and prices.—The returns received from the sale of crude platinum are disappointing to the miner who is not aware 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 subject to treatment costs.

Sellers of domestic crude platinum reported that they were paid for metal content based on assay. Buyers reported purchases at $16 to $30 an ounce for domestic and $17 to $38 an ounce for foreign crude platinum. A list of buyers of foreign and domestic crude platinum in the United States who reported purchases in 1932 follows:

American Platinum Works, 225 New Jersey Railroad Avenue, Newark, N.J.
Baker & Co., Inc., 54 Austin Street, Newark, N.J.
J. Bishop & Co. Platinum Works, Malvern, Pa.
Thomas J. Dee & Co., 1010 Mallers Building, Chicago, Ill.
Goldsmith Bros. Smelting & Refining Co., 1300 West Fifty-ninth Street, Chicago, Ill.
S. B. Gracier & Sons, 212 Stockton Street, San Francisco, Calif.
Kastenhuber & Lehrfeld, 24 John Street, New York, N.Y.
Montana Assay Office, 140½ Second Street, Portland, Oreg.
Pacific Platinum Works, Inc., 814 South Spring Street, Los Angeles, Calif.
Western Gold & Platinum Works, 589 Bryant Street, San Francisco, Calif.
Wildberg Bros. Smelting & Refining Co., 742 Market Street, San Francisco, Calif.
H. A. Wilson Co., 97 Chestnut Street, Newark, N.J.

REFINED PLATINUM METALS

New metals recovered.—Reports from refiners of crude platinum, gold bullion, and copper indicate that 17,616 ounces of platinum metals were recovered in the United States from these sources in 1932, a decrease of 51 percent compared with 1931. It is estimated that 3,192 ounces of the total in 1932 were derived from domestic sources.

New platinum metals recovered by refiners in the United States, 1931–32, by sources, in troy ounces

	Platinum	Palladium	Iridium	Osmiridium	Others	Total
1931						
Domestic:						
Crude platinum	198	2	29	35	3	267
Gold and copper refining	5,397	2,595	49		85	8,126
	5,595	2,597	78	35	88	8,393
Foreign:						
Crude platinum	25,671	145	1,654	237	6	27,713
Ore	8				91	99
	25,679	145	1,654	237	97	27,812
Total recovery	31,274	2,742	1,732	272	185	36,205
1932						
Domestic:						
Crude platinum	218	1	76	45	8	348
Gold and copper refining	1,694	1,147	2	1		2,844
	1,912	1,148	78	46	8	3,192
Foreign: Crude platinum	12,754	104	1,284	282		14,424
Total recovery	14,666	1,252	1,362	328	8	17,616

New platinum metals recovered by refiners in the United States, 1928–32, in troy ounces

Year	Platinum	Palladium	Iridium	Osmiridium	Others	Total
1928	51,427	5,148	1,658	458	348	59,039
1929	41,760	5,295	302	364	256	47,977
1930	37,780	3,801	1,468	334	119	43,502
1931	31,274	2,742	1,732	272	185	36,205
1932	14,666	1,252	1,362	328	8	17,616

Secondary metals recovered.—Secondary platinum metals are those recovered from the treatment of scrap metal, sweeps, and other waste products of manufacture that contain platinum. Secondary platinum metals recovered in 1932 were 32,588 ounces, a decrease of 25 percent from 1931.

Secondary platinum metals recovered in the United States, 1928–32, in troy ounces

Year	Platinum	Palladium	Iridium	Others	Total
1928	47,157	4,156	2,090	2,428	55,831
1929	33,638	5,120	2,057	1,944	42,759
1930	33,787	7,426	4,354	1,749	47,316
1931	33,837	6,331	1,823	1,743	43,734
1932	21,635	5,783	3,726	1,444	32,588

Prices.—Refiners reported the following prices for platinum: High \$42.50, low \$20, and average for the year \$32 an ounce, compared with \$45, \$16.50, and \$32 an ounce, respectively, for 1931. They gave the following prices for palladium: High, \$40, low \$14.50, and average for the year \$18 an ounce, compared with \$24, \$14, and \$18 an ounce, respectively, for 1931.

Figure 13 shows the average monthly official prices quoted for the platinum metals from January 1931 to April 1933. The effect of the world platinum accord is evidenced by the horizontal part of the platinum curve from July 1931 to April 1932.

A notable development in the market situation was the failure of Consolidated Platinums, Ltd., which had maintained the price of platinum at relatively high levels for over a year. The view is expressed on the Continent that, as a result of this, the Russians may embark on a vigorous selling policy based on lower prices in an

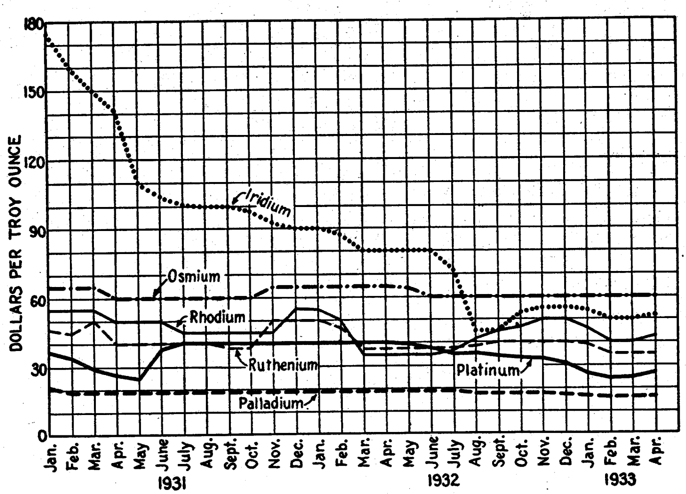

FIGURE 13.—Average price per troy ounce of platinum and allied metals at New York, January 1931 to April 1933.

endeavor to liquidate their large stocks of platinum held in banks in Germany.[1]

Consumption.—In the absence of more detailed figures it is impossible to make a thoroughly satisfactory report on the world consumption of platinum metals. The following estimates have been prepared after a careful study of all available information and after consulting with E. M. Wise and W. C. Kerrigan of the International Nickel Co., Inc., and members of Baker & Co., Inc.

The approximate average world consumption of platinum annually by important consumers is: United States 100,000 troy ounces, France 25,000 ounces, Germany 25,000 to 30,000 ounces, Great Britain 25,000 ounces, Japan 15,000 ounces, and the remainder of the world 5,000 to 6,000 ounces—a total of 195,000 to 201,000 ounces.

The following table shows the sales of platinum metals to consumers by refiners in the United States in 1931 and 1932. The figures include the sales by refiners in the United States of platinum metals recovered from crude platinum, from gold bullion, from copper and nickel

[1] Metal Bulletin no. 1766, Feb. 10, 1933, p. 16.

bullion and matte, from electrolytic muds, and from scrap materials and sweeps; in addition, they include the sales of considerable quantities of imported platinum metals which are handled by refiners in the United States.

The jewelry industry not only maintained its place as the leading user of platinum metals but accounted for a larger proportion of the total than in any year since 1928. According to Engelhard,[2]

With lower prices for platinum and a desire on the part of retail jewelers to carry better-quality merchandise, certain platinum articles had a wider distribution and sale. This was particularly true of wedding rings. Manufacturers of ring blanks made greater efforts to merchandise platinum rings and settings for the remounting of old jewelry, and they found a pleasingly responsive attitude. Better demand for articles for men, such as platinum collar pins, cuff links, pencils, and knives, also was reported by jewelers.

The dental profession purchased 10 percent more platinum metals in 1932 than in 1931, and displaced the electrical industry as the second largest consumer in 1932. Recognition of the fact that dental alloys of high palladium content are less conspicuous than gold has led to the development and marketing of such alloys by several of the leading manufacturers of dental supplies. The sales of palladium to the dental industry increased from 9,394 ounces in 1931 to 12,900 ounces in 1932.

Sales of platinum metals by domestic refiners to both the chemical and electrical industries slumped drastically in 1932.

Platinum metals sold by refiners in the United States, 1931–32, by consuming industries, in troy ounces

Industry	Platinum	Palladium	Iridium	Others	Total	Percentage of total
1931						
Chemical	11,483	979	18	64	12,544	11
Electrical	8,215	22,628	609	17	31,469	26
Dental	10,135	9,394	74	13	19,616	17
Jewelry	41,261	2,988	2,185	264	46,698	39
Miscellaneous	5,896	1,934	373	667	8,870	7
	76,990	37,923	3,259	1,025	119,197	100
1932						
Chemical	5,157	495	52	218	5,922	7
Electrical	3,456	6,309	431	23	10,219	12
Dental	8,683	12,900	73	9	21,665	26
Jewelry	33,376	5,817	1,719	314	41,226	50
Miscellaneous	3,896	204	274	27	4,401	5
	54,568	25,725	2,549	591	83,433	100

Stocks.—Stocks of platinum metals in the hands of refiners on December 31, 1932, amounted to 75,911 ounces, a decrease of 14 percent from 1931.

Stocks of platinum metals in the hands of refiners in the United States, Dec. 31, 1928–32, in troy ounces

Year	Platinum	Palladium	Iridium	Others	Total
1928	45,710	23,018	4,523	5,019	78,270
1929	51,853	20,154	4,716	5,461	82,184
1930	52,853	18,978	8,828	8,006	88,665
1931	51,231	17,553	10,193	9,508	88,485
1932	37,976	19,707	10,307	7,921	75,911

[2] Engelhard, Charles, Platinum in 1932: Metal and Mineral Markets, vol. 4, Feb. 23, 1933, p. 5.

Technology and uses.—Comprehensive articles on the refining of platinum and allied metals and on the recovery of these elements from waste material have appeared, but no significant advances were made in these fields during 1932. However, several investigations of interest with reference to platinum metals were conducted. Catalytic action in solutions, the streak of commercial alloys, and the characteristic appearance and structure of assay beads were proposed as criteria for the detection of platinum-group metals, and X-ray as well as new chemical methods were developed for their quantitative determination.

Studies of the physical properties of platinum metals and their alloys were conducted during the past year, and advances were made in their production and fabrication. Methods for the preparation of palladium leaf have been developed both in this country and abroad so that for the first time a nontarnishing, silver-colored leaf is available. The product, comparable to gold leaf in uses and methods of application, is expected to find a ready outlet in the decorative arts, as for example in decorating leather to produce "palladium slippers," in coating the edges of playing cards and books, and in making display signs. Platinum-clad nickel has been produced to take the place of gold-filled articles for fabricated products such as dresser sets, after-dinner coffee services, trophies, medals, and watchcases. A small quantity of palladium-clad molybdenum has been produced for special purposes. A detailed investigation of dental alloys showed that the presence of platinum and palladium was not only beneficial in the preparation of alloys with desirable physical properties but also economical, especially when palladium replaced a considerable quantity of gold. Alloys whitened by palladium to make them less conspicuous in the mouth have already been prepared and sold by several makers of dental alloys. Patents were granted in the past year for alloys containing platinum-group metals which were claimed to be suitable for dental work, for electrical contacts, and for catalysts.

Much attention has been given to reviving old and developing new ways of utilizing the metals of the platinum group. The low price of platinum and its alloys has helped it to compete with other catalysts and with other more or less satisfactory substitutes. The resistance of platinum alloys to chemical and mechanical action has led to their use for chemical-plant equipment when usual corrosion-resistant base-metal alloys have proved inadequate and for coating refractories used in the melting or extrusion of glass to increase their life. The superiority of rhodium to platinum alloys as resistance units of electric furnaces designed for high-temperature use was demonstrated.

New baths have been developed for the electrodeposition of heavy coats of platinum and palladium, and improvements have been made in rhodium electroplating baths that previously had been considered satisfactory. The perfected rhodium-plating process, due to the pleasing, uniform, nontarnishing coat produced, has virtually supplanted electroplating with chromium or other base metal in the finishing of white gold or silver jewelry, and the high reflecting power of rhodium for light has led to its use for coating reflectors of army searchlights and other lighting equipment.

FOREIGN TRADE

Imports.—The following tables show the imports into the United States of platinum metals. The imports decreased from 129,632 ounces in 1931 to 56,047 ounces in 1932. Colombia continued to be the chief source of crude platinum imported into this country.

Platinum metals imported for consumption in the United States, 1931–32, by metals

Metal	1931		1932	
	Troy ounces	Value	Troy ounces	Value
Platinum:				
Ores of platinum metals (platinum content)	1,097	$27,466	160	$4,782
Grains, nuggets, sponge, or scrap	67,078	1,905,062	25,440	722,353
Ingots, bars, sheets or plates, not less than ⅛-inch thick	23,553	657,413	7,618	237,086
	91,728	2,589,941	33,218	964,221
Manufactures of, not jewelry				15
Iridium	1,773	195,961	1,397	69,359
Osmiridium	4,877	225,485	5,195	188,634
Osmium	960	49,474	131	4,815
Palladium	28,070	389,880	15,445	167,804
Rhodium	1,629	61,402	436	16,537
Ruthenium	595	18,928	225	5,652
	129,632	3,531,071	56,047	1,417,037

Platinum metals (unmanufactured) imported into the United States in 1932, by countries, in troy ounces

[General imports]

Country	Platinum			Iridium	Osmium and osmiridium	Palladium	Rhodium and ruthenium	Total
	Ores of platinum metals (platinum content)	Grains, nuggets, sponge, or scrap	Ingots, bars, sheets or plates, not less than ⅛-inch thick					
Argentina		34				2		36
Australia					50			50
Canada		59	10					69
Colombia	160	16,220						16,380
Germany		2	(1)	610			150	762
Japan		104	1,998		12			2,114
Netherlands						31		31
Soviet Russia in Europe			76	100			50	226
United Kingdom		9,021	5,534	687	5,264	15,412	461	36,379
	160	25,440	7,618	1,397	5,326	15,445	661	56,047

1 Less than 1 ounce.

Platinum metals imported for consumption in the United States, 1928–32

Year	Troy ounces	Value	Year	Troy ounces	Value
1928	135,233	$9,357,737	1931	129,632	$3,531,071
1929	155,075	9,119,479	1932	56,047	1,417,037
1930	139,246	5,836,492			

Exports.—The export trade in platinum increased notably in 1932; unmanufactured products increased from 1,209 ounces in 1931 to 20,106 ounces in 1932, and platinum manufactures increased from 1,190 ounces in 1931 to 2,032 ounces in 1932. Germany, United Kingdom, Japan, and France were the chief purchasers of unmanufactured platinum, and the United Kingdom was the main purchaser of manufactured platinum.

Platinum exported from the United States in 1932, by countries

Country	Unmanufactured (ingots, sheets, wire, alloys, and scrap)		Manufactures of, except jewelry	
	Troy ounces	Value	Troy ounces	Value
Argentina	1,959	$61,896		
Australia	1	85	2	$224
Brazil	181	8,041	1	77
Canada	144	5,889	79	5,707
Chile			1	225
China			6	392
Costa Rica			1	47
Cuba	1	38		
France	3,912	131,917		
Germany	4,856	165,982	165	5,804
Italy			1	125
Japan	4,128	125,644	164	11,208
Mexico			20	813
Netherlands	249	9,380		
Philippine Islands			1	36
Surinam	404	13,615		
Union of South Africa			78	4,598
United Kingdom	4,271	142,542	1,513	78,140
	20,106	665,029	2,032	107,396

Platinum exported from the United States, 1928–32

Year	Unmanufactured		Manufactures of, except jewelry	
	Troy ounces	Value	Troy ounces	Value
1928	9,050	$619,478	2,168	$160,554
1929	2,567	193,122	1,455	112,252
1930	1,037	62,072	769	40,850
1931	1,209	40,769	1,190	48,464
1932	20,106	665,029	2,032	107,396

PRODUCTION IN FOREIGN COUNTRIES

Canada.—The production of crude platinum from placers in Canada in 1932 was 55 ounces, compared with 50 ounces in 1931.[3] The ore mined to satisfy the small demand for nickel supplied only enough material to keep the Acton refinery operating at about one fifth its rated capacity. Recoveries of platinum metals in 1932 from the copper-nickel ores of the Sudbury area were 27,151 ounces of platinum and 37,497 ounces of other platinum-group metals, compared with 44,725 ounces of platinum and 46,918 ounces of other platinum-group metals in 1931.

[3] Dominion Bureau of Statistics, Preliminary Report on the Mineral Production of Canada during the Calendar Year 1932: Ottawa, 1933.

Colombia.—The production of crude platinum in Colombia in 1932 was 45,075 ounces; 31,175 ounces were the product of dredges and 13,900 ounces the product of hand-working by native operators.

Ethiopia.—The production of crude platinum in Ethiopia in 1932 was 4,823 ounces, compared with 6,430 ounces in 1931.

Sierra Leone.—The production of crude platinum in Sierra Leone in 1932 was 531 ounces compared with 594 ounces in 1931.

Southern Rhodesia.—It is reported that the adoption of a new treatment process may make renewal operations practical in Southern Rhodesia.[4]

Tasmania.—The Government has been requested to drain a considerable area in the Adams River Valley in an attempt to extend the workable osmiridium ground.[5] The production of osmiridium in Tasmania in 1932 was 785 ounces compared with 1,280 ounces in 1931.

Union of South Africa.—According to the Department of Mines and Industries, the sales of platinum in South Africa in 1932 were 7,086 ounces valued at £42,352 (£5.98 an ounce), compared with 36,545 ounces valued at £217,807 (£5.96 an ounce) in 1931. The average composition of the product shipped in 1931 was: Platinum 74.99 percent, palladium 15.96 percent, iridium 0.21 percent, osmium and osmiridium 0.08 percent, rhodium 0.15 percent, ruthenium 1.39 percent, and gold 7.22 percent.

The sales of osmiridium in 1932 were 5,110 ounces valued at £40,344 (£7.90 an ounce), compared with 6,199 ounces valued at £63,174 (£10.19 an ounce) in 1931. The average composition of the product shipped in 1931 was: Osmium 32.09 percent, iridium 27.10 percent, ruthenium 13.12 percent, platinum 11.89 percent, rhodium 1.85 percent, gold 0.48 percent, and undetermined 13.47 percent.

Russia.—In the absence of authentic statistics on the production of platinum in Russia in 1931 and 1932, it is estimated that about 100,000 ounces were produced in each of these years.

WORLD PRODUCTION

World production of crude platinum from placers, 1928–32, in troy ounces

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

Country	1928	1929	1930	1931	1932
Australasia:					
New South Wales	354	128	155	283	(1)
New Zealand	35	7	3	1	(1)
Papua (osmiridium) [2]	215	29	11	20	(1)
Tasmania (osmiridium)	1,627	1,360	953	1,280	785
Canada	49	28	17	50	55
Colombia	[3] 53,531	[3] 45,577	[3] 42,382	[3] 44,311	45,075
Ethiopia	3,247	7,716	8,038	6,430	4,823
Japan	100	147	128	(1)	(1)
Madagascar	2				(1)
Russia	[4] 78,925	[5] 99,667	[6] 100,000	[6] 100,000	[6] 100,000
Sierra Leone		26	546	594	531
United States	528	797	527	885	1,074

[1] Data not available.
[2] Year ended June 30 of year stated.
[3] Exports, as reliably reported to the authors.
[4] Exports; year ended Sept. 30.
[5] Year ended Sept. 30.
[6] Approximate production.

[4] Foreign Trade Notes, Minerals and Metals: Bureau of Foreign and Domestic Commerce, vol. 2, no. 4, Feb. 22, 1933, p. 8.
[5] Mining Journal (London), vol. 180, no. 5090, Mar. 11, 1933, p. 154.

MINOR METALS: BERYLLIUM, BISMUTH, CADMIUM, COBALT, SELENIUM, TANTALUM, TELLURIUM, TITANIUM, AND ZIRCONIUM

By Paul M. Tyler and A. V. Petar

BERYLLIUM

No statistics are available for the production of beryllium or beryl in the United States. During 1932 several discoveries of beryl deposits were reported, and development work was undertaken in Colorado, Nevada, North Carolina, South Dakota, and Wyoming. The principal sources of beryl, however, are mica and feldspar operations in New York, New England, North Carolina, and South Dakota, where the beryl is recovered as a byproduct in ample tonnages to meet the present consumption.

The Beryllium Corporation (formerly the Beryllium Development Corporation) consolidated its Cleveland experimental plant and Detroit laboratory in a new plant at Marysville, Mich., during 1932 and produces beryllium oxide, beryllium, and master alloys of beryllium with copper and nickel to supply an increasing demand for these products. It is reported that the Beryllium Corporation contemplates increasing its plant capacity during 1933.

Beryllium is the newest of the rare metals to be listed among engineering materials. That it is now available in commerical form is due largely to the efforts of the Beryllium Corporation in the United States and Siemens & Halske in Germany. These firms have devoted many years of research to the development of processes for the production of a marketable product. The factor that delayed more rapid development has been the threatened shortage of raw material. This difficulty has in a measure been overcome, and a moderate supply of beryl, the only important ore, seems now assured. Although no single deposit has been reported which would sustain a large production of beryllium metal, enough ore is available to permit considerable expansion. Prospecting and development work during recent years have indicated possible extensive ore deposits.

Prices.—Imported beryllium metal is nominally quoted at $135 per pound, whereas domestic prices applying to production in this country are based on $25 per pound for contained beryllium. In small quantities, the beryllium master alloys are quoted as follows:

	Price per pound
Beryllium-copper containing 12 percent beryllium, balance copper	$6.25
Beryllium-iron containing 10 percent beryllium, balance iron	5.00
Beryllium-nickel containing 10 percent beryllium, balance nickel	5.00

Throughout the year beryllium ore was quoted at \$20 to \$30 per ton, minimum 10 percent BeO, f.o.b. New York. Formerly the price was much higher; in 1929 it was around \$60 a ton.

In September 1932 the Brush Chemical Laboratories, Cleveland, Ohio, issued a price list on beryllium compounds, such as beryllium sulphate, beryllium oxide, sodium beryllium fluoride, beryllium basic acetate, beryllium nitrate, and beryllium chloride.

Uses.—Beryllium is available in the form of master alloys from which several series of commercial alloys may be produced. Beryllium-copper alloys were exhibited at the Power Show in New York in December 1932 and are now sold by at least two companies—the American Brass Co., Waterbury, Conn., and the Riverside Metal Co., Riverside, N.J.—in the form of sheet, strip, wire, rod, and tubing. Many actual and potential uses are claimed for the material, particularly as springs and as piston rings, gears, cams, pinions, valves, bearings, bushings, connecting rods, shafts, high-pressure steam fittings, injector parts, worm gears, thrust plates, and clutch plates. As beryllium-copper alloys are nonsparking it is suggested that they may be useful for tools in industries where a serious fire hazard is involved. The attractive golden color of the alloys may also have value in decorative work.

Beryllium is said to have important applications both in steel and in aluminum alloys, but commercial development has so far been confined to the beryllium-copper alloys previously mentioned. Attempts to alloy beryllium and magnesium have not been successful.

A bibliography [1] on beryllium has been published. Other recent articles of special interest are listed in the footnote references.[2]

THE INDUSTRY IN FOREIGN COUNTRIES

Africa.—The Beryl Mining Co., Ltd., which has been developing beryl properties in the Leydsdorp District, northern Transvaal, continued production on a reduced scale.

Early in 1932 the French Government prohibited the export of beryllium ore from Madagascar to foreign countries, in order that the output might be reserved for France.

England.—Research on beryllium has been continued at the National Physical Laboratory, resulting in the successful preparation of pure beryllium, which was found to be not only strong but ductile.[3]

France.—The Compagnie Générale du Beryl was founded, with headquarters in Paris, to investigate and exploit beryl deposits.

Germany.—In Germany, beryllium is produced principally by Siemens Schuckert Werke A.G., through its subsidiary, the German Beryllium Research Society (Deutsche Berylliumstudiengesellschaft). The Goldund Silberscheideanstalt, of Frankfurt am Main, is also interested in beryllium but has devoted its attention to the production of beryllium oxide for ceramic use rather than to the metal or its alloys. Annual consumption of beryllium in Germany is estimated at a few hundred kilograms of metal and between 1,000 and 2,000

[1] Hoyt, Mary E., and von den Steinen, Karl, Beryllium, a Bibliography: Colorado Sch. Mines Quart., vol. 26, no. 4, October 1931, 35 pp.

[2] Imperial Institute, Beryllium (Glucinum) and Beryl: Mineral Industry of the British Empire and Foreign Countries, London, 1931, 26 pp.

Siemens-Konzern, Beryllium; Its Production and Application: Siemens Co., Germany; trans. by Richard Rimbach and A. J. Michel, Chem. Cat. Co., New York, 1932, 331 pp.

Stock, Alfred, Berryllium: Trans. Electrochem. Soc., vol. 61, 1932, pp. 451-468.

[3] Chemical Age (London), National Physical Laboratory Metallurgical Researches; Annual Report for the Year 1931: Vol. 26, no. 675, June 4, 1932, p. 35 (monthly metallurgical section).

kilograms of oxide. Ore is imported from the United States, Canada, and Madagascar, but no figures are available as to quantity.[4] During 1932 it was announced that the German Beryllium Research Society had developed new apparatus for the recovery of beryllium at a reduced cost.

Portugal.—Deposits of beryllium ore were reported to have been discovered in the Provinces of Aveiro, Viana de Castelo (near Gerez) and in Vizeu (near Mangualde).

BISMUTH

As in former years, there were two producers of bismuth in the United States in 1932, but figures on domestic production are not available for publication.

Prices.—The world production of bismuth metal is normally 300 to 500 tons annually. The nature of the consumption (at least 75 percent in medicinal and pharmaceutical preparations) is such that a recession in general industrial activity tends to curtail it to only a minor degree; at the same time, as it is a byproduct of the smelting of major metals, the supply tends to diminish. The bismuth market, however, has always been unusual to the extent that potential supplies are extraordinarily large compared with existing demands, and prices have been bolstered by international conventions comprising the leading foreign producers. Inasmuch as the American output of bismuth usually falls short of domestic requirements its price in the United States has been determined largely by the foreign price plus the cost of importation. The entrance of a large new South American producer into the field a year or two ago has increased efforts to find industrial uses for bismuth, and partly to stimulate such use the price of the metal has been sharply reduced.

After the second week in January 1932 the price of bismuth in ton lots, f.o.b. New York, was stationary at 85 cents a pound throughout the remainder of the year, and the corresponding London quotation was 75 cents a pound on a dollar basis. The New York price in 1932 represents a record low level since about 1895 and compares with $1.15 in December 1931 and a range from $1 to $1.70 during 1930. In 1926 bismuth sold as high as $3.35 a pound.

New uses.—Various new uses for bismuth include its employment in low-melting alloys (usually with about 50 percent bismuth), such as (1) "Bendalloy" (melting point, 160° F.), for filling thin-walled tubing during bending and for facilitating the bending of other light sections, notably for airplane construction; (2) "Sealalloy," for sealing glass joints (this alloy actually wets and thus adheres to the surface); (3) nonshrinking "Matrix alloy" (melting point 248° to 221° F.), for holding together parts of composite dies and for chucking small articles in machine shops; and (4) universal printing alloys. Since many bismuth alloys are quickly melted with a blowtorch or steam they can be poured about or melted away from heat-treated steel parts without drawing the temper; and since they are moderately strong and malleable, as well as nonshrinking, they are likely to find increasing application in tool and die work, replacing mechanical holding arrangements and also opening up a new field in design. It would seem possible to redesign many recessed dies which now have to be sunk into one piece so that the raised portions can be separate,

[4] Redecker, Sydney B, Metal and Mineral Notes: Foreign Trade Notes, Bureau of Foreign and Domestic Commerce, vol. 2, no. 2, Jan. 25, 1933, p. 6.

thereby cheapening the first cost of making the die and enabling parts that wear rapidly to be replaced without replacing the whole die. The use for metal seals may prove potentially important, as it appears to avoid a major objection to a wider use of glass pipes and tubes, as well as to have numerous minor applications in gasoline gages and scientific apparatus. Attention is also being devoted to the effect of bismuth upon cast iron; additions of bismuth, while reducing strength and hardness, apparently increase fluidity, produce cleaner surfaces, and improve machinability.

During the past year or two, processes for the recovery of bismuth have been patented. In a series of eight Betterton[5] patents calcium, barium, and zinc are employed to debismuthize lead bullion. A process for refining bismuth, patented by W. C. Smith,[6] specifies that a halogen gas such as chlorine be bubbled through a molten bismuth alloy, such as one containing lead, after which air is bubbled through the metal. Other patents provide for [7] (1) the smelting of flue dust to obtain a lead alloy containing bismuth, copper, and other metals, with final recovery of bismuth, and (2) the removal of lead and/or zinc from bismuth by treating the molten metal at 400° C. with a current of Cl_2 under a $PbCl_2$ and/or $ZnCl_2$ slag.

The Consolidated Mining & Smelting Co. of Canada also patented processes for refining lead-bismuth alloys.[8]

The co-deposition of lead and bismuth was described by Colin G. Fink and Otis H. Gray in a paper presented before the Electrochemical Society in September 1932.[9] Alloy deposits containing about 75 to 85 percent lead and the remainder bismuth are most resistant to dilute hydrochloric and sulphuric acids.

Consideration was given during 1932 to the use of bismuth oxide instead of lead oxide in optical glass.[10]

Imports.—Imports in recent years have not represented a very large fraction of the consumption in this country. As indicated in the accompanying table, the imports in 1932 increased compared with those for the previous year but were still somewhat under the average for recent years.

Bismuth and "compounds, mixtures, and salts of bismuth" imported for consumption in the United States, 1928–32

Year	Bismuth		Compounds, mixtures, and salts of bismuth	
	Pounds	Value	Pounds	Value
1928	41,383	$77,444	8,168	$16,336
1929	37,480	58,853	3,552	16,645
1930	24,405	20,088	657	5,083
1931	7,718	8,191	951	5,318
1932	28,620	29,295	3,095	5,283

[5] Betterton, Jesse O. (to American Smelting & Refining Co.): U.S. Patents 1853534–41, Apr. 12, 1932.

[6] Smith, W. C. (to Cerro de Pasco Copper Corporation). Process for Refining Bismuth: U.S. Patent 1870388, Aug. 9, 1932.

[7] Smith, W. C. (to Cerro de Pasco Copper Corporation), Production of Bismuth: U.S. Patent 1809871, June 16, 1931.

Smith, W. C., and Mack, Jr., Peter, (to Cerro de Pasco Copper Corporation and Anaconda Copper Mining Company), Process for Refining Bismuth: U.S. Patent 1816620, July 28, 1931.

[8] Consolidated Mining & Smelting Co.: U.S. Patent 1840028, Jan. 5, 1932; and Canadian Patent 324755, Aug. 2, 1932.

[9] Fink, Colin G., and Gray, Otis H., Co-deposition of Lead and Bismuth: Paper presented at 62d meeting, Electrochem. Soc., Cleveland, Sept. 22–24, 1932.

[10] Liddell, D. M., Rare Metals—An Interesting Field Largely Neglected This Year: Min. and Met., vol. 14, January 1933, p. 44.

THE INDUSTRY IN FOREIGN COUNTRIES

Australia.—Bismuth ores are produced in small quantities in New South Wales, Queensland, South Australia, and Tasmania. It is reported that in 1932 production in South Australia amounted to 475 pounds valued at £109 and in Tasmania a little more than a ton with a value of £541. In Queensland the quantity of bismuth concentrates produced has not amounted to as much as a ton since 1922, and in 1931 (the latest year for which figures are available) the output was only 3⅛ hundredweight valued at £37. Six producers in New South Wales contributed to a production of 37½ tons of bismuth ore and concentrates valued at £5,387 in 1931.

Bolivia.—In Bolivia, formerly the principal world source of the metal, the production of bismuth, as indicated by exports, has dwindled to relatively insignificant proportions. The export statistics for 1932 report only 2,316 kilograms of "bismuth," and even in 1931 the bismuth content of ores and concentrates exported was only 26,581 kilograms.

Canada.—In 1932 bismuth production, including metallic bismuth made at Trail, British Columbia, and the bismuth contained in silver-lead-bismuth bullion shipped during the year by the Deloro Smelting & Refining Co., totaled 16,855 pounds valued at $6,409—a decrease of 85.7 percent in quantity and 95.9 percent in value compared with 1931.

Japan.—The production of bismuth in Japan continued in 1931 at the level attained in 1929 and 1930, amounting to 57 metric tons of metal. This output was obtained from the Ashio mine of the Furukawa Mining Co. at Tochigi and the Kamioka mine of the Mitsui Mining Co. at Gifu.

Peru.—Within the past 2 or 3 years Peru has come to the fore as a source of bismuth due to processes developed by the Cerro de Pasco Copper Corporation for recovering bismuth from its copper-smelter fumes. No information is available as to output in 1932 but exports of metal were 83,475 kilograms, valued at 1,494,659 soles compared with 281,053 kilograms valued at 2,224,394 soles exported in 1931.

Spain.—The production of bismuth ore in Spain during 1931 amounted to 114 tons valued at 570,000 pesetas.

Sweden.—A few hundredths of 1 percent of bismuth are present in ores at Boliden on the Gulf of Bothnia. Owing to the amount handled (around 1,000 metric tons per day), a considerable quantity of bismuth accumulates in the slimes of the electrolytic copper refinery, and some is also caught in the Cottrell fumes.

CADMIUM

In 1932 the domestic output of cadmium metal by 5 companies totaled 799,501 pounds, and the production of cadmium in compounds, mainly sulphide, oxide, and lithopone, by 4 companies was 259,800 pounds. The corresponding figures for 1931 were 1,050,529 pounds of cadmium metal and 337,200 pounds of cadmium in compounds.

During the year the automobile industry normally charged with about 80 percent of the domestic cadmium consumption operated at only a little more than one fourth its 1929 rate, and the demand for cadmium was consequently curtailed sharply. The variety of articles protected from corrosion by cadmium plating was expanded somewhat, but the progress doubtless made in other avenues of use could not counteract the stagnating effects of the general industrial situation. On the other hand, since cadmium is mainly a byproduct of electrolytic zinc production, the output declined substantially, although certain cadmiferous residues from former years were worked up.

Cadmium produced in the United States, 1928-32

Year	Metallic cadmium		Cadmium compounds	
	Pounds	Value	Estimated cadmium content (pounds)	Value
1928	1,875,896	$1,144,297	239,900	$228,013
1929	2,481,427	2,009,956	433,300	498,734
1930	2,777,762	1,777,768	316,300	323,718
1931	1,050,529	409,706	337,200	331,119
1932	799,501	(1)	259,800	(1)

1 Producers' value not available for 1932. Average quoted price at New York was 55 cents a pound.

Prices.—In January 1931 the price of cadmium in New York dropped from 70 to 55 cents a pound, where it remained throughout 1932. The London quotation (nominal)—2s. 3d. early in 1932—was subsequently reduced below 2s., and at the end of the year was 1s. 8d., equivalent to approximately 27.3 cents.

Uses.—The improvement of cadmium plating baths and processes continues to receive attention; mention may be made especially of two recent papers by Wernick.[11]

Cadmium sulphide is employed with selenium in most high-grade red glasses; a new process [12] for making ruby-glass tubing obviates opalescence due to zinc by adding to the batch a small amount of cadmium oxide in addition to the cadmium sulphide and selenium required for coloring. In Germany [13] two distinct processes are employed by the four concerns engaged in making cadmium-red pigments. In 1907 the pigment manufacturer De Haen produced a vivid red pigment from cadmium sulphide and selenium. This pigment, used as enamel under the names Cadmium Rot, Feuerrot, or Selen Rot, is prepared by heating 80 to 90 parts of selenium in a muffle furnace to 700° C. The hues range from orange-red to deep purple-red and are used to coat colorless glass and to produce any colored art glass. The other process more recently developed by the I. G. Farbenindustrie consists of precipitating cadmium salts with a mixture of barium sulphide and barium selenide. These pigments range from orange through pure red to deep magenta. According to Wagner,[14] cadmium pigments have been greatly improved by the introduction of barium sulphate and by calcination. They have a high degree of light and lime resistance but a rather low degree of resistance to water

11 Wernick, S., The Stability of Cadmium Cyanide Plating Solutions: Preprint, Trans. Electrochem. Soc., vol. 60, September 1931, pp. 117-128. The Electrodeposition of Cadmium from Cadmium Sulphate Solutions. Part I. The Effect of pH, Current Density, and Temperature on the Crystal Size of the Deposit, the Current Efficiency, and the Electrode Efficiency Ratio: Metal Industry (N.Y.), vol. 30, no. 10, October 1932, p. 398 (abs. of paper presented at 62d meeting, Electrochem. Soc., Cleveland, Ohio, Sept. 22-24, 1932.

12 Rising, Walter H. (to Corning Glass Works), Ruby Glass Containing Cadmium: U.S. Patent 1864858, June 28, 1932.

13 Bureau of Foreign and Domestic Commerce, Production of Cadmium-Red Pigments in Germany: World Trade Notes on Chemicals, etc., vol. 6, no. 12, Mar. 21, 1932, p. 3.

14 Wagner, Hans, The Weather Resistance of Cadmium Pigments: Paint and Varnish Production Mgr., vol. 7, no. 4, 1932, p. 5f.

and carbon dioxide, hence for exterior use they must be protected with a good vehicle. Cadmium is deposited on zinc (galvanized iron) from water-absorptive films containing cadmium pigments. The action is both organic reduction and electrolysis, hence the permeability of a film to water can be determined by noting the amount of cadmium deposited when the film is moistened with a solution of cadmium sulphate.

In reviewing recent developments in the utilization of cadmium Phillips [15] refers to a patent covering a method of giving steel a protective coating of a cadmium-rich alloy by the hot-dipping process. Another interesting patent covers the use of an alloy of cadmium as a bearing metal. It is claimed that the cadmium-base alloy will support greater loads at higher temperatures than is possible with a tin-base babbitt. Apparently, the frictional properties compare favorably with those of regular tin babbitt. This use of cadmium gives promise of becoming important. A much greater interest has also been shown in the use of cadmium in solders.

Imports.—There were no imports of cadmium metal into the United States in 1932; in 1931 only 271 pounds were imported but in 1928, and again in 1929, more than 200,000 pounds of foreign cadmium were entered for the domestic market.

THE INDUSTRY IN FOREIGN COUNTRIES

Outside of the United States the output of cadmium declined in 1932. In Tasmania the decline in output was only from 445,158 to 354,621 pounds, but in Canada production dropped to small proportions, although the Hudson Bay Mining & Smelting Co., Ltd., produced cadmium sponge at Flin Flon for the first time in 1932. Norway has added cadmium to its long list of electrolytic products, deliveries having been made early in 1933 from the plant of the Norske Zinkkompani A./S., at Eitrheim, Hardanger.

World production of cadmium, 1928–32, by countries, in kilograms

Country [1]	1928	1929	1930	1931	1932
Australia [2]	174,810	202,261	234,510	201,889	160,854
Belgium [3]	(4)	2,313	5,080	2,903	(4)
Canada	223,118	351,068	207,101	146,573	29,676
France	47,000	59,000	72,000	82,176	(4)
Germany [5]	45,000	45,000	45,000	45,000	(4)
Great Britain [3]	768	2,357	6,584	2,171	(4)
Italy	(4)	(4)	[5] 12,000	[5] 12,000	(4)
Mexico [6]	40,293	248,577	496,183	(4)	(4)
Poland	4,213	3,584	94	109,000	34,602
United States:					
Cadmium compounds [7]	108,816	196,541	143,471	152,951	117,843
Metallic cadmium	850,888	1,125,550	1,259,965	476,509	362,646

[1] In addition to the countries listed cadmium is produced in Norway, Russia, and Sweden, but production figures are not available.
[2] Smelted in Tasmania.
[3] Exports of domestic produce. Production figures not available.
[4] Data not available.
[5] Approximate annual output (Imp. Inst., London).
[6] Cadmium produced in Mexico, exclusive of cadmium content of flue dust and other cadmium-bearing products exported for treatment elsewhere. The total output of cadmium reported for Mexico, including content of flue dust, etc., is as follows: 1928, 353,544 kilos; 1929, 606,050 kilos; 1930, 547,742 kilos; 1931, 31,831 kilos; 1932, 86,174 kilos.
[7] Estimated cadmium content.

[15] Phillips, Albert J., Byproduct Metals: Min. and Met., vol. 14, January 1933, p. 38.

COBALT

The United States has never been a large producer of cobalt, and the substantial domestic requirements have been supplied almost exclusively by imports. A small carload of low-grade ore shipped from Alabama in 1931 represents the only domestic output of record since 1921. Cobalt, however, has long been known to occur as a minor constituent of the iron-ore deposits at Cornwall, Pa. According to Hickok[16] the cobalt follows the pyrite, which is separated from the other minerals by flotation. The pyrite is burned to produce sulphur, and the residual iron oxide is chemically treated to extract the cobalt before being used as iron ore. Cobaltiferous crednerite and rhodochrosite were found by early investigators in the upper part (now removed) of the western ore body.[17]

Prices.—Little change was apparent in cobalt quotations during 1932. In general, they maintained the low level of the end of 1931, although slight increases were noted in 2 or 3 instances. The black oxide (70 to 71 percent cobalt) was quoted at $1.35 per pound except during the summer months, when the price sagged to $1.25 to $1.35. Quotations for 97 to 99 percent metal (imported from Belgium) remained unchanged at $2.50. During the first 6 months of 1932 cobalt ore, 12 to 14 percent grade, was quoted at 50 cents per pound f.o.b. cars, Ontario; from July to December, inclusive, the price was 48 cents.

London quotations for black oxide and gray oxide were slightly higher during 1932 than in the last half of 1931. The price of 5s. 4d. to 5s. 5d. for black oxide, quoted early in the year, declined to 4s. to 4s. 2d. in September, rising to 5s. 2d. in December. The January quotation for gray oxide, 6s. 1d. to 6s. 2d. (compared with 4s. 9d. in December 1931), gradually dropped to 4s. 10d. to 5s. in August and then rose to 5s. 6d. at the end of the year. Cobalt metal was quoted at 7s. 6d. per pound throughout most of the year, rising to 8s. in December.

Uses.—The use of cobalt—in the United States at least—is about evenly divided between the metallurgical industry, which employs the metal, and the glass, porcelain, enamel, chemical, and paint industries, which purchase the oxide and other compounds. The leading use of the metal is in Stellite alloys—cobalt-tungsten-chromium combinations for high-speed tools, hard-facing and wear-resisting metal, and sundry corrosion-resisting purposes. Permanent magnets of cobalt steel account for some quantity of the metal, and cobalt finds its way into a variety of other steels, including high-speed steel. It is a constituent of numerous hard-cutting materials and is the usual bonding agent for tungsten carbide. A variation of the usual methods for making these materials is set forth in the Welch patent[18] whereunder finely divided particles of tungsten carbide are electrolytically coated with cobalt and then sintered under nonoxidizing conditions at a temperature sufficient to melt the cobalt but not the tungsten carbide. Comprehensive studies of the influence of cobalt on carbon steels have been made recently in Germany.[19]

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[16] Hickok, W. O. (4th), The Iron-Ore Deposits at Cornwall, Pa.: Econ. Geol., vol. 28, no. 3, May 1933, p. 223.

[17] Hickok, W. O., work cited, p. 226.

[18] Welch, E. S. (to Firth Sterling Steel Co.), Compositions of Cobalt and Tungsten Carbide Suitable for Dies and Cutting Tools: U.S. Patent 1833099, Nov. 24, 1931.

[19] Houdremont, E. and Schrader, H., The Action of Cobalt on Carbon and High-Speed Steel: Arch Eisenhüttenw., vol. 5, 1932, pp. 523–534.

W. P. Sykes, of Cleveland Wire Works (General Electric), and C. P. Miller, of Romley, England, have developed a new cutting alloy composed of cobalt, tungsten, and iron, which is intermediate in properties and price (probably $4 a pound) between ordinary high-speed steel and cemented carbides. Konel metal, a platinum substitute, and Kanthal metal, for electrical resistances, are relatively new alloys containing considerable cobalt.

Imports.—The imports of cobalt ore, cobalt metal, and oxide have declined steadily since 1929, the apparent domestic supply of cobalt, as indicated by the imports, shrinking in 1932 to scarcely more than one fourth what it was 3 years earlier. The increased imports of cobalt sulphate and "other salts" in 1932 can doubtless be attributed to the reduction in European prices; it will be noted that the average declared value (foreign market value) of the imports of sulphate was 23½ cents a pound in 1932 compared with 33 cents in 1931 and 57½ cents in 1929.

Cobalt ore, cobalt metal, oxide, and other compounds of cobalt imported for consumption in the United States, 1929–32

	1929		1930		1931		1932	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Cobalt ore	434,443	$51,862	199,642	$18,994	83,895	$8,453	27,193	$12,516
Cobalt metal	806,640	1,743,465	460,251	984,244	164,967	254,520	123,112	147,925
Oxide	475,928	884,873	425,881	769,331	321,891	391,479	225,896	220,497
Linoleate			91	38				
Sulphate	60,596	34,893	33,084	17,564	23,147	7,595	51,048	12,040
Other salts	4,186	2,655	22,128	6,519	23,170	11,768	41,050	18,586

Cobalt and cobalt ore imported into the United States, 1930–32, by countries

[General imports]

Country	1930		1931		1932	
	Pounds	Value	Pounds	Value	Pounds	Value
Australia	49,034	$8,173	23,296	$4,542		
Belgium	368,788	809,156	99,198	159,299	57,403	$77,587
Canada	216,181	130,628	118,872	83,172	85,622	74,224
Germany	25,890	55,281	3,016	5,876	4,193	5,543
United Kingdom			4,480	10,084	3,087	3,087
	659,893	1,003,238	248,862	262,973	150,305	160,441

THE INDUSTRY IN FOREIGN COUNTRIES

The principal source of the world's rather meager supply of cobalt has shifted from Europe to New Caledonia, to Canada, and then to the Belgian Congo. At the end of 1932 the Belgian Congo and Canada were still the main sources, but there is the possibility of a large new supply—probably sufficient at least to double the present total annual output—as a byproduct from copper smelting in Rhodesia. Certain Rhodesian ores are unofficially reported to contain 0.15 percent of recoverable cobalt, which may be obtained from the converter slag. A prospective increase in supply, so far exceeding any diminution that may result from exhaustion or abandonment of other sources, should encourage more general employment of this useful element.

Available statistics on production of cobalt in foreign countries are set forth in the following table:

World production of cobalt, 1930–32, in metric tons

Country	Cobalt-bearing material	1930		1931		1932	
		Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content
Australia:							
New South Wales	Cobaltiferous manganese ore					(1)	(1)
Queensland	Cobaltite concentrates, etc.	(1)	4			(1)	(1)
Belgian Congo	(1)	(1)	[2] 700	(1)	[2] 370	(1)	(1)
Canada: Ontario	Cobalt, alloys, and chemicals	(1)	315	(1)	236	(1)	223
China: Yunnan [3]	(1)	250	(1)	250	(1)	250	(1)
India, British: Burma [4]	Cobaltiferous nickel speiss	3,102	109	3,504	123	3,060	107
Union of South Africa	Cobalt ore			45	1	(1)	(1)

[1] Data not available.
[2] Cobalt in metal, oxide, and salts produced at Oolen, Belgium.
[3] Approximate production.
[4] Year ended June 30 of year stated.

Australia.—In Queensland, during the latter part of the summer of 1932, the Metals Recovery Co. was treating about 4 tons of tailings daily at Mount Cobalt, Cloncurry. A shipment of 17½ tons returned 2.97 tons of cobalt, valued at £610.[20]

Canada.—In 1932 the production of cobalt (computed as cobalt in metal, in oxides sold, and in ores and residues exported) was 490,631 pounds valued at $589,062, compared with 521,051 pounds valued at $651,179 in 1931.

At the end of the year the Mining Corporation of Canada shut down, closing one of the old mining properties of the Cobalt camp. Early in 1932 the same company closed the Frontier mine at South Lorraine.[21] An interesting development was the utilization of airplanes to ship cobalt ore from Werner Lake, Ontario, to the rail base at Minaki, a distance of 40 miles, from which point it was sent by rail to American manufacturers.

The Canadian tariff rates, which went into effect October 12, 1932, provided a duty of 10 percent on oxide of cobalt.

Morocco.—Early in 1932 a shipment of 285 tons of manganese and 2 tons of cobalt was made from mines in the neighborhood of Taroudant to a European firm. It is reported that production will be increased during 1933 and 1934.[22]

Rhodesia.—The potential importance of cobalt as a byproduct from Rhodesian copper smelting has already been mentioned (p. 355). At the annual meeting of the Rhokana Corporation, Sir Auckland Geddes stated that the cobalt in N'Kana ore can be separated readily and that it will soon be possible to produce cobalt in the form of a high-grade iron-cobalt alloy.[23]

[20] Chemical Engineering and Mining Review: Vol. 24, no. 288, Sept. 5, 1932, p. 424.
[21] Bureau of Foreign and Domestic Commerce, Closing of Cobalt Mine: Foreign Trade Notes, Minerals and Metals, vol. 2, no. 2, Jan. 25, 1933, p. 3.
[22] Mines, Carrières, Revue économique: Vol. 11, no. 114, April 1932, p. 8.
[23] South African Mining and Engineering Journal, Rhokana Costs and Cobalt: Vol. 43, no. 2135, Oct. 22, 1932, p. 108.

SELENIUM

Two companies reported an output of selenium in 1932, but the Bureau of Mines is not at liberty to publish their total. Production was made in 1931 by three companies. The large stocks on hand at the end of 1931 were drawn upon in 1932. Available production data for 1928 to 1932 are presented in the following table.

Selenium sold by producers and in stock at producers' plants in the United States, 1928–32

Year	Sales			Stock at end of year (pounds)
	Pounds	Value		
		Total	Average	
1928	362,697	$607,382	$1.67	214,836
1929	344,288	568,265	1.65	391,033
1930	278,309	454,911	1.63	567,493
1931	292,234	386,255	1.32	[1] 457,911
1932	(2)	(2)	(2)	(2)

[1] Includes a small quantity of tellurium.
[2] Bureau of Mines not at liberty to publish figures.

Prices.—Selenium metal is usually sold powdered, packed in tin cans. In 1932 the New York price of this product in wholesale quantities was $1.75 (black, powdered, 99.5 percent pure); for the ferro-alloy $1.90 is asked per pound of selenium contained. In December the British quotation, which is calculated on a gold basis, was 7s. 8d. to 7s. 9d. exwarehouse Liverpool, or a trifle higher than the New York price.

Uses.—The potential demand for selenium received new impetus in 1932 with the announcement of the successful use of the metalloid in steel. In order of abundance in the earth's crust selenium lies between bismuth and gold, which are not classed as common metals. Nevertheless, as a minor constituent it is widely distributed in nature. The selenium originally present in copper ores becomes concentrated in the anode muds at electrolytic refineries, and until recently the potential supply as a byproduct from this source, though quite small, far exceeded existing demand. The range of uses as noted in a chapter of Mineral Resources for 1931[24] has been greatly extended, the principal outlets being in glass making, in rubber, and in the manufacture of certain dyes, but with interesting possibilities noted in the field of television and talking motion pictures. Other uses include the automatic lighting of navigation beacons and as a moldable building material (selenium sulphide binder with paper, etc.; see German Patent 542717); and for washing and preserving wool, feathers, and hair (soluble compounds; see German Patent 541279). The resistance of vulcanized rubber to abrasion is increased 50 percent or more by the addition of selenium. Still another new development is a process for improving the corrosion resistance of magnesium by immersion for a few minutes in a bath containing selenious acid.[25]

[24] Gerry, C. N., and Meyer, H. M., Arsenic, Bismuth, Selenium, and Tellurium: Mineral Resources of the U.S. Bureau of Mines, pt. I, 1931, pp. 15–16.
[25] Bengough, G. D., and Whitby, L., Magnesium Alloy Protection by Selenium and Other Coating Processes: Metal Ind. (N.Y.), vol. 30, no. 4, April 1932, p. 148.

Previous efforts to find a use for selenium in steel making had been unfruitful, and metallurgists generally were discouraged because of the rapid vaporization of the element at molten-steel temperatures. Having solved the practical difficulties connected with making the alloy additions, the Carpenter Steel Co. announced in 1932 the production of stainless steel in the form of rolled products. The effect of the selenium (about 0.25 percent) in stainless steel is to impart machinability in much the same manner as sulphur is employed in ordinary screw stock. The selenium is added in the form of a 50 percent ferro-alloy a few moments before the metal is ready to pour. Casting, forging, rolling, and annealing proceed as usual for any stainless steel, but the product differs in that it can be cut in automatic screw machines at 60 to 70 percent of the speed of Bessemer screw stock. Advantages of selenium over sulphur as a free-cutting agent are thus described in a press bulletin issued by the Carpenter Steel Co.[26]

> The greater transverse toughness of stainless steel containing selenium influences in several ways the fabrication and use of the product. The selenium steel is easier to roll and forge than the sulphur types—being less subject to splitting, cracking, or opening up at the ends. The selenium steel can be upset with greater safety and less trouble from splitting. High-sulphur stainless steels have fallen short of the requirements for pistol barrels because of this tendency to split. In any application where the parts are subject to internal bursting strain or transverse shock, the selenium steels will prove much safer than those containing high sulphur.

This development is likely to expand the applications of stainless steel and thereby create an important outlet for selenium.

Imports.—Imports of selenium and selenium salts in recent years have been as follows:

Selenium and selenium salts imported for consumption in the United States, 1928–32

Year	Pounds	Value	Year	Pounds	Value
1928	18,622	$33,998	1931	2,189	$2,777
1929	3,592	5,971	1932	1,914	2,240
1930	680	988			

THE INDUSTRY IN FOREIGN COUNTRIES

Canada.—In 1931 selenium was produced for the first time in Canada as a byproduct in copper refining at the Copper Cliff plant of the Ontario Refining Co. The recovery amounted to 21,500 pounds, valued at $40,850, and hope was expressed that the development of new uses for selenium would lead to the development of an important industry. In July 1932 it was reported that the new refinery of Canadian Copper Refineries, Ltd., at Montreal East would produce selenium as one of its chief products; however, selenium does not appear in preliminary statistics of mineral production in Canada in 1932.

Japan.—A report from the office of the American Embassy in Japan states that, although official data are not available, four companies in different sections of the country have a potential output of about 600 pounds of selenium monthly.

Russia.—The production of selenium by the Soviet Union (entirely from anode slimes at the electrolytic plants of the Zvelmetsoloto

[26] Literary Digest, Selenium Steel: Dec. 31, 1932, p. 21.

Trust) amounted to about 2½ tons in 1931. As requirements of Soviet glass factories are said to be far in excess of this amount, it is proposed to increase production by utilizing slimes at the sulphuric-acid plants.[27]

Sweden.—Blister copper at the Boliden mines on the Gulf of Bothnia contains 0.75 percent selenium, and there is 25 percent selenium in the anode muds from the electrolytic refinery. There is also some iron, but much less than the selenium.

TANTALUM

Small sales of columbite were made from New Mexico in 1932 by Philip S. Hoyt, who reported additional stocks for which no buyer could be found. An accumulation of 275 pounds of columbite at the Spruce Pine (N.C.) properties of the Consolidated Feldspar Corporation was purchased by a dealer for resale. The total output of columbite in the United States was 390 pounds, with an estimated value of $234 in 1932, compared with 700 pounds valued at $490 in 1931 and a maximum of 34,899 pounds valued at $26,332 in 1928.

Prices.—The price of tantalum (bar or sheet) was reduced from $160 to $91 a kilogram in 1930 and not changed in 1931 or 1932; the corresponding British quotation was £15 a pound. The purely nominal quotations for tantalum ore were advanced from 70 cents to $1.75 a pound in March 1932.

Uses.—The interest aroused in recent years by tantalum continued unabated in 1932. Still among the very rare elements and apparently destined to remain so, tantalum has such an unusual combination of valuable properties that it commands attention in a variety of fields. It has been employed mainly in connection with special corrosion problems in various industries and laboratories, replacing platinum and rendering services in which even platinum fails to meet conditions. Employed alone as a protective facing (or coating) or in certain alloys it is resistant to both acids and alkalies and is virtually the only metallic material that will withstand wet chlorine. In certain types of electron-emitting devices tantalum is more effective than tungsten or molybdenum. Many alloy combinations have been developed and studied; of particular interest are those for high-temperature service. Mention may be made of a new patented zinc alloy containing zinc 90, copper 5, aluminum 3.5, chromium 0.5, molybdenum 0.12, and tantalum 0.15 parts. High strength, tenacity, and ductility are claimed for this alloy, which is recommended for rolling, hammering, extruding, or die casting.[28]

Various steel mixtures containing tantalum have been investigated; several are patented. The Ramet tantalum carbide, of Fansteel Products Co. (North Chicago, Ill.) is a sintered mixture, practically infusible (the melting point of tantalum carbide is nearly 1,700° C. above that of tungsten carbide) and so hard that tools tipped with it will cut most of the so-called "unmachinable" metals; tantalum carbide tools cut superhard white cast iron and manganese steel quite rapidly and hold a keen edge against plastics of the bakelite class, duralumin, and other aluminum alloys and sundry bronzes that have caused machinists much trouble. An entirely new and highly efficient

[27] Metal Bulletin (London), Selenium: No. 1716, Aug. 16, 1932, p. 16.
[28] Schroeder, Henry F., and Russell, Charles D. (assigned to Ruselite Corporation): Zinc Alloy: U.S. Patent 1847941, Mar. 1, 1932.

cutting material patented by McKenna [29] combines tungsten and/or molybdenum with the tantalum carbide. The use of tantalum as a binder and otherwise in conjunction with tungsten carbide received further attention in 1932.

A better demand for columbium is predicted in the form of the twin carbides (tantalum-columbium) for use in welding as well as in cutting tools.

Imports.—Imports of tantalum ores into the United States jumped to 36,131 pounds valued at $51,033 in 1932; this compares with 6,288 pounds in 1931, 8,474 pounds in 1930, and about 15,250 pounds in 1929 (previous record).

World production.—Except for a few small and sporadic shipments the world supply of high-grade tantalite has come from Australia, principally from the Pilbarra field of Western Australia. A Rhodesian concern, however, is reported recently to have offered 5 tons of high-grade ore (72 percent Ta_2O_5) monthly. In the production statistics of British India a small quantity (100 pounds, valued at £4) of columbite was reported as produced in the Monghyr district, Bihar and Orissa, in 1931.

TELLURIUM

During 1932, as in 1931, only two companies reported a production of tellurium, and the Bureau of Mines is not at liberty to publish the amount. In 1930 three producers reported an output of 14,095 pounds and sales of 4,717 pounds valued at $7,996. The price of the metal is still more or less nominal. Throughout 1932 the quotation was $2 a pound, f.o.b. New York.

Uses.—Tellurium, even more than its sister element selenium, was long considered a metallurgical abomination. Its presence not only complicated the extraction of valuable metals from their ores, but the metalloid itself exhibited certain highly unpleasant properties. An enormous amount of laboratory time and effort was expended in the search for commercial uses for tellurium but with almost universally disappointing results. In one of the most promising fields, as an antiknock addition to gasoline, it was quickly displaced by tetraethyl lead. Of real importance was the startling discovery by U. C. Tainton that the element is a most valuable reagent for purification of zinc solutions at western electrolytic plants, and almost 90 percent of the domestic output was used for this purpose in 1930.[30] The quantity required is about 13 pounds per ton of zinc. In 1932 serious attention was directed to the successful use of tellurium as a rubber-compounding material. It is said to increase resistance of rubber to heat, to be effective in revitalizing old rubber, and to improve aging qualities. The bloom that frequently accompanies the use of selenium is absent when tellurium is employed. Much attention, especially in Europe, has recently been given to the use of tellurium as a lead-hardening agent.

Researches on the use of tellurium in glass making indicate that the color-producing tendencies are like those of selenium, but no commercial applications have yet been made.

[29] McKenna, P. M. (assignor to Vanadium Alloys Steel Co.), Composition of Matter (Tungsten-Tantalum Carbide Alloy): U.S. Patent 1848899, Mar. 8, 1932.

[30] Chemical and Metallurgical Engineering, Editorial Staff Report on Electrochemical Developments Discussed at Baltimore—Annual Meeting of Electrochemical Society, April 21-23, 1932: Vol. 39, no. 5, May 1932, pp. 276-278.

TITANIUM

The domestic production of titanium ores in recent years has been of the order of several hundred tons of rutile and 1,000 to 5,000 tons or more of ilmenite annually. The actual figures, however, cannot be published without revealing individual operations. The Vanadium Corporation of America undertook the manufacture and sale of ferrocarbon-titanium. As in former years, ferrocarbon-titanium was also made by the Titanium Alloy Manufacturing Co., and the carbide-free ferro-alloy was made by the Metal & Thermit Corporation. The Titanium Pigment Co. (subsidiary of the National Lead Co.) and the Krebs Pigment & Color Corporation (a du Pont affiliate) continued to be the leading manufacturers of titanium pigments. The former company, after seeking a suitable eastern location, was reported to have selected a site on the Raritan River near South Amboy or Sayreville, N.J.

Prices.—The prices of titanium pigments, after declining steadily for about a decade as a result of economies in manufacture, remained stationary in 1931 and experienced only a few minor downward readjustments in 1932. The pure dioxide and the barium product remained unchanged at 21 cents (barrels) and 6½ cents (car lots, bags), respectively, a pound. There were two reductions, however, in the price of titanium-calcium pigment, bringing the quotation (car lots, bags) to 6 cents, compared with 7 cents a pound at the beginning of the year. The new contract price of $137.50 a short ton for ferrocarbon-titanium (15 to 18 percent titanium, 6 to 8 percent carbon, producers' plants, freight allowed), initiated at the end of 1931, was continued throughout 1932.

The price of ilmenite, though nominally unchanged at $10 to $12 per long ton for high-grade imported ore (45 to 52 percent titanium dioxide), seaboard, tended to be slightly lower. In France, for example, the quotation at the end of the year was 300 to 325 francs ($11.75 to $12.70) a metric ton, compared with 360 francs at the end of 1931 and 400 to 425 francs early in 1930. The quotation of 10 cents a pound for domestic rutile, guaranteed minimum 94 percent concentrate, has not been changed for several years. In Australia a price of £45 a ton is mentioned, equivalent to about 7 cents a pound.

Metallic titanium was quoted at $5 a pound for the ordinary 75 percent quality; the new 96 to 98 percent product was offered on the market at $6, delivered New York.

Uses.—Titanium in the form of carbide is the latest element to be added to the list of superhard cutting materials; the new Widia X is said to contain titanium carbide (and nitride) in addition to tungsten carbide and the other usual ingredients of this German tool-tipping material. Another new development of special interest is the commercial use of titanium dioxide, under the trade name "Titantex", as coating material for onionskin paper. A substantially higher-grade metal, containing 96 to 98 percent titanium compared with the ordinary 75 percent product, was placed on the market by the Deutsche Gold-und Silber-Scheideanstalt; it is made in Frankfurt am Main, Germany, from American rutile.

A review of the technical literature and patents indicates renewed interest in titanium additions for conditioning or alloy purposes in various steels, including rail steel, stainless steel, and cutting alloys.

The new alloys of copper and titanium were studied further, particularly with respect to their marked age-hardening properties and corrosion resistance. Beneficial effects are produced in sundry aluminum-copper alloys by treatment with a fraction of 1 percent of titanium.

New uses reported for titanium salts include their employment in primary electric batteries and in forming a corrosion-resisting coating on steel.

As a constituent of glass titanium dioxide cuts down the selective transparency for short wave lengths. Consequently, according to a recent American abstract of a German patent,[31] the addition of up to 2 percent titanium dioxide is recommended to inhibit the coloration of certain kinds of glass upon prolonged exposure to sunlight or light of short wave length.

As usual, a variety of new processes and patents are reported in connection with the manufacture of titanium pigments from ilmenite. Mention may be made of a method for making the dioxide from rutile; a finely ground briquetted mixture of magnesia (1 part) and rutile (2 parts) with enough carbon to reduce ferric oxide is heated at 1,410° C., forming the titanate ($MgTiO_3$), which is dissolved in sulphuric acid and subsequently hydrolyzed.[32] Titanium chloride is the raw material in another process in which the volatilized salt is oxidized in the flame of a burning gas.[33]

Imports.—Imports of ilmenite amounted to 33,491 long tons in 1932 valued at $231,652 compared with 29,857 tons valued at $144,951 in 1931 and a previous maximum of 22,386 tons valued at $104,887 in 1929. The increase in the declared value from $4.85 per ton in 1931 to $6.92 in 1932 is noteworthy in view of the sharp drop in the exchange value of the rupee. As in the previous years, imports were all from British India, the dominant source of world supply. The beach deposits of the Travancore State, along the extreme southwesterly shore of the Indian Peninsula, contributed more than 80 percent of the known output of all countries in 1931 and possibly an even larger percentage in 1932. Although British controlled, this output is consumed mainly in the United States.

The imports of rutile jumped to 176,393 pounds valued at $4,508 compared with 2,000 pounds valued at $189 in 1931.

REVIEW BY STATES

Arkansas.—The Titanium Corporation of America at Malvern, Hot Springs County, Ark., reported an output of 100 tons of ilmenite and 40 tons of rutile, none of which was shipped due to lack of market. Brookite occurs in this vicinity, which is not far from the deposit at Magnet Cove. According to the trade press,[34] another company, the Rock Port Minerals, Inc., Malvern, Ark., was preparing to erect a plant with a daily capacity of 6 tons of titanium concentrates, construction to begin about December 1, 1932.

Virginia.—The new plant of the Southern Mineral Products Corporation, which came into production in 1931, was closed early in 1932; it was subsequently reopened but only for the production of

[31] Société Anononyme des Manufactures des Glaces et Produits Chimiques de St. Gobain, Chauny & Cirey, Glass: German Patent 543095, Jan. 12, 1927; Chem. Abs., vol. 26, May 10, 1932, p. 2566.

[32] Lubowsky, S. J. (Assr. to Metal & Thermit Corporation), Manufacture of Magnesium Titanate: U.S. Patent 1843427, Feb. 2, 1932.

[33] Mittasch, Alwin, Lucas, Richard, and Griessbach, Robert (to I. G. Farbenind. A.-G.), Titanic Oxide: U.S. Patent 1850154, Mar. 22, 1932.

[34] Rock Products. Vol. 35, no. 23, Nov. 19, 1932, p. 54.

calcium-acid phosphates (for baking powder, etc.). The massive ore body of this company contains an average of nearly 20 percent titanium dioxide, which is almost all recovered by the magnetic separators in the form of an ilmenite concentrate averaging 40 to 50 percent titanium dioxide, which may be made into white pigments in another section of the plant or shipped to Niagara Falls for the manufacture of ferrocarbon-titanium by the parent company.

In 1932, as in former years, the American Rutile Co. (a subsidiary of the Metal & Thermit Corporation) shipped ilmenite and rutile from its properties at Roseland, Nelson County, Va. As a result of new tables being installed and better classification improved recoveries were reported during the several months the mill was in operation.

The Bureau of Mines has received numerous specimens of ilmenite and rutile from Bedford County, and late in 1931 the senior author of this chapter with Dr. Frank L. Hess, principal mineralogist of the Bureau, visited an occurrence of nelsonite in the vicinity of Lowry, Va. No deposits of titanium ores of potential commercial size, however, have yet been found in this vicinity.

THE INDUSTRY IN FOREIGN COUNTRIES

Australia.—The first factory to produce titanium pigments in Australia was nearing completion in 1932.[35] It is at Brooklyn, 5 miles from Melbourne and will employ ilmenite from black sand beach deposits on King Island about 130 miles away. Analyses of beach sands of New South Wales indicate the occurrence of natural concentrates consisting mainly of zircon, ilmenite, and rutile, with only 2 to 8 percent of other minerals.[36] These deposits have been worked in the past for gold and platinum, but in 1932 two companies were reported to be working the sands on the north coast for zirconium and rutile. Beach Sands Mining Co. has a plant at Tugun Creek and is producing 50 tons of concentrates per month for export. Black Head Mineral Co. is treating its concentrates in Sydney.[37] A small experimental output of rutile has been officially reported in South Australia near Yankalilla Gorge.

Canada.—There was no production of titanium ores in Canada in 1932. Ilmenite, containing in places as much as 15 percent rutile, occurs in large deposits in the St. Urbain district, County Charlevoix, Quebec, about 7 miles north of Baie St. Paul, a town on the north shore of the St. Lawrence River about 60 miles northeast of the city of Quebec. Shipments of ilmenite or "titaniferous iron ore" for export to the United States have been made from this district for several years, amounting to 1,509 short tons valued at $10,261 in 1931. The genesis of these deposits has been discussed by Gillson [38] who after extensive field work in 1930–31, concluded that the ores were formed by replacement in previously solidified anorthosite and were deposited from solutions derived from the same magmatic reservoir from which the anorthosite had come a relatively short time before. An analysis of a deposit of titaniferous magnetite in diabase shows Fe 43.62, TiO_2 21.96, P_2O_5 0.05, V_2O_5 0.18, and S 0.03 percent.

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[35] Hunt, Ralph H., American Vice Consul at Melbourne, Titanium Oxide Plant Almost Completed in Australia: World Trade Notes on Chemicals, etc., Bureau of Foreign and Domestic Commerce, vol. 6, no. 52, Dec. 26, 1932, p. 6.

[36] Whitworth, H. F. Mineralogy and Origin of the Natural Beach-Sand Concentrates of New South Wales: Jour. Proc. Royal Soc. N. S. Wales, vol. 65, 1931, pp. 59–74.

[37] Chemical Engineering and Mining Review: Vol. 24, no. 286, July 5, 1932, p. 352.

[38] Gillson, Joseph L., Genesis of the Ilmenite Deposits of St. Urbain, County Charlevoix, Quebec: Econ. Geol., vol. 27, no. 6, September 1932, pp. 554–577.

France.—The production of titanium white in France was begun in 1923, and the annual output by two producers is estimated at about 600 tons. Plans are contemplated for expanding output.[39]

French West Africa.—Black sands occur all along the Senegal coast and southward in French Guinea and (British) Sierra Leone. Commercial exploitation has been confined to the stretch between Rufisque and the mouth of the Gambia, where the sands are rich in ilmenite due to decomposition of the basaltic rocks of Cape Verde and Gorel Island, the principal centers being in the vicinity of Joal near the mouth of the Saloum. A good grade of ilmenite (50 percent titanium dioxide) is readily separated from the associated minerals, which include zircon, garnet, magnetite, etc. A maximum of 7,240 metric tons was produced in 1929.

Italy.—According to a recently published review [40] the production of titanium white in Italy is increasing. Manufacture of this product was undertaken in 1925, and in 1930 the output had risen to 1,400 metric tons. Titanium white is manufactured by one Milanese firm, which treats titanium ore with sulphuric acid.

Russia.—A large paint and varnish factory with a projected output of 12,000 tons was scheduled to be built in 1932 at Cheliabinsk in the Urals.[41] Unofficial reports are to the effect that some 50 million rubles are to be expended in building 13 plants with an aggregate capacity of 150,000 tons of titanium white, lacquers, and mixed paints. Attention was directed to the smelting of Ural titaniferous magnetite, with the recovery of iron, titanium dioxide, and vanadium as joint products. Rock salt is added to the coal before coking, replacing part of the lime in the subsequent blast furnace smelting operation. Slags with 43 percent titanium dioxide were obtained in laboratory furnace, and subsequently [42] operation on a large scale has been successful.

Sierra Leone.—In the vicinity of York and Hastings, on the coast of Sierra Leone, small quantities of ilmenite, assaying 50 percent or more titanium dioxide, are recovered as a byproduct in mining alluvial platinum.[43] In 1931 an output of 10 tons was officially reported.

United Kingdom.—To provide a British source of titanium pigments for the Empire market a new plant was under construction near Luton by National Pigments, Ltd., a subsidiary of the Imperial Smelting Corporation, and Imperial Chemical Industries, Ltd., Goodlass Wall & Lead Industries, Ltd. of England, and the National Lead Co., and Titan Co. of America are reported to be jointly interested in this development. The Imperial Smelting Corporation is also engaged in production of other pigments.

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[39] Commerce Reports, Expansion of French Paint and Varnish Industry: Bureau of Foreign and Domestic Commerce, no. 17, Apr. 25, 1932, pp. 213–215.
[40] Chemical Age (London), White Pigments in Italy; Notable Increase in Production of Titanium White: Vol. 27, no. 702, Dec. 10, 1932, p. 554.
[41] Economic Review of the Soviet Union, Paint Factory to be built in Cheliabinsk: Vol. 7, Apr. 1, 1932, p. 167.
[42] Britzke, E. V., Shmanenko, I. V., and Tagirov, K. Kh., Utilization of Ural Titano-Magnetites Based on the Work of the Institute of Applied Mineralogy: Mineral. Suir'e, vol. 6, 1931, pp. 626–630; Chem. Abs., vol. 26, July 10, 1932, p. 3462.
[43] Mining Journal (London): Vol. 179, no. 5069, Oct. 15, 1932, p. 693.

World production of titanium minerals, 1931–32

Mineral and country	1931			1932		
	Ore produced	Content of TiO_2	Value [1]	Ore produced	Content of TiO_2	Value [1]
Ilmenite:	*Metric tons*	*Percent*		*Metric tons*	*Percent*	
Brazil [2]				35	(3)	$1,004
Canada (Quebec)	1,369	18–25	$9,884			
India (Travancore)	36,746	54	190,429	(3)	(3)	(3)
Norway	5,000	44	47,604	(3)	(3)	(3)
Portugal	152	50	645	(3)	(3)	(3)
Senegal [2]	1,074	47	14,319	(3)	(3)	(3)
Sierra Leone	10	(3)	(3)	(3)	(3)	(3)
United States	(4)	(4)	(4)	(4)	(4)	(4)
Rutile:						
Norway [5]	21	90–93	6,013	(3)	(3)	(3)
United States	(4)	(4)	(4)	(4)	(4)	(4)

[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] Exports.
[3] Data not available.
[4] Bureau of Mines not at liberty to publish figures.
[5] Concentrates.

ZIRCONIUM

Production of zirconium minerals in the United States has been irregular and almost insignificant, except for the brief period of operations at Pablo Beach, which culminated in an output of 3,646 short tons in 1927. No domestic production has been recorded since 1927, although consideration has been given the possible recovery of zircon as well as ilmenite from black sands in gold mining in North Carolina and other Southeastern States.

Zirconium minerals are widely distributed, but workable deposits are few, being mostly water-concentrated sands in which the zirconium, usually as zircon, is a joint product with other heavy minerals, such as ilmenite and monazite.

Prices.—The quotations for zirconium products, being more or less nominal, are modified infrequently and were only remotely affected by the downward movement of general commodity prices. Zircon ore, 55 percent, has remained stationary for several years at $40 to $45 a short ton, f.o.b. seaboard, in 30-ton lots. For high-grade "Zirkite" (natural ZrO_2) the quotation remained unchanged at 3½ cents a pound for 65 to 70 percent grade, powdered for refractory use; no extra charge is made for fine powdered material, 95 percent through 200 mesh, which is sold as zirkite cement. Zirkite brick at 80 cents to $1 each and "Zirconalba" (high-grade precipitated ZrO_2) at 80 cents to $1.10 a pound and the lower grades of zirconium dioxide at around 30 to 43 cents a pound (according to quantity and ZrO_2 content) were likewise quoted at the same or nearly the same level as in former years. Early in the year a small reduction was made in the price of zirconium-ferrosilicon (12 to 15 percent zirconium, 39 to 43 percent silicon), from $103.50 to $108.50 per long ton to $97.50 to $105 per long ton. In December a reduction was made in silicon-zirconium (35 to 40 percent zirconium, 47 to 52 percent silicon), which dropped from 16 to 19 cents a pound to 13 to 15 cents a pound. Zirconium metal of 98 percent purity has been on the market since 1930; in 1932 it was quoted at $7 a pound or less, according to quantity.

Zircon, which was quoted in France at 600 francs a metric ton in 1929 and 1930, had fallen to 500 francs in the latter half of 1931 and late in 1932 was further reduced to 480 francs a metric ton or only about $17 a short ton.

Uses.—The use of zirconium metal (mixed with magnesium) in flashlight powders seems to have decreased, but some quantity of zirconium is used with a primer to ignite the aluminum leaf in the relatively new "photoflash lamp." Zirconium-alloy additions are attracting more and more attention in the steel industry. Zirconium not only is a vigorous scavenger of oxides and nitrides but also counteracts the harmful effects of high sulphur. Consequently its wider employment is advocated by some metallurgical authorities. Small additions to iron and steel castings result in decided refinement of grain structure and better resistance to impact. Small amounts are used more or less experimentally in nonferrous metal foundries, and zirconium is mentioned as a constituent of several hard alloys (usually in conjunction with tungsten, boron, etc.) and also of certain new corrosion-resisting steels.

Additional data on zircon and zirconia refractories have recently been published by Comstock.[44] Further studies of suitable bonding agents have been mentioned in the trade press and patent literature.

Imports.—Consumption in this country, as indicated by imports (mainly from Brazil), has been as follows:

Imports of zirconium ores and alloys, 1928–32

Year	Zirconium ores		Ferrozirconium, zirconium, and zirconium ferrosilicon	
	Pounds	Value	Pounds	Value
1928	863,685	$9,788	941	$529
1929	2,689,120	35,416	47,048	4,488
1930	3,038,599	40,416	1,215	661
1931	1,124,034	18,945	496	312
1932	26,506	437	----------	----------

THE INDUSTRY IN FOREIGN COUNTRIES

Zirconium ore is mined in Brazil, the leading producing country, as a main product, but elsewhere it is generally a minor byproduct of monazite or ilmenite mining.

Australia.—Natural concentrates, consisting mainly of zircon, ilmenite, and rutile, are found at many points on the coast of New South Wales, and during 1932 two companies were reported to be working beach sands for zirconium and rutile. (See discussion of titanium industry in Australia, p. 363.) In Western Australia the occurrence of zircon in fine sand is widespread, and at Greenbushes and Cheynes Beach the mineral is said to be recoverable in commercial quantities.[45]

Brazil.—The so-called Caldas region on the border of Sao Paulo and Minas Geraes has been the main source of the world's supply of

[44] Comstock, George F., Some Experiments with Zircon and Zirconia Refractories: Jour. Am. Ceram. Soc., vol. 16, no. 1, January 1933, pp. 12–35.

[45] Simpson, E. S., Govt. mineralogist, Western Australia. The Mineral Resources of Western Australia. Undated publicity booklet.

zirconium oxide ores (zirkite, baddeleyite, etc.). Zircon occurs as a constituent of beach sands carrying monazite in Espirito Santo and Bahia, representing up to 63 percent of the total, whereas monazite sand available in Matto Grosso contains as little as 5 or 10 percent. According to a recent consular report [46] deposits in Pocos de Caldas are being exploited on a small scale; other reported deposits, at Franca and Jacupiranga (in Sao Paulo), are apparently idle. The best known deposits in the State of Minas Geraes are controlled by a Sao Paulo firm which reports an exclusive contract with a New York concern covering sales both to the United States and to Europe, where Germany is the principal buyer.

Exports from Brazil in 1932 were 815 metric tons, the largest reported for several years, comparing with 137 tons in 1931 and 237 tons in 1930 and being exceeded only in 1929, when a record total of 1,077 tons was reported.

British India.—Zircon, to the extent of about 6 percent of the total, is associated with ilmenite and monazite in Travancore, and production has grown with the increased demand for ilmenite. In 1931 the output of Indian zircon was 855 tons valued at £7,972 compared with 640 tons valued at £4,991 in 1930.

Madagascar.—Large crystals of zircon weighing several kilograms each are obtainable in substantial tonnages in a disintegrated pegmatite at Mount Ampanobe west of Fianarantsoa. An abundance of zircon sand can be produced in the Beforona district. As indicated by exports, the Madagascar output, reached a maximum of 59 metric tons in 1924 and has subsequently been almost nonexistent except for 24 tons exported in 1929.

[46] Cameron, C. R., Am. consul general, Sao Paulo. Zirconium: Foreign Trade Notes, Bureau of Foreign and Domestic Commerce, vol. 1, no. 5, Oct. 19, 1932.

NICKEL

By Charles White Merrill

Nickel is one of the few important metals supplied to the United States almost entirely by importation. Nickel imports into the United States during 1932 were valued at $4,694,430, while domestically produced supplies consisted of $88,515 worth of nickel, chiefly salts, derived as a byproduct from copper refining and $1,015,000 worth of secondary nickel reclaimed from scrap. Even the byproduct nickel cannot be fully credited to domestic mines because it appears that some of the blister copper richest in nickel is that imported into the United States for refining.

Summary of statistics for nickel in the United States, 1923–32

	1923–27 average	1928	1929	1930	1931	1932
Production:						
At copper refineries [1] short tons	349	522	340	308	373	195
From secondary sources short tons	2, 504	4, 500	4, 350	2, 900	2, 070	1, 450
Value of imports for consumption [2]	$7, 832, 074	$14, 364, 196	$19, 416, 259	$12, 878, 827	$7, 613, 834	$4, 694, 430
Value of exports [2]	$1, 193, 241	$2, 404, 703	$2, 795, 351	$2, 429, 964	$1, 411, 816	$1, 361, 472
Price per pound [3] cents	35.6	37	35	35	35	35

[1] Recovered as a byproduct in the refining of domestic and foreign blister copper.
[2] Includes ore, matte, manufactures, and other nickel products.
[3] Price quoted by International Nickel Co., Inc., for electrolytic nickel at New York, in 2-ton minimum lots.

The United States is the outstanding consumer of nickel, and in recent years its industries have absorbed regularly over half of the world output. The automobile industry alone requires between one quarter and one third of the domestic consumption. Much nickel enters the structural steel and machinery industries, in each of which the United States leads.

Figure 14 pictures outstanding trends in the nickel industry from 1901–32.

The accompanying graph, figure 14, illustrates some of the salient features of the nickel industry since 1901. World mine production and United States imports form two major peaks, one during the World War and the other during the late twenties. The value of United States exports of nickel products, which was plotted exclusive of nickel manufactures before 1918, has not recovered appreciably since the refining of Canadian nickel matte was largely transferred from the United States to Canada during 1918. The lines representing the prices of electrolytic and ingot nickel are only approximations, because there is no open market for these metals. The curves for United States secondary and byproduct outputs of nickel indicate

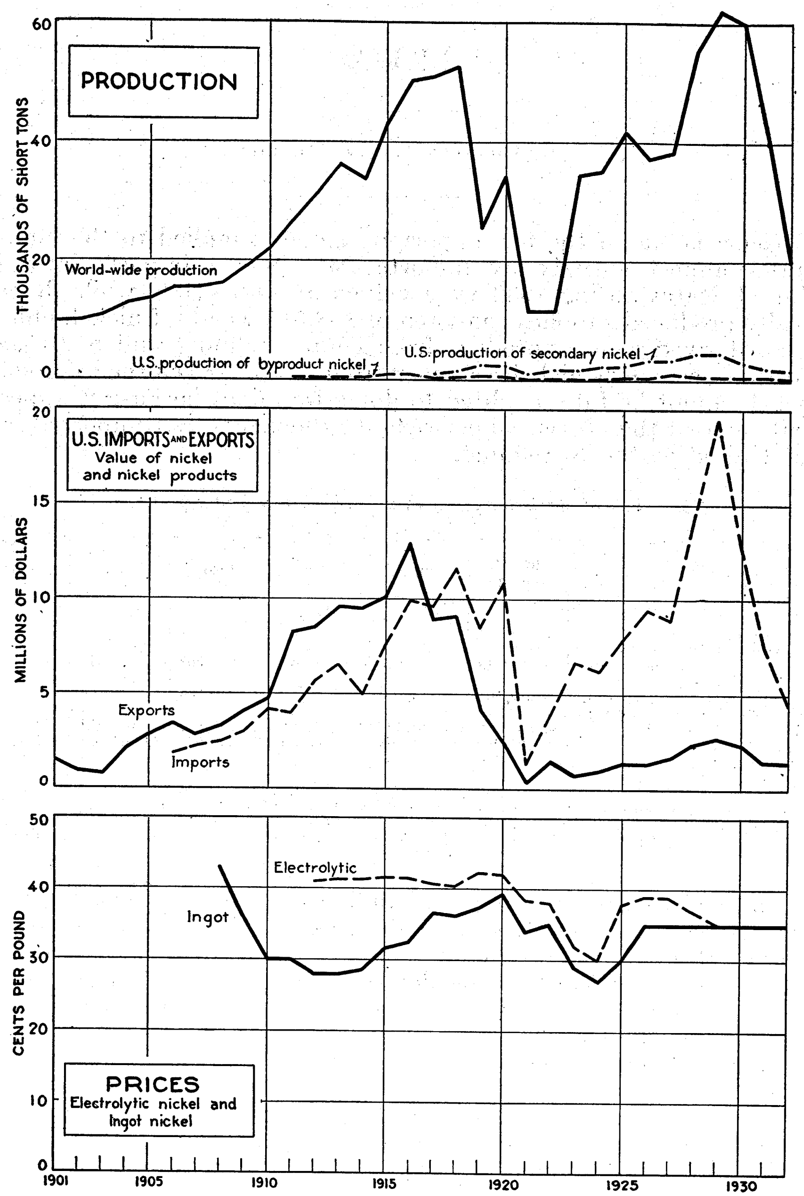

FIGURE 14.—Outstanding trends in the nickel industry, 1901-32.

that only a small proportion of the domestic requirements is supplied internally.

Canada continued to be the principal world source of virgin nickel, producing 15,184 short tons in 1932 or almost three quarters of the world output. The only other source of present importance is New Caledonia, a French island possession in the South Pacific. All the Canadian output was reduced to matte before export, but the refining was shared with the United States, Great Britain, and Norway.

The price of nickel has remained constant since 1928 in spite of the sharp decline in the average price of other commodities and in wages. The constancy of price has been made possible by the fact that the sales of one company in 1932 were 60 percent of world consumption for that year. This company, the International Nickel Co. of Canada, Ltd., together with the Falconbridge Nickel Mines, Ltd., of Canada and the Caledonickel Co. of New Caledonia, control directly, or through their subsidiaries, virtually all the primary nickel output of the world.

The producers of nickel have not curtailed their efforts toward expanding the uses for their product. Until the end of the World War the principal use of nickel was in nickel steel, which was used almost exclusively as armor plate and in various types of military and naval ordnance. At the close of the war, however, those in control of nickel production determined to expand the nonmilitary uses of the metal enough to utilize the capacity of the nickel mines, smelters, and refineries built to meet war-time demands.

This research was pursued with great energy and pronounced success. Today there is little special steel that does not contain some nickel. Ferrous alloys include structural nickel steel, stainless steel, nickel cast iron, nickel wrought iron, and many other alloys already indispensable to modern industry. Nickel plating has expanded, as well as the use of pure nickel and nickel alloys in coinage. Nickel-copper alloys, including Monel metal, have found wide application.

DOMESTIC PRODUCTION

Mine production of nickel in the United States has never been an important factor in the nickel industry. No domestic mine is now being operated for the nickel content of its ore, but in the past there has been some small-scale production.

The electrolytic copper refineries of the United States supply some virgin nickel as a byproduct. As the blister-copper anode dissolves the nickel goes into solution along with the copper, but only the copper is deposited at the cathode. When the electrolyte reaches a concentration of 1 percent nickel the operation of the cell is hindered, and the nickel must be removed. It is precipitated from the solution as a salt in which form it is marketed.

Nickel content of nickel salts and metallic nickel produced in the United States as a byproduct in the electrolytic refining of copper, 1923–32

Year	Short tons	Value	Year	Short tons	Value
Average 1923–27	349	$196,294	1930	308	$213,803
1928	522	291,836	1931	373	202,406
1929	340	297,273	1932	195	88,515

The nickel recovered from scrap and junk is an important item in supplying the domestic demand. During 1932 the nickel thus supplied exceeded 20 percent of the value of nickel imports for consumption.

Secondary nickel recovered as metal and in nonferrous alloys and salts in the United States, 1923–32

Year	Short tons	Value	Year	Short tons	Value
Average 1923-27	2,504	$1,671,260	1930	2,900	$2,030,000
1928	4,500	3,150,000	1931	2,070	1,449,000
1929	4,350	3,045,000	1932	1,450	1,015,000

IMPORTS AND EXPORTS

The value of nickel imports for 1932 declined 38 percent from 1931 and 76 percent from the record year 1929. As has been the case for many years, virtually all the imports were raw or semimanufactured.

Value of nickel imported into and exported from the United States, 1923–32

Year	Imports for consumption			Exports				
	Nickel, nickel ore and matte, nickel oxide, and alloys of nickel with copper, etc.	Manufactures and nickel sheets and strips	Total	Nickel, Monel metal, and other alloys	Manufactures	Nickel silver or German silver in bars, rods, or sheets	Nickel-chrome electric resistance wire	Total
Average 1923-27	$7,743,808	$88,266	$7,832,074	$547,542	$443,550	$202,024	(1)	[2] $1,193,241
1928	14,069,357	294,839	14,364,196	879,939	1,160,626	364,138	(1)	2,404,703
1929	19,098,105	318,154	19,416,259	1,115,568	1,347,391	325,992	(1)	[3] 2,795,351
1930	12,750,721	128,106	12,878,827	1,207,612	923,547	243,528	(1)	[3] 2,429,964
1931	7,565,824	48,010	7,613,834	648,026	438,333	72,350	$253,107	1,411,816
1932	4,660,489	33,941	4,694,430	635,399	432,173	43,219	250,681	1,361,472

[1] Not separately recorded.
[2] Includes oxide and matte valued at $626 in 1923.
[3] Includes nickel salts valued at $6,400 in 1929 and $55,277 in 1930; not separately recorded for other years.

Exports held up much better than imports, showing a 4 percent decline in 1932 compared with 1931 and a 51 percent decline compared with 1929. Exports are divided approximately equally with respect to values between nickel manufactures and the products of refineries.

Nickel imported for consumption in the United States, 1930–32, by classes

Class	1930		1931		1932	
	Pounds	Value	Pounds	Value	Pounds	Value
Unmanufactured:						
Nickel ore and matte	20,593,361	$2,940,074	11,629,709	$1,530,557	5,917,770	$775,438
Nickel alloys, pigs, bars, etc	38,323,029	9,600,404	23,633,754	5,987,610	15,023,813	3,764,803
Nickel oxide	1,353,096	209,420	304,991	47,522	687,597	120,248
Nickel silver or German silver	6,456	823	100	135		
Manufactured:						
Nickel silver or German silver in sheets, strips, and rods	10,101	6,513	10,111	5,247	2,193	1,743
All other manufactures of nickel		121,593		42,763		32,198
		12,878,827		7,613,834		4,694,430

Nickel exported from the United States, 1930–32, by classes

Class	1930		1931		1932	
	Pounds	Value	Pounds	Value	Pounds	Value
Nickel Monel metal and other alloys	2, 839, 446	$1, 207, 612	1, 776, 917	$648, 026	2, 059, 352	$635, 399
Manufactures	(1)	923, 547	(1)	438, 333		432, 173
Nickel-chrome electric resistance wire	(2)	(2)	175, 707	253, 107	229, 596	250, 681
Nickel silver or German silver in bars, rods, or sheets	1, 122, 050	243, 528	409, 847	72, 350	237, 128	43, 219
Nickel salts	815, 512	55, 277	(3)	(3)	(3)	(3)

1 Quantity not recorded.
2 Not separately recorded before 1931.
3 Not separately recorded.

CONSUMPTION, USES, AND SUBSTITUTES

The United States normally consumes more than one half of the world nickel output. Special alloy steels used in automobiles, machines, structural steels, and many other products have contributed to the demand for nickel. In these steels it has been the extraordinary qualities of strength and toughness imparted by nickel that have made its use so important. Nickel frequently is added to rust- and stain-resisting ferrous alloys.

Nickel has proved indispensable to modern industry in many of its alloys other than the ferrous group. Probably most important is the direct-smelted alloy containing approximately two thirds nickel and one third copper, known by the registered trade-mark name of "Monel" metal. The proportion of nickel to copper in Monel metal is the same as that in the typical ore of the Sudbury district. These nonferrous alloys are distinguished by their resistance to stain, their workability, and their strength. Nickel silver, an alloy containing nickel, copper, and zinc continues to be used extensively as a base for silver-plated ware, flat keys, plumbing fixtures, and many other uses.

Electroplating, an old use for nickel, has been superseded to some extent by chromium plating. It has been found necessary, however, to apply a heavy plate of nickel before applying the chromium plate to obtain the best results. In fact it is said that more nickel is consumed per unit area for chromium plating then was formerly used for nickel plating.

Nickel-clad steel plate, a product introduced during 1931, is reported to have received wider acceptance during 1932. It is made by roll-plating pure nickel on steel. The resulting sheets have a surface highly resistant to chemical attack but otherwise have the qualities of steel.

The use of nickel in coins, catalyzers, Edison storage batteries, heat-resisting alloys, electrical alloys, and many other products of modern civilization was continued. The legalization of 3.2-percent beer in the United States early in 1933 probably will increase the demand for nickel because of the trend toward the use of more white-metal alloys for fermentation tanks, storage tanks, shipping containers, and other brewing and beer-dispensing equipment. During the years that the brewing industry has been restricted in the United States nickel-bearing equipment has increased in popularity in foreign breweries.

PRICES AND STOCKS

The price range of nickel has been very narrow for many years as the control of price and stocks has been a matter of policy by the leading producers. Close cooperation among present producers and the lack of deposits not controlled by them, which promise much prospect of profitable exploitation at current prices, have made this constant price policy very effective.

Quoted prices [1] for nickel at New York, in cents per pound, 1923–32

	Electrolytic	Ingot	Shot
1923–27, average	35.6	31.2	31.8
1928	37.0	35.0	36.0
1929	35.0	35.0	36.0
1930	35.0	35.0	----------
1931	35.0	[2] 36.0	[2] 36.0
1932	35.0	[2] 36.0	[2] 36.0

[1] Prices quoted by International Nickel Co., Inc., for 2-ton minimum lots.
[2] Made from remelted electrolytic.

WORLD PRODUCTION AND RESOURCES

The production of nickel for the world in 1932 is estimated at 22,000 short tons compared with 39,800 tons in 1931 and 59,800 tons in 1930. Canada continues to be the outstanding producer, accounting for almost three quarters of the world output.

World production of nickel ore (content of ore), 1923–32, by countries, in short tons

Country	1923–27 (average)	1928	1929	1930	1931	1932
Australia	19	--------	95	132	--------	(1)
Canada	33,008	48,377	55,138	51,884	32,833	15,184
Greece	12	726	284	--------	715	(1)
India	100	814	930	1,065	984	840
Italy	11	--------	--------	--------	--------	--------
New Caledonia	[2] 3,767	4,480	[3] 4,816	[3] 5,376	[3] 4,256	5,000
Norway	36	451	483	965	586	(1)
United States [4]	349	522	340	308	373	195
Total	37,300	55,400	62,100	59,800	39,800	22,000

[1] Information not available.
[2] Exports.
[3] Nickel content of matte and ferronickel obtained at smelters.
[4] Nickel obtained from electrolytic refining of domestic and foreign blister copper.

Canada.—Canadian nickel production is localized in the Sudbury mining district of northern Ontario, where are the mines of the International Nickel Co. of Canada, Ltd., and of the Falconbridge Nickel Mines, Ltd., 2 of the 3 principal nickel-producing companies of the world (the third being the Caledonickel Co. of New Caledonia). Both companies smelt all their ore in Canada. The International Nickel Co. divides the matte produced at its smelters between its refineries in Canada, Great Britain, and the United States, where Monel metal is made at the Huntington (W.Va.) plant. The Falconbridge Co. matte goes to its refinery in Norway. Both companies report enormous ore reserves; it is estimated that well-authenticated reserves in the Sudbury district could maintain the present Canadian production rate for a century.

New Caledonia.—New Caledonia has been an important source of nickel for many years. The two principal nickel-mining companies of the island, La Société le Nickel and La Société Caledonia, recently formed a holding company, "Caledonickel", to work their properties jointly for the next 25 years. The ore is now reduced to matte and ferronickel and shipped to France and Belgium for refining.

Other countries.—There are no other important producers of nickel, but some output is reported from India, Norway, Greece, Australia, Italy, and Germany. Deposits have been reported in many other countries.

ORE CONCENTRATION

By T. H. Miller

The year 1932 was a period of retrenchment in the ore-dressing industry in the United States. The quantity of ore treated at concentration plants declined sharply, due chiefly to the closing of many large copper concentrators. However, a substantial increase was reported in the quantity of gold ore treated by concentration, and many advances in concentration practice during the year were made at mills treating ore of this type.

Figures covering the total consumption of flotation reagents during 1932 are not yet available, but there was undoubtedly a large decrease compared with the 1931 data in the accompanying table. Few changes were noted in reagent combinations, and no new flotation reagents which have reached an important position were introduced during 1932. The closing of many large mills and the curtailment at other plants have caused research activity to be suspended at many establishments, thereby retarding advancement in flotation technology. The manufacturers of flotation reagents and equipment had little incentive to push development of new reagents and machines during the year.

The steady decline in the mining of high-grade smelting ores in recent decades has resulted in a gradual increase in the quantity of ore treated by concentration. In recent years flotation has become the chief method of concentration, and the growth of this method has been so rapid that more than 80 percent of the total nonferrous ore mined in the United States is being treated at concentration plants using flotation equipment. Data on flotation concentration have value not only to manufacturers of flotation reagents and equipment but also to operators of concentration plants, because they show the trend in the use of flotation reagents, give average metallurgical results at concentration plants, and indicate improvements in milling.

Metallurgical results at concentration plants in 1932 improved over the preceding year. Several factors contributed to this improvement, including the betterment caused by operation of milling units at reduced capacity and the economic necessity of making the highest possible recoveries during periods of low metal prices. Improvements were also noted in the grade of concentrates produced at several large concentrators.

Consumption of reagents in the treatment of all ores in 1931

[160 plants treating 35,955,669 tons of ore]

Reagent	Plants using	Ore treated, tons	Consumption of reagents, pounds: Total, 1931	Per ton: 1931	Per ton: 1930
I. Frothers:					
Pine oils	132	26,633,104	3,281,543	0.123	0.121
Cresylic acid	69	13,463,643	2,225,282	.165	.156
Orthotoluidine	2	114,878	943	.008	.181
Total frothers	159	35,955,417	5,507,768	.153	.152
II. Collectors:					
Distillation products:					
Coal-tar creosotes	46	2,638,204	490,862	.186	.132
Wood-tar creosotes	8	1,334,456	68,880	.052	.057
Pine-tar oils	2	937,600	5,200	.006	--------
Petroleum products	3	153,059	15,799	.103	.089
Blast-furnace oils	2	2,117,951	169,102	.080	.074
Water-gas tars	2	13,291	2,825	.213	.250
Total distillation products	56	5,967,825	752,668	.126	.106
Synthetic products:					
Ethyl xanthates	123	21,818,994	2,411,203	.111	.108
Butyl xanthates	3	4,091,282	212,926	.052	.025
Amyl xanthates	34	10,573,890	300,904	.028	.022
Xanthate derivatives	8	5,718,156	64,764	.011	.001
Dicresol-dithiophosphoric acid	52	2,721,911	298,316	.110	.055
Sodium dicresol-dithiophosphate	23	3,071,868	106,172	.035	.039
Sodium diethyl-dithiophosphate	1	8,147,764	105,776	.013	.013
Thioamino-phosphate	1	252	40	.159	--------
Thiocarbanilide	8	705,204	42,975	.061	.030
Total synthetic products	153	35,474,637	3,543,076	.100	.107
Total collectors	160	35,955,669	4,295,744	.119	.130
III. Acids and alkalies:					
Acids—sulphuric acid	7	522,107	11,142,955	21.342	24.933
Alkalies:					
Sodium carbonate	32	1,498,036	877,852	.586	.420
Sodium bicarbonate	1	58,636	14,659	.250	--------
Sodium hydroxide	1	147,505	8,400	.057	.256
Lime	55	29,256,502	112,897,662	3.859	3.645
Cement	1	266,300	1,945,518	7.306	8.246
Total alkalies	80	30,045,158	115,744,091	3.852	3.560
IV. Other inorganic reagents:					
Sulphidizing—sodium sulphide	15	888,986	642,815	.723	.154
Activating—copper sulphate	83	5,611,071	3,324,908	.593	.697
Depressing:					
Cyanides	26	11,680,122	589,091	.050	.056
Sodium sulphite	4	318,045	368,171	1.158	.464
Sodium silicate	8	303,830	261,782	.862	.539
Zinc sulphate	23	3,509,850	1,018,803	.290	.423
Sodium bichromate	1	41,079	14,379	.350	.177
Sodium sulphate	1	43,342	6,049	.140	--------
Total depressing	43	13,591,367	2,258,275	.166	.239
Miscellaneous:					
Sodium chloride	1	80,968	100,645	1.243	.102
Sodium bisulphite	1	9,911	14,170	1.430	--------
Sodium aluminate	1	21,700	870	.040	--------
Starch	2	143,221	36,068	.252	--------
Total reagents	160	35,955,669	143,068,309	3.979	4.036

Comparatively few new milling plants were built during 1932. Several plants treating gold ores were remodeled during the year, and a few small gold mills were built, but the major new construction during 1932 was centered in the tri-State region. In this area two large central milling plants were built to treat zinc ore and lead-zinc ore from several mines in this district. Very little new construction was reported at the large copper and lead plants.

Many changes were made in the equipment and flow sheets of the plants treating gold ores, and the operators were experimenting with new machines and processes in an effort to improve gold recovery. Special interest centered around modifications effected to recover as much of the gold as possible at the earliest stage possible in the flow sheet. The grinding and classification operations in these mills are being studied in an effort to recover coarse free gold at an early stage and to prevent or reduce the accumulation of gold in the grinding circuit. Amalgamation, blanket concentration, tabling, and flotation have been employed successfully at various plants operating on the ball-mill discharge removing gold from the feed before advancing the pulp to the classifier. The recovery of bullion or rich gold concentrates at this point reduces the tenor of the pulp fed to the main treating equipment and has considerable economic value in that it tends to prevent mill losses due to fluctuating feed. The rich gold concentrates produced by these operations may be shipped direct to a smelter or in certain cases may be treated by barrel amalgamation to yield gold bullion.

As in previous years, there seems to be no definite trend toward standardization of flotation reagents used in treating gold ores. These ores represent a large variety of mineralogical mixtures, and the reagents giving the best results on one type may be decidedly different from those used in the treatment of other gold ores. The higher alcoholic xanthates seem to be gaining favor as the collecting, or promoting, reagent, but many operators using these reagents also use supplementary collectors of other types. Pine oils continue to be the chief frothing reagent employed in treating gold ores. Certain types of gold ores frequently present a primary slime problem caused by clay, talc, graphite, or some other substance which tends to float with the gold, thus diluting the gold concentrates. Efforts to remove these substances before floating the gold have as yet been generally unsuccessful due to losses of gold. The use of soluble starch, which tends to prevent flotation of the primary slime, has solved the problem of at least two flotation plants.

The activating, depressing, alkalinity-controlling, and sulphidizing reagents used in the treatment of gold ores depend on the character of the base-metal minerals with which the gold is associated. In these respects the flotation of gold ore is similar to that of base-metal ores.

Copper sulphate has been found to have considerable value in several gold-flotation plants. Many concentrating plants using flotation in the treatment of gold ores also use other treatment processes, such as amalgamation or cyanidation, and the trend seems to be toward the development of combined processes rather than the application of straight flotation. This trend is not only in evidence in the United States but also in other countries, notably Canada.

An interesting development in the application of flotation was in the experimental stage during 1932 and will probably receive commercial testing during 1933. The recovery of finely divided gold from placer sands has long been an ore-dressing problem, since the so-called "flour gold" does not amalgamate easily, and its recovery on blankets, strakes, and tables is very difficult. The application of flotation in recovery of gold from this material is being watched with great interest.

PART III. NONMETALS

COAL

By F. G. Tryon and H. O. Rogers

In the coal industry 1932 brought the smallest volume of tonnage in a generation. The demand for bituminous coal was the lowest since 1904 and for anthracite the lowest since the early nineties. The drop was chiefly due to the great depression, accentuated by extraordinarily mild weather in January and February and by continued incursions of competitive fuels, especially in the anthracite territory. It was a year of falling prices and of heavy financial loss. Wage rates declined in both union and nonunion bituminous fields, and while there was no change in the posted rates of the anthracite region, earnings there as elsewhere were reduced by low running time. Relief of the unemployed, everywhere a grave social problem, was especially serious in many communities of the bituminous fields, where other industries to fall back upon are lacking and resources were already exhausted by years of hard times dating back to 1924. In these communities the existence of a special relief problem had been recognized by the American Friends Service Committee, and at the peak of its activities in 1932 the committee, using both public and private funds, was feeding miners' children in 563 communities in 41 counties of West Virginia, Kentucky, Pennsylvania, southern Illinois, Tennessee, and Maryland. The committee's activities supplemented wide-spread relief work by the Red Cross, employers, and State and local authorities covering coal as well as other industries.

In spite of the money losses and the hardships of unemployment, the year was not without forward-looking developments. Further advances in operating efficiency were effected by mechanization, strengthening the industry's position in competing with other fuels. Liquidation of excess capacity through closing of marginal mines continued. After numerous unsuccessful attempts at district mergers and consolidations, plans for regional sales agencies took definite shape in the organization of Appalachian Coals, Inc., and steps were taken to test the legality of the new plan in the courts.

Coal mining is an industry of many thousands of competing units. Not counting wagon mines and country coal banks, bituminous coal was produced in 1931 by 5,642 mines of commercial size. As this book goes to the printer many of the mines have not yet reported their operations for 1932. The following analysis is therefore based on preliminary estimates made from railroad carloadings. The figures are subject to revision. Details will be published later when final returns have been received.

Salient statistics of the coal industry in 1931–32 [1]

[All tonnage figures represent net tons of 2,000 pounds]

	Bituminous coal			Pennsylvania anthracite		
	1931	1932	Percent of change	1931	1932	Percent of change
Production ....tons..	382, 089, 396	305, 667, 000	−20. 0	59, 645, 652	49, 900, 000	−16. 3
Value at mines	$588, 895, 000	$416, 000, 000	−29. 4	$296, 355, 000	$222, 000, 000	−25. 1
Average value per ton	$1. 54	$1. 36	−11. 7	$4. 97	$4. 45	−10. 5
Average retail price [2]	$8. 33	$7. 71	−7. 4	[3] $14. 80	[3] $13. 91	[3] −6. 0
Stocks on hand: [4]						
Jan. 1 ....tons..	37, 200, 000	35, 500, 000	−4. 6	2, 975, 000	3, 073, 000	+3. 3
Dec. 31 ....do....	35, 500, 000	29, 666, 000	−16. 4	3, 073, 000	1, 732, 000	−43. 6
Exports ....do....	12, 126, 299	8, 814, 000	−27. 3	1, 778, 000	1, 303, 000	−26. 7
Imports ....do....	206, 303	187, 000	−9. 4	638, 000	607, 000	−4. 9
Consumption (calculated) ....do....	371, 869, 000	302, 874, 000	−18. 6	58, 408, 000	50, 545, 000	−13. 5
Index of employment, yearly average [2] [5]	83. 2	67. 4	−19. 0	80. 5	62. 5	−22. 4
Index of pay-roll totals, yearly average [2] [5]	57. 5	35. 6	−38. 1	75. 4	53. 7	−28. 8

[1] Figures for 1932 are in most instances preliminary and subject to revision.
[2] Compiled by the Bureau of Labor Statistics, U.S. Department of Labor.
[3] Represents the average retail price of stove coal only.
[4] Figures for bituminous coal represent consumers' stocks; for anthracite, producers' stocks.
[5] 12-month average, 1929=100.0.

BITUMINOUS COAL

SOFT-COAL MARKET IN 1932

Output for year.—The total production of bituminous coal in 1932 was 305,667,000 net tons, compared with 382,089,396 tons in 1931. The 1932 output was below even that of 1922, the year of the great strike, and below the depression of 1921. In fact, to find a parallel tonnage it is necessary to turn back the calendar a quarter century. The fact vividly illustrates the depth of the great depression, for the demand for bituminous coal is a cross section of all industry.

In comparison with the year before the output of 1932 represents a decrease of 20 percent; in comparison with 1929, a decrease of 42.9 percent. To the harassed mine owner scarcely able to meet his pay rolls it is small comfort to be told that other industries have fallen off still more, yet it is a fact that the production of copper was 73 percent below 1929, of automobiles 75 percent below, and of steel 76 percent below. On the other hand, the production of foodstuffs and clothing held up better than did coal. The manufacture of food products in 1932 ran only 10 percent below 1929, of leather goods 17 percent below, and of cotton textiles 22 percent below. The decline of 42.9 percent in bituminous-coal mining was less than the average for business as a whole, as the Federal Reserve Board index of industrial production showed a decrease below 1929 or 46 percent.

Monthly production.—The trend of the year's business is shown graphically in figure 15. For the first 7 months virtually all accepted barometers of business were moving downward, and the retreat of bituminous coal was interrupted only by the exigencies of the weather and the negotiation of wage agreements. As the year opened, production was running at 1,102,000 tons a day. In January and February unseasonably mild weather limited demand. At Chicago the average temperature was 9.9 degrees above normal in January and 8.6

degrees above normal in February, and these records typified conditions over most of the soft-coal market. In March a belated cold spell arrived, and the average temperature at Chicago fell 5.2 degrees below the normal for the month, similar temperatures prevailing over much of the interior of the country. The effect of the cold snap was augmented by prospects of a suspension in Illinois and Indiana on April 1; some of the western railroads and industrials bought reserve coal, and output for the month of March passed the midwinter level. The stimulus of the suspension was short-lived. Although thousands of men quit work in Illinois, Indiana, and Ohio, with lesser demonstrations in Arkansas and Oklahoma, consumers found no difficulty in placing orders elsewhere. While production for April in the adjacent fields of the interior profited slightly by the stoppage, national production was 29.5 percent below that for 1931, and output continued to decline in the 2 months following. The

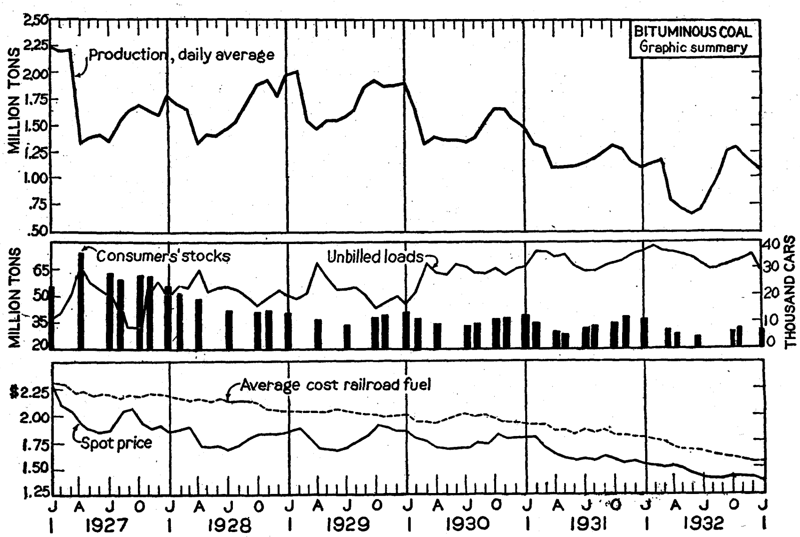

FIGURE 15.—Current trends of production, stocks, and prices of bituminous coal, 1927-32.

low point in bituminous production was reached in June; the low point in general business came a few weeks later.

During the black month of July the Federal Reserve Board index of industrial production dropped to 47, taking 1929 as 100. The index of factory employment dropped to 58 on the same base and the index of factory pay rolls to 37. In August conditions in the heavy industries grew worse; steel mills ran at 16 percent of capacity in June, at 15 percent in July, and at 14 percent in August. By this time, however, encouraging recovery in consumers' goods had begun. Cotton textiles, woolens, and leather goods reported a sudden increase, and bituminous coal joined in the advance. The lake trade expecially felt the stimulus, and production increased steadily to a daily average of 1,266,000 tons in November. In December for the first time the monthly output passed that of the corresponding season of 1931. As the year closed, however, the market was again weakening, reflecting the disturbances of credit which were to end in the bank closures of March 6, 1933.

Trend of stocks.—The number of unbilled loads—cars loaded with coal for which the railroads had received no billing instructions from the shipper—was high throughout the year (fig. 15). The average number of no bills for the year was 34,160 cars (1,708,000 tons). This was 56 percent higher than the average for 1929 and nearly four times as high as during the last period of really active market enjoyed by the industry toward the end of the 1927 strike. The increase in no bills was one sign of the presence of distress coal and exercised an unfortunate pressure on the market.

In other directions a notable liquidation of stocks was effected during 1932. The year opened with 8,634,000 tons in storage on the docks of Lakes Superior and Michigan and closed with 6,793,000 tons, a net reduction of 1,841,000 tons. The greatest reduction, however, occurred in the stocks of consumers. Liquidation had been in process ever since the accumulation of the extraordinary reserve of 75,000,000 tons on April 1, 1927, in anticipation of the end of the Jacksonville wage agreement (fig. 15); and while the usual seasonal recovery had occurred in the fall of 1929, 1930, and 1931, each succeeding year had witnessed a net decline in the tonnage on hand. The draft on storage was accelerated in 1932. The year opened with 35,500,000 tons in the hands of commercial consumers. As usual, a low point was touched in midsummer, and on July 1 reserves were 26,300,000 tons. Consumers normally lay in additional supplies in anticipation of the heating season, and on November 1 they reported 30,038,000 tons. December closed with stocks of 29,666,000 tons, a net curtailment of 5,834,000 tons for the year. Even at the reduced rate of consumption prevailing, the stocks on December 31 were sufficient for only 30 days and the tonnage was the smallest since the great strike of 1922. The progress in disposition of stocks was one encouraging feature of the year. It is a necessary step in business recovery, and by comparison with some other industries—copper, for example—the position of stocks of bituminous coal is now favorable. It is clear that stocks can no longer be regarded as an unduly heavy burden on the market and that any revival of consumption will be promptly reflected in an increased demand upon the mines.

Consumption.—Allowing for changes in stocks and for imports and exports, the year's consumption was 302,874,000 tons, as against 371,869,000 in 1931. The decrease in consumption was therefore slightly less than that in production, although the difference measured in terms of percentage is not material. The shrinkage of demand was felt nearly everywhere, and throughout the year the current indicators of consumption—railroads, coke ovens, electric utilities, and ships' bunkers—were running below the corresponding month of 1931.

Prices.—Prices, f.o.b. mines, moved downward. Discontinuance of Coal Age's excellent index of spot prices in October 1931 has deprived the industry of one of its most useful guides; but in figure 15 quotations from other coal-trade journals have been pieced to the Coal Age curve in such a way as to indicate the general trend, and from the quotations available it appears that the average of spot prices in 1932 was about 12 percent below the preceding year.

A more accurate indicator of the movement of the price level is the cost of locomotive fuel (fig. 15). The cost is reported monthly by class I carriers to the Interstate Commerce Commission. It excludes direct freight charges but includes certain expenses of handling by the receiving carrier. It includes both spot and contract tonnage. In December 1931 railroad-fuel costs averaged $1.77 per net ton. The price paid declined steadily and in December 1932 it stood at $1.54, 23 cents a ton below the year before. The average for the year 1932 was $1.66 a ton, as against $1.84 in 1931.

No average, however, can show the bottom levels of price. Trade-journal quotations indicate run-of-mine selling as low as 80 cents and 60 cents and screenings as low as 15 cents and 10 cents a ton. Even the trade-journal quotations fail to show the bottom of the market, and it is known that considerable blocks of screenings changed hands at 5 cents a ton.

The average sales realization on all coal produced during the year was $1.36, a preliminary figure based on incomplete returns and subject to revision on receipt of final data. It may be compared with the average of $1.54 in 1931 and $1.78 in 1929. In the decade since 1923 the average realization has come down $1.32 a ton, yet in spite of the decrease the 1932 average was still above the $1.18 in the pre-war year 1913. (See fig. 18.)

Wage changes in 1932.—To avoid misunderstanding of the decline in prices it is necessary to refer to changes in wage scales during 1932. Reductions were made in all the organized districts, which may be illustrated by the changes in Illinois and Indiana. After a suspension of 19 weeks, on August 10 a new agreement was signed in Illinois, reducing the basic rate for pick mining (Danville district) from 91 cents to 68 cents a ton and reducing the day scale for track layers and timbermen from $6.10 to $5. In Indiana an agreement was reached September 10 bringing the pick-mining rate down from 91 cents to 68 cents a ton and the inside day rate down to $4.57½, as against $6.10.[1] Reductions of greater or less degree were made in other organized districts. In the nonunion fields no systematic record of wage rates exists, though here, as in the union territory, the movement was downward in 1932.

Freight rates.—A general emergency increase in freight rates was granted the railroads, effective January 4. On coal the advance amounted to 6 cents a ton. According to the records of the Interstate Commerce Commission the average revenue per ton of bituminous coal originated by class I roads was $2.26 a ton in the first three quarters of 1932 against $2.22 in 1931. With freight rates increasing and mine prices declining, the influence of transport charges on the competitive position of the industry was greater than ever before. Ten years ago the mine price exceeded the average freight charge. Today the average freight charge far exceeds the average mine price. For the last 4 years the relation has been as given in the table on page 386.

The figures in column (1) are the average value per ton less selling expenses of all bituminous coal f.o.b. mine, as reported by the operators to the Bureau of Mines. Those in column (2) are the average receipts collected by class I roads on the revenue shipments originated by them. The total in column (3) will give a rough measure of the cost of bituminous delivered at the consumers' siding, although it does not include operators' selling expenses (or wholesalers' margins) or pier and vessel charges on that part of the output transported via

[1] Coal Age, February 1933, p. 35.

tidewater or the Great Lakes. The comparison illustrates how a large percentage cut in mine prices may result in a comparatively small percentage cut in delivered cost. From 1929–32 mine prices were cut an average of 23.6 percent, but as freight charges actually increased the net effect on the average delivered cost was a cut of 10.2 percent.

	(1) Average price of bituminous, f.o.b. mine	(2) Average railroad freight revenue per ton	(3) Total (1)+(2)		(1) Average price of bituminous, f.o.b. mine	(2) Average railroad freight revenue per ton	(3) Total (1)+(2)
1929	$1.78	$2.25	$4.03	1929 percent	44.2	55.8	100.0
1930	1.70	2.23	3.93	1930 do	43.3	56.7	100.0
1931	1.54	2.22	3.76	1931 do	41.0	59.0	100.0
1932, preliminary	1.36	2.26	3.62	1932, preliminary do	37.6	62.4	100.0

Retail prices.—Prices of house coal for sidewalk delivery also moved slowly downward during the year. According to the Bureau of Labor Statistics the average retail price of the grades typically sold for domestic use in 38 cities declined from $8.17 in January to $7.51 in December. The average price for the year was $7.71, against $8.33 in 1931. The decrease in the average was thus $0.62 (7.4 percent).

Employment in 1932.—Fewer men were employed at the mines in 1932, and those that managed to keep their jobs worked shorter time. Pending final returns from the operators, the best guide to the trend of employment is the monthly report of the Bureau of Labor Statistics, which covers about 1,200 mines employing nearly half of the workers in the industry.[2]

Taking the average for 1929 as 100.0, the index of number of men on the pay rolls stood at 80.8 in January 1932. At the midsummer low it fell to 58.6 but recovered to 70.0 in December at the time of the winter increase in demand. For the year as a whole the index of number on the rolls averaged 67.4, indicating a drop of one third below the 1929 level.

A much sharper drop occurred in the sum paid out in wages, partly because of diminished working time and partly because of the reduction in wage scales already cited. Taking 1929 as 100.0, the index of wage payments was 47.0 in January 1932, dropped to 24.4 in July, and stood at 37.7 at the close of the year. For 1932 as a whole the pay-roll index averaged 35.6, indicating that the sums paid in wages during this year of acute depression were 64.4 percent less than in more prosperous times. By years the employment indexes were:

	1929	1930	1931	1932
Index of number on pay rolls	100.0	93.4	83.2	67.4
Index of sum paid in wages	100.0	81.3	57.5	35.6

[2] Bureau of Labor Statistics, Trend of Employment: March 1933, p. 31.

Statistical summary of monthly developments in the bituminous-coal industry in 1932

[All tonnage figures represent thousands of net tons]

	January	February	March	April	May	June	July	August	September	October	November	December	Total, 1932	Total, 1931
Production, including mine fuel and local sales: [1]														
Monthly total	27,892	28,013	32,250	20,300	18,384	17,749	17,857	22,489	26,314	32,677	30,632	31,110	305,667	382,089
Average per working day	1,102	1,130	1,194	790	727	683	714	833	1,040	1,257	1,266	1,197	994	1,243
Distribution:														
Rail movements (including railway fuel):														
From Appalachians north of Alabama:														
To tidewater	2,574	2,435	2,483	2,260	1,967	1,921	1,832	2,055	2,067	2,331	2,288	2,564	26,777	33,486
To New England	540	445	468	398	318	236	275	281	337	450	439	526	4,713	5,675
To Lake Erie	17	21	346	1,320	2,156	2,514	2,997	3,506	3,681	4,128	2,871	128	23,685	30,182
Westbound, commercial	5,722	5,684	6,211	3,654	2,724	2,481	2,705	3,373	4,311	5,813	5,149	6,531	54,358	66,899
East and southbound, local and railway fuel (all rail)	7,235	7,632	8,794	6,924	5,725	5,123	4,609	6,021	6,648	7,888	7,959	8,294	82,852	102,918
From Alabama field	679	644	687	561	582	484	449	569	620	776	752	752	7,555	11,667
From Interior fields	6,457	6,716	8,892	2,008	2,244	2,417	2,604	3,619	4,790	6,420	6,562	7,294	60,023	72,464
From far western fields	2,085	1,919	1,473	969	835	828	638	968	1,468	1,926	1,820	2,145	17,074	19,861
Lake dock receipts	13	5	10	132	618	1,092	1,217	1,418	1,686	1,730	1,656	32	9,609	12,127
Lake dock deliveries	1,170	1,291	1,183	768	634	545	673	679	876	1,140	1,173	1,336	11,468	11,629
New England tide receipts	1,039	1,027	989	948	799	722	615	774	765	858	836	1,105	10,477	12,374
Exports to Canada and Mexico	377	396	431	578	704	717	751	924	906	1,110	1,044	491	8,429	10,647
Exports to Caribbean region	35	24	18	24	21	27	17	14	25	12	18	4	239	751
Exports "overseas"	23	12	2	14	17	3	25	23	2	12	(2)	13	146	728
Imports	18	28	17	16	12	8	8	11	15	15	20	19	187	206
Industrial consumption by: [1]														
Railroad fuel, class I roads	6,195	5,911	6,470	5,580	5,168	4,690	4,678	4,773	5,127	5,978	5,635	6,001	66,206	81,245
Electric-power utilities	2,852	2,598	2,727	2,332	2,261	2,347	2,330	2,517	2,558	2,610	2,480	2,678	30,290	38,735
Byproduct coke ovens	3,036	2,886	3,023	2,724	2,518	2,220	2,198	2,127	2,233	2,514	2,532	2,582	30,593	46,658
Beehive coke ovens	136	132	135	86	69	64	59	63	71	104	126	148	1,193	1,973
Bunker coal, foreign	104	137	100	104	125	123	117	121	112	110	104	93	1,350	2,195
Coal-mine fuel	266	267	307	193	175	169	170	214	251	311	292	296	2,911	3,205
Stocks at end of period shown: [1]														
Unbilled loads	1,949	1,814	1,808	1,756	1,749	1,632	1,480	1,505	1,555	1,677	1,751	1,494	1,494	1,820
Byproduct coke plants	4,894	4,326	3,766	3,646	3,702	3,662	3,741	4,020	4,083	4,375	4,710	4,382	4,382	5,449
Stocks on lake docks	7,474	6,185	5,024	4,364	4,342	4,911	5,467	6,218	7,029	7,609	8,095	6,793	6,793	8,634
Total, commercial consumers	--------	--------	30,050	--------	27,200	26,300	--------	--------	27,500	30,038	--------	29,666	29,666	35,500
Trend in prices: [3]														
Average cost of railroad fuel per ton, excluding freight charges	$1.77	$1.76	$1.75	$1.70	$1.67	$1.67	$1.65	$1.62	$1.60	$1.57	$1.56	$1.54	$1.66	$1.84
Average retail price per ton, 38 cities	$8.17	$8.14	$8.01	$7.85	$7.60	$7.53	$7.50	$7.52	$7.54	$7.60	$7.59	$7.51	$7.71	$8.33
Employment at collieries: [4]														
Men on pay rolls at representative mines	80.8	77.4	75.2	65.5	62.6	60.5	58.6	59.4	62.4	67.0	69.4	70.0	67.4	83.2

[1] Thousands of net tons. [2] Less than 500 tons. [3] Average per net ton. [4] Index number—1929 average=100.0.

Lake trade.—A mild winter in the Northwest resulted in a heavy carry-over from the preceding season's operations on the lake docks, and on April 1 the docks of Lake Superior and Lake Michigan reported a total of 5,024,000 tons still on hand. Shipments from lower lake ports were retarded accordingly, and up to October each month of 1932 fell below the corresponding month of 1931. (See fig. 16.) The total dumpings at Lake Erie ports for the season, including cargo and vessel fuel, were 25,173,211 tons, against 31,387,405 the year before, a decrease of 19.8 percent.[3] The lake docks, on the other hand, profited from the disturbed labor conditions in Illinois during the summer, and their total deliveries for the year were almost as great as in 1931—11,468,000 tons, against 11,629,000.

Other distributive movements.—Other distributive movements are shown graphically in figure 16. Up to the closing quarter shipments in 1932 ran below those of 1931 in almost every market. Exceptions were the movement from the far West during February and the

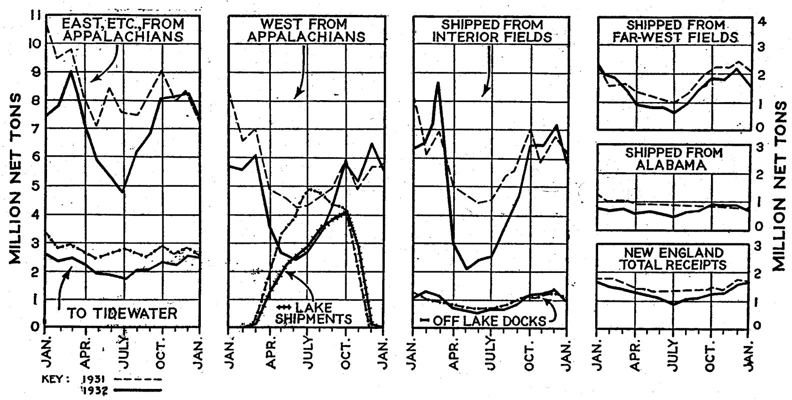

FIGURE 16.—Monthly movement of bituminous coal in the major channels of distribution, 1931–32.

accelerated shipments from the interior fields and the Lake docks during March, caused by the sudden cold snap and by the imminence of labor disturbances in Illinois and Indiana. During the summer shipments sagged heavily in every market, and it was not until October and November that the curves for 1932 began in some cases to mount above those of the year before. The totals for the year showed losses everywhere. The record month by month is given in the accompanying table, and details will be found in the Bureau of Mines Monthly Distribution Report.

Appalachian Coals, Inc.—The outstanding development of the year was the launching of the great district selling agency known as Appalachian Coals, Inc. The sales-agency plan was the outgrowth of a decade of discussion of a solution to the industry's difficulties which heretofore had achieved little tangible result.

Some progress had indeed been made in the direction of consolidations. Individual companies had acquired subsidiaries, and several northern interests had diversified their holdings by taking over properties in the South. There had been a few examples—including

[3] Coal loaded into vessels over piers as recorded by the Ore and Coal Exchange. The figures differ slightly from those given in the summary table, which represent shipments from the mines billed to the lakes, as reported by the Ohio Bureau of Coal Statistics.

a noteworthy one—of acquisition of a string of subsidiaries in several different fields, henceforth to be operated through a holding company. These scattering developments, however, had not changed the essential position of the industry, which continued to embrace a very large number of competing units struggling for a limited business. A special study by the Bureau of Mines in 1929 proved that even omitting the "captive" operations there remained 4,386 independent companies.[4] Of these, only 56 produced as much as 1,000,000 tons a year; these 56 companies controlled only 26.7 percent of the national output, the remaining 73.3 percent being divided among 4,350 smaller producers.

Plans for a merger of an entire district, however, had failed. In an earlier day district consolidations were effected in the Pittsburgh and Fairmont fields, but subsequent development of new companies had destroyed their anticipated effect. In the long depression following the Jacksonville wage agreement, similar district projects were given serious consideration, especially in the no. 8 field of Ohio,[5] in northern West Virginia,[6] and in the "smokeless" fields of southern West Virginia.[7] Among the objections encountered were the heavy fixed charges that would have to be assumed by the consolidation to bring in the necessary tonnage and the difficulty of agreeing on the terms under which each of the merged properties would enter the consolidation.

These obstacles inherent in any general consolidation, are avoided by the regional sales-agency plan. The sales agency assumes no responsibility for the investment of the contracting producer. If he can continue to produce at the established price, the agency undertakes to sell his coal on the same terms as that of other members; otherwise he will have to close down. Low-cost mines will continue to enjoy a larger profit margin than high-cost mines, and the value of each property turns on the success of its own management in keeping down the cost, not upon appraisal and negotiation, as in the organization of a merger. The staffs and personnel of the producing companies remain at their accustomed posts. Even the existing sales machinery is utilized by the device of permitting the contracting shipper to designate his accustomed sales outlet as a subagent of Appalachian Coals. Coupled with freedom to decline to renew the sales-agency arrangement at the end of the contract, these facts gave the sales-agency plan a flexibility wanting in the earlier projects for consolidation and contributed to its acceptance by the producing companies.

The territory of Appalachian Coals, Inc., includes most of the high-volatile fields of southern West Virginia, eastern Kentucky, Virginia, and northeastern Tennessee. One hundred and thirty-seven companies joined in launching the plan, and, as originally organized, the agency controlled 58,011, 367 tons of production (1929 figures), or about 74 percent of the noncaptive tonnage in the area proper, and 12 percent of the entire bituminous production, captive and commercial, in the region east of the Mississippi. The organization was completed March 1, 1932.

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4 Tryon, F. G., and Mann, L., Coal: Mineral Resources of the United States, 1929, part II, Bureau of Mines, 1931, pp. 715–734.

5 Black Diamond, Jan. 31, 1925, p. 119. Coal Age, May 14, 1925, p. 725; July 9, 1925, p. 50; July 30, 1925, p. 157.

6 Coal Age, Feb. 5, 1925, p. 224; Feb. 12, 1925, p. 258; Mar. 19, 1925, p. 438. Black Diamond, Apr. 4, 1925, p. 400; Aug. 29, 1925, p. 223; Oct. 10, 1925, p. 412.

7 Coal Age, July 1928, p. 450.

Action to test the legality of the plan under the antitrust laws was begun immediately by the Department of Justice, and the case was brought to trial at Asheville, N.C., August 1. An adverse ruling by the lower court, rendered October 3, was reversed by the United States Supreme Court, March 13, 1933. The high court's decision not only permits Appalachian Coals, Inc., to proceed with its plan, but by implication authorizes similar regional selling agencies in other sections, subject always to court review should their activities develop "an undue restraint upon interstate commerce."

Discussion of the legal and economic problems of the plan is out of place in a statistical review of the market. It is clear, however, that Appalachian Coals is potentially the most important development of the last decade in the bituminous-coal industry. In spite of the depression, the year 1932 will stand as one of far-reaching change and achievement.

PRODUCTION BY STATES AND FIELDS

The decline in production during 1932 was felt unequally in different parts of the country. While the national total showed a decline of 20 percent compared with the year before, in some States the decrease exceeded 30 percent, and in still others there was an increase. The following table gives the production by States. The 1932 figures are preliminary estimates based upon railroad car-loadings and are subject to revision when final returns are received from the operators. Among the States showing heavy losses were Illinois and Ohio, where long-drawn disputes between operators and mine workers kept many of the mines idle for some months after April 1. The tonnage lost by Illinois went in part to the adjacent fields of Iowa, Missouri, Kansas, and western Kentucky. In Indiana the labor disputes were more quickly adjusted, and this State also received some extra business lost by Illinois. For this reason Indiana, though reporting a decrease, held up better than the country at large, while western Kentucky and the Iowa-Kansas-Missouri area as a whole showed a slight gain over 1931. Unexpected gains are also indicated for Michigan and North Dakota.

The trend of production month by month in the principal fields is shown in figure 17. Among the striking features of the year was the sudden pick-up during March in the northern fields of Indiana, Illinois, and Ohio no. 8, which represented advance purchases of consumers in anticipation of the strike. The extent and duration of the subsequent suspension in these fields are also clearly indicated.

To western Kentucky, on the other hand, the suspension north of the Ohio brought increased orders, and from May to the end of the year the curve of 1932 production ran consistently above that of 1931.

All of the diagrams in figure 17 have been plotted on the same scale, except that in certain of the largest districts, such as northern West Virginia and Pocahontas, it was necessary to start at the bottom with 1,000,000 tons, instead of with zero, or even, in central Pennsylvania, to start with 1.5 million tons. The diagram for Pocahontas includes the output of Tug River.

Comparison of bituminous coal produced, by States, 1929–32

[Statistics compiled by L. Mann and R. McKinney, Bureau of Mines]

State	Production (net tons)				Percent of increase or decrease	
	1929	1930	1931	1932 (preliminary)	1929–32	1931–32
Alabama	17, 943, 923	15, 570, 058	11, 998, 781	7, 850, 000	−56. 2	−34. 6
Arkansas	1, 695, 108	1, 533, 434	1, 153, 555	1, 050, 000	−38. 1	−9. 0
Colorado	9, 920, 741	8, 196, 910	6, 604, 369	5, 564, 000	−43. 9	−15. 8
Illinois	60, 657, 641	53, 731, 230	44, 303, 295	32, 360, 000	−46. 7	−27. 0
Indiana	18, 344, 358	16, 489, 962	14, 295, 165	12, 400, 000	−32. 4	−13. 3
Iowa	4, 241, 069	3, 892, 571	3, 388, 355	3, 430, 000	−19. 1	+1. 2
Kansas and Missouri	7, 006, 282	6, 283, 079	5, 607, 367	5, 660, 000	−19. 2	+. 9
Kentucky	60, 462, 600	51, 208, 995	39, 963, 621	35, 610, 000	−41. 1	−10. 9
Maryland	2, 649, 114	2, 270, 593	2, 005, 773	1, 370, 000	−48. 3	−31. 7
Michigan	804, 869	661, 113	359, 403	446, 000	−44. 6	+24. 2
Montana	3, 407, 526	3, 022, 004	2, 378, 052	2, 155, 000	−36. 8	−9. 4
New Mexico	2, 622, 769	1, 969, 433	1, 552, 822	1, 220, 000	−53. 5	−21. 4
North Dakota	1, 862, 130	1, 700, 157	1, 519, 307	1, 650, 000	−11. 4	+8. 6
Ohio	23, 689, 477	22, 551, 978	20, 410, 995	13, 350, 000	−43. 6	−34. 6
Oklahoma	3, 774, 080	2, 793, 954	1, 908, 394	1, 326, 000	−64. 9	−30. 5
Pennsylvania	143, 516, 241	124, 462, 787	97, 658, 698	75, 772, 000	−47. 2	−22. 4
Tennessee	5, 405, 464	5, 130, 428	4, 721, 548	3, 240, 000	−40. 1	−31. 4
Texas	1, 100, 668	833, 872	716, 020	620, 000	−43. 7	−13. 4
Utah	5, 160, 521	4, 257, 541	3, 350, 044	2, 850, 000	−44. 8	−14. 9
Virginia	12, 748, 306	10, 907, 377	9, 698, 680	8, 025, 000	−37. 0	−17. 3
Washington	2, 521, 327	2, 301, 928	1, 846, 461	1, 625, 000	−35. 5	−12. 0
West Virginia	138, 518, 855	121, 472, 638	101, 473, 172	83, 765, 000	−39. 5	−17. 5
Wyoming	6, 704, 790	6, 088, 133	4, 993, 686	4, 140, 000	−38. 3	−17. 1
Other States	230, 734	196, 124	181, 833	189, 000	−18. 1	+3. 9
United States total	534, 988, 593	467, 526, 299	382, 089, 396	305, 667, 000	−42. 9	−20. 0

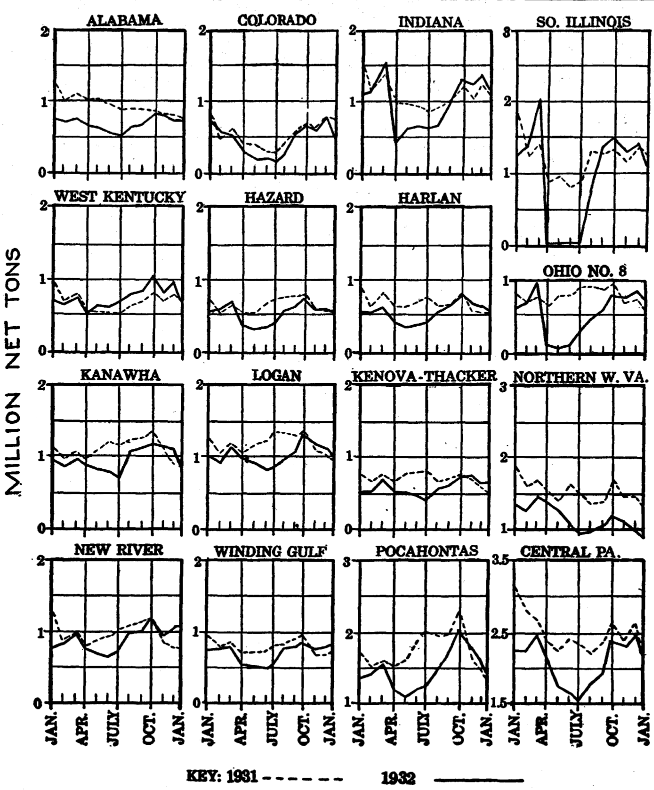

FIGURE 17.—Monthly production of bituminous coal in selected fields, 1931–32.

LIQUIDATION OF MINE CAPACITY

Trend of capacity, 1890–1931.—The depression of general business has continued the liquidation of mine capacity which has been going on in the bituminous industry ever since 1923. Figure 18 shows the capacity of the mines active in each year. The curve of "full-time capacity" represents what the mines in operation could do with the equipment and labor actually employed if they produced for 308 days at the same rate they actually did produce on the days they were operating. Coal is loaded on 308 days or more, and many individual mines work as much as 308 days. However, it is not feasible for all

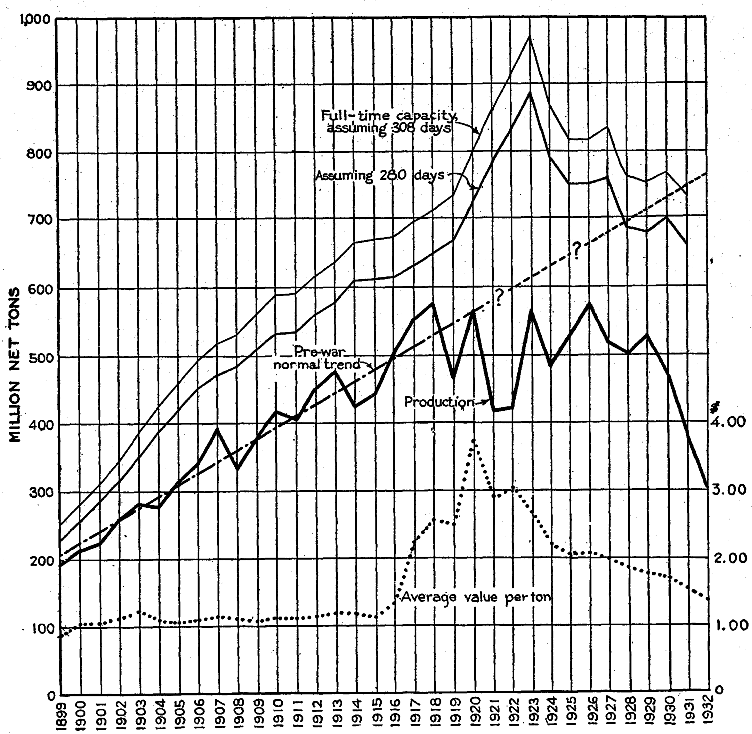

FIGURE 18.—Trend of bituminous-coal production and of mine capacity in the United States, 1899–1932.

mines to attain so high a figure because of unavoidable losses of time through breakdowns, falls of roof, failure of power supply, and the seasonal character of the market. For these reasons the more conservative figure of 280-day capacity is also shown, a figure suggested some years ago by the coal committee of the American Institute of Mining and Metallurgical Engineers.

Capacity was increasing rapidly in the period up to the World War. Expansion was greatly stimulated by the high prices of 1916 to early 1923. Thousands of new mines were opened, and the growth was especially rapid just after the war when additional labor was readily obtainable at the high wages then prevailing. The peak was reached in 1923, when the mines in operation had an annual capacity at 308 days of 970,000,000 tons. So great an excess above the needs of the market made liquidation inevitable, and since that year the industry has been involved in a continuous process of deflation, forcing heavy financial loss and decline in wages. Between 1923 and 1931 (the latest year for which complete returns from all operators are available as this is written) the net reduction in number of operating mines—commercial mines, not wagon mines—was 3,689, and the net reduction in operating capacity was 234,000,000 tons. Actually the number of commercial mines that have shut down is greater than 3,689, because meanwhile other new mines have been opened. In the same way, the capacity of the shut-down mines is greater than 234,000,000 tons, both because new mines have come in and because other mines remaining in operation throughout the period have added to their capacity. The figures of 3,689 mines and 234,000,000 tons are merely the net reduction to the end of 1931.

Capacity in 1932.—What happened to capacity in 1932? The question cannot be answered fully until final returns are received from all operators. It is known, however, that many additional mines closed during the year. Newell G. Alford, in a study of the records of the State mine inspectors that is one of the year's outstanding contributions to mineral economics, finds that at least 207 more mines suspended operations during 1932 and that these mines formerly had a production of 27,200,000 tons.[8]

Suspended capacity.—Alford's analysis also shows how many mines have suspended in the entire period since 1923. The study covers all bituminous fields east of the Mississippi except Ohio. The total number of mines suspending in this area during the 10 years from 1923 to 1932 was found to be 4,802. The total production of these mines when formerly in operation was 229,000,000 tons.[9] The study apparently included many small operations that would be classed by the Bureau of Mines as wagon mines, so that the figure of 4,802 mines is not comparable with the Bureau's record of the number of commercial mines. Inclusion of the wagon mines, however, has little effect on the tonnage, and the figure of 229,000,000 tons stands as the best record now available of the former production of the mines suspending in this area.

How many of these mines should be considered potential producers? The question cannot be answered accurately. The owners of the suspended properties themselves do not know. The mines are in all stages of collapse and disrepair, and the possibility of reopening depends in each case on physical conditions and most of all on the future of the market. Some of the closed mines were worked out and exhausted. It is known that the normal retirements through old age in the period before the war averaged about 200 mines a year, yet Alford concluded from study of all available records that "exhaustion accounts for a very limited part of the suspended production."

Idle versus abandoned mines.—To throw light on the problem the Bureau of Mines has reviewed the statistical reports courteously supplied by operators during the last 10 years. The work was done under a cooperative agreement with the industrial research department of the University of Pennsylvania. Every year the Bureau asks for a report on the production of every known mine of commercial

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8 Alford, Newell, G., Analysis of Bituminous-Coal Mines Suspended from 1923 to 1932: Paper presented at the February (1933) meeting of the Am. Inst., Min. and Met. Eng. Only those mines were counted as suspended in which ventilation and pumping had been discontinued.

9 In Alford's study each shut-down mine was represented by its largest annual output in the 5 years before suspension.

size. Where no coal was produced the operator is advised, "If idle, abandoned, or worked out please so state." If the owner reports that the mine is "abandoned" or "worked out" it is taken off the list; or if after due inquiry through the local post office no owner of the property can be found and the railroad records show no tonnage shipped for years, the mine is taken off the list. If, however, the owner reports the mine as "idle" it is kept on the list as a potential producer. In short, until the Bureau is advised to the contrary, statistically speaking the mine is not dead.

The lists were therefore examined to see how many mines were still being carried as idle but not definitely abandoned. It was found that at the end of 1930 there were 1,355 such mines. Some of them had mined no coal since 1923, and others had been shutting down in each year since. By years the record was as follows:

	Capacity, tons
219 had been idle since 1923	17, 000, 000
118 had been idle since 1924	19, 000, 000
83 had been idle since 1925	13, 000, 000
151 had been idle since 1926	12, 000, 000
313 had been idle since 1927	42, 000, 000
210 had been idle since 1928	27, 000, 000
261 had been idle since 1929	30, 000, 000
Total to end of 1930	160, 000, 000

As a mine closing 10 years ago would be more likely to reach the stage of definite abandonment than one closing 3 years ago, it was natural that the largest number of these statistically idle but not abandoned mines should consist of properties closed toward the end of the period. The largest single number, 313 mines with a capacity of 42,000,000 tons, dropped out during or after the strike of 1927. Capacity of 27,000,000 tons had been idle since 1928, and capacity of 30,000,000 tons had been idle since 1929.

In all, the 1,355 mines had a capacity at 308 days of 160,000,000 tons a year, equivalent to, roughly, 100,000,000 tons of normal production. Although the classification of idle but not abandoned is far from precise, the figures indicate a very large shut-down capacity which could conceivably resume operations if the price were attractive enough. If the country were plunged into another World War, with acute shortage of fuel, many would doubtless reopen. On the other hand, at the price levels of recent years they are clearly out of the running. They were high-cost operations when they were forced to close. Since then, rapid depreciation has further impaired their competitive standing, while in the meantime the surviving mines have increased an inherent advantage by further mechanization. One practical test of the response of the shut-down capacity to price was afforded by the price flurry in the fall of 1926. The 9-month strike of the British miners had created a vacuum in the sea-borne coal trade, and the unexpected demand from overseas was added to heavy purchases at home, as consumers built up their stocks to prepare for the end of the Jacksonville wage agreement. From $1.91 in July spot prices jumped to $3.19 in November, with sales along the seaboard at still higher figures. Yet while some mines reopened in 1926, many others closed, and the capacity in operation at the end of the year was no greater than at the beginning. The test indicated that more than a short-lived flurry of high prices is needed to revive suspended mines. On the other hand, there can be no doubt that continuance of high prices would bring scores or hundreds of them back into production.

The answer to the question of how far the idle mines must be reckoned in the productive capacity of the industry, therefore, depends upon the future of prices. Certainly idle coal mines are not like shut-in petroleum production that can be resumed with the turn of a valve. There is no prospect of car shortage. Recent strikes have failed to create a marked increase of price. While these conditions persist the idle capacity can have small effect upon the market. Any plan for stabilization of the industry that contemplates an increase in price, however, must reckon with the existence of the idle mines.

TREND OF CONSUMPTION

At the same time that productive capacity was expanding to the peak of 1923, the demand for coal was undergoing a profound change

FIGURE 19.—Tonnage of bituminous coal absorbed by the principal branches of consumption, 1917–32.

(fig. 18). Before the war the demand grew steadily, interrupted only by the occasional slumps of general business. After 1918 the former increase suddenly disappeared, and for the next decade production fluctuated now above, now below, a level of 500,000,000 tons a year. In fact, even in 1929, when general business reached the highest stage in the history of the country, the production of bituminous coal fell short of that in 1917, 1918, 1920, 1923, and 1926. This underlying change in demand is perhaps the chief cause of the industry's difficult position. Had the pre-war rate of growth continued the annual requirements would have reached 710,000,000 tons by 1929, or nearly 200,000,000 more than the market of the year could actually absorb. For this reason no feature of the industry deserves more careful study than the trend of demand. It is necessary to analyze not merely total demand but the requirements of each major class of consumers.

Figure 19 supplies such an analysis. It shows not production but consumption and exports, thus avoiding the deceptive appearance of years marked by heavy changes in stocks.

Since 1929 all branches of consumption have felt the depression. The decline has been least in the heating of buildings, in the domestic trade, and in the generation of central-station power. It has been greatest in the metallurgical industries and the manufacture of furnace coke.

SCRAP-IRON AND COAL CONSUMPTION

Among the causes of the flattening of coal demand after the war is the increasing use of scrap iron and steel, which has acted to slow down the former growth of pig-iron manufacture and therefore the consumption of blast-furnace coke. Even before October 1929 it had become apparent that the output of pig iron was lagging behind that of ingot steel. Thus, while the output of steel increased 30 percent from the period 1916-20 to the period 1926-30, the output of pig iron increased only 8 percent. This did not mean that the American people were using less iron but rather that an increasing proportion of each year's requirements was being met from scrap. Since iron-blast furnaces are ravenous consumers of fuel, the change had a powerful influence on the demand for coal. Coupled with advances in efficiency of furnace operation and coke manufacture, it meant that in spite of a large increase in the consumption of steel, the country actually needed less coking coal to smelt pig iron in 1929 than it did in 1916. In 1916 the blast furnaces required 66,500,000 tons of coking coal to make 39,435,000 tons of iron. In 1929 they got along with 63,200,000 tons of coking coal to make 42,614,000 tons of iron, yet the production of steel was 32 percent greater in 1929 than it was in 1916.

Fortunately for the producers of coking coal, there has been a large increase in the consumption of coke for domestic and miscellaneous industrial uses, which has helped to offset the stationary or declining demand for metallurgical coke.

COMPETITION OF OTHER SOURCES OF POWER

A major cause of the post-war change in coal demand has been the competition of other sources of energy. While production of coal showed no consistent gain after 1918, production of oil, gas, and water power continued to increase, growing like a sum at compound interest (fig. 20). Since 1929 coal's competitors have felt the depression but not to the same degree, and further gradual loss of business to the rival sources of heat and power occurred in 1932.

Fuel oil.—While the production of bituminous coal declined 20 percent as compared with 1931, production of crude petroleum declined only 8.1 percent. Fuel-oil output fell off 12.7 percent—more than crude, but substantially less than coal. Details of the distribution of fuel oil are not available, but three indicators show the trend. Consumption by locomotives of class I roads was 47,370,558 barrels in 1931 and 41,447,787 in 1932, a decrease of 12.5 percent.

Coal for locomotive use in the same period declined 18.5 percent. Fuel oil supplied for bunkers to ships in foreign trade declined from 23,793,944 barrels to 20,239,957 barrels, a decrease of 14.9 percent, but the decline in bunker coal was 38.5 percent. Electric central stations used 21.8 percent less coal but only 1.9 percent less fuel oil, the reported consumption of the latter being 8,123,000 barrels in 1931 and 7,967,000 barrels in 1932. No record of the use of oil for heating houses is yet at hand for 1932, but the figures for the 3 years preceding show the trend. Fuel oil and distillate consumed for this purpose increased from 19,581,000 barrels in 1929 to 25,359,000 in 1930; a decrease to 24,659,000 barrels in 1931 seems small in view of the depression. Meanwhile, sales of oil burners have continued. The number of domestic burners shipped by the 103 manufacturers reporting monthly to the Bureau of the Census was 67,335 in 1932, as against 83,350 in 1931. To meet this competition, coal men and stoker manufacturers pushed sales of small coal stokers. According to the reports of 55 manufacturers to the Bureau of the Census, total sales of domestic stokers were 6,783 against 6,915 in the same period of 1931.

Natural gas.—The production of natural gas declined 10 percent in 1932, according to preliminary estimates. New pipe lines connected the Tioga field with Syracuse, N.Y., and an 80-mile line of large diameter was laid in California. The chief activity in construc-

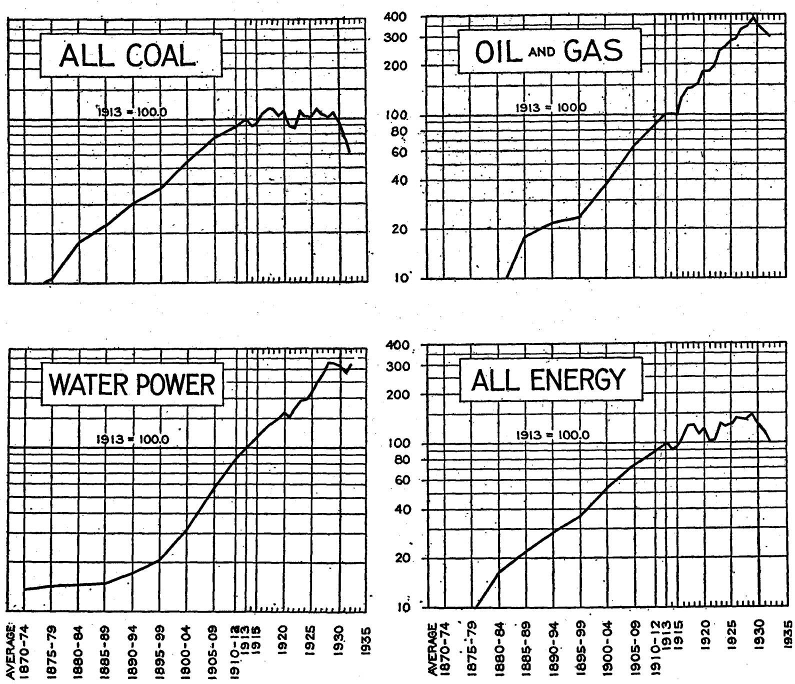

FIGURE 20.—Relative rate of growth of annual supply of coal, oil and gas, and water power in the United States, 1870–1932.

tion, however, was connecting up existing lines to new communities, especially in the Middle West. One check on the trend in natural-gas consumption is shown by the electric public utilities. The total quantity burned in central stations declined from 139,328,000,000 cubic feet to 107,875,000,000 cubic feet, a decrease of 22.6 percent, or slightly greater than the percentage decrease for coal. Most of the decline, however, occurred in California and represented increased use of water power and oil, not coal. In the competitive battleground of the Middle West, and Northwest, where the natural-gas invasion has so suddenly appeared, gas scored further gains in 1932. This is seen from the following comparison of the quantity of natural gas consumed in the last 4 years by power plants in typical States of this area.

Million cubic feet of natural gas consumed

	1929	1930	1931	1932
Indiana			2,361	8,567
Michigan				264
Minnesota				324
Iowa			358	1,313
Missouri	455	966	1,106	1,867
Nebraska		262	1,083	1,726
North Dakota			175	167
South Dakota				62
Georgia			1,232	115

Regions where a decade ago competition of natural gas seemed impossible have thus felt its attack, and although gas still supplies a very small portion of the total energy requirements of the States named, its pressure is already felt on the price structure of the local fuel markets.

Hydroelectricity.—Higher heads of water as the streams recovered from the droughts of 1930 and 1931 caused an increase in production of hydroelectricity in 1932. The output reported by public utility companies rose from 30,603,000,000 kilowatt-hours in 1931 to 34,098,000,000 kilowatt-hours in 1932. In kilowatt-hours the output of hydropower fell slightly short of that in 1928 and 1929, but the relative proportion of the total sales of all power by the utilities was higher than ever before. To save the cost of fuel the utility companies naturally used their hydropower as far as available, and the proportion furnished by water was 41 percent, as against 35.6 percent in 1929 and 33.4 percent in the dry year 1931.

Total consumption of energy.—The total supply of energy from all sources in 1932, including imports of crude oil, is reckoned as 17,841 trillion B.t.u. In comparison with the high mark established in 1929 (26,534 trillion B.t.u.), the year shows a decrease of 32.8 percent. Since the consumption of energy is one of the best indicators of economic activity, including as it does domestic as well as industrial consumption, the decline below the peak year of approximately one third may be taken as a measure of the impact of the great depression. The trend of total energy supply is shown graphically in the lower right diagram of figure 20.

It is significant, also, to compare the energy consumption of 1932 with that of still earlier years. In terms of raw fuels it was 3.9 percent less than in 1921, the year of the last preceding acute depression and it was almost exactly the same as in 1913, the year which still stands in the minds of business men as representing the "pre-war normal". Such historical comparisons, however, take no account of the improvement in efficiency of utilization. If it were possible to make any accurate allowance for the changes in fuel efficiency, the energy consumption of 1932 would appear larger than it does.

The total energy supply of 17,841 trillion B.t.u. in 1932 was derived as follows:

	Trillion B.t.u.	Percent
Anthracite	1,342	7.5
Bituminous coal	8,008	44.9
American oil [1]	4,691	26.3
Imported oil [1]	268	1.5
Natural gas, total production	1,632	9.1
Water power, fuel equivalent	1,900	10.7
Total	17,841	100.0

[1] Total crude, including that refined.

The figures are expressed in B.t.u. because some common denominator is necessary for 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 which remains unchanged throughout the period covered by figure 20. It is important to note that the figures for oil represent the entire production of crude petroleum. They include, therefore, not only 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 gasoline involves a measure of distant and indirect competition with coal, for the energy market of the country is becoming more fluid and competitive, and the demand which cannot be met by one source of supply tends to fall back on the others. Thus, were not gasoline cheap and abundant, automotive transport could hardly be a serious competitor of rail transport, and the steam and electric railways would be hauling vastly more freight and passengers by means of energy derived chiefly from coal.

TREND OF FUEL EFFICIENCY

While the pressure of competitive fuels continued unabated in 1932, there were signs that the advance of thermal efficiency, which has been so conspicuous a feature of the post-war years, is beginning to slow down.

The fuel-economy movement.—Progress in the arts of converting fuel into mechanical power has been going on ever since Watt developed the steam engine, but in the United States it was not until about 1908 that fuel saving began to take the form of an organized movement. Among the significant developments of that time were the first systematic work in fuel testing organized by the Government at the St. Louis Exposition of 1904; the introduction of byproduct coke in the steel industry; the National Conservation Congress (1908), which focused public attention on the prevailing wastes in utilization; and the organization of the International Railway Fuel Association in 1909.

The movement thus started was enormously stimulated by the high prices of fuel during the war. Commercial laboratories for fuel testing multiplied, engineering schools pushed research in fuel economy, and consumers who had hitherto enjoyed a perpetual buyers' market awoke to find the supply of fuel among their most pressing problems. From $1.23 in 1913 the average spot price of bituminous coal climbed to $3.25 in 1917, and in the run-away market of 1920 it skyrocketed to $9.51 during August, with individual sales recorded as high as $20 a ton.

For a time the effects of the movement were obscured by the munitions prosperity and the disturbed conditions of coal supply from 1916 to 1920. Interest in preparation lagged at a time when "anything black" was saleable; thousands of mushroomlike small mines diluted the supply with dirty coal; and war-time zoning regulations, priority orders, strikes, and car shortages often forced consumers to accept coal ill-suited to their needs. Thus, it was not until after 1920 that the effects of fuel economy began to register themselves in the national demand. Thereafter the movement gathered momentum, and for 10 years it has remained perhaps the most important single factor in the market, its effects remaining long after the immediate stimulus of high prices has disappeared. The cumulative result is summarized in the following statement, which shows the average percentage reduction in fuel consumed per unit of product from the beginning of the fuel economy movement in 1909 to the end of the post-war boom in 1929.[10]

	Percent reduction
Electric public utility power plants	−66
Steam railroads	−40
Petroleum refining	−36
Iron furnaces, steel works, and rolling mills	−25
Cement mills	−21
All other manufacturing, approximately	−21
All industries and railroads combined, approximately	−33

The average reduction in all industrial and railroad uses combined is 33 percent. Stated another way, had there been no advance in thermal efficiency during the 20 years and had the efficiencies of 1909 continued without change, American business would have consumed 210,000,000 tons more of bituminous coal in 1929 than were in fact required.

Savings during this period were not so much due to the appearance of epoch-making inventions like those of Watt and Neilson as to the cumulative effect of many small economies and to the general application of improvements and practices which the best plants had already shown to be profitable. Much of the result is attributable to the training of firemen and boiler-room personnel, such as the notable work accomplished by the railroads through the International Railway Fuel Association and other means. Such progress can be measured only by statistical records covering the mass of establishments; it is a question of how far average practice is catching up with demonstrated good practice. Hence arises the importance of general statistics of fuel consumption as a guide to the long-time changes of the market. Study of these records shows that much of the rapid advance in the post-war period has represented a taking up of slack which could not be expected to continue indefinitely.

Furthermore, while more efficient equipment, once installed, continues to be utilized regardless of the price of coal, every decline in price undermines the money saving to be made and acts to retard new investment in additional equipment. Equipment that is clearly profitable when the average sales realization, f.o.b. mine, is $3.02, as it was in 1922 may fail to earn dividends when the sales realization drops to $1.36 in 1932.

[10] Tryon, F. G., and Rogers, H. O., Statistical Studies of Progress in Fuel Efficiency, Transactions: 2d World Power Conf., vol. 6, sec., 12, 1930, pp. 343-365.

It is therefore of the greatest interest to trace the record of average fuel efficiency through the depression years, and this is done for certain major types of consumption in figure 21.

Railroad fuel.—As one fourth of the entire bituminous output is used by the railroads, economies in locomotive fuel have had a powerful influence on the market. In freight service the average consumption per 1,000 gross ton-miles, including weight of locomotive and tender, stood at 176 pounds in 1917 and was nearly as high in 1920, both years of disordered fuel supply. Steady progress continued after 1923, but the curve has tended to flatten. Thus in the 5 years from 1917 to 1922 there was a net reduction of 13 pounds in the average consumption. In the next 5 years, 1922 to 1927, the rate of savings

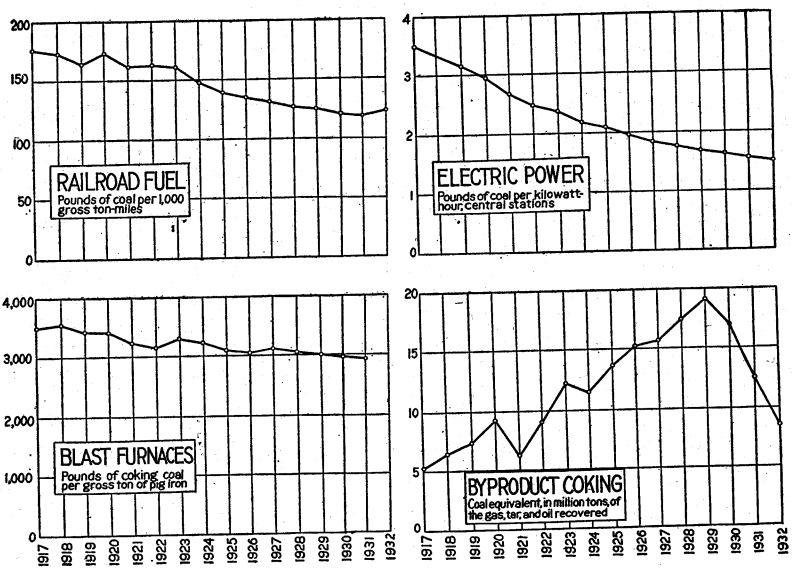

FIGURE 21.—Trends in fuel efficiency in the United States, 1917–32.

was at a maximum, and the net reduction was 32 pounds. In the last 5 years, 1927 to 1932, it has been only 8 pounds. In fact, during 1932 the average consumption actually increased, standing at 123 pounds as against 119 the year before. It is true that the record for 1932 was affected by certain influences peculiar to the depression, tending to increase the unit consumption, such as postponement of repairs and replacements and smaller loads per train. On the other hand, the depression made it possible to withdraw from present use the more obsolescent equipment and to haul the smaller volume of traffic with the carriers' most efficient locomotives, factors that should operate to increase efficiency.

In the passenger service a similar tendency appears. The average consumption per passenger-train car-mile declined as follows:

	Net reduction, pounds
From 1917 to 1922	1.5
From 1922 to 1927	2.5
From 1927 to 1932	.5

In this case, also, the average consumption for 1932 was actually higher than for 1931, being 14.9 pounds as against 14.5 pounds.

The conclusion seems warranted that while progress in economy of railroad-fuel coal is by no means at an end the rate of change is slowing down.

Electric public utilities.—In power generation at electric central stations economies continued in 1932 but at a slower rate than in any year since the beginning of the record. The net reduction in the average consumption per kilowatt-hour has been:

	Net reduction, pound
From 1917 to 1922	0. 97
From 1922 to 1927	. 66
From 1927 to 1932	. 34

For 1932 the average was 1.50 pounds per kilowatt-hour against 1.55 pounds in 1931 and represents a saving of 0.05 pound in a year, but a decade ago the saving was running about 0.20 pound a year.

The influence of the depression on the average efficiency has been mixed. At a given station, lowering of the load factor tends, of course, to increase unit consumption, but where the load is spread over many stations a smaller load may render it unnecessary to utilize the less-efficient stand-by plants. Whatever the cause, the curve of figure 21 shows a slowing down in the rate of saving.

Blast furnaces.—About one eighth of the national supply of bituminous coal finds its way into iron blast furnaces in the form of coke. Here economies in use have arisen, partly through increased yield of merchantable coke per ton of coal carbonized in the coke oven and partly through decreased consumption of coke per ton of pig iron made. The combined result of the two factors is shown in figure 21.

It will be seen at a glance that improvement in efficiency was comparatively rapid during the early part of the period but that it has slowed down greatly since 1927. By periods, the net reduction in pounds of coking coal required per ton of pig iron was:

	Net reduction, pounds
From 1917 to 1921	287
From 1921 to 1926	188
From 1926 to 1930	70

Byproduct coking.—The introduction of the byproduct coke oven effected large savings by recovery of the volatile matter in the coal which the beehive oven wasted. In 1913 the surplus gas, breeze, tar, and light oil recovered were equivalent to 2,600,000 tons of coal, and by 1929 this had increased to 19,262,000 tons. Insofar as the byproduct coke produced displaced beehive coke, the thermal byproducts involved displacement of raw coal. Fortunately for the coal man, this item of saving is now approaching the saturation point, with rapid elimination of the beehive oven. In 1929 the byproduct ovens produced 89 percent and in 1932 over 96 percent of the total output.

With the decline in production of coke brought on by the depression, the coal equivalent of the byproducts has declined also (fig. 21). A clear way to show the progress is to note that the coal equivalent of the byproducts now amounts to about 25 percent of the total coal charged into coke ovens. As this is close to the theoretical limit, it is clear that further curtailment of the demand for raw coal from this quarter cannot be large.

Other consumers.—In still other quarters, such as general manufacturing and heating of buildings, rapid progress in fuel efficiency is believed to be still going on. Unfortunately, there are no annual records of consumption to measure advances in these lines.

EXPORTS AND IMPORTS

The international trade in bituminous coal in 1932 reflects the general disruption of world commerce. Depressed business in virtually all countries resulted in a shrinkage of consumption, and the normal flow of coal was disturbed further by Government subsidies, quota restrictions upon imports, and mounting tariff barriers. In addition, American exporters were handicapped by depreciation of foreign currencies, especially of the pound sterling, which gave their British competitors a great advantage. As a result, shipments of bituminous coal to foreign destinations during 1932 dropped to 8,814,047 net tons, a decrease of 27.3 percent compared with the preceding year and barely half the 1929 level.

Canada has always been the principal foreign market for United States coal (fig. 22). Although the Dominion has extensive resources of coal and lignite, the deposits are located chiefly in the coastal regions or western plains, remote from the densely populated and industrialized sections of the central Provinces. In consequence, approximately half of Canada's total bituminous-coal requirements have been imported from the United States. From 1925 to 1930 our annual exports of soft coal to Canada averaged about 14,000,000 tons. During the past 2 years, however, shipments to Canada have fallen sharply, amounting to 10,630,898 tons in 1931 and only 8,426,886 tons in 1932. Most of the loss is ascribable to the depression, but among the contributing factors was an increase in the Canadian tariff, which was raised from 50 to 75 cents a ton, effective June 2, 1931.

Shortly after the advance in the tariff, Great Britain went off the gold standard—September 20, 1931—and the sudden depreciation of the pound stimulated shipments of bituminous coal from Great Britain, the total imports for 1932 rising to 362,068 tons against 122,298 for 1931. At the same time, the Dominion Government granted further subventions to stimulate the output of Canadian mines. In an effort to decrease the country's dependence upon the mines of the United States the Government had experimented as early as 1924–25 with subventions to defray part of the cost of transport into the "acute fuel area" in the Provinces of Quebec and Ontario. Early in 1932 the Government offered to absorb part of the spread between the cost of United States coals delivered at points in Quebec and Ontario and the cost of coal produced in the Maritime Provinces. The scheme agreed upon authorized payment of subventions to the railroads in return for a reduction in freight rates on maritime coal. On other than railway fuel the subventions ranged from one seventh to one third cent per ton-mile, and similar assistance was accorded the movement of locomotive fuel. The Dominion Fuel Board was also authorized, with certain exceptions, to pay operators of coke

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ovens and coal-gas retorts the difference between the laid-down cost of Canadian and imported coals up to a maximum of $1 a net ton.

The trend of exports to the Caribbean is also shown in figure 22. In this region American exporters have a decided advantage in distance over British and German shippers but have felt increasing pressure from the competition of fuel oil. From 1925 to 1929 the movement to the Caribbean averaged about 1,500,000 tons annually. In the last 2 years depreciation of the pound has enabled British coal to offer serious competition. In 1932 exports to the Caribbean region

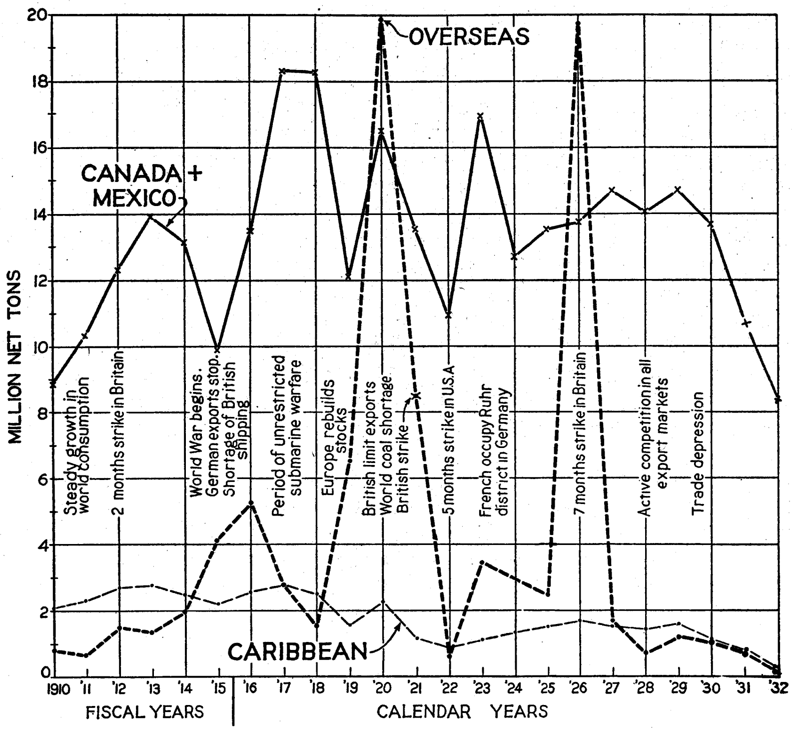

FIGURE 22.—Twenty-two years' exports of bituminous coal to (1) Canada and Mexico, (2) the Caribbean, and (3) "overseas" destinations. Exports to Canada (including also the small shipments to Mexico) have been relatively stable, except for changes due to general business conditions, and run closely parallel to the internal demand within the United States. Exports to the Caribbean region and other destinations adjacent to North America have also been comparatively stable in normal times because American shippers have a decided advantage of distance in these markets. Exports "overseas" have been small except when competition of British or German coal was shut off. In 1920 and 1926, overseas exports increased so as to be a dominant influence on prices in the internal markets of the country. All three movements, however, have declined greatly during the depression.

were only 239,000 tons, a decrease of 68.2 percent compared with the previous year and less than a fifth of the 1929 shipments.

In marked contrast to the movement to Canada and the Caribbean, which was relatively stable up to the time of the depression, exports overseas have been subject to violent and unpredictable fluctuations. A series of fortuitous circumstances during and after the World War brought windfalls of unexpected business to exporters, but since settlement of the British strike of 1926, American coal is once more faced with the full pressure of European competition. In fact, since 1931 American coal has been practically driven from the overseas markets. Overseas exports in 1932 totaled only 146,000 tons as against 728,000 in the previous year and 1,202,000 in 1929.

Imports of soft coal have seldom been a material factor in the domestic coal market. The small tonnage that is imported consists chiefly of coal from Vancouver Island and the Crow's Nest Pass field in British Columbia, received in Washington, Montana, and Idaho. There is also a small movement of coal from Nova Scotia into New England. Except in years when strikes or other interruptions caused a shortage, however, the tonnage imported has never been large. For the 6 years 1924 to 1929, inclusive, imports averaged about 500,000 net tons. Since 1929 the imported tonnage has been greatly reduced, amounting to 206,000 tons in 1931 and only 187,000 tons in 1932.

PROGRESS OF MECHANIZATION [11]

Growth of mechanized mining.—From 1,880,000 tons in 1923 the production of bituminous coal by mechanized mining increased to

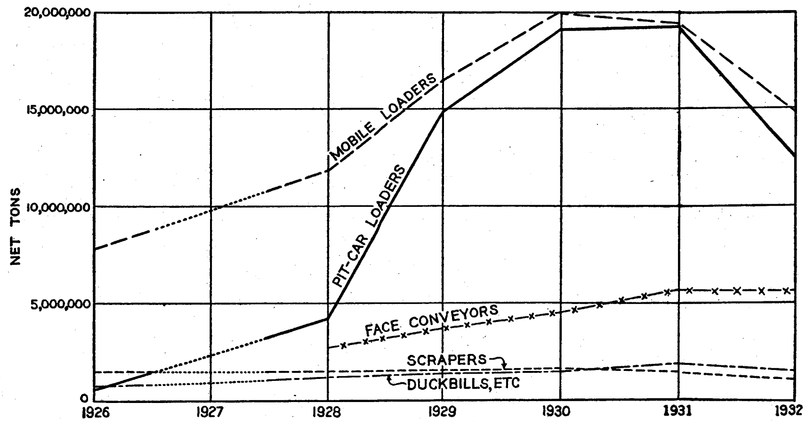

FIGURE 23.—Tonnage of bituminous coal loaded mechanically, specified by types of machines, 1926–32.

47,562,000 tons in 1931, a growth of twenty-fivefold in 8 years. In 1932, while the tonnage mined mechanically decreased, the relative proportion mined mechanically increased in 7 out of the 10 leading States.

A decline in tonnage was, of course, expected on account of the depression. The total mechanically mined was 35,817,000 tons in 1932, a decrease of 11,745,000 tons from the record established in 1931. It is important to note that much more than half the decrease occurred in the State of Illinois, where labor conditions were greatly disturbed during the year and where production fell off more than for the country as a whole. Eliminating Illinois on account of these exceptional conditions, it is found that for the rest the country mechanical mining decreased 18 percent, whereas hand mining decreased 21 percent. (In fact, in two leading States the tonnage mined mechanically actually increased in spite of the depression.)

These figures refer only to mechanical devices designed to reduce the labor of hand-shoveling into mine cars, although in a larger sense the introduction of any machine, such as the cutting machine or the haulage locomotive, is a form of mechanization. They cover only operations underground and do not include coal loaded by power

[11] See Mechanical Loadings in Bituminous Mines in 1932, by F. G. Tryon and L. Mann, May 13, 1933, mimeographed.

shovels in strip pits, which amounted to 19,000,000 tons in 1932. Corresponding figures for Pennsylvania anthracite are given on page 416.

The figures are preliminary and the Bureau will appreciate advice as to omissions, if any are noted.

Figure 23 gives the tonnage of bituminous coal loaded mechanically by types of machines, for the past 7 years.

Tonnage by types of machines.—Of the 35,817,000 tons mechanically mined, 14,825,000 tons (41.4 percent) were loaded by mobile loading machines of both track-loading and caterpillar types. Scraper loaders accounted for 1,132,000 tons (3.2 percent). Duckbills and other types of self-loading conveyors loaded 1,630,000 tons (4.5 percent). These three classifications include all types of machines that eliminate hand-shoveling except for incidental clean-up, and together they loaded 17,587,000 tons of coal (49.1 percent of the total). In addition, 12,590,000 tons (35.2 percent) were shoveled by hand on pit-car loaders and 5,640,000 tons (15.7 percent) on hand-loaded face conveyors. These last two devices, though not loading machines proper, greatly reduce the labor of hand-shoveling by reducing the height to which miners must lift the coal.

Mechanized production by States.—Illinois leads all States in tonnage mined mechanically, with Pennsylvania second, Indiana third, and Wyoming fourth. For 1932 the record was as follows:

State	Loaded by machine (tons)	Handled on pit-car loaders and hand-loaded conveyors (tons)	Total produced by mechanized mining (tons)
Illinois	7,747,000	7,613,000	15,360,000
Pennsylvania	1,796,000	5,618,000	7,414,000
Indiana	2,364,000	861,000	3,225,000
Wyoming	2,127,000	571,000	2,698,000
Alabama	157,000	1,080,000	1,237,000
West Virginia and Virginia	569,000	603,000	1,172,000
Kentucky	86,000	1,007,000	1,093,000
Montana	933,000	141,000	1,074,000
Ohio	(1)	(1)	850,000
Utah	(1)	(1)	754,000
Other States [2]	245,000	695,000	940,000
Total	17,587,000	18,230,000	35,817,000

[1] Separation not made here.
[2] Washington, Colorado, Arkansas, New Mexico, Maryland, Tennessee, Missouri, Oklahoma, North Dakota, and Iowa.

Percent of total output mechanized.—The real test of how mechanization has fared during the great depression is the percentage of the underground output obtained by mechanized mining as opposed to hand mining. Applying this test, it is found that in 7 out of the 10 leading States the percentage mined mechanically was larger in 1932 than in 1931. An example is Montana, which leads all other States in percent of mechanization. In 1931, 66 percent of the deep-mined output of the State was mechanized, and in 1932 the proportion increased to 76 percent, a gain of 10 points. In Wyoming the proportion mechanized increased from 56 to 66 percent. In Indiana it increased from 39 to 48 percent. Smaller increases were shown by Utah, Pennsylvania, Ohio, and Kentucky among the leading States.

This showing is the more encouraging to advocates of mechanization when the conditions of the year are borne in mind. Some operators reported storing the machines and reverting to hand-loading to spread employment. In addition, the decline in wage rates operated to reduce the cost of hand-loading compared with machine loading.

Number of machines in use.—Compared with 1931, the number of mechanical loaders in use—mobile machines, scrapers, and duckbills—decreased from 894 to 835. The number of pit-car loaders in use decreased from 3,428 to 3,112. The number of mines using hand-loaded face conveyors decreased from 152 to 136.

PENNSYLVANIA ANTHRACITE [12]

THE MARKET IN 1932

Production.—The year's production of Pennsylvania anthracite—including colliery fuel, washery, and dredge coal—was 49,900,000 net tons (preliminary figure).[13] Save for the great strike of 1902, this was the smallest output recorded in any year since 1890.

As all but a small part of the supply of anthracite goes for heating houses, apartments, hotels, and office buildings, it was to be expected that production of hard coal would be less affected by the depression than that of soft coal, the demand for which is dominantly industrial. In comparison with 1931 the production of anthracite declined 16.3 percent against 20.0 percent for bituminous.

Statistical summary of the monthly developments in the Pennsylvania anthracite industry in 1932

[All tonnage figures represent thousands of net tons]

	January	February	March	April	May	June	July
Production, including mine fuel, local sales, and dredge coal: [1]							
Monthly total	3,940	4,064	4,842	5,692	3,314	2,578	3,055
Average per working day	157.6	165.9	179.3	227.7	132.6	99.2	122.2
Shipments, breakers and washeries only: [1] [2]							
Monthly total, all sizes	3,370	3,575	4,313	5,014	2,901	2,227	2,778
Distribution: [1]							
Lake loadings	-------	-------	-------	10	56	35	26
Receipts at Duluth-Superior	-------	-------	-------	-------	7	28	10
Shipments from lake docks	41	42	37	25	19	22	42
New England receipts:							
By tide	112	109	90	188	206	114	127
By rail	330	326	390	398	280	190	251
Exports	107	96	152	118	103	69	112
Imports	81	71	37	59	97	44	30
Stocks at end of period shown: [1]							
Producers' stocks	2,741	2,265	1,794	1,733	1,906	2,076	2,081
Retail stocks, representative dealers	1,193	609	272	647	(3)	675	757
Upper lake docks	595	553	519	504	506	546	519
Prices at mines, average per net ton: [4] [5]							
Company stove	\$8.00	\$7.75	\$6.90	\$6.50	\$6.65	\$6.65	\$6.65
Independent stove	7.60	7.60	7.38	6.50	6.40	6.40	6.40
Company buckwheat no. 1	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Independent buckwheat no. 1	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Retail prices (average 25 cities): [4] [6]							
Stove	15.00	14.98	14.54	13.62	13.30	13.36	13.37
Chestnut	14.97	14.95	14.45	13.46	13.11	13.16	13.16
Employment at collieries: [7]							
Men on pay rolls at 159 mines [8]	76.2	71.2	73.7	70.1	66.9	53.0	44.5

See footnotes at end of table.

[12] All figures of Pennsylvania anthracite in this report are in net tons of 2,000 pounds, unless specifically noted to the contrary. This follows the change in usage adopted by the industry in 1931.

[13] The figures for the 1932 production of Pennsylvania anthracite here given are estimates based on reports of car loadings kindly furnished by the railroads. The original estimate of 49,350,000 net tons published on Jan. 7, 1933, has been increased to 49,900,000 tons, on the basis of later information, and stands as the best estimate the Bureau of Mines can make until complete returns are received from all operators.

Statistical summary of the monthly developments in the Pennsylvania anthracite industry in 1932—Continued

	August	September	October	November	December	Total 1932	Total 1931
Production, including mine fuel, local sales, and dredge coal: [1]							
Monthly total	3,504	4,154	5,292	4,319	5,146	49,900	59,646
Average per working day	129.8	166.2	211.7	180.0	197.9	163.9	196.5
Shipments, breakers, and washeries only: [1] [2]							
Monthly total, all sizes	3,050	3,664	4,758	3,881	4,512	44,043	53,624
Distribution: [1]							
Lake loadings	46	67	44	10	-------	294	761
Receipts at Duluth-Superior	-------	-------	21	-------	-------	66	300
Shipments from lake docks	51	67	65	56	45	512	720
New England receipts:							
By tide	139	133	151	161	129	1,659	1,939
By rail	294	349	425	350	397	3,980	5,125
Exports	92	126	125	103	100	1,303	1,778
Imports	22	42	43	49	32	607	638
Stocks at end of period shown: [1]							
Producers' stocks	2,250	2,263	2,261	2,164	1,732	1,732	3,073
Retail stocks, representative dealers	[3]	805	832	[3]	636	636	1,150
Upper lake docks	508	491	480	434	389	389	632
Prices at mines, average per net ton: [4] [5]							
Company stove	$6.85	$7.05	$7.25	$7.25	$7.25	$7.06	$7.79
Independent stove	6.40	6.60	7.25	7.25	7.25	6.93	7.62
Company buckwheat no. 1	3.25	3.25	3.25	3.25	3.25	3.25	3.11
Independent buckwheat no. 1	3.25	3.25	3.25	3.25	3.25	3.25	3.23
Retail prices (average 25 cities): [4] [6]							
Stove	13.50	13.74	13.79	13.83	13.87	13.91	14.80
Chestnut	13.28	13.52	13.58	13.60	13.65	13.74	14.72
Employment at collieries: [7]							
Men on pay rolls at 159 mines [8]	49.2	55.8	63.9	62.7	62.3	62.5	80.5

[1] Thousands of net tons.
[2] As reported by the Anthracite Bureau of Information.
[3] No data.
[4] Average per net ton.
[5] Quoted by trade journals in New York market.
[6] Bureau of Labor Statistics, white ash, sidewalk delivery.
[7] Index number — 1929 average=100.
[8] Bureau of Labor Statistics.

Comparison with other consumers' goods.—It will give a clearer perspective of the industry's position, however, to measure its output against the years of general prosperity and to see how the decline in anthracite compares with that in other necessaries of life. In measuring the volume of manufacturing production the Federal Reserve Board usually takes the period 1923 to 1925 as the starting point. Taking that base as 100 the trend of production in a number of lines of consumers' goods has been as follows:

	1923–25 average	1928	1929	1930	1931	1932
Tobacco manufactures	100	124	134	131	123	111
Automobiles	100	110	135	85	60	35
Food manufactures	100	98	97	93	90	87
Shoes and leather products	100	103	105	94	92	87
Textiles	100	107	115	91	94	82
Anthracite	100	93	91	86	74	62

In general, goods used directly by consumers have declined much less than have producers' goods, such as steel, copper, and cement. Thus the output of tobacco products was actually 11 points greater in 1932 than in 1923–25, illustrating the fact that a man will cling to his pipe even when he is short of clothes. Goods involving a large cash outlay in one sum have fallen off much more, and the index of automobile production dropped to 35 in 1932 (65 points below 1923–

25). The trend of the big necessaries of life is illustrated by food and clothing, which have held up surprisingly well. The index of food products stood at 87 in 1932; the index of shoes and leather goods was also 87, and the index of textile products was 82. For anthracite production the 1932 index was 62. Anthracite thus fared better than automobiles but worse than food and clothing. While food and leather products fell 13 percent below the 1923–25 base and textile products 18 percent below, anthracite production fell 38 percent below.[14]

The causes of the decline are not far to seek. Contraction of purchasing power forced consumers to economize in fuel bills as elsewhere. For still another year temperatures during the heating season were distinctly above normal. The heavy inroads of competitive fuels that have been so apparent since the strike of 1922 continued, and exports to Canada again declined.

Weather conditions.—The mild weather of 1932 affected anthracite even more than bituminous coal, because the most striking and prolonged abnormalities in temperatures occurred in the anthracite-consuming territory. In January, for example, the departure from the normal was greatest in the North Atlantic coast area, where the average temperatures for the month ranged from 10.9 degrees above normal in Boston to as high as 13.6 degrees above normal in Philadelphia. At Baltimore, Philadelphia, New York, and Buffalo the temperature was as high or higher than in any January of record. In February, also, the weather in this area continued very warm, considering the season. In the vicinity of Boston, one of the most important anthracite-consuming centers, above-normal temperatures prevailed throughout the heating season. Even in March, when the rest of the country was in the grip of the one severe cold spell of the year, the average temperature at Boston was slightly above normal. During the fall and early winter the weather was closer to normal, but in the anthracite territory the average for the last quarter was distinctly above the usual experience of the season. How much of a loss of tonnage the mild weather caused is unknown, but that it was a factor in the declining market of 1932 is beyond dispute.

Competitive fuels.—Although the effects of the weather are temporary, the competition of other fuels has been cumulative and was responsible for a gradual decline in sales of anthracite even during the years from 1924 to 1929, when business in general was highly prosperous. In 1932 the pressure of competition increased, and all information now at hand indicates further incursions by other fuels.

Sales of byproduct coke for domestic use broke all previous records, chiefly because of drastic reductions in price. From 2,812,771 tons in 1924, the tonnage of domestic coke had jumped to 8,376,652 in 1931, an increase of over 5,500,000 tons in 7 years. In 1932 sales increased to 9,249,000 tons, a gain of 10 percent in spite of the depression. There was also an increase in domestic beehive coke, the sales of which rose from 118,665 to 207,857 tons. Imports of coke in 1932 were 117,275 tons, 13 percent higher than in 1931, though below the level of other recent years.

Sales of fuel and distillate oils for househeating increased from 5,021,000 barrels in 1924 to 24,659,000 in 1931. Returns for 1932 are not available, but with prices of oil still low it is probable that

[14] The showing of anthracite is still less favorable if the strike year 1925 is excluded in calculating the base. In point of fact, the year 1924 is a better standard, in comparison with which 1932 shows a decline of 43 percent.

consumption was not far from that of the preceding year. This view is substantiated by the continued heavy sales of oil burners. The total shipments of oil burners to points in the United States during the past year amounted to 64,706, of which 58,445 were domestic types.[15]

On the other hand, the production of fuel briquets fell off sharply, the total output for the year being 470,604 tons, as against 698,316 tons in 1931. Imports of briquets in 1932, however, amounted to 80,288 tons, an increase of 32 percent over 1931.

The production of other competitive fuels in 1932 showed a downward tendency, but the declines for the most part were not as severe as in the case of anthracite. A loss of 10 percent is shown in the production of anthracite and semianthracite outside of Pennsylvania and a decrease of 12 percent in the output of petroleum coke. Details for other fuels will be published later.

It does not follow, of course, that the increase in the use of competitive fuels necessarily represents displacement of anthracite. Much of the oil used for househeating, for example, has been introduced in communities depending primarily on bituminous coal.

Imports.—Foreign anthracite continued to be a factor in the New England market. The total imports in 1932 were 607,097 tons, slightly less than the 1931 tonnage but 25 percent more than in 1929 and over five times as much as in 1927. The domestic producers appealed for protection, and on June 15, 1932, an excise tax of $2 per net ton on foreign coal was appended to the revenue act. But the tax failed to keep out the foreign product, and both British and Russian hard coal continued to be imported in appreciable quantities during the latter part of the year. Of the total imports in 1932, more than 38 percent came from Soviet Russia and 46 percent from Great Britain. The remainder was supplied by Germany, Belgium, and French Indo-China.

Exports.—Exports of anthracite in 1932 totaled 1,303,000 tons. In comparison with the previous year this is a decrease of 26.7 percent and is less than half the tonnage exported in 1929. A major factor in the shrinkage of anthracite exports has been the increased competition of British anthracite in the Canadian market. Formerly virtually all the hard coal used in Canada came from the United States. Since 1929, however, Canadian imports from Great Britain have nearly doubled, and in 1932 a total of 1,399,000 tons (nearly half of the anthracite used in Canada) was British. The influx of British anthracite was greatly stimulated by depreciation of the pound sterling. The shift from American coal also reflects a recent change of policy by the Dominion Government in levying a tariff on the American product, while British hard coal is permitted to enter Canada duty free. Effective June 2, 1931, a duty of 40 cents a ton was imposed on Pennsylvania anthracite, and under the provisions of the Empire Agreements made in Ottawa in the summer of 1932 the tariff was raised to 50 cents a ton. Still another factor has been the subventions offered by the Dominion Government to promote the use of Canadian coal.

Trend of stocks.—An encouraging development of the year was the sharp reduction of anthracite in storage. The trend of producers' stocks has been downward since 1927 (fig. 24). At the beginning of

[15] As reported by 103 manufacturers to the Bureau of the Census.

the year the operators reported 3,073,000 net tons in their storage yards. A sharp drop during the first quarter was followed by the usual seasonal increase in preparation for the fall demand, but at the end of December the stocks on hand stood at 1,732,000 tons, a net decrease of 1,341,000 tons for the year.

Stocks at the head of the Lakes and in the yards of retail dealers were likewise drastically reduced. At the beginning of the year stocks on the lake docks stood at 632,000 tons, while on December 31 they were 389,000 tons, a reduction of 38 percent. Complete figures on retail stocks are not available, but a canvass of a selected group of dealers believed to be representative of the trade as a whole shows that the draft on retailers' stocks was even more pronounced, the tonnage on hand at the end of the year being 45 percent less than on January 1. In normal times the reserves of anthracite carried by producers and distributors are by no means excessive, and they contribute to the stability of the trade. The reduction of inventories at this time, however, may be taken as a sign of the general liquidation of stocks necessary to recovery from a depression. It means that any

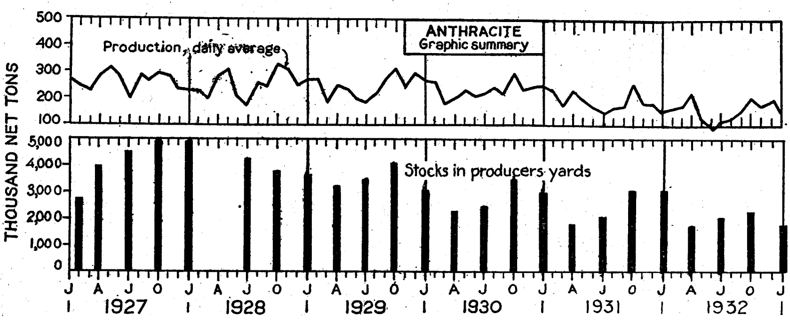

Figure 24.—Current trends of production and stocks of Pennsylvania anthracite, 1927–32.

revival of demand will be felt promptly in increased activity at the collieries.

Consumption.—As the drafts on storage went to increase consumption the decline in the quantity consumed was somewhat less than appears from the record of production alone. Allowing for exports, imports, and withdrawals from producers' stocks, the apparent consumption in 1932 was 50,545,000 tons, a decline of 13.5 percent from the previous year.[16]

Movement through major distribution channels.—With requirements curtailed and consumers relying as much as possible upon reserves, shipments of hard coal declined in virtually all directions. The most striking feature of the distribution statistics is the sharp decrease in the lake trade. Loadings of hard coal at the lower Lake Erie ports amounted to only 294,000 tons in 1932, which, in comparison with the preceding year, is a decrease of 61.4 percent. Receipts at Duluth-Superior fell from 300,000 tons in 1931 to 66,000 tons in 1932 (a decrease of 78 percent). The decline is largely accounted for by the action of the dock operators in liquidating stocks already referred to. Including deliveries of storage coal, the total movement off the lake docks came within 28.9 percent of the previous year, amounting to 512,000 tons as against 720,000 tons in 1931.

16 If allowance is made for changes in stocks on the lake docks and in retailers' yards, the consumption appears to be 51,302,000 tons. Comparable figures for earlier years are not available.

More moderate declines are shown in shipments of anthracite to other markets. Tidewater receipts in New England, for example, fell off 14.4 percent, while rail receipts declined 22.3 percent. The total receipts of anthracite in New England during the year amounted to 5,639,000 tons (20.2 percent less than in 1931).

Trend of mine prices.—An outstanding development in the anthracite market in 1932 was the reduction of $1 per ton in the price of the domestic sizes, which became effective February 25. This reduction was followed a month later by announcement of the usual spring discounts of 50 cents a ton on all sizes above buckwheat. These two reductions brought the price of hard coal down to the lowest level in more than a decade (fig. 25).

The price cuts were anthracite's answer to the challenge of competition. In part, the February reductions in circular prices were forced

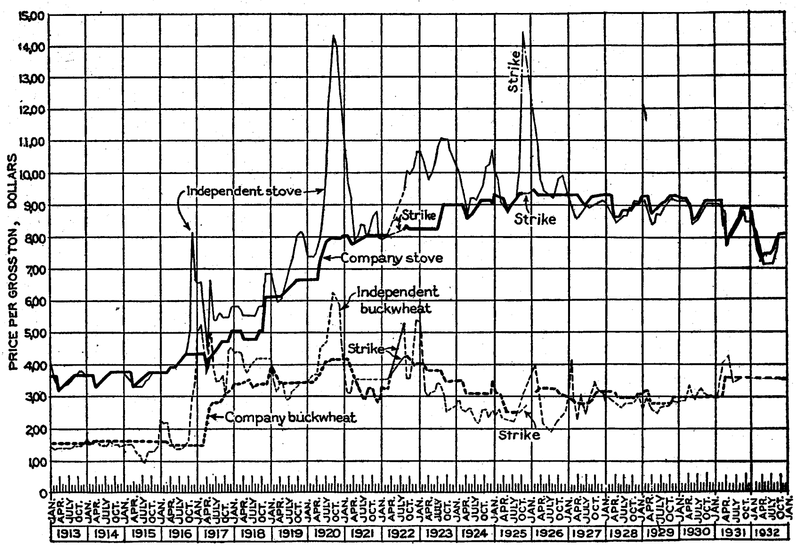

FIGURE 25.—Monthly prices of Pennsylvania anthracite, f.o.b. mines, as quoted by the trade journals, 1913–32. Prices shown are averages of the range as quoted in the New York market.

by the independent companies which, since the beginning of the 1931–32 heating season, had been quoting prices on prepared sizes 40 or 50 cents a ton below the circular prices of the line companies. To illustrate, independent stove coal was quoted on the New York market from October 1931 to January 1932 inclusive, at $7.60 per ton f.o.b. mines, while company coal of the corresponding size was quoted at $8. After the February reductions the situation was reversed, and for a few weeks company coal undersold independent. In March, for example, company stove coal was quoted on the New York market at $6.90 per ton as against $7.38 for independent. During the summer independent prices again dropped below, but in the last quarter of the year the price differential was wiped out, and the same prices were quoted on substantially all sizes by both the old-line companies and the independent operators.

The readjustment of prices applied to the domestic sizes. With respect to buckwheat, years of vigorous sales effort had so increased the demand that no sacrifice in price was deemed necessary, and the posted prices of both the line companies and independents remained $3.25 throughout the year (fig. 25).

Average value, f.o.b. mines.—What effect did the reductions in price of the domestic sizes have upon the average sales realization of the industry? The question cannot be answered accurately until final reports from the operators are received. A preliminary tabulation of returns from the principal companies, however, shows that the average realization on all sizes shipped from breakers declined 10.5 percent from 1931 to 1932. If this ratio is found to hold for the remainder of the output it follows that the average value per ton for the entire industry, including dredge and washery coal, local sales, and colliery shipments, was about $4.45 per net ton in 1932 against $4.97 in 1931.

Retail prices.—The reduction in the mine price made possible a cut in price to the consumer. According to the Bureau of Labor Statistics, the average retail price of stove coal in 25 cities, sidewalk delivery, was $13.91 per ton in 1932, as compared with $14.80 in 1931. The average retail price of chestnut coal was $13.74 in 1932, as against $14.72 in the previous year.

Employment and wage rates.—A distressing consequence of the reduced output was widespread unemployment. Between 1927 and 1931 nearly 26,000 miners lost their jobs, and the 139,000 who were still employed comprised the smallest working force the industry has reported since 1894. In 1932 many more men were laid off, the preliminary figures indicating not quite 120,000 employed during the year.

Pending receipt of complete returns from all operators the best guide to the trend of employment is the monthly report of the Bureau of Labor Statistics, covering an identical group of presumably representative collieries. Taking the average for 1929 as 100, the index of number of men on pay rolls stood at 76.2 in January, fell to 44.5 in July, and was running a little over 62 in the closing months of the year.

Even the miners fortunate enough to retain jobs have felt the pressure of hard times as a result of heavy reductions in working time. In 1931 the average number of days worked by the anthracite mines was 181 days, against 225 in 1927. Running time fell to still lower levels in 1932.

In the second half of the year, following the cuts in circular prices, the operators requested a reduction of the wage scale which had been established by the 1930 agreement. Under the terms of the agreement the question of wages could be reopened for discussion at any time if either party felt that circumstances warranted modification of the contract. The producers contended that a scaling down of wages would permit a further substantial reduction in selling price which would widen markets and, in turn, result in increased working time and consequently provide higher annual earnings for the miners. Early in September a joint conference between representatives of the operators and miners met in New York to discuss the proposed reduction. The union leaders, however, declined to accept the suggested cut, and the conference adjourned without reaching an agreement. Convening again on October 3, with the miners still opposed to any reduction, a special board of reference was appointed under the arbitration clause of the agreement, to which the issue in controversy was referred. The board was composed of George Rublee, attorney, of Washington, D.C., and Frank Morrison, secretary of the American Federation of Labor. After some weeks of deliberation, the board on March 1, 1933, announced that it had failed to reach an agreement, and the basic wage of the hard-coal miners was left unchanged.[17]

MECHANIZATION OF ANTHRACITE

While on the economic side the record of recent years has been far from satisfactory, on the technical side there is brilliant progress to record. Under the pressure of competition, anthracite engineers have attacked both improvement of quality and reduction of cost.

Mechanical cleaning.—In the field of preparation, the last 6 years have seen great activity in the development and installation of new devices for the mechanical cleaning of coal, particularly the smaller sizes, reducing ash content, and standardizing quality. In this work the anthracite region has assimilated the best that bituminous experience had to offer, both in the United States and Europe, and at the same time has made outstanding contributions of its own. The Chance sand-flotation process, the Menzies hydroseparator, and the hydrotator were all developed in the anthracite region during the last decade and have established themselves firmly there, while the first two have been extended to the bituminous field. Mechanical cleaning of anthracite has been applied even to the treatment of dredge coal, and the leading river interest now cleans its product on concentrating tables at a central preparation plant. The Bureau of Mines has collected no statistics of mechanical cleaning of anthracite comparable to its surveys of the bituminous industry (Coal in 1929, pp. 765–769), but it is known that installation of new cleaning equipment continued on a large scale even under the depressed conditions of 1932. Coal Age prints a list of 19 installations made during the year, with a capacity of 2,385 tons per hour, or, say, 4,500,000 tons per year.[18]

Central breakers.—Progress continued also in construction of large, centrally located breakers to handle the output of several collieries. The Philadelphia & Reading Coal & Iron Co. completed the second of its central breakers at St. Nicholas, Pa., during the year. Coal from distant mines in the Mahanoy division of the company is transported to the breaker in railroad cars and from two adjacent collieries by belt conveyor. The rated capacity of the breaker is 14,000 net tons a day, sufficient to care for all the coal produced in the company's Mahanoy division.[19]

Advance in stripping.—Improved equipment and high wage rates have combined to simulate open-pit mining, and while the tonnage produced underground decreased 28 percent from 1929 to 1932 the tonnage recovered by stripping increased 106 percent. Illustrative of the range and size of the new equipment is a 6-cubic-yard dragline, equipped with 160-foot boom and Diesel-electric drive, recently installed at Forest City. The remarkable increase in the production by stripping is shown below:

[17] A transcript of the proceedings of the board of reference and copies of the briefs submitted and othe documents have been deposited in the Library of Congress.
[18] Coal Age, February 1933, p. 57.
[19] Coal Age, February 1933, p. 42.

	Net tons		Net tons
1927	2, 153, 156	1930	2, 536, 288
1928	2, 422, 924	1931	3, 813, 237
1929	1, 911, 766	1932	3, 947, 090

In 1932 the strip pits supplied 8 percent of the total fresh-mined output. A large part of the stripping is done by contractors.

Cutting machines.—Anthracite has been cut by machine for many years in some of the gently-dipping beds of the Northern field, but the tonnage has been small because the physical conditions and system of mining have seldom favored the machine. In 1932 the quantity cut by machine increased for those companies that have so far reported to the Bureau, indicating again the quickened interest in cost reduction through mechanization.

Mechanization of underground loading.—Mechanization of underground loading, made faster progress in 1932 than in any year preceding. The last decade has witnessed the beginnings of a quiet revolution in methods of loading anthracite comparable to that so widely heralded in the bituminous fields. While bituminous coal has set a more imposing record in terms of tonnage, anthracite has so forged ahead in the last 3 years that in terms of percent produced mechanically it now compares favorably with bituminous. In 1932 the proportion of the deep-mined output handled mechanically was 12.6 percent for bituminous coal and 12.2 percent for anthracite.

The type of mechanization has necessarily been adapted to the difficult physical conditions of the anthracite region. Many operations in the Northern field especially have exhausted the thick virgin coal and face the alternatives of shutting down or working thin beds and beds already mined once or twice before. Under these conditions the types of equipment most widely applicable are scrapers and face conveyors. The first experimental use of scrapers in the anthracite mines dates from 1914 and 1916.[20] Their chief advantages have been found in direct saving of the loading cost, concentration of production in fewer working places, and reduction in the amount of rock yardage to be driven. By 1932, according to a special survey by the Bureau of Mines, the number of scraper units installed had increased to 479, and the tonnage loaded by scrapers was 2,591,030.

Although conditions in the region are generally less well suited to mobile loading machines of the track-loading or caterpillar type, 11 mobile machines were in use in 1932, and they loaded 60,561 tons of coal. In 1932, also, duckbills were successfully used. The number of "duckbills and other self-loading conveyors" was 17, and the tonnage loaded was 26,442. Grouping all types of equipment that dispense with hand-loading except for incidental clean-up—scrapers, mobile loaders, duckbills, and other self-loading conveyors—the total quantity loaded mechanically in 1932 was 2,678,033 tons.

The first recorded use of conveyors in the anthracite region was in 1912 at the Dodge mine of the Delaware, Lackawanna, & Western Railroad.[21] Until recently the use of conveyors has lagged behind that of scrapers, but in 1932 for the first time the conveyor tonnage exceeded the scraper tonnage. In that year 818 hand-loaded face conveyor units were at work in the region, and the tonnage handled was 2,724,433. The greater number of these were shaker chutes, but chain-and-flight and belt conveyors were also successfully used.

[20] American Mining Congress, 1929 Yearbook on Coal-Mine Mechanization, p. 4.
[21] American Mining Congress, 1929 Yearbook on Coal-Mine Mechanization, p. 365.

Twenty-four pit-car loaders were employed in 1932 and handled 30,874 tons of coal.

Combining both loaders and conveyors, the total production by "mechanized mining" in 1932 was 5,433,340 net tons. In 1927, the year of the first statistical record, it was 2,223,281 net tons, so that 5 years have seen an increase of 144 percent. The advance was especially rapid in 1932. Compared with the year before, mechanized mining increased 23.9 percent, while hand-mining underground decreased 20 percent. The largest increase has occurred in conveyor types of equipment. The first year for which separate records of tonnage handled by types of machines is available is 1929. From that year to 1932 the tonnage loaded by scrapers and mobile machines increased 8 percent, but the tonnage handled on conveyors, pit-car loaders, and duckbills increased 173 percent. The record year by year is given in the table below:

Growth of mechanization in anthracite mining

Year	Scrapers and mobile loaders		Conveyors and pit-car loaders [1]		Total mechanized mining	
	Number of units	Net tons loaded	Number of units	Net tons handled	Number of units	Net tons handled
1927 [2]	305	(3)	159	(3)	464	2,223,281
1928 [2]	302	(3)	184	(3)	486	2,351,074
1929	350	2,450,279	355	1,019,879	705	3,470,158
1930	384	2,927,088	421	1,540,662	805	4,467,750
1931	462	2,462,370	576	1,922,410	1,038	4,384,780
1932	490	2,651,591	859	2,781,749	1,349	5,433,340

[1] Includes duckbills and other self-loading conveyors.
[2] Figures for 1927 and 1928 as reported by the Pennsylvania Department of Mines.
[3] Not separately reported; see total.

The achievement of rapid mechanization is the more impressive in the light of the growing natural difficulties in the anthracite mines. The workings are getting steadily deeper, the average thickness of the beds operated is decreasing, virgin coal is no longer generally accessible, and most operations (in the Northern field, especially) are forced to second or third mining of pillars and stumps and to work in crushed areas and in badly broken ground. The multiplication of these physical conditions is an increasing handicap to the engineers of the anthracite industry and has necessarily absorbed much of the savings effected by mechanization. Indeed, mechanization of thin beds has been the one means by which many operations have avoided closing down.

WORLD PRODUCTION

The world production of coal of all grades in 1932, according to preliminary figures, was 1,120,000,000 metric tons, a decrease of 136,000,000 tons compared with 1931. Of the 1932 production, 170,000,000 tons (about 15 percent of the total quantity), was lignite, and 950,000,000 tons was bituminous coal and anthracite. In comparison with 1931 the output of lignite decreased 5.6 percent, and the output of bituminous coal and anthracite 11.7 percent (fig. 26). The following table shows production by countries and is based upon information from such official sources as are at present available, supplemented by trade information.

All countries listed show a decrease in production below 1931 if coal and lignite are combined, except Russia which reported a substantial gain in 1932 and New South Wales which increased slightly.

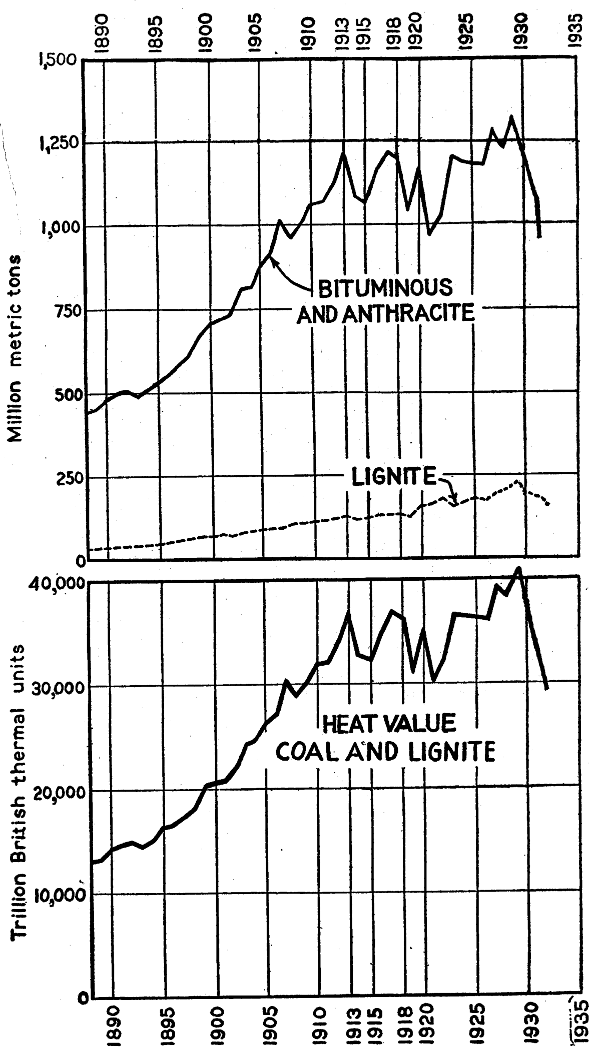

FIGURE 26.—World production of coal and lignite, 1888–1932.

In no country, however, was the decrease as great as in the United States. In 1929 the United States produced 35.4 percent of the total tonnage of coal and lignite, but in 1932 its share had fallen to 20.6 percent. The statement following shows the percentage of decrease (or increase) in the output of each of the principal countries from 1929 to 1932.

	Change since 1929, percent
United States, bituminous and anthracite	−42
Canada, coal	−39
Poland	−38
Germany, coal	−36
Germany, lignite	−30
Union of South Africa	−24
Japan	−23
Belgium	−21
India	−20
Great Britain	−19
France	−14
Netherlands	+10
Russia in Europe	+48

In the United States the decline in tonnage produced from 1929 to 1932 was 42 percent, counting both anthracite and bituminous, compared, for example, with 39 percent for Canada, 36 percent for Germany, 19 percent for Great Britain, and 14 percent for France. In the Netherlands and Russia, on the other hand, there has been an increase. Coal production is universally regarded as one of the most important business barometers, and the comparison indicates that the effects of the depression during 1932 were even more serious in North America than in Europe and the rest of the world.

Taking the world as a whole the combined production of bituminous coal and lignite in 1932 was roughly equal in heating value to that of 1908. It is striking testimony to the vitality of the world's economic life, that in spite of what has been called the greatest of all depressions, men are using as much raw coal today as they were only 24 years ago.

Coal produced in the principal countries of the world in the calendar years 1930, 1931, and 1932, in thousands of metric tons [1]

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

Country	1930	1931	1932
North America:			
Canada:			
Coal	10,367	8,468	7,503
Lignite	3,133	2,638	3,130
United States:			
Anthracite	62,945	54,109	44,769
Bituminous and lignite	424,131	346,624	277,295
Other countries	1,299	927	(2)
South America	2,157	1,787	(2)
Europe:			
Belgium	27,415	27,038	21,414
Czechoslovakia:			
Coal	14,435	13,103	13,243
Lignite	19,194	17,932	17,061
France:			
Coal	53,884	50,023	47,258 (coal and lignite)
Lignite	1,143	1,040	
Germany:			
Coal	142,699	118,640	104,740
Lignite	146,010	133,311	122,615
Saar [3]	13,236	11,367	10,438
Hungary:			
Coal	812	776	(2)
Lignite	6,176	6,197	[4] 5,700
Netherlands:			
Coal	12,211	12,901	12,756
Lignite	144	122	(2)
Poland:			
Coal	37,506	38,265	28,835
Lignite	55	39	33
Russia:			
Coal and Lignite	[5] 39,952	50,400	[6] 53,700
Europe—Continued			
Spain:			
Coal	7,120	7,186	[7] 6,890
Lignite	388	353	[7] 349
United Kingdom:			
Great Britain	247,796	222,981	212,608
Other countries	14,384	13,251	(2)
Asia:			
China	26,455	27,682	(2)
India, British	24,185	22,065	[4] 19,000
Japan (including Taiwan and Karafuto):			
Coal	33,454	28,095	[8] 28,000
Lignite	129	(2)	(2)
Other countries	13,497	13,826	(2)
Africa:			
Southern Rhodesia	939	587	438
Union of South Africa	12,223	10,881	9,921
Other countries	511	456	(2)
Oceania:			
Australia:			
New South Wales	7,207	6,536	6,700
Other States	4,338	3,920	(2)
New Zealand:			
Coal	1,404	995	
Lignite	1,179	1,197	
Other countries	10	9	
Total	1,414,000	1,256,000	1,120,000

[1] 1 metric ton equivalent to 2,204.6 pounds.
[2] Estimate included in total.
[3] Mines under French control.
[4] Estimated on the basis of 10 month's figures.
[5] Figures for fiscal year ended September 30.
[6] Estimated on the basis of 9 month's figures.
[7] Estimated on the basis of 8 month's figures.
[8] Approximate production.

COKE AND BYPRODUCTS

By F. E. Berquist and H. L. Bennit

The coke industry shared the further sharp recession which characterized the iron and steel industries during 1932. Production of both beehive and byproduct coke totaled only 21,912,511 short tons, the lowest output since 1901, which represents a decrease of 34.6 percent from 1931 and 63.4 percent from 1929, the peak year of coke production in the United States. The annual output for the 10-year period 1922–31 averaged 27,261,624 tons (24.4 percent greater than that in 1932).

Most of the decline in 1932, as in 1930 and 1931, was accounted for by reduced activity in the metallurgical industries. In years of high industrial activity, pig-iron furnaces consume approximately three fourths of the total supply of coke; the proportion was 75.4 percent for the period 1925–29. The rate of activity of the iron and steel industries, therefore, largely determines the rise or fall in the activity in the coke industry as a whole. The output of pig iron in 1932 was 79.5 percent less than in 1929; coke production decreased 63.4 percent.

Coke production was marked by a steady decline in the daily rate from the first of the year through August, after which a temporary improvement in the iron and steel industries resulted in the recovery of a substantial part of the ground lost during the first 8 months. (See fig. 27). The daily average of beehive and byproduct production was 71,153 tons in January, 49,052 tons in August, and 61,293 tons in December.

Byproduct ovens contributed 97 percent of the total production, virtually the same proportion as in 1931. The output of these plants fell to 21,258,948 tons, a decrease of 11,096,601 tons (34.3 percent) from 1931. However, curtailment at "furnace" plants (those affiliated with blast furnaces) was much greater than at merchant plants. (See fig. 29.) Furnace plants produced 11,373,352 tons, a decrease of 9,443,888 tons (45.4 percent) from 1931. Production at merchant plants was 9,885,596 tons, a decrease of 1,652,713 tons (14.3 percent). The difference in the rates of decline is accounted for by the difference in stability of the markets supplied by the two classes of plants. The bulk of the output of furnace plants is used in blast furnaces, which suffered considerably more reduction in activity than industry as a whole. Total deliveries of byproduct coke to blast furnaces (interplant transfers and sales) fell from 18,448,986 tons in 1931 to 8,942,435 tons in 1932 (51.5 percent).

On the other hand, merchant plants enjoy a better balanced, diversified market for their coke and depend much less on the metallurgical industries. Most of them dispose of their surplus gas for distribution through city mains, either operating as public utilities or selling to public-utility distributors under contract. Naturally, the operation of these plants has been favored by a relatively stable demand for gas while their principal outlet for coke (the domestic market) has grown during the depression period.

The activity of beehive ovens declined even more in proportion than that of byproduct plants. Production amounted to 653,563 tons in 1932, a decrease of 42.1 percent from that in 1931.

Of particular significance is the growing demand for coke for domestic use. While other uses of coke have shown marked declines during the depression, sales of domestic coke have increased each year to 9,457,259 tons in 1932, an increase of 11.3 percent over 1931. In fact, the domestic consumption of coke reached an all-time peak in 1932 and exceeded the furnace-coke demand for the first time.

Coke sold or used by producers for furnace purposes amounted to 9,043,985 tons, a decrease of 9,872,550 tons (52.2 percent) from 1931;

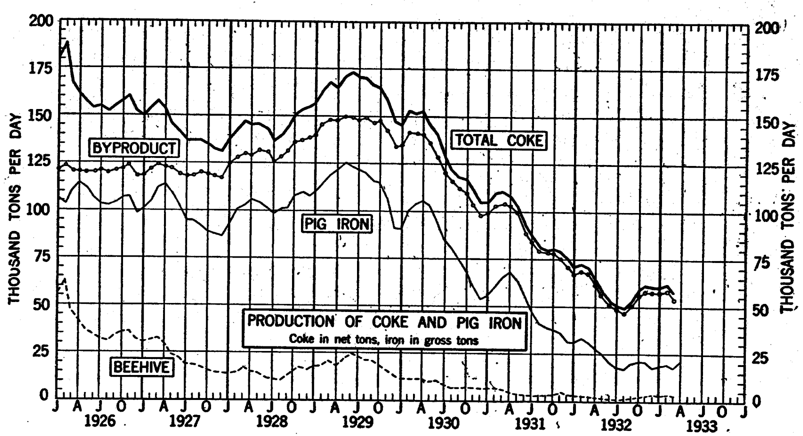

FIGURE 27.—Average daily production of beehive and byproduct coke and of pig iron, by months, 1926–33.

that sold for foundry use fell from 1,357,276 tons to 1,100,314 tons (18.9 percent); and that sold for manufacture of water gas decreased from 622,917 tons to 531,189 tons (a decline of 14.7 percent). Exports of coke amounted to 630,151 tons, a decline of 16.5 percent from 1931 and approximately one half of exports in 1929. Imports totaled 117,285 tons, an increase of 13.2 percent over 1931.

Stocks remained at relatively high levels throughout the year, particularly in relation to consumption. Byproduct coke stocks on hand at producers' plants amounted to 4,379,000 tons on January 1 and 3,590,000 tons on December 31 (a decrease of 18 percent); however, stocks represented 60.8 days' supply at the beginning of the year and 62.3 days' supply at the end of the year based on the rate of consumption prevailing during the month preceding each date.

Prices.—The average value for all grades of byproduct coke was $4.89 a ton, the same as in 1931. This maintenance of value is due to the fact that, although coke prices continued to decline, the total sales in 1932 include a smaller proportion of furnace coke, much of which is transferred to affiliated pig-iron furnaces at nominal accounting values as opposed to the higher prices of coke sold in the market. Average receipts for sales of coke show considerable decline as follows: Domestic coke declined from $5.73 to $5.26; foundry coke from $6.11 to $5.72; and industrial, including water-gas, coke from $5.73 to $5.32. The spot price of Connellsville furnace coke f.o.b. ovens declined from $2.25 in January to $1.80 in December and that of foundry coke from $3.25 to $2.50. These decreases reflect the further decline in the cost of coking coal and the sharp recession in the demand for metallurgical coke. However, the average cost of all coal consumed in byproduct plants was $3.55, the same as in 1931, due to the fact that a larger proportion of the total in 1932 was consumed by plants at a distance from the mines, whose average delivered prices included larger transportation charges than those for plants closer to the sources of supply of coal.

Spot prices of coking coals f.o.b. mines were reduced sharply in 1932. This is reflected in sales realization at the mines on all coal produced in McDowell, Mercer, and Raleigh Counties, W.Va., which supply a large part of the byproduct coking coal. The average realization for these counties was $1.12, compared with $1.41 in 1931, a drop of 20.6 percent.

The production of byproducts reflected an adjustment in operations due to changing market for the several products. The recovery of gas and tar per ton of coal charged in byproduct ovens was virtually the same as that in 1931. The yield of tar, however, was considerably higher than before 1931. In 1932, 9.77 gallons of tar were recovered per ton of coal charged, compared with an average of 8.71 gallons per ton for the 7-year period 1924–30. On the other hand, the average recovery of ammonia and crude light oil declined in 1932. The recovery of ammonium sulphate (and sulphate equivalent of ammonia liquor) was 22.81 pounds per ton of coal charged, compared with 24.33 pounds in 1931. The average sales realization for ammonium sulphate was 31 percent less than in 1931, and a number of plants ceased operating their ammonia departments on account of the weak market. The production of motor benzol, the most important light-oil derivative, and the recovery of tar derivatives likewise were curtailed below the general level of byproduct-plant activities. The total value of all byproducts per ton of coke produced was $4.133.

Salient statistics of the coke industry in 1932

[Figures subject to revision]

	Byproduct	Beehive	Total
Coke produced:			
At merchant plants:			
Quantity ... net tons	9,885,596		
Value	$56,072,079		
At furnace plants:			
Quantity ... net tons	11,373,352		
Value	$47,951,039		
Total:			
Quantity ... net tons	21,258,948	653,563	21,912,511
Value	$104,023,118	$1,763,548	$105,786,666
Screenings and breeze produced:			
Quantity ... net tons	2,123,162	47,968	2,171,130
Value	$4,717,334	$86,723	$4,804,057
Coal charged into ovens:			
Quantity ... net tons	31,045,064	1,033,379	32,078,443
Value	$110,178,215	$1,342,852	$111,521,067
Average value ... per ton	$3.55	$1.30	$3.48
Average yield in percent of coal charged:			
Coke	68.48	63.21	68.31
Breeze (at plants actually recovering)	6.84	6.98	6.84

Salient statistics of the coke industry in 1932—Continued

[Figures subject to revision]

	Byproduct	Beehive	Total
Ovens:			
In existence Jan. 1	13,108	21,588	34,696
In existence Dec. 31	13,053	19,278	32,331
Dismantled during year	142	2,746	2,888
In course of construction Dec. 31			
Daily capacity of ovens Dec. 31 ... net tons	171,632	(1)	(1)
Coke used by operator:			
In blast furnaces:			
Quantity ... net tons	8,032,027		8,032,027
Value	$33,110,777		$33,110,777
For other purposes:			
Quantity ... net tons	1,625,095	21	1,625,116
Value	$9,665,193	$76	$9,665,269
Disposal of coke:			
Sold for furnace use to affiliated corporations:			
Quantity ... net tons	569,289	1,644	570,933
Value	$2,763,274	$5,342	$2,768,616
Merchant sales of furnace coke:			
Quantity ... net tons	341,119	99,906	441,025
Value	$1,441,248	$256,860	$1,698,108
Sold for foundry use:			
Quantity ... net tons	954,601	145,713	1,100,314
Value	$5,462,983	$475,791	$5,938,774
Sold for domestic use:			
Quantity ... net tons	9,249,402	207,857	9,457,259
Value	$48,692,899	$454,256	$49,147,155
Sold for manufacture of water gas:			
Quantity ... net tons	446,548	84,641	531,189
Value	$2,795,496	$189,397	$2,984,893
Sold for industrial and other use:			
Quantity ... net tons	636,721	117,240	753,961
Value	$2,970,235	$386,199	$3,356,434
Disposal of screenings and breeze:			
Used by operator:			
For raising steam:			
Quantity ... net tons	1,403,734	1,289	1,405,023
Value	$2,977,911	$1,289	$2,979,200
To make producer or water gas:			
Quantity ... net tons	80,602		80,602
Value	$333,711		$333,711
Other purposes:			
Quantity ... net tons	134,283	3,239	137,522
Value	$235,182	$5,070	$240,252
Sold:			
Quantity ... net tons	589,116	24,228	613,344
Value	$1,333,412	$39,761	$1,373,173
Average receipts per ton sold:			
Furnace coke (merchant sales)	$4.23	$2.57	$3.85
Foundry coke	$5.72	$3.26	$5.40
Domestic coke	$5.26	$2.19	$5.20
For manufacture of water gas	$6.26	$2.24	$5.62
Other industrial coke	$4.66	$3.29	$4.45
Screenings and breeze	$2.26	$1.64	$2.24
Stocks on hand on Jan. 1, 1933:			
Furnace ... net tons	1,387,021	12,067	1,399,088
Foundry ... do	105,519	7,062	112,581
Domestic and other ... do	2,097,720	7,390	2,105,110
Breeze ... do	392,440	6,882	399,322
Imports ... do			117,275
Exports ... do			630,151
Calculated consumption ... do			22,208,565
Byproducts produced:			
Gas ... M cubic feet	347,847,192		347,847,192
Wasted ... percent	0.8		0.8
Burned in coking process ... do	32.9		32.9
Surplus sold or used ... do	66.3		66.3
Tar ... gallons	303,408,299		303,408,299
Ammonium sulphate or equivalent ... pounds	708,207,288		708,207,288
Crude light oil ... gallons	73,724,230		73,724,230
Yield of byproducts per ton of coal:			
Gas ... M cubic feet	11.20		11.20
Tar ... gallons	9.77		9.77
Ammonium suphate or equivalent ... pounds	22.81		22.81
Crude light oil ... gallons	2.93		2.93
Value of byproducts sold:			
Gas (surplus)	$54,515,361		$54,515,361
Tar:			
Sold	8,831,812		8,831,812
Used by producer	3,279,237		3,279,237
Ammonium sulphate or equivalent	6,408,348		6,408,348
Crude light oil and derivatives	9,378,414		9,378,414
Other byproducts [2]	757,595		757,595
Total value of coke, breeze, and byproducts [3]	191,911,219	$1,850,271	193,761,490

[1] Data not available.
[2] Includes naphthalene and tar derivatives.
[3] Includes value of tar used by the coke plants.

Statistical trends of the coke industry, 1923 and 1929–32

[1932 figures subject to revision]

	1923	1929	1930	1931	1932
Coke produced:					
Beehive ____ net tons	19,379,870	6,472,019	2,776,316	1,128,337	653,563
Byproduct ____ do	37,597,664	53,411 826	45,195,705	32,355,549	21,258,948
Total ____ do	56,977,534	59,883,845	47,972,021	33,483,886	21,912,511
Percent of total from byproduct ovens	66.0	89.2	94.2	96.6	97.0
Disposal of coke (beehive and byproduct):					
Furnace coke (including all coke used by producer) ____ net tons	47,774,408	46,785,722	34,524,554	20,608,175	10,669,101
Foundry coke ____ do	3,600,719	2,888,508	2,127,715	1,357,276	1,100,314
Other industrial ____ do	2,283,888	2,334,999	2,030,103	1,838,566	1,285,150
Domestic coke ____ do	2,733,414	7,511,023	8,027,823	8,495,317	9,457,259
Number of ovens in existence:					
Beehive	62,349	30,082	23,907	21,588	19,199
Byproduct	11,156	12,649	12,831	13,108	13,053
Number of new byproduct ovens under construction at end of year	629	408	276		
Cost of coal charged, byproduct ovens, average per ton	$4.76	$3.50	$3.48	$3.55	$3.55
Prices of coke:					
Average spot price of Connellsville furnace coke f.o.b. ovens	$5.33	$2.75	$2.56	$2.43	$2.06
Average realization on byproduct coke sold:					
Furnace coke (merchant sales)	$6.74	$5.38	$4.95	$4.59	$3.85
Foundry coke	$10.54	$6.97	$6.57	$6.11	$5.40
Other industrial	$9.06	$5.77	$5.88	$5.72	$4.93
Domestic	$9.05	$6.28	$6.03	$5.73	$5.20
Yield of byproducts per ton of coal charged:					
Tar ____ gallons	8.1	8.9	9.20	9.62	9.77
Ammonium sulphate or equivalent ____ pounds	21.2	22.3	23.47	24.33	22.81
Light oil ____ gallons	2.7	2.9	3.06	3.03	2.93
Surplus gas sold or used ____ M cubic feet	5.9	6.6	6.75	7.02	7.42
Average gross receipts of byproducts per ton of coke produced:					
Tar sold or used	$0.51	$0.65	$0.656	$0.637	$0.569
Ammonia and its compounds	.84	.54	.502	.441	.301
Light oil and its derivatives	.51	.58	.527	.447	.443
Surplus gas sold or used	1.37	1.58	1.754	2.084	2.564
Total byproducts, including breeze	3.48	3.60	3.708	3.863	4.133

Scope of report.—This report summarizes the salient features of operations in the coke industry in 1932. It covers only coke and byproducts made by high-temperature carbonization of coal in beehive and byproduct ovens. It is important to note that data for the output of byproduct plants operated by city gas companies also are included. In recent years the adaptation of byproduct ovens to the needs of city-gas manufacture has led a number of gas companies to install batteries of byproduct ovens to supplement or replace their coal-gas or water-gas plants. For supplying gas to lesser cities small byproduct ovens have been developed to meet local requirements. The method of production in these plants, as well as the products, are similar to those of the standard-size plants. From the standpoint of ownership and accounting, these city installations are part of the gas-utility system, but from other standpoints they are part of the byproduct coke industry and are therefore covered in the statistics for that industry by the Bureau of Mines.

Coke is also made by other processes not covered in this report. It is estimated that approximately 1,200,000 tons of gas-house coke were made by high-temperature carbonization of coal in types of equipment other than coke ovens, chiefly horizontal retorts. Petroleum coke is a byproduct of petroleum refining; the production in

1932 amounted to 1,789,000 tons, a decline of 12.0 percent from 1931. The manufacture of coke from coal tar is established on a commercial basis, but the tonnage produced is small. Gas-house coke and petroleum coke are not adapted for blast-furnace and foundry purposes, which consume the great bulk of all the coke produced, and the production of coal-tar pitch coke is so limited as to have small importance. Practically, therefore, the coke trade is concerned with beehive and byproduct-oven coke (fig. 28).

This report reviews only the major developments during 1932. Complete and detailed statistics similar to those presented in previous coke reports will be printed later. For further information on the classification of coking activities, the method of treatment of statis-

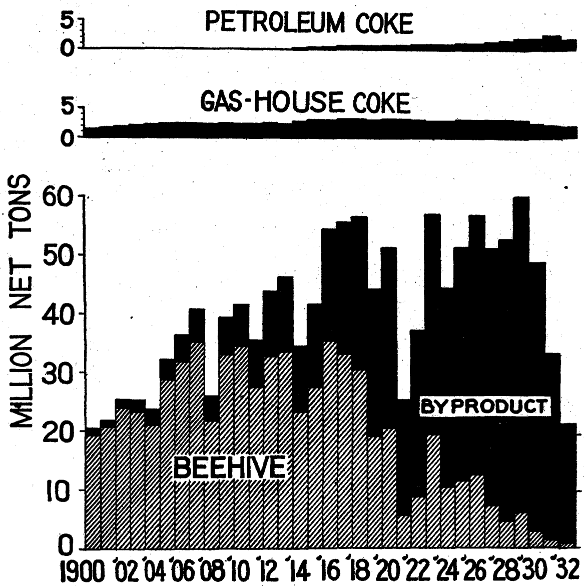

FIGURE 28.—Production of petroleum coke, gas-house coke, and beehive and byproduct coke in the United States, 1900–1932. No figures on production of petroleum coke are available before 1914, when the production was 213,777 tons.

tics, and the scope of the Bureau's series of reports on coke, see "Coke and By-Products in 1930," pages 492–496.

Monthly production.—Except for temporary improvement in the first quarters of 1930 and 1931 the output of coke had fallen sharply from the middle of 1929 until August 1932. (See fig. 27.) The peak month in 1929 was May, with a production of 5,301,500 tons, from which the output dwindled to 2,189,000 tons in January and 1,515,000 tons in August 1932, the lowest for any month since July 1921. The recovery in prices of certain farm products in the late summer stimulated a revival of optimism which resulted in considerable improvement in many lines in the fall. Among these was coke, the output of which reached 1,882,000 tons in December (24.2 percent above the low of August). The monthly average for the year, however, was only 1,828,000 tons, compared with 2,790,300 in 1931 and 4,990,300 in 1929.

Trend in byproduct and beehive coke production.—The output of byproduct plants first exceeded that of beehive plants in 1919 after a decade of rapid growth in the byproduct industry associated with the demand for munitions. Since then this growth has persisted, so that in 1931 and 1932 byproduct coke accounted for over 96 percent of the total. The relation of beehive plants to the industry has become one of "stand-by" capacity to take care of peak demands for coke. In fact, the capacity of byproduct plants was ample to have taken care of the entire demand for coke in 1921, 1922, 1924, and each year since 1926, had there been no output by beehive plants in those years.

Production by furnace and nonfurnace plants.—During the decade closing with 1929 the relative output of furnace and nonfurnace byproduct plants was quite constant, averaging 79 percent for furnace and 21 percent for nonfurnace plants. In 1930 the ratios shifted in favor of nonfurnace plants, which in 1932 contributed 46.5 percent of the total. (See fig. 29.) The failure of furnace plants to maintain their relative position reflects the decline in pig-iron output, while

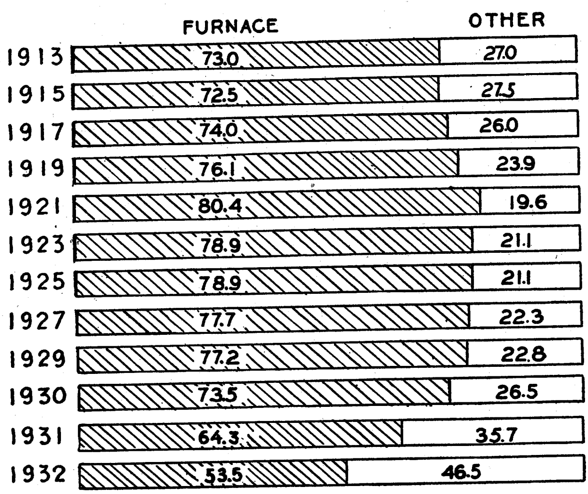

FIGURE 29.—Output of byproduct coke by furnace plants and by all other plants, 1913–32. Figures in bars represent percentage of the total produced during year.

the nonfurnace plants have suffered less because of the greater stability of the nonmetallurgical coke markets.

Production by States.—The States showing the greatest losses in 1932 were naturally the important iron-producing States—Alabama, Illinois, Indiana, Ohio, and Pennsylvania—whose combined output of byproduct coke fell from 19,636,923 tons in 1931 to 10,648,812 tons in 1932 (45.8 percent). Production in other States decreased from 12,718,626 to 10,610,136 tons (16.6 percent).

Byproduct and beehive coke produced in the United States, 1932

[Figures subject to revision]

State	Byproduct: Plants in existence	Byproduct: Ovens in existence	Byproduct: Coal used (net tons)	Byproduct: Yield of coke from coal (percent)	Byproduct: Coke produced (net tons)	Byproduct: Value of coke at ovens: Total	Byproduct: Value of coke at ovens: Per ton
Alabama	8	1,248	2,025,710	69.14	1,400,597	$3,770,988	$2.69
Colorado	1	151	135,476	68.19	92,384	(1)	(1)
Connecticut	1	61	(2)	(2)	(2)	(2)	(2)
Illinois	8	950	2,151,004	66.40	1,428,334	6,870,191	4.81
Indiana	6	1,550	2,071,953	69.28	1,435,385	7,894,902	5.50
Kentucky	1	108	(2)	(2)	(2)	(2)	(2)
Maryland	1	361	682,167	73.22	499,502	(1)	(1)
Massachusetts	3	430	1,406,764	70.17	987,106	6,493,682	6.58
Michigan	9	674	3,091,775	70.03	2,165,109	10,144,218	4.69
Minnesota	3	196	573,354	67.10	384,700	3,012,677	7.83
Missouri	1	64	(2)	(2)	(2)	(2)	(2)
New Jersey	2	202	1,310,077	70.94	929,343	(1)	(1)
New York	9	1,024	4,499,561	69.56	3,130,078	19,246,204	6.15
Ohio	15	1,834	3,450,326	68.01	2,346,686	10,388,072	4.43
Pennsylvania	13	3,478	6,134,737	65.82	4,037,810	16,131,015	3.99
Rhode Island	1	65	(2)	(2)	(2)	(2)	(2)
Tennessee	1	24	101,085	71.75	72,529	239,346	3.30
Utah	1	56	190,468	54.53	103,862	(1)	(1)
Washington	1	20	57,672	56.54	32,610	228,270	7.00
West Virginia	4	362	1,340,622	67.35	902,872	1,997,441	2.21
Wisconsin	2	195	(2)	(2)	(2)	(2)	(2)
Combined States			1,822,313	71.89	1,310,041	7,754,116	5.92
Undistributed						9,851,996	6.06
	91	13,053	31,045,064	68.48	21,258,948	104,023,118	4.89

State	Beehive: Ovens in existence	Beehive: Coal used (net tons)	Beehive: Yield of coke from coal (per cent)	Beehive: Coke produced (net tons)	Beehive: Value of coke at ovens: Total	Beehive: Value of coke at ovens: Per ton	Total: Coke produced (net tons)	Total: Value of coke at ovens
Alabama							1,400,597	$3,770,988
Colorado	378	(2)	(2)	(2)	(2)	(2)	[3] 92,384	(1)
Connecticut							(2)	(2)
Illinois							1,428,334	6,870,191
Indiana							1,435,385	7,894,902
Kentucky							(2)	(2)
Maryland							499,502	(1)
Massachusetts							987,106	6,493,682
Michigan							2,165,109	10,144,218
Minnesota							384,700	3,012,677
Missouri							(2)	(2)
New Jersey							929,343	(1)
New York							3,130,078	19,246,204
Ohio							2,346,686	10,388,072
Oklahoma	100							
Pennsylvania	14,185	779,381	64.97	506,377	$1,238,846	$2.45	4,544,187	17,369,861
Rhode Island							(2)	(2)
Tennessee	430	22,320	49.08	10,954	24,925	2.28	83,483	264,271
Utah	819	(2)	(2)	(2)	(2)	(2)	[3] 103,862	(1)
Virginia	1,520	95,486	58.80	56,143	185,871	3.31	56,143	185,871
Washington	80	1,206	61.03	736	3,680	5.00	33,346	231,950
West Virginia	1,687	81,688	58.32	47,642	146,746	3.08	950,514	2,144,187
Wisconsin							(2)	(2)
Combined States		53,298	59.50	31,711	163,480	5.16	1,341,752	7,917,596
Undistributed								9,851,996
	19,199	1,033,379	63.21	653,563	1,763,548	2.70	21,912,511	105,786,666

1 Included under "Undistributed."
2 Included under "Combined States."
3 Byproduct only. Beehive included under "Combined States."

Consumption of coke.—The aggregate consumption of coke may readily be calculated by adding the production and imports, subtracting the exports, and making allowances for changes in stocks at producers' plants. The indicated consumption thus determined was 22,208,565 net tons in 1932 compared with 31,705,322 tons in 1931 and 58,352,535 tons in 1929. According to figures compiled by the American Iron and Steel Institute the consumption of coke by iron furnaces averaged about 75 percent of the total for the decade preceding the depression. Since 1929 this ratio has dropped sharply; in 1930 it was 69.8 percent and in 1931 57.9 percent. The Institute figure for 1932 has not been released; however, based on the average consumption of coke per ton of pig iron produced in 1931 the consumption by iron furnaces is estimated at only 39 percent of the total. The actual tonnages consumed by the furnaces were 43,601,743 in 1929, 32,130,070 in 1930, 18,352,522 in 1931, and 8,746,000 in 1932. The 1932 figure was 52.3 percent below the 1931 and 79.9 percent

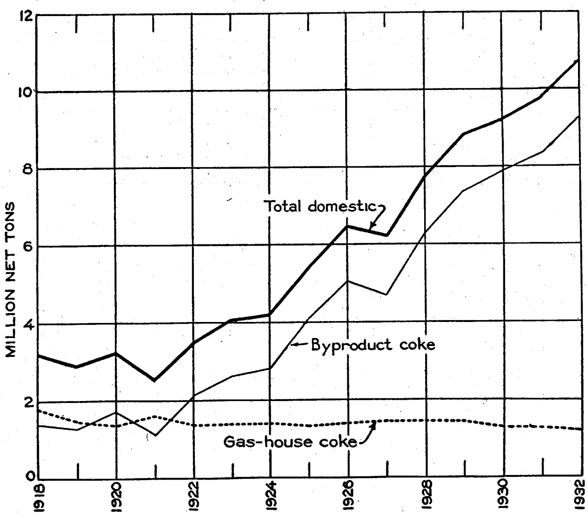

FIGURE 30.—Growth of sales of domestic coke, byproduct coke, and gas-house coke.

below the 1929 figure. Sales of coke by producers for foundry use, for the manufacture of water gas, and for industrial uses totaled 2,385,464 tons compared with 3,195,842 tons in 1931, a decrease of 810,378 tons (25.4 percent). In contrast to the decline in consumption for industrial purposes sales of coke for domestic use continued to increase during the depression much the same as during the preceding decade. (See fig. 30.) In 1932 sales for domestic use reached 9,457,259 tons, an increase of 961,942 tons (11.3 percent) over 1931 and 1,946,236 tons (25.9 percent) over 1929. Much of the coke supplied to the domestic market arises in the manufacture and distribution of large quantities by city gas plants. Plants supplying gas have found it necessary to promote the domestic market for coke, the output of which has increased with the demand for gas.

With curtailment of the metallurgical industries furnace plants also have turned to the domestic market to dispose of surplus coke. The success of this combined attack becomes evident when consumption of coke is compared with that of other domestic fuels in recent years. Coke may be said to be a natural competitor of anthracite, and most of its use as domestic fuel is in the area which consumes the bulk of the anthracite—the northeastern quarter of the country. Although fuel oil probably has been the most serious competitor of anthracite coke also has displaced a considerable quantity of hard coal. Shipments of domestic sizes of Pennsylvania anthracite have declined sharply in the past decade. In 1924 these totaled 56,576,296 tons, in 1929, 46,141,575 tons, and in 1931, 35,437,946 tons. Similar figures are not available for 1932, but the decline in total production from 55,536,972 tons in 1931 to approximately 49,900,000 tons in 1932 indicates further drastic decrease in

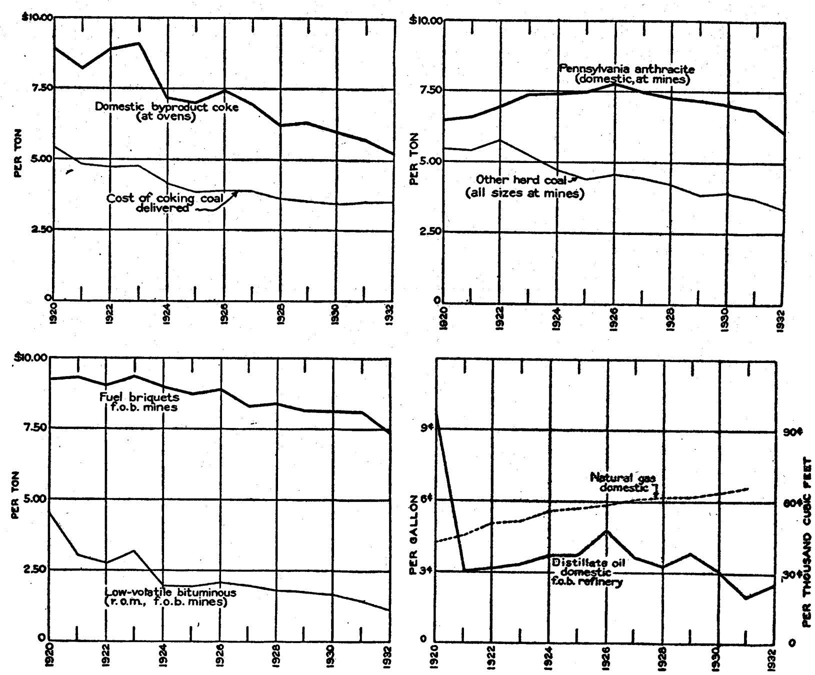

FIGURE 31.—Price trends of domestic fuels, 1920–32. As the figures are not retail prices they do not show comparative costs to the consumer, but they do indicate the general movement of prices. Prices of solid fuels including anthracite are all per net ton.

domestic consumption in 1932. On the other hand, byproduct coke sold for domestic use increased from 2,812,771 tons in 1924 to 7,376,320 tons in 1929, 8,376,652 tons in 1931, and 9,249,402 tons in 1932. Production of fuel briquets was 580,470 tons in 1924, increased to 1,212,415 in 1929, and then declined to 698,316 tons in 1931 and 470,604 tons in 1932. Gas-house coke sold and petroleum coke produced declined proportionately less than anthracite and fuel briquets.

Prices of domestic coke, f.o.b. plants, have declined from an average realization of over $9 a ton in 1923 to $5.20 in 1932. Although coke represents only a small part of the total supply of domestic fuels, the growing supply and decreasing price doubtless accounted partly for the declining prices of other domestic fuels. (See fig. 31.)

Stocks of coke.—Before the depression stocks of byproduct coke at producers' plants normally were considerably less than 2,000,000 tons, reaching approximately that figure in the summer of 1928. However, since the end of February 1929 stocks increased from approximately 1,000,000 tons to a peak of 4,379,000 tons on January 1, 1932. Stocks remained abnormally high throughout 1932 but receded somewhat at the close of the year and during the first 3 months of 1933. (See fig. 32.)

Quantity and cost of coal charged.—Although the quantity of coal used in the manufacture of coke has fluctuated widely in the past decade the proportion of the total output of bituminous coal carbonized each year has remained remarkably constant, ranging from 13.4 to 16.2 percent; with an average of 14.8 percent, for the period 1923

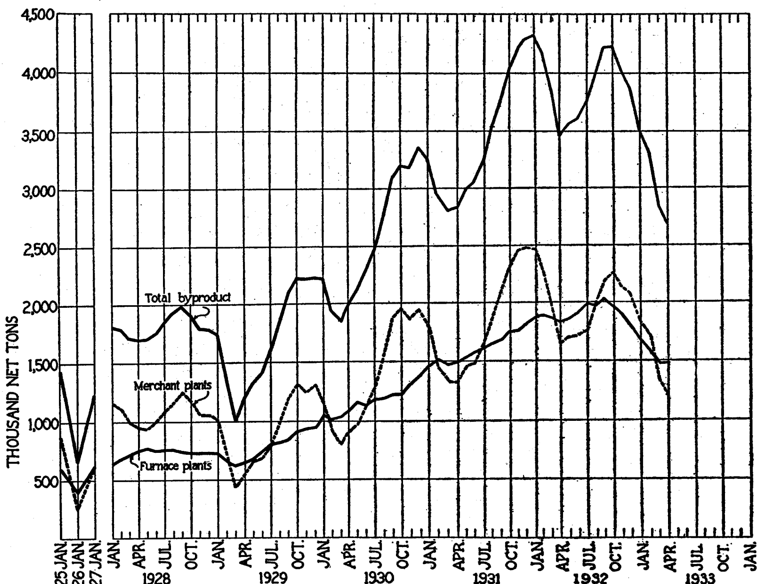

FIGURE 32.—Total stocks of byproduct coke at producers' plants on the first of each month. The diagram represents stocks at all byproduct plants.

to 1930. In 1932 the proportion fell considerably below the normal for coke making. Coke ovens consumed 32,078,443 tons (only 10.5 percent) of the total output of bituminous coal. Of this quantity 31,045,064 tons were used in byproduct ovens. Normally, Pennsylvania heads the list of States in the supply of byproduct coking coal. In 1932, however, West Virginia supplied 40.1 percent of the total, Pennsylvania 36.9 percent, Kentucky 11.8 percent, and Alabama 6.8 percent.

The cost of coking coal has declined appreciably during the depression. The trend of price of low-volatile coal is reflected in the drop in the average f.o.b. mine value of all coal produced in McDowell, Mercer, and Raleigh Counties, W.Va., in which much of this grade of coal is mined. The average mine value of coal from these counties in 1932 was $1.12 a ton compared with $1.41 in 1931 and $1.69 in 1930; from these figures it must be inferred that the mine cost of coking coal declined appreciably although not necessarily to the extent indicated by the figures for the total production in these counties.

Coke-oven byproducts.—This discussion is confined to the products of coal obtained in the high-temperature byproduct ovens. These products fall into five general groups, some of which are further subdivided. They are: (1) Tar, (2) ammonium sulphate and ammonia liquor, (3) gas, (4) light oil and its derivatives, and (5) miscellaneous products. In value these products represent a total almost equal to that of byproduct coke itself; in 1932 their combined value per ton of coke produced was \$4.13 compared with \$4.89 for the coke. In 1913 the value of byproducts was only 27 percent of the total gross

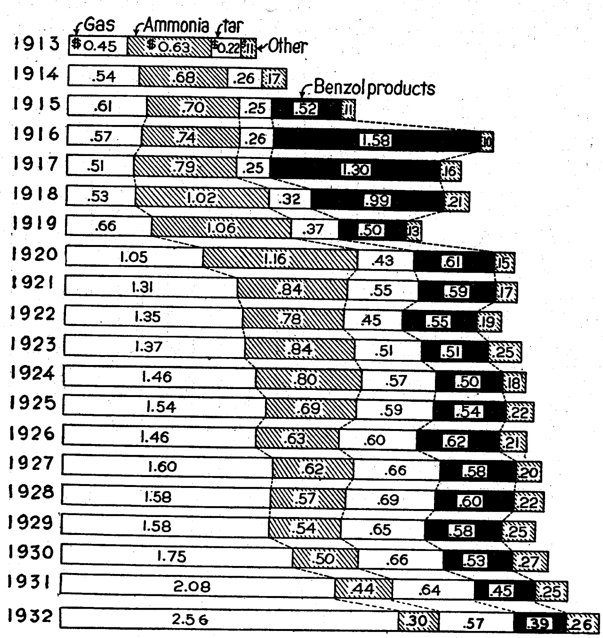

FIGURE 33.—Gross value of the several byproducts per ton of byproduct coke produced, 1913–32.

value of all products per ton of coke produced. In 1932 their share had risen to 45.8 percent. (See fig. 33.)

The average gross value of the byproducts per ton of coke produced increased from \$3.86 in 1931 to \$4.13 in 1932; however, this increase was due to the increase in the average realization for gas from \$2.08 to \$2.56 per ton of coke produced. These averages represent the composite realizations for gas produced by all byproduct plants. In normal times the average price for gas is dominated by the large establishments associated with iron furnaces at which gas is credited at relatively low prices. With the decline in operation of furnace plants the proportion of the total byproduct gas contributed by public-utility and city plants has increased. Since the price of such gas delivered to city gas lines is higher than that used in interplant transfers at furnace plants the average return for all byproduct gas produced in 1932 shows a substantial increase over that in 1931.

Byproducts obtained from coke-oven operations in 1932 [1]

[Figures subject to revision]

Product	Production	Sales		
		Quantity	Value	
			Total	Average
Tar .... gallons	303,408,299	221,427,368	$8,831,812	$0.040
Ammonia:				
Sulphate .... pounds	575,208,800	610,580,389	5,421,809	.009
Ammonia liquor (NH_3 content) .... do	33,249,622	32,651,803	986,539	.030
	....	....	6,408,348	....
Sulphate equivalent of all forms .... do	708,207,288	741,187,601	....	....
Gas:				
Used under boilers, etc .... M cubic feet	[2]347,847,192	9,569,519	542,751	.057
Used in steel or affiliated plants .... do		64,904,429	7,248,949	.112
Distributed through city mains .... do		144,705,196	44,694,159	.309
Sold for industrial use .... do		11,090,992	2,029,502	.183
	....	230,270,136	54,515,361	.237
Light oil and derivatives:				
Crude light oil .... gallons	[3] 73,724,230	5,571,435	472,255	.085
Benzol, crude and refined .... do	10,508,819	10,839,630	1,909,010	.176
Motor benzol .... do	32,879,326	32,652,235	3,831,908	.117
Toluol, crude and refined .... do	8,941,235	8,725,572	2,343,394	.269
Solvent naphtha .... do	2,080,169	1,919,223	349,335	.182
Xylol .... do	1,562,651	1,466,450	346,061	.236
Other light oil products .... do	2,945,875	1,856,168	126,451	.068
	[4] 58,918,075	63,030,713	9,378,414	.149
Naphthalene, crude and refined .... pounds	4,618,792	3,701,130	33,263	.009
Tar derivatives:				
Creosote oil, distillate as such .... gallons	5,733,819	5,741,600	435,242	.076
Creosote oil in coal-tar solution .... do	1,652,005	1,985,128	127,623	.064
Pitch of tar .... net tons	42,161	1,427	11,501	8.060
Other tar derivatives	....	....	53,678	....
Phenol .... gallons	100,064	90,988	18,569	.204
Other products [5]	....	....	77,719	....
Value of all byproducts sold	....	....	[6] 79,891,530	....

[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. Excludes screenings or breeze.
[2] Includes gas wasted and gas used for heating retorts.
[3] Refined on the premises to make the derived products shown, 70,822,122 gallons.
[4] Total gallons of derived products.
[5] Carbolate, crude products, cyanogen, sodium prussiate, sulphur, and vented vapors.
[6] Exclusive of the value of breeze production, which in 1932 amounted to $4,717,334.

The average realization for ammonium sulphate fell to the extremely low level of 30 cents per ton of coke produced. The continued decline in the receipts for ammonium sulphate is a reflection of the depressed condition of agriculture. According to the National Fertilizer Association the consumption of all fertilizers in 1932 declined 46.6 percent from that in 1930. The trend in average receipts over a series of years for the principal byproducts is shown in figure 33.

Prices of byproducts.—The price of sulphate of ammonia with few exceptions, has declined each year over a long period. As quoted by Steel,[1] the average for 1932 was only $1.12 per 100 pounds, f.o.b. producers' works compared with $1.57 in 1931, $2.03 in 1930, and $3.08 in 1923. Besides indicating the marked decline in consumption of nitrogen by agriculture the falling prices also indicate the influence of increased supplies of nitrogen made available in recent years by large increments in synthetic nitrogen production.

[1] Steel, vol. 92, Jan. 2, 1933.

The prices of coal-tar products have remained more stable than those of ammonia. According to Steel [2] the averages for benzol (90 percent) and solvent naphtha increased slightly over 1931. Benzol was quoted at 20 cents per gallon throughout the year, as against 19.5 cents in 1931 and 22.7 cents in 1929. Solvent naphtha held the quotation (26 cents per gallon) of the last 3 months of 1931 throughout 1932, compared with 27.5 cents in 1930 and 30 cents in 1929.

Average toluol and naphthalene prices were somewhat lower for the year. Toluol remained at 30 cents throughout the year compared with 34 cents in 1931 and 35 cents in 1930. Although the average price quoted for naphthalene flakes was 4 cents in 1932 compared with 4.5 cents in 1931, quotations for the last 3 months of 1932 rose to 4.75 cents per pound.

[2] See footnote 1.

RECENT DEVELOPMENTS IN COAL UTILIZATION

By A. C. Fieldner

RESEARCH BY COAL PRODUCERS' ASSOCIATIONS

Continued inroads by oil and natural gas into its markets have induced the coal industry to make organized research an aid in the commercial battle with competitive fuels. The laboratory of the Anthracite Institute at Primos, Pa., has made progress in the development and approval of domestic stokers, thermostats, ash-removal devices, and other appliances for improving the convenience and efficiency of utilizing anthracite fuel.

A research group of the Anthracite Institute at the Mineral Industries Experiment Station of Pennsylvania State College studied the use of anthracite for water filtration and reports that, due to the angularity of the particles, such material showed greater efficiency than sand in the reduction of turbidity.[1] Anthracite is now being tried on a large scale at a number of municipal filtration plants.

Within the past year the bituminous-coal industry has organized Bituminous Coal Research, Inc., which will give special attention to the study of appliances for improving the convenience and efficiency of burning bituminous coal of the different types.

COMBUSTION OF COAL

Automatic equipment for domestic use.—To resist the encroachments of gas and oil the coal industry has given increased attention to the improvement of automatic stokers for domestic use. In addition, several new makes of pulverized-coal burners for househeating furnaces have appeared in recent years, and in one city a dealer organization is trying the experiment of making a charge per ton for furnishing the pulverized coal, putting it into the furnace hopper, removing the ashes, and keeping the equipment in order.

Colloidal fuel.—Interest in colloidal fuel, mixture of pulverized coal and fuel oil, was renewed by the experiments on the Cunard liner *Scythia*, which made a trip from Liverpool to New York last June with one of her battery of six oil-fired boilers supplied with 156 tons of fuel consisting of a 40:60 percent mixture by weight of very finely pulverized coal and oil.[2] Published reports do not indicate any marked advance over results obtained by Lindon W. Bates in 1918 in tests of colloidal fuel under the boilers of the United States Navy Scout Vessel *Gem*.[3] This fuel consisted of a mixture of 2 parts of

[1] Turner, H. G. and Scott, G. S., Clarification of Water Supplies by Filtration through Anthracite. Water Works and Sewerage, vol. 80, no. 4, April 1933, pp. 135–136.

[2] Wiggington, R., Colloidal Fuel. Fuel (London), vol. 11, 1932, p. 241.

[3] Brownlie, David, Colloidal Fuel for Steam Generation. Eng. and Boiler House Rev. (London), vol. 46, 1932, pp. 86–87.

petroleum and 1 part of coal, ground through 200 mesh and stabilized by the addition of 1 or more percent of certain chemicals such as lime-rosin soaps, coal-tar fractions, etc.[4] The evaporative capacity, the efficiency of steam generation, and the performance of the vessel at sea were excellent and almost equaled that of oil alone. It was claimed that the coal would not separate from the oil to any material degree in a 6-month period. With modern equipment, grinding in a colloid mill may decrease the need of adding stabilizing chemicals. However, such very fine grinding is costly and would eliminate the relatively small margin that now exists between the cost of coal and oil for bunker use.[5]

Coal-dust engine.—Work is being continued in Germany on overcoming the difficulties of using coal dust as diesel-engine fuel. Wantzel,[6] studying the influence of air excess, air temperature, injection pressure, particle size, and composition of coal on the ignition, temperature, ignition lag, and ignition limit, found that ignition lag depended principally on the size of the finest coal particles. If no very fine particles were present in a dust the ignition lag increased rapidly. Pawlikowski[7] hopes to eliminate the abrasive action of fused ash particles by leaching the pulverized coal with dilute mineral acids to remove fusible ash-forming constitutents.

BROWN COAL AS FERTILIZER

The direct application of pulverized coal as a fertilizer was tried by Lampadius[8] at Freiberg in the beginning of the nineteenth century. Recently, German investigators have found that agricultural yields from soil lacking humic compounds were improved by direct application to the soil of limited amounts of raw, pulverized brown coal; better results were obtained by treating the coal with ammonia or nitric acid and ammonia to form soluble humates.[8 9 10 11] The favorable action of these coal humates is due partly to improving the physical, chemical, and biological condition of the soil (thus promoting better utilization of plant foods)[8 9 10 11] and possibly to furnishing part of the plants' carbon requirements.[12]

Nemac,[13] of the Prague Agricultural Experiment Station, concludes that while brown-coal preparations improve the physical condition of poor soils, such improvements occur slowly, and observations over a number of years will be required to obtain reliable information. Although American lignites represent a more advanced stage of coal formation than the German brown coal they may serve as raw materials for humic preparations.

[4] Sheppard, S. E., Colloidal Fuels, Their Preparation and Properties. Ind. and Eng. Chem., vol. 13, 1921, pp. 37–47.

[5] Brame, J. S. S., Colloidal or Coal-Oil Fuel. Jour. Soc. Chem. Ind., (London), vol. 51, 1932, p. 855.

[6] Wantzel, W., The ignition and combustion process in the coal dust engine. Fuel (London), vol. 11, 1932, pp. 177–196, 222–228.

[7] Pawlikowski, Rudolf, Improvements in Preparatory Treatment of Pulverized Fuel for Engines and Furnaces: British Patent 370461, Apr. 4, 1932.

[8] Eck, L., Investigation of the Fertilizing Action of Bituminous Coal. Ztschr. angew. Chem., vol. 45, 1932, p. 124.

[9] Kissel, A., The Use of Coal as a Fertilizer. Trans. Fuel Conference, World Power Cong., London, 1928, vol. 1, pp. 80–101.

[10] Kissel, A., The Use of Low-Grade Brown Coals as Raw Material for the Preparation of Fertilizers. Brennstoff-Chem., vol. 13, 1932, p. 414.

[11] Lieske, R., Investigations on the Use of Coal as Fertilizer. Brennstoff-Chem., vol. 12, 1931, pp. 81, 426–434.

[12] Geiter, J., The Possibility of Making Brown Coal Available for Plant Food. Braun Kohlen Archiv., vol. 36, 1932. pp. 43–55.

[13] Nemac, A., The Use of Brown-Coal Preparations as Fertilizers. Brennstoff-Chem., vol. 13, 1932, p. 168.

PLASTICS FROM GERMAN BROWN COAL [14]

The Institute for Coal Research at Muelheim-Ruhr, Germany, has made molded articles from a plastic material called "Kolinite", consisting of 90 percent brown coal. In general, the process consists of digesting lignitic brown coal with an excess of phenol or technical cresol mixtures, removing the excess with suction or by distillation, and washing the product with benzol. The resulting mass is molded at 300 kilograms per square centimeter pressure and at a temperature of about 150° C. The Kolinite products so formed are tough and possess high shock resistance and high electrical insulating power. They have a very hard surface but can be machined, sawed, and polished. While having limitations in comparison with bakelite, Kolinite is said to cost only one tenth as much and therefore deserves consideration by the plactics industry. Experiments are being continued with peat and bituminous coal.

BRIQUETTING

Only coals containing appreciable amounts of free humic acid, or more than 3 percent of material extractable by carbon disulphide, have been considered briquettable by pressure alone, without adding a binder.[15] American lignites are not of this type. A recent report indicates that this limitation may have been removed. Dr. Apfelbeck of Karlsbad has made thin, rectangular briquets (about one fourth inch thick), weighing approximately one fourth pound each, by heating fine bituminous coal to incipient softening and then compressing the coal in an annular press at a very high pressure. Experimental units are said to be in operation in Czechoslovakia and Yugoslovia, and a trial plant is proposed in the Ruhr.

SEPARATION OF BRIGHT AND DULL COAL

Lehmann and Hoffmann [16] have made a practical application of microscopic studies of the constitution of coal. They found that the bright or "anthraxylous" banks of poorly coking coals are friable and strongly coking while the dull or splint bands are hard and weakly coking. By feeding the coal through a special-type hammer mill and then screening the product the coking bands were concentrated in the fines, producing a satisfactory product for coke-oven trade, while the oversize coal is free-burning and excellent for the domestic trade. A 5-ton-per-day experimental plant has been operated at the Graeppel Engineering Works near Bochum in the Ruhr district, Germany.

HIGH-TEMPERATURE CARBONIZATION

In 1910, 83 percent of the coke produced in the United States was made in beehive ovens; in 1929 proportions were reversed, and 90 percent of the production was made in byproduct coke ovens.

[14] Fischer, Franz, Plastics from German Brown Coal. Brennstoff-Chem., vol. 13, 1932, pp. 445–48; abs. British Plastics and Moulded Products Trader (London), March 1933.

[15] Blum, I. L., The Role of Humic Acids in Briquetting Brown Coals: Proc. 3d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., part 2, 1931, p. 646.

[16] Lehmann, K., and Hoffmann, E., Coal Preparation from Petrographic Viewpoints: Brennstoff-Chem., vol. 13, 1932, pp. 21–9.

Although war needs for coke and its byproducts greatly stimulated the building of new byproduct ovens expansion continued until 1929, when 60,000,000 tons of coke were produced. Since that time the business depression, introduction of long-distance transmission of natural gas, utilization of volatile petroleum products and refinery gases for augmenting city-gas supplies, and reduced returns from byproducts due to the competition of cheap synthetic ammonia, and gasoline and fuel oil, have virtually stopped the construction of new gas- or coke-manufacturing plants.[17]

At some ovens the cost of recovering ammonia is greater than the return from its sale. As a result, it is being wasted, especially in England.[18] However, ammonia liquor must not be discharged directly into streams because its phenol content imparts a disagreeable taste to the water if it subsequently is chlorinated for domestic use. These liquors should not be used for quenching coke because the ammonium chloride they contain corrodes the coke-quenching cars and the equipment in which the coke is used. At the coke works of the du Pont Co., Belle, W.Va., the ammonia liquors are run through a steam still which removes over 99 percent of the phenols. The liquor then may be discharged directly into the river, and the phenol condensate, now free from corrosive ammonium chloride, may be used for quenching coke.[19]

Since sulphuric acid is the highest element of cost in the recovery of ammonia as sulphate, many unsuccessful efforts have been made to utilize the sulphur in coke-oven gas for acid manufacture. Recently Denig [20] has proposed the production of sulphuric acid at the coke plant from sulphur recovered from the gas by the ammonia-thylox purification process. He estimates the cost at $13.06 per ton of 66° B. acid, allowing no credit for gas purification.

Coke-oven light oil (benzol) because of its high "antiknock" value as a blending agent with gasoline, still yields a fair return, although less than it did a few years ago. Benzol recovery and refining methods are being modified to reduce refining losses due to unnecessary removal of non-gum-forming unsaturated compounds by the action of a strong sulphuric acid wash. The Instill process,[21] which has been installed at the Rotherham Main coke plant in England, uses ferric sulphate mixed with an absorbent earth containing a trace of sulphuric acid to remove only the higher unsaturated hydrocarbons that form gums. Activated charcoal is used for benzol recovery at about 20 European gas or coke-oven works, including the Beckton byproduct coke-oven plant of the London Gas Light & Coke Co.,[22] the largest charcoal-recovery plant in the world. The 16,000 gallons of crude benzol produced per day are nearly water white. Organic sulphur compounds are removed from the gas at the same time. Charcoal purification has the advantage over oil absorption in eliminating further chemical purification, which consumes part of the useful motor fuel.

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[17] Fieldner, A. C., Recent Developments in Byproducts from Bituminous Coal: Rept. of Investigations 3079, Bureau of Mines, 1931, 13 pp.

[18] Foxwell, G. E., Modern Trends in British Byproduct Coking Industry: Jour. Soc. Chem. Ind., vol. 52. 1933, p. 49.

[19] Moses, D. V., and Maskey, B. H., Disposing of Ammonia Liquor as a Waste Product: Chem. and Met. Eng., vol. 39, 1932, pp. 441–43.

[20] Denig, Fred, New Ideas on Gas Purification and Ammonium Sulphate Manufacture. Paper given at Joint Production and Chemical Conference, American Gas Assoc., New York, May 22–23, 1933.

[21] Brownlie, David, The Instill Process, Gas Age-Record, vol. 69, 1932, pp. 159–60.

[22] Gas World (London), coking section, 1932, p. 123.

The Rochester Gas & Electric Co. is making a new byproduct—ammonium thiocyanate—from a combination of the cyanogen, ammonia, and sulphur in coke-oven gas.[23] Ammonium thiocyanate has been found effective as a weed killer [24] and is a raw material for thiourea resin plastics, which are similar to transparent bakelite.

Sulphur from gas.—The recovery of marketable sulphur in the purification of gas is one of the notable achievements of recent years. The sulphur obtained by some of these liquid-purification processes is in a very fine state of subdivision, which has been found advantageous to its utilization as a fungicide.[25]

Coal tar and pitch.—The most important recent commercial development in the treatment of byproduct tar is its partial refining at the ovens, utilizing the sensible heat of the coke-oven gas for the distillation.[26] Hot coke-oven gases enter a distilling main, where they are showered with a spray of tar. The hot gases vaporize the tar oils, which are condensed by the cool incoming tar in heat interchangers. The heavy tar or pitch overflows continuously from the bottom of the still. The advantages claimed for this process are low cost, high yields, and flexibility in permitting the removal of only those fractions which have a good market. The remainder can be utilized as fuel or charged back into the coke oven. Such recovery units have been installed on eight coke-oven plants in the United States, with an annual capacity of 36,000,000 gallons of tar. These units produce tar-acid oils, creosote oils, and a variety of residuals ranging from lightly distilled tars to pitches melting at 400° F.

Some pitch is marketed now in the form of flakes produced on rotating cooled drums or on water-cooled moving metal belts. Large quantities of pitch have been used in coating long-distance gas-transmission pipe lines, and in the past 2 years much of this residue has been shipped to Europe for briquet binders. Such pitch as finds no other market is converted to a lustrous, dense, extremely hard coke of very low volatile content and almost no ash.

Marked improvements have been made in recent years in the carbonization of pitch. One method [27] uses a modified beehive oven, the volatile oils that distill off serving as fuel for the operation. In another process [28] molten pitch is sprayed continuously down through the top of a highly-heated byproduct oven. When the coke has built up almost to the top the entire charge is pushed from the oven. Recently, the Knowles shallow sole-fired oven has been applied successfully to coking petroleum pitch.[29] The bitumen is sprayed continuously into the oven, the coke accumulates gradually and, finally, is pushed mechanically from the oven.

Manufactured gas as motor fuel.—The question of using gas as fuel for trucks and automobiles is being raised again in England and

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[23] Shnidman, Louis, Ammonium Thiocyanate Recovered from Manufactured Gas. Proc. Am. Gas Assoc., 1932, pp. 950–976.

[24] Weidlein, E. R., Progress at Mellon Institute during 1931–32. Ind. and Eng. Chem., News Ed., vol. 10, 1932, p. 97.

[25] Powell, A. R., Recent Developments in Special byproducts of Coal Carbonization. Proc. Am. Gas Assoc., 1932, pp. 904–913.

[26] Miller, S. P., Improvements in the Art of Manufacturing and Utilizing Coal-Tar Products: Jour. Franklin Inst., vol. 215, 1933, pp. 373–399. Weiss, J. M., The Distillation of Coal Tar. Chemistry and Industry, vol. 51, 1932, pp. 248–9.

[27] Barrett Co., Coke and Process of Producing the Same. U.S. Patent 1650126, Nov. 22, 1927.

[28] Koppers Co., Improvements in Coking Bituminous Material. British Patent 337800, Nov. 10, 1930.

[29] Knowles, Alexander S., assignor to Tar & Petroleum Process Co. of Chicago, Method of Coking Liquid Hydrocarbons. U.S. Patent 1879983. Sept. 27, 1932.
Foster, Arch L., Knowles Ovens Solve Residium-Disposal Problem, Pay Satisfactory Profit. Nat. Petrol. News, vol. 25, no. 10, Mar. 8, 1933, pp. 26–33.

Europe.[30] Road tests with trucks and busses indicate that the cost of gaseous fuel is about 40 percent less than of gasoline. The gas is confined in special alloy cylinders of about half the weight of the usual compressed gas cylinders, built to stand pressures of 8,000 pounds per square inch. For bus service in England it is claimed that 6 cylinders of high-pressure gas (3,000 pounds per square inch) are sufficient for a journey of about 70 miles.[31]

Determination of gas- and coke-making properties of coals.—The United States Bureau of Mines, in cooperation with the American Gas Association, has developed a standard apparatus and method whereby 100- to 200-pound samples of coal may be carbonized at various temperatures, and the quantity and quality of the gas, coke, and byproducts obtained may be measured under each of the various conditions of carbonization.[32] Using this method of test, samples have been examined exhaustively from mines in the Pittsburgh and Lower Freeport beds of Pennsylvania; the Davis bed in Maryland; the Alma, Pittsburgh, no. 2 Gas, and Chilton beds in West Virginia; the Taggart bed in Virginia; the Elkhorn bed in Kentucky; the Black Creek and Mary Lee beds in Alabama; and the no. 6 bed of Illinois.[33]

The Midland Coke Research Committee in England, using an experimental silica-brick oven 3 feet long, 3 feet high, and 18 inches wide, heated on both sides and the bottom, has conducted an extensive study of blending coals and the effect of various factors on the physical properties of the resulting coke.[34] Addition of 3 to 5 percent of finely ground fusain or coke breeze to high-volatile coking coals increased the size and hardness of the resulting coke. The Scottish Coke Research Committee [35] found that carbonization of a mixture containing up to 15 percent of pulverized low-temperature coke gave a solid product of somewhat larger size and with a greater 2-inch shatter index than if the fine inert material were omitted. This corroborated the earlier work of King.[36] The addition of finely ground high-temperature coke gave progressive increase of size of product and of resistance to shatter. Addition of up to 15 percent

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[30] Walters, C. M., Gas for Motors: Jour. Inst. Fuel, vol. 5, 1932, p. 176; Fuel, vol. 11, 1932, p. 426; Gas Jour. (London), vol. 198, 1932, p. 715; Gas Jour. (London), vol. 200, 1932, p. 314.

[31] Foxwell, G. E., Coke-Oven Gas as a Substitute for Gasoline: Coll. Eng., vol. 9, 1932, pp. 404–6.
Klinkhardt, —., Methane as a Fuel for Motor-Driven Vehicles. Gas u. Wasserfach, vol. 75, 1932, pp. 495–8.
Delagarde, L., Jour. Usin. Gaz. vol. 56, 1932, p. 39, and Gas World, vol. 96, 1932, p. 1015.

[32] Fieldner, A. C., Davis, J. D., Thiessen, R., Kester, E. B., and Selvig, W. A., Methods and Apparatus Used in Determining the Gas, Coke-, and Byproduct-Making Properties of American Coals. Bull. 344, Bureau of Mines, 1931, 105 pp.

[33] Fieldner, A. C., Davis, J. D., Kester, E. B., Selvig, W. A., Reynolds, D. A., and Jung, F. W., Carbonizing Properties of Davis Bed Coal from Garrett County, Md., and of Mixtures with Pittsburgh Bed Coal. Tech. Paper 511, Bureau of Mines, 1932, 39 pp. Comparison of Small- and Large-Scale Experimental Carbonizing Apparatus; Tests of Pittsburgh Bed Coal from the Allison Mine, Fayette County, Pa., and of a Coal from the Michel Mine, British Columbia. Tech. Paper 543, Bureau of Mines, 1932, 34 pp.
Fieldner, A. C., Davis, J. D., Thiessen, R., Kester, E. B., Selvig, W. A., Reynolds, D. A., Jung, F. W., and Sprunk, G. C., Carbonizing Properties and Constitution of Washed and Unwashed Coal from Mary Lee Bed, Flat Top, Jefferson County, Ala. Tech. Paper 519, Bureau of Mines, 1932, 78 pp. Carbonizing Properties and Constitution of No. 6 Bed Coal from West Frankfort, Franklin County, Ill. Tech. Paper 524, Bureau of Mines, 1932, 60 pp. Carbonizing Properties and Constitution of Pittsburgh Bed Coal from Edenborn Mine, Fayette County, Pa. Tech. Paper 525, Bureau of Mines, 1932, 60 pp. Carbonizing Properties and Constitution of Black Creek Bed Coal from Empire Mine, Walker County, Ala. Tech. Paper 531, Bureau of Mines, 1932, 44 pp. Carbonizing Properties and Constitution of Chilton Bed Coal from Boone No. 2 Mine, Logan County, W.Va. Tech. Paper 542, Bureau of Mines, 1932, 60 pp. Carbonizing Properties and Constitution of No. 2 Gas Bed Coal from Point Lick No. 4 Mine, Kanawha County, W.Va. Tech. Paper 548, Bureau of Mines, 1933, 52 pp. Carbonizing Properties and Constitution of Alma Bed Coal from Spruce River No. 4 Mine, Boone County, W.Va. (In prep.)

[34] Mott, R. A., and Wheeler, R. V., Blending Coal, for Coke-Making. Fuel, vol. 11, 1932, pp. 204–213; Proc. 3d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., pt. 1, 1931, pp. 587–606.

[35] Davidson, W., The Work of The Scottish Coke Research Committee; Blending for Coke-Making. Gas World, coking section, vol. 98, 1933, pp. 8–13.

[36] King, J. G., The Blending of Coal for Carbonization Purposes; the Suitability of Constituents. Fuel, vol. 10, 1931, pp. 521–531.

anthracite dust had a similar effect, raising the 1½-inch shatter index from 77 at zero addition to 89 at 15 percent addition.

It is well known that weathering or oxidation easily destroys the coking power of high-oxygen or poorly coking coals. In the production of coal balls by the Wisner process of low-temperature carbonization partial oxidation is used to destroy the excess plasticity of high-volatile, strongly coking coals. Wheeler and Woolhouse [37] found that high-oxygen or low-carbon coals were affected most easily by oxidation, and the amount of oxygen absorbed was not detectable by ultimate analysis. Coals of higher carbon content were oxidized less readily, and their caking power was affected only after an appreciable change in the ultimate analysis was noted. Other investigators [38] found that the coke-making properties of certain coals could be improved by the addition of oxidized coal or semicoke to high-volatile coking coals. On the other hand, if a coal does not become sufficiently plastic on heating to form coke the British Fuel Research Station has shown that [39] it can be converted into good coking coal by treatment with hydrogen for a limited time at 370° to 380° C., and at a maximum pressure of 230 to 270 kilograms per square centimeter. Use of certain catalytic materials appears to reduce the pressure required.[40]

LOW-TEMPERATURE CARBONIZATION

Low-temperature carbonization of coal may be defined as the heat treatment of coal in the absence of air at 450° to 700° C. to prevent decomposition of the primary tar. This gives the maximum yield of liquid products, at the same time producing a reactive, easily ignitable, smokeless, solid fuel for domestic use.[41]

Although low-temperature carbonization of coal for the production of smokeless domestic fuel dates back almost 30 years to the pioneering work of Parker in England and Parr in the United States, there was no general interest in the subject until the World War focused the attention of England and the European powers on their lack of petroleum and their needs for home sources of liquid fuels. Low-temperature carbonization, which yielded 20 to 30 gallons of tar oils per ton of coal, was given serious consideration as a source of motor fuels. This interest increased progressively in the 10 years after the war, due partly to the fear that gasoline from petroleum would not be able to keep pace with the mounting needs of the fast-multiplying numbers of automobiles and partly to the tremendous industrial expansion which sought to capitalize without delay every possible new application of the results of scientific research. The climax was reached about 1928, when, at the Second International Conference on Bituminous Coal, at Pittsburgh, more papers were read on low-temperature carbonization than on any other subject.

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[37] Wheeler, R. V., and Woolhouse, T. G., Effect of Oxidation on Coking Properties of Coal. Fuel, vol. 11, 1932, pp. 44–55; Proc. 3d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., vol. 1, 1931, pp. 406–435.

[38] Koppers, H. H., Improvement of Upper Silesian Blast-Furnace Cokes and Oxidation of Upper Silesian Coal. Gas World, coking section, vol. 97, 1932, pp. 86–92.

Pieters, H. A. J., and Koopmans, H., Influence of Heating and Oxidation upon the Properties of Coke Coals. Brennstoff-Chem., vol. 13, 1932, pp. 261–4.

[39] Crawford, A., Williams, F. A., King, J. G., and Sinnatt, F. S., Action of Hydrogen on Coal. Dept. Sci. Ind. Research, Fuel Research, Tech. Paper 29, 1931, 37 pp.

[40] Holroyd, Ronald, and Imperial Chemical Industries, Converting Noncoking Coal to Coking Coal. British Patent 379755, June 5, 1931.

[41] Fieldner, A. C., Low-Temperature Carbonization of Coal: Tech. Paper 396, Bureau of Mines, 1926, 46 pp.

Recent European developments.—It is reported that the German K.S.G.[42] plant near Essen, as well as all other German plants for the low-temperature carbonization of bituminous coal, are closed; only the brown-coal plants of central Germany continue in operation.

The Maclaurin low-temperature carbonization plant,[43] erected in 1923 at the Dalmarnock gas works, Glasgow, has been closed down permanently and is to be converted to water-gas production.[44] The coke produced by this gas-producer-type carbonizer was light and friable. The demand for it was too limited to justify continuing the plant in operation. The Maclaurin producers at Nuneaton are continuing in operation for the production of low B.t.u. gas. The Midland Coal Products plant at Nottingham [45] and the Bussey plant near Glasgow, also operating on the principle of the gas producer, have been closed for several years.[46] The K. S. G. rotary retort at the South Metropolitan gas works, and the "Plassmann" [47] plant at Barking on the Thames, failed on account of mechanical troubles. The plant of the Fuel Research Board, consisting of 32-inch, cast-iron, type E, vertical retorts, operating since June 1929 at the Richmond works of the Gas Light & Coke Co., was closed in June 1932 because of distortion of the cast-iron retorts.[48] At the British Fuel Research Station research is being undertaken at medium carbonization temperatures, using narrow retorts of refractory materials.

The three coalite plants of Low-Temperature Carbonization, Ltd., at Barugh near Barnsley, at the Askern Colliery [49] near Doncaster, and at the South Metropolitan gas works, Greenwich, London, are in regular operation. The company is reported to have made a small profit in 1932 and to have received a contract from the Government for supplying some fuel oil and motor fuel made from low-temperature tar. "Coalite" is made by the Parker process,[50] which uses externally heated, small-diameter, cast-iron, tubular retorts. The coke is firm and compact; it ignites readily and burns freely. "Coalite" and "Ricoal", made in a similar manner by the Illingworth process, appear to have real merit as fireplace fuels for those who can afford to pay the price, which, obviously, must be 50 to 100 percent higher than that of the coal from which it is made.

Several low-temperature carbonization plants have been installed at coal mines in France to convert slack coal into smokeless fuel to replace imported anthracite.[51] Although most of these must be regarded as yet in the experimental stages they have operated to some extent during the past 3 years. They include the Illingworth plant [52] at the Mines de Courrières; the Mascart process, which carbonizes pitch-bound briquets, at the Mines de Besseges; the

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42 Fieldner, A. C., work cited, p. 18.
43 Fieldner, A. C., work cited, p. 25.
44 Wiggenton, R., The Maclaurin Process: Fuel, vol. 11, 1932, p. 354.
45 Report of Test by the Director of Fuel Research on the Carbonization Plant of Midland Coal Products, Ltd., Netherfield, Nottingham, Dept. of Scientific and Industrial Research, 1925, 23 pp.
46 Brownlie, David, Low-Temperature Carbonization; the Record of Depressing Year in Great Britain: Iron and Coal Trades Rev., Jan. 23, 1931, pp. 137–138.
47 Plassmann, Josef, The Conversion of Slack Coal and Fines into Lumpy Smokeless Fuel—Low-Tem perature Coke—by the C.T.G. Process: Proc. 2d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., vol. 1, 1928, pp. 338–357.
48 Fuel Research Board, Report: London, Mar. 31, 1932, p. 34.
49 Fuel Economist, vol. 8, 1932, pp. 72–73.
50 Fieldner, A. C., work cited, p. 5.
51 Berthelot, C., Low-Temperature Carbonization and the Production of Artificial Anthracite; Chimie et Industrie, vol. 29, 1933, pp. 18–44.
52 Colliery Guardian, vol. 144, 1932, p. 629.

Ab-der-Halden process,[53] at the Mines de Sarre et Moselle; and the Honnay process,[54] at the Mines de Liévin. The latter two processes produce a pulverulent semicoke from noncoking coal, which is briquetted subsequently with pitch binder.

One of the interesting developments in France is the attempt to make low-temperature coke with the new type of Koppers (German) recirculation oven at the Bruay Mines near Bethune. There is no reason why low-temperature, or, at least, a mid-temperature, coke should not be made in a standard-type byproduct oven, except the reduction of capacity due to increase of coking time. It is this increase of coking time that renders low-temperature coking less economical than the usual high-temperature process.

American and Canadian developments.—In 1929 the world's largest low-temperature plant [55] was built at New Brunswick, N.J., but was unable to compete with other fuels in the lean years after the financial crash of 1929. This plant, designed to carbonize 640 tons of coal per day, consisted of eight rotary retorts which followed the design of the K.S.G. retort which had been operating in Germany for several years. Unfortunately, American coals acted differently from the German coals in this retort, and much trouble was experienced in getting the right blends to give a satisfactory lump coke for domestic use. Also, profitable outlets for the low-temperature tar were not found. Despite much research the tar acid did not prove suitable for the resin plastic trade and could be sold only for fuel purposes in competition with cheap oil.

Although confidence in the future of low-temperature carbonization in the United States suffered a severe blow with the failure of the large New Brunswick plant, the Pittsburgh Coal Co. is developing the Wisner process [56] under license from owners of the Wisner patents. For the past 18 months the company has been operating a 25-ton-a-day Wisner unit and in 1933 plans to build a 75-ton-per-day unit. The Pittsburgh Coal Co. also controls the patents on the Illingworth process for the United States and Canada.

The plant of the Lehigh Briquetting Co. near Dickinson, N.Dak., after being closed for some time, is again in operation. Raw lignite of about 6,400 B.t.u. is carbonized by the Lurgi process,[57] forming a char which is pulverized and briquetted with pitch binder, making a fuel of about 13,000 B.t.u.

The Hayes process,[58] at Moundsville, W.Va., which produces a briquetted fuel from carbonized bituminous slack, has operated intermittently in accordance with market demands.

Tests by the Canadian Department of Mines at the Illingworth Experimental Plant in South Wales showed that Sydney coal from Nova Scotia was suitable for this process and produced a hard, dense fuel suitable for Canadian conditions of househeating.[59]

[53] Ab-der-Halden, Ch. Continuous Low-Temperature Distillation in the Rotary Hearth Furnace: Proc. 3d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., part 1, 1931, pp. 352–367; Chimie et Industrie: special no., Mar. 1932, pp. 234–240.

[54] Berthelot, C., work cited.

[55] Soule, R. P., The "K.S.G." Low-Temperature Carbonization Plant at New Brunswick, N.J.: Proc. 2d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., vol. 1, 1928, pp. 494–507.

[56] Allen, W. H., Jr., Low-Temperature Distillation of Coal by the Carbocite Process: Proc. 2d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., vol. 1, 1928, pp. 403–412.

[57] Fieldner, A. C., work cited, p. 35.

[58] Balph, James, and McQuade, M. J., Low-Temperature Carbonization of Coal by the Hayes Process: Proc. 2d Internat. Conf. Bit. Coal, vol. 1, 1928, pp. 269–279.

[59] Report of tests on Sydney coal in the Illingworth low-temperature carbonization retort. Investigations on Fuels and Fuel Testing, No. 721, Canada, Dept. of Mines, 1929, pp. 8–30.

Low-temperature carbonization has possible interest only to the coal operator who seeks to produce a premium domestic fuel from his slack coal. A commercially successful process must produce a reasonably dense and strong lump fuel, which must be sold at a price that will bear most of the costs of the operation. The returns from tar and light oil will not be any greater than the prevailing price of the corresponding products from petroleum, which, under present conditions, means a very low return from the byproducts. In general, low-temperature processes will have to meet severe competition from anthracite and high-temperature coke, even though it is granted that easier ignitability and ability to hold a fire are real advantages for the low-temperature product. At present no low-temperature process has demonstrated that it can operate at lower cost than existing high-temperature plants.

HYDROGENATION AND LIQUEFACTION OF COAL

Bergius process.—Dr. Frederich Bergius, inventor of the process for the hydrogenation and liquefaction of coal, states that the direct addition of hydrogen to coal was first carried out in his laboratory in Hanover in 1913, as a result of some 3 years' study of the chemical nature of coal.[60] In his first experiments a product resembling anthracite was obtained by subjecting cellulose to very high pressures in steel bombs at elevated temperatures. In 1912 and 1913 he found that under certain conditions of temperatures and pressures the chemical compounds in coal could be made to take up hydrogen and be converted into liquid and gaseous compounds and pressures of 100 atmospheres at temperatures of 350° to 400° C. Parallel experiments with oil instead of coal showed that heavy oils and tars could be cracked and hydrogenated under pressure with large yields of light, saturated hydrocarbons. Even in these early experiments as much as 85 percent of the coal was converted to gaseous liquids and benzene-soluble products. It was not until 1921 that the principal difficulties in developing high-pressure apparatus on a technical scale were overcome and a systematic examination of various types of coal and lignite was undertaken.

In normal bituminous coal the ratio of hydrogen to carbon is approximately 16 to 1, while in petroleum the ratio is about 8 to 1, hence in the conversion of coal to oil it is necessary to double the quantity of hydrogen. The process of liquefaction of coal consists in cracking coal molecules with simultaneous absorption of hydrogen, or possibly absorption of hydrogen, followed by splitting up of large molecules into smaller ones, with continued addition of hydrogen.

In the large-scale process as finally developed in 1926 at Rheinau by Bergius, a paste of finely pulverized coal mixed with about 40 percent of its weight of oil from a previous cycle and 5 percent of iron oxide was pumped through a heat exchanger into a thick-walled steel reaction cylinder, where it was subjected to the action of hydrogen at a pressure of 150 to 200 atmospheres and a temperature of 450° to 490° C. The éffluent was a black, mobile liquid containing the residual inorganic matter and unconverted carbonaceous matter of the charge. The oil was distilled from the solid residue, which

[60] Bergius, F., The Transformation of Coal into Oil by Means of Hydrogenation: Proc. 1st Internat. Conf. Bit. Coal, Carnegie Inst. Technol., 1926, pp. 102–131.

contained the sulphur of the coal combined with the iron oxide. The gases formed were treated to recover the hydrogen, which was used again in the process. The yields from a typical gas-flame coal of 6 percent ash are as follows:[61]

Product:	Yield as weight percent of coal charged
Neutral refined motor spirit (boiling range, 86°–446° F.)	15.0
Diesel oil and creosote oil	20.0
Lubricating oil	6.0
Fuel oil	8.0
Gas	23.5
Coke	24.0
Water	7.5
Ammonia	.5
Loss	5.5
Total	110.0

NOTE.—Total includes 5 percent hydrogen and 5 percent iron oxide added to the charge of coal.

The process of the I. G. Farbenindustrie.—While Bergius was completing the development of his large-scale plant at Rheinau the I. G. Farbenindustrie, which previously had carried to commercial success the synthesis of ammonia and methanol, attacked the problem of coal liquefaction. They found that by admixture of suitable catalytic materials the yields and proportion of gasoline to heavy oil could be increased, and the quality of the oils could be improved by elimination of the phenols and cresols that detracted from the value of the Bergius oil. According to Grimm:[62]

> The greatest activity was found when catalysts containing elements of group 6 of the periodic system, especially molybdenum and tungsten, were used, and furthermore that the efficiency of these could be augmented by certain combinations with metalloids. In place of metalloids, other activators alone or in combination with them were found to be effective.

The company has developed poison-resisting catalysts, such as the sulphides themselves; and it is claimed that, through proper selection of catalysts, the proportions of high- and low-boiling hydrocarbons can be controlled, together with the relative amounts of aliphatic and aromatic hydrocarbons in the oil. About 1927 the I. G. acquired the Bergius patents and constructed a commercial plant for hydrogenation of brown coal and tar at Leuna near Merseberg. In November 1928 Krauch[63] reported the annual production of 70,000 tons of gasoline by hydrogenation, of which 40,000 tons were obtained from coal and the remainder from petroleum and coal tar.

In recent years it is believed that direct hydrogenation of brown coal has been superseded largely by hydrogenation of mixtures of approximately 85 percent brown-coal tar and other tar oils and 15 percent petroleum crudes. The annual output of gasoline has been about 100,000 to 150,000 tons per annum.

In view of the application of the hydrogenation process to the refining of petroleum the Standard Oil Co. of New Jersey joined with the I. G. Co. in 1927 for further development of the process and its

[61] Warren, T. E., Status of Hydrogenation of Petroleum, Bitumen, Coal Tar, and Coal: Canada Dept. of Mines, Mines Branch, Mem. Series, No. 52, 1932, 8 pp.

[62] Grimm, H. G., The Processing of Coal and Oil with Special Regard to the Catalytic High-Pressure Hydrogenation: Proc. 3d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., vol. 2, 1931, pp. 49–65.

[63] Krauch, Carl, Catalysis Applied to the Conversion of Hydrocarbons: Proc. 2d Internat. Conf. Bit. Coal, vol. 1, 1928, p. 47.

exploitation in the United States.[64] Unusually rapid progress was made in developing a flexible process for refining high-sulphur asphaltic crudes and refractory tars and residues with a yield of more than 100 percent distillate by volume. Large-scale plants now operating at Bayway, N.J., and Baton Rouge, La., are said to be producing hydrogenated products on a price basis at least equal to that of the older refining methods.[65]

British developments.—Following closely the original work of Bergius, British investigators took up experimental study of the hydrogenation of bituminous coal. Summaries [66] of the large amount of work conducted by the Mining Research Laboratory of Birmingham University were presented at the several international conferences. These showed that catalysts, of which ammonium molybdate was the best, increased the yields of liquid products and that high-rank bituminous coals, such as occur in the eastern United States and Nova Scotia, are more completely liquefied than low-rank coals of higher oxygen content. These results have been confirmed on a series of American coals by Beuschlein, Christensen, and Wright,[67] working at the University of Washington.

In 1927 the Fuel Research Station installed a continuous Bergius experimental plant capable of treating 1 ton of coal per 24 hours. The results obtained were similar to those of Bergius. A mixture of 20 parts of coal, 8 parts of tar oil, and 1 part of alkaline iron oxide gave, in percentages by weight of the coal used: 50 percent distillable oil, 20 percent gas, and 15 percent partly converted material.[68] Undoubtedly the iron oxide had a catalytic action, for parallel experiments without the oxide gave an insoluble residue of 50 percent, compared with only 10 percent with the oxide. Equally good results were had with zinc oxide and nickel oleate and much better results with lead hydroxide and tin hydroxide and tin sulphide.[69]

Hydrogenation of tar.—Using an ammonium molybdate catalyst suspended on active charcoal, together with sulphur, about 60 percent by weight of motor spirit was obtained from hydrogenation of low-temperature tar oil (distilling up to 360° C.) by a single treatment at 480°–495° C. and 200 atmospheres pressure.[70] The molybdenum consumption was 0.03 percent and the hydrogen consumption 8.8 percent of the raw material treated. The yields obtained were 11.6 imperial gallons of motor spirit and 8.6 gallons of Diesel oil from the 20 gallons of tar obtained by the low-temperature carbonization of 1 ton of coal.

Morgan and Veryard [71] likewise found that molybdic acid plus sulphur was the best catalyst for hydrogenation of the heavier constituents of tar boiling above 200° C. The waxes from low-tempera-

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[64] Haslem, R. T., and Russell, R. P., Hydrogenation of Petroleum: Ind. and Eng. Chem., vol. 22, 1930, pp. 1030–1037.

[65] Industrial and Engineering Chemistry, Progress in Petroleum Hydrogenation: News ed., vol. 10, 1932, pp. 205–207.

[66] Graham, J. Ivon, Some Aspects of the Hydrogenation of Coal: Proc. 2d Internat. Conf. Bit Coal, Carnegie Inst. Technol., vol. 2, 1928, pp. 456–484. Graham, J. Ivon, and Skinner, D. G., Further Investigations Connected with the Action of Hydrogenation upon Coal: Proc. 3d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., vol. 2, 1931, pp. 17–27.

[67] Beuschlein, W. L., Christensen, B. E., and Wright, C. C., Hydrogenation of American Coals: Ind. and Eng. Chem., vol. 24, 1932, pp. 747–751, 1010.

[68] Lander, C. H., Oil and Petrol from Coal: Proc. Royal Inst. Great Britian, vol. 27, pt. 1, 1932, pp. 7–106.

[69] Fuel Research Board, Report: London, 1932, 96 pp.

[70] King, J. G., and Matthews, M. A., Motor Spirit from Hydrogenation of Tar: Gas Eng., vol. 49, 1932, pp. 593–597; Gas Jour., vol. 200, 1932, pp. 213–215; Jour. Inst. Fuel, vol. 6, 1932, p. 33.

[71] Morgan, Gilbert T., and Veryard, Jack T., Hydrogenation of Low-Temperature Tar Products: Jour. Soc. Chem. Ind., vol. 51, 1932, pp. 80T–82T.

ture tar yielded mobile, colorless oils, the distillates of which were of low specific gravity, low iodine value, water white, and stable on exposure.

Padovani and Bartholomaeis [72] obtained almost a theoretical yield of saturated hydrocairbons by the hydrogenation of phenolic tars, using molybdenum and cobalt sulphides as catalysts.

Cawley,[73] using a catalyst consisting of charcoal impregnated with ammonium molybdate, completely deoxygenated and partly hydrogenated phenol at 450° C. and at an initial pressure of 100 atmospheres of hydrogen. With 10 percent of catalyst the pehnol was converted almost completely into benzene and cyclohexane after 2 hours of heating at 450° C. Addition of sulphur improved the catalyst efficiency and increased the ratio of cyclohexane in the product.

Schoorel, Tulleners, and Waterman [74] converted benzene almost entirely into cyclohexane by hydrogenation at 190° C. and on raising the temperature to 460° C. transformed the cyclohexane into methyl cyclopentane. Similar treatment of paracymene at 200° C. yielded methane.

Fischer [75] and associates, at the Mülheim-Ruhr Coal Research Institute, found molybdenum oxide catalysts more effective than molybdenum sulphide for the reduction of tar pehnols to benzene hydrocarbons at ordinary temperatures and pressures; but, at temperatures of 400° to 450° C. and maximum hydrogen pressures of about 200 atmospheres, Tropsch,[76] at the Coal Research Institute in Prague, found the sulphides of molybdenum, tungsten, and cobalt and molybdic oxide to be very effective catalysts for the reduction of cresols; nickel hydroxide was only slightly less effective. Nickel sulphide, zinc chloride, aluminum hydroxide, vanadium oxide, chromium hydroxide, uranium oxide, and cobalt hydroxide were only moderately active. Zinc oxide, ferric hydroxide, ferrous sulphide, and tungstic oxide were without any catalytic effect. Hydrogenation of the hydrocarbons formed took place simultaneously with the reduction of the hydroxyl group but more extensively at lower than at higher reaction temperatures. Molybdenum and tungsten sulphides were the best catalyzers for the hydrogenation of gas oil. Sulphides of the iron group had some value, but the oxides were entirely ineffective.

As a result of the work of Imperial Chemical Industries, Ltd., on developing a process for the manufacture of gasoline from British bituminous coal a continuous experimental plant treating 15 tons of coal per day was started in 1929 and operated for about 2 years. The process is similar in principle to that of the I. G. and is best understood by reference to figure 34, the materials flow sheet, and figure 35, the flow diagram of the plant. The process is described briefly by Gordon,[77] of Imperial Chemical Industries, as follows:

> The raw material—coal, tar, or oil—is treated with hydrogen in the presence of catalysts at temperatures between 400° and 500°C., and at a pressure of 200

[72] Padovani, C., and Bartholomaeis, E. D., Hydrogenation of Tar: Anali Chim. Appl., vol. 22, 1932, p. 221

[73] Cawley, C. W., The Reactions of Phenol with Hydrogen at High Pressures: Fuel, vol. 11, 1932, pp 217–221.

[74] Schoorel, G. F., Tulleners, A. J., and Waterman, H. I., J. Inst. Pet. Tech., vol. 18, 1932, p. 179.

[75] Fischer, Franz, Bahr, Theo, and Petrick, A. J., The Catalytic Reduction of Tar Phenols to Benzene. Hydrocarbons: Brennstoff-Chem., vol. 13, 1932, pp. 45–46.

[76] Tropsch, Hans, Catalysts for High-Pressure Hydrogenation of Phenols and Hydrocarbons: Proc. 3d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., vol. 2, 1931, pp. 35–48; Fuel, vol. 11, 1932, pp. 61–66.

[77] Gordon, K., Oil from Coal; position of the Hydrogenation Process: Iron and Coal Trades Rev., vol. 126, 1933, pp. 127–128. For extended description and theory of process see: Gordon, K., Oil from Coal: Trans. Inst. Min. Eng., vol. 82, pt. 4, 1932, pp. 348–363; Fuel, vol. 10, 1931, pp. 481–484.

to 250 atmospheres, either in one operation or in successive stages. The raw material is thus completely converted into gasoline, and other light oils if required, and hydrocarbon gas. In the case of coal, the ash of the coal and a small proportion of the carbonaceous matter, is left as a solid residue which can be used

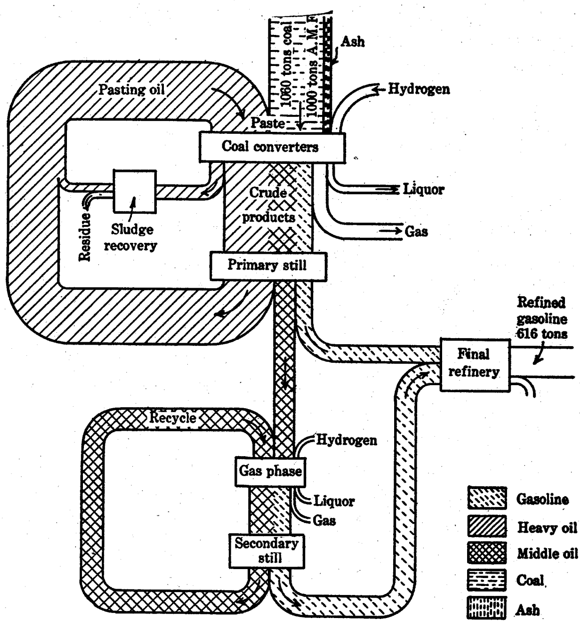

FIGURE 34.—Materials flow sheet for coal hydrogenation.

for steam raising. The gas is used as the raw material for hydrogen manufacture, which follows the general lines so well worked out for ammonia synthesis. The yield obtained is 62 percent by weight of gasoline from coal, 80 percent from low-temperature tar, and 90 percent from creosote oil. Including the coal required

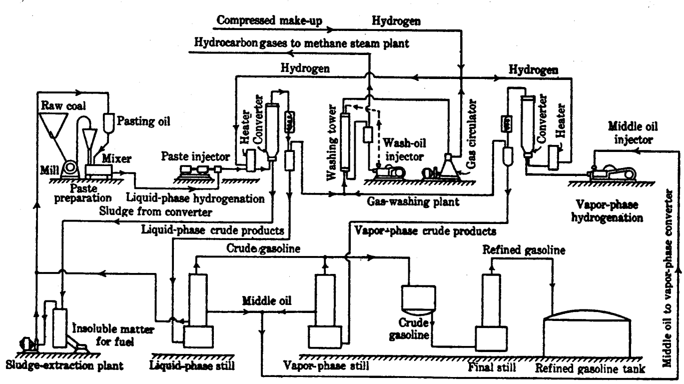

FIGURE 35.—Flow diagram of coal-hydrogenation plant of Imperial Chemical Industries, Ltd., at Billingham-on-Tees, England.

for power generation and heating, 3½ tons of coal are required for the production of 1 ton of gasoline by the hydrogenation of bituminous coal.

To obtain low costs large-scale operation is essential. Messrs. Imperial Chemical Industries, Ltd., worked out in detail a plant for the manufacture of

214,000 tons per year of gasoline (5 per cent of the country's requirements). The total capital required, including working capital, was £8,000,000, and the production cost, including overhead charges and obsolescence, was 7d. per imperial gallon. Such a plant would replace part of its coal consumption by low-temperature tar and creosote oil when these materials were available at suitable prices.

Since last year, when Imperial Chemical Industries, Ltd., first published their results, work has continued at their Billingham laboratories, with the result that a somewhat smaller plant than that previously envisaged has now proved economically practicable.

In the preceding estimate of the cost of producing an imperial gallon of gasoline, 2d. of the 7d. total cost represents the cost of the coal. The over-all thermal efficiency of the plant is 43 percent; that is, 57 percent of the original heat units in the coal used are lost in the transformation into gasoline.

SYNTHESIS OF CHEMICAL PRODUCTS FROM GASES PRODUCED FROM COAL OR COKE

The synthesis of ammonia from nitrogen and hydrogen became possible when chemists discovered that certain substances called "catalysts" greatly speeded up chemical reactions, and the commercial production of synthetic ammonia became a reality when engineers devised gas-tight equipment in which the process could be conducted under pressures of hundreds of atmospheres and at temperatures approaching red heat. This accomplishment marked the beginning of a new epoch in chemical engineering. Useful chemical compounds formerly obtained by round-about methods from plants or animals now could be synthesized directly from the elements carbon, hydrogen, and oxygen, or from simple compounds of these elements, such as carbon monoxide, water, acetylene, and ethylene. European chemists were quick to see the possibilities of making alcohols and hydrocarbon motor fuels from water gas or coke-oven gas.

Methanol, higher alcohols, and dimethyl ether from water gas.—Fischer and Tropsch [78] reported the production of a mixture of hydrocarbons, alcohols, aldehydes, ketones, and organic acids by pressure synthesis from water gas using an alkalized iron catalyst, although the mixture, which they called "synthol", was usable for motor fuel it was obviously inferior to a straight hydrocarbon gasoline, and the pressure process was dropped in favor of the subsequently discovered atmospheric pressure synthesis, which yielded hydrocarbons only.

Patart [79] and Audibert [80] in France and the Badische Anilin und Soda Fabrik (now the I. G. Farbenindustrie) in Germany developed methods independently for producing methanol from carbon monoxide and hydrogen. The methods were essentially similar to the production of synthetic ammonia and consisted of subjecting 2 volumes of hydrogen and 1 of carbon monoxide to pressures of 200 to 800 atmospheres at 300° to 450° C., in the presence of catalysts of zinc oxide, zinc chromate, copper, etc. Commercial development in the manu-

[78] Fischer, Franz, and Tropsch, Hans, Über die Reduktion des Kohlenoxyds zu Methane am Eisenkontakt unter Druck: Brennstoff-Chem., vol. 4, 1923, p. 193, vol. 5, 1924, pp. 201, 217; also, see Fischer, Franz, The Synthesis of Petroleum: Proc. 1st Internat. Conf. Bit. Coal, Carnegie Inst. Technol., 1926, pp. 234–246.

[79] Patart, Georges, The Industrial Transformation of Bituminous Coal into Organic Technical Products: Proc. 1st Internat. Conf. Bit. Coal, Carnegie Inst. Technol., 1926, pp. 132–160; Une nouvelle conquête de la catalyse sous pression: la production industrielle de l'alcool méthylique de synthèse: Chimie et Industrie, vol. 13, 1925, pp. 179–185.

[80] Audibert, E., La fabrication des carburants synthétiques aux depénds des mélanges de carbone et d'hydrogène: Chimie et Industrie, vol. 13, 1925, pp. 186–194; trans. in Fuel, vol. 5, 1926, p. 170; also A Contribution to the Study of the Synthesis of Methyl Alcohol: Proc. 2d Internat. Conf. Bit. Coal, Carnegie Inst. Technol. vol. 2, 1928, pp. 508–522

facture of methanol proceeded rapidly. The German I. G. organization, due to its experience on synthetic ammonia manufacture, was ahead of other countries and exported synthetic methanol in 1925, but it was not many years until methanol was being made commercially in England, France, the United States, and other countries.

In 1927 the Du Pont Ammonia Co. at Belle, W.Va., adapted the methanol process to the removal of carbon monoxide from the water-gas hydrogen used in the ammonia process, thus advantageously combining the manufacture of methanol and ammonia. In the same year the Commercial Solvents Co. began manufacturing methanol from the waste fermentation gases (carbon dioxide and hydrogen) resulting from the butanol fermentation of corn. In 1929 the Union Carbide Co. began production of synthetic methanol from the waste carbon monoxide issuing from calcium carbide furnaces.

The production of synthetic methanol has held up well during the depression years. Some of the manufacturers also produce from water gas higher alcohols, such as propanol and isobutanol, the newest addition being dimethyl ether,[81] a liquefied gas boiling at −24° C., which is being offered for solvent and other purposes. In 1929 the Pittsburgh Experiment Station of the United States Bureau of Mines, in its investigation of the fundamentals of the methanol process, described the conditions under which this substance was obtained as a byproduct in the manufacture of methanol.[82]

Chemical utilization of coke-oven gases.—When synthetic ammonia and methanol began to attract attention, European coke-oven companies whose plants customarily are situated at the mines where the market for gas is limited took advantage of the opportunity to utilize the 50 to 60 percent of hydrogen in coke-oven gas. The hydrogen is separated by cooling the coke-oven gas to very low temperatures (−200° C.), at which all the constituents but hydrogen become liquid.

By 1929, nearly 100,000,000 cubic feet per day of coke-oven gas were being liquefied for the extraction of hydrogen for ammonia synthesis;[83] and today it is estimated that 40 plants are making synthetic ammonia from coke-oven gas, largely in European countries.[84] Five of these plants combine the manufacture of ammonia and methanol, while a few have developed procedures for fairly complete utilization of each of the different constituent gases in the manufacture of various chemical products. For example, the coke-oven plant of the Bethune mines in France, in addition to synthetic ammonia, methanol, and the usual coke-oven byproducts, is manufacturing ethyl alcohol and ether from the ethylene in coke-oven gas. At the Ougree (Belgium) coke-oven plant a process has been developed for producing ethyl and isopropyl alcohols, ethers, and acetone from the unsaturated constituents of coke-oven gases. This company converts methane to carbon-free carbon monoxide and hydrogen for the production of synthetic ammonia or methanol, mixing the purified

[81] Industrial and Engineering Chemistry, Synthetic Dimethyl Ether; Properties and Application: News ed., vol. 10, 1932, p. 136.

[82] Brown, R. L., and Galloway, A. E., Dimethyl Ether: Ind. and Eng. Chem., vol. 21, 1929, pp. 310–313; vol. 22, 1930, pp. 175–176.

[83] Pallmaerts, F. A. F., Synthetic Ammonia Plant at Ostend: Ind. and Eng. Chem., vol. 21, 1929, pp, 22–29; also, Proc. 2d Internat. Conf. Bit. Coal, Carnegie Inst. Technol., vol. 2, 1928, pp. 178–201. Battig, Rudolph, The Manufacture of Ammonia by the Mont-Cenis Process: Proc. 2d Internat. Conf. Bit. Coal, vol. 2, 1928, pp. 202–222. Delorme, Jean, The Processes of Georges Claude for the Separation of Gas by Liquefaction and the Synthesis of Ammonia: Proc. 2d Internat. Conf. Bit. Coal, vol. 2, 1928, pp. 223–230.

[84] Thau, A., The Chemical Utilization of Coke-Oven Gas: Gas World, coking section, vol. 97, 1932, p. 10. Osterrieth, J. W., and Dechamps, Georges, The Production of Organic Compounds from Coke-Oven Gas: Gas Jour., vol. 201, 1933, pp. 202–206; Gas World, coking section, vol. 98, 1933, no. 2531, pp. 8–11; Jour. Inst. of Fuel, vol. 6, 1933, pp. 215–225.

coke-oven gas with steam and passing it over catalysis of nickel activated with rare earths and heated to a temperature of about 800° C.

In the Kuhlmann process, which is used by several French synthetic ammonia plants, coke-oven gas or methane mixed with superheated steam is passed under pressure through a chamber like a regenerator filled with checker brickwork encased in a steel shell and heated to about 1,300° C. The methane is decomposed, and the carbon liberated is subjected to the water-gas reaction.[85]

The Gesellschaft für Kohlentechnik at Dortmund-Ewing, Germany, has developed processes for the production of pure nitrogen-hydrogen for ammonia synthesis by the cracking of mixtures of methane, air, and steam and scrubbing out the carbon dioxide formed. They use an externally heated reaction vessel made from a heat-resisting alloy of 20 percent nickel, 25 percent chromium, and 55 percent iron.[86] The United States Bureau of Mines cyclic process [87] avoids the use of expensive alloy reaction vessels by employing a water-gas generator in which the coke bed is replaced by a bed of alumina refractories impregnated with nickel catalysts. The catalyst bed is heated to the reaction temperature of 1,100° C. by blasting with air and gas; steam and gas then are passed through the bed until the temperature drops to 900° C., when the blast is turned on again; 85 to 95 percent decomposition is obtained readily.

Acetylene and benzol from methane in coke-oven gas.—Acetylene is very active chemically and reacts readily to make a large variety of compounds. It is the starting material for the new rubber substitute, "Duprene," and it can be converted completely into benzol or high-grade antiknock motor fuels. Two general lines of attack have been followed in the development of methods for the conversion of methane into acetylene or benzol: (1) Pure thermal decomposition and (2) electrical discharge.

Recent reviews of the literature [88] on the thermal decomposition of methane show that investigators in this field—Fischer, Wheeler, Nash, Frohlich, etc.—are in substantial agreement that the maximum yields of acetylene, ethylene, and benzol are obtained when the methane is brought momentarily to a high temperature (for example, 1,600° C.) and then cooled quickly.

Osterrieth [89] states that the Société Franco-Belge d'Ougrée has devised a thermal pyrolysis process which yields a gas containing 8 percent acetylene. Thirty-five to forty-five percent of the methane is converted to acetylene.

Franz Fischer and associates,[90] continuing their investigations of the conversion of methane to acetylene by treatment at low pressures (50 mm water column) with high-tension electrical discharges, obtained 7 percent acetylene in coke-oven gas. Thirty-two cubic meters of the acetylene-containing gas then were passed over a

[85] Bünge, C., The Utilization of Methane in Coke-Oven Gas: Metallbörse, vol. 22, 1932, pp. 1053–1054. Hirsch, E., Bull. Mem. Soc. Ing. Civils France, vol. 85, 1932, pp. 286–302.

[86] Gluud, W., and others, 1925 Ber. Gesell. Kohlentechnik, Dartmund-Ewing, Germany, vol. 1, pp. 248, 515; Hydrogene: vol. 3, 1930–31, p. 20.

[87] Hawk, C. O., Golden, Paul L., Storch, H. H., and Fieldner, A. C., Conversion of Methane to Carbon Monoxide and Hydrogen: Ind. and Eng. Chem., vol. 24, 1932, pp. 23–27.

[88] Storch, H. H., Physical-Chemical Properties of Methane: Inf. Circ. 6549, Bureau of Mines, 1932, 14 pp. Fischer, Franz, and Pichler, Helmut, The Benzine and Acetylene Synthesis: Brennstoff-Chem., vol. 13, 1932, pp. 381–383, 406–411, 435, 441–445.

[89] Osterrieth, J. E., The Production of Organic Compounds from Coke-Oven Gas: Jour. Inst. Fuel, vol. 6, 1933, pp. 215–225. Smith, H. M., Grandone, Peter, and Rall, H. T., Production of Motor Fuels from Natural Gas: Rept. of Investigations 3143, Bureau of Mines, 1931, 3 pp.

[90] Peters, Jurt, and Neumann, Ludwig, Formation of Liquid Hydrocarbons from Acetylene: Brennstoff-Chem., vol. 14, 1933, pp. 165–168.

catalyst of iron-nickel and yielded 1.7 liters of benzol containing light oils. A large-scale experimental plant has been installed at the nitrogen plant of the "Ruhr-Chemie" at Holton in the Ruhr district.[91]

Synthetic gasoline from water gas at atmospheric pressure.—The production of synthetic gasoline by passing mixtures of hydrogen and carbon monoxide at atmospheric pressure over iron or cobalt catalysts at approximately 260° C., reported by Fischer and Tropsch [92] in 1926, has not reached commercial realization, although a semicommercial scale plant at the Mülheim Coal Research Institute has been operating experimentally during the past few years. The earlier cobalt catalyzers have been superseded by nickel-manganese-aluminum oxide on kieselguhr.[93] This catalyzer gave yields of 100 to 120 cm of liquid products per cubic meter of gas during 4 weeks of continuous operation. The yield then had decreased to 30 percent of the initial value. The catalyst must be regenerated by removing the accumulated paraffin. The optimum reaction temperature ranges from 190° at the beginning of a run to 210° C. at the end. The principal difficulties in large-scale commercial operation of the process are to dissipate the high heat of reaction and keep the catalyst at the proper temperature; also, the gases must be purified carefully to remove sulphur. It is believed that these problems are nearly solved.

SUMMARY

A review of the world-wide technical developments in the utilization of coal during the depression years shows little tangible progress in providing new markets for coal. In the United States continued competition by cheap petroleum and natural gas has prevented practical application of new methods of coal processing because of lack of adequate market for the liquid and gaseous byproducts; therefore, low-temperature carbonization must support itself almost wholly on the returns from low-temperature coke. The possibility has not yet been demonstrated in the United States.

The technical process for hydrogenating and liquefying coal is now available and may be put to use when and if a failing petroleum supply requires oil from coal. The process is too costly for use under present conditions.

A number of important elements, such as ammonia, methanol, higher alcohols, solvents, etc., are now being made from gases obtained from coal; but even if all the ammonia and methanol consumed in the United States were made from coal it would require only 700,000 tons per annum, or 0.15 percent of the 1930 production of bituminous coal. There seem to be no uses for coal in sight which run into sizable tonnages other than combustion for the generation of heat and power.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to Ch. Berthelot, of Paris, David Brownlie, of London, and Dr. A. Thau, of Berlin-Grunewald for valuable information on European developments in recent years.

[91] Thau, A., Steinkohlenchemie und Verkehrswesen (Chemistry of Bituminous Coal and Transportation): Jahrb. brennkrafttechnischen Gesell., vol. 13, 1932, p. 14.

[92] Fischer, Franz, and Tropsch, Hans, Die Erdölsynthese bei gewöhnlichem Druck aus den Vergasungs produckten der Kohlen: Brennstoff-Chem., vol. 7, 1926, p. 97; see also The Synthesis of Petroleum; Proc. 1st Internat. Conf. Bit. Coal, 1926, pp. 234–246.

[93] Fischer, Franz, Roelen, Otto, and Feiszt, Walter, The Present Technical Status of the Gasoline synthesis: Brennstoff-Chem., vol. 13, 1932, pp. 461–468; see also pp. 412–13; pp. 428–434; pp. 421–428.

FUEL BRIQUETS

By W. H. Young and J. M. Corse

In 1932 the production of fuel briquets declined to the lowest level since 1921. According to reports courteously furnished the Bureau of Mines by the operators of briquetting plants, the total output in 1932 was 470,604 net tons valued at $3,458,663, a decrease of 32.6 percent in tonnage and 34.3 percent in value from 1931.

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, 1907–32

Year or yearly average	Production of briquets: Eastern States	Production of briquets: Central States	Production of briquets: Pacific Coast States	Production of briquets: Total	Imports	Consumption [1]	Value of products, 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
	Thousands of net tons										
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											
1928	229	605	113	947	71	1,018	7,706	21	45,115	6.38	8.38
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

[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.

In 1932 the Central States showed the smallest proportional decrease in production of briquets. Their output was 295,549 tons, 22.5 percent less than in 1931. The Pacific Coast States reported a decrease of 35.8 percent. Production in the Eastern States totaled 127,867 tons, a decrease of 47.5 percent from 1931.

In 1932 Wisconsin accounted for more than half the total output. Its 4 plants and the 3 plants active in Pennsylvania produced more than 65 percent of the total tonnage of the country. Figure 36 shows the trend of production during the last 18 years.

182217—33——30

Fuel briquets produced in the United States, 1931–32

	Production			Value		
	1931	1932	Decrease	1931	1932	Decrease
	Net tons	*Net tons*	*Percent*			*Percent*
Eastern States	243,402	127,867	47.5	$1,405,292	$665,918	52.6
Central States	381,443	295,549	22.5	3,094,787	2,246,682	27.4
Pacific Coast States	73,471	47,188	35.8	760,506	546,063	28.2
	698,316	470,604	32.6	5,260,585	3,458,663	34.3

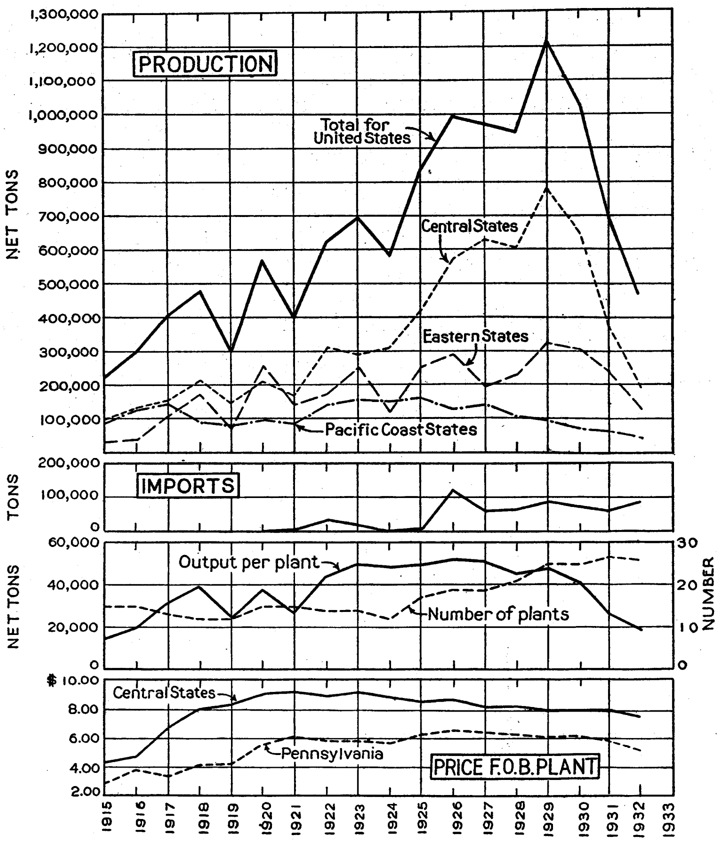

FIGURE 36.—Production and imports of fuel briquets, number of plants in operation, and average prices received f.o.b. plants, 1915–32.

Monthly production of fuel briquets in the United States, 1930–32, in net tons

Month	1930	1931	1932	Month	1930	1931	1932
January	175,503	102,602	58,380	August	53,446	41,943	36,287
February	86,645	57,764	45,649	September	73,325	60,552	44,332
March	48,858	40,537	29,848	October	145,260	76,723	65,695
April	24,865	32,590	14,223	November	105,556	68,104	55,157
May	110,544	82,777	25,433	December	127,861	70,092	60,341
June	38,776	34,905	16,845				
July	38,226	29,727	18,414		1,028,865	698,316	470,604

Value.—The total value of the briquets manufactured during 1932 was $3,458,663, a decrease of $1,801,922 (34.3 percent) compared with 1931. The average value per net ton, f.o.b. plant, was $7.35 compared with $7.53 in 1931 and $7.80 in 1930. The drop in the average value per ton reflects lower price trends for almost all solid fuels.

The sales realizations obtained on briquets in the scattered producing centers in a given year vary considerably. The figure on average value per ton for the entire industry therefore has doubtful significance because of the different conditions under which briquets are manufactured in certain sections of the country. Among the factors that influence the value per ton at any plant, the most important are probably the cost of raw materials and the prices of competing fuels. Hence, the trend of prices from year to year is indicated best by the average value in particular localities, as shown in the table on page 451.

Number and capacity of plants in operation.—Twenty-six plants, one less than in 1931, reported production of briquets on a commercial scale in 1932. In the 25 years from 1907 to 1931 the number of plants has more than doubled. Average production per plant in 1932 was 18,100 tons, a decrease of 7,764 tons from 1931 and the lowest since 1914.

Although the number of plants has increased the industry has not escaped failures. From 1907 to 1932, 54 briquetting plants were abandoned, indicating that the costs of production and the possibilities of markets should be weighed carefully before a new plant is constructed. As the record of the industry shows, a number of companies are firmly established.

The increase in the number of briquetting operations and the average output per plant over an extended period are indicated in the table on page 451.

Four plants active in 1931 produced no briquets in 1932, but three new ones began commercial operation during the year—the Raleigh-Wyoming Mining Co., Glen Rogers, W.Va.; the Christopherson-Renstrom Co., Omaha, Nebr.; and the Staples Coal Co., Fall River, Mass.

Classification of briquet plants, by hourly capacity in 1932

Capacity per hour, net tons	Number of plants	Capacity per hour, net tons	Number of plants
Less than 5	8	50 and less than 75	3
5 and less than 10	4	75 and over	2
10 and less than 25	5		
25 and less than 50	4		26

Classification of briquet plants, by size of output, 1930–32

Output, net tons	Number of plants			Output, net tons	Number of plants		
	1930	1931	1932		1930	1931	1932
Less than 2,000	5	5	9	100,000 and less than 200,000	1	2	
2,000 and less than 5,000	1	3	2	200,000 and over	2		
5,000 and less than 10,000	5	5	5				
10,000 and less than 25,000	6	6	3		25	27	26
25,000 and less than 100,000	5	6	7				

Classification of briquet plants, by number of hours operated per day during busy season, 1931–32

Hours per day	Number of plants		Production, net tons	
	1931	1932	1931	1932
14 to 24 hours	14	13	600,431	259,286
8 to 12 hours	13	13	97,885	211,318
	27	26	698,316	470,604

Raw fuels.—A total of 462,439 net tons of raw fuel of all kinds was briquetted in 1932; 33 percent of this amount was anthracite and semianthracite, 56 percent semibituminous and bituminous coal, and 11 percent semicoke, oil-gas residue, or petroleum coke.

Eight plants reported that from a small portion to all of the raw coal used was washed either by the colliery operator or the briquet manufacturer.

Raw fuels used in making briquets in the United States, 1927–32, in net tons

Fuel	1927	1928	1929	1930	1931	1932
Anthracite culm and fine sizes and semianthracite	359,438	376,257	408,967	368,294	243,888	151,400
Semibituminous, bituminous, and subbituminous slack	521,318	512,806	[1] 711,459	[1] 569,057	[1] 360,226	[1] 260,050
Semicoke, oil-gas residue, and petroleum coke	70,052	51,743	67,513	67,014	67,064	50,989
	950,808	940,806	1,187,939	1,004,365	671,178	462,439

[1] Includes no subbituminous coal.

In 1932 anthracite fines were used as raw material at 9 operations, either alone or in combination with other coal, and bituminous coal alone was employed at 9 plants. The following table shows the character of the raw fuel used by the 26 active plants.

Classification of briquet plants, by kinds of raw fuel used in 1932

Kind of raw fuel used:	*Number of plants*
Anthracite fines	4
Mixture of anthracite or semianthracite fines and bituminous or semibituminous slack	5
Bituminous slack	9
Semibituminous fines	1
Semicoke (low-temperature coke or char)	2
Carbon residue from the manufacture of oil gas	2
Petroleum coke	3
	26

Weight and shape of briquets.—In 1932 the Bureau of Mines asked the producers to give information on the weight, size, and shape of briquets. Little change was registered in the weight and shape of briquets in 1932 compared with 1931. The smaller sizes comprised by far the greater percentage of briquets produced. Briquets weighing less than 3 ounces accounted for 72.1 percent of the production in

1932 compared with 75.7 percent in 1931. In 1932, 27.6 percent of the production of briquets weighed 3 and under 5 ounces, whereas only 15.9 percent was in this group in 1931. Thus, 99.7 percent of the briquets in 1932 weighed less than 5 ounces. Two plants produced briquets weighing 5 to 16 ounces. One plant manufactured large cube-shaped briquets weighing 43 ounces. However, all the briquets weighing more than 5 ounces accounted for only 0.3 percent of the total production.

Pillow-shaped briquets continued to be most popular. Of the 26 producing plants, 19 made pillow-shaped briquets, 3 cylindrical briquets, 1 ovoid, and 1 cube-shaped; 1 plant produced both pillow-shaped and cylindrical briquets, and 1 plant produced both ovoid and cylindrical briquets.

Classification of briquet plants by prevailing weight of briquets manufactured, 1931–32

Weight of briquet, ounces	Number of plants		Percent of production	
	1931	1932	1931	1932
Less than 2	4	5	75.7	72.1
2 and under 3	13	13		
3 and under 4	3	3	15.9	27.6
4 and under 5	4	3		
5 and under 6	1	------	8.4	0.3
6 and under 10	1	(1)		
10 and under 16	(1)	[1] 1		
43 and over (brick-shaped)	1	1		
	27	26	100.0	100.0

[1] Part of the production of 1 plant in 1932 was in the classification "6 and under 10" and part of that of 1 plant in "10 and under 16 ounces."

Binders and recarbonization.—Asphaltic pitch is the binder used most often in the manufacture of briquets, and it was employed either alone or in combination by 23 out of 26 plants active in 1932. Of the producers, 16 used asphaltic pitch exclusively; 1, asphalt and lignite pitch; 1, aspholeum; 1, asphaltic pitch and corn flour; 2, starch, asphalt, and water; 1, petroleum asphalt; and 2, mixed pitches. Two plants 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 9 or more. The proportion used most was 5 or 6 percent.

Classification of briquet plants, by percentage of binder used in 1932

Binder used:	*Number of plants*
Using no binder (carbon residue)	2
Using:	
Less than 5 percent binder	3
5 and less than 7 percent	16
7 and less than 9 percent	4
9 percent and over	1
	26

One producer using a binder reported recarbonizing the briquets coming from the presses to drive off smoke from the binder. Two other producers reported that they partly recarbonized the briquets.

DISTRIBUTION

In its questionnaire for 1932 the Bureau of Mines requested, as for 1931, information on the tonnage of briquets shipped to each State. It should be noted that the commercial sales were slightly greater than the total output, as changes in producers' stocks were taken into account.

The tonnage produced in 1932 was distributed widely, briquets being shipped into no less than 36 States, the District of Columbia, Alaska, and Canada. This distribution indicates a notable broadening of markets compared with 1928. (See Fuel Briquets in 1928, fig. 1, p. 5.)

Although the consumption of briquets in 1932, as in 1931, was concentrated in the Central, Eastern, and Pacific Coast States, all the principal consuming States registered sharp declines in 1932 compared with 1931. (See Fuel Briquets in 1930, fig. 2, p. 6, for a map of consumption of fuel briquets by States.) The following table gives the tonnage consumed in each State in 1931 and 1932:

Fuel briquets of domestic manufacture consumed in the United States and exported, 1931–32, in net tons

	1931	1932		1931	1932
Consumed in:			Consumed in—Continued		
Alaska	547	425	New Mexico		109
Arizona	194	140	New York	5,066	5,086
California	9,711	9,663	North Carolina	2,819	2,272
Colorado	400	455	North Dakota	52,288	43,915
Connecticut	343	661	Ohio	7,727	4,188
Delaware	926	712	Oklahoma	473	188
District of Columbia	46	139	Oregon	34,801	31,747
Florida	204	183	Pennsylvania	11,120	7,629
Georgia	49	(1)	Rhode Island	9,884	7,610
Idaho	33		South Carolina	499	[1] 218
Illinois	7,918	5,474	South Dakota	39,490	29,999
Indiana	3,502	1,964	Texas	2,000	1,300
Iowa	23,843	18,310	Utah		36
Kansas	10,033	6,262	Vermont	111	
Louisiana	600	450	Virginia	17,573	14,734
Maine	3,449	1,948	Washington	20,992	11,962
Maryland	6,391	4,074	West Virginia	398	244
Massachusetts	85,362	42,497	Wisconsin	77,907	65,872
Michigan	11,650	4,761	Wyoming		32
Minnesota	200,583	137,292	Miscellaneous	1,735	140
Missouri	4,271	3,005	Exported to Canada	7,085	3,053
Nebraska	16,975	8,245			
New Hampshire	4,446	1,955		688,258	485,288
New Jersey	4,814	6,339			

[1] Georgia included in South Carolina.

Producers' stocks of finished briquets.—For 1932, as for earlier years, the Bureau requested information regarding the quantity of finished briquets on hand in producers' yards. The replies show that on January 1, 1932, producers had on hand 25,901 tons compared with 11,217 tons at the end of the year, indicating a net decrease of 14,684 tons in stocks.

Producers' stocks of finished briquets in 1932, in net tons

Jan. 1, 1932	25, 901	Oct. 1, 1932	13, 369
July 1, 1932	11, 914	Jan. 1, 1933	11, 217

FOREIGN TRADE IN BRIQUETS

Imports of fuel briquets in 1932 were 80,288 net tons, an increase of 19,338 tons (31.7 percent) over 1931. In 1932 imports were equivalent to 17.1 percent of the domestic production.

According to the customs records, 77,259 tons (96.2 percent of the total imported in 1932) were discharged at or in the vicinity of Boston; 1,808 tons were imported into Maine and New Hampshire. Very small tonnages also were imported into Philadelphia.

Of the total imports 67,015 tons (83.5 percent) came from Germany, 10,762 tons from Belgium, and 2,511 tons from the United Kingdom.

Briquets and other composition coals for fuels imported for consumption in the United States, 1927–32 [1]

Year	Net tons	Value	Year	Net tons	Value
1927	60, 601	$314, 435	1930	73, 418	$399, 146
1928	71, 485	353, 168	1931	60, 950	325, 189
1929	89, 458	458, 517	1932 [2]	80, 288	335, 358

[1] Compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.
[2] Beginning July 1, 1932—coal and coke briquets only.

Fuel briquets imported into the United States, 1930–32, by months, in net tons

[General imports]

Month	1930	1931	1932	Month	1930	1931	1932
January	22, 146	6, 712	6, 409	August		2, 466	
February	8, 780	7, 311	15, 176	September	4, 706	4, 738	6, 873
March	560	3, 360	7, 996	October	3, 136	3, 475	5, 687
April	6, 053	5, 519	5, 715	November	6, 953	8, 959	6, 162
May			11, 078	December	21, 077	15, 135	10, 488
June	7	3, 275	4, 704				
July					73, 418	60, 950	80, 288

WORLD PRODUCTION

World production of fuel briquets, 1928–32, in metric tons

Country [1]	1928	1929	1930	1931	1932
Algeria	33,767	101,552	96,812	73,828	(2)
Austria		420			(2)
Belgium	1,959,130	2,018,110	1,875,210	1,850,330	1,320,750
Czechoslovakia:					
Coal	214,613	270,294	239,080	285,782	(2)
Lignite	241,174	256,111	180,718	209,435	(2)
France	5,885,616	6,670,000	6,810,000	[3] 6,800,000	(2)
Germany: [4]					
Coal	5,375,842	6,059,195	5,176,628	5,186,566	4,375,512
Lignite	40,157,264	42,136,834	33,988,162	32,422,214	29,752,172
Saar				1,178	6,939
Great Britain	1,151,270	1,394,898	1,149,114	883,498	(2)
Hungary:					
Coal, Lignite	56,165	109,570	176,265	188,219	(2)
Indo-China	127,000	113,225	144,000	134,000	(2)
Italy		6,716	2,002	2,450	(2)
Netherlands:					
Coal	785,829	958,186	945,939	1,161,648	(2)
Lignite	69,091	54,498	48,868	40,892	(2)
Netherland East Indies	82,629	64,099	52,292	17,418	(2)
Poland	264,362	354,783	234,123	300,999	(2)
Spain	846,645	921,906	929,736	914,117	(2)
United States	859,483	1,099,879	933,366	633,498	426,923
Venezuela	1,232	1,691	524	(2)	(2)
Yugoslavia	27,582	51,477	32,413	36,345	(2)
	58,138,694	62,643,444	53,015,252	51,142,417	(2)

[1] In addition to the countries listed briquets are produced in Australia, Canada, and New Caledonia, but data of output are not available.
[2] Data not available.
[3] Approximate production.
[4] Exclusive of the Saar.

CRUDE PETROLEUM AND PETROLEUM PRODUCTS

By G. R. Hopkins

In general, the petroleum industry experienced a more profitable year in 1932 than in 1931. The output of crude petroleum was curtailed, and stocks of all oils continued to decline, with the result that prices of crude oil and gasoline improved materially. Although the domestic consumption of motor fuel showed its first annual decline, the fact that consumption amounted to 93 percent of the 1931 total exceeded the expectations of many observers. The increased crude prices were reflected in higher quotations for the majority of refined products, although the increase in the price of gasoline was virtually nullified by the 1-cent Federal tax enacted June 21. Import duties on crude petroleum and the major refined products, also enacted June 21, were instrumental in reducing imports of all oils to nearly 12,000,000 barrels below the 1931 total; this was more than balanced by a 21,000,000-barrel decline in exports.

The record of production of crude petroleum in the United States during 1932 reflected the effort to curtail operations in line with demand. As the potential production of crude petroleum was several times the indicated demand at the beginning of the year, increasing rapidly with development of the East Texas field, and as the capacity of the refineries far exceeded actual runs to stills, the majority of the operators evidently supported the various proration programs and committee recommendations. The success of curtailment in 1932 is best illustrated by the data for stocks of all oils, which declined 43,514,000 barrels, bringing the total to well below the 600,000,000-barrel mark at the close of the year.

Drilling was stimulated by the higher prices and increased substantially over the low levels of 1931. There were 10,444 oil wells completed in 1932 compared with 6,788 in 1931. Of the oil wells completed in 1932, 5,641 (54 percent) were in the East Texas field, indicating that development work in the older fields continued at a comparatively low level. "Wildcatters" were more active in 1932 than in 1931, consequently the number of new discoveries increased. The center of "wildcatting" was in eastern and coastal Texas and extended into Louisiana.

Only three States—Michigan, New York, and Pennsylvania—increased their output in 1932. Texas continued to be the leading producing State, although a gain of more than 10,000,000 barrels in production in the East Texas field was outweighed by declines in the other major districts. The record of production in leading fields in 1932 was as follows:

Field	Production in 1932 (barrels)	Approximate increase or decrease compared with 1931 (barrels)	Field	Production in 1932 (barrels)	Approximate increase or decrease compared with 1931 (barrels)
East Texas, Tex	120,158,000	+10,500,000	Santa Fe Springs, Calif	22,538,000	−1,800,000
Seminole, Okla	42,983,000	−4,900,000	Kettleman Hills, Calif	21,961,000	+4,400,000
Oklahoma City, Okla	32,924,000	−13,400,000	Van, Tex	17,206,000	+1,600,000
Long Beach, Calif	27,436,000	−2,700,000	Salt Creek, Wyo	8,006,000	−800,000
Yates, Tex	23,744,000	−4,500,000			

The consumption of crude at refineries in 1932 was influenced principally by the continued curtailment of production, which tended to restrict the supply in certain areas, by a further gain in the percentage yield of gasoline, by a decline in motor-fuel consumption, and by a continued decrease in the demand for fuel oil. The combined effect of these and other less important factors resulted in a decrease of 74,611,000 barrels (8 percent) in crude runs. Imports of crude declined 2,562,000 barrels (5 percent), but exports increased 1,858,000 barrels (7 percent). Canada remained the chief foreign market for crude oil, although the increase in 1932 resulted from heavier shipments to Europe. The decline in crude stocks, which began in 1930, was continued throughout 1932. The major part of the decline affected Mid-Continent crudes.

The refining branch of the industry, which has been handicapped by low prices and surplus equipment, received another setback in 1932, when the domestic demand for motor fuel declined for the first time. The decrease in domestic demand of motor fuel in 1932 was 29,698,000 barrels (7 percent). This loss of business resulted primarily from a decrease of about 2,000,000 in the number of cars in use. Exports of gasoline, by far the most important element in shipments of refined products to foreign countries, again declined materially. Imports of gasoline declined to 8,209,000 barrels from 13,621,000 barrels in 1931, as the duty enacted June 21 proved virtually prohibitive. Stocks of motor fuel made a relatively good showing in 1932, declining nearly 1,500,000 barrels after increasing about 2,250,000 barrels in 1931. The yield of gasoline in 1932 was 44.7 percent, an increase of 0.4 percent over 1931. Using the 1932 yield as a basis the declines in domestic consumption and exports of motor fuel in 1932 represented a reduction of about 87,000,000 barrels in the refinery demand for crude oil.

The demand for the light fuel oils, such as kerosene and possibly furnace oil, increased in 1932, but that for the heavy residual fuels continued to decline. The domestic demand for lubricating oils continued to decline as general industrial activity continued at low ebb and as many motorists practiced rigid economy in changing their oil at infrequent intervals.

In general, the straight refiners—that is, those who derive their income solely from selling refined products in tank-car lots and who have no crude production—did not experience a much more profitable year in 1932 than in 1931. The price of the raw material (crude) was about $0.25 per barrel higher, and although this was balanced by increased prices for gasoline, it was often difficult to move fuel oil, except at concessions in price. In addition, the requirements for quality in refined products, particularly gasoline, became more stringent, necessitating costly re-forming and re-running.

Although the number of refiners increased materially the total capacity decreased substantially for the first time. The total capacity of cracking units also declined in 1932 for the first time.

Graphic data covering supply, demand, and prices are given in figures 37 and 38.

Salient statistics on the supply and demand of all oils, 1931–32

[Thousands of barrels of 42 U.S. gallons]

	1931		1932 [1]	
	Total	Daily average	Total	Daily average
New supply:				
Domestic production:				
Crude petroleum	851,081	2,332	781,845	2,136
Natural gasoline	43,617	119	35,772	98
Benzol	1,826	5	1,144	3
Total production	896,524	2,456	818,761	2,237
Imports:				
Crude petroleum	47,250	130	44,688	122
Refined products	38,837	106	29,757	81
Total new supply, all oils	982,611	2,692	893,206	2,440
Decrease in stocks, all oils	44,989	123	43,514	119
Demand:				
Total demand, all oils	1,027,600	2,815	936,720	2,559
Exports:				
Crude petroleum	25,535	70	27,393	75
Refined products	98,859	270	75,695	206
Domestic demand	903,206	2,475	833,632	2,278
Stocks (end of year):				
Crude petroleum:				
East of California	328,805		299,378	
California	42,114		39,340	
Total refinable crude	370,919		338,718	
Natural gasoline	2,825		3,203	
Refined products	258,879		247,188	
Total stocks, all oils	632,623		589,109	
Days' supply	225		230	

[1] Subject to revision.

CRUDE PETROLEUM

The production of crude petroleum has declined steadily since 1929, the total in 1932 being 781,845,000 barrels, a decrease of 8 percent from 1931 and 22 percent below the peak production of 1929 (1,007,323,000 barrels). Imports of crude petroleum in 1932 were 44,688,000 barrels, which with production gave a total new crude-oil supply of 826,533,000 barrels.

The total demand for crude petroleum in 1932 was 858,734,000 barrels, a decrease of 80,560,000 barrels (9 percent) from 1931. This substantial decline resulted primarily from a decrease of about 75,000,000 barrels in runs to stills. The use of crude as fuel without refining, a common practice 8 or 10 years ago, has declined in recent

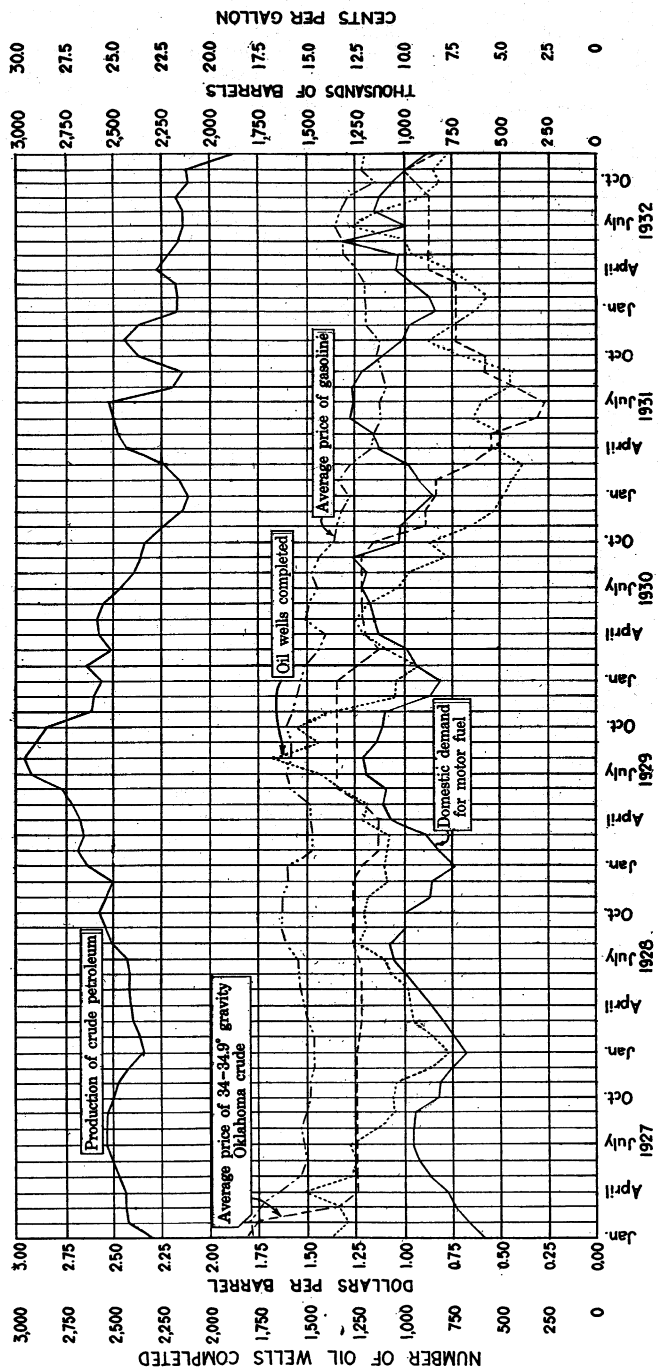

FIGURE 37.—Daily average production of crude petroleum, daily average domestic demand for motor fuel, total number of oil wells completed, average price per barrel of a selected grade of Oklahoma crude petroleum, and average tank-wagon price per gallon (excluding tax) of gasoline at 50 cities in the United States, 1927–32, by months.

years as the output of low-gravity crude has decreased steadily and as gasoline has steadily eclipsed fuel oil in relative importance. The indicated decrease in consumption of crude oil as fuel in 1932 was about 5,000,000 barrels.

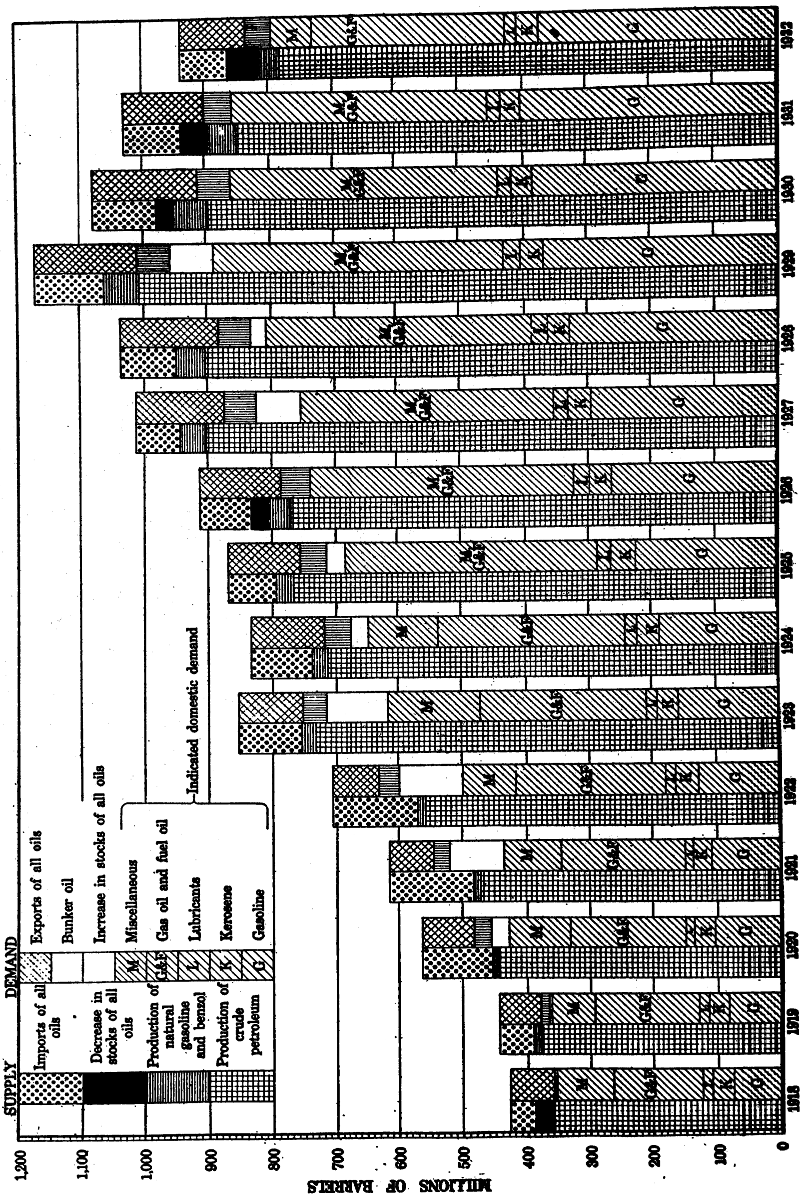

FIGURE 38.—Supply and demand of all oils, 1918–32.

The domestic demand for all oils in 1932 was 833,632,000 barrels, virtually the same as the indicated domestic demand for crude oil (831,341,000 barrels). They are in such close agreement because the crude oil needed to supply the excess of exports of refined products over imports (about 46,000,000 barrels) is nearly balanced by the production of natural gasoline and benzol (37,000,000 barrels) and the net decrease in stocks of refined products (11,000,000 barrels), both items of which are included in the figure of domestic demand for all oils.

Demand for crude petroleum, 1931–32

[Thousands of barrels of 42 U.S. gallons]

	1931	1932
Production	851,081	781,845
Imports	47,250	44,688
Decrease in stocks	40,963	32,201
Total new supply plus decrease in stocks	939,294	858,734
Runs to stills:		
Domestic	847,671	777,696
Foreign	46,937	42,301
Total runs to stills	894,608	819,997
Exports	25,535	27,393
Fuel and losses	19,151	11,344
Total demand	939,294	858,734

PRICES AND VALUES

Final data on the value of the crude petroleum produced in 1932 are not available, but it is estimated that the total was about $680,000,000, an average of about $0.87 per barrel. The total value represents an increase of nearly $130,000,000 (24 percent) over 1931, which shows that the gain in average price ($0.65 per barrel in 1931 to $0.87 in 1932) had far more influence on total value than the seemingly large decline in output.

In general, the crude-oil price was lower at the end of 1932 than at the beginning, but there were a few times during the year when the market was classed as strong. The price record of East Texas crude was fairly representative and may be used to illustrate the trend in Mid-Continent. The price of 38–38.9 gravity East Texas crude on January 1, 1932, was $0.81 but advanced to $0.98 on April 1. This increase, and a smaller one on October 15, were justified by the purchasers on the basis that stocks were being steadily reduced and that the producers should be rewarded for curtailing output so effectively. However, it became evident that considerable "hot" oil, or oil in excess of the allowable, was being produced and sold under the established prices, a condition that became acute after the second increase in price and as the demand for crude decreased with the approach of winter. Accordingly, the price of East Texas crude was reduced to $0.75 on December 15. In general, posted prices in fields outside the Mid-Continent and California were increased in April in response to the improved "statistical position," but either fell or were weakening at the time of the second increase (Oct. 15). Prices in California were changed only once—on June 26, when most light grades were advanced about 33 percent.

The price trends of certain representative grades of crude petroleum over a period of years are shown graphically in figure 39.

STOCKS

Except for March, when stocks of foreign crude increased materially, total stocks of refinable crude declined steadily throughout 1932. The total on hand at the close of the year—338,718,000 bar-

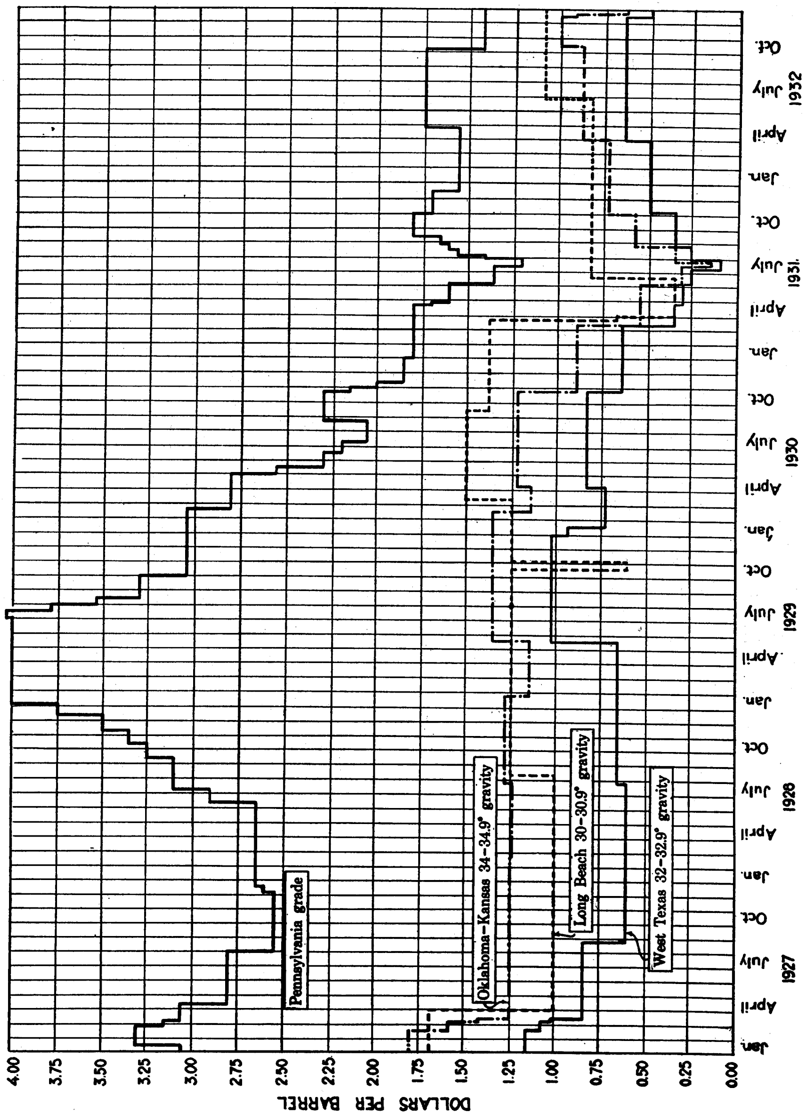

Figure 39.—Posted prices of selected grades of crude petroleum, 1927–32, by months.

rels—represented a net decline of 32,201,000 barrels from the stocks at the beginning of the year. Except for 1931, when stocks declined 40,963,000 barrels, this was the largest annual withdrawal ever made from stocks of refinable crude. In general, the substantial declines of

1931 and 1932 reflected the successful curtailment of production to below market demands.

In 1932 virtually all the decline in stocks was in tank-farm stocks; in fact, stocks held at refineries evidenced a small increase. The increase in refinery stocks in 1932 resulted from an increase in stocks of foreign crude, which made a material gain despite imposition of a tariff in June. The largest decline in 1932 affected Oklahoma-Kansas-Inland Texas grades in pipe lines and tank farms, which was logical in view of the fact that such stocks comprise nearly half of the total. Stocks of East Texas crude were not reported separately in 1932, hence no record on the trend of such stocks is available; however, most of the decline in the Oklahoma-Kansas-Inland Texas division probably did not affect East Texas oil but represented withdrawals from oil placed in storage before the East Texas field was discovered. Stocks of crude petroleum in California continued a slow but steady decline in 1932, although the total decrease was less than the proration committees had hoped. Producers' stocks, or stocks at wells, decreased slightly in 1932, as an increase in the East Texas field was more than compensated by declines elsewhere.

CONSUMPTION AT REFINERIES

The decline in the consumption of crude oil at refineries, which began in 1930, was accentuated in 1932 as the domestic consumption of motor fuel registered its first drop and as the percentage recovery of gasoline at refineries continued to increase. Crude runs to stills in 1932 totaled 819,997,000 barrels, a decrease of 74,611,000 barrels from 1931. Of the total, 777,696,000 barrels (95 percent) were domestic crude and 42,301,000 barrels (5 percent) foreign crude. These data indicate a small decrease in the relative proportion of foreign oil refined.

All major refining districts processed less crude oil in 1932 than in 1931, the east coast, Indiana-Illinois, and Texas Gulf coast districts having the smallest relative decreases. Data on crude runs refined in the various districts for 1922, 1931, and 1932 are given in the accompanying table.

Crude runs to stills, 1922, 1931, and 1932, by districts

District	1922		1931		1932	
	Thousands of barrels	Percent of total	Thousands of barrels	Percent of total	Thousands of barrels	Percent of total
East coast	100,525	20	168,790	19	162,534	20
Appalachian	20,661	4	36,372	4	34,136	4
Indiana, Illinois, Kentucky, etc	45,606	9	115,442	13	106,758	13
Oklahoma, Kansas, Missouri	70,934	14	105,050	12	87,170	11
Texas Inland	22,664	5	61,696	7	49,435	6
Texas Gulf coast	78,032	16	155,660	17	147,143	18
Louisiana Gulf coast	27,176	5	40,022	5	35,853	4
Arkansas and Louisiana Inland	7,689	2	19,889	2	18,297	2
Rocky Mountain	24,391	5	18,679	2	13,934	2
California	103,028	20	173,008	19	164,737	20
Total	500,706	100	894,608	100	819,997	100

These figures indicate that the relative proportion of crude runs in the various districts has not changed greatly between 1922 and 1932. The most important changes affected the Indiana-Illinois and Texas Gulf coast districts, where the ratio increased, and the Oklahoma-Kansas and Rocky Mountain divisions, where it decreased.

DISTRIBUTION BY STATES

Arkansas.—The production in Arkansas in 1932 (11,907,000 barrels) was augmented by the receipt of 643,000 barrels of Texas crude. Of the total supply, 7,244,000 barrels were consumed at refineries within the State and 5,578,000 barrels were shipped out, mainly to Louisiana.

California.—California continued to be self-sufficient as to crude requirements, with no receipts from or important shipments to other States. Production exceeded runs to stills by 13,391,000 barrels, and withdrawals from stocks amounted to 2,774,000 barrels; the total of these two items balances exports and shipments (9,833,000 barrels), a small delivery to Utah, and crude used as fuel plus losses.

Colorado and Utah.—Production in Colorado totaled 1,177,000 barrels in 1932; the few thousand barrels produced in Utah were not included in the preliminary figures. Receipts for the 2 States totaled 1,466,000 barrels; nearly all represented tank-car shipments to Utah from California, Colorado, Montana, New Mexico, Texas, and Wyoming.

Georgia, Maryland, and South Carolina.—None of these States produce, all crude requirements for the half dozen refineries being supplied by receipts from other States and by imports. Imports of foreign crude into these 3 States in 1932 totaled 3,553,000 barrels; receipts of domestic crude from Louisiana, Oklahoma, and Texas, principally the latter, were 11,456,000 barrels.

Illinois.—Crude requirements of the refineries in Illinois far exceed production, and nearly six times as much oil is received from outside sources as is produced. Total receipts from other States in 1932 were 26,574,000 barrels, the major part of which came from the Mid-Continent, with relatively small amounts from Indiana and Kentucky. Some Illinois oil is exported, and some is shipped eastward, but of the production plus receipts (31,235,000 barrels) 28,531,000 barrels were run to stills.

Indiana.—Production in Indiana is relatively small, but the State is an important refining center. There were 52,336,000 barrels of crude oil refined in Indiana in 1932, nearly all from Kansas, Oklahoma, and Texas, except for a relatively small amount from Louisiana.

Kansas and Missouri.—The new supply of crude oil in Kansas totaled approximately 40,000,000 barrels in 1932, of which about 34,000,000 barrels were production and 6,000,000 barrels receipts from Oklahoma. Runs to stills in the two States were about 36,000,000 barrels, leaving several million barrels for exports and shipments to Illinois, Indiana, and Ohio.

Kentucky.—The production in Kentucky in 1932 (6,264,000 barrels) roughly equaled runs to stills (6,332,000 barrels), the receipt of slightly more than 2,000,000 barrels of Oklahoma oil being nearly balanced by a total delivery of 1,820,000 barrels to Illinois, Ohio, and West Virginia.

Louisiana.—The new supply in Louisiana in 1932 consisted of 21,478,000 barrels produced, 2,179,000 barrels imported, and 33,396,000 barrels received from Arkansas, Oklahoma, and Texas, particularly from the East Texas field. Runs to stills totaled 46,906,000 barrels, a relatively small amount was exported, and 12,454,000 barrels were shipped to other States, principally Atlantic Seaboard States.

Massachusetts, Rhode Island, and Virginia.—The refinery requirements of these three States in 1932 (14,654,000 barrels) were met by receipts of 13,871,000 barrels from Texas, plus 1,116,000 barrels imported.

Michigan.—Production in Michigan increased nearly 3,000,000 barrels in 1932, and receipts of Oklahoma oil remained virtually unchanged at between 2 and 3 million barrels. Consumption as fuel in the raw state was more than 1,000,000 barrels, shipments to Ohio plus exports were nearly 3,500,000 barrels, and local refineries increased their runs by about 700,000 barrels.

Montana.—Production plus receipts from Wyoming totaled 2,600,000 barrels; runs to stills were 1,569,000 barrels. The difference—about 1,000,000 barrels—represents exports of 761,000 barrels plus tank-car shipments to Utah, consumption as fuel, and additions to stocks.

New Mexico.—The production, roughly 12,500,000 barrels, was accounted for by shipments of 11,703,000 barrels to Texas and Utah and runs to stills of 808,000 barrels. A considerable quantity of the oil shipped from New Mexico to Texas was transshipped to Pennsylvania and possibly to other States.

New York.—Production in 1932 was hardly more than one third the refinery requirements of 9,685,000 barrels, the balance being supplied by receipts from Oklahoma and Texas. A total of 662,000 barrels was shipped to Pennsylvania, but this was offset by a reverse movement of approximately the same amount.

Ohio.—Ohio was one of the comparatively few States in which runs to stills increased in 1932. The total refinery consumption in 1932 was 25,552,000 barrels; shipments to other States were nearly 1,000,000 barrels. The new supply consisted of 4,597,000 barrels produced plus 22,915,000 barrels received from Oklahoma and seven other States.

Oklahoma.—Oklahoma is one of the chief sources of supply for other States, as it only refines about one third of its production. Receipts from Kansas and Texas were relatively small, but nearly 115,000,000 barrels were shipped to 14 States and 7,269,000 barrels exported. The total demand for Oklahoma crude in 1932 was about 174,000,000 barrels, as production plus receipts were about 154,000,000, and 20,000,000 barrels were withdrawn from storage.

Pennsylvania.—The refining industry in Pennsylvania consists of two distinct divisions, the 30 or more small plants in the western part of the State, and a small group of relatively large refineries in the general vicinity of Philadelphia. The western division utilizes principally Pennsylvania-grade crude produced nearby, although several plants use Oklahoma crude. The refineries of the eastern division utilize principally Texas crude augmented by imports. Of the total runs to stills in 1932 (75,143,000 barrels), 14,422,000 barrels were refined in the western division, 51,310,000 barrels were domestic crude refined in the eastern division, and 9,411,000 barrels were foreign crude also refined in the eastern division. A few million barrels are shipped annually to New Jersey, New York, and Ohio.

Texas.—Texas is the leading State in refining but is also the chief source of supply for the refineries on the Atlantic seaboard. Shipments are made to Eastern States by water, as overland pipe-line shipments have virtually ceased. Receipts from other States totaled 23,353,000 barrels in 1932, nearly half coming from New Mexico. Imports totaled nearly 1,000,000 barrels; exports were 7,680,000 barrels.

West Virginia.—The consumption of crude at refineries in West Virginia in 1932 exceeded production by about 500,000 barrels. This apparent deficiency in supply was compensated by a small withdrawal from storage and by an excess of several hundred thousand barrels in receipts from Kentucky, Ohio, and Oklahoma over deliveries to New Jersey, Ohio, and Pennsylvania.

Wyoming.—Production in Wyoming exceeded runs to stills by about 4,000,000 barrels, in 1932; the major part of this difference was added to stocks, although exports and consumption as fuel accounted for several hundred thousand barrels and about 1,000,000 barrels were shipped to other States.

Distribution of crude petroleum in 1932, by States [1]

[Thousands of barrels of 42 U.S. gallons]

State	Production	Imports	Receipts from other States		Runs to stills	Exports	Deliveries to other States		Fuel and losses	Change in stocks
			Quantity	State			Quantity	State		
Arkansas	11,907		643	Tex.	7,244		5,578	La., Tex.	50	−322
California	178,128				164,737	9,833	14	Utah	6,318	−2,774
Colorado	1,177		[2] 1,466	Wyo.	[2] 2,344		230	do.	10	[2] +59
Georgia		285	[3] 11,456	Tex.	[3] 14,869				[3] 32	[3] +108
Illinois	4,661		26,574	Ind., Kans., Ky., Okla., Tex.	28,531	802	784	N.J., Ohio	125	+993
Indiana	804		52,969	Kans., La., Okla., Tex.	52,336		809	Ill., Ohio	200	+428
Kansas	34,300		[4] 11,765	Okla.	[4] 35,905	400	8,754	Ill., Ind., Mo., Ohio, Okla.	237	[4] +769
Kentucky and Tennessee	6,269		2,016	Okla.	6,332	18	1,825	Ill., Ohio, W.Va.	40	+70
Louisiana	21,478	2,179	33,396	Ark., Okla., Tex.	46,906	234	12,454	Ind., Md., N.J., Pa., Tex.	318	−2,859
Maryland		2,410	(3)	La., Okla., Tex.	(3)				(3)	(3)
Massachusetts		370	[5] 13,871	Tex.	[5] 14,654				[5] 7	[5] +326
Michigan	6,729		2,333	Okla.	4,292	104	3,354	Ohio	1,141	+171
Missouri			(4)	Kans., Okla.	(4)					(4)
Montana	2,449	14	133	Wyo.	1,569	761	36	Utah	54	+176
New Jersey		27,002	41,571	Ill., La., Okla., Pa., Tex., W.Va.	67,626					+947
New Mexico	12,511				808		11,703	Pa., Tex., Utah	50	−50
New York	3,501	43	6,795	Okla., Pa., Tex.	9,685	3	662	Pa.	40	−51
Ohio	4,597		22,915	Ill., Ind., Kan., Ky., Mich., Okla., Pa., W.Va.	25,552		970	Pa., W.Va.	100	+890
Oklahoma	152,621		1,437	Kans., Tex.	51,265	7,269	114,980	Ill., Ind., Kans., Ky., La., Md., Mich., Mo., N.J., N.Y., Ohio, Pa., Tex., W.Va.	675	−20,131
Pennsylvania	12,403	9,834	57,346	La., N.Mex., N.Y., Ohio, Okla., Tex., W.Va.	75,143		3,984	N.J., N.Y., Ohio	369	+87
Rhode Island		556	(5)	Tex.	(5)				(5)	(5)
South Carolina		858	(3)		(3)				(3)	(3)
Texas	311,069	945	23,353	Ark., La., N.Mex., Okla.	196,578	7,680	143,170	Ark., Ga., Ill., Ind., La., Md., Mass., N.J., N.Y., Okla., Pa., R.I., Utah, Va.	1,221	−13,282
Utah			(2)	Calif., Colo., Mont., N.Mex., Tex., Wyo.	(2)					(2)
Virginia		190	(5)	Tex.	(5)					(5)
West Virginia	3,882		3,268	Ky., Ohio, Okla.	4,408		2,923	N.J., Ohio, Pa.	25	−206
Wyoming	13,359				9,213	289	1,077	Colo., Mont., Utah	330	+2,450
	781,845	44,686	313,307		819,997	27,393	313,307		11,342	−32,201

[1] This table represents the first attempt to compile complete information on the distribution of crude petroleum by States. The data on production, imports, runs to stills, and exports are essentially correct, but in some cases it was necessary to estimate receipts, deliveries, and fuel and losses.
[2] Colorado includes Utah.
[3] Georgia includes Maryland and South Carolina.
[4] Kansas includes Missouri.
[5] Massachusetts includes Rhode Island and Virginia.

PRODUCTION BY STATES

The fluctuations of domestic crude production in 1932 were much less pronounced than in 1931, and in most months the daily average output was very nearly 2,150,000 barrels. The highest daily average recorded—2,257,000 barrels—was in April, when many settled pools were opened up because of increased demand and higher prices. The lowest daily average production (1,872,000 barrels) was for December, when the East Texas field was closed down for nearly 2 weeks.

Production in all major producing districts except the Lima-Indiana-Michigan area decreased in 1932. Production in the Lima-Indiana-Michigan district rose from 4,941,000 barrels in 1931 to 7,822,000 barrels in 1932; this gain was due entirely to an increase in Michigan. Production in the Mid-Continent field, by far the leading producing district of the country, totaled 490,324,000 barrels in 1932 (63 percent of the total for the United States) compared with 64 percent in 1931.

The production of Pennsylvania-grade crude declined for the second successive year, although the decrease in 1932 was much less than in 1931. The amount produced in 1932 was 21,513,000 barrels, of which about 58 percent came from Pennsylvania, 8 percent from Ohio, 18 percent from West Virginia, and 16 percent from New York.

The relative importance of the various States in crude production is shown graphically in figure 40.

Arkansas.—The production of crude petroleum in Arkansas has declined steadily in recent years, coincident with the decreased output of the Smackover field, the only major field so far discovered in the State. The production in 1932 was 11,907,000 barrels, a decline of 2,884,000 barrels (19 percent) from 1931. Of the 1932 total about 79 percent was produced in the Smackover field, compared with 78 percent in 1931.

Drilling fell to a very low ebb in Arkansas in 1932 and only 4 oil wells were brought in out of a total of 50 completions. Of the total completions 45 (90 percent) were dry holes, this high percentage of failures tending to restrict exploratory work further. The most encouraging feature of the year in "wildcatting" in Arkansas was the discovery of commercial production in the Miller County pool in the southwest corner of the State. This field was discovered in 1930, but its record, up until late in 1932, was not impressive. The deep test in the center of the Smackover field was completed in 1932 as a dry hole in rock salt at 7,255 feet. The results of this test, the deepest well ever drilled in the area, were naturally disappointing, although it yielded valuable geological information.

California.—According to monthly figures of the American Petroleum Institute, the production of crude petroleum in California in 1932 totaled 178,128,000 barrels, a decrease of 10,702,000 barrels (6 percent) from 1931.

Prices of crude petroleum in California showed only one change in 1932—a general advance for all but the lower-gravity crudes effective June 26. For the first half of the year much effort was devoted to curtailing output enough to offset the decline in demand, and during the last half even more strenuous measures were needed. The daily allowable recommended by the proration committee was reduced several times during the year in the endeavor to compensate for the decline in demand, but these moves were only partly successful, as several town-lot fields in the Los Angeles basin continually exceeded their allowable.

In 1932 the Long Beach and Santa Fe Springs fields retained their positions as the first and second ranking producing fields in California, but the Kettleman Hills field displaced Midway-Sunset in third place. The Kettleman Hills field might easily have been first, except

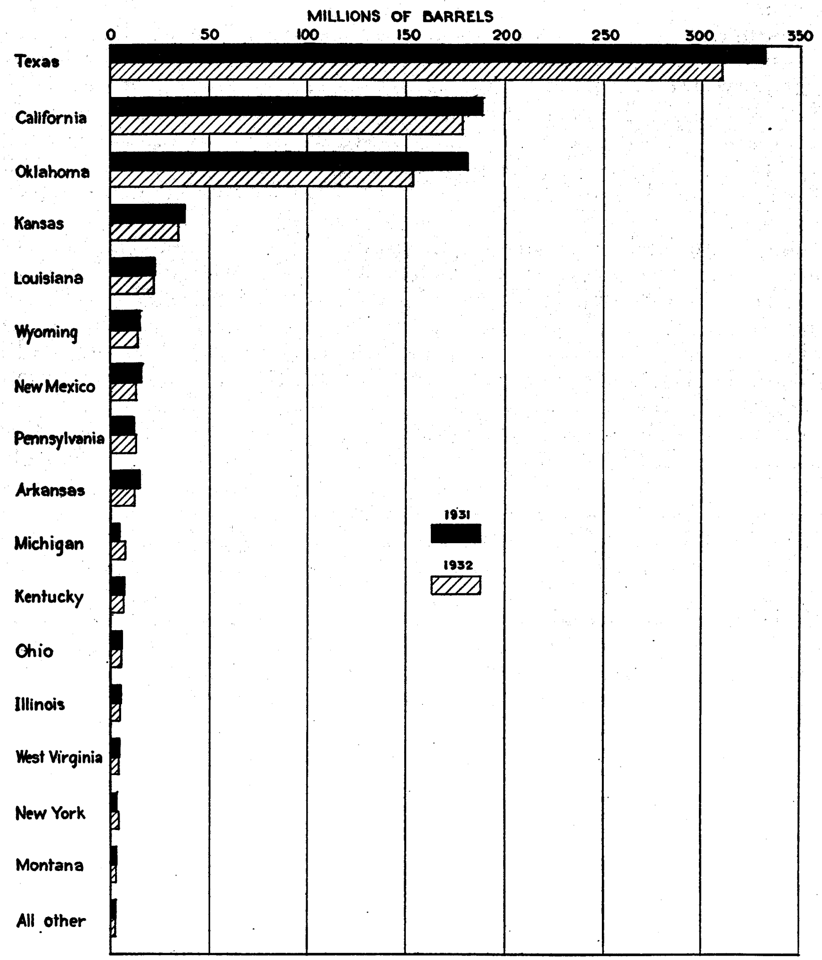

FIGURE 40.—Production of crude petroleum, 1931–32, by States.

that it was under rigid proration throughout the year, whereas many operators in the Long Beach and Santa Fe Springs fields did not cooperate in curtailment. Other fields that increased in production in 1932 were Coalinga, Lost Hills-Belridge, Dominguez, Huntington Beach, and Torrance. Decreases were recorded in the majority of the fields, the losses in the Elwood and Playa del Rey fields being particularly severe.

Unlike the majority of States, drilling in California declined materially in 1932. Only 184 oil and gas wells were completed in 1932 compared with 246 in 1931 and 755 in 1930. The largest decline in drilling occurred in the Playa del Rey field, where only 6 oil wells were completed in 1932 against 66 in 1931. The leading field in number of oil wells completed in 1932 was Fruitvale; this was surprising, as the field has not been regarded as important and had only three successful completions in 1931.

Wildcatting fell to a low ebb in California in 1932, and no new fields were discovered; however, better success was obtained through deeper drilling, and new reserves were uncovered in the Kettleman Hills, North Belridge, Ventura Avenue, and Miguelito fields. The discovery at North Belridge was interesting, as the oil was obtained from the pre-Miocene, thus establishing the possibility for deeper production in other fields on the west side of the San Joaquin Valley. A well was drilled in the Ventura Avenue field at 9,710 feet, which at the time of its completion was a new world record for depth for producing wells. A dry hole completed in Santa Maria district at 10,294 feet at the end of 1932 was the deepest ever drilled in the United States prior to 1933. Another well was completed on the middle dome at Kettleman Hills but it, like the discovery well which was completed in 1931, experienced mechanical difficulties and did not produce commercially in 1932. The two wells indicate a structure much smaller than the north dome but containing a substantial reserve of oil and gas.

Colorado.—Production in Colorado in 1932 was 1,177,000 barrels (24 percent below 1931). This material decline resulted largely from the natural decline of the settled production.

The most interesting discovery of the year was the finding of oil in a deep test drilled on a large structure near Buckingham in the northeastern corner of the State. As was true of the Greasewood field, later developments revealed that the producing sand (Muddy) was comparatively thin, and the underlying Dakota contained water. The other discoveries in 1932 were mainly gas fields in the northwest corner of the State.

Illinois.—Production in Illinois in 1932 fell to the lowest level since 1906; the output for the year was 4,661,000 barrels compared with 5,039,000 barrels in 1931.

Although crude-oil prices made some improvement in Illinois in 1932 the advance was not enough to promote much exploratory work. Only 47 wells were completed in the State in 1932, and 29 of these were dry holes.

Low prices and slack demand were instrumental in the restoration in September of the 25 percent restriction on production in effect during parts of 1930 and 1931.

Indiana.—Indiana experienced a revival in drilling activity in 1932, and 54 oil wells were completed compared with 35 during 1931. However, this gain in development work did not prevent a decline in output to 804,000 barrels from 840,000 barrels produced in 1931. The major part of the output in 1932 came from the fields in southwestern Indiana as the part of the old Lima pool that lies in the northeastern corner is nearly exhausted.

Kansas.—Although development work in Kansas increased materially in 1932 production declined 7 percent from 1931. However, this decrease resulted primarily from generally satisfactory adherence to the proration program of the Kansas Public Service Commission. Production in 1932 totaled 34,300,000 barrels, an average of about 94,000 barrels daily. The trend in output in 1932 was fairly uniform until December, when the productive rate declined to about 85,000 barrels daily.

The leading producing field in 1932, the Ritz-Canton pool of McPherson County, produced nearly 5,000,000 barrels in 1932 compared with about 3,500,000 barrels in 1931. Very few other fields recorded a substantial increase in output in 1932, an exception being the Winfield pool, where an active townsite drilling campaign was carried on. Voshell, the leading field in 1931, declined materially in output in 1932.

Drilling in Kansas made a partial recovery from the slump of the previous year, as 572 completions were recorded compared with 470 in 1931. The number of oil wells drilled rose from 229 in 1931 to 363 in 1932, but the daily initial production of these wells decreased from 633 barrels in 1931 to 532 barrels in 1932. The percentage of dry holes was higher than in 1931, but was considerably under the high ratio of 41 percent recorded in 1930. The most actively developed area in 1932 was the Ritz-Canton-Decker field, where 122 oil wells were completed.

Wildcatting was comparatively successful in 1932, and a number of new pools were opened; the most promising were the Johnson and Mabee pools in McPherson County, the Chase and Steckel pools in Rice County, and the Stratman pool in Ellsworth County. The majority of the new fields were "one-well" fields at the close of 1932, with production shut in for the want of a market or curtailed by proration. Of the newer fields in Kansas the Johnson and Hollow pools were most actively developed in 1932. The Hollow pool in Harvey County was discovered in 1931 but not actively developed until 1932.

Drilling in the far western counties of Kansas was not particularly successful in 1932, although a possible extension to the Hugoton gas field was discovered in Finney County. Of considerable geological interest was the discovery of substantial production from the Hunton lime in McPherson County. This formation, which lies above the productive Siliceous lime, had been considered a negative factor in Kansas oil production.

Kentucky.—Production in Kentucky decreased in 1932, although the decline was much less than in 1931. The total produced in 1932 was 6,264,000 barrels (3 percent less than in 1931). The number of oil wells completed in 1932—279—was 100 more than in 1931 but far below the average for the past decade. The majority of the wells drilled in Kentucky in 1932 were in Daviess, Ohio, and Hart Counties, all in western Kentucky. As late as 1927 the pools in eastern Kentucky yielded the major part of the State's production; however, most of the recent drilling has been in the western part of the State, and the eastern district is now a negligible producer of oil.

Louisiana.—Production in the northern fields of Louisiana continued to decline and in 1932 totaled only 10,123,000 barrels compared with 12,244,000 barrels in 1931 and with a peak of 33,629,000 barrels in 1922. On the other hand, production in the coastal fields continued to increase, amounting to 11,355,000 barrels in 1932 compared with

9,560,000 barrels in 1931. The total output of the State in 1932—21,478,000 barrels—was only 1 percent below that of the previous year. The increased production in the coastal fields and the decline in the northern fields in 1932 caused the former to become the outstanding producing district of the State, whereas 10 years ago its output was relatively small.

The Zwolle field was the center of activity in the northern fields in 1932; it led in production, was the only field in that district that increased its output in 1932, and was credited with more than 90 percent of the oil wells completed. About 100 oil wells were completed at Zwolle in 1932, and the field was extended greatly in area. Of further encouragement to the operators in that and other fields producing from marl-chalk formation were the successful results of using the acid treatment to stimulate production. On the other hand, the high percentage of dry holes, about 60 percent, continued to retard development.

Wildcatters were fairly active in northern and central Louisiana in 1932, with most of the efforts directed toward finding a field corresponding to the East Texas on the southeast side of the Sabine uplift and toward discovering deeper producing sands in the old fields. These attempts were generally unsuccessful, but two apparently small fields—the Converse and the Spring Ridge—were discovered in Sabine Parish.

Approximately half the fields in the Louisiana Gulf coast decreased in output in 1932, but substantial increases in production in the Lake Barre and East Hackberry fields more than compensated for the recession. The Vinton and Lockport fields, which ranked first and second, respectively, in 1931, registered substantial declines in output in 1932 and fell to the third and fourth places, respectively.

Field activity in the Louisiana Gulf coast in 1932 was overshadowed by interest in the neighboring Texas district; nevertheless, two new fields—the Gueydan and the Darrow—were opened in Vermilion and Ascension Parishes, respectively. Three oil wells were completed at Gueydan in 1932, and the field produced about 200,000 barrels in 9 months. The Iowa field, discovered in 1931, proved a consistent producer and yielded about 500,000 barrels in 1932 compared with a few thousand barrels the previous year. The East Hackberry field led in drilling activity in 1932 after the discovery of deeper sands and cap-rock oil.

Michigan.—Production in Michigan rose to a new level in 1932, the only State in which a new record was established in 1932. The total production in 1932 was 6,729,000 barrels compared with 3,789,000 in 1931.

The material gain in output in Michigan in 1932 resulted largely from the development of flush production in the east extension of the Mount Pleasant field and from the removal of proration on May 17. Although the number of oil wells completed in 1932 (113) was more than double such completions in 1931 it was considerably less than the record figure of 348 established in 1929. However, the oil wells brought in during 1932 were on the average much larger than those completed when field work was at its peak. Production of the Mount Pleasant field was about 5,800,000 barrels (86 percent of the State output) in 1932. Many wells in the Muskegon field were successfully rejuvenated with acid, but the total production for the year (about 480,000 barrels) was about 10 percent below the 1931 total.

Several wildcat strikes were made in Michigan in 1932, the most promising being the discovery of a productive spot 4 miles south of the Mount Pleasant field.

Mississippi.—Although most of the drilling in Mississippi in 1932 was limited to defining the Jackson gas field the year was notable in marking the discovery of the first oil well in the State. This well, on the southeast side of the Jackson gas field, produced at the rate of 500 barrels of oil daily but went to water in a short time and was shut down.

Montana.—Production in Montana continued to decline, as not enough new production was discovered to compensate for the decline in the Kevin-Sunburst and other settled fields. The total production was 2,449,000 barrels compared with 2,830,000 barrels in 1931. The only field that increased its production in 1932 was the Dry Creek field, Carbon County. Several large wells were completed there in 1932 but proved to be erratic producers. The only new discovery of importance was the finding of oil on one side of the Cut Bank gas field at a depth of just under 3,000 feet. The wells in this field will probably be small, averaging possibly 100 barrels daily, but the quality of the crude is high, and considerable development is expected in 1933.

New Mexico.—After establishing a new record in 1931 production in New Mexico declined 18 percent in 1932. The quantity produced in 1932 was 12,511,000 barrels compared with 15,227,000 in 1931. The decreased output resulted from rigid adherence to proration in the Hobbs field, which produces about 80 percent of the State output. The light-oil fields in the northwest corner of the State yielded about 400,000 barrels in 1932, a decline of 24 percent from 1931. Although drilling in southeast New Mexico increased in 1932 developments continued to be retarded by low prices and the focusing of attention on the East Texas field. No new fields of importance were discovered in New Mexico in 1932, although some promising extensions were made. A second well was completed to the deep Pennsylvania zone in the Rattlesnake field; it was drilled to 7,370 feet but was plugged back to 6,620 feet, where it was completed as a 600-barrel producer. Of considerable importance to the future of the Hobbs field was the discovery that part of the water which has been encroaching on one flank of the structure for some time was top water. This top water was shut off in some wells by packers with beneficial results.

New York.—The production of crude petroleum in New York has increased steadily in recent years due to widespread application of water-flooding. The total output of the State in 1932 (3,501,000 barrels) was, except for 1930, the highest annual total recorded since 1883. Notwithstanding unsatisfactory prices—lowest since 1915—drilling for oil in New York in 1932 was about 40 percent above that in 1931.

Ohio.—Drilling in the fields of central and southeastern Ohio fell off materially in 1932, and production continued to decline. The quantity of crude petroleum produced in 1932 was 4,597,000 barrels (14 percent less than in 1931). Only 23 percent of the year's output came from the old Lima district in the northwest corner of the State, but the decline of that district in 1932 was much less than in the districts yielding Pennsylvania-grade oil. Medina, Stark, and Washington Counties led in drilling in 1932, with much of the work in Stark County confined to the Clinton gas field. The shallow Chatham field in Medina County was actively exploited in 1932, with a high percentage of dry holes (46 percent) but with generally satisfactory results because of low drilling costs.

Oklahoma.—The general condition of the industry in Oklahoma improved in 1932 to the extent that average prices were about 30 cents per barrel higher than in 1931, but as production declined materially the total monetary return to producers was not substantially changed. The total production in Oklahoma in 1932 was 152,621,000 barrels (15 percent less than in 1931 and 45 percent below the 1927 peak). Proration of the flush fields of Oklahoma was continued during 1932 in an attempt to restrict output to demand. The administration of proration proceeded more smoothly in 1932 than in 1931, although troops were kept in the Oklahoma City field to enforce the orders of the Oklahoma Corporation Commission.

More wells were drilled in Oklahoma in 1932 than in 1931, but the average size of the wells (1,120 barrels daily initial) was the lowest in several years. This resulted from the fact that the number of completions in the Oklahoma City field, where the wells have a very high potential output, dropped sharply in 1932 compared with a gain in the number of oil wells completed elsewhere. Furthermore, the average of the completions in the Oklahoma City field was much lower than in 1931 due to rapid lowering of bottom-hole pressures caused by heavy withdrawals of gas. Drilling in Carter, Creek, and Hughes Counties and in the greater Seminole district increased substantially in 1932. The drilling at Seminole was confined largely to prospecting shallow pay sands, such as the Booch and Calvin, which were neglected in the rush to reach the prolific Wilcox zone in 1927 and 1928.

With a few minor exceptions the production of all fields in Oklahoma declined in 1932. The Holdenville and Chandler pools, with a few stripper areas, gained in output in 1932, but nearly all the flush areas, or fields in which most of the production is from flowing wells, were under some form of proration in 1932 and recorded material declines. An additional factor that restricted production in 1932 was the limiting of discovery wells to 50 barrels of production daily. The Oklahoma City field produced 32,924,000 barrels in 1932 (29 percent less than in 1931); production in the greater Seminole district was better sustained and only declined from 47,883,000 barrels in 1931 to 42,983,000 barrels in 1932.

Wildcatting recovered from its slump of 1931, and more new discoveries were made in Oklahoma in 1932 than for several years. The outstanding event of the year was the opening of a new field near Perry, Noble County. The productive zone in this field was the Wilcox sand, which was found at about 5,200 feet. This discovery aroused considerable interest, as it was on a promising structure and was drilled under the unit plan. Another discovery, less spectacular than the find at Perry but having a greater effect on production, was the opening of a new field at West Holdenville, Hughes County. The potential output of this field rose to 20,000 barrels daily late in the year, but drilling activity declined when proration was introduced. Other discoveries in Oklahoma in 1932 were the West Konawa pool;

two apparently small pools in Osage County; deep production in the Marshall pool, Logan County; the County Line pool in Lincoln County; and extensions to the Oklahoma City field. An interesting feature of these discoveries was that no two were reported to have been completed in the same zone, an indication of the great number of producing formations in Oklahoma.

Pennsylvania.—The record of production in Pennsylvania in recent years has been similar to that of New York, as in both States there was a steady increase through 1930 and a decline in 1931 followed by a gain in 1932. This similarity in the trend of production is not accidental but is due to the fact that the Bradford field, the most important producing district east of the Mississippi, occupies parts of both States.

The production in Pennsylvania in 1932 totaled 12,403,000 barrels compared with 11,892,000 barrels in 1931. All the increase in 1932 came from the Bradford field, as production in the other fields declined materially.

Prices of crude petroleum in Pennsylvania remained too low to encourage the drilling of many wildcats. The number of oil wells completed in 1932 was substantially higher than in 1931 but far below the level of previous years. The desire to curtail drilling expenses is illustrated by a decrease in the percentage of dry holes—from 16 in 1931 to 8 in 1932.

Tennessee.—Nothing occurred in Tennessee in 1932 to check the slump in production, which totaled only 5,000 barrels for the year compared with 6,000 barrels in 1931.

Texas.—Texas registered a 6 percent drop in production in 1932 but continued to rank first among the producing States. The total output was 311,069,000 barrels compared with 332,437,000 barrels in 1931. In six of the seven major producing districts of Texas—Panhandle, North Texas, Central Texas, West Texas, Southwest Texas, and Gulf coast—the output fell in 1932; the lone exception was East Texas, where production increased slightly over 10,000,000 barrels.

The Texas Panhandle experienced some revival of interest in drilling for oil in 1932, but the trend of production continued downward. The total output was 18,380,000 barrels compared with 21,851,000 barrels in 1931. The Gray County pools, particularly the Finley, Bowers, and Le Fors, continued to dominate production in the Texas Panhandle, although the Borger pool, Hutchinson County, continued as the largest single factor.

Very few new discoveries were made in the Texas Panhandle in 1932, the most important being a rich spot in the granite wash in the Le Fors pool. Acid was successfully used to stimulate production in a few lime wells.

Production in North Texas, including the districts sometimes referred to as North Central and West Central Texas, totaled 26,588,000 barrels in 1932 (a decline of 11 percent from 1931). Although drilling in North Texas increased in 1932 the district was under proration, which with the low price of oil forced abandonment of many wells. In spite of these handicaps some of the older fields increased production over 1931, and in the majority of the others the output was well maintained. There were no important discoveries in the area in 1932, although several interesting extensions were made. Archer County was the most active area from the standpoint of drilling in 1932 and was credited with the majority of the new extensions. Some wells in North Texas produce from lime formations, and the acid treatment was successfully employed in a number of these in 1932.

The East Texas field proper continued to be the leading producing field in the world in 1932. At the close of 1932 the field covered approximately 114,000 acres in five counties, had about 9,500 producing wells, and from the standpoint of estimated reserves was by far the largest oil field ever discovered.

The production of the East Texas field in 1932 totaled 120,158,000 barrels, which was 10,528,000 barrels, or 10 percent, above 1931. The 1932 total represents a daily average of 328,300 barrels for the year, although the average for the operating period was higher because the field was closed down for two weeks in December. The production in 1932 fluctuated little from month to month, the daily allowable production per well being reduced as the number of producing wells increased. The allowable at the beginning of the year was 100 barrels but was reduced about twice every month to 33 barrels on December 11. The order of December 11 was on a two thirds well and one third acreage and bottom-hole-pressure basis, being the first order to incorporate acreage and potential factors. The various orders of the Texas Railroad Commission were frequently contested in the courts in 1932, the most important decision being rendered by the Supreme Court of the United States on December 12. Troops first entered the field August 17, 1931, but were gradually withdrawn, the last contingent leaving December 21, 1932. The last order of the commission for the year closed down the field on December 17 to obtain bottom-hole pressures on key wells.

In all, 5,760 wells were drilled in the East Texas field in 1932, of which 5,641 (97.9 percent) were oil wells, 6 (0.1 percent) gas wells, and 113 (2 percent) dry holes. This represents a very low percentage of failures, reflecting the consistency of the Woodbine sand under the field. The average daily initial production of the oil wells completed in 1932 was about 2,500 barrels, the total initial being about 14,000,000 barrels.

From an engineering standpoint the East Texas field exceeded expectations in 1932. Bottom-hole pressures did not fall as rapidly as predicted, and the movement of encroaching water was mainly restricted to comparatively small areas on the west side of the field. Only about 2 percent of the producers were on the pump at the close of 1932.

Production in the other fields of the East Texas district, including Van, Boggy Creek, and small pools in Panola and Nacogdoches Counties, increased in 1932. This increase resulted solely from a gain at Van, where production rose from 15,598,000 barrels in 1931 to 17,206,000 barrels in 1932.

The Central Texas fields, including principally those along the Balcones fault zone, declined materially in output in 1932, as no outstanding discovery was made to compensate for decreased production in older fields, like Powell, Salt Flat, and Luling. In the northeast end of the fault zone—that is, in the Mexia-Powell district—activity was at a low ebb in 1932, as nearly all the wildcatters had transferred their activities to East Texas. More wildcatting was done in the southwest end of the fault zone—that is, in the Luling-Darst Creek area—and several new strikes were made, consisting mainly of crevice wells, with later offsets completed as dry holes. A new field called Tuleta was discovered near the Pettus field in Bee County in 1932, but it proved small in area and its output fell far short of compensating for the decline at Pettus.

Interest in the West Texas district in 1932 was quite generally eclipsed by developments in the East Texas field, with the result that drilling declined to below the low level of 1931 and production again decreased substantially. The total output of the district in 1932 was 63,542,000 barrels, compared with 78,524,000 barrels in 1931 and with 133,328,000 barrels in 1929, the peak year.

The Yates field, Pecos County, continued to be the chief factor in production in the West Texas district; its output for 1932 was 23,744,000 barrels, compared with 28,226,000 barrels in 1931. The decrease in production of the Yates field in 1932 resulted directly from lowering of the allowable on October 31, 1931, as nearly all of the wells are still flowing, and the field can produce much more than the total assigned to it under proration. The field continued as a model from an engineering standpoint, being particularly outstanding because of the success attained in the substitution of bottom-hole pressures for open flow in establishing potentials.

The Hendricks pool, Winkler County, was the second most important producer in West Texas in 1932, although it was not far ahead of the Big Lake field. The water problem in the Hendricks field became increasingly serious in 1932, forcing the operators to raise immense quantities of water with the oil. Production at Big Lake registered a comparatively small decline in 1932, as the deep wells bottomed in the Ordovician continued to be well sustained in output. However, the chances for increasing Ordovician production in 1933 were dimmed by the appearance of water in some wells and by failure to extend the producing area.

Only 144 oil wells were completed in West Texas in 1932, compared with 170 in 1931 and 715 in 1929, the peak year. Ward County again ranked first in drilling, but the average initial output of the oil wells completed in that county in 1932 was low.

Production in Southwest Texas, including principally the fields in Webb, Zapata, Starr, Jim Hogg, and Duval Counties, continued to increase and in 1932 totaled 6,337,000 barrels, compared with 5,002,000 barrels in 1931. The gain in production in 1932 resulted from increased drilling and from generally successful wildcatting.

The most important discovery in Southwest Texas in 1932 was the Government Wells field, composed of a group of partly contiguous pools in northern Duval County. About 100 oil wells were completed in this field in 1932, these having an average daily initial production of 737 barrels, a high figure for the district. Other promising new fields discovered in Southwest Texas in 1932 were the Laurel pool, Webb County, and the Jacob pool, McMullen County. The oil found at Laurel is of high gravity, whereas that from the Jacobs pool is a heavy oil; however, the fact that the wells in the latter pool are shallow (900–1,000 feet) compensates for the low gravity of the oil.

Production in the Texas Gulf coast declined from 48,032,000 barrels in 1931 to 41,791,000 barrels in 1932, but the district experienced its most successful year since the discovery of Spindletop in 1901.

The Conroe field, discovered late in 1931, was the center of interest in the Texas Gulf coast in 1932, and its performance more than justified the attention given it. Although the first real producer was not completed at Conroe until June, development was rapid in the last half of the year, and about 100 wells were completed before January 1, 1933. The productive area exceeded expectations, amounting to about 15,000 acres at the end of the year. The production under fairly rigid proration was 2,608,000 barrels in 1932.

Another 1931 discovery, the Rabb Ridge field, proved an important producer in 1932, ranking second only to Barbers Hill as the leading field in the district. The yield at Refugio, the leading producer in 1931, declined very rapidly and amounted to only 3,429,000 barrels, compared with 9,274,000 barrels in 1931. The output of most of the older salt domes fell in 1932, one exception being High Island, which was extended during the year.

Wildcatting was active in the Texas Gulf coast; in fact, the area led the country in exploratory work in 1932. Most wildcat wells were on the Pettus-Conroe trend from Colorado to Tyler Counties. The most promising new discoveries in the district in 1932 included Buckeye, Matagorda County; Pledger, Brazoria County; and Livingston, Polk County. Of these only Buckeye produced oil in 1932.

West Virginia.—Low prices, continued decline of the producing wells, and another material decrease in drilling were the chief factors that led to another substantial decline in production in West Virginia. The total output of the State in 1932 was 3,882,000 barrels, compared with 4,472,000 barrels in 1931. Only 46 oil wells were completed in 1932, compared with 73 in 1931; however, the average daily initial of the 1932 completion was larger than in 1931.

Wyoming.—Production in Wyoming continued to decline in 1932, although the decrease was not as large as in 1931. The total output for the year was 13,359,000 barrels, compared with 14,834,000 barrels in 1931.

Salt Creek, the principal field in the State, produced 8,006,000 barrels in 1932 (9 percent less than in 1931). Production in the other fields decreased 11 percent. In general, the only fields that increased in output in 1932 were the heavy or black-oil fields at Hamilton Dome and Byron-Garland, which were provided with a refinery outlet for the first time. The Frannie field was extended during the year, although that discovery did not prevent a drop in output.

Only 31 oil wells were completed in Wyoming in 1932, compared with 40 in 1931 and 100 in 1930. In 1932, as in 1931, the majority of the completions were in the Osage field, Weston County.

WELLS

Data on the number of producing wells at the close of 1932 are not available, but it appears probable that the total was less than 315,850, the number on January 1, 1932. More oil wells were complated in 1932 than in 1931, and prices advanced, but it is doubtful if these factors were powerful enough to prevent several thousand wells from being abandoned.

The number of wells completed in 1932 totaled 15,040, 10,444 (69 percent) being oil wells, 1,027 (7 percent) gas wells, and 3,569 (24 percent) dry holes. These data indicate a sharp decrease in the percentage of gas wells and a substantial decline in the percentage of dry holes balanced by a large increase in the ratio of oil wells. The decrease in percentage of failures was due largely to the fact that 38 percent of the wells completed were in the East Texas field, which has had an unusually low number of failures. Drilling increased steadily after the April price advances but receded in the late months when the market weakened. In addition to East Texas, the active districts in drilling in 1932, as measured by the total completions, were as set forth in the following table:

Drilling activity in leading districts in 1932

District	State	Completions in 1932[1]	District	State	Completions in 1932[1]
Archer County	Texas	302	McPherson County	Kansas	151
Bradford-Allegany	New York-Pennsylvania.	769	Midland County	Michigan	125
			Ohio County	Kentucky	120
Conroe	Texas	100	Oklahoma County	Oklahoma	136
Creek County	Oklahoma	219	Sabine Parish	Louisiana	251
Daviess County	Kentucky	132	Wichita County	Texas	136
Government Wells	Texas	110	Young County	do	361
Medina County	Ohio	145			

[1] Totals for oil wells, gas wells, and dry holes.

The total number of wells completed, divided as between oil wells, gas wells, and dry holes, is shown graphically in figure 41.

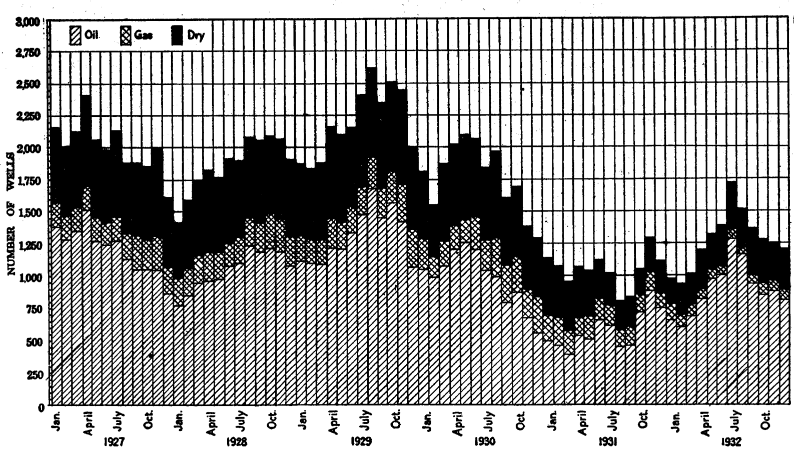

FIGURE 41.—Wells drilled, 1927–32, by months.

WORLD PRODUCTION

The world production of crude petroleum during 1932 totaled 1,305,563,000 barrels, a decrease of nearly 67,000,000 barrels, or 5 percent, from 1931. In 1932, as in 1931, production outside the United States increased; consequently, the ratio of the production in the United States to the world total declined from 62 percent in 1931 to 59.9 percent in 1932. Production in 1932 was divided according to continents as follows: North America, 62.5 percent; South

America, including Trinidad, 12.8 percent; Europe, 16.6 percent; Asia, including Japan, East Indies, and Sakhalin, 8 percent; and Africa, 0.1 percent. These data indicate chiefly a gain in the relative proportion produced in the Eastern Hemisphere.

Production in Russia showed a small decline in 1932, although it was the last year of the 5-year plan. However, that country continued to rank second to the United States in production, with plans to triple the output under a new 5-year plan.

The production of Venezuela, the third-ranking nation, totaled 116,300,000 barrels in 1932, virtually the same as in 1931. Drilling declined materially in Venezuela in 1932.

Production in Rumania rose to a new high level in 1932 due to competitive drilling in certain prolific fields. Production in Persia also reached a new high level in 1932, although the gain was due to increased demand. Production in Mexico continued to decline, although the drop in 1932 was relatively small.

IMPORTS AND EXPORTS

In spite of imposition of a tariff on imports of crude oil on June 20, 1932, the total brought in during 1932 (44,688,000 barrels) decreased but slightly from 1931 because passage of the duty was anticipated several months in advance, and imports for April, May, and June were far above normal. Imports of Venezuelan crude showed a small increase in 1932, but receipts of all other common types of foreign crude declined. Imports from Venezuela in 1932 (25,632,000 barrels) were equivalent to 57 percent of the total crude imports and to 22 percent of the production of that country. Imports of Colombian crude into the United States were equivalent to 64 percent of that country's output and imports of Mexican crude to 22 percent of production in that country.

Exports of crude oil rose to a new high level of 27,393,000 barrels in 1932. Exports of crude to Canada, which comprise about two thirds of the total, declined in 1932, but exports to other countries, principally Japan and France, gained 46 percent.

REFINED PRODUCTS

Several hundred refined products are made from crude petroleum, but only about a dozen are important enough quantitatively to show separately in statistics. Gasoline is easily the most important product, with fuel oils second, kerosene third, and still gas fourth. Kerosene was the leading product until about 1909, fuel oil from 1909 to 1930, and gasoline from 1930 to the present. The rapid rise of still gas in recent years has resulted from the use of increasingly high temperatures in refining and from the widespread growth in number of installations to recover this high-B.t.u. fuel. Shortage, including chiefly losses from unrecovered still gas, totaled 20,652,000 barrels in 1932; this was equivalent to 3 percent of crude runs.

Natural gasoline.—The production of natural gasoline dropped sharply in 1932, as comparatively few new flush oil fields with surplus gas were discovered. Much of the field work in 1932 was in East Texas which, because of its low gas-oil ratio, did not become a factor in production until late in the year.

The consumption of natural gasoline in motor blends at refineries—the principal use of the product—also declined materially in 1932, and prices fell to below even 1931 levels.

Details on the production, consumption, and stocks of natural gasoline are given on pages 535 to 544.

Analysis of production and consumption of petroleum products in 1932

[Thousands of barrels of 42 U.S. gallons]

Product	Production	Imports	Exports	Change in stocks	Domestic demand
Motor fuel:					
Gasoline	366,291	8,209		−1,799	
Natural gasoline	32,089		35,434	+378	373,720
Benzol	1,144				
Total motor fuel	399,524	8,209	35,434	−1,421	373,720
Kerosene	43,836	72	10,956	−358	33,310
Gas oil and fuel oil	294,287	21,229	19,874	[1] −5,422	[2] 307,668
Lubricants	22,433	11	6,857	−1,110	16,697
Wax	1,639	119	840	−28	946
Coke	9,123		455	−925	9,593
Asphalt	13,249	108	1,233	−141	12,265
Road oil	6,879			+231	6,648
Still gas	40,905				40,905
Miscellaneous oils	2,568	2	46	−278	2,802
Unfinished oils (net)	[3] −1,865	7		[1] −1,861	−460
Refinery losses	20,652				20,652
Natural gasoline losses	3,683				3,683
	856,913	29,757	75,695	−11,313	[2] 828,429

[1] 463,000 barrels transferred from fuel oil to unfinished oils Sept. 30, 1932.
[2] Includes transfers of 463,000 barrels of fuel oil (see footnote 1) and 6,141,000 barrels of heavy crude.
[3] Excess of unfinished oils rerun over unfinished oils produced.

MOTOR FUEL AND GASOLINE

Motor fuel, consisting of refinery gasoline, natural gasoline distributed directly to the trade, and benzol, is the most important refined product in quantity and value. Accordingly, the chief interest of refinery engineers has been first to improve the yield of gasoline and more recently to improve the quality of that product. Due largely to improved methods of cracking, the yield of gasoline increased rapidly through 1931; however, in 1932 the incentive of increasing demand was lacking, and only a small gain in yield was recorded. As the decline in crude runs exceeded the small increase in percentage yield the production of motor fuel in 1932 was 9 percent below that in 1931.

The domestic demand for motor fuel, which had increased consistently, declined for the first time in 1932, when the total was 373,720,000 barrels, compared with 403,418,000 barrels in 1931. This decrease of 7 percent resulted primarily from a decline in the number of automobiles in use. Exports of motor fuel continued to be affected adversely by the increasing competition in foreign countries and decreased from 45,716,000 barrels in 1931 to 35,434,000 barrels in 1932.

Motor-fuel production comprises three principal elements—the production of straight-run and cracked gasoline at refineries, the production of natural gasoline less losses in handling, and the production of motor benzol at byproduct coke plants. In 1932 the total output of motor fuel was 399,524,000 barrels, a decrease of 9 percent from 1931.

Prior to 1930 the proportion of natural gasoline in motor fuel increased, but since that time has declined steadily. This decrease in the relative importance of natural gasoline has resulted largely from proration, which by curtailing the flush production of crude oil has restricted the supply of natural gas. Less-important factors have been the decreasing level of natural-gasoline prices and lower yields per thousand cubic feet of gas treated.

Benzol is used as a blending agent by a comparatively small group of manufacturers. It has a relatively high antiknock rating, and the blended motor fuel generally sells at a premium; however, the production of benzol has fallen steadily since 1929 and in 1932 was only 1,144,000 barrels, less than one third of 1 percent of the total output of motor fuel.

The principal statistics on motor fuel are shown in figure 42.

Motor fuel is produced at refineries by three methods—straight-run, cracking, and blending of natural gasoline. Although the produc-

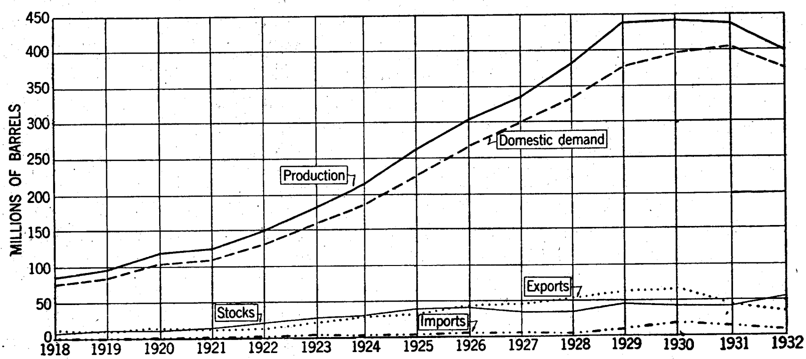

FIGURE 42.—Trends in production, domestic demand, exports, imports, and stocks of motor fuel, 1918–32.

tion of gasoline by cracking declined for the first time in 1932 the relative importance of that method increased, because the total production decreased even more than production by cracking.

The total production of gasoline at refineries in 1932 was 392,623,000 barrels, of which 195,386,000 barrels (50 percent) were produced by straight distillation, 170,905,000 barrels (43 percent) were produced by cracking, and 26,332,000 barrels (7 percent) were natural gasoline. Compared with 1931 these data indicate decreases in the relative importance of the straight-run and natural gasoline fractions, balanced by a gain in the proportion obtained by cracking.

The octane rating of gasolines—in other words, the measure of their antiknock properties—continued to be an important subject in the refining industry, and doubtless had some influence in the relative increase of cracking. However, the use of the cracking process to increase the octane rating of gasoline made only a moderate gain in 1932; this resulted chiefly from increased operations at skimming plants utilizing East Texas and Oklahoma City crudes.

The East Coast, Indiana-Illinois, and Texas Gulf Coast districts, the leading areas in cracking, showed small declines in the quantity produced by cracking in 1932 but increases in the relative proportions to the total gasoline output. Several districts made material gains in quantity and percentage in 1932, the most outstanding being the Appalachian, where some refiners have installed cracking units to offset the comparatively low octane rating of their gasoline, and California, where little cracking was done until 1928.

The percentage yield of gasoline in 1932 was 44.7 percent, a gain of 0.4 percent over 1931. Although this increase was relatively small compared with the average annual increase for the last decade, it represented a decrease of about 6,000,000 barrels in crude-oil requirements. The percentage yields of gasoline in 1932 ranged from 43.7 in July to 45.9 in February and October, a narrower range than in 1931, although it is interesting to note that the peak of November 1931 (45.9) was not surpassed.

The majority of refining districts reported a gain in gasoline yield in 1932, with the Arkansas-Louisiana Inland, Texas Inland, and Appalachian districts making the largest increases. The Rocky Mountain district, which had the highest yield in 1931 (56.6 percent) decreased most in 1932, primarily as a result of less cracking. In some districts the yield of gasoline from cracking exceeded recovery by straight-run methods; in fact, if cracking had been carried on as extensively in California as elsewhere in 1932 the total production of cracked gasoline would have exceeded straight-run production.

In general, refinery prices of gasoline evidenced marked improvement over the low level of 1931. The average refinery price of a representative grade of United States motor gasoline in Oklahoma in 1932 was 4.19 cents per gallon, compared with an average of 3.54 cents in 1931. This increase, while apparently small, represented in many instances the difference between a profit and a loss in refinery operations.

The trend of refinery prices for gasoline east of California in 1932 closely followed that of crude, with the highest quotations in May and June after the increased crude postings of April and with a weaker gasoline market in the last quarter of the year, when it was evident that the price level for crude could not be maintained. The trend of refinery prices of gasoline in California in 1932 was unlike that of prices east of California, being downward in the middle of the year and upward in the closing months.

The refinery price of a representative grade of gasoline is shown in figure 43.

In general, tank-wagon prices of gasoline moved upward with refinery prices in 1932. The average tank-wagon price of gasoline less tax at 50 cities in the United States was 12.45 cents in 1932, compared with 11.8 cents in 1931. In general, service-station prices, which in many cities represent tank-wagon prices plus tax, were raised 1 cent (in some cities the increase was 1.1 cents, the 0.1 cent covering the cost of collection) on June 21 to cover the Federal tax. Although the average gasoline price at 50 cities increased in 1932 it is interesting to note that in the majority of cities a price decline in late September more than compensated for the increase of June 21;

also, that most consumers were paying no more for gasoline on December 31, 1932, than they paid January 1, 1931, despite the fact that in the 2-year interval the average State tax increased, and a 1-cent Federal tax was imposed.

Stocks of motor fuel, the chief barometer measuring the success attained by refiners in balancing operations with demand, were reduced nearly 1,500,000 barrels in 1932, a relatively better showing than in 1931, when a somewhat larger amount was added to storage. Of the 53,805,000 barrels of motor fuel in storage December 31, 1932, 34,532,000 barrels were held at refineries and natural-gasoline

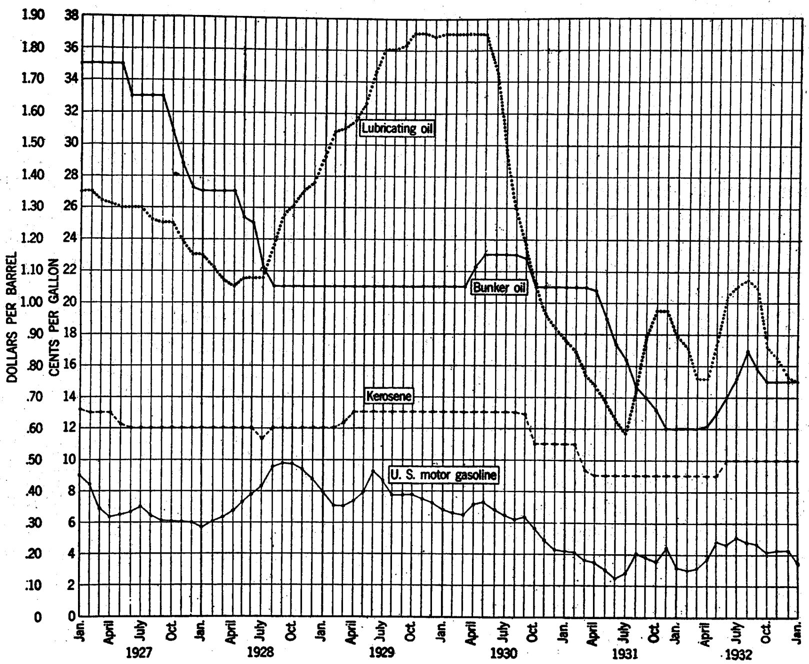

FIGURE 43.—Trends in prices of refined petroleum products, 1927–32, by months. Refinery price per gallon of United States motor gasoline, group 3; tank-wagon price per gallon of kerosene at Chicago; refinery price per barrel of grade C bunker oil at New York; refinery price per gallon of 150–160 viscosity at 210° bright stock in Oklahoma.

plants, 18,075,000 barrels at bulk terminals, and 1,198,000 barrels in pipe-line systems.

Bulk terminal stocks held on the Pacific coast have been included in total stocks since June 30, 1923, but bulk terminal stocks for the rest of the country only since January 1, 1932. Accordingly, 1932 was the first year for which days' supply of motor fuel could be computed for all districts on a comparable basis. As indicated in the following table, the East Coast and California districts held the largest stocks of gasoline in terms of days' supply, the Arkansas-Louisiana Inland and Texas Inland districts the smallest.

Stocks, deliveries, and days' supply of motor fuel, 1931–32

[Thousands of barrels of 42 U.S. gallons]

District	Stocks, Dec. 31		Daily average deliveries		Days' supply	
	1931	1932	1931	1932	1931	1932
East Coast	13,461	13,552	193	186	70	73
Appalachian	2,313	2,142	47	47	49	46
Indiana, Illinois, Kentucky, etc	6,760	6,815	180	169	38	40
Oklahoma, Kansas, Missouri	4,621	4,826	166	140	28	34
Texas Inland	2,217	1,747	86	77	26	23
Texas Gulf Coast	5,898	5,922	205	186	29	32
Louisiana Gulf Coast	1,427	1,416	49	43	29	33
Arkansas and Louisiana Inland	573	334	24	24	24	14
Rocky Mountain	1,532	1,192	32	23	48	52
California	13,599	12,656	196	182	69	70
Total	52,401	50,602	1,178	1,078	44	47

According to reports of the American Petroleum Institute, the quantity of gasoline "sold or offered for sale, as reported by wholesalers and dealers in the various States under provisions of the gasoline tax or inspection laws" in 1932, totaled 15,497,409,000 gallons (368,986,000 barrels), a decrease of 1,221,830,000 gallons, or 7 percent, from 1931.

The three leading gasoline-consuming States—New York, California, and Pennsylvania—registered small declines in consumption in 1932 but were the only States in which it exceeded 1,000,000,000 gallons. Consumption in Illinois, more than 1,000,000,000 gallons in 1931, fell to 950,822,000 gallons in 1932.

Three States—Delaware, Maryland, and Rhode Island—and the District of Columbia reported increased sales of gasoline in 1932; all other States showed declines, as high as 27 percent in some instances. In general, the largest decreases in gasoline consumption in 1932 were in the Middle Western or agricultural States. It is interesting to note that the increases in consumption were confined to Eastern Seaboard States.

The relative rank of the States in gasoline consumption is shown in figure 44.

The delivery of gasoline by pipe line, the latest development in transportation in the oil industry, made another rapid advance in 1932. The first gasoline pipe line was placed in operation in 1930, but it was not until May 1931 that appreciable quantities of gasoline were transported. Total deliveries in 1931 were 12,766,000 barrels, but in 1932 totaled 29,573,000 barrels, a gain of 132 percent over 1931.

The material gain in the quantity of gasoline carried by pipe line in 1932 was due to the placing in full operation of three lines begun in 1931. In spite of the apparent success of this method of transportation, there was a noticeable slackening in new construction in 1932; however, 2 new lines, 1 in Michigan and 1 in Kansas, were being laid or contemplated at the close of the year. The total mileage of gasoline pipe lines increased from 3,175 on January 1 to 3,662 at the close of the year. The quantity of gasoline stored in lines and working tanks decreased during the year, but this resulted from a transfer of most of the working stocks to bulk stocks.

KEROSENE

The statistical record for kerosene in 1932 was surprising as production and domestic demand increased, not only for the first time in a number of years but at a time when the consumption of all other

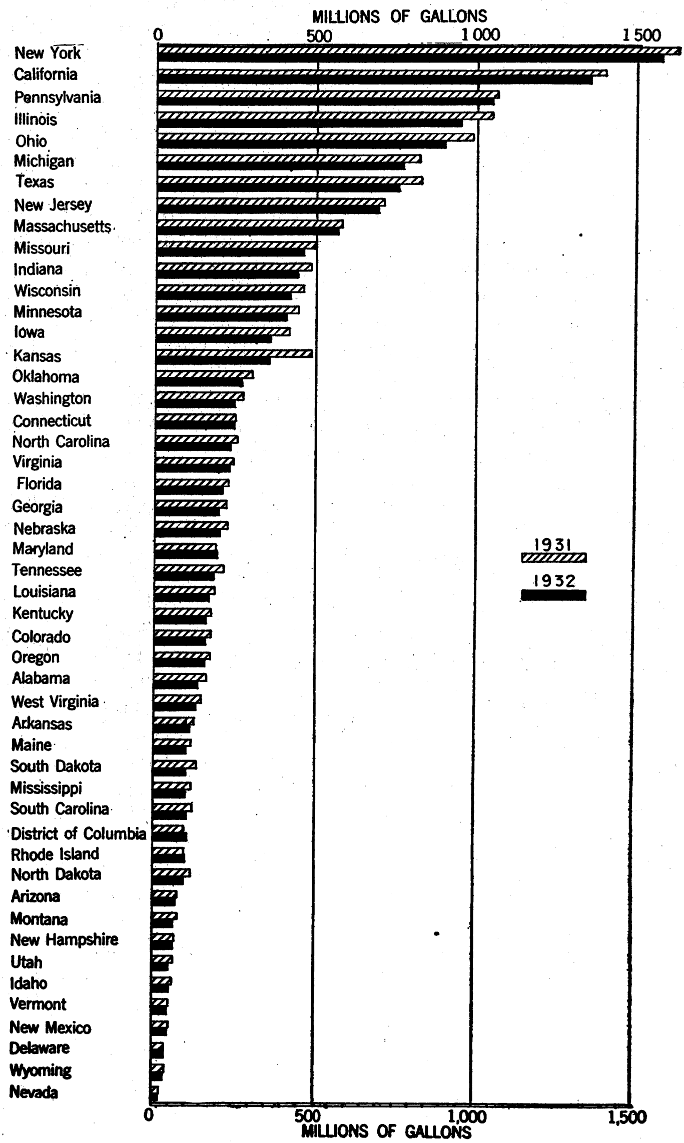

FIGURE 44.—Gasoline consumption, 1931–32, by States.

important refined products was dropping sharply. A number of reasons have been assigned to account for the revival of the kerosene trade in 1932; of these, the gain in use as range oil, particularly in New England, appears most important.

The production of kerosene in 1932 was 43,836,000 barrels, an increase of 1,390,000 barrels over 1931. Imports continued negligible; in 1932 they consisted principally of one cargo from Rumania. Exports declined 14 percent, but domestic demand rose to 33,310,000 barrels from 31,296,000 barrels in 1931. Stocks of kerosene held at refineries, which had fallen to a record low level in 1931, again decreased in 1932; the total on hand December 31, 1932, was 4,974,000 barrels compared with 5,332,000 barrels in storage January 1.

According to reports of the American Petroleum Institute covering the quantities of kerosene inspected, consumption in 14 States (Alabama, Arkansas, Colorado, Florida, Georgia, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Carolina, and South Dakota) totaled 9,359,000 barrels in 1932. Data for 5 States were not compiled for 1931, but when they are eliminated the 9 remaining had a total consumption of 6,602,000 barrels in 1932 compared with 6,231,000 barrels in 1931. This indicated increase of 6 percent compares favorably with the increase for the country as a whole. Minnesota led the 14 States in kerosene consumption, having a total several times that of other States with greater population.

Tank-wagon prices of kerosene did not reflect the increased consumption in 1932 but were generally lower than in 1931. The average tank-wagon price per gallon at six large cities in 1932 was 10.8 cents, 1 cent below the average in 1931.

The price trend of a representative grade of kerosene is shown in figure 43.

GAS OIL AND FUEL OIL

The production of the two classes of products—(1) gas oil and distillate fuel oils and (2) residual fuel oils—totaled 294,287,000 barrels, a decline of 42,680,000 barrels (13 percent) from 1931. This substantial decrease resulted primarily from the reduction in crude runs. Net transfers to fuel-oil stocks, including principally transfers of heavy crude in California, totaled 6,141,000 barrels. In spite of an import duty of one half cent per gallon effective June 21, imports of gas oil and fuel oil were only moderately less than in 1931 and totaled 21,229,000 barrels. Stocks were reduced 5 to 6 million barrels, but this encouraging feature was more than balanced by a 10-million-barrel decrease in exports. The indicated domestic demand (available for the first time since 1924) was 307,668,000 barrels, a daily average of 841,000 barrels.

The production of gas oil and distillate fuel oils was 69,467,000 barrels, 17 percent less than in 1931. Data on the consumption of the distillate fuel oils, such as furnace oil, are not available for 1932, but there may have been a slight increase. The consumption of gas oil in gas making, probably the primary use for straight-gas oil, the heaviest member of the class, has fallen in recent years due to increasing competition of other methods of enrichment.

A further decline in the percentage yield of residual fuel oil in 1932 and the decrease in crude runs to stills were reflected in production, which dropped to 224,820,000 barrels from 253,085,000 barrels in 1931. California continued to rank well ahead of the other districts as a producer of residual fuel oil and also to hold the major part of the storage.

The history of residual fuel-oil consumption in 1932 probably was not unlike that of 1931, with continued decreases in the amounts taken by the principal consumers—steamships, railroads, and petroleum refineries. As the amount of bunker fuel used by vessels in foreign trade (the largest element in steamship consumption) fell about 5,000,000 barrels in 1932, the total for steamships and tankers probably decreased to 75,000,000 barrels from 83,559,000 barrels in 1931. Gas oil and fuel oil (principally residual fuel oil) burned by railroads in 1932 totaled about 50,000,000 barrels compared with 58,150,000 barrels in 1931. The consumption of heavy fuel oil at petroleum refineries undoubtedly declined in 1932, as operations decreased and the competition of refinery gas became more intense. Fuel oil used at smelters and mines and in general manufacturing probably decreased in 1932 commensurate with the lowering of industrial activity. In general, prices of fuel oil, which reached low levels in 1931, recovered somewhat in 1932. Most bunker-oil prices were increased when the import duty went into effect (June) but the averages for the year were below those of 1931. Prices of gas oil improved materially, particularly in the last half of the year; for example, a representative grade of househeating oil in Oklahoma sold for 2 cents per gallon on January 1 and 3.375 cents at the close of the year.

The price trend of a representative grade of bunker fuel oil is shown in figure 43.

LUBRICANTS

The recession in industrial activity and the decline in the number of cars in use were reflected in the domestic demand for lubricants, which declined from 20,068,000 barrels in 1931 to 16,697,000 barrels in 1932. In 2 months of 1932 the domestic demand was less than 1,000,000 barrels, a condition that had not occurred since April 1922. However, it should be noted that the indicated consumption in those months (August and September) was low primarily because large purchases were made in June before enactment of a manufacturer's tax of 4 cents per gallon.

The production of lubricants in 1932—22,433,000 barrels—represents a yield of only 2.7 percent of total crude runs. Based on the crudes processed for lubricating oils the yield would be much higher; for example, the yield in some plants that operate on Pennsylvania Grade crude was more than 30 percent.

Imports of lubricants continued to have negligible importance. Exports totaled 6,857,000 barrels, a decrease of 16 percent from 1931.

Prices of lubricants were generally lower in 1932, although the declines were not as severe as in 1930 and 1931. The price of a representative grade of Oklahoma bright stock made marked improvement in April and May but lost all the gain later in the year. Prices of most Pennsylvania grades decreased; for example, the average price of a representative grade of filtered neutral dropped from 20 cents per gallon in 1931 to 17 cents in 1932, the latter being about half the 1927 price.

The price trend of a representative grade of lubricating oil is shown in figure 43.

WAX

Exports of paraffin wax, which were well-maintained in 1931, slumped 19 percent in 1932. The domestic demand also declined, but not as severely as exports, so that total domestic demand in 1932

(264,445,000 pounds) exceeded exports (235,323,000 pounds), the first such occurrence in many years. Stocks of wax fluctuated considerably during the year, but heavy domestic shipments in December reduced the total to 163,628,000 pounds, nearly 8,000,000 pounds below stocks on January 1, 1932.

The production of wax in 1932 totaled 458,920,000 pounds (18,480,000 pounds less than in 1931). Of the total output in 1932, 46 percent came from the East Coast district and 19 percent from the Appalachian district. In 1931, 61 percent was produced in these two districts, indicating further concentration of wax production in the Eastern States in 1932.

Stocks of wax are segregated into two major classes, refined and crude scale. On December 31, 1932, 37,199,000 pounds of refined wax and 126,429,000 pounds of crude-scale wax were in storage. These data indicate a small increase in the relative proportion of crude scale.

Using the price record of a representative grade of crude-scale wax as a basis it is reasonably evident that most wax prices weakened in the middle of the year but recovered the loss later. The refinery price of the representative grade was 2.125 cents per pound January 1 and 2.10 cents on December 31.

COKE

The annual output of petroleum coke, which had increased rapidly, due principally to the use of higher refining temperatures, registered its first decline in 1932, when 1,788,800 short tons were produced compared with 2,032,000 short tons in 1931. This substantial decrease resulted chiefly from cumulative effects of the reduction in crude runs and reduced cracking. The Indiana-Illinois district, the leader in coke production, gained slightly in output in 1932, but production in the majority of the other districts decreased.

Data on coke consumption in 1932 are incomplete, but the domestic demand (1,880,900 short tons) was encouraging, as it was 23 percent higher than in 1931. This increase in domestic demand resulted primarily from a material gain in use as domestic fuel in the Eastern and Central States. It was reported that some companies on the Atlantic seaboard had difficulty in producing enough coke to fill their contracts. Stocks, which had increased materially in 1931, reflected the gain in demand and declined about 180,000 short tons in 1932.

The data available indicate that coke prices were uniform throughout the year until December, when there was a slight increase in most quotations.

ASPHALT AND ROAD OIL

The production and consumption of petroleum asphalt declined materially in 1932, and the average price level continued to recede. On the other hand, the production of road oil gained materially.

Details on these two commodities may be found on pages 555 to 564.

STILL GAS

Although essentially a byproduct, "still" gas has rapidly forged to the front as one of the leading refined products from the standpoint of volume. The liquid equivalent of still-gas production in 1932 was

40,905,000 barrels, which places it close behind kerosene quantitatively. The output, expressed in cubic feet, was 160,812,000,000 (4 percent above 1931).

The production of still gas, most of which is used as refinery fuel, is usually associated with cracking; however, as cracking declined in 1932 the increased production was probably caused by an increase in the number of plants that have recovery systems.

IMPORTS, EXPORTS, AND SHIPMENTS THROUGH PANAMA CANAL

Imports.—Imports of refined products were restricted by the enactment of import duties on the important products on June 21 and dropped from 38,837,000 barrels in 1931 to 29,757,000 barrels in 1932. The decreases in the imports after the duties went into effect are indicated in the following table:

	Duty	Jan. 1-June 20	June 21-Dec. 31	Total for year
Crude oil	$0.21 per barrel	31,236,000 barrels	13,452,000 barrels	44,688,000 barrels.
Gasoline	$1.05 per barrel	7,634,000 barrels	575,000 barrels	8,209,000 barrels.
Fuel oil	$0.21 per barrel	14,100,000 barrels	7,129,000 barrels	21,229,000 barrels.
Wax	$0.01 per pound	22,126,000 pounds	11,130,000 pounds	33,256,000 pounds.
Other		95,000 barrels	105,000 barrels	200,000 barrels.

The data for the first period of nearly 6 months are high because passage of the tax bill was anticipated several months in advance; nevertheless, it is reasonably evident that the major part of gasoline imports was excluded by the tax, but that approximately half of the crude oil, fuel oil, and wax continued to enter.

Exports.—Exports of refined oils continued to reflect the expansion of refining facilities and the unsettled conditions abroad and suffered another material setback in 1932. Total exports of refined products in 1932 were 71,994,000 barrels, and shipments to noncontiguous territories were 3,701,000 barrels, 75,695,000 barrels in all, compared with 98,859,000 barrels in 1931. Of the 1932 total, 47 percent was gasoline, natural gasoline, and benzol; 14 percent, kerosene; 26 percent, fuel oil; 9 percent, lubricants; and only 4 percent, asphalt, wax, and miscellaneous oils. Exports of refined products, particularly gasoline, declined rapidly in the last half of the year, due partly to the competition of gasoline and other products excluded by import duties.

The United Kingdom continued to be the chief customer of the United States for refined products, leading all countries in purchases of gasoline, kerosene, lubricants, and wax. Exports of gas oil and fuel oil to Japan continued at a relatively high level and were more than three times exports to Canada, the second most important customer. Of particular interest was a 48 percent increase in exports of gasoline to Australia and a substantial gain in exports of wax to Germany. Of interest also was the decline in shipments of fuel oil to South America, once an important customer. This loss of trade is probably a result of increased competition of fuel oil from Venezuela, a much nearer source of supply.

Shipments of refined products through the Panama Canal.—Shipments of refined products from California through the Panama Canal to Atlantic and Gulf ports of the United States continued to decline and were only 12,036,000 barrels in 1932 compared with 17,605,000 barrels in 1931. This decrease affected principally shipments of gasoline (including natural gasoline), which decreased from 15,602,000 barrels in 1931 to 8,911,000 barrels in 1932. Fuel-oil shipments increased, possibly to replace part of the imports from Venezuela now diverted elsewhere.

Several cargoes of East Texas gasoline moved through the canal to the Northwest in 1932, constituting the first real attempt in a number of years of Mid-Continent refineries to compete in the Pacific coast territory.

EQUIPMENT SURVEYS

A survey of refinery equipment as of January 1, 1933, indicates that during 1932 the number of refineries continued to increase but that the totals of crude-oil capacity and cracking capacity declined for the first time in many years. The decline in crude-oil capacity despite more plants resulted from the construction of many refineries in the East Texas field and elsewhere in 1932, but as the average capacity of these plants was small (about 750 barrels daily), the increment in total capacity was too slight to compensate for the equipment dismantled at the older plants.

Straight distillation.—On January 1, 1933, there were 505 completed refineries and 18 plants under construction in the United States. Of the completed refineries, 372 (74 percent) were operating on January 1, 1933, and 133 (26 percent) were shut down.

The total capacity of all refineries on January 1, 1933 was 3,921,055 barrels, a decrease of 102,273 barrels (3 percent), from the previous year, marking the first time since 1926 that the total capacity has failed to increase. In general, the decrease in capacity in 1932 resulted from cumulative effects of decreased crude runs, beginning in 1930, plus the continued gain in the percentage yield of gasoline by cracking. Of the total daily capacity (3,921,055 barrels) on January 1, 1933, 3,445,118 barrels (87.9 percent) represent the capacity of the operating plants; 444,392 barrels (11.3 percent), the inoperative capacity; and 31,545 barrels (0.8 percent), the capacity of the plants under construction.

Texas not only continued to lead all States in number of plants but displaced California as the leader in total capacity. In spite of a gain of 27 in number of plants in Texas in 1932, the total capacity decreased, hence the change in rank resulted because of a larger decrease in capacity in California. The majority of refineries are classed as skimming plants, which, as the name implies, skim the crude, obtaining gasoline and kerosene as the principal finished oils and fuel oil as the residual product. Skimming plants, particularly those without cracking equipment, were regarded as somewhat obsolete several years ago, but a material decline in crude-oil prices and a gain in the relative importance of gasoline have tended to restore them to favor. Accordingly, the total capacity of the skimming plants increased slightly in 1932. Complete plants (those which, in addition to producing the three primary products—gasoline, kerosene, and fuel oil—make lubricants and wax and asphalt if the necessary constituents are present in the crudes used) continued to lead all the types in total capacity, as the majority of the large established refineries are in this class.

Cracking.—In general, a cracking plant is an auxiliary to the main refinery and has as its purpose the conversion of fuel oils and other unfinished oils to gasoline. The capacity of a cracking plant is usually given in terms of fresh feed (charging stock) daily.

Rapid advances in the technique of cracking, making it possible to produce large quantities of high-quality gasoline from cheap fuel oils, resulted in a steady increase in the total capacity of cracking equipment throughout 1931. However, in 1932, the desire to economize in new construction, probable increase in the obsolescence rate, and the conversion of some cracking equipment into reforming units were reflected in a decrease in the total daily capacity from 2,046,981 barrels January 1, 1932, to 2,031,395 barrels January 1, 1933.

The total capacity of cracking plants in Texas declined substantially in 1932, but that State continued far to outrank the others in the capacity of such equipment. The rating of the cracking units in New Jersey rose materially in 1932, and that State displaced California as the second ranking State in capacity.

There was a distinct trend toward construction of cracking plants to suit individual needs in 1932; this fact is substantiated by an increase in the relative proportion of the capacity classified as "own" and a corresponding decrease in the capacity of the "licensed" group. Vapor-phase cracking continued to increase in popularity, although the total capacity of such units is still small compared with the liquid-phase capacity.

TECHNICAL DEVELOPMENTS IN PETROLEUM AND NATURAL-GAS PRODUCTION

By H. C. Fowler

Recent technical progress in the production of petroleum and natural gas has influenced, modified, and helped to solve many of the involved and at times almost indeterminate problems confronting the industry. In this review no attempt is made to differentiate between technical research and field applications of newly determined, fundamental data regarding physical laws. Today, engineering research is conducted as an integral part of complicated industrial operations, and frequently the results, even in pure science, soon are applied as the working tools of industry, so that an exact demarcation cannot be made between technical study and operating conditions that are changed and often controlled by the findings of the investigative work.

The discussion is not confined to technical and related developments in 1932 only. The significance of newly found engineering facts and resulting new departures in economic arrangements cannot be bounded by definite calendar limits. Several years of experiment may be required to bring a newly conceived idea to satisfactory practical application, although during the development stage it may exert an influence on the industry. Even after a new idea, resulting in a method of operation, device, or tool, is proved its ultimate effect is not easy to determine because of the appreciable "time-lag" required properly to evaluate cause and effect.

INTERRELATION OF OIL AND GAS PRODUCTION

Crystallization of thought has grown about the nucleus of the idea propounded by Bureau of Mines engineers prior to 1917–18 that oil and gas production cannot be treated as separate problems, because in addition to the economic factors controlling natural-gas production a large part of the natural gas produced in the United States (probably 60 percent) is dependently variable upon the production of oil. To the growing understanding of this interrelationship of natural hydrocarbons in the liquid and gaseous phases has been added a third phase—the energy attributes of oil-gas reservoirs.

Because of this knowledge the industry has been trying to adjust restricted oil and gas production during a period of depressed markets to conserve gas and its contained energy; devising means of operation that will cause the energy in the expanding gas to do its maximum useful work in bringing oil from the reservoir sands to the wells, and thence to the surface, and subsequently using this gas for fuel or other gainful purposes.

In studying oil-gas-energy relationships the engineer is dealing with two interdependent and connected flow systems: (1) Flow within the reservoir and (2) vertical flow in the column from the bottom of the well to the surface, including the well-head connections, flow lines, and oil-and-gas separators. Each system and its operation exert a definite and positive effect upon the other, and without knowledge of both reservoir energy will be dissipated; gas will be lost at the surface (if an adequate market outlet is not provided); an appreciable quantity of recoverable oil will remain in the reservoir until stimulative production methods bring it to the wells; and eventually mechanical means will have to be used to raise oil that otherwise could have been produced by natural flow at lower production costs.

PETROLEUM TECHNOLOGY AND ECONOMICS

The fluid and mobile characteristics of petroleum and natural gas have led to confusion in their production, technically and economically out of all proportion to the production of other natural resources. An erroneous concept of "capture and reduction to possession" has spread and permeated the whole oil-and-gas structure since 1875 when a court decision was rendered that put the search for these hydrocarbon companions in the same category as the hunting of wild game. Many efforts toward a wiser and more efficient use of oil and gas have been hindered by the legal and economic conditions compelling highly competitive drilling and production methods in a common pool. These uncontrolled practices, engendered by human traits and interpretations rather than by physical laws and desirable economic considerations, have led to physical and economic losses.

The actual physical losses of oil at the surface are relatively small compared with the total production of oil. The proximate and contributing causes of these surface losses are well known, and in general engineering methods have been devised to bring them under good control. The quantity of oil lost through spillage now is almost negligible, although the disposal of oil-field (also refinery and tanker) waste has been costly to the petroleum industry. In the absence of steel storage earthen pits have been and still are used. Confronted by highly competitive drilling and production practices some operators hold that it is better to lose an appreciable quantity of oil through seepage than to lose their oil through underground drainage across property lines. It has been estimated that the total evaporation and leakage losses for 1 year in the handling of oil from the wells to the ultimate consumer of gasoline is about 3½ percent. This percentage probably can be reduced appreciably if the best-known engineering practices are applied to keep the oil in the ground until needed.

Although calculation of the actual surface losses of natural gas up to now would reach astronomical dimensions if it were possible to measure them in cubic feet, an active and well-defined movement has been made by industry and government (State and Federal) to control factors contributing to natural-gas losses. Some engineering factors of natural-gas conservation are discussed in report V of the Federal Oil Conservation Board to the President of the United States, 1932, pages 47 to 56.

Underground losses of oil, dissipated gas energy, and economic losses resulting from highly competitive development programs and from unwarranted withdrawal of oil from the reservoirs in excess of what the market will absorb at a reasonable price are more vital at present than the surface losses just described.

From the preceding paragraphs it will be recognized that no discussion of engineering methods to prevent underground losses caused by premature and irregular water encroachment, dissipation of gas energy, changes in the physical characteristics of the oil (making it more difficult to recover because of gas liberation), and others is complete without a discussion of attendant economic losses.

At present, when the current language noticeably reflects such phraseology as "distress oil", "depressed prices", "inventories above and below ground", and "waste", studied consideration is being given to the related technical and economic problems to mitigate existing conditions. The petroleum and natural-gas industry of its own volition has taken the active lead, knowing that unwarranted and wasteful depletion of reserves destroys the raw material on which the industry depends for its continued existence and that the marginal profit whereby the business can continue frequently depends upon the reduction of losses through engineering efforts. The technical, economic, legal, executive, and other representative organizations of the industry have met in various open forums and considered such problems as proration, unit operation, the part played by gas in producing oil, and the oil-gas-energy relationships in the reservoir. These topics have proved to be so interrelated that it has been difficult to confine the discussions on the agenda to any one definite subject.

Proration.—The history of proration, with a treatment of its many engineering factors and its effects upon conservation and stabilization, has too many ramifications to be included in this résumé. It is sufficient to state that proration as applied to individual fields has been and is being used as a necessary but temporary expedient to balance supply with market demand. There are nearly as many proration programs as there are oil fields to be prorated, and the whole gamut of technical, economic, and legal controversy has been run in attempting to determine methods for the equitable production of oil and gas.

Some persons claim that proration has failed in its entirety, others concede that proration as practiced has many limitations, but no one can estimate what the demoralization of market demand would have been if these attempts to give each producer a ratable share of the market outlet had not been made. Proration in the broader sense, without the implication of price maintenance, has helped to curtail wasteful physical and economic conditions. As an example, engineering data prove that water encroachment along the western edge of the East Texas field has been retarded through restricted methods of production, and thus the ultimate recovery from that field has been increased.

Careful estimates of unbiased engineers "indicate that the displacement of oil by water in the East Texas field has been efficient, and only small quantities of oil have been trapped and left behind in the water-flooded area."[1]

[1] Lindsly, Ben E., A Study of "Bottom-Hole" Samples of East Texas Crude Oil: Rept. of Investigations 3212, Bureau of Mines, 1933, p. 22. (Read before Am. Petrol. Inst. Division of Production, Tulsa, Okla., May 19, 1933.)

The greatest hindrance to the solution of the petroleum industry's problems solely by proration within a pool is that this method is not directed toward the fundamental concept of developing a pool as a unit, and no proration plan has yet been devised whereby many of the evils of highly competitive off-set drilling and production in a common pool have been eliminated.

Unit operation.—The subject of unit operation is not new, but the industry generally has been slow in giving favorable consideration to proposed plans while individualistic ideas of capture (sometimes referred to as "legalized piracy") have predominated.

The term "unitization" is subject to several definitions, depending upon the viewpoint, but fundamentally it refers "to the practice of unifying the ownership and control of an actual or prospective oil and/or gas pool by the issuance or assignment of units or undivided interests in the entire area with provision for development and operation by an agent, trustee, or committee representing all holders of undivided interests therein."[2] Unitization is to be distinguished from cooperative development and operation.

The complete record of public hearings of the Federal Oil Conservation Board, February 10 and 11, 1926, and later symposiums in the publications of the American Institute of Mining and Metallurgical Engineers and the American Petroleum Institute, the Handbook on Unitization of Oil Pools published by the Mid-Continent Oil and Gas Association in 1930, and many other public writings in the petroleum and legal press set forth the principles of unitization and unit development and operation. The North Dome of the Kettleman Hills (Calif.), field is the outstanding example in this country at present of a working unit plan effected through efforts of the operators and the Federal Government.

Many legal considerations have complicated the problem of unit operation, but from the technical standpoint only the general consensus of opinion expressed among engineers is that development and operation of pools as units accord with desirable economic considerations and the best-known principles of physical laws, and there is no technical reason why the quantity of oil and gas originally within the structural confines of the respective original properties in a common pool cannot be estimated and allocated with fair accuracy.

Within the last year the energy factor of the reservoir has been under consideration in the open meetings of various technical organizations. It has been postulated, without serious contradiction, that to obtain maximum extraction of oil and gas from a reservoir without waste the energy in the pool must be used for the common benefit. Whether or not the reservoir energy is divisible and subject to allocation is still under debate.

ENGINEERING RESEARCH

Among the most important recent production-engineering developments, which have been prompted by the economic conditions already mentioned, and others, or which will influence the future technique of controlled production, are methods for obtaining and interpreting data that pertain to the following:

[2] Mid-Continent Oil and Gas Association, Handbook on Unitization of Oil Pools: Tulsa, Okla., 1930, p. 15.

1. Subsurface pressures and temperatures in wells, involving problems of reservoir and vertical flow (more frequently referred to as "bottom-hole" problems).

2. Solubility of gas in oil and the phenomena attending the liberation of natural gas from solution in oil under conditions approximating those of the reservoir.

3. The flow of oil, gas, and oil-gas mixtures through porous media, to which the complicated problem of well spacing is directly related.

Subsurface pressures and temperatures.—The evolution of equitable methods of production control by means of precise information regarding conditions at the bottoms of wells has been rapid.

In 1928 Sclater [3] gave one of the first technical papers on the subject, and about the same time K. B. Nowels (then an engineer of the Bureau of Mines and now chief petroleum engineer, Forest Oil Corporation, Bradford, Pa.) began development of an instrument to obtain subsurface data needed in the study of energy requirements of vertical flow in wells.

Hawthorn [4] states that 8 or 10 different instruments have been developed to the practical stage. He gives the following classification, based upon the manner in which the pressures are recorded: (1) Maximum recording, (2) indicating, (3) selective recording, (4) continuous recording, and (5) continuous recording and indicating.

The various recording devices are interesting as examples of unique instrument making, and the several designers have overcome great obstacles in developing sensitive mechanisms that will withstand shock and temperature changes and yet give the required accuracy; however, these devices are only the means to an end, and the primary concern is the interpretation of data obtained with them.

Reistle and Hayes [5] in a cooperative study in East Texas with an instrument of the continuous-recording type having, in addition, a continuous temperature-recording mechanism, recently obtained data from which they computed the minimum reservoir pressure necessary to maintain natural flow through 2½-inch tubing for existing energy conditions.

Knowledge of the gas-oil-energy relationships not only makes it possible to determine correct sizes of flow strings, limiting flowing pressures and other production methods and operations, but also well data pertaining to reservoir conditions should assist materially in determining rational and equitable production programs for a field.

Extensive reservoir-pressure surveys have been made in East Texas, and during the early part of 1933 the railroad commission of Texas based the allowable production from the various leases in that field partly upon subsurface pressure data.

Surveys are in progress in Kettleman Hills, Calif. Clark and Kimberlin [6] of the Kettleman Hills North Dome Association made the

[3] Sclater, K. B., and Stephenson, B. R., Measurements of Original Pressure-Temperature and Gas-Oil Ratios in Oil Sands: Trans. Am. Inst. Min. Eng., Petrol. Dev. and Technol., 1928–29, pp. 119–136.

[4] Hawthorn, D. G., Rapid Advance Made in Perfecting Instruments for Exact Recording of Subsurface Pressures: Oil and Gas. Jour., Apr. 20, 1933, p. 16. (Read before southwestern district, Am. Petrol. Inst., Division of Production, Houston, Tex., Apr. 7–8, 1933.

[5] Reistle, C. E., Jr., and Hayes, E. P., A Study of Subsurface Pressures and Temperatures in Flowing Wells in the East Texas Field and the Application of These Data to Reservoir and Vertical Flow Problems: Rept. of Investigations 3211, Bureau of Mines, 1933. (Read before Am. Petrol. Inst., Division of Production, Tulsa, Okla., May 19, 1933.)

[6] Clark, C. L., and Kimberlin, C. B., Bottom-Hole Pressure Work at Kettleman: Petrol. World, April 1933, p. 20. (Read before the Pacific Coast district of the Am. Petrol. Inst., Division of Production, Apr. 6, 1933.)

following timely statement regarding the value of "bottom-hole" pressure data:

> The use of bottom-hole pressure instruments affords a splendid means of securing data to determine the rate at which drainage is affecting not only the various areas immediately involved, but areas removed from them by considerable distance. The periodic taking of shut-in pressures in all the wells available, and a correlation of the results obtained with the production data at hand, should give accurate information on drainage conditions. This information will apply as between the wells of the area being produced and the extent to which the concentration of production in a few small areas is affecting the field as a whole. The difference between the shut-in pressure readings from available points in the field will indicate the degree of drainage, and subsequent readings will indicate its rate and the areas that are being affected most.

They also point out that the method may be used in establishing "potentials" and in planning future development programs. Referring to well spacing, they say:

> As pressure-survey data accumulate and the results are correlated and plotted on pressure-contour maps, a long step will have been taken toward removing the problem of correct well spacing from the realm of theory and placing it on a basis of determinable fact.

Solubility of gas in oil.—The relationships of dry gas dissolved in relatively stable samples of oil, as stated in Henry's law, and the attending phenomena of change in viscosity, surface tension, and gravity of the oil have been common knowledge in the industry for some years. The work of Lacey [7] at the California Institute of Technology, conducted as American Petroleum Institute Research Project 37, has increased this knowledge in an exceptional and practical way.

Engineers have recognized for some time that the relationships of fluid movement in the reservoir and in the wells cannot be understood thoroughly and applied in rational production programs, with a maximum recovery of oil and gas, without knowledge of the character of naturally dissolved gas in crude oil, as these mixtures occur under reservoir conditions, and of the effects to be expected when gas is liberated from solution upon diminution of pressure as the fluid travels from the reservoir to the bottom of the well and up the flow column to the surface. Nevertheless, very little experimental work has been done in this country to determine these natural solubility or "liberation" factors.

In this connection, Sir John Cadman [8] in his recent paper on Persia wrote:

> Certain problems, which have only recently attracted general interest, have been under investigation in the Persian fields for several years.

Among the problems which he named was determination of the physical characteristics and dissolved-gas content of crude oil under reservoir conditions and their relationship to pressure and temperature and determination of the permissible bottom-hole pressure drop during flow before unnecessary gas is produced with the oil. In writing of the special instruments developed by the Anglo-Persian Oil Co., Ltd., to obtain the necessary data, he said:

> These include instruments for use at any point in a well: Pressure indicators—the first accurate bottom-hole pressures having been observed in 1928; tempera-

[7] Lacey, William N., Practical Benefits of Pressure Maintenance in Petroleum Production: Oil and Gas Jour., Nov. 17, 1932, p. 49; also, Oil Weekly, Jan. 9, 1933, p. 19. (Read before Thirteenth Ann. Meeting, Am. Petrol. Inst., Houston, Tex., Nov. 17, 1932. An earlier report on project 37 was given by Lacey before the Am. Petrol. Inst., Dallas, Tex., June 3–4, 1931.)

[8] Cadman, John, Persia: Trans. Am. Inst. Min. Eng., Petrol. Dev. and Technol., 1933, in press; also Am. Inst. Min. Eng. Contribution 36, class G, Petrol. div., February 1933, pp. 23–26.

ture recorder and sample taker for collecting samples of reservoir crude under full pressure.

The Bureau of Mines in January 1930 began a specific study of this phase of gas-solubility and gas-liberation research. The initial work was on well-head samples, from which valuable data were obtained, and a technique of operation was developed. A sampling device then was constructed which made it possible to take samples in wells at or near reservoir conditions and bring them to the surface for subsequent analysis in the laboratory. This instrument, devised by Lindsly [9], had its initial trial in March 1932 in the Seminole (Okla.) field, and later a series of tests was made in the East Texas field with the financial assistance of a majority of the oil companies operating in that field.

Although technical and economic conditions are unique in the East Texas field the results of the cooperative work indicate a satisfactory method for determining the maximum amount of energy in a given volume of reservoir oil. Data of this type can be used to design flow strings properly and, possibly, in the equitable valuation of properties if a pool is to be operated as a unit.

The data on shrinkage of oil caused by liberation of gas give workable figures with which to make reasonable estimates of the fluid content of the reservoir, and fair approximations of the quantity of recoverable oil can be determined.

The studies established an important technical fact influencing economic conditions, namely, that the gas begins to be liberated from solution in the East Texas reservoir oil only when the pressure reaches 755 pounds per square inch absolute. Incidental experiments were made on the compressibility of East Texas oil which showed that the over-all lifting effect caused by this phenomenon is relatively minor as a source of energy in raising the oil to the surface.

Fluid movement.—All production problems of the reservoir, the flow column, and pipe-line transportation problems are concerned with fluid movement caused by differential pressures. The results of recent research strengthen the consensus of opinion among engineers that the same physical laws of flow pertain to oil, gas, and oil-gas mixtures, whether the travel is in horizontal pipes, vertical pipes, or through the interconnected pore spaces of the oil-and-gas reservoirs. Naturally, the type of conductor and physical characteristics of the moving fluid change the character of flow, but various investigators have interpreted many of these conditions mathematically with reasonable accuracy. The flow of oil and gas, or mixtures of these substances, through sands and other porous media is more complicated than horizontal or vertical pipe-line flow, requiring more factors in the equations to be supplied empirically.

The work on this problem is closely related to that on well spacing.

Well spacing, also dependent upon the relationships of reservoir pressure and the solubility of gas in oil, has been an engineering and economic problem from the early days of the industry. Engineers are concentrating on this phase of petroleum production, and the petroleum literature contains numerous references to the many technical and economic factors connected with the problems. In fact, as recently as May 1933 a symposium on well spacing was held under the auspices of the American Petroleum Institute, and the subjects

[9] Lindsly, Ben E., work cited.

of "determination of permeability from field data" and "approximate comparative ultimate yield from varied well spacings" were considered. Except in some special fields where underground conditions are well known and the structure is under a unified plan of operation no definite criteria for well spacing have yet been determined, although a suggested method for determining the average permeability of a producing zone through knowledge of well performance is an important forward step.

Unfortunately, even when engineering facts regarding the reservoir have been known, it frequently has been impossible to work out rational spacing programs due to conditions of competitive drilling calling for a multiplicity of "off-set" wells in place of a few carefully selected wells which would have recovered the oil and gas effectively from the reservoir and would have prevented attendant physical losses.

The influence of porosity (or space between the sand grains) upon oil and gas production is well known. Recent scientific investigation has shown that the sand characteristic of permeability (broadly defined, the quality of allowing passage of fluids) is even more important than porosity if definite knowledge regarding fluid movement is to be obtained. The characteristics of porosity and permeability are related, but it is possible for a sand of high porosity to have a low permeability factor. One of the greatest advancements to the science of oil recovery will be the general acceptance of a definite meaning for the term "permeability." Discussions of fluid flow through porous media have been hampered because various investigators have presented their data on noncomparable bases. In 1932, the Bureau of Mines determined experimentally permeability factors in terms of "mean effective pore diameter" for a wide range of grain sizes and pressure differentials. Not only do these data apply in oil flow and well spacing, but they have been used practically in the natural-gas industry in gaging the ability of gas wells to produce gas, in calculating gas reserves, and in solving other gas-production problems.

In May 1933 the eastern district committee on development and production research, K. B. Nowels, chairman, of the American Petroleum Institute, issued a report on Proposed Standardization of Laboratory Technique and Nomenclature in the Determination of Permeabilities and Porosities of Oil Bearing Structures. This report was reviewed carefully by petroleum engineers at the midyear meeting of the institute, Tulsa, Okla. Although there was general agreement with most of the conclusions of the report, definite action was postponed until the subject can be given further study by the industry. A suggestion of the Tulsa meeting was that the unit of permeability be called the "perm" and that provision be made for both the C.G.S. (metric) and English system of units.

Water flooding.—Although data on the water-flooding problems in the Bradford (Pa.) district involve stimulative methods of oil recovery, nevertheless they augment and assist in the further understanding of fluid movement in other areas, particularly in those fields where a natural "flood", or encroachment of edgewater, is supplying part of the energy required to produce the oil. The knowledge regarding water displacement of partly depleted oil sands has been augmented to a noteworthy degree during the last year or so.

Improved production practices in water-flooding areas, superseding the older "circle-flood" and "line-flood" methods, include special well-spacing patterns, for example, the "five-spot" and hexagonal or "seven-spot" patterns; the use of pumps to increase the flooding pressure caused by the hydrostatic head of water; and delayed drilling, whereby the water is forced to move through the beds of low permeability, making it possible to recover more oil at faster rates when the producing well is drilled in the central portion of the flood zone.

A seemingly anomaly has developed out of the fact that, coincident with these newer methods making possible the extraction of more oil, a definite program of production control has been practiced in the Bradford area.

Oil recovery.—With special emphasis being laid on practices and methods that will help bring production and demand into balance, so-called "increased recovery methods" are not being studied and practiced as assiduously as before, when the then discovered reserves of oil were appreciably less than they are known to be today. Nevertheless, the total reserves are subject to exhaustion, and no method of oil production that leaves large quantities of oil in the ground unrecovered is economically sound. Therefore, the forward-looking viewpoint is to devise methods that will make it possible to increase the recovery from sands by stimulative methods.

The Bureau of Mines, the American Petroleum Institute cooperative project, and a few oil companies are about the only agencies that have maintained active work during the last year on this phase of production. The work at the California Institute of Technology has been mentioned. In the oil-recovery laboratory at the Petroleum Experiment Station of the Bureau of Mines data of a fundamental nature on repressuring, pressure maintenance, air and gas drive, and the complementary fluid-flow problem have been obtained and compiled. These data give evidence of practical application when the industry and the Nation again concentrate on diminishing reserves and maximum recovery of oil from the reservoirs.

Acid treatment.—During the latter part of 1932 and the early part of 1933 interest throughout the industry was directed to the new application of an old method of oil-production stimulation. This method is generally referred to as the acid treatment of wells. Several applications for patents on this method have been filed in the United States Patent Office. United States Patent 556669 (granted to Herman Frasch on March 17, 1896) describes a method by which the flow of an oil well in a limestone formation may be increased by treatment with a quantity of acid such as hydrochloric acid. In United States Patent 1877504 (granted to Dow Chemical Co. of Midland, Mich., assignee, on September 13, 1932) an improved method is disclosed wherein certain inhibitors such as arsenic compounds soluble in acid solution and aniline derivatives are used in conjunction with the acid to prevent excessive deterioration of the metal and other equipment in wells.

It is understood that this method was first tried in fields of Michigan with apparent success, and today acid-treatment methods, patented or otherwise, have been tried in almost all fields having limestone, chalk-rock, or dolomitic formations. According to reports, dolomitic formations do not respond as readily to acid treatment as those containing a higher percentage of calcium carbonate. The method also has been tried in sandstones where the cementing material is of a calcareous composition.

Probably the Zwolle (La.) field has been the largest proving ground for this method. Up to May 1, 1933, 157 treatments had been made in the Zwolle area, a number of which were second treatments, and it is recorded that at least one well has been treated three times. The first treatment in the Zwolle field is reported to have been on December 5, 1932, although it appears that some other wells were treated in Louisiana before that date.

The procedure in treating the wells has technical interest, but this subject has been well covered in the literature and in the patents. A treatment usually consists of 1,000 gallons of solvent, with accompanying inhibitor.

According to computations, 1,000 gallons of the solvent should dissolve 10 to 11 cubic feet of chalk rock. This dissolving action appears to take place laterally rather than vertically. Suitable pressures (as high as 600 pounds per square inch in some wells) are maintained at the casing head, and the well may be allowed to stand for 12 to 48 hours. The cost of one treatment is about $250.

Some very spectacular results have been reported. For example, two wells in the Zwolle area before treatment were producing 8 and 6 barrels per day. These wells were treated, and after 120 days they were producing 295 and 435 barrels, respectively. It should not be inferred, however, that all wells are successfully stimulated. Some wells have failed to respond; others have an increased production for a short time only; and still others, which made no water before treatment, have increased in water production to as much as 50 percent of the total fluid produced. This variation in successful treatment is the natural result of the complicated reservoir conditions, particularly in the Zwolle area, and each well is a separate problem.

A detailed study of the results of acid treatment in the Zwolle field to determine the total increase in production caused by this stimulative method has not been completed. In time, an analysis of the production figures should show with reasonable accuracy results obtained for the field as a whole. It is likely that a creditable increase will be indicated.

The general economic effect of this method of stimulation is not yet known. If the method continues to be used extensively it appears that recoverable reserves will be increased. Naturally, the market outlet in a given area and the attending price of the oil will determine whether or not the method can be used to economic advantage by an operator in any given field.

Natural gas.—Although attention has been directed to the fact that oil and gas production are too closely related to be treated as separate subjects certain problems and developments pertain individually to natural gas. Cooperative research by the natural-gas industry and the Bureau of Mines has culminated in a method for gaging the capacity of natural-gas wells without the need for blowing large quantities of gas to the air in open-flow tests. This method and some of the results of its growing application are given in report V of the Federal Oil Conservation Board to the President of the United States, 1932, pages 53 and 54.

Other cooperative research by the natural-gas industry and Federal agencies has resulted in the working out of a new set of orifice coefficients and related facts that will make it possible to gage delivered gas with greater accuracy than heretofore.

In pipe-line transportation a definite criterion for designing and operating natural-gas transmission lines has been established. This criterion is based upon the results of experimental work lasting more than 5 years on representative commercial lines in all parts of the country.

The problem of combating external corrosion of pipe lines, both oil and gas, has been studied as a cooperative research by the industry and the Bureau of Standards. Many long-time tests of buried specimens, treated with various types of coating materials, have led to the development of suitable external corrosion preventive measures.

A recent study of the Bureau of Mines has determined many valuable facts regarding internal corrosion of gas pipe lines caused by traces of hydrogen sulphide, oxygen, and moisture. A report on some of the conditions contributing to "modified gaseous corrosion" in natural-gas pipe lines is in press. These studies are being extended with a view to determining more exactly the experience of companies in removing the causes that reduce the operating life of their lines.

In the construction of many of the longer natural-gas pipe lines (1929 to 1931), machinery largely supplanted the older hand methods of laying the lines. Mileage of line construction per day was increased to almost unbelievable figures compared with that of the older methods of construction. Recently, in an effort to help the unemployment situation generally prevailing throughout the country, some companies, for the present at least, have returned to the older manual methods of trenching, laying, and back filling.

DEEP WELLS

For several years the object has been to reach depths of 10,000 feet. In 1931 three wells were drilled to this depth. The first was the Chanslor-Canfield-Midway Oil Co.'s well near the Rincon (Calif.) field in June. Logan [10] has given a very complete record of deep wells drilled throughout the world, but deep-well records are subject to frequent change.

On May 10, 1933, the North Kettleman Oil & Gas Co. (Ed McAdams) Lillis-Welsh No. 1 well (Kettleman Hills, Calif.) reached a depth of 10,927 feet, with a reported gas pressure of 6,400 pounds per square inch—the highest ever recorded for a well. The full significance of this recent discovery of oil sand and high gas pressure below the Kreyenhagen shale, in what is believed to be a formation of Eocene age, has not been determined, but it indicates future oil and gas production at depths exceeding 2 miles. Previously, a well has been producing from a depth of 9,710 feet in the Ventura Avenue (Calif.) field. Some indication of the changed viewpoint regarding estimates of known reserves as influenced by deep drilling is discussed in report IV of the Federal Oil Conservation Board to the President of the United States, 1930, pages 6 to 8.

[10] Logan, Jack, The World's Deepest Wells: Oil Weekly, Nov. 7, 1932, p. 24.

Well equipment.—Improvements in design and materials, stronger derricks and their appurtenances, the use of hard-facing alloys for bits, and better technique have made deep drilling possible. In this report it is impractical to mention and impossible to discuss the many new developments that have helped to bring about this changed condition of deeper drilling. Every new field is a proving ground for new equipment. For example, innovations in the Seminole (Okla.) field were improved upon and added to in the drilling of the Oklahoma City field. The problem of keeping holes straight was met, and ways were found to correct this condition. Some form of weight indicator is now considered an essential part of the drilling equipment of a well.

The technique of casing practice has changed materially in the last few years. With wells reaching depths of 10,000 feet suitable clearance between strings of pipe must be maintained. Recently, a new type of flush-joint casing (both inside and outside) has been tried and found to have several advantages over older styles of casing joints. It is claimed that the efficiency of this type of joint is satisfactory and that, for the same size of flow string, less earth need be removed by the drill with an attendant lessening of drilling time and costs.

The invention of equipment suitable for drilling through high-pressure areas and for running tubing in wells under high pressures has been an important engineering achievement. By the use of snubbing equipment and hydraulic cylinders, drill pipe or tubing may be forced into a well under pressure through a suitable casing-head stuffing box or packer. Not many years ago, if a well encountered high pressures, a "blow-out" was likely to occur.

"Christmas-tree" connections at the well head now are manifolding systems of high-pressure pipe and fittings that make the well-head fittings of a few years ago appear to be exceedingly insecure.

The limit of deep drilling has not been reached. In fact, it has been reported that a new type of rotary table and draw works has been designed and developed for drilling to 15,000 feet. The machine has no headboards, and there are 4 shafts instead of 3 (the usual practice in heavy-drilling equipment). Two speeds are provided for the rotary drive, one for drilling and the other for coring operations.

Deep-well pumping.—With the increased depths of wells, it has been necessary to devise equipment by which the oil may be lifted mechanically after the natural flowing life has ceased. Even now in the Oklahoma City field several wells have ceased their natural flow, and the gas-lift method, used so generally in the Seminole area, is being used to lift the oil from these deep wells. The indications are that the gas-lift method will again be used extensively, especially in producing oil from deep sands in various parts of the country when "flush" production no longer supplies a large part of current market needs.

A number of deep-well pumps have been devised, and slow-speed pumping has increased over-all efficiency. A positive displacement pump of the rotary type, motivated by electrical energy conducted to the bottom of the well through insulated cables, has attracted attention. The fluid-plunger pump is another recent development. These and other pumping methods are making it possible to lift oil when the natural energy of the reservoir no longer brings oil to the surface.

MOVING EQUIPMENT

One of the essentials of intensive drilling campaigns in fields of diversified ownership is speed in setting up and dismantling equipment. As the equipment at one well is used in drilling several others and the time required to move the equipment, although necessary, is nonproductive, close study has been given to developing a plan which will reduce this time to a minimum, especially in the East Texas and Conroe fields. The layouts of the drilling rigs have been standardized and a high degree of organization and team work in the moving schedule has been developed.

By having adequate transportation facilities, including caterpillars and trucks provided with crane equipment, by having the draw works, engine, feed pumps, and other appurtenances on welded-steel skids, and by providing flange or flexible couplings for all pipe connections, it is possible to dismantle completely and set up a drilling rig in approximately 3 days. According to Teague,[11] the Humble Oil & Refining Co. has been able to make 15 moves of equipment at an average cost of $230, including the movement of machinery and drill pipe. Although this development is largely one of organization, nevertheless many technical factors are involved, and the economies effected by this plan of organization are far-reaching.

CONCLUSION

Industry, Government, and the public are vitally concerned in the resources of oil and gas and in their continued supply without evident shortage. The growth of the petroleum and natural-gas industry has been remarkable, and the ability of the industry to meet the demands placed upon it has been the result largely of technical knowledge, most of it attained recently. Production methods conceived only a few years ago now supply a large part of the crude oil from which the refined products are made. The research agencies of the industry and Government have been responsible for most of this technical progress, with some outstanding individual contributions. In the past the public generally has failed to understand the significance of technical research, but more is becoming known about the effects on social economy of an orderly recovery of oil and gas and the proper utilization of the manufactured products.

Recent engineering advancement has complicated many of the economic problems during a period when all industries have been depressed, but statements that technical research and its resulting practical applications in the petroleum and natural-gas industry have acted as a retarding agent in the stabilization of economic conditions have been made by persons who have failed to learn that the best attainable engineering practices and sound economic principles cannot be dealt with separately in industry because the two are synonomous.

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[11] Teague, J. U., Improvements in Setting Up and Dismantling Rotary Rigs: Oil Weekly, Apr. 10, 1933, p. 13. (Read before the Southwestern district, Am. Petrol. Inst., Houston, Tex., Apr. 7 and 8, 1933.)

PETROLEUM-REFINERY TECHNOLOGY

By A. J. Kraemer

In 1932 the petroleum-refining industry of the United States, like other industries, experienced severe distress caused by decreased demand coupled with inability to regulate supply to market demand, which resulted in low prices for products. Despite this unfavorable condition important engineering and technologic advances were made, and improved products were placed on the market.

In the following paragraphs the changed status of petroleum refining during the past few years is given in brief résumé. A few years ago steadily increasing demand taxed the capacity of refineries in the United States in spite of continued enlargements of plant equipment. Since then a major portion of the export trade in petroleum products has been lost to United States refiners, who formerly supplied the major portion of the world demand for some products, for example, lubricating oils. Domestic demand also has been reduced, temporarily at least, and refiners in the United States now have facilities ample to supply current demand, both domestic and foreign, for refined products without drawing on stocks of finished products.

The changed situation of petroleum refining in the United States also is shown by the fact that consumers now are more critical of the quality of petroleum products and are better informed as to the essential properties of the various products than they were in the past. There is an unmistakable trend toward rationality in referring to the properties of petroleum products. This change has been due almost entirely to efforts within the petroleum industry and not to consumers' efforts. Consumers generally have done little to educate themselves on the essential properties of petroleum products; such education as has come to them has been urged upon their attention by the petroleum industry.

The change in requirements for automobile gasoline constitutes an outstanding example of results obtained from a basic cooperative investigation. The fact that the essential properties of fuels for automotive equipment are understood much more clearly and generally than formerly is due largely to cooperative work by the petroleum industry, the automotive industry, and the Federal Government in the Cooperative Fuel Research project (C.F.R.). The work of the C.F.R. on distillation range and vapor pressure of gasoline recently has been augmented by the adoption of a method for determination of octane number ("antiknock" rating) as a tentative standard method of the American Society for Testing Materials. Although this cooperative project began as an investigation of motor fuels to improve motor performance, tests of the C.F.R. have shown definitely that many troubles were due to inherent faults in the construction of automobiles and could be eliminated more easily and satisfactorily by changes in automobile design than by changes in properties of motor fuels.

Another example of cooperation is the commercial standard for fuel oil. This standard was developed cooperatively by manufacturing and consuming interests, the Bureau of Standards acting as a coordinating agency, for the purpose of unifying consumer demands for fuel oils and correcting an undesirable condition of ambiguity and emphasis on nonessentials in fuel-oil requirements. An important research now in progress is the cooperative study of Diesel fuel oils by the American Society for Testing Materials, the American Society of Mechanical Engineers, and the Society of Automotive Engineers, assisted by the research laboratories of oil companies, engine builders, engineering colleges, and the Federal Government. This research has a similar object to the C.F.R. research, although the technical problems are somewhat more involved.

Similar cooperative effort would bring forth needed information on the essential properties of other petroleum products, such as automotive lubricating oils, turbine oils, and electric-insulating oils. These products are used in large quantities without definite knowledge of the influence of inherent properties on the quality of the service obtained from them.

As a result of technologic developments obsolete refining equipment in the United States has been replaced by equipment that yields better products at lower cost. These changes in refining practice have increased the difficulties of poorly equipped refiners who operate under high production costs in markets where the supply equals or exceeds the demand.

The following paragraphs refer briefly to some of the outstanding new installations, new processes, and new products that have been announced during the past year; these give a general idea of the range and variety of technologic progress that has been made.

A partial list of refinery-construction jobs completed in 1932, or in progress, was published in the Oil and Gas Journal for September 29, 1932, page 17. This list shows the enormous amount of modernization undertaken at refineries in the United States during severe business depression.

All phases of refinery operation have been modernized, but results have been particularly significant in the following: (1) Remodeling older installations; (2) building new cracking plants, especially combination plants for skimming, cracking, and reforming; (3) vapor recovery and stabilizing plants; (4) improvements in the manufacture of lubricating oils; (5) installations for better utilization of heat; and (6) improvements in minor details of refinery operation, making for better over-all efficiency of the plants.

Cracking plants built only a few years ago have been rendered technologically obsolete. Refiners have been confronted with the alternative of junking the plants or modernizing them. It has been possible and economical to remodel many plants to increase throughput, improve the quality of products, obtain a better utilization of heat, and reduce manufacturing costs.

Modernization of cracking plants has not increased production enough to supply the demand for cracked gasoline, and a considerable increase in cracking capacity has been attained by the construction of new plants. Many of these plants have embodied significant improvements in design and construction. For example, a cracking plant with a throughput capacity of 9,000 barrels daily which was installed in 1932 in an eastern seaboard refinery, includes a bubble tower 12 feet in diameter and 93 feet in length which was completely shop-welded; all seams were X-rayed, and the entire tower was stress annealed. This installation is an example of the progress that has been made in the fabrication of large vessels to operate under high pressures and temperatures and is in marked contrast to the type of construction formerly used that was hazardous under less severe conditions of pressure and temperature.

A single cracking unit with a capacity of 10,000 barrels per day was installed in a California refinery in 1932. The furnace is designed for a heat absorption of 50,000,000 B.t.u. per hour, 85 percent of which are transferred in the radiant-heat section. Tubes in the cracking furnace are 4½ inches in outside diameter with a wall thickness of 0.4 inch made possible by the use of KA2S alloy (a low-carbon, nickel-chromium steel). Contemporary metallurgical developments have provided the necessary materials to make much of the modern refinery equipment possible.

A combination skimming, re-forming, and cracking plant with a throughput capacity of 20,000 barrels of crude oil per day was installed at an Indiana refinery. The plant is reported to be capable of converting 20,000 barrels of crude oil daily into 70 percent gasoline with an octane number of 70, leaving byproducts consisting only of refinery gas and fuel oil having a viscosity of approximately 150 to 200 seconds Saybolt Furol at 122° F. Coke formation is said to be almost negligible. This large recovery of high-octane gasoline illustrates the progress that has been made in adapting gasoline production to modern demands. The normal octane number of average Mid-Continent straight-run gasoline is approximately 50 and raising the octane number to 70 materially increases the price at which the gasoline can be sold.

Refiners in the Pennsylvania district have found it advantageous to install cracking and re-forming plants to produce gasoline with high octane numbers from their straight-run gasoline, naphthas, kerosene, gas oil, and other fractions of the crude oil to impart a greater degree of flexibility to their refinery operations, thus enabling them to adjust manufacture of products in their plants to market demands.

The increased use of cracking processes, the re-forming of straight-run gasoline, and the necessity for lowering vapor pressures of refinery products have had an important bearing upon the great development that has taken place in another phase of refinery operation, namely, gas-absorption and stabilizing plants. Moreover, the severe requirements of present gasoline specifications necessitate the utmost operating flexibility and thorough stabilization of products. In consequence, combination stabilizing units and vapor-recovery systems, have been installed in a number of refineries. One such unit is reported to recover 45,000 gallons of gasoline per day from refinery gases.

In refineries where the plant gases contain large proportions of hydrogen sulphide and other sulphur compounds, it is desirable to treat the gases to minimize corrosion of equipment used for the recovery of gasoline from the gases. One such plant, in a Gulf coast refinery which treats approximately 9,000,000 cubic feet of refinery gas daily, is reported to remove an average of 14 tons of hydrogen sulphide per day from the gases. This gas is treated only to the point that serious corrosion of recovery equipment does not occur. After being stripped of its gasoline content the gas is burned as fuel in the refinery. The hydrogen sulphide is liberated at one stage of the purification process and blown into the atmosphere.

Burning refinery gas under stills, however, is not justified if more economic outlets are available. Better methods of using it are being found, either as fuel in public-service corporation lines or as raw material for the production of chemical products.

A method of utilizing refinery gases is illustrated by a plan for supplying gas from three petroleum refineries in the Chicago district to a public-service corporation. The purification plant for processing this gas completely frees it of hydrogen sulphide. The capacity of the purification plant is 3,000,000 cubic feet per day, and the gas is supplied to service mains at 1,000 B.t.u. per cubic foot, equivalent in heating value to natural gas from the fields and almost twice the B.t.u. content of "producer gas".

A method based upon the use of a solution of lime and salt in water as an absorption medium for scrubbing gases to remove hydrogen sulphide prior to the extraction of gasoline is described by Rue.[1]

Other methods, most of them patented, are being used. These include the caustic soda and triethanolamine processes.

The use of ammonia in combating corrosion of refinery equipment has increased due to the decrease in price and availability of anhydrous liquid ammonia. The ammonia usually neutralizes hydrochloric acid that results from the decomposition of metallic chlorides during the distillation process.

At a new refinery in Michigan the crude oil is treated for removal of sulphur by mixing it with a treating compound before the oil enters a heat exchanger, and vapors from the crude oil are contacted again with chemicals in a treating tower in which the vapors pass upward countercurrent to the chemical mixture.

A vacuum pipe still for redistilling heavy naphtha is an interesting example of economy in operation. A Texas refinery has installed a plant with a capacity of 7,000 barrels of heavy naphtha per day. The plant operates with an absolute pressure of approximately 53 mm of mercury at the dry line (beyond the partial condenser) and 60 mm at the base of the column. It is stated that the steam requirement is approximately 20 to 25 percent of that necessary for steam distillation at atmospheric pressure. The maximum temperature of the oil in the column is said to be 275° F., and the end point of the overhead product is approximately 400° F.

New processes for treating light distillates that have been developed recently include the Lachman process, which employs aqueous solutions of metallic chlorides, typically zinc chloride, and the bruceite (magnesium hydroxide) process. Both processes are used for treatment of light distillates in the production of motor fuels. The zinc chloride process, developed in California, has been adopted in refiner-

[1] Rue, H. P., The Use of Lime in a Salt Solution for Removing Hydrogen Sulphide from Natural Gas: Rept. of Investigations 3178, Bureau of Mines, 1932, 7 pp.

ies in other areas. The bruceite process, developed in Oklahoma, was announced in 1932.

The most interesting new products are those developed in connection with the beneficiation of lubricating distillates by the use of selective solvents. The following solvents are employed in processes announced recently: (1) Benzol in liquid sulphur dioxide, (2) nitrobenzene, (3) dichlorethyl ether, and (4) phenol. These processes are designed to improve the viscosity-temperature characteristics and the thermal stability of oils. The processes usually are covered by patents.

Development of the hydrogenation process on a plant scale in the United States has been in the hands of one company and its subsidiaries. Such general information as is available indicates that development has been steady, and the process apparently has been proved commercially feasible.

A new product of the hydrogenation process is a motor fuel that has the required volatility characteristics for use in aviation and yet is fire safe. In view of the flash point of approximately 105° F., it appears that the Reid vapor pressure at 100° F., is practically nil; however, it is stated that the volatility characteristics of the fuel are excellent.

The proposal to require the inclusion of grain alcohol in gasoline as a measure of agricultural relief has caused much discussion. The various aspects of the proposal have been discussed extensively in the newspapers as well as in the technical press, and the plan has been tried in some corn-growing States of the Middle West. Several bills have been introduced in Congress making the mixing of alcohol with gasoline alternative to heavy increases in the Federal gasoline tax.

Advancements in the field of heat conservation in refineries are evidenced by the following applications: (1) Higher pressures on steam boilers, (2) use of fluids such as diphenyl and mercury with special thermal properties, and (3) use of refinery wastes as fuels.

A large refinery in the Chicago district has installed high-pressure boilers to generate electricity and supply process steam. The operating pressure of the boilers is 400 pounds. Steam at this pressure is put through turbines for generating electricity, thereby reducing the pressure to 125 pounds gage, at which pressure the steam is used for plant processing. The boiler-feed water is Lake Michigan water that has been used for cooling and condensing in the refinery. The water, after treatment to remove dissolved solids and traces of oil at a treating plant, is heated to 200° F., before it enters the boilers. Part of the steam for heating the feed water comes from the exhaust from three low-pressure turbines operating at 125 pounds initial pressure.

Conditions in the petroleum-refining industry in 1932 can scarcely have been regarded as satisfactory from the standpoint of economic considerations, but important advancements were made in technology. These advancements occurred in (1) plant improvement and enlargements, (2) improvement in products, and (3) increased economy of operation which resulted in the production of better products at lower costs.

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NATURAL GAS

By E. B. Swanson

The decline in the marketed production of natural gas, which began in 1931 after a decade of steady expansion, was continued in 1932, when, according to estimates, 1,518,000,000,000 cubic feet, valued at $357,000,000, were used or sold. Compared with 1931 the 1932 figures represent a decline of 10 percent in volume and 9 percent in value.

The demand for natural gas is divided into that sold for industrial and domestic fuel needs, that consumed as fuel directly in oil and gas operations, and that used in the manufacture of carbon black. The domestic and commercial market normally consumes slightly more than 20 percent of the national total, while industrial requirements (apart from those of the oil industry) take nearly 30 percent of the total. The requirements of the oil industry for natural gas as a fuel at refineries and gasoline plants and for drilling and other field purposes comprise about 40 percent of the total, and the remaining 10 percent is used as raw material in the manufacture of carbon black.

With industrial markets comprising approximately 80 percent of the demand for natural gas, fluctuations in industrial activity are reflected promptly by corresponding variations in demand. Because of its large share of the total demand, the oil industry undoubtedly influences the demand for natural gas more than do any of the other factors. The magnitude of the fluctuations in the larger items consequently tends to obscure the relative steadiness of the annual demand for natural gas to meet domestic needs in heating and cooking.

From data on natural-gas demand in 1932 it appears that gas sales for domestic and commercial purposes, while slightly lower than in 1931, held relatively close to the preceding levels, particularly during the closing months of the year. Some indication of the decline in industrial demand, on the other hand, is found in the records of natural-gas consumption in the generation of electricity at central power plants. Natural-gas consumption for this purpose during 1932, according to the United States Geological Survey, totaled 107,875,000,000 cubic feet, a decline of 22.6 percent from the 139,328,000,000 cubic feet recorded for 1931.

A somewhat similar decline was recorded in the carbon-black industry; the quantity of gas burned during 1932 amounted to 168,237,000,000 cubic feet, a decline of 12 percent from the 1931 consumption of 195,396,000,000 cubic feet.

The decline in demand, particularly for industrial purposes, retarded developments in a number of States and, in others, resulted in a reduction of output. The effect of the lowered demand was felt particularly in some of the principal producing States, notably Louisiana, Kansas, West Virginia, and Pennsylvania.

In some of the smaller producing States, on the other hand, the 1932 output increased appreciably over that in 1931. Due to the development of the Jackson field, natural-gas production in Mississippi in 1932 was considerably larger than in 1931. Michigan also recorded a substantial increase. In the eastern fields interest in natural-gas developments was stimulated by the continued exploration which resulted from discovery of the Wayne-Tyrone field in New York and the Tioga and Hebron fields in Pennsylvania. Deeper drilling in West Virginia resulted in several gas shows in the Devonian shale above the Oriskany sand, indicating the possibility of further development of gas reserves in that State.

Particular attention was paid during the year to the problem of reducing gas wastage, especially in California and Oklahoma. In California the gas wasted during 1932 was only 6 percent of the recorded output compared with 44 percent in 1929. In Oklahoma a concerted effort was made to reduce the gas wastage in the Oklahoma City field.

The following review, by States, of natural-gas developments during 1932 is based primarily on information received from local authorities.

RECENT NATURAL-GAS DEVELOPMENTS

Arkansas.—Little progress was made in the development of new natural-gas fields in Arkansas during 1932, according to George C. Branner, State geologist. In western Arkansas one test each was completed in Franklin, Crawford, and Washington Counties, and a test was begun in Yell County. The Crawford and Washington County tests were dry holes. The Franklin County test, in sec. 13, T. 8 N., R. 29 W., near Vesta on the Vache Grasse anticline, was completed to a depth of 2,380 feet in the Atoka formation. Initial production was about 3,000,000 cubic feet, with a rock pressure of 400 pounds.

The Russellville field, which was discovered in October 1929, has not been drilled out or connected with a pipe line. Three gas wells in that field were shut in during 1932. It is estimated that leases on approximately 300,000 acres of potential gas territory in western Arkansas were held during 1932 by gas companies.

California.—Natural gas is produced in California from 35 oil and gas fields. Production during 1932 totaled 276,877,100,000 cubic feet, according to Claude C. Brown, gas and electric engineer, California Railroad Commission. Of the 1932 total, 144,106,500,000 cubic feet were sold to gas-utility companies and others; 53,697,100,000 cubic feet represented gasoline-plant fuel and shrinkage; 40,654,500,000 cubic feet were used as fuel in the field; 8,666,000,000 cubic feet were used as fuel at refineries; 12,242,100,000 cubic feet were returned to the formations for storage or for use in repressuring operations; and 17,510,900,000 cubic feet were blown into the air.

California is the outstanding example in the United States of reduction in natural-gas wastage. During 1929, 248,477,000,000 cubic feet, or nearly 700,000,000 cubic feet daily, were blown into the air (44 percent of the recorded output). During 1932 the quantity of gas so wasted averaged 48,000,000 cubic feet daily, only about 6 percent of the recorded output and 93 percent less than in 1929. This material reduction in gas wastage has resulted from voluntary curtailment of both oil and gas production, expansion of natural-gas utilization, and vigorous administration of State conservation legislation.

The major part of the increase in natural-gas utilization has been due to the extension of distribution facilities into areas and communities formerly served with manufactured or mixed gas and those formerly having no gas service. A substantial part of the increase also is attributable to the greater use of natural gas by individual consumers, particularly for space heating.

The steady decline of production in the "town-lot" fields of the Los Angeles Basin has contributed materially to the decrease in gas wastage, as these fields were sources of prolific waste during their periods of peak production.

In fields where the greater part is controlled by a relatively small number of operators more reasonable and economical drilling programs have been followed, with the result that many such fields are still producing and will continue to produce for many years. The Kettleman Hills field, a principal source of natural gas supply, is regarded as the most noteworthy of this group.

Colorado.—A discovery of considerable importance was made early in 1932 in the test of the Piceance Creek anticline, Rio Blanco County, Colo. A flow of gas, which gaged 13,000,000 cubic feet daily, was encountered in the sand, presumably of the lower Green River or the upper Wasatch formation of the Tertiary system, at a depth of 2,917 feet. Although the first discovery for the field was made in August 1929 the initial well had a daily open flow of only 2,000,000 cubic feet which was not sufficient to insure an outlet. The recent discovery, it is reported, may enable the towns along the Colorado River Valley, several miles south, to be served with natural gas, or the several small gas fields of northwestern Colorado may be linked to create a reserve great enough to justify connection with the Hiawatha-Salt Lake City line.

Gas was discovered on the Craig structure, Moffat County, on March 10, 1932. The gas was found in a sand of the Iles formation of the Mesa Verde group at a depth of 2,802 feet. The field is only 2½ miles from the town of Craig.

Illinois.—No new natural-gas areas were discovered in Illinois in 1932, according to Alfred H. Bell, geologist, head of the oil and gas division, Illinois State Geological Survey. In the two old producing areas 8 gas wells were drilled, of which 6 were in Morgan County 10 miles east of Jacksonville, and 2 on the Ayers anticline in Bond County.

The producing horizon in the Morgan County wells is a sandstone near the base of the Pennsylvanian system at depths ranging from 300 to 400 feet. One of these wells was reported to have an initial daily open-flow capacity of 1,500,000 cubic feet, the other 5 ranging from 50,000 to 200,000 cubic feet. Two wells are connected by a pipe line to the village of Alexander, which is 1 to 2 miles southeast of the wells. The remaining 4 are either capped or abandoned.

The two new wells in Bond County each had a reported initial open-flow capacity of 1,000,000 cubic feet. They are connected to a pipe line which supplies the town of Greenville 5 miles south. The producing horizon is a sandstone in the lower part of the Chester series (Upper Mississippian), possibly the Yankeetown formation.

Indiana.—Natural-gas production in Indiana began in 1886, reached its peak about 1900, and has since declined gradually until, in recent years, the annual output has been relatively constant at slightly in excess of one billion cubic feet, according to William N. Logan, State geologist. Gas is being produced in two principal areas, northeast Indiana and southwest Indiana.

In northeast Indiana gas is obtained in the geanticlinal area, the northwestern extension of the Cincinnati arch. This structural feature passes northwesterly from the eastern part of Switzerland County to the vicinity of Logansport, Cass County, where the arch sags. The gas is obtained from minor structures on the surface of the geanticline. Gas is still being produced from the Trenton limestone horizon in a number of counties along this extension of the Cincinnati arch, among them Blackford, Decatur, Grant, Jay, Randolph, Rush, Shelby, and Switzerland. The wells in this area range in depth from 400 to 1,200 feet.

In recent years a large part of the natural-gas production in Indiana has been obtained in southwest Indiana. Gas has been obtained in Davies, Greene, Gibson, Knox, Martin, Perry, Pike, Sullivan, Vanderburgh, and Warrick Counties. The area is in general synclinal, but minor irregularities of deposition or folding have produced structural conditions that favor accumulation of gas. The production obtained in this area has come largely from the Chester division of the Mississippian. The wells range in depth from 500 to 1,600 feet. Devonian strata in Indiana have been the sources of natural-gas production in Greene and Harrison Counties. Most of the gas comes from the Devonian shales; very little, if any, comes from the Devonian limestone which underlies the shales. Gas from the Harrison County field is piped to Louisville, Ky.

Many wells have been drilled to the Trenton limestone in southwest Indiana, but no gas production has been obtained from that formation. In Gibson County, the upper surface of the Trenton limestone lies 4,500 feet below sea level. Although no wells have been drilled to the Trenton in the Gibson County area, wells that have reached it in neighboring counties have not produced natural gas.

It is reported that a number of counties in Indiana contain untested areas, some of which undoubtedly will be productive.

Kansas.—The lack of a market greatly retarded natural-gas developments in Kansas during 1932, according to the Geological Survey of Kansas. Only 30 gas-well completions were recorded for 1932 compared with 129 in 1931. No new wells were drilled in the Hugoton field in 1932, and in the McPherson County gas fields wells drilled fell from 58 to 7 for 1931 and 1932, respectively. Considerable gas is being produced and marketed in eastern Kansas, where small shallow wells are abundant, but the major gas fields in the State are not being drawn on by the large pipe lines. Many pipe lines running through Kansas are taking their gas from Oklahoma and Texas, with very little from the Kansas fields.

The 30 gas-well completions show an aggregate initial daily production of 613,000,000 cubic feet. The completion of 1 gas well each was was reported in Chautauqua, Ellsworth, Finney, Kingman, Morris, Sedgwick, and Woodson Counties; 2 each in Chase and Rush Counties; 3 in Butler County; 4 in Reno County; 5 in Cowley County; and 7 in McPherson County.

Several new gas developments are of interest. In December 1932 a well in sec. 16, T. 25 S., R. 34 W., Finney County, was completed with an initial flow of 5,500,000 cubic feet. This well is 60 miles north of the Hugoton gas field as now outlined, and some geologists believe that the Finney area is an extension of the Hugoton field. If so, it will greatly increase the already large Hugoton field.

In Kingman County a well in sec. 30, T. 27 S., R. 10 W., was completed in the Siliceous lime with an initial daily production of 38,000,000 cubic feet. The new Johnson pool in McPherson County has combination oil and gas wells which produce as much as 10,000,000 cubic feet of gas daily with the oil. In Rush County two gas wells with a total initial flow of 75,500,000 cubic feet were completed during the year but have been shut in awaiting a market outlet.

The largest gas well in Kansas was completed in April in Reno County. It is in sec. 25, T. 23 S., R. 4 W., and gaged 86,500,000 cubic feet of gas per day with a rock pressure of 1,170 pounds from the Mississippian "chat" at a depth of about 3,200 feet.

The largest gas field in Kansas and the second largest in the United States is the Hugoton, in southwestern Kansas, occupying all, or part, of Stevens, Morton, Seward, and Haskell Counties. It is estimated that there are close to 1,000,000 acres of proven gas territory in this field. At present there are 115 gas wells in the field, with an estimated open-flow capacity of 690,000,000 cubic feet per day or an average of 6,000,000 cubic feet per well. The field is not being drawn from to any extent.

Kentucky.—Most of Kentucky's natural gas comes from the eastern part of the State, where in 1932 production was between 26 and 27 billion feet, according to Arthur C. McFarlan, State geologist. The main production, comprising about 71 percent of the total, comes from the Black shale of Floyd County and vicinity. The Black shale here ranges in age from the Genesee into the lower Mississippian, a much thicker and more comprehensive section but not so rich in bitumen as the area of outcrop in the Knobs. Production apparently is not restricted to any one horizon. The Corniferous, including the Niagaran, which has been Kentucky's biggest producer of petroleum, ranks second with about 9 percent. This includes a number of pools scattered along the western margin of the eastern coal field.

In Knox and adjoining counties the production is mainly from the Big Lime and Maxon sands, next to the Shale region in activity. These produce about 7 and 6 percent, respectively. Other producing sands include the Salt sands (Pennsylvanian), 4 percent; the Weir (Waverly) of Magoffin, Johnson, and Lawrence Counties, 2 percent; the Big Injun (Waverly), 1 percent; and the Berea, a small quantity.

Trenton gas has been discovered within the past 2 years in Carroll and Gallatin Counties, but production has been small. Within the past year activities in the central Blue Grass resulted in a number of deep tests to the St. Peter and below. These and earlier attempts have not been encouraging.

Louisiana.—Natural-gas production in Louisiana during 1932 totaled 194,000,874,000 cubic feet, according to the report of J. A. Shaw, director, minerals division, Louisiana Department of Conservation. The production was divided by fields as follows: Monroe, in

Morehouse, Ouachita, and Union Parishes, 90,266,883,000 cubic feet; Richland, Richland Parish, 81,244,039,000 cubic feet; Sugar Creek, Claiborne Parish, 3,833,401,000 cubic feet; Rodessa, Caddo Parish, 1,272,839,000 cubic feet; and all others, 17,383,712,000 cubic feet.

The production reported for 1932 represents a decline of 14.6 percent from the output of the preceding year. An important part of the decline may be contributed to the Louisiana carbon-black plants, which used 40 billion cubic feet of natural gas for carbon-black manufacturing during 1932, or 11 billion less than the 51 billion consumed during 1931. The new Jackson (Miss.), gas field has contributed an additional supply to the pipeline extending to Birmingham and Atlanta and has lessened somewhat the demand for Louisiana gas to serve this line. Until the discovery of the Jackson gas field the Monroe and Richland fields supplied the demand for both domestic and industrial consumption in the area served by this pipe line. A mild winter in Louisiana and the adjoining Gulf coast area was partly responsible for the decline in local consumption, while an extremely cold winter in northern Arkansas and Missouri resulted in heavier demands on the 522-mile pipe line to St. Louis and intermediate points. It is reported that approximately 131 billion cubic feet of gas were put into pipe lines and transported to Texas, Missouri, Arkansas, Alabama, and Tennessee for industrial and domestic consumption.

The production of natural gas in the State is confined to northern Louisiana. The major producing fields are Monroe, Richland, Sugar Creek, Rodessa, Waskom, and Pine Island. Innumerable smaller fields are scattered throughout the area. The Monroe field, in Morehouse, Ouachita, and Union Parishes, comprises approximately 227,000 acres and was originally estimated to have a potential of 3,768 billion cubic feet. At the close of 1932 the field had produced a total of 1,392 billion cubic feet. According to the 1932 regage there were 850 producing wells in the field with a total open-flow capacity of 4½ billion cubic feet daily. Although 25 wells were drilled in the three parishes during the year little new production was added to the Monroe field, as the wells were drilled in widely separated areas in search of production apart from the Monroe field. Only 14 wells were abandoned during 1932, indicating that the field is withstanding water encroachment.

The Richland gas field, discovered in 1926, has been the second largest gas field in the State. At the close of the year it comprised 27,000 acres, with 239 producing wells capable of delivering 3,340,029,000 cubic feet daily. The Richland field had only three new drilling operations in 1932, while 30 permits were issued to abandon and pull casing. It is reported that much of the field's reserve was destroyed by numerous craters and that water encroachment is noticeable in the outer wells and those near the crater areas.

Sugar Creek and Rodessa, the next largest fields in the State, are very similar. Both are producing from the Trinity horizon and are exceedingly rich in gasoline. Heavy withdrawals are not being made from these fields because of insufficient gasoline-plant capacity. The limits of the fields have not been defined. Sugar Creek is producing from a depth of 4,300 to 4,400 feet, while Rodessa is producing from 5,600 to 5,700 feet. The latter field added a 62½ million cubic foot well to its production during 1932. While many of the less outstanding fields of northern Louisiana are still capable of producing a great deal of gas they cannot be looked upon as a source of supply for any length of time, because the heavy withdrawals made upon them for the past several years have depleted their reserves, as shown by the number of wells abandoned during 1932.

There is still much undeveloped territory in northern Louisiana that undoubtedly is worthy of exploitation and will be developed as the need for additional supply increases, according to M. E. Nash, engineer, minerals division, Louisiana State Conservation Department. East Carroll, West Carroll, Madison, Franklin, Tensas, Concordia, and Catahoula Parishes, all in eastern and northeastern Louisiana, are potential gas territories and have received considerable attention. Several "wildcat" wells are being drilled at widely separated places in this area.

Central Louisiana, from the Texas State line to the Mississippi State line, is receiving the most attention. A belt approximately 30 miles wide, running northeast from De Ridder, La., to Jackson, Miss., known as the "Conroe Trend," is the center of leasing and drilling activities. Several new gas discoveries are expected along this trend, because of its relationship to the producing horizon at Jackson, Miss.

Michigan.—The total reported production of natural gas in Michigan for 1932 was 1,405,880,000 cubic feet, according to F. R. Frye, petroleum engineer, geological survey division, Michigan Department of Conservation, compared with 472,000,000 cubic feet for 1931, reported by the Bureau of Mines. Of the 1932 production, 828,980,000 cubic feet were used for domestic and industrial purposes and 576,900,000 cubic feet in the field. A number of gas wells were completed during the year with initial productions ranging from 1,000,000 to 11,000,000 cubic feet, but no new producing areas were opened up. Natural gas was distributed for domestic purposes to Mount Pleasant, Midland, Clare, and Rosebush, while distribution for industrial purposes was continued in Muskegon.

In May the 8-inch line from the Broomfield area to Midland was connected with the 6-inch manufactured-gas line from Saginaw to Midland to conduct a heavy-duty test by burning natural gas at a power plant near Saginaw to determine the ability of the Broomfield gas pool to withstand sustained withdrawals for regular commercial service. After the test had been continued for 4 months proposals were presented to the city officials of Saginaw and Bay City to supply natural gas. Negotiations still were pending at the close of the year.

Early in January 1933 a small gas well was completed 2 miles southeast of the developed area in the Broomfield pool in Isabella County. The well was abandoned temporarily, but it is reported that the completion may indicate a considerable extension in the proved area of this pool. Shortly thereafter a well in Mecosta County, 14 miles west of the Broomfield area, encountered 4,120,000 cubic feet of gas in the same formation which is productive in the Broomfield area.

At the close of the year there were 62 producing gas wells in the State—30 in the Muskegon field, 14 in Broomfield, 7 in Clare, 6 in Vernon, and 5 in Ashley.

Mississippi.—Natural-gas production in Mississippi during 1932 totaled 9,847,907,000 cubic feet, according to George C. Swearingen, Mississippi State oil and gas supervisor. This represents an increase of about 63 percent over the 1931 output of 6,048,000,000 cubic feet reported by the Bureau of Mines. Gas was produced and distributed from two fields. The older of these is the Amory gas field, which was discovered in 1926 and consists of three small wells in Monroe County. Gas from this field is being piped to Amory, Aberdeen, and Tupelo. During 1932, 152,972,000 cubic feet of gas were produced and marketed from this field. The gas has high B.t.u. content, and the rock pressure of the field is about 600 pounds.

The discovery well of the Jackson gas field was completed in February 1930, and since that date 152 wells have been drilled on the Jackson structure. Of these wells, 97 are now producing gas, 8 are abandoned producers, and 5 have made heavy oil, salt water, and some gas. Two of these wells are producing about 50 barrels per day of heavy oil each, and it is reported that a small refinery is being erected for making asphalt from the oil.

During 1932, 31 gas wells, 2 oil wells, and 5 dry holes were drilled on the Jackson structure. Production in 1932 was 9,694,935,000 cubic feet of gas. The greater part of this production has been distributed through the pipe line to Mobile, Ala., and Pensacola, Fla., and the line south of Jackson as far as McComb, Miss. From the line to Mobile a lateral runs down to Bogalousa, La., and from there gas is piped into a number of other Louisiana towns north of New Orleans. Some gas from the Jackson field also reaches Birmingham and Atlanta. The rest of the production, except that distributed locally, goes to Hattiesburg, Miss., and intervening towns.

The production from the Jackson field comes from the top of the Selma chalk of Upper Cretaceous age. This chalk is very porous and is overlain by a hard cap rock 1 to 3 feet thick. The cap rock in turn is overlain by 90 feet of Midway shale. The surface formations in the field are Jackson and Yegua. The average depth of the producing horizon is 2,300 to 2,500 feet, and the chalk is about 350 feet thick on the structure. The salt-water level is approximately 2,200 feet below sea level. The largest well in the field gaged 57 million cubic feet, and the average is about 40 million. The rock pressure is 978 pounds, and there has been very little decline from the original rock pressure. The gas is reported to average 940 B.t.u. per cubic foot.

Missouri.—The area producing natural gas in Missouri extends from southwestern Vernon County north through Vernon, Bates, Cass, Jackson, Clay, and Clinton Counties, with some production in Johnson, Ray, and Platte Counties, according to H. A. Buehler, State geologist. Within this area are approximately 40 pools. All the production is from sands and black shales of the Pennsylvanian series at depths ranging from 140 to 600 feet.

The pools range in size from less than 160 acres to 9 square miles, although the larger pools are interrupted by dry areas. The initial flow of the wells has ranged from a few thousand cubic feet daily, in wells saved for use in private houses, to as high as 2,500,000 cubic feet. The rock pressure is about normal, ranging from 20 pounds in shallow wells to 190 pounds in the deeper wells.

No entirely new and distinct pools were discovered during 1932. Drilling operations were quiet during the early part of the year but increased in the late summer and fall. It is believed that about 75 wells were completed during the year. The pool along Blue River in the eastern part of Kansas City was extended into sec. 8, T. 49 N., R. 32 W., by a small group of new wells, the largest having an initial daily open flow of 475,280 cubic feet, with 130 pounds pressure. The Independence pool was extended into sec. 1, T. 49 N., R. 32 W., by the completion of a small number of wells, the largest having an initial open flow of 150,000 cubic feet daily.

Montana.—No new gas fields were discovered in Montana during 1932, according to Francis A. Thomson, director, Montana Bureau of Mines and Geology, and Eugene S. Perry. Two gas wells were added to the list of 18 in the Cut Bank field. Five wells in the Dry Creek field near Red Lodge found gas in sands of the Middle Cretaceous, above the oil horizon, which is of Lower Cretaceous age. One of these wells is reported to have had a flow of 45,000,000 cubic feet daily, with a pressure of 1,400 pounds.

A new development during 1932 was the completion of 12 oil wells near Cut Bank. The oil area lies adjacent to the gas area on the western, or down-dip, side. The oil was found in the Lower Cretaceous, the same sands which produce gas.

New Mexico.—Natural-gas production in New Mexico has advanced rapidly during the past few years. In the northwestern part of the State commercial-gas production has been developed on the Barker and Ute Domes and in the Aztec and Kutz Canyon areas. Gas from the latter area is transported to Albuquerque, Santa Fe, and Farmington. The town of Aztec gets its gas from the wells nearby, while gas from the Ute Dome is taken to Durango, Colo. Gas is produced from the Pictured Cliff sandstone (Upper Cretaceous) in the Kutz Canyon area and from the Dakota sandstone on the Barker and Ute Domes.

In southeastern New Mexico gas is produced, either directly or in conjunction with oil, in the Artesia, Maljamar, Hobbs, Eunice, and Jal areas. Gas is transported from the latter area to El Paso, to towns in southwestern New Mexico and southeastern Arizona, and across the border into Mexico.

No oil or gas has been discovered in New Mexico west of the Pecos River. Although shows of both oil and hydrocarbon gas have been reported at a number of places in northeastern New Mexico no oil or gas of commercial importance, except carbon dioxide gas, has been found.

New York.—Exploration for natural gas, which was stimulated by the discovery of the Wayne-Tyrone field in 1930, was still apparent during 1932 in central and western New York, particularly in the area embraced by the first two tiers of counties north of the Pennsylvania border, according to D. H. Newland, State geologist. Outside of this area the interest shown was more moderate, but exploration was still noticeable over the territory north to Lake Ontario. A few tests have been reported from outlying districts. Notable in the recent exploration has been the tendency to rely upon close geological study of the ground preliminary to a drilling campaign and, where this does not give the desired information, to apply geophysical tests. These methods were not practiced to any great extent in New York until recent years.

The Wayne-Tyrone field has been delimited by border drilling and put into production with about 115 tributary wells. The gas is transported by trunk lines, east as far as Binghamton and west to Buffalo, and by a local pipe line to several communities lying north of the field. The results of overdrilling in the Wayne Village area are manifested by a substantial falling off of pressure. A curious feature is the fact that the latter area produces sweet gas whereas in the eastern or Tyrone tract the gas is sour and has to be treated before it is run into pipe lines. It is reported that, with the accentuated drain upon the Wayne wells, some of them have turned sour.

In Steuben County, beyond the limits of Wayne Township, tests have been made of various structures to the horizon of the Oriskany sandstone, but so far no definite pools have been established. Most of the wells for exploring the sandstone have encountered salt water and no gas in quantity. Two wells in Greenwood Township may have considerable significance; one shows a large flow and the other a moderate yield, both being on or near structure.

A shallow pool in the basal part of the Chemung beds has been opened in Rathbone Township, where some 20 producers are reported. Their volume ranges from a few thousand to 2 or 3 million cubic feet. Outlet is by a newly built pipe line to the village of Bath. The Oriskany horizon is not reached in any of the wells.

In Allegany County the occurrence of the Oriskany has been established locally by some deep tests, but thus far no important field has been discovered. In the town of Allen the sandstone was drilled into at about 3,000 feet for a reported yield of 2,000,000 cubic feet, besides 8 or 10 barrels of high-grade oil. Most of the oil and gas production of this county is from the Chemung beds, usually less than 1,500 feet from the surface.

In Ontario County a good deal of interest was aroused by the bringing in of several gas wells near Geneva, 30 miles northeast of the Wayne-Tyrone field. Their sites are on the outcrop of the Onondaga limestone, and the gas comes from a depth of about 1,000 feet from what appears to be the Niagara or Lockport dolomite. This formation has not been found productive elsewhere. The first well was completed in August 1932 to a depth of 1,079 feet and showed a rock pressure of 640 pounds. The initial flow was given as 5,000,000 cubic feet, but later the figure was reduced considerably. A second test at essentially the same horizon was reported as showing a rock pressure of 920 pounds. A third well, less than 1½ miles from the first two, was estimated at 5,000,000 cubic feet, with 640 pounds pressure. Three or four other tests failed to get any substantial results from the Lockport horizon and were drilled to the upper Medina, resulting in small yields only. Additional wells proved to be dry, one being drilled to 2,800 feet. Plans have been discussed for drilling one or more tests to the Trenton limestone, about 3,500 feet below the surface.

Figures for production in 1932 probably will show a good gain over the State totals in 1931. It is certain that more natural gas is now available for local consumption from sources outside of the State than in previous years. The most notable recent additions to the potential supplies are the Tioga and Potter County fields in Pennsylvania, not far south of the State boundary. From the Tioga field a 20-inch pipe line has been laid to Syracuse to supply that city, as well as Ithaca and Cortland. The Potter County field doubtless will be tapped by the trunk lines already in existence to supply Buffalo and other points in western New York. The outlook is for a much increased use of natural gas in central and western New York, but it is not certain that the market will be extended into the populous districts of eastern New York.

Ohio.—Natural-gas developments in Ohio during 1932 were not extensive, according to Wilbur Stout, State geologist. In the old Clinton area additional pools have been brought in along the eastern margin of the main field. The outstanding new pools have been in the townships of Springfield, Franklin, and Coventry, in Summit County, and Lawrence and Jackson, in Stark County. Initial production has ranged from 1,000,000 to 20,000,000 cubic feet daily, with rock pressures from 1,000 to 1,300 pounds. Exploratory work is being continued northeast of the old Clinton area.

The production of shale gas is gaining in importance. This new development is confined mainly to Union and Rome Townships of Lawrence County. Wells have been completed with an initial production ranging from 300,000 to 2,000,000 cubic feet daily and rock pressures from 700 to 900 pounds. The area to the north is regarded as promising, and it is expected that the field will be extended into Gallia and possibly Meigs County. Prospecting for shale gas is also under way in other areas as the belt in which gas may be obtained crosses the State from the Ohio River to Lake Erie.

Oklahoma.—Although primarily an oil field, the Oklahoma City field during 1932 was the center of interest in natural-gas developments in Oklahoma, because of the attention directed toward the problem of gas wastage and the endeavor to conserve natural gas, both because of its relationship to the production of oil and its value as an industrial and domestic fuel.

Some constructive measures directed toward the conservation of natural gas have been put into effect in the Oklahoma City field. Gas losses from the pre-Pennsylvanian zones have been reduced appreciably by classifying wells with high gas-oil ratios as gas wells instead of oil wells. An order issued by the Corporation Commission permitted operators to transfer allowable oil production from wells with high gas-oil ratios to those with lower ratios.

On May 1, 1933, there were 967 completed oil wells and 58 completed gas wells in the Oklahoma City field. In December 1932 there were 14 natural-gasoline plants in the field, with an aggregate daily capacity of 636,000,000 cubic feet. The average daily volume treated during 1932 was 442,000,000 cubic feet. The estimated daily demand for gas during the fall of 1932, including field operations and sales to pipe-line companies, was over 100,000,000 cubic feet.

There was no expansion of distribution properties during 1932, according to local reports. Pipe-line construction was nominal and consisted of one 12-mile line from the Bebee field to Stratford and a 16-mile extension in Le Flore County to Red Oak.

Pennsylvania.—No new gas fields were discovered in Pennsylvania during 1932, as the decline in industrial consumption discouraged both exploration and development, according to George H. Ashley, State geologist. Production of 63,286,242,000 cubic feet of natural gas from 16,426 wells in 22 counties was reported for 1932 by the State Bureau of Statistics compared with 74,797,000,000 cubic feet reported by the United States Bureau of Mines for 1931.

Interest in gas-field development centered in the Hebron and Tioga fields, Potter and Tioga Counties, where important discoveries were made in the Oriskany sand in 1931 and 1930, and in the region adjacent to the new fields where prospecting of the Oriskany sand has been in progress or is contemplated.

In the Tioga field 18 wells were completed during 1932, of which 15 were gas wells having a total initial daily production of about 135,000,000 cubic feet. It is reported that development work has proceeded slowly, only a few locations being active at any one time, as the shut-in production at present far exceeds the demand for the gas. As now outlined, the probable productive area of this field is about 6,000 acres. At the close of 1932 there were 41 wells with initial daily outputs ranging from 100,000 to 70,000,000 cubic feet, and averaging about 15,000,000 cubic feet. The initial rock pressures ranged from 1,450 to 1,675 pounds, and the aggregate initial daily production of all wells was about 620,000,000 cubic feet. The producing sand averages about 50 feet thick and the porosity of extruded fragments a little more than 9 percent. Wells average about 4,100 feet in depth and cost about $20,000 each to complete. The gas is dry and sweet and has a heat value of 1,030 B.t.u.

The Hebron field, Hebron Township, Potter County, was discovered in November 1931. During 1932, 8 wells were drilled in the field, of which 6 were producers ranging from 3,600,000 to 20,000,000 cubic feet in initial daily production and totaling 73,240,000 cubic feet. Rock pressures ranged from 1,950 to 2,200 pounds. One of the dry holes is well up on structure 7 miles southwest of production but did not find the Oriskany sand; the other dry hole, 7 miles northeast of production, was off apparent closure and brought in salt water. At the close of 1932, 9 wells had been completed, of which 7 were productive and had an aggregate initial daily flow of about 81,500,000 cubic feet. All the producing wells are within an area 2 miles long by 1½ miles wide; however, nothing definite is known as yet about the extent of the field. Thickness of the sand has not been determined. The porosity of fragments blown from wells averages about 9 percent. The gas is dry and sweet and has a heat value of 1,020 B.t.u.

All wells producing from the Oriskany sand are in the Tioga and Hebron fields. Thirteen wildcat wells have been completed and are dry. In addition to the 41 gas wells completed in Tioga County at the close of 1932, 37 dry holes and 5 abandoned holes above the sand are on the Sabinsville anticline and represent the effort to define the Tioga field. Fifteen or more of these 37 failures are located where, according to surface geology, production was expected, and the lack of gas is reported to be due to faulting. One dry hole is on the Harrison anticline and 1 on the Towanda anticline, and 6 dry holes and 1 abandoned hole are on the Wellsboro anticline. In Bradford County 4 holes were completed and 5 abandoned above the sand. One hole in Susquehanna and 1 in Lycoming County were abandoned above the sand, and in Erie County 1 well to the Medina was dry.

Two wells were drilled during 1932 in the Texas School field, Quemahoning and adjacent townships, Somerset County; 1 was dry, and 1 had an initial daily flow of 1,500,000 cubic feet. Fourteen wells have been drilled in this field since its discovery in 1930, 3 being gas wells with initial daily outputs of 200,000, 900,000, and 1,500,000 cubic feet. Rock pressure ranges from 725 to 800 pounds. The producing sand is near the middle of the Catskill formation. Development work was suspended in 1932.

The 20-inch pipe line from the Tioga field to Syracuse, N.Y., was completed during 1932 and placed in operation at part capacity late in the year. It is reported that the line may be extended during 1933 40 miles west to connect with the Hebron field. Gas from the Tioga field also is being supplied to towns in the Susquehanna Valley through the 14-inch line completed in 1931. Williamsport and near-by towns are being served. Local Pennsylvania and New York markets are served through lines existing when the field was discovered. A small line was built into the Hebron field during 1932, and gas from that field is being marketed in New York State.

South Dakota.—Natural-gas production in South Dakota during 1932 was approximately 16,400,000 cubic feet. There were no new developments during the year, according to E. P. Rothrock, State geologist.

Tennessee.—There was very little natural-gas development in Tennessee during 1932, according to Walter F. Pond, State geologist. The completion of a well with an initial daily capacity of 300,000 cubic feet was reported in the Sunbright field. The small fields near Sunbright, Morgan County, and Glenmary, Scott County, continued to supply gas locally. The small field at McMinnville continued to produce a limited amount of gas.

The completion of a well in Macon County in the Northern Highland Rim area was reported from local sources; also the completion of some small wells in Robertson County. A deep test is being drilled in the extreme northwestern part of Tennessee, in Obion County, and has apparently found an unexpectedly great depth of the Cretaceous. An examination by Dr. J. A. Cushman, Tennessee Division of Geology, indicated that the top of the Cretaceous was at 2,100 feet. The well is shut down temporarily at 2,500 feet. It was stated that no commercial development has taken place in the Dickinson County fields. Pipe lines from the Morgan County area to Knoxville and eastern Tennessee and from the Dickinson County fields to Nashville have been projected, but no construction has been begun.

Texas.—Natural-gas developments in Texas during 1932 were concentrated mainly in the Panhandle section and in the south and south-central section, according to W. F. Knode, chief petroleum engineer, Railroad Commission of Texas. In the Panhandle section, 24 gas wells were completed in Carson, Gray, Moore, and Potter Counties with an aggregate initial open flow daily of 707,000,000 cubic feet. These wells were classified as dry-gas wells, as the gasoline content in this general section averages less than one half gallon per 1,000 cubic feet. In view of the vast drainage area assignable to each gas well completed in the Panhandle area the 24 wells completed during 1932 are estimated to have proved approximately 100,000 acres of gas production.

The area known as south and south-central Texas comprises approximately 50 counties lying in the extreme southern tip of the State. Natural-gas developments during 1932 were confined largely to Zapata, Webb, Victoria, Nueces, and Refugio Counties, being incidental, for the most part, to the development of the various oil pools and to exploratory drilling.

In south and south-central Texas the Railroad Commission of Texas has instituted a new method of regulating gas production from a field which has oil and gas in the same pay sand. In Duval and Nueces Counties the commission has issued conservation rules governing the production of oil and gas based on an allowance of equal displacement to both the oil and gas wells. These orders are predicated on the belief that the owners in a common reservoir should be given the same privilege to produce, as it was judged unfair to shut in the gas wells to protect the oil-producing properties, and to protect the interest of both types of producers it was necessary to give each the same amount of displacement from the producing formation.

In the development of other oil fields the commission has found it necessary to regulate the spacing of the wells and the settling of casing in such manner as to best bring about conservative conditions of production. As an example, in the Conroe field in Montgomery County it was found that there was an immense gas cap overlying the oil. Here it was deemed necessary to require the operators to establish the oil-gas contact by coring before setting the producing string of casing. It was shown that by this method the over-all gas oil ratio could be reduced from approximately 4,000 cubic feet per barrel to as low as 400 cubic feet per barrel. This results in a distinct saving in gas energy and will in all probability result in a longer flowing life and increase the ultimate recovery of the pool.

During 1932, 134 wells were completed in Texas which were classified as gas wells. These 134 wells had a daily initial open flow of 1,940,500,000 cubic feet. In addition to this a quantity of gas amounting to 175,000,000 cubic feet per day was developed with oil production. Also, during 1932 the commission shut in 1,364,750,000 cubic feet due to lack of market outlet.

One gas well was completed in the North Texas district, with initial daily production of 6,500,000 cubic feet. The output is being used for domestic and industrial purposes. In West Texas, four wells were completed with an aggregate daily initial flow of 39,000,000 cubic feet, of which 30,000,000 cubic feet are being utilized. In West Central Texas, 49 wells were completed with a total initial daily production of 132,250,000 cubic feet, of which 61,250,000 cubic feet are being utilized and 71,000,000 cubic feet shut in. In East Texas, 12 wells were completed with total initial daily flow of 46,000,000 cubic feet, of which 26,000,000 cubic feet are being used for domestic purposes, 6,000,000 cubic feet processed for gasoline and the residue vented to the air, and 14,000,000 cubic feet shut in. One well in East Central Texas, with initial open flow of 42,000,000 cubic feet daily, is shut in. In the Texas Gulf coast, seven wells were completed with aggregate initial open flow daily of 175,000,000 cubic feet, of which 123,000,000 cubic feet were shut in and 52,000,000 cubic feet, produced with oil, used for domestic and industrial purposes. In South and South Central Texas 39 wells were completed with aggregate initial open flow daily of 792,750,000 cubic feet, of which 583,750,000 cubic feet were shut in and 171,000,000 cubic feet used for domestic and industrial purposes.

Utah.—The Cisco gas field remained shut in as a result of the overproduction of carbon black, the only market for gas produced in this field. Gas wells at Ashley Valley and Farnham Dome operated below capacity due to lack of a market.

Washington.—The only commercial natural-gas development in Washington is in the Rattlesnake Hills, Benton County, where 15 wells had a measured production of 132,320,000 cubic feet during 1932, according to a summary prepared by Harold E. Culver, supervisor of geology, Washington Department of Conservation and Development.[1] Additional quantities, unmetered, were utilized for lease operations, compressors, and minor uses. Seven towns in the Yakima Valley—Grandview, Prosser, Sunnyside, Mabton, Toppenish, Granger, and Zillah—are served from this field.

The Rattlesnake Hills field lies in the midst of the vast plateau of Columbia River lavas. It is regarded as a freak field in that production is from basalt, an igneous rock. Although gas has been withdrawn from the field for more than 20 years and withdrawals have increased greatly during recent commercial development of the area, there has been no appreciable decline in the flow of gas. A feature of special interest is the low pressure of the gas, the authentic maximum being 32 ounces. Because of the known occurrence of natural gas and the results of structural and stratigraphic studies one of the producing wells is being deepened in an attempt to locate source beds of the gas, which may lie below the igneous rocks.

Another test, also within the area of the Columbia basalts, is that at Union Gap just south of Yakima. Here a hole, already down 3,000 feet, is soon to be deepened in an attempt to complete a conclusive test of the structure, which is well-defined in the Columbia basalt formation. Gas showings indicate the possibility that this area may become a commercial producer.

The occurrence of natural gas is also considered a possibility in the lower Wenatchee Valley. Here the top covering of glacial drift and river alluvium is underlain by a thick series of presumably continental sediments called the Swauk formation. This is of Tertiary age, antedating the great basalt flows of the Columbia Plateau. Careful geologic work has resulted in the discovery of structures which are soon to be tested in the hope of obtaining natural gas. The petroliferous content of the rocks is indicated by the presence of several natural oil seeps. Besides considerable folding, the series has been slightly faulted, but these fractures are held of little consequence as far as the prospect for gas is concerned.

In addition to these operations on the eastern side of Cascade Mountains, there are several tests in progress on the western side which may prove of value in the production of natural gas. One regarded as promising on the basis of advanced showings is in western Clallam County. Here a test, now below 1,800 feet, is being pushed to determine the possible gas production of the sands of the Hoh formation, or of other Tertiary zones. The stratigraphy in the Olympic Peninsula is not completely worked out, but it is probable that a rather thick series of Tertiary marine sediments underlies a belt bordering the Pacific.

Other tests which warrant consideration in a survey of the gas possibilities of Washington are in Grays Harbor, Clallam, and in Whatcom Counties. From present information all of these tests, although widely separated, lie within areas of marine Tertiary beds.

West Virginia.—Production of natural gas in West Virginia for domestic purposes has been light owing to the mild winters of the

[1] In the preparation of the summary, Culver acknowledges the cooperation of R. B. Newbern, president Northwestern Natural Gas Corporation, T. A. Rogers, president Northwest Oil Research Corporation, and M. S. Hurwitz, secretary Northwest Oil and Gas Association.

past 2 years, according to Rietz C. Tucker, assistant geologist, West Virginia Geological Survey, who has stated that a larger production would have been possible in 1932 had there been a larger demand. Productive gas wells were drilled in 25 counties during 1932, and 163 gas wells were completed, with an initial production of approximately 106,000,000 cubic feet daily.

The deepest well ever drilled in West Virginia was completed in Roane County on May 11, 1932. This was the J. W. Heinzman No. 4053, on which the final report showed a depth of 9,104 feet. Three gas shows and 2 oil shows were found at depths below the Berea sand. This and upper sands had previously been productive of gas. Completions in the county totaled 17 gas wells with an aggregate initial daily production of 16,250,000 cubic feet. Three wells were estimated at 2,000,000 cubic feet each, while others ranged from 250,000 to 1,500,000 cubic feet. Depths ranged from 1,497 to 2,556 feet.

In Kanawha County 4 gas wells were completed, with a total initial production of 1,500,000 cubic feet. Depths ranged from 960 to 4,755 feet. This deep well has since been deepened further according to reports. Another deep well in Kanawha County, completed since the close of 1932, found some gas in the Devonian shale above the Oriskany sand at a depth of 4,848 feet. A strong show of gas in the Devonian shale above the Oriskany sand was reported late in the fall of 1932 in a well drilling on the Dry Fork anticline in McDowell County. The tools were blown up the hole and bridged. The well has recently been cleared and drilling resumed at a depth of over 6,600 feet. It is stated that the finding of these deep gas horizons may lead to further development.

In Boone County 19 gas wells were completed, averaging 1,000,000 cubic feet daily. One large well has an estimated production of 6,000,000 cubic feet. The others ranged from 250,000 to 1,500,000 cubic feet. Depths ranged from 1,242 to 2,978 feet. In Cabell County 9 gas wells were completed, with a total initial production of 12,500,000 cubic feet; depths ranged from 1,366 to 3,690 feet. In Calhoun County 26 gas wells were completed, with a total initial production of 17,500,000 cubic feet, depths ranging from 1,830 to 2,987 feet. In Gilmer County 7 gas wells were completed, with a total daily production of 3,750,000 cubic feet, depths ranging from 1,734 to 2,054 feet.

In Lincoln County 22 gas wells were completed, with a total initial production of 7,500,000 cubic feet daily; depths ranged from 1,945 to 3,441 feet. In Logan County 4 gas wells were completed, with a total initial production of 2,000,000 cubic feet daily and depths ranging from 1,247 to 2,981 feet. In Marian County 5 gas wells were completed, with a total initial production of 4,000,000 cubic feet daily and depths ranging from 2,030 to 3,624 feet. In Mingo County 3 gas wells were completed, the largest having a capacity of 500,000 cubic feet daily and the others of 250,000 cubic feet each, the depths ranging from 3,854 to 4,095 feet. In Monongalia County 4 gas wells were completed, the largest having a capacity of 750,000 cubic feet and the others of 250,000 cubic feet each, depths ranging from 3,072 to 3,633 feet. In Putnam County 5 gas wells were completed, with a total daily initial production of 4,250,000 cubic feet, the largest being 2,000,000 cubic feet and the others ranging from 250,000 to 1,000,000 cubic feet. Depths ranged from 1,090 to 2,107 feet. In Ritchie County 7 gas wells were completed, with a total initial daily production of 2,500,000 cubic feet, the largest having a capacity of 750,000 cubic feet while the others ranged from 250,000 to 500,000 cubic feet each. Depths were 1,880 to 2,330 feet. In Wayne County 9 gas wells were completed, with a total initial daily production of 5,750,000 cubic feet, the largest being 1,500,000 cubic feet, while the others ranged from 250,000 to 1,250,000 cubic feet. Depths were from 1,720 to 3,791 feet. In Wetzel County 3 gas wells were completed, each with a daily initial production of 250,000 cubic feet. Depths ranged from 3,213 to 3,643 feet.

One gas well each was completed in Doddridge, Harrison, Marshall, Mason, Nicholas, Pleasants, Raleigh, Tyler, Wirt, and Wood Counties. Initial productions ranged from 250,000 to 1,000,000 cubic feet daily with an average of 500,000 cubic feet. Depths were from 1,794 to 4,375 feet.

Wyoming.—Production of natural gas in Wyoming during 1932 was slightly greater than in 1931, according to local reports, approximately half being obtained with oil. A large proportion of the gas produced was returned to the sands in gas-drive projects.

The gas-drive project in the Salt Creek field was continued, residue gas from natural-gasoline plants being recycled to the producing sands. On June 30, 1932 there were 194 gas-injection wells in the field taking a daily aggregate of 20,000,000 cubic feet. The second Wall Creek sand has been found to be most adaptable for gas-drive operations and has participated to the extent of about 96 percent of the total gas recycled.

NATURAL GASOLINE

By G. B. Shea

Production of natural gasoline in 1932, on the basis of preliminary figures, totaled 1,502,400,000 gallons compared with 1,831,900,000 gallons in 1931, a decrease of 18 percent. The decline in 1932 conforms to a downward trend in natural-gasoline output which began in 1930. It is a result of voluntary curtailment and State proration of crude-oil production, plus reduction in yield caused by the adoption of rectification in the manufacture of natural gasoline to obtain volatility within the limits of specifications.

The only major outlet for natural gasoline is its utilization by refineries for blending to increase the volatility and antiknock qualities of motor fuel. In 1932 the volume blended at refineries fell sharply to 1,053,402,000 gallons, a decline of 26.2 percent from 1931. Several major economic forces were responsible for this shrinkage in the demand for natural gasoline by refineries. The reduced demand for motor fuel, the expansion of cracking facilities and vapor-recovery plants, and the intensive cracking of charging stocks, from which large yields of light condensible vapors are obtained, (making it possible for many refiners to meet the volatility requirements of motor fuel without utilizing much, if any, natural gasoline) all operated to restrict the demand for the product. Still another factor is the refining of large quantities of lighter-gravity oils found in the deeper sands, which yield gasoline of such volatility that only a relatively small amount of natural gasoline is required to blend it into satisfactory motor fuel. As a result of these factors the commodity was marketed at abnormally low prices during the year.

Contraction of the refinery demand for natural gasoline has forced the manufacturers to seek other markets, and there has been a noticeable trend toward superstabilizing to lower vapor pressures and marketing the product directly as motor fuel. In consequence, an increasing volume of low-vapor-pressure natural gasoline that had no outlet at refineries was moved directly to jobbers and sold to the retail trade in competition with refinery gasoline.

The marked decline in the need of natural gasoline by refiners was reflected in an increase in stocks, despite the decrease in output. The supply in storage was increased from 118,336,000 gallons at the beginning of the year to 134,256,000 gallons on December 31, 1932 (13.5 percent).

Salient statistics of the natural-gasoline industry, 1931–32

[Thousands of gallons]

	1931	1932	Percent of increase or decrease
Production:			
Appalachian	72,500	66,700	−8.0
Indiana, Illinois, Kentucky	10,500	8,100	−22.9
Oklahoma	454,900	377,700	−17.0
Kansas	32,700	24,600	−24.8
Texas	426,700	352,500	−17.4
Louisiana	58,000	46,400	−20.0
Arkansas	26,300	19,400	−26.2
Rocky Mountain	70,000	62,000	−11.4
California	680,300	545,000	−19.9
Total production	1,831,900	1,502,400	−18.0
Stocks:			
At plants Jan. 1	24,316	27,070	+11.3
At plants Dec. 31	27,070	18,840	−30.4
Net change	+2,754	−8,230	
At refineries Jan. 1	105,924	91,266	−13.8
At refineries Dec. 31	91,266	115,416	+26.5
Net change	−14,658	+24,150	
Total, Jan. 1	130,240	118,336	−9.1
Total, Dec. 31	118,336	134,256	+13.5
Net change	−11,904	+15,920	
Total supply [1]	1,843,804	1,486,480	−19.4
Distribution:			
Blended at refineries:			
East Coast	63,378	26,922	−57.5
Appalachian	21,630	15,834	−26.8
Indiana, Illinois, Kentucky	121,716	78,078	−35.9
Oklahoma, Kansas, Missouri	224,742	203,574	−9.4
Texas	413,574	270,858	−34.5
Louisiana, Arkansas	106,218	68,796	−35.2
Rocky Mountain	53,172	41,622	−21.7
California	422,478	347,718	−17.7
Total blended at refineries	1,426,908	1,053,402	−26.2
Blended at plants [2]	6,216	2,043	−67.1
Run through crude oil pipe lines in California	47,964	52,542	+9.5
Exports, sales to jobbers, etc	178,500	223,818	+25.4
Losses	184,216	154,675	−16.0
Total distribution	1,843,804	1,486,480	−19.4

[1] Production plus or minus changes in stocks.
[2] East of California.

Prices.—The estimated sales value of natural gasoline at the plants in 1932 was $47,620,000, representing an average price of 3.2 cents a gallon compared with 3.5 cents in 1931, when the total value was $63,732,000. The average spot price of representative grade natural gasoline during 1932 was 2.23 cents a gallon in Oklahoma and 5.18 cents in California.

MARKETS AND CONSUMPTION

Natural gasoline is an important factor in the motor-fuel market, its only major outlet. In addition to its suitability as an ingredient in motor fuel several other factors, influencing the production of the product and operating independently of demand, affect the relative position of natural gasoline in the total motor-fuel market.

The extraction of natural gasoline from the "wet" natural gas produced with oil was initiated as a conservation measure to save condensible fractions of the gas that otherwise would have been wasted. Natural-gasoline production therefore is not independently variable but fluctuates with the production of crude petroleum, increasing or decreasing according to the increase or decrease in oil production. Another factor influencing natural-gasoline production is the quantity extracted from recycled gas in repressuring and the gas lift.

At present there is a surplus of natural gas in conjunction with crude-oil production. This surplus of gas may exist even under the best operating methods now known; consequently, there is and will be a surplus of gas which at least should be processed for its gasoline content if waste is to be prevented. Part of the surplus residue gas after extraction can and will be burned to produce carbon black. The several oil and gas-producing States are taking increasing cognizance of these conservation problems, and it is entirely possible that regulations may force increased production of natural gasoline in the future or at least processing of all "wet" gas.

In addition to the natural gasoline produced from the gas that accompanies oil production an increasing quantity is being extracted by utility companies by processing "dry" gas before it is admitted to their pipe-line transportation systems. According to recent reliaable estimates approximately 20 percent of the natural-gasoline output of the greater Mid-Continent area is produced by utility companies. Since this process is a necessary step in gas collection and transportation, to remove such gasoline and water that would otherwise collect in the lines and interrupt service, such production of natural gasoline will continue regardless of market price.

Although the drop in output resulting from proration of oil production and the decline in yield resulting from rectification in processing has tended to keep the market from being flooded with distress natural gasoline, the beneficial results have been more than offset by contraction of the demand for the product by refineries as a result of expansion in cracking processes in recent years to meet the increasing market for high-octane gasoline for high-compression automotive engines. The trend toward replacement of natural gasoline in motor fuel by cracking products began in 1930, and since that date there has been a marked decline in the percentage of natural gasoline in total motor fuel. In 1932, 8 percent of the total output of motor fuel was natural gasoline compared with 9 percent in 1931 (see fig. 45).

Since, as previously stated, utilization as a blending material in motor fuel is the principal outlet for natural gasoline, the manufacturers, faced with a demand by the refineries insufficient to absorb their output, have found it necessary to seek direct marketing outlets. With efficient stabilizing and control facilities, manufacturers can produce natural gasoline with lower vapor pressures which conforms with the volatility requirements of motor fuel, and large amounts have been sold through direct-marketing channels and blended by jobbers with naphtha or refinery gasoline. Some manufacturers produce finished motor fuels with vapor pressure as low as 6½ pounds, and relatively large quantities of the product having vapor pressures of 11 to 18 pounds have been blended at bulk-station plants, particularly during the winter. These lower-pressure products are marketed as premium gasolines and are likewise suitable for aviation gasolines.

Prices of natural gasoline in relation to refinery gasoline also have been conducive to selling direct to jobbers. Analysis of the marketing situation during the past few years indicates that whenever the price of natural gasoline falls materially below tank-car prices of motor fuel there has been a tendency to find direct retail outlets. In marketing through retail channels natural-gasoline manufacturers enter into direct competition with the refiners, and the availability of cheap natural gasoline has been an unfavorable influence on the price structure of motor fuel.

The success of natural-gasoline manufacturers in reducing manufacturing costs has given them an economic advantage to compete with refiners in the retail market. Available data indicate that the average cost of manufacturing refinery gasoline is higher than that of natural gasoline. A factor in the cost of manufacturing natural gasoline is the degree of stabilization. For example, in reducing the

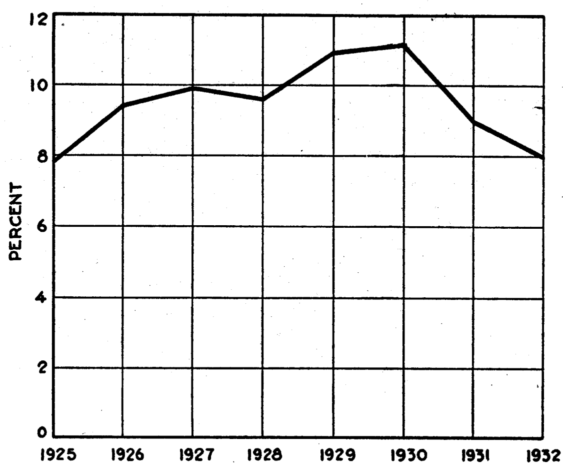

FIGURE 45.—Trend of the proportion of natural-gasoline content in motor fuel, 1925-32.

vapor pressure of the normal 26-70 grade to the desired range for motor fuel by removing the more volatile fractions, recovery is reduced 30 percent, thereby increasing the cost of manufacture. Despite this sacrifice in yield, manufacturers can produce and stabilize grades of natural gasoline at a cost below the refiners' cost of producing motor fuel.

An analysis of prices in the Mid-Continent over a period of years shows that generally the price of natural gasoline fluctuated closely with the price of refinery gasoline, a conformance in the trend that did not prevail in 1932. Although the price of refinery gasoline was advancing during the first 6 months, natural-gasoline prices changed only slightly, and during the last half of the year natural-gasoline prices strengthened perceptibly while refinery-gasoline prices trended downward. During May, June, and July a differential of approximately 2 cents per gallon between the price of refinery gasoline and the 26-70 grade of natural gasoline was the largest in recent years.

At the close of the year, however, there was relatively little difference between the price of this grade of natural gasoline and that of refinery gasoline. The relative price trends of natural gasoline and U.S. Motor gasoline over a 10-year period are shown in figure 46.

Both natural-gasoline manufacturers and refineries are faced with an oversupply of the more volatile fractions, particularly butane. Butane is a very desirable constituent of motor fuel, but its vapor pressure limits its inclusion in motor fuel according to the design of automotive fuel systems. As this equipment is developed to permit the use of motor fuel having greater volatility, the butane content of motor fuel will be increased appreciably, to the economic advantage of both the natural-gasoline manufacturers and refiners. It appears, however, that this development will be slow. Although increasing amounts of the volatile fractions are being distributed as "bottled gas" and for gas manufacturing, the market is so far short of consuming the total possible supply that the industry must depend on utilization in motor fuel as the principal market for these fractions.

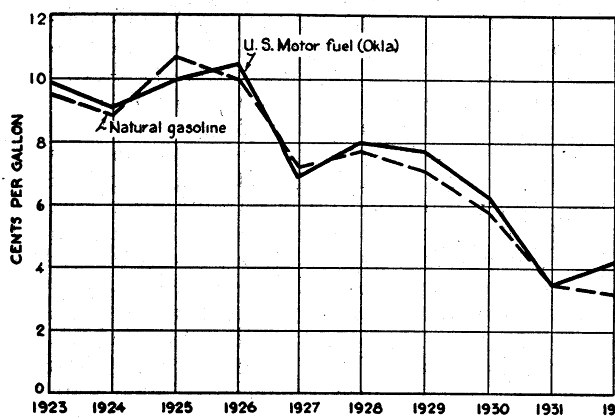

FIGURE 46.—Trends in the average refinery price of U.S. Motor fuel (Oklahoma) and in the average value of natural gasoline at plants, 1923–32.

Storage of gasoline as a factor in the market.—With limited facilities for storage at plants, manufacturers cannot accommodate the excess production during periods of declining seasonal demand. As a result, natural gasoline is first to enter the market as distress gasoline with attendant recessions in prices, which in turn tend to weaken the price structure of motor fuel.

To balance supply with fluctuations in market demand there is a growing tendency to store increasing quantities of light fractions during the summer to be blended with motor fuel during the winter, in which period present automotive fuel systems can utilize successfully products with much higher vapor pressure.

During the year there was also a trend toward blending at bulk-station plants. This practice not only provides desirable storage facilities but also has the economic advantage of entailing only one freight charge compared with the double charge when the product is transported to the refinery and out again to the consuming market.

Grading system.—An important influence on marketing has been the closer evaluation of the composition of natural gasoline conforming with the vapor-pressure requirements of motor fuel. On January 1, 1932, the Natural Gasoline Association of America adopted a differential scale of grading natural gasoline based on vapor-pressure specifications, whereby refiners or marketers can select a blending material that will meet their particular requirements. This grading scale, closely defining the composition of the products, enables buyers to determine in advance the quality of motor fuel produced by blending. The basic grade is now classified as grade 26-70 [1] and is comparable with the former AA grade of natural gasoline. This product is virtually propane-free and has a butane content of 35 percent.

The effects of the foregoing factors on the economic structure of the natural-gasoline industry are reflected in the following review of quantities distributed.

Blended at refineries.—Since 1929 the refinery demand has been decreasing steadily, each year showing a marked decline from that preceding. In 1932 a drop of 26.2 percent from the 1931 total reduced the amount blended at refineries to 1,053,402,000 gallons (70.1 percent of the total production of natural gasoline for the year).

The refinery utilization of natural gasoline by districts in 1931 and 1932 is given in the accompanying table. Except for the Oklahoma-Kansas-Missouri and the Inland Texas districts sharp reductions in the volume blended by refineries occurred in all districts in 1932.

The extremely large decrease of 57.5 percent in the amount of natural gasoline used at refineries in the east coast district reduced the volume blended with naphthas, to 26,922,000 gallons, less than 1 percent of the total motor-fuel output from this district during the year (2,866,962,000 gallons). Although the expansion of cracking facilities and vapor-recovery units is an important factor in the decline in utilization of natural gasoline by refineries in this district, the remoteness of these refineries from sources of supply is partly responsible for the small amount of natural gasoline blended with motor fuel. Despite the prevailing low prices of natural gasoline transportation charges increase its cost at these refineries to such a degree that the existing small operating margin between the manufacturing cost of motor fuel and its selling price at the refinery precludes the purchase of natural gasoline for blending in this district.

Compared with 1931 relatively small declines in the refinery usage of natural gasoline were recorded in the Oklahoma-Kansas-Missouri and inland Texas districts—9.4 and 8.1 percent, respectively. These small reductions are accounted for by the fact that many large refiners in these districts are also large manufacturers of natural gasoline. In 1932 the percentage of natural-gasoline content in refinery output of gasoline in the Oklahoma-Kansas-Missouri district was 9.4 and in the inland Texas district 11.6 percent.

During 1932 the second largest reduction in the amount of natural gasoline blended at refineries was recorded in the Texas Gulf coast district, which showed a decrease of 49.3 percent, indicating further contraction of the major market for Mid-Continent manufacturers. Of the total output of refinery gasoline from this district 4.7 percent was natural gasoline.

[1] Grade 26-70 represents vapor pressure of 26 pounds per square inch abs. at 100° F. (Reid) and 70 percent evaporated at 140° F.

Although utilization of natural gasoline for blending in the Rocky Mountain district in 1932 dropped 21.7 percent from 1931 the total refinery output of gasoline consisted of 12.4 percent natural gasoline.

The amount of natural gasoline used for blending by refineries in California continues to be largest of any district, both in volume blended and in percentage of total motor-fuel output. In 1932, 14.5 percent of the total gasoline output in California consisted of natural gasoline. The relatively high degree of utilization of natural gasoline for blending by California refineries is explained by the fact that a major part of the large output of natural gasoline is manufactured by integrated companies whose refineries are an outlet for most of the product of the natural-gasoline departments.

Blended at plants.—The practice of some manufacturers in blending natural gasoline with naphtha purchased from refiners to produce a finished motor fuel has declined rapidly since 1929, when 27,569,000 gallons of natural gasoline were blended at plants. Following this trend, purchases of naphtha from refineries have dropped also. In 1932 only 2,043,000 gallons of natural gasoline were used in motor-fuel blends by manufacturers (a loss of 67.1 percent from 1931).

The practice of blending at plants is affected primarily by the price of motor fuel in relation to that of naphtha. Under existing market conditions, with only a small margin between the price of naphtha and that of motor fuels, natural-gasoline manufacturers find it unprofitable to continue blending at plants.

Exports and sales to jobbers.—Shipments of natural gasoline to foreign markets dropped sharply in 1932. A major part of the exports of stabilized natural gasoline originates at California and Gulf coast ports. An analysis of exports of natural gasoline from California through the Panama Canal to Atlantic foreign markets shows that shipments dropped from 95,906,000 gallons in 1931 to 39,710,000 gallons in 1932 (58.6 percent). This decrease was partly offset by an increase in Pacific foreign shipments, from 8,296,000 gallons in 1931 to 15,234,000 gallons in 1932 (83.6 percent). Total exports of natural gasoline from California in 1932 were 54,944,000 gallons (47.3 percent less than the amount exported in 1931). The recent trend toward expansion of direct marketing outlets was reflected in an increase of sales to jobbers in 1932 compared with 1931.

Stocks.—On December 31, 1932, stocks of natural gasoline at plants were the lowest in 7 years, the supply in storage being 18,840,000 gallons (8,230,000 gallons below the stocks recorded at the beginning of the year). However, an increase of 24,150,000 gallons in stocks at refineries during the year more than offset the decrease at plants, and at the close of the year total stocks were 134,256,000 gallons (an increase of 13.5 percent for the year).

Total stocks of natural gasoline in California December 31, 1932 were 101,378,000 gallons (75.5 percent of the total supply in storage) of which 98,742,000 gallons were stored at refineries. During the year stocks of natural gasoline at California refineries increased 26,670,000 gallons (37.0 percent). This large increase was partly offset by a decline of 2,520,000 gallons in refinery stocks of natural gasoline east of California, resulting in a net increase of 24,150,000 gallons in stocks at refineries throughout the country.

LIQUEFIED PETROLEUM GASES

The production of liquefied petroleum gases as byproducts of natural-gasoline manufacture has increased rapidly in recent years. The suitability of these gases for domestic fuels, for use in conjunction with gas manufacturing, and for special fuels in diversified industries has led to wide expansion of the liquefied petroleum-gas industry. At present, however, the available supply greatly exceeds market requirements.

In 1932, 33,630,000 gallons of propane, butane, pentane, and propane-butane mixtures were marketed, representing an increase of approximately 5,000,000 gallons (17 percent) above that recorded in 1931. A marked increase in the utilization of liquefied petroleum gases for gas manufacturing accounted for nearly all the gain in total sales during the year. Nearly all of the output came from natural-gasoline plants, although some refinery production was marketed.

The market for propane is predominantly domestic utilization for fuel in areas beyond the range of present gas-distributing systems. In 1932 the domestic market for propane totaled 14,570,392 gallons compared with a consumption of 257,407 gallons in gas-manufacturing and 354,072 gallons for industrial and miscellaneous purposes.

Although some propane is shipped in tank cars, tank wagons, or pipe lines, by far the largest quantity is marketed in steel cylinders, and therefore it is commonly referred to as "bottled gas." Of the total marketed production of propane in 1932 (15,181,871 gallons), 13,416,567 gallons were shipped in cylinders or drums, and 1,765,304 gallons were shipped in tank cars, tank wagons, or pipe lines. The demand for propane during the year was only slightly above that recorded in 1931. The number of "bottled gas" customers is estimated at 160,000.

The principal market for butane is in industry, where it is used in conjunction with gas manufacturing for gas enrichment and for supplying additional volume to meet peak loads in gas systems; as a source of gas supply in localities to which other types of gas service are not available; and as a fuel for special heating requirements in manufacturing. In 1932 the market for butane in gas manufacturing totaled 7,225,851 gallons (approximately one half the total demand). There is also a growing demand for butane as an industrial fuel and other miscellaneous applications, and during the year this outlet consumed 7,353,856 gallons. The total demand for butane was 14,661,688 gallons, of which 14,658,737 gallons were shipped in tank cars, tank wagons, or pipe lines and only 2,951 gallons in cylinders or drums.

Propane-butane mixtures, including some pentane, amounting to 3,786,677 gallons also were marketed in domestic, gas-manufacturing, and industrial channels.

The communities served by butane-air gas plants or through the distribution of undiluted gases at the close of 1932 represent a net gain of 16 over the 188 reproted at the close of the preceding year.

TECHNOLOGIC DEVELOPMENTS

Under the present practice of manufacturing products within the limits of vapor-pressure specifications, ranging from motor fuel to the more volatile grades of natural gasoline, efficient plant control and flexibility in operation have become increasingly important. As a result, there has been continued improvement in stabilizing equipment and automatic-control devices. Economies have been effected through improved methods of water-treating, proper lubrication of high-pressure cylinders, and prevention of corrosion.

The trend toward larger but fewer plants continued during the year, although activity in new-plant construction was retarded. Many small plants were closed because they could not make a profit at the abnormally low prices of natural gasoline. With a large volume of through-put the unit cost of processing gas per thousand cubic feet is less in larger plants, thereby reducing the cost per gallon of the product. Another factor influencing the construction of large plants is the relatively high cost of stabilizing equipment, the installation of which can be justified only in connection with large plants.

REVIEW BY STATES

A large part of the decline in output of natural gasoline in all areas in 1932 compared with 1931 (see accompanying table) resulted from curtailment of crude-oil production in nearly all fields.

California.—Regulation of gas wastage by the State and the proration of crude-oil production in every important California field had a major influence on natural-gasoline production, as evidenced by an output for 1932 of 545,000,000 gallons, a decline of 135,300,000 gallons (19.9 percent) below the 1931 figure. This large decrease in output in the leading natural-gasoline-producing State is 41 percent of the total drop in production—329,500,000 gallons—for the country in 1932. The Kettleman Hills field, with an output of 135,300,000 gallons in 1932, the largest of any field in the State, declined 21.4 percent from the 1931 output. Production of the Long Beach field was 104,400,000 gallons (off 22.9 percent from 1931), and the output of Santa Fe Springs dropped to 99,400,000 gallons (a decrease of 19.3 percent). Although restriction of oil production is an important factor in the reduced output from the Long Beach and Santa Fe Springs fields, these fields are showing definite signs of natural decline. On the other hand, the restricted output from the Kettleman Hills field is only a small part of its potential output.

Oklahoma.—The Oklahoma output dropped from 454,900,000 to 377,700,000 gallons (17 percent). Except for the Oklahoma City field, which increased its output from 53,800,000 to 77,100,000 gallons, all fields in Oklahoma showed relatively large declines in 1932. The increase in the Oklahoma City field in comparison with 1931 is accounted for by an increase in the allowable withdrawals of crude oil from that field under 1932 proration orders. However, the gain in output of 23,300,000 gallons in the Oklahoma City field fell far short of offsetting the loss of 76,300,000 gallons in the Seminole field. The year's output in that field—112,400,000 gallons—was 40.4 percent less than in 1931, indicating a material depletion of the gas supply from the field. The drop in output of 28.8 percent in the Osage field likewise was abnormally large.

Texas.—Texas, the third ranking producing State, had an output of 352,500,000 gallons (74,200,000 gallons below the 1931 output). The prolific East Texas field, though a dominating influence in the crude-oil market, is relatively unimportant as a producer of natural gasoline because the oil in the reservoir is "undersaturated," and therefore gas-oil ratios are lower than in most fields, accounting for the relatively small volume of wet gas available at the wells. All gas is dissolved in the oil at the bottom of the flow string, and no free gas exists in the reservoir.

Recent tests in the East Texas field by Bureau of Mines engineers reveal that whereas "bottom-hole" samples of oil were obtained indicating a reservoir pressure of approximately 1,400 pounds per square inch absolute, no gas is liberated from solution in the oil, at reservoir temperature, above a pressure of 755 pounds per square inch absolute. However, the extreme richness of the gas in gasoline content offsets to a considerable degree the low volume of gas produced with the oil. Analyses of gas from vent lines have indicated a gasoline content as high as 4 to 6 gallons per 1,000 cubic feet of gas, promising a large potential volume of natural gasoline. The small number of gasoline plants in the field may be ascribed to existing conditions, such as competitive drilling, acreage held in small blocks, and depression in the natural-gasoline market. At the end of 1932 natural gasoline was produced in the East Texas field at the rate of 1,000,000 gallons a month.

In the Panhandle field inactivity in drilling and production and the manufacture of gasoline having lower vapor pressures in 1932 depressed the output about 20 percent—to 170,800,000 gallons.

West Virginia.—West Virginia, the largest natural-gasoline-producing State in the Appalachian district, had an output of 46,363,000 gallons in 1932 compared with 52,844,000 gallons in 1931, a decline of 12.3 percent.

Pennsylvania.—With an output of 15,047,000 gallons, representing an increase of 708,000 gallons or 4.9 percent above 1931, Pennsylvania was the only State that produced more natural gasoline in 1932 than in 1931.

Other States.—The production of 17,353,000 gallons in New Mexico in 1932 was only slightly less than in 1931, when the output was 17,775,000 gallons. Production in Wyoming declined from 51,523,000 gallons in 1931 to 44,211,000 in 1932 (14.2 percent).

CARBON BLACK

By G. R. Hopkins and H. Backus

The year 1932 in the carbon-black industry was generally satisfactory as to tonnage moved but was disappointing from the standpoint of prices and profits. The statistical position of the industry, as measured by the number of days' supply in storage, showed marked improvement in 1932, but stocks on hand remained at high levels, and prices receded to below generally accepted costs. (See fig. 47.) The production of carbon black, which had declined 26 percent in 1931, decreased 14 percent more in 1932. Although this decline in production was material, it would doubtless have benefited

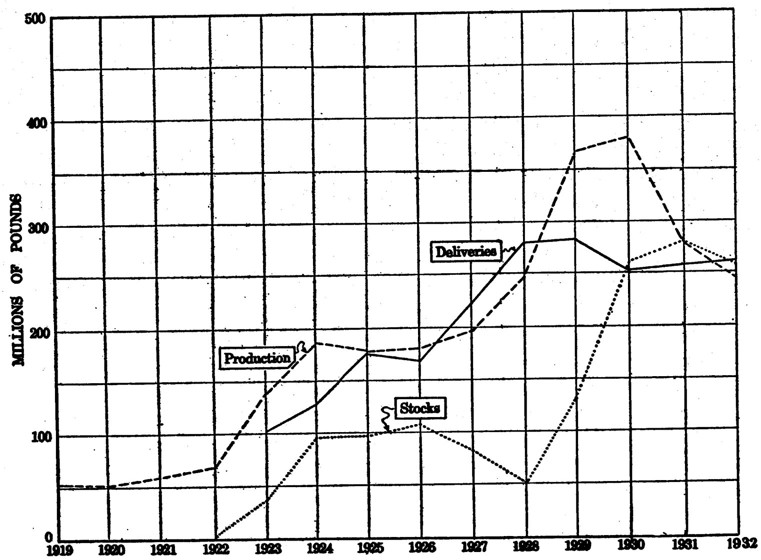

Figure 47.—Carbon-black production, stocks, and deliveries, 1919-32.

the industry if it had been larger; however, this was not possible because, as one authority states, "since there is so much residue gas available and with so many contracts with strict minimums in force, it means that the producer must either burn gas or pay for it."

Although the production of carbon black in the Texas Panhandle declined 10 percent in 1932 the drop in output elsewhere was greater, with the result that the industry was further centralized in the Amarillo district.

There are two general types of carbon black—contact blacks (made, as the name implies, by impinging the flame against a relatively cold surface) and furnace blacks (made by cracking gas in a retort). Contact blacks may be divided further according to type of contact surface, such as channel, roller, and disk. In 1932 the production of channel blacks, which comprises nearly all the production of contact blacks, totaled 224,536,000 pounds; the output of all other blacks was 18,164,000 pounds. In 1931 channel blacks represented 91 percent of the total output and in 1932, 93 percent, indicating a further gain in the relative importance of this class.

The yield of carbon black has increased slowly in recent years, but in 1932 as in 1931 it averaged 1.44 pounds per thousand cubic feet of gas burned, indicating that no outstanding changes had been made in technical methods. The average yields reported for 1932 ranged from a low of 1.08 pounds per thousand cubic feet for Louisiana to 1.88 pounds for the plants near Breckenridge, Tex., and in Oklahoma and Wyoming. The average yield of 1.44 pounds indicates a total consumption of 168,237,000,000 cubic feet of natural gas at carbon-black plants during 1932. Complete statistics for natural gas in 1932 are not yet available, but the quantity burned for carbon black was probably about 11 percent of the total amount utilized.

An encouraging feature of the industry in 1932 was the declining trend in producers' stocks of carbon black. Before 1932 such stocks increased rapidly, particularly in 1930, when they nearly doubled. Despite a material decline in production in 1931, stocks continued to rise, but in 1932 they declined for the first year since 1928. However, the quantity on hand December 31, 1932—257,998,000 pounds—was virtually a year's supply.

Total sales of carbon black in 1932 amounted to 261,555,000 pounds, an increase of 1 percent over 1931. This gain resulted solely from a gain in exports, as domestic sales decreased slightly. Sales to rubber companies continued to absorb the greater part of the domestic demand (81 percent in 1932), although the relative proportion of total sales credited to the rubber industry declined in 1932.

Exports of carbon black, an important element in the total demand, rose to a new high level in 1932. The continued increase in foreign trade has been encouraging to the industry, although the decline in export prices has been relatively greater than that in domestic prices. Less encouraging reports from foreign countries which indicate increasing competition abroad concern the operation of a plant in Japan and the probable construction of one in Rumania. It has been reported that the Japanese plant was placed in operation about May 1, 1932, treating 2,500,000 cubic feet of gas per day with a yield of 1.5 to 1.8 pounds per thousand cubic feet.

Salient statistics of carbon black made from natural gas in the United States, 1928–32

	1928	1929	1930	1931	1932
Number of producers reporting	31	35	33	26	24
Number of plants	65	71	69	58	50
Quantity produced:					
By States and districts:					
Kentucky ... pounds	484,000				
Louisiana ... do	136,320,000	127,345,000	96,729,000	57,485,000	42,260,000
Texas:					
Breckenridge ... do	35,901,000	29,079,000	16,905,000	13,332,000	[1] 23,071,000
Panhandle ... do	64,927,000	199,104,000	254,844,000	197,546,000	177,369,000
Total Texas ... do	100,828,000	228,183,000	271,749,000	210,878,000	[1] 200,440,000
West Virginia ... do	697,000	578,000	(2)		
Other States ... do	10,461,000	10,336,000	11,464,000	12,544,000	
Total ... do	248,790,000	366,442,000	379,942,000	280,907,000	242,700,000
By processes:					
Channel process ... do	220,532,000	327,552,000	350,254,000	255,322,000	224,536,000
Other processes [3] ... do	28,258,000	38,890,000	29,688,000	25,585,000	18,164,000
Stocks held by producers Dec. 31 ... pounds	50,240,000	132,203,000	259,245,000	280,010,000 [4] 281,667,000	257,998,000
Losses ... do	802,000	673,000	1,361,000	1,716,000	4,814,000
Quantity sold:					
Domestic—					
To rubber companies ... do	140,938,000	138,474,000	128,572,000	134,315,000	130,380,000
To ink companies ... do	27,223,000	27,350,000	19,220,000	15,184,000	18,341,000
To paint companies ... do	20,040,000	17,257,000	11,922,000	6,760,000	7,636,000
For miscellaneous purposes ... do	14,475,000	8,896,000	7,565,000	5,453,000	5,126,000
Total ... do	202,676,000	191,977,000	167,279,000	161,712,000	161,483,000
Export ... do	77,903,000	91,829,000	84,260,000	96,714,000	100,072,000
Total ... do	280,579,000	283,806,000	251,539,000	258,426,000	261,555,000
Value (at plants) of carbon black produced:					
Total ... dollars	13,782,000	18,720,000	14,852,000	8,621,000	6,664,000
Average per pound ... cents	5.54	5.11	3.91	3.07	2.75
Estimated quantity of natural gas used ... M cubic feet	175,137,000	261,107,000	266,625,000	195,396,000	168,237,000
Average yield per M cubic feet ... pounds	1.42	1.40	1.43	1.44	1.44

[1] Oklahoma and Wyoming included with Breckenridge district.
[2] Included under "Other States."
[3] 1928–30 and 1932: Disk, Lewis, roller, "special", and thermatomic; 1931: Disk, roller, "special," and thermatomic.
[4] Revised to compare with 1932.

Domestic consumption.—Total sales of carbon black in 1932 amounted to 261,555,000 pounds, an increase of 3,129,000 pounds, or 1 percent, over 1931 but 8 percent below the peak figure of 1929. Of the 1932 total, 161,483,000 pounds (62 percent) represented domestic sales and 100,072,000 pounds (38 percent) exports. Of the total domestic deliveries, 130,380,000 pounds (81 percent) were consigned to rubber companies, 18,341,000 pounds (11 percent) to ink companies, and 7,636,000 pounds (5 percent) to paint and varnish companies, leaving 5,126,000 pounds (3 percent) used in miscellaneous products. (See fig. 48.) Unlike the experience of 1931 these data indicate increases in the relative proportions consigned to ink and paint companies at the expense of sales to rubber companies.

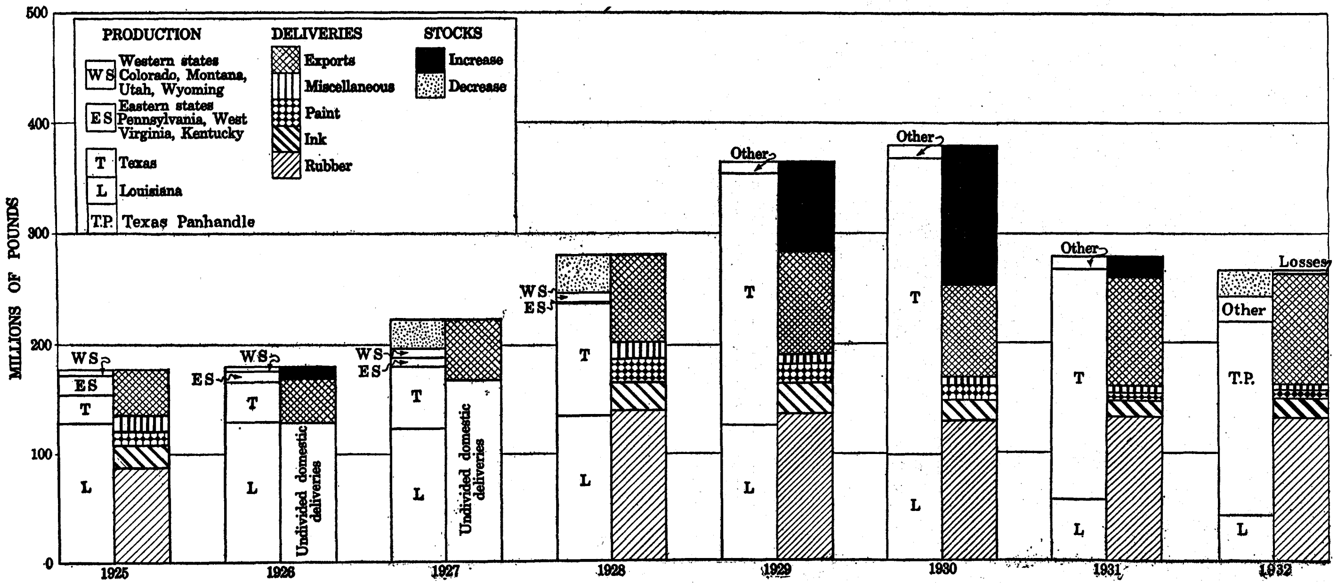

FIGURE 48.—Production and consumption of carbon black, 1925–32.

Sales of carbon black to rubber companies increased steadily until 1928, but since then have tended to decline. In general, this decline was expected, as the number of automobile casings manufactured has decreased coincident with the slump in motor-vehicle production and with the more recent decrease in the number of cars in use. Another viewpoint may be obtained through an analysis of figures supplied by E. G. Holt, chief, Rubber Division, Bureau of Foreign and Domestic Commerce. According to Holt, the consumption of crude rubber in 1932 was 332,000 long tons and that of reclaimed rubber 77,500 long tons. The total consumption of 409,500 long tons represents a decrease of 14 percent from 1931, but as reclaimed rubber probably does not require much carbon black in reprocessing the relative decline in crude-rubber consumption in 1932 (5 percent) should approximate the decrease in sales of carbon black to rubber companies. That the actual decrease in such sales was considerably below 5 percent indicates the coexistence of other factors, such as the possibility that rubber manufacturers added to their carbon-black stocks in 1932 or that the consumption of carbon black in the average casing increased either by changes in formula or through the introduction of the new "doughnut" tire.

Sales of carbon black to ink companies in 1932 increased 21 percent but did not equal the 1930 figure and were about a third lower than in 1928–29. According to N. S. Meese, assistant chief, Paper Division, Bureau of Foreign and Domestic Commerce, sales of newsprint continued to be affected adversely by business conditions and radio competition, declining 13 percent in 1932. In view of these conditions, it is surprising that sales of carbon black to ink companies increased in 1932; a possible explanation is that stocks at ink plants were depleted in 1931 but augmented in 1932.

The indicated sales to paint and varnish companies totaled 7,636,000 pounds in 1932, 13 percent over 1931. Little data are available on the production of paints and varnishes in 1932, but possibly there was some recovery from the low point reached in 1931 and reported by the Bureau of the Census. Other explanations of the increase in sales in 1932 are that black paints have returned to favor in the automobile trade, or that stocks at paint factories were increased.

Carbon black is adaptable for use as a filler and as a coloring and reenforcing agent in many articles, such as phonograph records, crayons, typewriter ribbons, carbon paper, and artificial stone. This class of consumption has decreased rapidly in recent years due to the decline in manufacturing and to the competition of cheaper agents. In 1932, 5,126,000 pounds of carbon black were sold to manufacturers of the various miscellaneous articles, a decrease of 6 percent from 1931. Newer uses for carbon black that appear to have commercial possibilities are in automobile brake bands and in the preparation of dark-surfaced highway construction, which eliminates road glare, permits more definite contrast in lanes to reduce traffic hazards, and accelerates the melting of ice and sleet.

Losses of carbon black incurred in handling at the plants have tended to increase in recent years. Losses were 4,814,000 pounds in 1932 compared with 1,716,000 pounds in 1931; however, the greater part of this increase resulted from fires rather than from less efficient methods generally.

Prices and value.—The average value at plants of the carbon black produced in 1932 was 2.75 cents, compared with 3.07 cents in 1931. The 1932 figure undoubtedly represented the lowest average yet recorded. Most contracts for deliveries over the early part of the year were based on a price of 3 cents, but general competitive conditions and the failure of the rubber industry to make a substantial recovery resulted in a decline to 2.75 cents in the late spring. This price held generally over the remainder of the year, but the insistence of some large buyers on a protective clause in their contracts to cover decreases in price made the outlook for higher quotations in 1933 doubtful. Average values in 1932 ranged from 2.68 cents for Panhandle black to 3.02 cents for Louisiana black.

Quoted prices of various grades of carbon black, 1931–32, in cents per pound

[Oil, Paint and Drug Reporter]

Date	Lithoink qualities (bags)	Standard rubber, ink, and paint qualities (bags, cases)	Works, Louisiana (bags)	Works, Texas (bags)
1931				
Jan. 1 [1]	22.0	7.5	4.1	4.0
Jan. 12		7.0	3.6	3.5
Feb. 9			3.1	3.0
1932				
Apr. 25		5.75	2.85	2.75
June 13		5.0		
July 18			2.82	2.72

[1] In effect as of first of year.

Competitive products.—Carbon black competes with a number of other products of which the most important are zinc oxide, bone black, and lampblack. In many instances the competition of these products with carbon black is very slight. Each has certain uses in which it excels; nevertheless it might be helpful to show the pertinent statistics for the three principal competitors, as follows:

Salient statistics of competitive products

	Production (pounds)			Value per pound (cents)		
	1929	1931	1932	1929	1931	1932
Bone black	[1] 54,277,051	33,214,240	(2)	4.6	3.9	(2)
Lampblack	[1] 10,765,492	3,424,048	(2)	11.0	9.4	(2)
Zinc oxide	394,978,000	218,964,000	160,784,000	6.3	6.2	5.3

[1] Represents sales by manufacturers.
Not available.

REVIEW OF PRODUCTION BY STATES AND DISTRICTS

Since the days when carbon black was relatively scarce and used only by a few ink manufacturers the carbon-black industry has depended upon large supplies of cheap gas. It was founded in Pennsylvania but moved to West Virginia early in the twentieth century. The next step in the southwesterly migration of the center of the industry was to Louisiana, about 1920, to take advantage of the large supply of gas available in the Monroe field. The next and most recent move was to the Texas Panhandle in 1928. The discovery of large reserves of gas in west Texas led some to believe that the industry might advance still further southwest; however, construction in west Texas so far has been confined to the erection of an experimental plant in the Big Lake field.

Production in the 23 plants of the Texas Panhandle in 1932 totaled 177,369,000 pounds, which, although a decrease of 10 percent from 1931, constituted 73 percent of the country's output. In 1930 and 1931 this ratio was 67 and 70 percent, respectively, indicating continued centralization in the Texas Panhandle. Utah and Montana ceased producing in 1932, leaving only Texas, Louisiana, Oklahoma, and Wyoming.

Carbon black produced from natural gas in the United States, 1932, 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)	Estimated quantity of natural gas used (M cubic feet)	Average yield per M cubic feet (pounds)
Louisiana: Monroe-Richland district (Morehouse, Ouachita, and Richland Parishes)	11	20	42,260,000	$1,278,000	3.02	39,070,000	1.08
Oklahoma	1	1	(1)	(1)	(1)	(1)	(1)
Texas:							
Breckenridge district (Eastland and Stephens Counties)	4	5	[1] 23,071,000	[1] 631,000	[1] 2.74	[1] 12,276,000	[1] 1.88
Panhandle district (Carson, Gray, Hutchinson, and Wheeler Counties)	[2] 13	23	177,369,000	4,755,000	2.68	116,891,000	1.52
Total Texas	[2] 14	28	[1] 200,440,000	[1] 5,386,000	[1] 2.69	[1] 129,167,000	[1] 1.55
Wyoming	1	1	(1)	(1)	(1)	(1)	(1)
Total United States, 1932	[2] 24	50	242,700,000	6,664,000	2.75	168,237,000	1.44
1931	[2] 26	58	280,907,000	8,621,000	3.07	195,396,000	1.44

[1] Oklahoma and Wyoming included with Breckenridge district.
[2] In counting the total number of producers, a producer operating in more than 1 State, district, or county is counted only once.

Number and capacity of plants.—In 1932, 50 carbon-black plants were operated, 8 less than in the previous year. The number of operators declined from 26 to 24 during the same period. This centralization of the industry in fewer hands in 1932 further reflected the generally unsatisfactory conditions resulting from the low prices, which were, in turn, due mainly to overproduction. However, the change in the list of carbon-black producers in 1932 was not as marked as in 1931, indicating that most high-cost producers were eliminated when the average price reached 3 cents per pound.

The total daily capacity of the plants operated during 1932 was 1,244,975 pounds, compared with 1,366,975 pounds for those operated during 1931. As the average daily production of carbon black in 1932 was 663,115 pounds, the plants operated at an average of about 53 percent of their capacity compared with 56 percent in 1931.

Number and daily capacity of carbon-black plants operated in the United States, 1931–32, by counties or parishes

State	County or parish	Number of plants		Total daily capacity (pounds)	
		1931	1932	1931	1932
Louisiana	Morehouse	8	4	101,900	59,850
	Ouachita	13	14	271,425	238,925
	Richland	2	2	26,000	20,000
		23	20	399,325	318,775
Montana	Stillwater	1		5,000	
Oklahoma	Beckham	1	1	(1)	(2)
Texas	Carson	2	1	86,800	(3)
	Eastland	1	1	(4)	(2)
	Gray	9	9	308,400	308,400
	Hutchinson	11	10	435,500	414,250
	Stephens	5	4	[4] 50,450	[2] 104,550
	Wheeler	3	3	24,000	[3] 99,000
		31	28	905,150	[2] 926,200
Utah	Grand	1		(1)	
Wyoming	Niobrara	1	1	(1)	(2)
Undistributed [5]				57,500	
United States		58	50	1,366,975	1,244,975

[1] Included under "Undistributed"; Bureau of Mines not at liberty to publish figures.
[2] Oklahoma, Wyoming, and Eastland County included with Stephens County.
[3] Carson County included with Wheeler County.
[4] Eastland County included with Stephens County.
[5] 1931: Oklahoma, Utah, and Wyoming.

Carbon-black producers of the United States, as of Dec. 31, 1932

State and company	County	Nearest town	Process
Louisiana:			
Century Carbon Co., 251 Front Street, New York, N.Y.	Ouachita	Swartz	Channel.
	Richland	Archibald	Do.
	do	Mangham	Do.
J. Smylie Herkness, route no. 2, Bastrop, La	Morehouse	Bastrop	Do.
J. M. Huber Co. of Louisiana, Inc., 460 West Thirty-fourth Street, New York, N.Y.	Ouachita	Swartz	Do.
Imperial Oil & Gas Products Co., 1104 Union Bank Building, Pittsburgh, Pa.	do	Sterlington	Do.
Monroe-Louisiana Carbon Co., 45 East Forty-second Street, New York, N.Y.	do	Hancock	Lewis.
Peerless Carbon Black Co., 3003 Grant Building, Pittsburgh, Pa.	do	Bourland	"Special."
	do	Guthrie	Do.
Southern Carbon Co., 45 East Forty-second Street, New York, N.Y.	Morehouse	Perryville	Channel.
	Ouachita	Fowler	Do.
	do	Swartz	Do.
Texas-Louisiana Producing & Carbon Co., post-office box 181, Monroe, La.	Morehouse	Collinston	Do.
Thermatomic Carbon Co., 230 Park Avenue, New York, N.Y.	Ouachita	Sterlington	Thermatomic.
United Carbon Co., post-office box 1475, Charleston, W.Va.	Morehouse	Bastrop	Channel.
	Ouachita	Cargas	Do.
	do	Phillips	Do.
	do	Swartz	Do.

Carbon-black producers of the United States, as of Dec. 31, 1932—Continued

State and company	County	Nearest town	Process
Oklahoma: Oklahoma Carbon Industries, Inc., Sayre, Okla.	Beckham	Sayre	Channel.
Texas:			
Cabot Carbon Co., 940 Old South Building, Boston, Mass.	Gray	Pampa	Do.
	Hutchinson	Stinnett	Do.
Cabot Co., 940 Old South Building, Boston, Mass.	Carson	Skellytown	Channel and roller.
Coltexo Corporation, 45 East Forty-second Street, New York, N.Y.	Gray	Lefors	Channel.
	Stephens	Parks	Do.
Crescent Carbon Co., Point Pleasant, W.Va.	Hutchinson	Borger	Do.
Eastern Carbon Black Co. (United Carbon Co., owner), post-office box 1475, Charleston, W.Va.	do	Borger (2 plants)	Do.
	do	Borger	Channel and disk.
General Atlas Chemical Co., 60 Wall Street, New York, N.Y.	Gray	Pampa	"Special."
J. M. Huber Co. of Louisana, Inc., 460 West Thirty-fourth Street, New York, N.Y.	Hutchinson	Borger	Channel.
Magnolia Petroleum Co., Dallas, Tex.	Gray	Pampa	Do.
	Wheeler	Magic City	Do.
Palmer Carbon Co., 80 East Jackson Boulevard, Chicago, Ill.	Hutchinson	Borger	Do.
Peerless Carbon Black Co., 3003 Grant Building, Pittsburgh, Pa.	Eastland	Pioneer	"Special."
	Gray	Pampa	Do.
Texas Carbon Industries, Inc., Sayre, Okla.	Stephens	Breckinridge (2 plants.)	Channel.
Texas Elf Carbon Co., 940 Old South Building, Boston, Mass.	Gray	Pampa	Do.
	Stephens	Eliasville	Do.
Western Carbon Co., 45 East Forty-second 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 Thirty-fourth Street, New York, N.Y.	Niobrara	Manville	Do.

FOREIGN TRADE

Contrary to the general trend in foreign trade, exports of carbon black increased consistently in 1931 and 1932. In 1932 shipments totaled 100,072,486 pounds, an increase of 3 percent over 1931 and 84 percent over 1927. Although the carbon black exported still commands a higher price than that sold to domestic consumers, the increase in exports has been accompanied by a steady decline in average value. Thus, in 1932 the average value of exports was 4.43 cents per pound, compared with 5.25 cents in 1931 and 8.45 cents in 1927. Imports of "gas black and carbon black" in 1932 totaled 175,940 pounds, valued at $15,448. These imports probably were special blacks, that is, not true contact blacks.

The United Kingdom continued to be the leading carbon-black customer, although shipments to that country declined from 32,279,-788 pounds in 1931 to 31,059,005 pounds in 1932. Exports to France and Germany, which rank second and third, respectively, increased in 1932. The largest increase was in exports to Australia, which more than doubled in 1932; the largest decrease was recorded in exports to Canada.

The principal exporting months in 1932 were July, October, and December; 33 percent of the total exports was shipped in those months. The principal exporting ports for carbon black in 1932 were Galveston and New Orleans, 88 percent of the total exports being shipped from those ports.

Carbon black exported from the United States, 1930–32, by countries

Country	1930		1931		1932	
	Pounds	Value	Pounds	Value	Pounds	Value
Australia	2,630,771	$184,283	1,915,738	$97,890	4,052,346	$184,713
Belgium	2,644,502	174,676	2,896,126	139,952	3,351,515	156,027
Canada	11,757,174	601,134	9,825,346	352,236	6,977,194	224,254
China	995,423	70,614	1,047,870	58,320	1,328,446	63,114
France	16,438,685	1,179,074	18,039,671	1,005,411	19,459,854	895,177
Germany	12,369,542	902,712	14,414,348	771,243	16,216,415	695,446
Italy	2,485,113	210,034	2,808,707	165,458	3,391,780	151,893
Japan	4,402,010	299,254	6,313,937	327,366	5,997,461	278,464
Netherlands	1,896,430	138,249	1,583,015	86,051	2,424,612	108,426
United Kingdom	24,017,974	1,695,203	32,279,788	1,763,180	31,059,005	1,392,895
Other	4,622,823	334,225	5,589,570	311,731	5,813,858	285,922
Total	84,260,447	5,789,458	96,714,116	5,078,838	100,072,486	4,436,331

Carbon black exported from the United States in 1932, by months and districts

Month	Pounds	Value	District	Pounds	Value
January	8,200,319	$392,157	Galveston	48,439,856	$2,101,399
February	6,382,126	299,977	New Orleans	39,283,798	1,846,099
March	7,926,121	382,250	Michigan	6,641,262	209,647
April	7,808,998	378,303	Los Angeles	2,851,233	125,010
May	7,244,208	360,611	San Francisco	1,437,756	68,499
June	8,151,354	373,629	Sabine	667,659	32,726
July	10,848,456	493,660	New York	333,920	32,038
August	6,328,333	265,504	Vermont	176,862	5,575
September	7,328,454	302,900	Buffalo	61,296	4,787
October	11,338,757	464,313	Washington	50,606	1,989
November	7,493,622	298,351	San Antonio	34,588	2,983
December	11,021,738	424,676	Other	93,650	5,579
Total	100,072,486	4,436,331	Total	100,072,486	4,436,331

ASPHALT AND RELATED BITUMENS

By A. H. Redfield

Decreased activity in road and street surfacing, in the manufacture of prepared roofing, and in general building construction lowered the sales of petroleum asphalt one sixth from 1931 to 1932. Sales of cut-back and emulsified asphalts, however, decreased little, because of the development of low-cost bituminous types of surfacing, especially for secondary roads. Production of petroleum asphalt kept pace with sales, but refinery stocks were slightly lower at the end than at the beginning of 1932.

Domestic demand for petroleum and lake asphalt in 1932 was 16 percent lower than in 1931. In contrast to the general decline, railroad deliveries of asphalt in the North Central States were one fourth larger in 1932 than in 1931.

Sales of road oil were 15 percent larger in 1932 than in 1931 as a result of continued increase in the use of low-cost bituminous types of surfacing highways.

Cheaper types of highway construction and a general policy of spending highway funds to spread employment reduced sales of natural rock asphalt one third from 1931 to 1932. Gilsonite sales were 21 percent smaller in 1932 than in 1931 as a result of reduced activity in the paint, rubber, and insulated-wire industries and in building construction.

Exports of petroleum asphalt decreased 29 percent from 1931 to 1932. Imports of asphalt and bitumen in 1932 were relatively unimportant.

Salient statistics of asphalt and related bitumens in the United States, 1931–32

	1931	1932
SUPPLY		
Native asphalt and related bitumens:		
Produced……short tons	503,383	340,019
Imported (chiefly lake asphalt)……do	73,672	20,474
Petroleum asphalt (excluding road oil):		
Produced at refineries from—		
Domestic petroleum……do	1,274,744	1,115,547
Foreign petroleum……do	1,700,946	1,359,372
	2,975,690	2,474,919
Stocks, Jan. 1……do	287,891	304,623
Total supply……do	3,840,636	3,140,035

Salient statistics of asphalt and related bitumens in the United States, 1931–32—Con.

	1931	1932
DISTRIBUTION		
Native asphalt and related bitumens: short tons..		
Indicated domestic demand..........do....	484, 406	327, 654
Exports (unmanufactured)..........do....	18, 977	12, 365
Petroleum asphalt (excluding road oil):		
Indicated domestic demand (including lake asphalt)..........do....	2, 744, 531	2, 295, 326
Exports..........do....	288, 099	206, 006
Stocks, Dec. 31..........do....	304, 623	298, 684
Total distribution..........do....	3, 840, 636	3, 140, 035
VALUES		
Native asphalt and related bitumens:		
Sales..........	$2, 930, 451	$1, 942, 943
Imports (chiefly lake asphalt)..........	726, 217	251, 402
Exports (unmanufactured)..........	530, 822	448, 949
Petroleum asphalt:		
Sales (excluding road oil) from—		
Domestic petroleum..........	10, 855, 688	8, 591, 564
Foreign petroleum..........	14, 005, 651	10, 013, 553
Total sales..........	24, 861, 339	18, 605, 117
Exports..........	4, 940, 611	3, 168, 138

NATIVE ASPHALTS AND BITUMENS

Bituminous rock.—Sales of bituminous rock by producers in the United States were 33.3 percent less in quantity and 36.9 percent less in value in 1932 than in 1931. They totaled 470,491 short tons, valued at $2,244,739, in 1931, and 314,039 tons, valued at $1,415,427, in 1932. Kentucky producers furnished 161,202 tons, valued at $1,197,620, in 1931, and 91,289 tons, valued at $792,643, in 1932; Texas producers sold 228,956 tons, valued at $705,437, in 1931, and 132,636 tons, valued at $312,663, in 1932. Minor quantities were marketed by producers in Alabama, California, Kansas, Missouri, Oklahoma, and New Mexico.

The demand for rock asphalt was less in 1932 because a lower mileage of hard-surfaced highways and a smaller yardage of paved city streets were built in 1932 than in 1931. Much of the money available for road and street construction was spent by States, counties, and cities in laying types of surface that would require less expenditure for materials and would provide more employment.

Exports of natural asphalt, unmanufactured, from the United States decreased 34.8 percent in quantity and 15.4 percent in value from 1931 to 1932. They totaled 18,977 short tons, valued at $530,822, in 1931, and 12,365 tons, valued at $448,949, in 1932. Seventy-four percent of these exports in 1931 and 80 percent in 1932 were shipped to Europe. Canada received 12.3 percent of the total in 1931 and 11.3 percent in 1932.

Gilsonite and wurtzilite.—Reduced activity in the manufacture of paint, rubber, and insulated wire and in building construction resulted in a decrease of 20.8 percent in the tonnage of gilsonite sold by producers in northeastern Utah (from 32,763 short tons in 1931 to 25,955 tons in 1932), and of 22.1 percent in the values obtained (from $674,102 in 1931 to $525,266 in 1932).

Sales of wurtzilite from northeastern Utah decreased from 129 tons, valued at $11,610, in 1931, to 25 tons, valued at $2,250, in 1932.

MANUFACTURED OR PETROLEUM ASPHALT

Domestic demand for petroleum and lake asphalt declined 16.4 percent, while the refinery production of petroleum asphalt declined 16.8 percent in 1932 compared with 1931. Production of asphalt (exclusive of road oil) at petroleum refineries in the United States totaled 2,474,919 short tons in 1932, compared with 2,975,690 tons in 1931. Stocks of asphalt held by refineries were reduced from 304,623 tons on December 31, 1931, to 298,684 tons on December 31, 1932. Imports, chiefly of lake asphalt and grahamite, dropped from 73,672 tons in 1931 to 20,474 tons in 1932. Exports of petroleum asphalt declined from 288,099 short tons in 1931 to 206,006 tons in 1932. The indicated domestic demand for petroleum and lake asphalt was 2,295,326 tons in 1932, a decline of 449,205 tons from the 2,744,531 tons reported for 1931.

Production.—Of the 2,474,919 short tons of asphalt manufactured at petroleum refinieries in 1932, 1,359,372 tons were made from foreign crude oil, imported chiefly from Venezuela, Colombia, and Mexico, and 1,115,547 tons from crude petroleum produced in the United States. The total output in 1932 included 107,491 short tons of other petroleum products blended with the asphalt to produce commercial varieties of the required hardness and consistency.

Production, receipts, stocks, consumption, transfers and losses, and sales of asphalt (exclusive of road oil) at petroleum refineries in the United States in 1932, by districts

District	Production	Other petroleum products blended	Receipts from other sources	Stocks	
				Dec. 31, 1930	Dec. 31, 1931
	Short tons	*Short tons*	*Short tons*	*Short tons*	*Short tons*
East coast	1,120,561	69,637	72,466	85,506	108,439
Appalachian	113,770	2,430	730	19,922	9,360
Indiana-Illinois-Kentucky	352,860	7,466	167	89,039	66,277
Oklahoma-Kansas-Missouri	34,228	772	1,719	3,915	4,706
Texas: Gulf coast	143,900			8,398	5,963
Total, Texas	143,900			8,398	5,963
Louisiana-Arkansas:					
Louisiana Gulf coast	158,743	23,958	404	27,311	38,392
Northern Louisiana and Arkansas	64,366	2,628		22,739	22,819
Total Louisiana and Arkansas	223,109	26,586	404	50,050	61,211
Rocky Mountain	3,300	600	1,544	2,213	3,231
California	375,700		96	45,580	39,497
Grand total, 1932	2,367,428	107,491	77,126	304,623	298,684
Total, 1931	2,933,193	42,497	10,674	287,891	304,623

District	Consumption by companies	Transfers and losses	Sales	
			Quantity	Value
	Short tons	*Short tons*	*Short tons*	
East coast	2,201	29,554	1,207,976	$9,012,756
Appalachian	69	14,062	113,361	963,258
Indiana-Illinois-Kentucky	1,411	193	381,651	2,890,910
Oklahoma-Kansas-Missouri	149		35,779	290,393
Texas: Gulf coast	23,668	7,908	114,759	833,549
Total, Texas	23,668	7,908	114,759	833,549

Production, receipts, stocks, consumption, transfers and losses, and sales of asphalt (exclusive of road oil) at petroleum refineries in the United States in 1932, by districts—Continued

District	Consumption by companies	Transfers and losses	Sales	
			Quantity	Value
	Short tons	*Short tons*	*Short tons*	*Short tons*
Louisiana-Arkansas:				
Louisiana Gulf coast	10,901	105	161,018	$1,154,097
Northern Louisiana and Arkansas			66,914	275,318
Total, Louisiana and Arkansas	10,901	105	227,932	1,429,415
Rocky Mountain	2	957	3,467	37,085
California	25,835	32,151	323,893	3,147,751
Grand total, 1932	64,236	84,930	2,408,818	18,605,117
Total, 1931	74,396	21,945	2,873,291	24,861,339

Sales by uses.—Refinery sales of petroleum asphalt were 16.2 percent less in quantity and 25.2 percent less in value in 1932 than in 1931. They decreased from 2,873,291 short tons, valued at $24,861,339, in 1931 to 2,408,818 tons, valued at $18,605,117, in 1932. Street paving and road building accounted for nearly 60 percent of the total tonnage of asphalt sold in 1931 and 1932, in the form of paving asphalt, paving flux, cut-back asphalt, and asphalt emulsions. The manufacture of prepared roofing required 28 percent of the asphalt sold in 1931 and 29.2 percent of that sold in 1932. About 5 percent of the asphalt sold in 1931 and 1932 was consumed in the construction of buildings, tanks, reservoirs, and bridges, in the form of waterproofing asphalt and flux, mastic and mastic flux, pipe coatings, and paints, lacquers, and varnishes.

Due to a general decrease in road and street surfacing, sales of paving asphalt by petroleum refineries declined 23.8 percent (from 1,124,253 short tons in 1931 to 856,638 tons in 1932). The average value of paving asphalts sold in the United States decreased from $8.65 in 1931 to $7.41 in 1932. Sales of paving flux declined from 113,801 tons in 1931 to 107,468 tons in 1932.

Refinery sales of roofing asphalt and flux were 16 percent less in 1932 than in 1931, as a result of decreased manufacture of prepared roofing, indicated by a decrease of 9.5 percent in factory shipments of dry roofing felt. Sales of roofing asphalt declined from 708,850 short tons, valued at $6,053,780, in 1931 to 567,962 tons, valued at $4,102,311, in 1932. Sales of roofing flux, however, increased slightly, from 127,262 tons, valued at $901,021, in 1931, to 134,431 tons, valued at $1,146,032, in 1932.

Sales of cut-back asphalts decreased slightly in quantity, from 446,413 short tons in 1931 to 440,838 tons in 1932; however, they gained in relative importance from 15.5 percent of all asphalt sold in 1931 to 18.3 percent of that sold in 1932.

Refinery sales of asphalts and fluxes emulsified with water increased from 16,805 short tons (3,954,134 gallons) in 1931 to 44,354 tons (10,436,288 gallons) in 1932. In addition, 32,550,000 gallons of asphalt emulsions in 1931 and 25,800,000 gallons in 1932 were sold by industrial companies which emulsified asphalts or fluxes bought from petroleum refiners.

Asphalt and asphaltic material (exclusive of road oil) sold at petroleum refineries in the United States in 1932, 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	353,506	$2,880,650	503,132	$3,466,478	856,638	$6,347,128
Roofing	293,299	2,196,883	274,663	1,905,428	567,962	4,102,311
Waterproofing	59,206	578,311	43,547	308,714	102,753	887,025
Blending with rubber	1,361	19,604	17,826	134,753	19,187	154,357
Briquetting	24,574	262,842	2,888	21,205	27,462	284,047
Mastic and mastic cake	637	8,042	1,060	6,974	1,697	15,016
Pipe coatings	4,177	48,896	4,562	32,761	8,739	81,657
Molding compounds	8	181	1,997	13,005	2,005	13,186
Miscellaneous uses	24,610	203,294	44,310	256,025	68,920	459,319
	761,378	6,198,703	893,985	6,145,343	1,655,363	12,344,046
Semisolid and liquid products of more than 200 penetration:[1]						
Flux for:						
Paving	79,566	514,484	27,902	209,101	107,468	723,585
Roofing	40,938	252,860	93,493	893,172	134,431	1,146,032
Waterproofing	1,477	9,258	1,854	12,051	3,331	21,309
Cut-back asphalts	148,860	1,315,630	291,978	2,328,101	440,838	3,643,731
Emulsified asphalts and fluxes	12,121	177,063	32,233	395,264	44,354	572,327
Paints, enamels, japans, and lacquers	5,584	65,687	2,848	19,036	8,432	84,723
Other liquid products	12,892	57,879	1,709	11,485	14,601	69,364
	301,438	2,392,861	452,017	3,868,210	753,455	6,261,071
Grand total, 1932	1,062,816	8,591,564	1,346,002	10,013,553	2,408,818	18,605,117
Total, 1931	1,163,898	10,855,688	1,709,393	14,005,651	2,873,291	24,861,339

[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 molding compositions, such as battery boxes, electrical fittings, push buttons, knobs, handles, and other equipment.
Miscellaneous uses.—Asphalts 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 asphalt for paving, roofing, waterproofing, and other purposes.
Cut-back asphalts.—Asphalts softened or liquefied by mixing them with petroleum distillates.
Emulsified asphalts 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.

DOMESTIC DEMAND

The indicated domestic demand for petroleum and lake asphalt, calculated by adding imports to domestic production and subtracting exports, plus or minus stock changes, averaged 191,277 short tons per month in 1932, a decrease of 16.4 percent from the monthly average of 228,711 tons in 1931 and of 19.7 percent from the monthly average of 238,271 tons in 1930.

In comparing the asphalt demand in 1932 with that in 1931, or any preceding year, the year chosen as a standard of comparison may be one in which asphalt demand was abnormally high or low, or subject to unusual conditions. If this uncertainty is eliminated by using the average demand for several preceding years as a standard of comparison, no allowance is made for any tendency toward increase or decrease in asphalt demand during those years. These disadvantages may be overcome by using as a standard of comparison the long-time trend, that is, the underlying tendency to increase or decrease over a period of years. The long-time trend of asphalt demand from 1908 to 1931, inclusive, calculated mathematically, gives an expected monthly demand of 230,815 short tons in 1929, 240,708 tons in 1930, 250,577 tons in 1931, and 260,423 tons in 1932. However, the actual asphalt demand during 1931 was 8.7 percent below

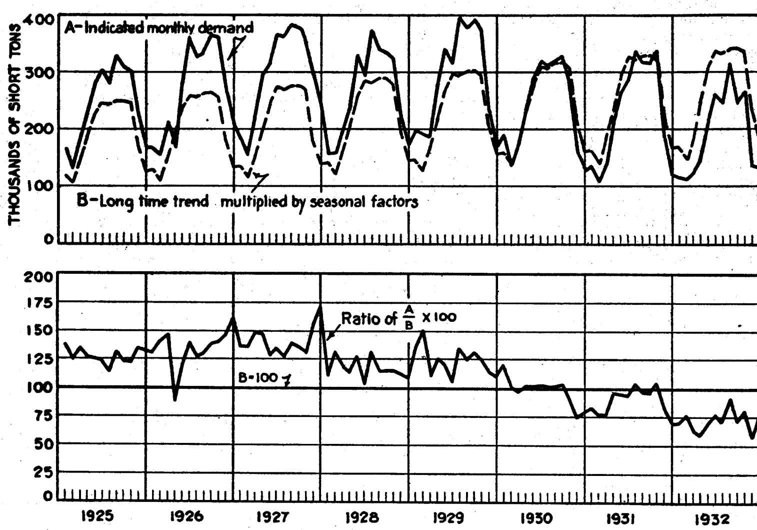

FIGURE 49.—Relation of indicated monthly demand for asphalt, 1925–32, to long-time trend, 1908–31, multiplied by seasonal factors. The long-time trend is expressed by the formula, $\log Y=1.095818+0.944148 \log X$, in which Y equals the average monthly demand for petroleum and lake asphalt during each 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.

the expected demand and during 1932 was 26.6 percent below the expected demand. On the other hand, the average monthly demand during 1930, although it fell far short of the average demand for 1929, closely approximated the long-time trend.

The demand for asphalt, however, is highly seasonal, reaching its maximum from June to September and its minimum during December, January, and February. Any comparison between months of the same year should, therefore, take into account seasonal variations from the average demand for the year. Accordingly, in the following table and in figure 49 the expected trend determined on the long-time basis has been multiplied by seasonal factors, and the modified monthly figures are compared with the actual monthly demand for asphalt in 1931 and 1932.

Relation of indicated asphalt demand to basic trend multiplied by seasonal factors, 1931–32

Month	1931			1932		
	Trend multiplied by seasonal factors (short tons)	Indicated monthly demand (short tons)	Relation of indicated monthly demand to trend (percent)	Trend multiplied by seasonal factors (short tons)	Indicated monthly demand (short tons)	Relation of indicated monthly demand to trend (percent)
January	160,011	133,371	83.35	166,421	115,302	69.28
February	137,536	105,068	76.39	143,027	110,536	77.28
March	182,035	138,361	76.01	189,278	123,435	65.21
April	238,160	216,998	91.11	247,600	147,276	59.48
May	292,955	262,723	89.68	304,528	214,976	70.59
June	322,665	286,367	88.75	335,366	259,498	77.38
July	320,024	335,540	104.85	331,831	243,532	73.39
August	325,916	314,733	96.57	338,657	313,353	92.53
September	325,892	313,267	96.13	338,589	241,124	71.21
October	318,791	337,236	105.78	331,169	262,806	79.36
November	222,107	185,255	83.41	230,700	132,375	57.38
December	165,352	115,612	69.92	171,728	131,113	76.35
Total		2,744,531			2,295,326	

During the first 3 months of 1932 the indicated domestic demand averaged 70.6 percent of the long-time trend multiplied by seasonal factors, compared with 78.6 percent during the first 3 months of 1931. In the second quarter of 1932 domestic demand averaged 69.2 percent of the expected demand, compared with 89.9 percent in the second quarter of 1931. From July to September 1932 the actual demand averaged 79 percent of the expected demand, compared with 99.2 percent in the same months of 1931. In the last 3 months of 1932 domestic requirements of asphalt averaged 71 percent of the expected requirements, compared with 86.4 percent in the last 3 months of 1931.

DISTRIBUTION BY RAIL

The tonnage of asphalt (natural, byproduct, or petroleum) terminated by class I railroads in the United States totaled 2,617,253 short tons in 1932, a decrease of 6.4 percent from the 2,795,457 tons terminated in 1931, according to statistics compiled by the Interstate Commerce Commission. In contrast to the general decline, railroads of the Northwestern region terminated 246,485 tons of asphalt in 1931 and 302,613 tons in 1932, chiefly in Wisconsin, Minnesota, Iowa, Nebraska, Montana, Wyoming, Idaho, Washington, and Oregon; and railroads of the Pocahontas district terminated 72,075 tons in 1931 and 81,696 tons in 1932, chiefly in Virginia and West Virginia.

Sixty-four percent of the asphalt (petroleum, lake, and natural rock) terminated in the United States by land carriers in 1932 was delivered to consumers in the Northeastern district, lying north of the Potomac and Ohio Rivers and east of the Mississippi and Illinois Rivers. The tonnage of asphalt terminated in this district was 9.4 percent lower in 1932 than in 1931. In the Southeastern district, lying south of the Potomac and Ohio Rivers and east of the Mississippi and Pearl Rivers, railroad deliveries of asphalt were 31.4 percent lower in 1932 than in 1931. In the Southwestern district, west of the Mississippi and Pearl Rivers and south of St. Louis, Kansas City, and Amarillo, asphalt deliveries fell 62.2 percent from 1931 to 1932. On the other hand, the tonnage of asphalt terminated in the North Central district increased 25.8 percent (from 247,201 tons in 1931 to 311,019 tons in 1932). West of Great Falls, Cheyenne, Denver, Albuquerque, and El Paso, in the Pacific-Rocky Mountain district, the tonnage of asphalt terminated was 5.9 percent larger in 1932 than in 1931.

Supply and distribution of asphalt (petroleum, lake, and natural rock) exclusive of road oil, in the United States, by districts, 1932, in short tons

	Northeastern district	Southeastern district	Southwestern district	North Central district	Pacific-Rocky Mountain district
SOURCE					
Produced within district	1,498,239	297,334	596,292		423,073
Imported	10,891	8,666	807		109
Received by rail from:					
Northeastern district		30,000	2,400	182,035	
Southeastern district	310,606		24,000	25,000	
Southwestern district	25,000	274,923		75,000	
Pacific-Rocky Mountain district	25,000		30,000	29,032	
Received by water (coastwise)	165,908	22,932	7,067		103,802
Withdrawn from stocks	11,334				5,065
	2,046,978	633,855	660,566	311,067	532,049
DISTRIBUTION					
Shipped by rail:					
Within district	1,680,535	272,429	111,868	311,019	[1] 247,128
To Northeastern district		310,606	25,000		25,000
To Southeastern district	30,000		274,923		
To Southwestern district	2,400	24,000			30,000
To North Central district	182,035	25,000	75,000		29,032
Shipped by water (coastwise and intraport)	100,000	706	88,191		110,812
Exported	52,008	171	76,067	48	90,077
Added to stocks		943	9,517		
	2,046,978	633,855	660,566	311,067	532,049

[1] Includes shipments by electric railroads, minor steam railroads, and motor trucks.

FOREIGN TRADE

Imports.—Imports of asphalt and bitumen into the United States decreased from 73,672 short tons, valued at $726,217, in 1931 to 20,474 tons, valued at $251,402, in 1932. Lake asphalt imported from Trinidad amounted to 29,543 tons in 1931 and 12,596 tons in 1932. From Venezuela 29,718 tons of lake asphalt were imported in 1931, but none was imported in 1932. Glance pitch or grahamite imported from Cuba decreased from 13,764 tons in 1931 to 7,457 tons in 1932.

Exports.—Exports of petroleum asphalt from the United States were 28.5 percent less in quantity and 35.9 percent less in value in 1932 than in 1931. They decreased from 288,099 short tons, valued at $4,940,611, in 1931 to 206,006 tons, valued at $3,168,138, in 1932. The largest declines in tonnage of asphalt exported were in shipments in northern and western Europe, Canada, Latin America, and Africa. On the other hand, more asphalt was sold to Australia, British India, the Philippine Islands, French Indo-China, Italy, and Belgium in 1932 than in 1931.

ROAD OIL

Continued increase in the use of low-cost bituminous types of paving and surfacing, especially in the construction of secondary roads, increased the sale of road oil 15.3 percent from 1931 to 1932. Petroleum-refining companies in the United States sold 7,170,102 barrels (1,200,579 short tons) of road oil in 1931 and 8,264,824 barrels (1,389,046 tons) in 1932. Because of lower prices, however, the value obtained from these sales increased only 5.2 percent (from $6,944,320 in 1931 to $7,306,332 in 1932). The average value of road oil sold in the United States was $0.969 per barrel in 1931 and $0.884 in 1932, a decrease of 8.8 percent.

Only 13.1 percent of the road oil sold in the United States in 1931 and only 10.3 percent in 1932 were made from foreign crude, imported chiefly from Venezuela and Mexico. Eighty-four percent of the road oil made from foreign crude in 1931 and 86.4 percent in 1932 were manufactured in refineries of the Atlantic seaboard; the rest was made in Gulf coast refineries of Louisiana and Texas.

Road oil sold by petroleum refineries in the United States, 1931–32, by districts

District	1931		1932	
	Barrels	Value	Barrels	Value
East coast	1,023,830	$1,302,827	1,042,185	$1,205,069
Appalachian	209,667	240,309	199,273	172,519
Indiana-Illinois	2,250,744	2,104,650	2,574,621	2,053,411
Oklahoma-Kansas-Missouri	801,067	656,117	1,058,854	809,584
Texas:				
Gulf coast	83,258	103,480	90,893	107,617
Rest of State	1,362	2,825	196,713	62,960
Total Texas	84,620	106,305	287,606	170,577
Louisiana-Arkansas:				
Louisiana Gulf coast	110,355	124,156	75,649	63,756
Northern Louisiana and Arkansas	81,934	39,989	153,117	61,918
Total Louisiana and Arkansas	192,289	164,145	228,766	125,674
Rocky Mountain	795,277	853,594	904,892	998,910
California	1,812,608	1,516,373	1,968,627	1,770,588
Grand total	7,170,102	6,944,320	8,264,824	7,306,332

Seventy-one percent of the road oil sold in 1931 and 67.6 percent of that sold in 1932 came from three refining districts—the East coast, the Indiana-Illinois-Kentucky, and the California. Road-oil sales in all three districts increased from 1931 to 1932. There were large gains also in road-oil sales in Oklahoma, Kansas, and Missouri; in inland Texas; and in northern Louisiana and Arkansas. On the other hand, sales of road oil by refineries of the Louisiana Gulf coast continued to decrease in 1932, and sales by Appalachian refineries were slightly less in 1932 than in 1931.

Petroleum refineries in the United States reported the production of 6,879,000 barrels of road oil in 1932 compared with 5,177,000 barrels in 1931.

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The refinery output of road oil in 1932 included 1,579,590 barrels of other petroleum products, chiefly fuel oil, transferred to road-oil stocks compared with 2,450,192 barrels similarly transferred in 1931. Stocks of road oil, and of transferred fuel and other oils, held at refineries in the United States increased from 487,237[1] barrels on December 31, 1931, to 571,333 barrels on December 31, 1932. Consumption of road oil by the petroleum-refining companies in their own operations, losses, and adjustments accounted for 109,670 barrels during 1932.

Prices of road oil were generally lower in 1932 than in 1931. The greatest decrease in value was in the Indiana-Illinois-Kentucky district, where the average sales value declined from $0.935 per barrel in 1931 to $0.798 in 1932. In the East coast district the average sales value of road oil decreased from $1.273 in 1931 to $1.156 in 1932; and in the Oklahoma-Kansas-Missouri district from $0.819 in 1931 to $0.765 in 1932. On the other hand, refineries of the Rocky Mountain district averaged $1.073 a barrel in 1931 and $1.104 in 1932, and California refineries averaged $0.837 a barrel in 1931 and $0.899 in 1932.

[1] Revised.

CEMENT

By H. H. Hughes and B. W. Bagley

Despite efforts of Federal and local Governments to relieve unemployment through appropriations for highways and public works, shipments of portland cement in 1932 declined 36.6 percent from 1931. Stocks decreased 16.4 percent, and production declined 39.0 percent. If it is assumed that the producing capacity of the industry remained constant from 1931 to 1932, the industry operated throughout the year at only 28.1 percent of capacity.

Salient statistics of the cement industry in the United States, 1931–32

	1931	1932 [1]	Percent change	
			1932 from 1931	1932 from 1923–25 average
Portland cement:				
Production ... barrels	125,429,071	76,509,000	−39.0	−48.8
Shipments ... do	127,150,534	80,579,000	−36.6	−45.0
Stocks [2] ... do	24,177,159	20,205,000	−16.4	+40.0
Capacity ... do	271,850,000	[3] 271,850,000		+53.7
Value of shipments	$140,976,450	$80,835,000	−42.7	−69.7
Unit factory value	$1.11	$1.00	−9.9	−45.4
Exports [4] ... barrels	429,653	374,581	−12.8	−61.2
Total value	$1,220,600	$802,205	−34.3	−71.9
Value per barrel [5]	$2.84	$2.14	−24.6	−27.5
Imports ... barrels	457,238	462,496	+1.0	−81.4
Total value	$507,918	$351,033	−30.9	−91.3
Business indicators:				
Capacity utilized:				
Portland cement ... percent	46.1	[6] 28.1	−39.0	−66.8
Steel [7] ... do	38.0	19.0	−50.0	−73.0
Industrial production [8] ... index number	81.0	64.0	−21.0	−36.0
Asphalt, domestic demand [9] ... short tons	3,228,937	2,622,979	−18.8	−24.7

[1] Figures for 1932 are subject to revision.
[2] End of year.
[3] Capacity for 1932 not yet computed but virtually identical to 1931.
[4] Does not include shipments to Alaska, Hawaii, and Puerto Rico—353,136 barrels in 1931 and 296,562 barrels in 1932.
[5] The value of exports of domestic cement is the actual cost at the time of exportation in the ports of the United States, as declared by the shippers on the export declarations.
[6] Computed from 1931 capacity figure.
[7] Computed from statistics of the American Iron and Steel Institute.
[8] Federal Reserve Board; 1923–25 average=100.
[9] Compiled by A. H. Redfield, U.S. Bureau of Mines, includes both petroleum and native asphalt.

Although cement prices stiffened during the last 6 months of 1932, the average factory value for the year declined 9.9 percent—from $1.11 in 1931 to $1 in 1932. This drop, coupled with that of shipments, resulted in a decline of 42.7 percent in total value. The cement industry, which did a volume of business ranging from $228,779,756 to $278,854,647 each year from 1923 to 1930, suffered materially in 1931, when the total value of its product dropped to \$140,976,450 and became virtually stagnated in 1932, when the total value dropped to \$80,835,000. This amount is the lowest reported since 1915. As the producing capacity of the industry, an accurate indicator of capital investment, has been more than doubled since 1915, it follows that overhead charges per barrel of output have grown to alarming proportions. Revival of construction will remedy the situation, but if it is delayed too long drastic revision of the financial structure of some companies is indicated.

To gain a proper perspective of the cement industry it must be compared with other industries. Production of steel ingots in 1932 amounted to only 19 percent of available capacity, compared with 38 percent in 1931. This represents a decrease of 50 percent from 1931 to 1932. In 1932 the indicated domestic demand for asphalt, a competitor of cement in the highway field, declined only 18.8 percent from 1931. The drop in paving asphalt, however, was greater than that in asphalt used for roofing, the only other large market.

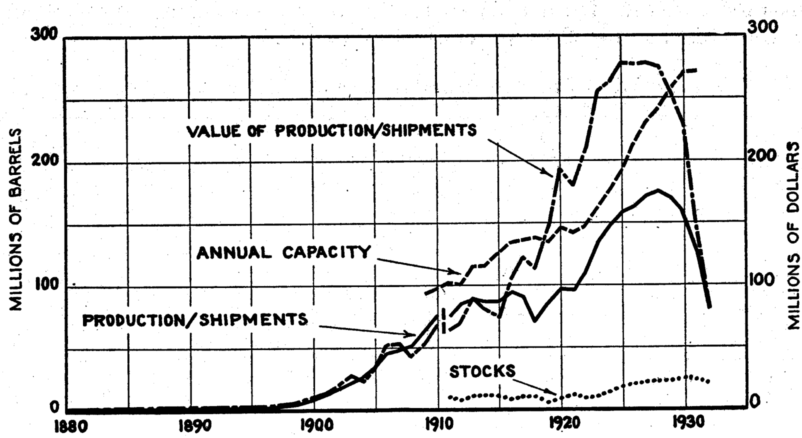

FIGURE 50.—Growth of the portland-cement industry, 1880–1932.

Index numbers of the Federal Reserve Board, computed to show industrial production compared with 1923–25 as 100, stood at 81 in 1931 but declined to 64 in 1932. This index, of course, is weighted by industries less susceptible to fluctuating conditions than cement or steel. Index numbers for cement shipments calculated on the same base were 87 for 1931 and 55 for 1932. The cement industry, therefore, was relatively active in 1931 but dropped below the general business level in 1932.

Figure 50 shows the relation among cement shipments, value, capacity, and stocks. Although the centennial of the discovery of portland cement was celebrated in 1924, the development of the domestic industry was slow until about 1900. Normal growth was interrupted in 1918, but with this exception progress continued at a relatively uniform rate until 1922. The cement industry then experienced a boom which continued until 1928, the output increasing each year. Such prosperity was bound to attract capital, and the increase in production was accompanied by even greater activity in plant construction.

In the table already given 1932 and the period 1923–25 are compared. This 3-year period is especially significant in the study of cement, not only because it is used as the base for other business indicators but also because the industry itself then experienced a better balance between production and capacity than at any time in its history.

Relation of production to capacity.—In 1932 production and shipments of cement declined 48.8 and 45.0 percent, respectively, from the 1923–25 average, whereas capacity increased 53.7 percent. Figure 51, showing the percentage of available producing capacity utilized by the cement industry since 1910, reveals that production was maintained at nearly 85 percent of capacity from 1923 to 1925, inclusive. This apparently represents the optimum of past experience. An ever-widening breach since 1924 between production and available capacity for production aroused concern among the more conservative leaders of the cement industry, and the depression of the past 3 years focused the attention of the entire industry upon this problem.

Careful study reveals that the situation is far more complicated than the curves indicate. Even if the Bureau of Mines estimate of

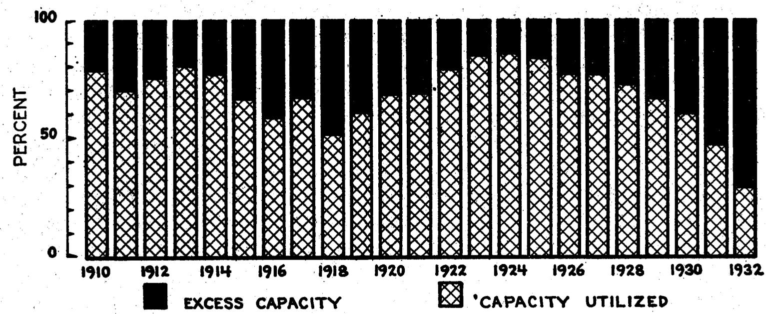

FIGURE 51.—Relation of production of portland cement to total producing capacity, 1910–32.

271,850,000 barrels annual capacity at the end of 1931 was revised downward 10 percent, conditions still would be acute. Reduction of estimated capacity would necessitate eliminating from consideration high-cost plants that have been inactive for several years. Any such procedure immediately involves a discussion of obsolescence, a problem of special significance in its relation to the cement industry.

Obsolescence.—Broadly speaking, the cement plants of the United States can be divided into three classes. The first class includes plants that are virtually obsolete and inactive most of the time. The out-of-pocket manufacturing costs of such plants are extremely high, but because of low overhead charges total production costs may be only slightly higher than those at more modern plants in the same district.

The second general class includes most of the cement plants in the United States—those built during the last 25 years and kept reasonably modern through frequent remodeling. Production costs conform in general to the average of the industry. Saving a fraction of a cent per barrel in production costs by curtailing output was not attractive to the operators during the boom years when most of these plants were built. As a result the average production cost for most of them probably is slightly higher than it might have been if they had been built in a period of economy and conservatism.

The third class of plants includes those built primarily for economy of operation and low unit cost regardless of ultimate output. Developments in Europe are characteristic of this trend.

The obvious procedure would seem to include wholesale replacement of existing plants with more modern equipment designed to reduce production costs. The solution, however, is not so simple. As depreciation, interest, and tax charges make up a considerable part of the final production costs, any contemplated new venture or modernizing program, unless carefully planned, may increase overhead charges enough to more than offset savings in actual manufacturing costs. Continuation of adverse economic conditions such as prevailed in 1932 tend to force an adjustment of the situation. Furthermore, agitation among architects and engineers for cement approaching high-early-strength properties but at no increase in price may encourage producers to rebuild obsolescent plants.

New developments.—Although no new cement plants were built in 1932, persistent rumors of promotional activities were prevalent, and stock in a company proposing to build a plant in the Lehigh district was offered for sale during the year. Remodeling and modernizing construction was reduced to a minimum due to the curtailed income of virtually all cement companies. Despite the drastic slump in production, however, the Portland Cement Association continued with increased vigor promotion of cement for all classes of construction.

Considerable publicity was given to experimental highways of cement-bound macadam. Wide adoption of this type of highway would open a large market for portland cement in secondary road construction. Concrete in residential construction, especially concrete joists, a system of precast reinforced-concrete mine timbering, wider use of concrete in large monolithic structures, and concrete mats for levee and flood-control work also offer potential outlets for large quantities of cement.

MARKETS

The Portland Cement Association released the following estimate of cement distribution by consuming markets for 1928, the peak year of cement shipments.

Distribution of portland cement by consuming markets, 1928 [1]

	Percent	Barrels
Concrete roads, streets, alleys, curbs and gutters, and pavement bases	32.5	57,000,000
Structural concrete in commercial, industrial, public, and private buildings of all types	25.0	43,900,000
Rural uses exclusively, including products and all farm structures of concrete	15.5	27,200,000
Concrete products, including block tile and brick, cast stone, and stucco but not products used on farms	7.5	13,200,000
Railways, all uses, including street railways	6.5	11,500,000
Sewerage, drainage, irrigation, culverts, concrete pipe, draintile, and specialties	5.0	8,900,000
Sidewalks and private driveways, exclusive of rural	4.0	7,000,000
Bridges, river and harbor works, dams and water-power projects, storage tanks, and reservoirs	4.0	7,000,000
Total	100.0	[2] 175,700,000

[1] From Cement and Concrete (a general reference book), Portland Cement Association, 1929.
[2] Shipments in 1928: Bureau of Mines statistics, 175,838,332 barrels.

Concrete pavement and building construction are the two principal outlets for cement, accounting in 1928 for 32.5 and 25 percent, respectively, or a total of 57.5 percent of all cement shipped from mills. The relation of cement shipments to highway and building construction is illustrated in figure 52. By means of index numbers, cement shipments since 1920 are compared graphically with concrete-pavement awards and with construction-contract awards. Asphalt, the principal competitor of cement in the highway field, is included for comparison.

The dependence of the cement industry upon both pavement and building construction is revealed strikingly by the curves since 1928. The cement curve lies between the pavement and building curves and somewhat closer to the latter, a logical position because the decline in building has been too great to be compensated by even abnormal highway construction.

Concrete paving.—Although enough data are not available to estimate cement consumption by markets in 1932, comparison of indicators for 1928 and 1932 reveals interesting relationships. The monthly average of concrete-pavement awards during 1928 was

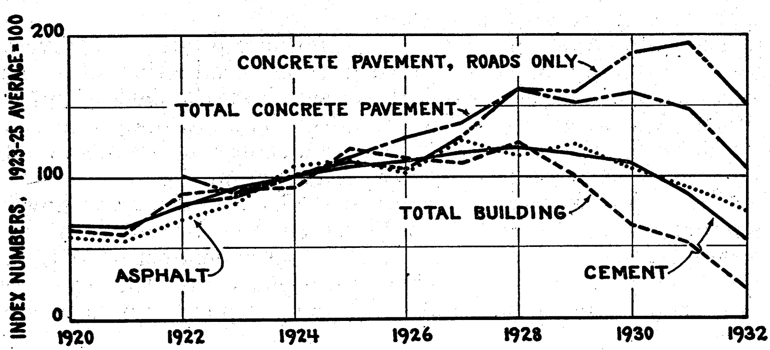

FIGURE 52.—Trends of principal markets for cement compared with cement and asphalt shipments, 1920–32.

12,340,000 square yards; in 1932 the comparable figure had dropped to 8,069,000 square yards, a decline of nearly 35 percent. If the quantity of cement per square yard of pavement was the same in 1932 as in 1928, about 37,200,000 barrels, or 46 percent of the cement shipped in 1932, were consumed in concrete pavements. It is evident from figure 52 that most of the decrease took place from 1931 to 1932, concrete-pavement-contract awards having declined only about 9 percent from 1928 to 1931. Figure 52 shows further that road construction has been maintained at a higher level than street and alley construction.

Building construction.—Similar deductions can be made for building construction with the aid of statistics of the F. W. Dodge Corporation. In 1928 contracts equivalent to 80,547,000 square feet of floor space were awarded, but in 1932 the volume dwindled to 12,966,000 square feet, a decrease of 84 percent. If the same percentage of decline is applied to cement, only 7,000,000 barrels, approximately 9 percent of the 1932 consumption, went into building. This figure, however, cannot be accepted without modification, as other indicators reveal varying relationships. The value of construction contracts awarded declined 80 percent from 1928 to 1932, building permits dropped 85 percent, but heavy engineering-construction-contract awards decreased only 66 percent. Furthermore, construction in 1932 was weighted with Government projects more heavily than in previous years, and a preponderance of this type of construction may tend to increase the quantity of cement used per dollar of contracts awarded. This change is especially evident from 1931 to 1932; whereas the value of building permits in 1932 declined 61 percent from 1931, contracts awarded by State governments decreased only about 37 percent and those awarded by the Federal Government actually increased 6 percent. Thus, the quantity of cement consumed in building construction cannot be estimated accurately from available data.

Other outlets for cement.—To estimate the quantity of cement used on farms is equally difficult but the index of the purchasing power of farmers is a possible indicator. In 1928, on the basis of the 1910–14 average as 100, the United States Bureau of Agricultural Economics computed this index at 89.6, whereas in 1932 it had declined 41 percent to 52.6. This drop cannot be interpreted as representing exactly cement consumption on farms, but it does reveal the downward trend of total farm purchases.

No accurate estimates of concrete-products production have been made since 1930. Roughly, however, the production of concrete products in 1932 declined about 80 percent from the peak of 387,000,000 units (8 by 8 by 16 inches) in 1928. This estimate is based on the available figures on output of face brick, common brick, and hollow tile, as well as on general statistics of construction.

Railway expenditures for cement in 1932 are not known; however, class I roads in 1932 spent about 77 percent less for ballast, a reasonably comparable item, than in 1928. Total expenditures in 1932 for maintenance of way and structures dropped 58 percent from 1928. Drastic economies doubtless affected cement purchases in a similar manner.

The depleted condition of many municipal, county, and State treasuries unquestionably curtailed greatly the use of cement for sewers, irrigation, and other similar projects. Construction programs for unemployment relief, however, offset part of these losses.

The volume of sidewalk and driveway construction roughly parallels promotional activity in real estate. In 1928 new subdivisions were developed in all parts of the country; in 1932 forced sales of many of these properties discouraged new ventures. Furthermore, the volume of residential construction in 1932 was 87 percent less than in 1928.

Statistics on engineering construction indicate that cement consumption in large-scale public works other than highways was maintained in 1932 at a level comparatively higher than that of other types of construction. The Boulder Dam project provided an enormous market in this field.

The following table summarizes available data on markets for cement. These data are useful in interpreting past records and in predicting future market trends. Average figures for the period 1923–25, relatively stable years for the cement industry, are included for comparison with recent years. Figures for 1928 show the midpoint in the 10-year span and correspond with data in the table of cement consumption by uses, compiled by the Portland Cement Association. The trend of the statistics in 1931 and 1932, of course, reveals the effects of the depression.

Summary of data relating to markets for cement [1]

	Average 1923–25	1928	1931	1932 [2]
Concrete pavement awards: [3]				
Total, monthly average......square yards..	7,647,000	12,340,000	11,207,000	8,069,000
Index numbers [4]	100	161	147	106
Roads only, monthly average square yards..	4,805,000	7,794,000	9,321,000	7,199,000
Index numbers [4]	100	162	194	150
Construction contract awards: [5]				
Total floor space, monthly average square feet..		80,547,000	30,487,000	12,966,000
Index numbers [4]	[6] 100	124	47	20
Total value, monthly average		$552,357,000	$257,737,000	$112,613,000
Index numbers [4]	[6] 100	137	64	28
Residential, floor space, monthly average square feet..		47,365,000	15,856,000	6,134,000
Index numbers [4]	[6] 100	122	41	16
Residential, value, monthly average		$232,360,000	$67,616,000	$23,339,000
Index numbers [4]	[6] 100	126	37	13
Building permits: [7]				
Total value	$3,659,197,000	$3,304,670,000	$1,237,985,000	$481,490,000
Index numbers [4]	100	90	34	13
Engineering construction: [8]				
Value, monthly average	$179,517,000	$298,215,000	$204,515,000	$101,609,000
Index numbers [4]	100	166	114	57
Government contract awards: [9]				
States, total value			$83,932,889	$53,261,615
Federal, total value			$141,102,645	$149,849,762
Concrete products production: Index numbers [4]	100	190	[10] 88	[10] 38
Purchasing power of farmers: [11] Index number, 1910–14 average=100	89.0	89.6	63.4	52.6
Railway expenditures, class I roads: [12]				
For maintenance of way and structures		$847,991,732	$535,876,483	$354,965,379
For ballast		$35,517,000	$13,921,000	$8,109,000

[1] Most of the information in this table is available by months in Survey of Current Business.
[2] 1932 figures are subject to revision.
[3] Compiled by the Portland Cement Association.
[4] Computed on base, 1923–25 average=100.
[5] Compiled by F. W. Dodge Corporation for 37 States east of the Rockies.
[6] Partly estimated from data for 27 States.
[7] Compiled by U.S. Bureau of Labor Statistics; figures for 257 cities.
[8] Compiled by Engineering News-Record; covers heavy engineering construction contracts awarded.
[9] Compiled by U.S. Bureau of Labor Statistics.
[10] Estimated.
[11] Compiled by U.S. Bureau of Agricultural Economics.
[12] Compiled from reports of the Interstate Commerce Commission and the Bureau of Railway Economics.

CONSUMPTION BY STATES

Although shipments of cement in the United States dropped 6.6 percent in 1932 compared with 1931, the rate of decline varied considerably in different parts of the country. Nevada was the notable exception, Boulder Dam construction being responsible for an increase in consumption of 371.5 percent. Figure 53, *A*, compares cement consumption by States in 1931 and 1932. The total area of each circle represents the magnitude of 1931 consumption for that particular State, assuming that consumption is equivalent to shipments into the State. Imports and exports may alter actual consumption in the seaboard States, but from the viewpoint of the producer actual shipments into States indicate available markets.

New York was by far the largest consumer of cement in 1931, followed by Illinois, Pennsylvania, Ohio, and California. The other large markets, except Texas, were confined to the East and Middle West. Consumption in the Rocky Mountain States normally is small, although in 1932 Nevada showed the largest increase of all cement-marketing territories.

The black sector of each circle represents consumption in 1932 compared with 1931. It is apparent from the map that markets in

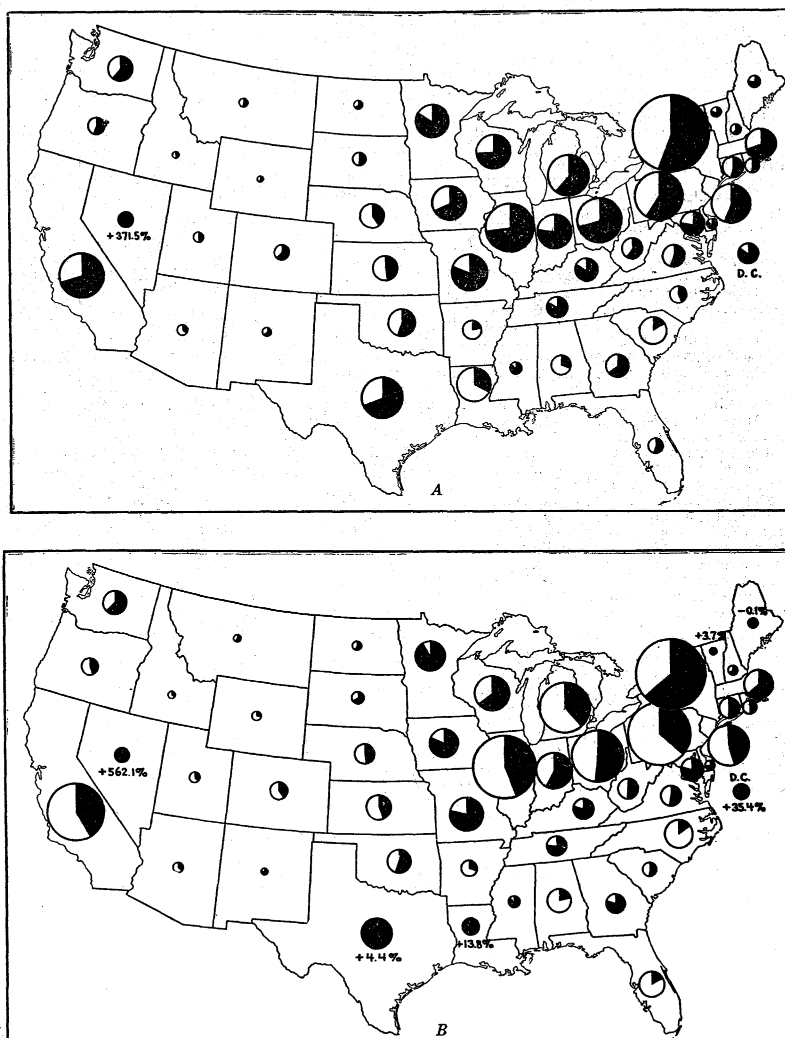

FIGURE 53.—Consumption of cement by States in 1932 compared with 1931 and with the 3-year average 1923–25. The total area of each circle represents consumption in each State, for 1931 in map A, and for the 1923–25 average in map B. In both maps the black sector shows the relation of 1932 consumption. Increases in 1932 are designated by figures showing the percent of change.

Minnesota, Kentucky, Tennessee, Delaware, District of Columbia, Mississippi, and a few other States held up well compared with 1931. On the other hand, the decline in several States, notably South Carolina and Arkansas, was especially drastic. Shipments into the large consuming States decreased at approximately the same rates as the rate for the United States.

Figure 53, *B*, compares average consumption for the 1923–25 period with that in 1932. Study of these two maps reveals trends in cement consumption by States during the past 10 years.

PRICES

Before 1900 prices of portland cement were relatively high. This can readily be understood, for the product was new, manufacturing technique had not yet been perfected, production was small, and demand was increasing rapidly. Since 1900 cement prices (compared with price indexes of the Bureau of Labor Statistics computed on the basis of 1926 as 100) have been slightly lower than those of building materials generally. During the price peak of 1920 cement remained unusually low, the index number increasing to only 117.2, compared with 150.1 for building materials and 154.4 for all commodities.

Detailed price fluctuations of cement since 1928 are shown in figure 54. Three sets of data compiled by the United States Bureau of Labor

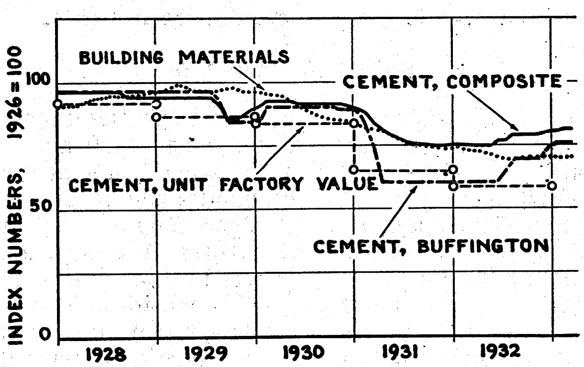

FIGURE 54.—Trends in prices of portland cement compared with a weighted price of all building materials 1928–32. The curves, "Cement, composite," and "Cement, Buffington," are plotted from index numbers compiled by the U.S. Bureau of Labor Statistics from quoted prices, f.o.b. plant. The curve, "Cement, unit factory value," represents prices actually received by manufacturers as reported by them to the Bureau of Mines. All curves are plotted as index numbers with the average for 1926 equalling 100.

Statistics and the average factory value of cement reported by producers to the United States Bureau of Mines are plotted for comparison. The curve labeled "Building materials" represents the weighted index of 86 price series covering all building materials. Data for the curve "Cement, composite" are compiled by averaging quoted prices, f.o.b. plant, at six plants in the United States. The curve "Cement, Buffington" represents prices, f.o.b. plant, at Buffington, Ind., and is included to show conditions in the Middle West, where price cutting during 1931 and 1932 was especially severe. The annual average factory value of cement—shown by the curve "Cement, unit factory value"—is compiled 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 adjustment for cash discounts allowed. The average factory value therefore should represent the actual average price received by the cement industry for its product. To permit ready comparison, all curves are plotted as index numbers calculated in terms of values for 1926 as 100. The year 1926 has been selected because it is used by the Bureau of Labor Statistics for calculations of commodity price indexes.

The most significant feature of the chart is that cement prices, both composite and Buffington, after dropping precipitously dur ng the first few months of 1931, began to recover during the latter half of 1932. By the early part of 1933 the composite price curve had reached a level comparable to its average position with respect to building materials, and the Buffington curve was almost as high.

Regardless of the upward turn in prices in midsummer, however, the average factory value per barrel of cement dropped from $1.11 in 1931 to $1.00 in 1932, a decline of 9.9 percent. The monthly average of the composite price index in 1932 decreased only 3 percent from 1931. From 1928 to 1932 the average factory value per barrel of cement declined 36 percent, whereas the composite price index dropped only 19 percent. This discrepancy apparently reflects the difficulty of compiling a price index which reveals prices of actual sales rather than quotations. It is generally known that in 1932 sales were made in the Middle West at prices appreciably below prevailing quotations. This problem is unusually real during periods of keen competition such as the cement industry has experienced in recent years.

SPECIAL CEMENTS

Natural cement competed sharply with portland cement during the early years of its manufacture, but since 1900 portland cement has dominated the industry. Ten years ago portland cement comprised about 99 percent of total shipments; the other 1 percent consisted of natural, masonry, and puzzolan cements, used primarily for mortar and stucco. Shipments of natural, masonry, and puzzolan cements amounted to 1,226,850 barrels in 1931 but apparently declined about 55 percent in 1932. This is considerably more than the comparable decrease for portland cement, but it must be remembered that in 1932 the principal market for portland cement—concrete paving—dropped only 28.0 percent from 1931 whereas the volume of building construction declined 57.5 percent.

During the past 10 years numerous cements selling at premium prices and recommended for special purposes have been developed. Since 1927 the Bureau of Mines has attempted to collect statistics to show their growth, but the problem is difficult because of the confusion which still exists regarding the exact classification of these so-called "special cements." However, a logical break-down was adopted for 1931 statistics, and this classification will be continued even if differences are noted in comparing figures with those for preceding years.

Production of high-early-strength portland cement in 1931 amounted to 1,366,468 barrels, whereas shipments were 1,422,633 barrels valued at $2,278,236. This quantity represents returns from 16 plants, some of which reported production of high-early-strength cement for the first time in 1931, indicating that interest in the material is increasing. The average factory value of the product was $1.60 a barrel, $0.49 higher than that of standard portland cement. Obviously, only cement selling at premium prices has been included in the total, but information from producing companies is insufficient to determine accurately whether or not all the cement thus reported actually conformed with the temporary specification of A.S.T.M., C 74–30 T. The adoption of a permanent specification for high-early-strength cement will aid in developing an accurate statistical record of production of the material. No estimate of production or shipments of high-early-strength portland cement in 1932 is yet available. Close observers of the industry, however, believe that it did not decline as drastically as standard portland cement.

Since 1927 statistics also have been compiled for a group of miscellaneous special cements classified as "plastic and waterproofing portland cement." Among the cements included in this class prior to 1931 were those manufactured expressly for oil-well cementing, others recommended where a highly impermeable waterproof concrete is desired, and masonry cements related to portland cement.

In 1931, however, a separate classification was established for the masonry cements formerly included under this heading. The principal product is masonry cement made by mechanical mixing of portland cement and hydrated lime. Proportions of the two materials may vary with the brand, but a common mixture is 60 percent of cement and 40 percent of lime. Production of this class of masonry cement was reported in 1931 from 24 plants. Statistics revealed production of 677,451 barrels and shipments totaling 632,173 barrels, valued at $1,041,486, an average factory value of $1.65 per barrel. Comparable figures are not available for previous years or for 1932, but it is believed that the proportion of this type of masonry cement to the total cement produced has been increasing.

The remaining miscellaneous special cements include primarily oil-well and waterproofing cements. Production of these types of cements in 1931 amounted to 429,822 barrels, and shipments to 404,161 barrels valued at $674,399. The average factory value was $1.67 per barrel. These figures also are not comparable to any compiled in previous years, and statistics for 1932 are not yet available.

Although no records of production have yet been included in producers' reports, a new type of special cement has attracted attention in connection with Boulder Dam. Standard or high-early-strength portland cement gives off considerable heat during hardening, which may crack concrete used in large monolithic masses. A new special cement designed to attain its ultimate strength slowly with little evolution of heat may be developed for dam, bridge, pier, or other engineering projects requiring large volumes of concrete.

FOREIGN TRADE

The tariff of $0.06 per hundredweight proved ineffectual in stemming imports of cement in 1932, and 462,496 barrels of portland cement were imported during the year compared with 457,238 barrels in 1931. Although this represents an increase of 1 percent in quantity of cement imported, the total value of imports declined 30.9 percent (from $507,918 in 1931 to $351,033 in 1932).

Imports of cement amounted to only 0.36 percent of shipments from domestic mills in 1931 and 0.57 percent in 1932, but even this comparatively small quantity may exert a considerable influence upon market conditions in the ports of entry and adjacent territory.

Exports of portland cement dropped from 429,653 barrels in 1931 to 374,581 barrels in 1932 with an attendant decrease in unit value from $2.84 to $2.14 a barrel. These figures do not include shipments to Alaska, Hawaii, and Puerto Rico, which amounted to 353,136 barrels in 1931 and 296,562 barrels in 1932.

DIMENSION STONE

By Oliver Bowles and A. T. Coons

Stone in blocks of various shapes and sizes is used principally for building purposes. Construction activities are always sensitive to periods of industrial depression; consequently, during the past 3 years the dimension-stone industry has declined sharply. Value of output in 1932 was about 41 percent less than in 1931 and 62 percent less than in 1926. The following table of salient statistics reveals a general downward trend in every branch of the industry for 1932, the decreases ranging from 8 to 68 percent.

Salient statistics of the dimension-stone industries in the United States, 1931–32

	1931	1932 [1]	Change from 1931, percent
Granite:			
Building stone (cut stone) ... cubic feet	2, 171, 830	1, 477, 000	−32
Value	$6, 740, 729	$4, 179, 000	−38
Average value per cubic foot	$3. 10	$2. 83	
Monumental stone ... cubic feet	2, 231, 320	1, 550, 000	−31
Value	$7, 456, 512	$4, 474, 000	−40
Average value per cubic foot	$3. 34	$2. 90	
Paving blocks ... number	21, 287, 500	6, 812, 000	−68
Value	$1, 859, 485	$595, 000	−68
Other granite, value [2]	$2, 201, 889	[3] $1, 255, 000	
Total value	$18, 258, 615	$10, 503, 000	−42
Marble:			
Building stone (cut stone) ... cubic feet	1, 661, 350	1, 667, 000	+0. 3
Value	$7, 842, 496	$5, 539, 900	−29
Average value per cubic foot	$4. 72	$2. 96	
Monumental stone ... cubic feet	637, 830	417, 600	−35
Value	$2, 177, 656	$1, 609, 700	−26
Average value per cubic foot	$3. 41	$3. 85	
Total value	$10, 020, 152	$6, 149, 600	−39
Limestone:			
Building stone (cut stone) ... cubic feet	8, 973, 080	6, 640, 000	−26
Value	$10, 540, 845	$6, 535, 000	−38
Average value per cubic foot	$1. 17	$0. 98	
Other limestone, value [4]	$699, 453	[3] $433, 700	
Total value	$11, 240, 298	$6, 968, 700	−38
Sandstone:			
Building stone (cut stone) ... cubic feet	1, 073, 990	660, 000	−39
Value	$1, 925, 816	$924, 000	−52
Average value per cubic foot	$1. 79	$1. 39	
Paving blocks ... number	1, 153, 090	815, 000	−29
Value	$78, 673	$65, 000	−17
Other sandstone, value [4]	$1, 223, 625	$598, 600	
Total value	$3, 228, 114	1.587, 600	−51

[1] Figures for 1932 subject to revision.
[2] Rough construction stone, rubble, and curbing.
[3] No figures available; estimate only.
[4] Rough construction stone, rubble, curbing, and flagging.

Salient statistics of the dimension-stone industries in the United States, 1931–32—Continued

	1931	1932	Change from 1931, percent
Slate:			
Roofing slate ... squares	277,700	136,000	−51
Value	$2,364,861	$1,000,000	−58
Average value per square	$8.52	$7.35	
Mill stock ... square feet	5,794,380	2,828,300	−51
Value	$1,754,054	$830,000	−53
Average value per square foot	$0.30	$0.29	
Flagging and miscellaneous ... square feet	765,620	296,000	−61
Value	$66,904	$33,000	−51
Average value per square foot	$0.09	$0.11	
Total value	$4,185,819	$1,863,000	−55
Miscellaneous building stone ... tons	84,220	[5] 68,000	
Equivalent in cubic feet	935,780	756,000	
Value	$216,559	[5] $635,000	
Total:			
Building stone (cut stone) ... cubic feet	14,816,030	11,200,000	−24
Value	$27,049,886	$17,177,900	−36
Monumental stone ... cubic feet	2,869,150	1,967,600	−32
Value	$9,634,168	$6,083,700	−31
Paving blocks ... number	22,440,590	7,627,000	−66
Value	$1,938,158	$660,000	−66
Other stone, value [4]	$4,124,967	$2,287,300	
Slate ... tons	138,440	68,400	−51
Value	$4,185,819	$1,863,000	−55
Miscellaneous stone (building) ... cubic feet	935,780	[5] 756,000	
Value	$216,559	[5] $635,000	
Total value	$47,149,557	$28,706,900	−39
Total tonnage	2,894,920	1,942,000	−33

[4] Rough construction stone, rubble, curbing, and flagging.
[5] Includes soapstone.

The preceding table of salient statistics briefly portrays the conditions in each branch of the industry in 1932 compared with 1931, the column at the right showing the percentages of change. Complete 1932 figures cannot be compiled until later in the year because all the hundreds of questionnaires sent out by the Bureau have not yet been returned. Figures for marble and slate are nearly complete, but many are lacking for granite, limestone, sandstone, and miscellaneous stone.

Enough 1932 statistical data on limestone and sandstone are available to permit making fair estimates of the quantities consumed for certain uses. It seemed advisable, therefore, to segregate the more complete data and to group figures for the other uses. Thus, reasonably accurate estimates have been made for cut stone, monumental stone, and paving blocks. Materials devoted to other uses, for which 1931 figures are complete and 1932 figures are estimated on arbitrary bases, are grouped under the headings "Other granite", "Other limestone", and "Other sandstone."

Definition of terms.—Dimension stone is a general term covering stone sold in the form of blocks which, with certain exceptions mentioned later, are cut to definite shapes and often to specified sizes. It includes cut, carved, and also roughhewn blocks of building stone; monumental stone; paving blocks; curbing; flagging; roofing slabs; and many special products, such as tubs, sinks, blackboards, furnace blocks, steps, baseboard, and floor tile. Such products are contrasted with crushed and broken stone which consists of irregular fragments that are sized chiefly by mechanical screening or air separation.

A border-line group includes rough wall stone, rubble, and riprap. Although the first two may consist of quite irregular fragments, they are used with mortar in building masonry walls and are classed with dimension stone. Riprap consists of irregular masses used in loose piles without cementing material and is therefore included with crushed and broken stone.

Processes of quarrying and manufacturing, uses, and market channels of dimension stone differ greatly from those for crushed stone. Because there is so little similarity between these two great branches of the stone industries it seems desirable to discuss them in separate chapters, therefore no consideration is given herein to crushed-or-

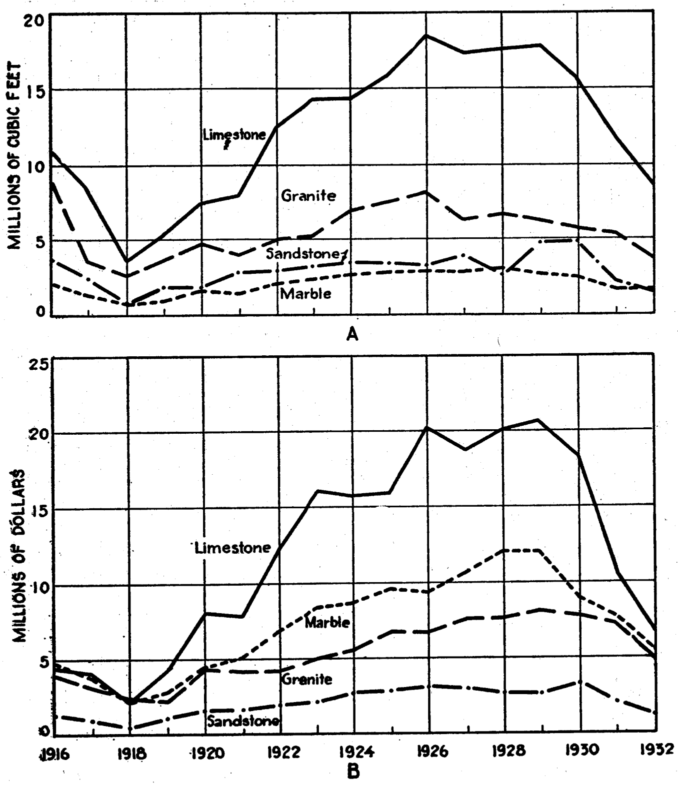

FIGURE 55.—Trends in building stone sold, 1916–32, by kinds: *A*, Quantity; and *B*, value.

pulverized-stone products. Slate, which heretofore has been considered in a separate chapter, is now included with the other varieties of dimension stone. Soapstone, formerly included with talc, also is discussed in this chapter.

Interrelation in use of limestone, sandstone, granite, and marble.—For certain important products different varieties of stone are used interchangeably. Their relationship is presented in graphs showing the history of production of each major variety. Thus their relative growth or decline and their price history may be compared.

Trends in the use of the different varieties of stone for building purposes are shown in figure 55. In volume of production (fig. 55, *A*) limestone always leads, making the greatest growth of all varieties and accounting for more than half of the total since 1922. Granite stands second, and its output has receded less than that of limestone during recent years. Sandstone maintained a fairly uniform course for many years, increased considerably in 1929 and 1930, and declined rapidly thereafter. Marble, the smallest in volume of production of the leading building stones, has shown no striking fluctuations.

Figure 55, *B*, shows the value of production over the same period, including the value of finished products of plants operated by quarry companies, but only that of rough blocks sold by quarrymen to independent fabricating plants. Therefore, the figures comprise some

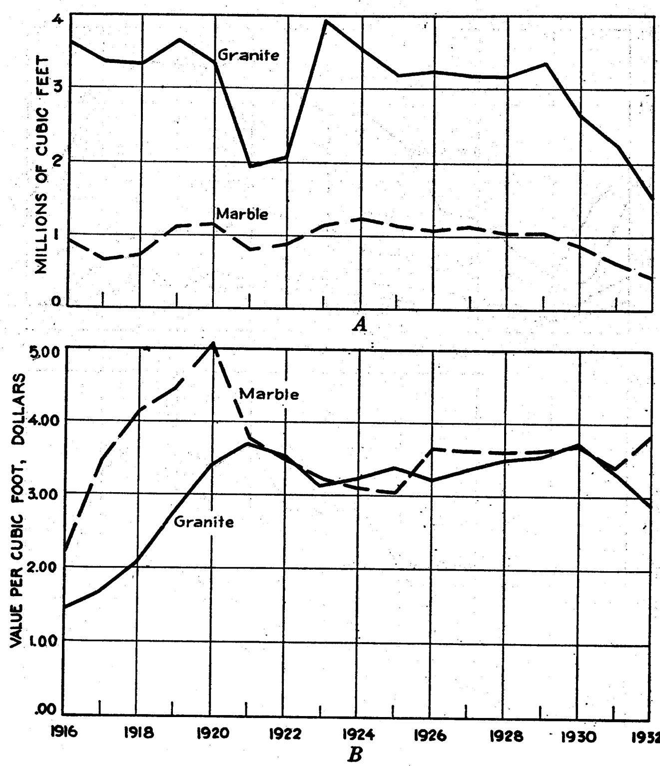

FIGURE 56.—Trends in memorial stone sold, 1916–32, by kinds: *A*, Quantity; and *B*, value.

rough-block and some finished-product values but are comparable to a degree because independent mills exist in each of the four main branches of the industry.

It will be observed that limestone leads consistently in value as well as in quantity of output. Marble, although the least of the four varieties in volume of production, is second in value, reflecting the relatively high price it commands per cubic foot. Moreover, a large proportion of all marble sold is fabricated by quarry companies, and the figures represent finished-product rather than rough-block values. Since 1926 granite has maintained a higher level in value than in volume, reflecting a smaller recession in unit prices than is apparent for other varieties of stone.

The history of memorial-stone production for the past 17 years is traced in figure 56, *A*. Granite has always provided the greatest quantity of material for this purpose but its use has fluctuated more than that of marble. Both have decreased rapidly since 1929. The price curve shows an exceptionally high unit value for marble in 1920, but thereafter granite maintained a higher level until 1932 when marble, unlike most products, increased substantially.

Eighty to ninety percent of all paving blocks are granite and the rest chiefly sandstone; smaller quantities of trap or other varieties of stone are unrecorded. Street paving has increased enormously in the last 25 years, and a corresponding increase in demand for paving blocks would be expected; however, this has not occurred, because

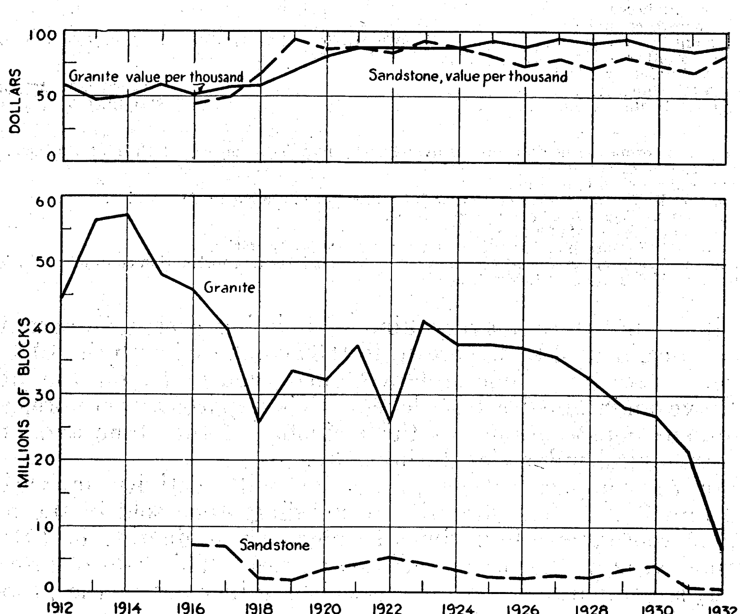

FIGURE 57.—Trends in production and unit value of paving blocks sold, 1912–32, by kinds.

concrete has been substituted very widely instead. Consequently, paving-block production has declined steadily, particularly since 1923. The sandstone branch of the industry, although much smaller, has maintained production fairly well. It has, of course, failed to keep parallel with the growth in paving but has not shown the downward trend apparent in granite. Production in 1930 was, in fact, nearly equal to that in 1923. Figure 57 pictures trends in paving-block production.

Curbing is often exposed to very severe shocks and excessive abrasion. On account of its toughness and strength, stone has withstood the competition of concrete better than paving blocks.

Stone in relation to other industries.—As stated previously the principal markets for stone are the construction industries. It is interesting, therefore, to trace trends in construction of various types during recent years. The following table presents data bearing on markets for dimension stone.

Summary of data relating to markets for dimension stone [1]

	Average, 1923–25	1928	1931	1932 [2]
Construction contract awards: [3]				
Total floor space, monthly average square feet		80,547,000	30,487,000	12,966,000
Index numbers [4]	[5] 100	124	47	20
Total value, monthly average		$552,357,000	$257,737,000	$112,613,000
Index numbers [4]	[5] 100	137	64	28
Residential floor space, monthly average square feet		47,365,000	15,856,000	6,134,000
Index numbers [4]	[5] 100	122	41	16
Residential, value, monthly average		$232,360,000	$67,616,000	$23,339,000
Index numbers [4]	[5] 100	126	37	13
Building permits: [6]				
Total value	$3,659,197,000	$3,304,670,000	$1,237,985,000	$481,490,000
Index numbers [4]	100	90	34	13
Engineering construction: [7]				
Value, monthly average	$179,517,000	$298,215,000	$204,515,000	$101,609,000
Index numbers [4]	100	166	114	57
Government contract awards: [8]				
States, total value			$83,932,889	$53,261,615
Federal, total value			$141,102,645	$149,849,762

[1] Most of the information in this table is available by months in Survey of Current Business, U.S. Department of Commerce.
[2] 1932 figures are subject to revision.
[3] Compiled by F. W. Dodge Corporation, for 37 States east of the Rocky Mountains.
[4] Computed on basis of 1923–25 average equals 100.
[5] Partly estimated from data for 27 States.
[6] Compiled by U.S. Bureau of Labor Statistics from figures for 257 cities.
[7] Compiled by Engineering News-Record; covers heavy engineering construction contracts awarded.
[8] Compiled by U.S. Bureau of Labor Statistics.

It will be noted that every kind of building except Government contracts declined 13 to 57 percent in 1932 compared with the 1923–25 average. State and Federal Government contracts, on the other hand, have maintained a high level. It is apparent, therefore, that Government construction was the mainstay of the stone and other building-material industries during 1932.

Figure 58 compares stone production with activity in various related industries. The quantity of building stone sold in the peak year 1929 was almost four times as much as production in 1918, a subnormal year in the nonmetallic industries. This rate of growth, however, is comparable with the astonishing increase in the production of cement, crushed stone, and sand and gravel during the same period, caused by the vast highway programs and by greater use of these materials in general building. Face brick kept pace with the exceptionally high level of building activity before 1929 but began to decline before building stone.

On the other hand, monumental stone evidenced no similarity to the widely fluctuating curves of materials related to construction. Periods of industrial depression, such as 1921 and 1930–32, affected sales of monumental stone because of the generally decreased purchasing power of the people. However, there appears to be a long-time downward trend in production.

The curves of construction contracts awarded and structural steel indicate the current demand for construction materials. Various construction data, including shipments of fabricated structural steel, are available in Survey of Current Business.[1]

[1] Published monthly by the U.S. Bureau of Foreign and Domestic Commerce. The subscription price of $1.50 a year includes the 1932 annual supplement, the 12 monthly numbers, and the 52 weekly supplements. Remittances should be sent only to the Superintendent of Documents, Washington, D.C.

Employment conditions.—Conditions of relative employment and pay rolls in the quarry and other industries are shown in the following table. The quarrying and nonmetallic mining industries in 1932 maintained a higher relative level of employment and pay rolls than the metalliferous mining industries, but a lower level than the manufacturing industries.

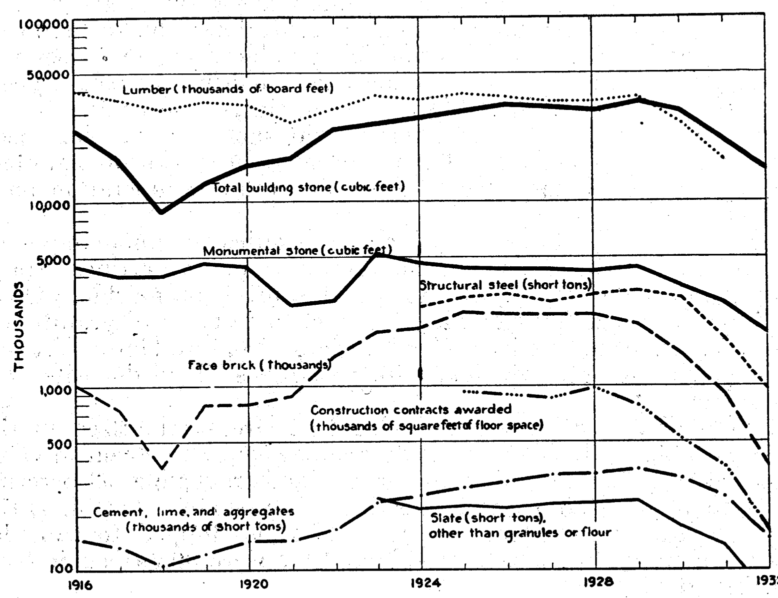

FIGURE 58.—Trends in the stone and construction industries. Data for production of building and monumental stone, slate, cement, lime, and aggregates are from Bureau of Mines statistics. Figures for 1932 are partly estimated. Data for lumber and face-brick production are from U.S. Bureau of Census statistics. The 1932 face-brick production is partly estimated. Construction contracts awarded are figures of F. W. Dodge Corporation covering 37 States east of the Rocky Mountains. Data for shipments of fabricated structural steel are from Survey of Current Business, published by U.S. Bureau of Foreign and Domestic Commerce. The vertical logarithmic scale facilitates comparison of unlike commodities varying in units of measurement and differing greatly in magnitude. The slopes of the individual curves are proportional to the percent increase or decrease from year to year. Thus, building stone and the group composed of cement, lime, and aggregates declined less in 1932 than did slate, brick, or construction contracts. Monumental stone declined least of all.

Indexes of employment and pay rolls [1]

[12-month average—1929=100]

	1930	1931	1932
Quarrying and nonmetallic mining:			
Employment	84.3	67.4	49.0
Pay rolls	79.3	53.4	29.1
Metalliferous mining:			
Employment	83.2	59.1	36.5
Pay rolls	78.0	44.8	21.6
Manufacturing industries:			
Employment	84.7	72.2	60.1
Pay rolls	81.3	61.5	41.6

[1] From Trend of Employment, issued by the U.S. Bureau of Labor Statistics.

Retrenchment in fixed charges.—During the past 3 years of low production the burden of fixed charges has been heavy. Companies operating on a royalty basis have some advantage, because if production does not fall below minimum requirements royalties are proportional to output. Most companies, however, are burdened with heavy capital investment and other charges that continue with little abatement even though production may be greatly reduced.

Definite steps have been taken to promote economies that will reduce overhead expense. To attain this object, companies in some districts consolidated even during the more prosperous years prior to 1930. Advantages accruing from more centralized control, reduced overhead, and higher specialization in manufacturing processes will doubtless encourage further consolidations. During the past 2 years a reverse trend has been noted among crushed-stone companies—a return to the small wayside quarry. No such reaction has been noted among producers of cut stone because processes of manufacture are too highly specialized to permit profitable operation on a small scale.

Imports and exports.—The principal varieties of stone imported into the United States are marble, granite, and travertine. Italy, France, and Belgium are the principal sources of marble. Onyx marble is imported from Mexico. The chief imports of granite are black varieties from Sweden and red varieties from Finland. Travertine imports originate principally in the famous Tivoli deposits near Rome, Italy.

Imports of dimension stone during 1932 are summarized in the following table. Marble imports decreased about 53 percent in value compared with 1931; granite, 40 percent; and travertine, 63 percent.

Exports of stone from the United States are small. Marble is the principal variety exported, and most of it is shipped to Canada. Exports of rough or dressed marble in 1932 were 30,691 cubic feet, valued at $99,943.

Stone imported for consumption in the United States in 1932, by classes

Class	Quantity	Value	Class	Quantity	Value
Marble, breccia, and onyx:			Quartzite ....short tons..	51,415	$79,979
In blocks, rough, etc. ....cubic feet..	153,660	$318,469	Travertine stone (unmanufactured) ....cubic feet..	37,706	23,583
Sawed ....do....	168	619	Stone (other):		
Slabs or paving tiles ....superficial feet..	232,264	71,832	Dressed..........	....	9,163
All other manufactures..........	....	64,724	Rough (monumental or building stone) ....cubic feet..	25,931	18,867
Mosaic cubes of marble or onyx: Loose..........	....	54	Rough (other)..........	....	10,717
	....	455,698		....	38,747
Granite:					
Dressed..........cubic feet..	18,193	90,700	Grand total..........	....	766,706
Rough..........do....	49,140	77,999			
	67,333	168,699			

GRANITE

Markets and uses.—Building-granite sales dropped about 32 percent in quantity and 38 percent in value in 1932 compared with 1931. Corresponding decreases for monumental stone were 31 and 40 percent, respectively. The paving-block branch of the industry receded most during 1932, sales decreasing about 68 percent in volume and value.

The principal constituents of granite are harder than steel, consequently the stone is costly to quarry and dress. It is, in fact, the hardest of all building or ornamental stones commonly used. On account of its crystalline nature, attractive colors, and ability to take a high polish granite is a popular stone for high-class architectural, ornamental, or memorial uses.

The two principal uses of granite are for building purposes and for monuments. As a building stone it is employed for entire exteriors or only for base courses, columns, sills, steps, caps, cornices, or other trimming. It may be used with either tooled or polished surfaces. Polished stone is costly but is preferred by many because it is attractive and easy to clean.

Granite is very widely used for memorials; in fact, the quantity and value of granite sold for monuments exceed that sold for building. It has a Nation-wide market range. Monuments from the best-known deposits may be found in cemeteries in all parts of the country.

Granite is the principal material for paving-block manufacture. Because of its hardness and toughness it withstands the abrasion of heavy traffic.

Review by States.—The granite industry is widely scattered, the chief production being from the rugged Appalachian district of eastern United States. The principal producing States outside this region are Minnesota, Wisconsin, California, and Texas. As indicated by preliminary figures, the chief States in output of building granite in 1932, in order of their importance, were Maine, New Hampshire, Massachusetts, Vermont, Georgia, North Carolina, Minnesota, Texas, and California. The leading position of New England is due to an abundance of high-grade granite, to convenient water transportation, and to proximity to large centers of building construction. All of the important producing States showed a substantial drop in production during 1932, except New Hampshire, where there was a considerable increase.

The leading States for production of memorial granite in 1932, in order of importance, were Vermont, Georgia, South Carolina, Minnesota, Massachusetts, Rhode Island, Wisconsin, Maine, North Carolina, and Pennsylvania. Final figures may change their relative position. All showed a substantial drop in 1932 compared with 1931. The leading production centers are Barre, Vt. (614,000 cubic feet valued at $1,544,000 in 1932), which supplies a fine-grained gray granite; Quincy, Mass., which offers a coarse-grained gray variety; St. Cloud, Minn., where the principal stone quarried is a medium-grained red granite; Westerly, R.I., which sells fine-grained gray, blue-gray, pink, and buff stone; and Elberton, Ga., which produces a fine- to medium-grained blue-gray variety.

Maine produced more than half of the entire output of granite paving blocks in the United States. The proximity of quarries to water transportation is advantageous in marketing. Other States producing paving blocks, in order of output, were Massachusetts, Georgia, New Hampshire, and Wisconsin.

Improvements in technology.—Producers of standard building, memorial, and paving granite place on the market products of superior quality, but they are handicapped by the heavy expense of quarrying and dressing a stone of unusual hardness. Quarry and mill operators therefore are directing their energies toward the development of equipment and processes that will reduce the cost of production. Much progress has been made in perfecting circular saws and drag-saws that cut much more rapidly than those formerly used. Surface-finishing processes have been greatly improved. Abrasive wheels now perform many operations more quickly and accurately than do hand tools. Drum drills have been used successfully for cutting granite cores more than 4 feet in diameter. Improvements in drills and wedges and more complete electrification have accomplished other economies in quarrying. Such improvements in technique strengthen the position of granite in a highly competitive market.

MARBLE

Markets and uses.—Production of marble was maintained fairly well in 1932, but values fell greatly. The output in cubic feet declined about 15 percent and the value nearly 39 percent compared with 1931. There was only a small decrease in the quantity of building marble produced, but the value dropped from an average of $4.72 to less than $3 a cubic foot.

Because of its beauty and permanence, marble has long been regarded as a choice material for architecture. It has constituted an important branch of the stone industry of the United States for a great many years. Marble is employed principally in two ways—as a building stone, for which purpose two thirds to three fourths of the total production is used, and for the manufacture of monuments. It may be used for entire exteriors of buildings or for trimming only. The more ornamental types are utilized for interior decoration. Marble is employed extensively for steps, floor tile, and sanitary uses.

Production for building was maintained remarkably well, considering the general stagnation in construction work, which in 1932 was only 28 percent of the 1923–25 average. The following discussion of the marble industry in individual States indicates that conditions varied throughout the country. Government projects provided a large part of the market requirements, but they were confined to relatively few localities, probably accounting for the great variation in conditions from State to State.

Conditions in the monument trade were quite different. The number of cubic feet reported was only approximately two thirds of that for 1931, but the average price per cubic foot was considerably higher.

REVIEW BY STATES

The principal marble centers of the United States are Vermont, Tennessee, Georgia, Alabama, and Missouri. Smaller quarries are operated in about 12 other States.

Tennessee.—The marble industry of Tennessee is centered in the territory surrounding Knoxville. From 15 to 20 companies are normally in operation, but activity was somewhat reduced in 1932. Production fell about 21 percent in quantity and approximately 23 percent in value compared with 1931.

Georgia.—The marble industry of Georgia is confined almost entirely to the district surrounding Tate and Marble Hill, Pickens County. Several types of architectural and monumental marbles are obtained from a number of deep quarries. The number of cubic feet produced in the district in 1932 was about 35 percent less than in 1931, and the value dropped about 50 percent.

Missouri.—Carthage, Jasper County, and Phenix, Greene County, are long-established centers of marble production in Missouri. The Ozora district in Ste. Genevieve County is a more recent development. It provides a fossiliferous marble used principally for interior decoration. Production in the State in 1932 fell about 13 percent in volume and 30 percent in value compared with 1931.

Alabama.—The marble belt of Alabama lies near Sylacauga, southern Talledega County. White and clouded varieties are sold for architectural and monumental uses. Activity in this district increased in 1932; the volume of production more than doubled, and the value increased more than 47 percent compared with 1931.

Other States and Territories.—Commercial marbles occur at Tokeen, Marble Island, and at Calder, Prince of Wales Island, Alaska. The Alaska quarries were idle in 1931 but resumed activity in 1932.

Gray marbles have long been produced near Batesville, Independence County, Ark. An interesting recent development is the production of black marble near this place.

Marble is produced in small quantities at several points in California.

A marble quarry has been operated for many years high in the mountains in Gunnison County, Colo.

White and verd antique marbles are quarried in Maryland, the former at Cockeysville in Baltimore County and the latter at Cardiff, Harford County.

White and verd antique marbles are also produced in Massachusetts, the former at Lee in Berkshire County and the latter near Westfield in Hampden County. The principal quarrying centers of New York are Wingdale, Dutchess County, and Gouverneur, St. Lawrence County.

The foregoing minor producing States show a much smaller production in 1932 than in 1931, but a large increase was recorded for the quarries at Thistle, Utah, and activity in Cherokee County, N.C., was renewed.

LIMESTONE

Markets and uses.—Preliminary 1932 figures for cut stone, the most important product of the limestone industry, indicate a decrease of 26 percent in quantity and 38 percent in value compared with 1931. Estimates of production are shown in the table on page 577. Very little of the rougher types of building stone, including rubble, was produced, because only small quantities are used in Government and other large buildings which consumed most of the output.

Limestone is the most widely used building stone in the United States. The largest quantity is employed as cut or roughhewn blocks for exterior walls of entire structures or for certain parts, such as window sills, caps, cornices, or base course. It is also used extensively for interior structural and decorative purposes. Negligible quantities are used for curbing, paving, and monuments.

Because of its relatively low cost, attractiveness, and durability limestone is used widely for Government structures. It is used extensively in the immense Federal buildings in Washington, D.C.

With the exception of Radio City in New York and a very few other large private building enterprises the limestone industry found its chief outlet during 1932 in Federal, State, and municipal construction work.

During recent years several smaller companies have been consolidated with larger ones. Thus, overhead expense has been reduced, and with a decreasing use of old-type mills and equipment operations have become more efficient. There are also many large well-equipped and efficient independent mills.

REVIEW BY STATES

Alabama.—High-grade oolitic limestone quarried at Rockwood, Franklin County, Ala., is fabricated into cut-stone products and shipped to many cities. The output in 1932 was less than half that in 1931.

Colorado.—Travertine is quarried near Salida, Fremont County, Colo., and green siliceous limestone near Manitou, El Paso County. Production was almost at a standstill in 1932.

Florida.—Shell limestones, some of which resemble travertine, are quarried at several points in Florida. Production held up well in 1932, although prices were lower than in 1931.

Indiana.—Indiana oolitic limestone is one of the most widely known building stones. Normally, Indiana produces 80 to 85 percent of the building limestone in the United States. The principal quarries are in Lawrence and Monroe Counties near Bedford and Bloomington. Twelve or more quarry companies operate well-equipped mills for sawing the stone into slabs or fabricating it into finished products. Moreover 12 to 15 independent mills in the district normally are active. They purchase rough blocks from quarry companies and manufacture cut-stone products. Indiana limestone is shipped to all parts of the country and to Canada and Mexico.

Sales by quarry companies in 1932 decreased about 24 percent in quantity and 36 percent in value compared with 1931. The relatively low value reflects keen competition for the limited market requirements.

Kansas.—Rough and sawed limestone was produced near Silverdale, Cowley County, Kans.

Kentucky.—Production of oolitic limestone at Bowling Green, Warren County, Ky., was very small in 1932.

Minnesota.—Attractive gray, yellow, and mottled limestones are quarried near Mankato and Kasota, Blue Earth and Le Sueur Counties, Minn. Architectural limestone is quarried at Winona, Winona County. Production was maintained fairly well in 1932, although prices were considerably lower than in 1931.

Montana.—Development of a travertine deposit near Gardiner, Mont., was reported in 1932.

Texas.—Texas is becoming increasingly important as a limestone producer. An oolitic stone similar to Indiana limestone is obtained principally at Cedar Park, Williamson County. Other deposits are at Lueders, Jones County, and near Del Rio, Kinney County. The output of the State in 1932 was about double that in 1931.

SANDSTONE

Markets and uses.—The building-sandstone industry declined about 39 percent in volume and 52 percent in value in 1932 compared with 1931. Paving blocks decreased about 29 percent in number and 17 percent in value. Figures for curbing and flagging in 1932 are not yet available.

Sandstone, as the name implies, results from consolidation of sand grains into rock. It is used widely for building purposes and to a smaller extent for paving blocks, curbing, and flagging. The manufacture of grindstones and pulpstones from sandstone, formerly an important industry, has declined greatly because of increasing competition from synthetic abrasive stones.

Sandstone may be employed in buildings for entire exteriors, columns, steps, and trimming or for interior structural and decorative purposes. It is used widely in public and private buildings and is marketed in all parts of the country. As with other types of building stone, recent trends are toward the use of the rougher, seam-faced, highly colored sandstone.

Wire saws are used successfully in making primary cuts in at least one sandstone quarry and probably will find wider use. They are employed also in several sandstone mills or yards for jointing blocks of stone, cutting columns, and even for removing larger masses of stone in carving processes.

REVIEW BY STATES

California.—The sandstone production of California, consisting principally of rough construction stone, flagging, and rubble, in 1932 dropped to a mere fraction of its 1931 volume.

Connecticut.—The well-known "Portland brownstone" is the most widely used sandstone of the State, but sales in 1932 were very small.

Indiana.—Sandstone is quarried in Indiana a few miles south of Mitchell in Orange County, and at St. Meinrad in Spencer County. Production was very small in 1932, but increased activity at St. Meinrad was in prospect for 1933.

Kentucky.—The sandstone industry of Kentucky is centered in Rowan and Rockcastle Counties. There was a small increase in quantity but a decrease in value in 1932 compared with 1931.

New York.—Curbing, flagstones, and sandstone paving blocks were produced in small amount during 1932 in New York State.

Ohio.—Ohio is the leading producer of sandstone, just as Indiana is the leading producer of limestone. Normally the State furnishes 50 to 60 percent of the dimension sandstone in the United States. The principal quarries are near Amherst, Lorain County, although important deposits are worked at many other places in the State. All types of products are manufactured. Building stone is fabricated in many large well-equipped mills. Production in 1932 decreased 40 percent in quantity and 56 percent in value compared with 1931.

Pennsylvania.—Brownstone, bluestone, and many other types of sandstone occur in Pennsylvania, but production in 1932 was small compared with that of the previous year.

Washington.—The most important sandstone quarries in Washington are in Pierce County. The industry expanded considerably in 1932 to supply building stone for a number of Government projects.

Wisconsin.—In Wisconsin sandstone occurs principally near Lake Superior and in the west-central part of the State. Production in 1932 was much smaller than that in the preceding year.

SLATE

Markets and uses.—As indicated in the table on page 578, the value of slate production in 1932 dropped about 55 percent compared with that in 1931. The production of roofing slate and mill stock was less than half of that in 1931, while values dropped 58 percent and 53 percent, respectively. The volume of flagging and similar products decreased 61 percent and the value about 50 percent from 1931 figures. The accompanying table shows quantities and values of the principal slate products during recent years.

Slate other than granules and flour sold by producers in the United States, 1919–32

Year	Roofing			Mill stock		Other (flagging, etc.)		Total	
	Squares	Tons	Value	Tons	Value	Tons	Value	Tons	Value
1919–28 average	456,714	157,322	$4,361,257	54,259	$3,398,135	6,956	$60,897	218,537	$7,820,289
1929	462,120	178,500	4,920,766	53,710	3,702,145	8,920	124,524	241,130	8,747,435
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	136,000	50,000	1,000,000	16,300	830,000	2,100	33,000	68,400	1,863,000

Slate, as considered herein, includes only products that may be designated "dimension stone." Slate granules and slate flour are included in the chapter on Crushed and Broken Stone.

The most characteristic feature of slate is its fissility which permits it to be split readily into thin, smooth sheets such as roofing slates. Because of the high degree of resistance to weathering of the silicate minerals in slate, roofs last extraordinarily well. Splitting properties combined with easy workability render some slates adaptable for manufacture into various mill products.

Slate products fall into three main groups—roofing slate; mill stock; and a third group including flagging, walkways, building stone, and similar products. Mill stock is subdivided into structural and sanitary products, electrical slabs, grave vaults, blackboards, billiard-table tops, and school slates. Thus, a large percentage of all slate sold is employed in the building industries. Conditions in the slate industry and the building trades, therefore, are intimately related, and the decided depression in building since 1929 is reflected in a greatly reduced output of slate.

Slate enters a highly competitive market for every use to which it is put. In the roofing trade some lower-priced materials have seriously invaded its field, but the lasting qualities of slate have reacted in its favor. When its attractiveness as well as its enduring qualities are recognized more fully greater demand is to be expected. To attain the most satisfactory service for its products the industry is attempting to divert each type of slate to the use for which it is best adapted. Operators also are developing better mechanical equipment so that slate will be able to compete more favorably in cost with other materials. The employment of wire saws in slate mills, improvements in circular saws, the use of drum sanders, and more economical use and recovery of abrasive sand are under investigation or in prospect.

Some branches of the stone industry have consolidated into larger units, but little headway along this line has been made by slate companies. However, the establishment of centralized sales agencies has been beneficial, and if the tendency toward more scientific marketing grows greater business is expected. No problems in the slate industry are more difficult to solve than those of marketing, and the best thought of the industry, whether devoted to the technique of

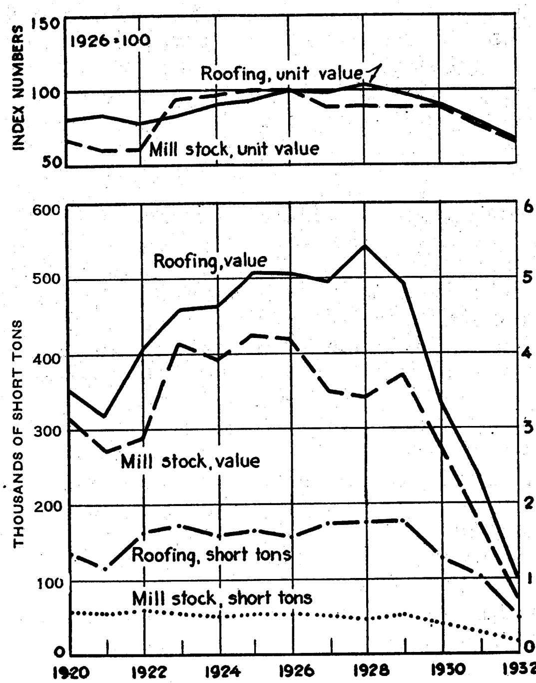

FIGURE 59.—Trends in quantity and unit value of slate sold, 1920–32.

quarrying and manufacture or to problems of distribution and sale, has in view more successful competition with other products and systematic widening of market channels.

Quantities and values of roofing slate sold during the period 1920–32 are shown graphically in figure 59. Since 1928 the industry has not declined as seriously as might be expected from the decided curtailment in building construction. According to the United States Bureau of Labor Statistics building contracts in 1932, measured in terms of floor space, were only 18 percent of those recorded for 1926. During the same period roofing-slate sales fell to 32 percent of those in 1926. Roofing slate is used in two ways—for new construction and for reroofing; it is therefore evident that reroofing has materially assisted sales. The quantity of mill stock sold in 1932 was about 30 percent of that in 1926. Material used in vaults and covers has been in fair demand and has helped to sustain sales. Slate for flagging and walkways has become increasingly popular during recent years, and an enlarged market is to be expected when building activity is resumed.

Prices.—Market quotations for the different grades of roofing slate vary considerably in different localities. Furthermore, sales are commonly made at figures other than those quoted. Mill-stock prices are not quoted in the market columns. Therefore, prices are measured best by the quantities sold and receipts therefor as reported by slate companies to the Bureau of Mines.

The unit values of roofing slate and mill stock thus determined are shown in figure 59. For comparison they are reduced to index numbers with 1926 equal to 100. The high peak for roofing slate was in 1928, and the average value in 1932 was the lowest since 1919. Unit values for mill stock fell a little lower in 1932 than those for roofing slate compared with 1926, but they were considerably above the figures prevailing in 1921 and 1922.

REVIEW BY STATES

The active slate-producing districts of the United States are the Monson district of Maine; 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.; and the Buckingham County (Arvonia) and Albemarle County districts of Virginia. Small productions of roofing slate and flagging were reported in 1932 from Montgomery County, Ark., and Inyo County, Calif.

Maine.—Slate produced in the Maine district is sold chiefly for electrical work; smaller quantities are sold for roofing and structural purposes. The quantity of roofing slate, which is always relatively small, declined about 55 percent in 1932 compared with 1931, while mill stock, chiefly electrical slate, fell about 57 percent.

New York-Vermont.—The New York quarries produce millstock, flagging, and red roofing slate. The Vermont quarries produce principally green, purple, and mottled roofing slates and small quantities of black and gray slate. Many small quarries are worked at irregular intervals, and their products are sold to the larger quarry companies or through dealers. Because of their attractive colors slates from this region sell at prices somewhat above the average for the country. Millstock is produced in considerable quantities. Sales of flagging, stepping stones, and similar products have increased during recent years because beautiful patterns may be obtained with combinations of the various colors available. The output of both roofing slate and millstock in 1932 was little more than one third of that in 1931, and flagging-stone sales were likewise small.

Peach Bottom district.—An area on the Pennsylvania-Maryland boundary near Delta, Pa., and Cardiff, Md., is known as the "Peach Bottom district". The first quarry was worked more than 200 years ago. The blue-black slate from this district is regarded generally as one of the best varieties in the United States, but the industry has been handicapped by rather difficult quarry conditions. Disastrous rock slides and a heavy flow of water have impeded operation. Production was virtually at a standstill in 1932.

Pennsylvania.—The slate district of Northampton and Lehigh Counties, Pa., is the most productive in the United States. Roofing slate is produced at Chapmans Quarries, and roofing slate and all types of mill products are manufactured near Bangor, Pen Argyl, Windgap, and Slatington. An important product of the district is blackboard slate, which is used widely in schools and colleges. Although production in this district was very small, it declined less than in other slate regions during 1932. The quantity of roofing slate sold was about 44 percent less than in 1931, and that of millstock was about 53 percent less.

Virginia.—The slates of Buckingham County are too hard to be used successfully as millstock, but they have a high reputation for use as roofing. The quantity sold in 1932 was only about one third of that in 1931.

MISCELLANEOUS STONE

In addition to the five principal varieties of stone—granite, marble, limestone, sandstone, and slate—basalt, volcanic rocks, and numerous other kinds are used as dimension stone to a limited extent. Their principal use is for rough building construction. Soapstone, a massive rock related to talc, has been discussed in preceding years in the chapter on talc, but as 95 percent of it is employed in block form and is an integral part of the dimension-stone industry it is included herein. Ground soapstone, which is similar in character and use to talc, is included in the talc chapter. Soapstone is manufactured into highly specialized products which have a relatively high unit value. It is not related to the stone included in the miscellaneous group, which is sold principally in rough blocks of low unit value, but it is included with this group because so much of the production is by a single company that separate figures cannot be shown.

Prior to 1930, 80,000 to 150,000 tons a year of basalt were used as rough building stone or rubble. Since that time the output has been much smaller. Many different kinds of stone are classed as dimension stone. Among the more important are tuff and other light-colored volcanic rocks used for building stone in some Western States; argillite used for building stone in Arkansas, New Jersey, and Pennsylvania; mica schist from Pennsylvania used as building and refractory stone; and miscellaneous boulders used for rough construction in many States. It is probable that large quantities of boulders used locally for special building projects are unrecorded, as the Bureau has no means of collecting such data.

Soapstone is a massive rock of variable composition consisting chiefly of talc, actinolite, and chlorite. As it is highly resistant to the action of acids and heat, it is well adapted for furnace blocks in paper mills and for laboratory equipment, including table tops, sinks, fume hoods, and tanks. It is used also for laundry tubs and aquariums and is finding increasing use for spandrels, baseboard, floor tile, and other structural units. Most soapstone now marketed is produced in Nelson County, Va. The principal products are building materials or accessories for which there was little demand in 1932, consequently sales of soapstone were relatively low.

CRUSHED AND BROKEN STONE

By J. R. Thoenen

Crushed and broken stone has heretofore been included in the annual Mineral Resources report of the Bureau of Mines entitled "Stone." This year all nondimension stone has been segregated in a separate chapter, "Crushed and Broken Stone," to clarify production statistics and to serve better the two classes of producers. Since the advent of concrete the crushed-stone industry has far surpassed the dimension-stone industry in tonnage and value. Very few producers of crushed stone are interested in dimension-stone sales or markets, and vice versa. Discussion of crushed stone, as in preceding years, is confined to stone sold for railway ballast, concrete aggregate, and road metal. Broken stone includes all types or classes of nondimension stone except crushed stone. Thus, the term includes riprap but excludes rubble, because the latter is laid as individual pieces in masonry.

The total production of crushed and broken stone is estimated at 87,314,000 tons in 1932, 34 percent below the production in 1931. No data are available on values in 1932. Crushed-stone output, estimated at 46,800,000 tons in 1932, was 35.6 percent below that in 1931. Broken stone, estimated at 40,514,000 tons in 1932, was 32.4 percent below that in 1931. The rate of decline in production of crushed and broken stone for various uses, however, varied in 1932 compared with 1931. The output of concrete aggregate and road metal declined 35 percent in 1932 compared with 1931, and that of railway ballast fell off 41.2 percent. Production of crushed stone for cement manufacture dropped 40.8 percent in 1932 from 1931, and that of crushed stone for other uses decreased as follows: Furnace flux 58.9 percent, lime manufacture 26.2 percent, alkali works 10.2 percent, riprap 5.2 percent, agricultural limestone 33.1 percent, stone for refractory purposes 50.9 percent, asphalt filler 35.1 percent, stone for calcium carbide manufacture 8.5 percent, and slate granules and flour 11.3 percent. Crushed-stone output for other uses increased 120 percent in 1932 compared with 1931.

A number of current barometers or indicators are available for measuring recent activity in the crushed and broken stone industry. These barometers are particularly useful because current data are not available readily in this industry. For example, shipments of portland cement are often assumed to indicate current consumption of aggregates. Portland-cement shipments for 1932 fell off 36.6 percent compared with 1931. Assuming that the production of concrete aggregate and road metal declined in the same ratio, the estimated output for 1932 was 41,900,000 tons, 900,000 tons below the estimate used in this report. Information from the field indicates that construction of low-cost secondary roads increased in 1932. Since this type of road uses less cement and more road metal it is apparent that an estimate based only on cement shipments would be lower than the actual production of concrete aggregate and road metal.

Salient statistics on crushed and broken stone sold or used by producers in the United States, by principal uses, 1931–32, short tons

	1931	1932 [1]	Gain or loss, percent
Concrete and road metal	65,811,520	42,800,000	−35.0
Railway ballast	6,812,890	4,000,000	−41.2
Cement manufacture	31,736,000	18,750,000	−40.8
Flux stone	9,727,230	4,000,000	−58.9
Lime manufacture	5,420,000	4,000,000	−26.2
Alkali works	3,340,290	3,000,000	−10.2
Riprap	4,222,570	4,000,000	−5.2
Agricultural limestone	1,421,050	950,000	−33.1
Refractory stone	611,070	300,000	−50.9
Slate granules and flour	229,980	204,000	−11.3
Asphalt filler	247,450	160,000	−35.1
Calcium carbide	164,180	150,000	−8.5
Other uses	2,818,450	5,000,000	+120.0
Total	132,562,680	87,314,000	−34.1
Rock asphalt	470,491	314,027	−33.3

[1] Subject to revision.

Likewise, railway shipments of crushed stone (exclusive of ballast) indicate production of crushed stone. Railroad shipments of crushed stone in 1932 were 15,287,000 tons, a drop of 40.9 percent compared with 1931. In 1928 the railroads carried 47.7 percent of the crushed-stone production, and in 1931 they carried only 39.3 percent, or an average loss of 2.8 percent annually. If it is assumed that the proportion carried by the railroads declined at the same rate in 1932 as in previous years, the 15,287,000 tons carried in 1932 would represent 36.5 percent of the total production. Then the total estimated production would be 41,900,000 tons, which checks with the estimate based on cement shipments. Although no actual figures are available on the tonnage hauled by auto trucks, reports indicate that shipments by trucks increased in 1932 over those in 1931. Reports from Pennsylvania show a greatly increased production of field stone which would not be reflected in railway-car loadings. This increase and the general increase in secondary road construction seems to confirm the tabulated estimate of 42,800,000 tons.

Another indicator of activity in the crushed-stone industry is the building contracts awarded. Since the larger part of production of crushed and broken stone is employed for concrete aggregate and road metal, there is a fairly close relationship between building-construction contracts and production of crushed stone. During 1932 contract awards for building construction based on floor space fell off 58 percent from 1931, while cement-pavement construction based on square yards of area fell only 29 percent. Apparently, therefore, producers of crushed stone enjoyed the benefit of the continued, although reduced, road-building programs in the various States.

Railroad expenditures for ballast also can be used to estimate the production of crushed stone for ballast. Railroad expenditures for ballast in 1932 decreased to $8,109,000 (41.7 percent of those in 1931). Assuming the same value per ton in 1932 as in 1931, this represents 9,700,000 tons. Moreover, if gravel and crushed-stone ballast retained their relative proportions, the crushed-stone ballast estimate on this basis would be 41 percent of 9,700,000 tons or 3,975,000 tons, which checks closely the original tabulated estimate.

Trends in consumption and uses.—Trends in production and value per ton of crushed and broken stone by major uses for the past 10 years appear in the following table. The value per ton is calculated from the total value of product as reported by producers. This value is f.o.b. plant and is the nearest approach to selling prices that the Bureau can make from its records. The estimated production for each class of stone in 1932 is also shown. These estimates are based upon early returns compared with the reports of the same producers for 1931.

Crushed and broken stone sold or used by producers in the United States, by principal uses, 1922–32

[Tons of 2,000 pounds]

	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932 [1]
Concrete and road metal ... tons	42, 426, 500	51, 047, 900	57, 684, 210	62, 823, 800	66, 892, 530	78, 544, 210	74, 384, 490	76, 174, 770	74, 293, 090	65, 811, 520	42, 800, 000
Value per ton [2]	$1. 12	$1. 14	$1. 13	$1. 11	$1. 12	$1. 07	$1. 09	$1. 06	$1. 04	$0. 99	----------
Railway ballast ... tons	7, 337, 240	11, 274, 810	10, 514, 230	12, 849, 130	15, 623, 030	16, 404, 560	16, 880, 870	16, 546, 490	12, 817, 800	6, 812, 890	4, 000, 000
Value per ton	$0. 89	$0. 85	$0. 83	$0. 82	$0. 82	$0. 81	$0. 78	$0. 83	$0. 80	$0. 81	----------
Cement manufacture [3] ... tons	30, 218, 000	34, 934, 000	37, 963, 000	41, 012, 000	41, 974, 000	44, 195, 000	45, 012, 000	43, 612, 000	40, 841, 000	31, 736, 000	18, 750, 000
Value per ton	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Flux stone ... tons	18, 718, 000	25, 602, 450	19, 690, 490	22, 860, 890	23, 859, 390	21, 666, 070	23, 123, 870	24, 393, 500	17, 090, 710	9, 727, 230	4, 000, 000
Value per ton	$0. 76	$0. 80	$0. 80	$0. 76	$0. 76	$0. 74	$0. 73	$0. 74	$0. 72	$0. 74	----------
Lime manufacture [5] ... tons	7, 280, 000	8, 140, 000	8, 144, 000	9, 100, 000	9, 121, 000	8, 830, 000	8, 920, 000	8, 540, 000	6, 780, 000	5, 420, 000	4, 000, 000
Value per ton	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Alkali works ... tons	2, 494, 260	3, 338, 910	2, 950, 120	3, 549, 930	3, 556, 490	3, 848, 490	4, 231, 750	5, 004, 930	4, 436, 160	3, 340, 290	3, 000, 000
Value per ton	$0. 75	$0. 70	$0. 70	$0. 70	$0. 66	$0. 64	$0. 61	$0. 65	$0. 62	$0. 65	----------
Riprap ... tons	2, 048, 580	3, 185, 900	3, 265, 130	3, 079, 270	4, 060. 280	4, 618, 500	3, 993, 190	4, 212, 990	4, 292, 030	4, 222, 570	4, 000, 000
Value per ton	$0. 86	$0. 94	$1. 11	$0. 91	$1. 15	$1. 02	$0. 97	$1. 20	$1. 11	$1. 01	----------
Agricultural limestone ... tons	1, 195, 000	1, 278, 770	1, 352, 600	1, 954, 480	1, 850, 620	2, 206, 470	2, 186, 870	2, 654, 580	2, 542, 100	1, 421, 050	950, 000
Value per ton	$1. 80	$1. 69	$1. 51	$1. 47	$1. 66	$1. 52	$1. 44	$1. 42	$1. 30	$1. 49	----------
Refractory stone [6] ... tons	902, 170	1, 151, 900	1, 093, 940	1, 261, 130	1, 531, 070	1, 362, [illegible]20	1, 348, 160	1, 558, 200	1, 197, 500	611, 070	300, 000
Value per ton	$1. 26	$1. 37	$1. 27	$1. 23	$1. 25	$1. 26	$1. 29	$1. 16	$1. 17	$1. 04	----------
Slate granules and flour ... tons	379, 980	462, 260	512, 810	497, 700	498, 050	459, 760	413, 980	428, 940	289, 700	229, 980	204, 000
Value per ton	$5. 73	$7. 70	$6. 19	$6. 45	$6. 02	$6. 03	$5. 97	$5. 82	$5. 85	$5. 88	----------
Asphalt filler ... tons	138, 930	225, 400	284, 850	390, 140	415, 920	420, 860	407, 350	344, 880	430, 290	247, 450	160, 000
Value per ton	$3. 95	$3. 23	$3. 69	$3. 59	$3. 40	$3. 19	$3. 15	$3. 38	$2. 61	$3. 15	----------
Calcium carbide ... tons	256, 190	276, 760	312, 670	308, 660	357, 450	316, 960	282, 610	339, 510	364, 750	164, 180	150, 000
Value per ton	$0. 46	$0. 50	$0. 49	$0. 66	$0. 66	$0. 52	$0. 63	$0. 70	$0. 75	$0. 59	----------
Other uses [7] ... tons	1, 269, 160	1, 812, 940	1, 834, 020	1, 991, 330	2, 062, 050	2, 503, 820	2, 514, 110	5, 233, 810	5, 214, 540	2, 818, 450	[8] 5, 000, 000
Value per ton	$2. 83	$2. 43	$2. 49	$2. 30	$2. 41	$2. 31	$2. 13	$1. 24	$1. 09	$1. 57	----------
Total ... tons	114, 664, 010	142, 732, 000	145, 602, 070	161, 678, 460	171, 801, 880	185, 377, 620	183, 699, 250	189, 044, 600	170, 589, 670	132, 562, 680	87, 314, 000
Less lime and cement ... do	37, 498, 000	43, 074, 000	46, 107, 000	50, 112, 000	51, 095, 000	53, 025, 000	53, 932, 000	52, 152, 000	47, 621, 000	37, 156, 000	22, 750, 000
Total commercial stone ... do	77, 166, 010	99, 658, 000	99, 495, 070	111, 566, 460	120, 706, 880	132, 352, 620	129, 767, 250	136, 892, 600	122, 968, 670	95, 406, 680	64, 564, 000
Average value per ton	$1. 05	$1. 06	$1. 09	$1. 04	$1. 06	$1. 03	$1. 02	$1. 00	$0. 98	$0. 98	----------
Asphaltic stone [9] ... tons	298, 088	365, 601	525, 831	545, 060	672, 750	796, 100	760, 497	748, 550	664, 871	470, 491	314, 000
Value per ton	$5. 47	$5. 99	$6. 26	$6. 17	$5. 34	$5. 86	$5. 34	$5. 44	$5. 36	$4. 78	----------

[1] Subject to revision.
[2] Value per ton at the plant as reported to the Bureau of Mines by producers.
[3] Estimated quantity of limestone used in the manufacture of portland and natural cement.
[4] No value shown because the greater part of the stone is used by the producer without marketing as stone.
[5] Estimated quantity of limestone used in the manufacture of lime.
[6] Ganister, mica schist, and dolomite.
[7] Carbonic acid works, coal-mine dusting, fertilizer filler, filter beds, magnesia works (dolomite), mineral food, mineral (rock) wool, poultry grit, stucco, terrazzo, artificial stone, whiting substitute, ammonia, baking powder, dye works, nitrates, phosphates, and purification of copper, soap, and sulphuric acid.
[8] Includes 3,000,000 tons of uncrushed field stone used in Pennsylvania for road base.
[9] Asphaltic stone figures have been added from the chapter on asphalt.

Production and value of crushed and broken stone for the past 10 years is shown graphically in figure 60 *A* and *B*.

Production figures are presented in a somewhat different form in figure 61. In this chart the 1922 production for each major class or use is assumed as 100 percent, and the production for each subsequent year plotted as a percentage of 1922. The graph thus represents index numbers for each commodity, based on 1922 production. The figure shows that production in 1932 of all classes of crushed and broken stone declined from that in 1931, but at varying rates.

The following table compares data on employment and production at 70 commercial crushed-stone quarries with data at a larger group of quarries of all classes. The output of the 277 quarries of all classes represented 37 percent of the total crushed and broken stone production for 1931 and 1932 and includes that of the 70 commercial crushed-stone quarries.

Comparison of production and data on employment at 277 identical quarries, all classes, and at 70 identical commercial crushed-stone quarries, 1931 and 1932

	277 quarries, all classes			70 commercial crushed-stone quarries		
	1931	1932	Gain or loss, percent	1931	1932	Gain or loss, percent
Tons produced	49,476,740	31,966,899	−35.4	20,579,858	12,040,161	−41.5
Total man-hours worked	56,748,108	40,917,499	−27.9	8,827,182	7,082,418	−19.8
Total man-shifts worked	6,511,593	4,864,964	−25.3	1,054,627	806,029	−23.5
Total men employed	26,689	23,571	−11.7	5,365	4,603	−14.2
Average days worked	244	206	−15.6	196.5	175	−10.9
Percentage of possible time worked	81.3	68.7	−15.6	65.5	58.3	−10.9
Average number of weeks worked [1]	42.3	35.7	−15.6	34.0	30.6	−10.9
Average hours worked per man	2,126	1,736	−18.3	1,645	1,538	−6.5
Average hours worked per man per week [1]	50.2	48.6	−3.2	48.4	50.3	+3.9
Average hours worked per shift	8.7	8.4	−3.4	8.4	8.8	+4.8
Average tons per man-shift	7.6	6.6	−13.2	19.5	14.9	−23.6
Average tons per man-hour	.87	.78	−10.3	2.33	1.70	−27.0

[1] Represents the average number of full weeks worked and hours worked per man per week assuming continuous operation; all operations, however, were subject to a certain amount of intermittent activity due both to weather conditions and to market factors.

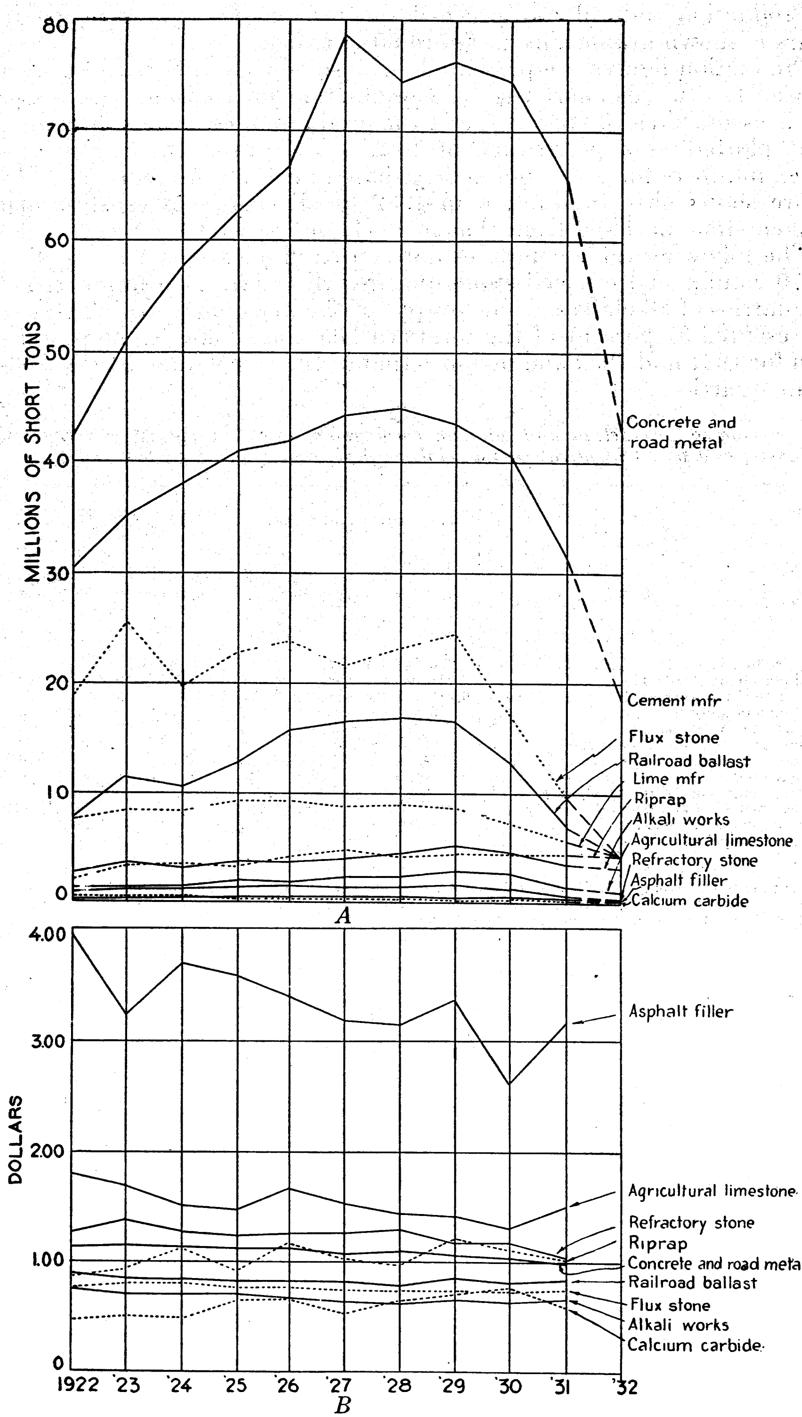

FIGURE 60.—*A*, Principal uses of crushed and broken stone produced, 1922–32; *B*, trends in average values per ton of crushed and broken stone employed for certain principal uses, 1922–32.

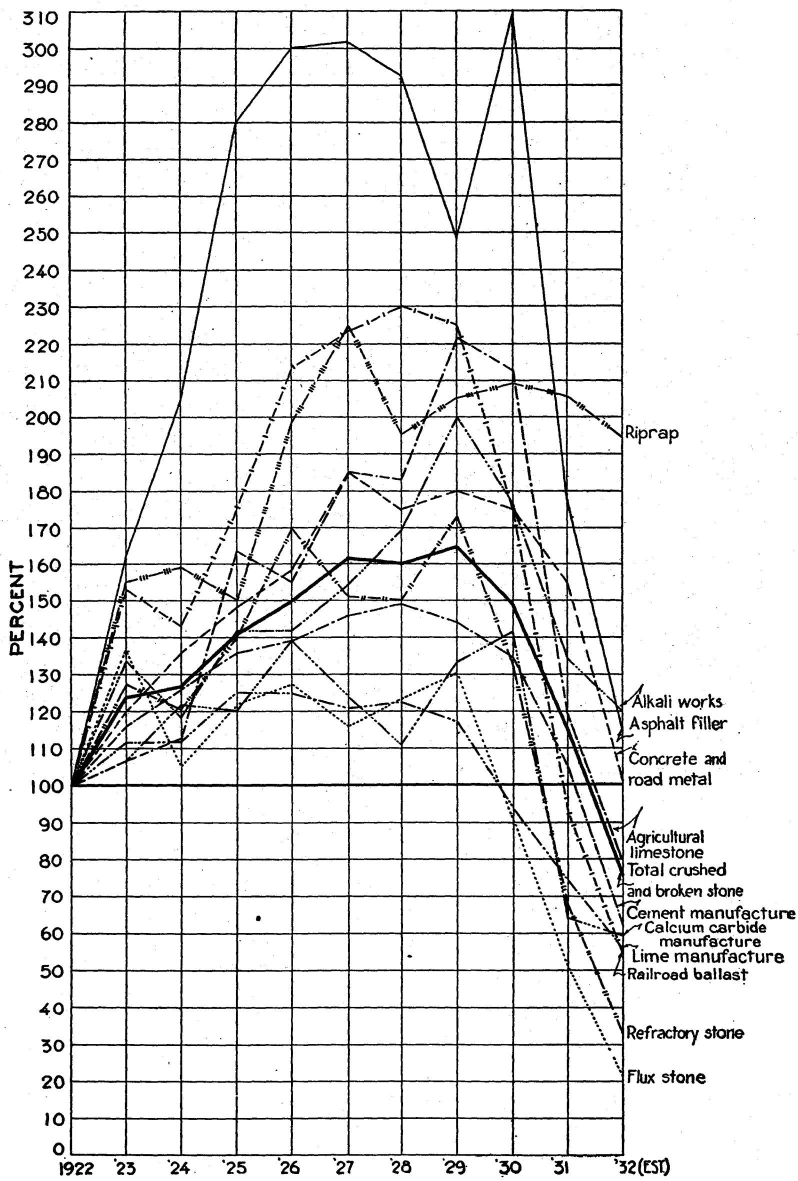

FIGURE 61.—Comparison of trends in principal uses of crushed and broken stone, 1922–32. In the above graph the annual quantity indicated for each principal use is expressed as a percentage of the quantity produced in 1922 for the same purpose.

SAND AND GRAVEL

By H. H. Hughes and E. R. Phillips

The output of sand and gravel in 1932 reflected the sharp declines in building and highway construction. A preliminary estimate based on rail and water shipments indicated that 87,500,000 short tons of sand and gravel were sold or used by producers in 1932. Subsequent partial returns from producers, however, suggested an upward revision of the estimate to 89,000,000 short tons. This quantity represents a decline of about 42 percent from 1931 and 60 percent from the peak of 1929. Salient statistics of the sand and gravel industry in 1931 and estimates for 1932 are summarized in the following table:

Salient statistics of the sand and gravel industry in the United States, 1931–32

	1931	1932 [1]	Change, percent
Sand and gravel shipments:			
Rail shipments, class I roads [2] ... short tons	53,561,587	28,721,000	−46
Water shipments:			
Pittsburgh district [3] ... do	3,003,803	1,250,000	−58
Coastwise from Long Island [4] ... do	8,880,766	4,257,208	−52
Delaware River above Philadelphia [5] ... do	2,749,781	2,020,700	−27
Sand and gravel sold or used by producers: [6]			
Total ... do	153,479,044	89,000,000	−42
Value	$86,280,320	$46,280,000	−46
Average value per ton	$0.56	$0.52	−7
Sand ... short tons	64,492,826	36,250,000	−44
Value	$36,696,746	$19,277,500	−47
Average value per ton	$0.57	$0.53	−7
Gravel ... short tons	88,986,218	52,750,000	−41
Value	$49,583,574	$27,002,500	−46
Average value per ton	$0.56	$0.51	−9
Sand sold or used by producers, by uses: [7]			
Glass ... short tons	1,677,882	1,330,000	−21
Molding ... do	2,138,305	1,100,000	−49
Building ... do	25,178,572	11,200,000	−56
Paving ... do	27,459,581	17,000,000	−38
Grinding and polishing ... do	607,589	400,000	−34
Engine ... do	1,604,123	1,300,000	−19
Fire or furnace ... do	88,189	52,000	−41
Filter ... do	55,319	38,000	−31
Other [8] ... do	5,683,266	3,830,000	....
Gravel sold or used by producers, by uses: [7]			
Building ... do	21,426,814	10,500,000	−51
Paving ... do	56,716,230	36,250,000	−36
Railroad ballast [9] ... do	10,843,174	6,000,000	−45

[1] Figures for 1932 are subject to revision.
[2] As reported by the Interstate Commerce Commission; figures exclude glass and molding sand and nonrevenue railroad ballast.
[3] As reported by the Chief Statistician, Board of Engineers for Rivers and Harbors.
[4] Coastwise shipments from Hempstead Harbor, Huntington Bay, and Port Jefferson Harbor only.
[5] Delaware River between Philadelphia and Trenton; internal shipments and local.
[6] Figures for 1932 are preliminary estimates based on: (a) Shipments of sand and gravel by rail and by water, (b) analysis of conditions in consuming industries, and (c) trends indicated by partial returns from producers.
[7] Figures for 1932 estimated from data available on consuming markets; checked by preliminary reports from producers.
[8] Includes some sand used for railroad ballast, fills, and similar purposes.
[9] Includes some gravel used for fills and other purposes; in 1931, 8,814,907 tons of gravel, valued at $2,898,598 were used exclusively for ballast.

The drop of 42 percent in sales of sand and gravel may seem severe compared with 37 percent for cement shipments. Study of available markets reveals that larger than average decreases were registered for building, paving, and molding sands and for railroad ballast, markets in which large quantities of sand and gravel are used for purposes other than concrete.

Total sales of all kinds of sand in 1932 are estimated at 36,250,000 short tons, a decrease of 44 percent from 1931, whereas total gravel sales are estimated at 52,750,000 short tons, a drop of only 41 percent. The smaller decline for gravel is a continuation of the trend of the past 10 years during which gravel has accounted for an ever-increasing percentage of total sales of sand and gravel.

Prices.—The average value per ton, according to estimates, dropped 7 percent, from $0.56 a ton in 1931 to $0.52 in 1932. This decline is slightly greater than that registered in the index numbers for wholesale prices compiled by the United States Bureau of Labor Statistics, which for gravel amounted to 6.4 percent and for building sand to 4.5 percent. Similar discrepancies occur for cement and other commodities, and they probably reflect merely the inherent difficulty of differentiating between quotations and actual sales prices. The total value of sand and gravel sold or used by producers in 1932 declined 46 percent from the previous year, from $86,280,320 in 1931 to $46,280,000 in 1932.

MARKETS

Data on rail and water shipments, combined with preliminary returns from producers, provide reliable indicators from which the total quantity of sand and gravel sold or used may be estimated. To effect a statistical break-down by uses, however, is more difficult and can be approximated only by careful study of consuming markets. Data used in computing estimates of sand and gravel production by uses are summarized in the following table.

Summary of data relating to markets for sand and gravel [1]

	1928	1931	1932 [2]	Change in 1932 from 1931,
Highway construction:				
Concrete pavement awards: [3]				*Percent*
Total, monthly average ---------square yards--	12,340,000	11,207,000	8,069,000	−28
Roads only, monthly average----------do----	7,794,000	9,321,000	7,199,000	−23
Portland cement shipments---------------barrels--	175,838,332	127,150,534	80,579,000	−37
Paving asphalt shipments------------short tons--	1,676,531	1,124,253	856,644	−24
Cut-back asphalt shipments----------------do----	--------------	446,413	440,832	−1
Road-oil sales----------------------------barrels--	3,670,000	7,170,102	8,315,823	+16
Federal-aid highways completed [4]-----------miles--	7,864	10,832	4,785	−56
Building construction:				
Construction contract awards: [5] Total floor space, monthly average-------------------square feet--	80,547,000	30,487,000	12,966,000	−58
Building permits, value [6]--------------------------	$3,304,670,000	$1,237,985,000	$481,490,000	−61
Engineering construction: Value, monthly average [7]---	$298,215,000	$204,215,000	$101,609,000	−50
Railway expenditures, class I roads: For ballast [8]------	$35,517,000	$13,921,000	$8,109,000	−42

[1] Many of the data in this table are available monthly in "Survey of Current Business."
[2] Figures for 1932 are subject to revision.
[3] Compiled by the Portland Cement Association.
[4] Issued by U.S. Bureau of Public Roads.
[5] Compiled by F. W. Dodge Corporation for 37 States east of the Rockies.
[6] Compiled by U.S. Bureau of Labor Statistics; figures for 257 cities.
[7] Compiled by Engineering News-Record, covers heavy engineering contracts awarded.
[8] Compiled from reports of the Interstate Commerce Commission and the Bureau of Railway Economics.

Summary of data relating to markets for sand and gravel—Continued

	1928	1931	1932	Change in 1932 from 1931
				Percent
Glass production, monthly average:				
Containers [9] ... gross..	2,366,000	2,057,000	1,713,000	−17
Illuminating glassware [10] ... turns..	3,254	1,925	[11] 1,224	−36
Polished plate [12] ... square feet..	10,887,000	7,243,000	4,352,000	−40
Foundry activity:				
Foundry and malleable pig iron,[13] production gross tons..	6,132,760	3,079,603	1,231,207	−60
Malleable castings,[14] monthly average .short tons..	58,573	24,069	14,290	−41
Dimension stone: Cut-stone sales ... cubic feet..	....	14,816,030	10,386,000	−30
Freight car loadings, all commodities: Total, monthly average [15] ... number of cars..	4,229,000	3,106,000	2,350,000	−24

[9] Compiled by the Glass Container Association.
[10] Compiled by the Illuminating Glassware Guild.
[11] 11 months.
[12] Compiled by the Plate Glass Manufacturers of America.
[13] Compiled by the American Iron and Steel Institute.
[14] Compiled by the U.S. Bureau of the Census.
[15] Compiled by the American Railway Association.

Highway construction.—Highway construction was maintained at a relatively high level during 1930 and 1931 as an aid in relieving unemployment but declined sharply in 1932. Total shipments of portland cement dropped 37 percent, although the decrease in cement used for highways was less than in that used for building construction. Statistics of the Portland Cement Association reveal that concrete-pavement contracts awarded during 1932 amounted to 8,069,000 square yards compared with 11,207,000 square yards in 1931, a decline of 28 percent. Road contracts, however, held up considerably better than street and alley contracts, dropping only 23 percent, from 9,321,000 square yards in 1931 to 7,199,000 square yards in 1932.

Total mileage of Federal-aid highways completed during 1932 was 4,785 compared with 10,832 in 1931, a decrease of 56 percent.

During the last 10 years the ratio of paving-gravel tonnage to square yards of concrete-pavement contracts awarded has been increasing at a relatively uniform rate, unbroken until 1931. This relationship may indicate two trends; namely, that gravel is becoming relatively more important as coarse aggregate in concrete pavements and that an ever-increasing percentage of gravel is used in low-type roads. The drop in the ratio in 1931 may reflect activity of wayside pits, the entire output of which may not be included in statistical returns. A similar condition doubtless prevailed during 1932. Quantities of sand and gravel actually used per square yard of concrete pavement changed little, if any, from 1931 to 1932.

No figures are available to reveal accurately the magnitude of low-type road construction or to indicate the logical distribution of paving-asphalt shipments by kind of pavement. General trends, however, are shown by statistics of asphalt shipments and road-oil sales. Shipments of paving asphalt dropped from 1,124,253 short tons in 1931 to 856,644 short tons in 1932, a decline of 24 percent. Accurate allocation of this decrease by kind of surface is impossible, but sheet-asphalt paving is believed to have declined at a greater rate than bituminous concrete or bituminous macadam by penetration. If this inference is true, then the market for paving sand to be used in sheet asphalt was curtailed further than that for coarse aggregates to be used in other types of bituminous pavements.

Cut-back asphalts commonly are used for mixed-in-place bituminous surfaces. Shipments of this type of material declined only 1 percent from 1931 to 1932, and the quantity shipped in 1932—440,832 short tons—represented an increase of more than 240 percent over 1929, the first year for which statistics for cut-back asphalt were segregated. Road-oil sales made an even better showing, increasing 16 percent from 7,170,102 barrels in 1931 to 8,315,823 barrels in 1932. Both cut-back asphalts and road oils are used with varying quantities of crushed stone, gravel, or possibly sand, but much of the material thus used is taken from wayside pits adjacent to the job. Collectively, low-type roads have provided a great stimulant for wayside-pit production of sand and gravel, but their effect on permanent plant operations varies in different localities.

To estimate the quantities of paving gravel and paving sand sold or used in 1932 on the basis of the foregoing discussion of conditions in the field of highway construction obviously is difficult. Declines in construction registered yearly are not reflected faithfully in sales of aggregates, and estimates based on these data should be modified by a study of long-time trends. However, careful analysis of existing data on markets and preliminary reports of producers indicate that the quantity of paving gravel sold or used by producers in 1932 was approximately 36,250,000 short tons, a drop of 36 percent from 1931. Paving-sand production, however, declined about 38 percent from 1931, total sales being only 17,000,000 short tons. The fact that sales of paving sand registered a greater decline than sales of paving gravel may be due to increased activity in construction of highways requiring little or no fine aggregate.

Building construction.—Nonresidential reinforced-concrete structures, in terms of both unit value and volume of construction, afford a much greater outlet for sand and gravel than frame residences. Unfortunately, however, the break-down of available statistics of construction is not complete enough to indicate markets for sand and gravel in each of the various types of construction. Total figures, therefore, provide the best general barometer. The F. W. Dodge Corporation compiles statistics of construction contracts awarded in the 37 States east of the Rocky Mountains. Total contracts awarded in 1932 amounted to only 12,966,000 square feet of floor space compared with 30,487,000 square feet in 1931, a decline of 58 percent.

Another source of information on conditions in the construction industry is the Bureau of Labor Statistics, which compiles figures on total building permits issued in 257 principal cities of the United States. The total value of permits issued in 1932 was $481,490,000 compared with $1,237,985,000 in 1931, a decrease of 61 percent.

Statistical records of the F. W. Dodge Corporation show that residential construction dropped comparatively more than other types, therefore the total volume of construction in 1932 apparently included a greater proportion of large projects than in previous years. This conclusion is substantiated by the relatively high level of figures on engineering construction compiled by Engineering News-Record. The monthly average of heavy engineering construction contract awards amounted to $204,215,000 in 1931 and $101,609,000 in 1932.

This drop of 50 percent was less than the decline of 58 percent in total volume of all types of construction and the drop of 61 percent in value of building permits.

These declines, a study of trends over a 10-year period, and preliminary returns from producers indicate that sales of building sand and gravel in 1932 must have been 50 to 55 percent less than in 1931. It is estimated, therefore, that the quantity of building sand sold or used by producers in 1932 was 11,200,000 short tons and the quantity of building gravel 10,500,000 short tons.

Railroad ballast.—The demand for railroad ballast has declined sharply as a result of railroad economies during the depression. Class I railroads in 1932 spent 42 percent less on ballast than in 1931 and 79 percent less than in the peak year 1929. The total ballast expenditures of class I roads during 1932 amounted to about $8,109,000. Of this total, approximately $5,300,000 was charged to operating expenses and represents ballast used primarily for maintenance. The remaining $2,809,000 was charged to capital account and represents money expended for ballast to be used primarily in new construction work.

Expenditures for ballast includes chats, cinders, burned clay, and slag, as well as crushed stone, gravel, and sand. The total also includes charges for moving the ballast from the source of supply to the place of use plus unloading costs. Nevertheless about 60 percent of the reported expenditures represents the actual cost of the ballast purchased. The constancy of this relationship can be shown by comparing index numbers of ballast expenditures reported by class I roads with index numbers of the volume of ballast sales reported by crushed stone, gravel, and sand producers. For the past 5 years, on the basis of 1928 as 100, these index numbers have not varied more than 4 points for any particular year, and in 1931 both stood at 39.

It is therefore reasonable to assume that the decline in ballast sales from 1931 to 1932 was essentially the same as that in railroad expenditures for ballast. From what is known of railroad expenditures it is estimated that total sales of ballast in 1932 were 9,730,000 short tons of material. Furthermore, analysis of producers' reports for previous years indicates that the ratio of crushed stone to gravel and sand ballast has remained reasonably constant during the past 5 years. If a similar ratio is applied to 1932 it is estimated that approximately 5,750,000 short tons of gravel and sand were sold for railroad ballast during the year. This estimate, however, does not include material used for fills and similar purposes; gravel alone for such uses amounted to 2,028,267 short tons in 1931. After a reasonable correction is made for the sand ballast probably included in the estimate of 5,750,000 short tons and for the gravel used in fills, it seems logical that about 6,000,000 short tons of gravel were sold in 1932 for railroad ballast, fills, and related purposes. No attempt is made to segregate the quantity of sand similarly used, but it is included in the group of miscellaneous sands.

Glass production.—Production of glass sand during 1932 was maintained at a higher rate comparatively than that of any other class of material included in the sand and gravel industry with the possible exception of engine sand. The Glass Container Association compiles statistics of production for about 83 percent of the glass-container industry. These figures show that production of glass containers declined only 17 percent in 1932 from 1931. Actual production in 1932 was 1,713,000 gross compared with 2,057,000 gross in 1931.

Data from 70 to 75 percent of the illuminating-glassware industry, compiled by the Illuminating Glassware Guild, indicate that production in this branch of the glass industry declined 36 percent in 1932 from 1931. Production is calculated in number of turns, a turn being a 4-hour working period for one shop. In 1931 the monthly average production was 1,925 turns, but on the basis of figures for 11 months in 1932 the monthly average dropped to 1,224 turns.

The Plate Glass Manufacturers of America compile statistics covering practically their entire industry. These records reveal that production of polished plate glass declined from a monthly average of 7,243,000 square feet in 1931 to 4,352,000 square feet in 1932. This decrease of 40 percent, apparently the largest recorded for any branch of the glass industry, is explained by the declines in building construction and automobile manufacture, which are the two principal markets for plate glass.

Sales of glass sand over the past 10 years have conformed more closely to production of glass containers than to the output of other branches of the glass industry. On the basis of this relationship it is estimated that glass-sand sales in 1932 amounted to about 1,330,000 short tons, a decline of 21 percent from 1931. Preliminary reports from producers tend to confirm this estimate.

Foundry activity.—Production of molding sand depends upon activity in foundries throughout the United States. According to statistics compiled by the American Iron and Steel Institute production of foundry and malleable pig iron dropped from 3,079,603 gross tons in 1931 to 1,231,207 gross tons in 1932, a decline of 60 percent. These figures include virtually all pig iron produced expressly for foundry castings.

The United States Bureau of the Census collects statistics of foundry production. In 1931 and 1932, 130 identical establishments covering about 90 percent of the industry reported an average monthly production of 24,069 and 14,290 short tons, respectively, a decrease of 41 percent.

On the basis of these indicators of foundry production in 1931 and 1932, trends over the past 10 years, and preliminary reports of producers it is estimated that sales of molding sand in 1932 amounted to 1,100,000 short tons, a decline of 49 percent from the previous year.

Markets for grinding and polishing sand.—Two principal markets for grinding and polishing sand are the plate-glass and dimension-stone industries. Production of polished plate glass was 40 percent less in 1932 than in 1931, but the dimension-stone industry was aided by the increase in Federal Government building contracts awarded. As a result the output of cut stone declined only about 30 percent from 1931 to 1932, considerably less than declines recorded for other nonmetals used as building materials.

Although these data may not portray accurately market conditions for grinding and polishing sand, they serve as a basis for the estimate that 400,000 short tons of grinding and polishing sand were sold or used by producers during 1932. This represents a decline of 34 percent from 1931.

Engine sand.—No accurate indicator of market trends for engine sand is available, but freight-car loadings may be interpreted as a suggestion of engine-sand requirements. The monthly average of freight-car loadings in 1931 was 3,106,000 cars, but in 1932 it declined 24 percent to 2,350,000 cars. On the assumption that the number of locomotives in use has not decreased as rapidly as car loadings, it is estimated that sales of engine sand in 1932 were 1,300,000 short tons, a drop of 19 percent from 1931.

Sales of miscellaneous sands.—No data are available to estimate markets in 1932 for fire or furnace and filter sands. Preliminary returns from producers, however, indicate that sales in 1932 amounted to 52,000 and 38,000 short tons, respectively. The quantity of miscellaneous sands sold in 1932 is estimated by subtracting the total of all estimates for other kinds of sand and gravel from the estimated grand total of 89,000,000 short tons. The difference, 3,830,000 short tons, is set up arbitrarily as sales of miscellaneous sands.

ECONOMIC CONDITIONS

Sand and gravel operations are less restricted as to location of raw materials than almost any other branch of the minerals industry, and this wide-spread occurrence of sand and gravel deposits has resulted in the establishment of hundreds of small semipermanent plants, each supplying a local market.

Preponderance of small plants.—The following table, compiled from reports of producers, shows the preponderance of small plants in the industry. Production of sand and gravel was reported in 1931 from approximately 2,650 plants of varying sizes. Several hundred of these operations, however, were plants or pits operated by or for States, counties, or municipalities. Such plants have been excluded from the table in order that it may represent the commercial sand and gravel industry; also 46 plants reporting sales amounting to less than 100 tons each were excluded.

Number and output of commercial sand and gravel plants, by size classes, 1931 [1]

Size group	Plants [2]			Production		
	Number	Percent of total	Cumulative percent	Short tons	Percent of total	Cumulative percent
Less than 25,000 short tons	1,277	59.09	59.09	9,518,000	7.43	7.43
25,000 to 49,999	295	13.65	72.74	10,875,000	8.49	15.92
50,000 to 99,999	297	13.74	86.48	20,969,000	16.37	32.29
100,000 to 199,999	166	7.68	94.16	23,939,000	18.69	50.98
200,000 to 299,999	49	2.27	96.43	12,009,000	9.38	60.36
300,000 to 399,999	24	1.11	97.54	8,130,000	6.35	66.71
400,000 to 499,999	16	.74	98.28	7,302,000	5.70	72.41
500,000 to 599,999	11	.51	98.79	5,865,000	4.58	76.99
600,000 to 699,999	4	.19	98.98	2,649,000	2.07	79.06
700,000 to 799,999	5	.23	99.21	3,795,000	2.96	82.02
800,000 to 899,999	5	.23	99.44	[3] 5,207,000	4.06	86.08
900,000 to 999,999	1	.05	99.49			
1,000,000 to 1,999,999	10	.46	99.95	[3] 17,828,000	13.92	100.00
2,000,000 short tons and over	1	.05	100.00			
Total	2,161	100.00	100.00	128,086,000	100.00	100.00

[1] Plants operated by or for States, counties, and municipalities and 46 plants reporting less than 100 tons each are excluded.
[2] May include a few companies operating more than 1 plant, but not submitting separate returns for individual plants.
[3] Combined to avoid revealing production of individual plants.

Of the 2,161 plants included, 1,277 or more than 59 percent produced less than 25,000 short tons of sand and gravel each and collectively accounted for only a little more than 7 percent of the total sales of sand and gravel represented. Plants producing less than 50,000 tons each comprised 73 percent of the total number but accounted for only 16 percent of total sales. More than 86 percent of the plants produced less than 100,000 tons each, but this group of 1,869 plants accounted for only 32 percent of the total sales. The remaining 292 plants, only about 14 percent of the total number, accounted for the other 68 percent of sales.

From these figures it is evident that small enterprises are overwhelmingly in the majority, although the bulk of the output is contributed by large permanent plants. Regrouping of these data by companies rather than by plants would result in an even more pronounced concentration of sales by the larger enterprises, as combinations of plants would shift the resultant items into higher brackets. In 1927, 370 companies reported sales of sand and gravel amounting to more than 100,000 short tons each. These companies, although representing only 22 percent of the total number, accounted for 82 percent of the sales'

Comparison of large and small plants.—Small sand and gravel plants may be divided into three classes. The first includes plants located near a small town which supply a limited local demand with little competition. Such plants are more or less permanent operations but are subject to seasonal fluctuations as well as to varying market conditions.

The second class comprises the so-called "fly-by-night" producers, which have been of continuous concern to the operators of more permanent enterprises. Plants in this class specialize in supplying sand and gravel for individual jobs, moving elsewhere when the immediate demands cease. Preparation equipment of many such operations is limited, and the material produced may be inferior to that of modern efficient plants. Such plants exist because their proximity to markets and their low overhead charges permit drastic cuts in delivered prices.

The modern wayside pit operation is typical of the third general class of small plants. These plants, in addition to their ideal location, are designed to take advantage of recent developments in preparation equipment which make possible the production of high-quality washed aggregate, heretofore confined to large permanent installations.

Large plants, of course, have advantages over small operations. Large-scale production results in lowered costs per ton for labor, supplies, fuel, and purchased energy. Transportation costs, however, begin to mount as the marketing radius of any plant widens. Furthermore, overhead charges remain about the same whether a plant is operating near peak capacity or at only a small fraction of its maximum output.

During the present period of limited production a trend toward decentralization of the sand and gravel industry has been apparent. This trend indicates that the higher average out-of-pocket cost per ton of the small plant is more than offset by savings in transportation charges and overhead expenses. It is significant that class I railroads received $0.81 for each ton of sand and gravel transported during 1932, whereas the average value of sand and gravel as reported by the producers was $0.53 f.o.b. plant. Although glass and molding sands and railroad ballast have been excluded from these computations, the figures are not strictly comparable. Exclusive of these items, estimated sales by producers in 1932 amounted to 80,570,000 short tons, but class I roads originated only 28,721,000 short tons. The other 64 percent was shipped by means of transportation affording a shorter and more economical haul which would permit a lower delivered price.

Decline in rail shipments.—The rapid decline in rail shipments of sand and gravel since 1928 indicates further the trend toward small plants and truck shipments, although large plants also may have shipped an ever-increasing percentage of their output by truck or barge. The relation of rail shipments to other modes of transportation is shown in figure 62. The Interstate Commerce Commission classification of sand and gravel does not include glass sand, molding sand, and nonrevenue railroad ballast, and to maintain uniformity these items also have been excluded from the yearly totals.

In 1928, the first year that the Interstate Commerce Commission adopted its present freight commodity classification, 50 percent of the

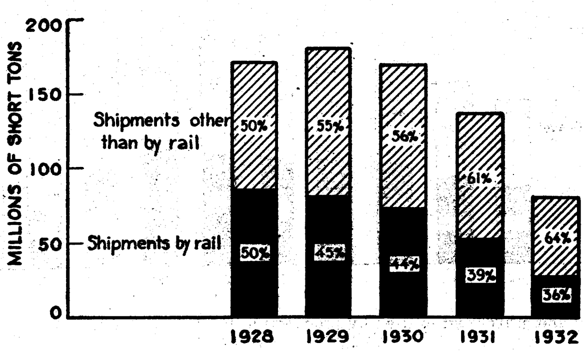

FIGURE 62.—Shipments of sand and gravel, by modes of transportation, 1928–32.

sand and gravel was shipped by rail. The decline to 45 percent in 1929 may be due partly to the more complete statistical coverage of small plants by the Bureau of Mines that year. Nevertheless, the drop from 50 percent in 1928 to 36 percent in 1932 can be interpreted only as a revolutionary shift from shipment of sand and gravel by rail to other modes of transportation, primarily motor trucks.

Production by Government agencies.—Statistical records indicate that the quantity of sand and gravel produced by States, counties, and municipalities has been increasing for the past 5 years. The exact magnitude of this trend, however, cannot be determined because reports have not been received from comparable sources each year. In 1931 production of more than 24,000,000 short tons of sand and gravel was credited to Government agencies. This represents about 16 percent of the total quantity sold or used during the year.

Although an output of 24,000,000 tons is appreciable, it probably is only a fraction of the total tonnage produced and used by States, counties, and municipalities. Since 1930 the United States Bureau of Public Roads has not been able to collect enough data to estimate the mileage of low-type roads constructed on secondary systems.

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Obviously, if data on mileage of roads cannot be obtained, statistics on materials used in their construction will be inadequate.

All the sand and gravel produced by Government agencies is not in direct competition with that of commercial plants. Much of it is reported by Western States where the only available market is occasional road work, not extensive enough or sufficiently regular to support commercial ventures. Furthermore, about 12 percent of the 24,000,0000 tons credited to Government agencies was produced for their direct use by individuals working deposits leased to them by the States or counties. There is no way of determining how much of the remaining 88 percent may have been produced under similar arrangements. Secondary-road programs for unemployment relief have been an incentive for production of sand and gravel by this type of operation.

TEN-YEAR TRENDS IN PRODUCTION

Examination of trends in sand and gravel production for the past 10 years reveals that sales of paving gravel not only have increased at

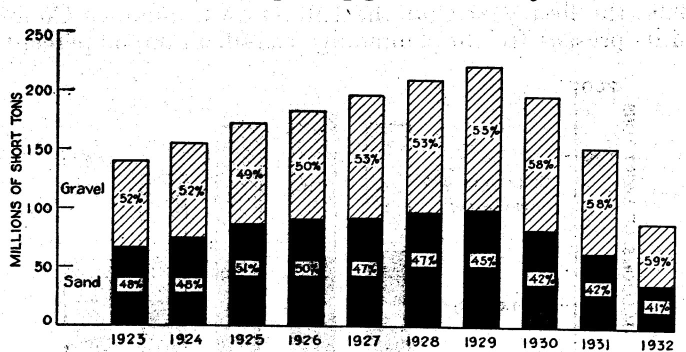

FIGURE 63.—Sand and gravel sold or used by producers in the United States, 1923–32, showing relative importance of each.

a faster rate than sales of gravel for other uses but also have maintained a higher level during the depression. Wayside-pit production of paving gravel is a logical development, especially for material to be used in construction of secondary roads outside the marketing areas of established plants.

The trend of total sales of sand and gravel in the United States is shown in figure 63. From 1923 to 1929 the average yearly increase in the output of the industry was nearly 14,000,000 short tons. Declines since 1929, however, have more than offset increases during earlier years, and total sales in 1932 were 43 percent below the 1923–25 average.

Increasing importance of gravel.—Sales of gravel in 1932 declined less from 1931 than sales of sand, indicating that gravel represented a greater percentage of total sand and gravel sales in 1932 than in the previous year. This change was not unprecedented as there has been a marked increase in the ratio of gravel to sand for several years. Ten years ago 48 percent of the total output was sand and 52 percent gravel, whereas in 1931 only 42 percent was sand and 58 percent gravel. Estimates indicate that the trend continued in 1932, sand accounting for 41 percent and gravel 59 percent of the total quantity. Figure 63 shows not only the total yearly sales of sand and gravel for the past 10 years but also the relative proportion of each.

In 1923 the quantity of gravel used for paving, building, and railroad ballast was about the same, but by 1932 there was a decided variation among the three items. Railroad-ballast sales in 1931 declined 48 percent from the 1923-25 average and in 1932 about 71 percent. Building gravel, after maintaining a fairly uniform level until 1929, also declined considerably in 1931 and 1932 from the 1923–25 average (26 percent in 1931 and about 64 percent in 1932). On the other hand the trend of paving-gravel sales has been consistently upward, reaching a peak of 64,408,274 short tons in 1930. Furthermore, since 1930 the decline in sales of paving gravel has been less severe than that in sales of building gravel and railroad ballast.

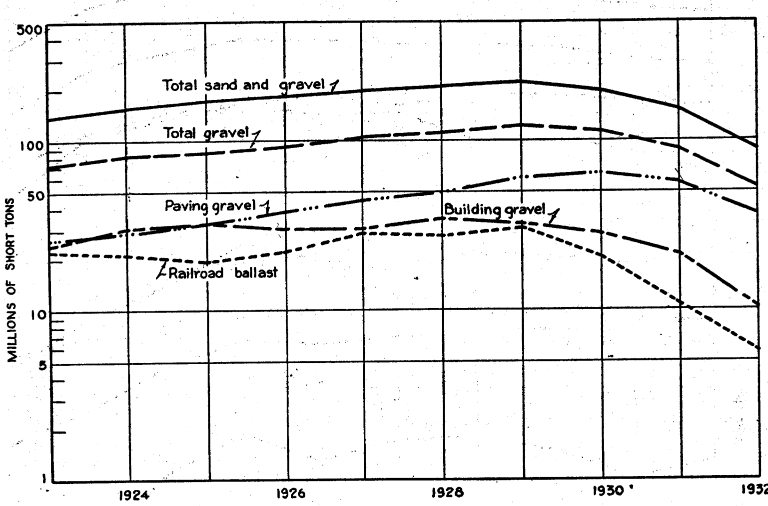

FIGURE 64.—Trends in sales of gravel, by uses, 1923–32. All curves are plotted on a logarithmic scale in order to show the proper percentage-change relationships. The foreshortening effect of the logarithmic scale should be interpreted properly in comparing the magnitude of the curves.

Estimated sales in 1932 were approximately 24 percent higher than the 1923–25 average.

These trends in sales of gravel are plotted on a logarithmic scale in figure 64. Total sales of gravel in 1923 amounted to about 72,000,000 short tons, whereas total sales of both sand and gravel were nearly 140,000,000 short tons. Due to the foreshortening feature of the logarithmic scale, however, the curve for total sand and gravel lies only a short distance above the curve for total gravel rather than approximately twice the distance from the base line as it would on an ordinary vertical scale. The principal advantage of logarithmic-scale graphs is to show trends; the percentage increases or decreases from year to year are shown in their proper relationship regardless of actual quantities plotted.

Changing trends in sales of sand.—Figure 65 illustrates 10-year trends in sales of sand for various purposes. Data for these curves also are plotted on a logarithmic scale to bring out relations similar to those shown for gravel in figure 64.

Comparison of sales of building and paving sand over the 10-year period reveals marked changes. In 1923, paving-sand sales amounted to only 15,632,419 short tons whereas building sand sales were 39,234,762 short tons. By 1927, however, paving-sand sales had increased to 35,606,622 short tons while building-sand sales remained about the same. In 1930, sales of paving sand exceeded sales of building sand for the first time, and the two curves continued to diverge during 1931 and 1932. Sales of paving sand in 1932 apparently declined 17 percent from the average for 1923–25, but building con-

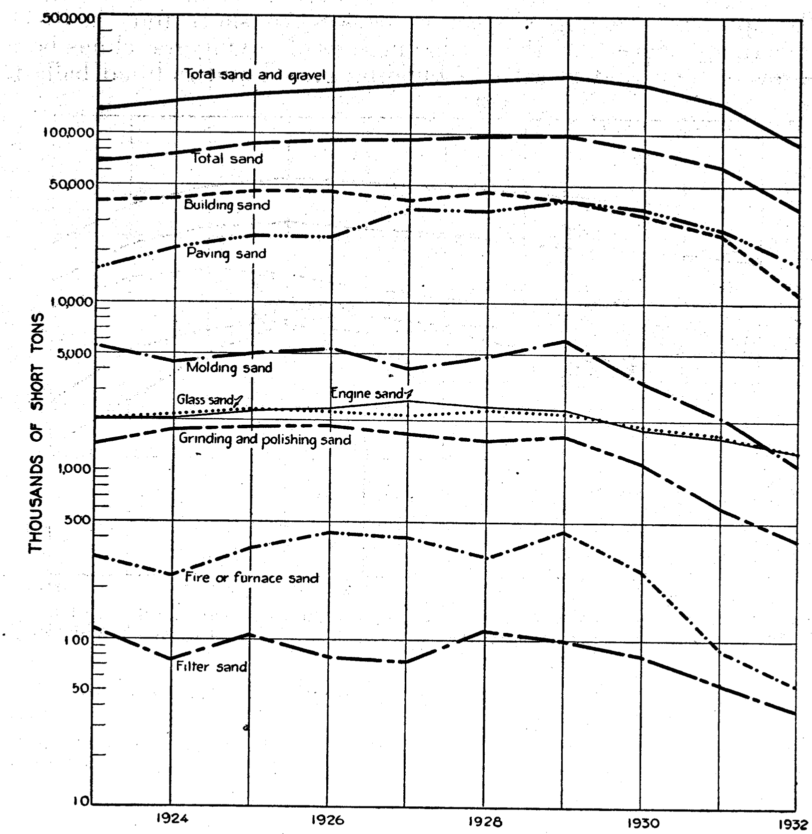

FIGURE 65.—Trends in sales of sand, by uses, 1923–32.

struction dropped so low that sales of building sand decreased 73 percent from the yearly average for the period 1923–25.

Sales of molding sand after maintaining for 6 years a level virtually equivalent to the 1923–25 average, rose to a peak of 6,195,343 short tons in 1929. Since then however, the decline has been more drastic than that for total sales of sand; the quantity sold in 1932 dropped about 78 percent from the 1923–25 average.

Glass-sand producers apparently have not felt the effects of the depression as severely as the sand and gravel industry in general. Sales of glass sand were remarkably uniform from 1923 to 1929. Since then sales have declined appreciably but much less than in most other branches of the sand and gravel industry. Sales of glass sand in 1932 were only about 39 percent less than the 1923–25 average.

Engine-sand sales also have maintained a relatively uniform level during the past 10 years, declining less since 1929 than many other kinds of sand. Sales in 1932 dropped about 38 percent from the 1923–25 average.

Sales of grinding and polishing sand and of fire and furnace sand dropped precipitously after 1929. Filter sand began to decrease from 1928 to 1929, and the decline has been fairly uniform during the past 5 years. The quantity of sand consumed by these three groups is relatively insignificant compared with the output of the entire sand and gravel industry. These markets, however, become more important in a study of local areas, for individual plants may produce special sands as the principal part of their output.

and other branches of the [illegible] and [illegible] the [illegible] [illegible] than the [illegible] [illegible]

[illegible]

[illegible] and [illegible] [illegible] quality, and nothing [illegible] [illegible]

GYPSUM

By R. M. Santmyers

During 1932 the gypsum industry experienced the greatest recession in tonnage output since the beginning of the present century. Production of crude gypsum as reported by 53 operators totaled only 1,355,219 short tons (slightly more than that reported in 1905 and a decrease of 47 percent compared with 1931). This decline in output resulted from drastic curtailment in building construction in 1932. The value of the building contracts awarded in 1932 declined 56 percent from those of the previous year and 79 percent from those of the peak year 1926.[1] Activities in residential and nonresidential building construction, the principal markets for gypsum plaster and tile, registered 49 percent and 60 percent less, respectively, than in 1931. Since approximately 95 percent of the gypsum products produced is consumed in building construction, either directly or indirectly, any drop in construction work greatly affects the gypsum industry. Research has been continued in the hope that new industrial uses for gypsum will be discovered that will broaden the markets and provide a more balanced outlet during periods of decline in construction. The recession in building-construction activities was due primarily to difficulties in financing new projects, although the fact that large numbers of people were uncertain of continued employment played an important role in curtailing the construction of residential buildings.

During the latter part of the summer there was a slight increase in light construction. Modernizing and repairs were reported to be about at the 1930 level. Toward the end of the year civic organizations, in conjunction with city heads, architects, and others, stressed building repairs and remodeling as a means of relieving unemployment, and this improved prices of many gypsum products. The requirements for these small repair jobs were inadequate, however, to offset the tremendous tonnage losses affecting the larger outlets, and it has been stated that during the year only about 17 to 20 percent of the plant capacity of the United States was utilized. This estimate, however, includes data on a fairly large number of plants that may be considered obsolete when called upon to compete with those constructed during recent years.

In the absence of incentive for enlarging capacity most producers limited their efforts to retaining the present markets for standard gypsum commodities, and only a few new products were reported. One company added three new products to its wall-board line—a regular gypsum wall board, covered on one side with aluminum foil

[1] Survey of Current Business, U.S. Dept. of Commerce (monthly).

and used for heat insulation; a wood-veneered wall board; and a wall board lithographed to resemble wood. None of these, however, may be deemed important outlets for new tonnage.

A product that may help to lower costs of certain types of temporary construction is a wall board for exterior use. The Century of Progress Exposition, which opened in Chicago on May 27, experimented in cheap, noninflammable building construction. In cooperation with officials of the exposition, the gypsum industry worked out a type of board which appears weatherproof enough for exterior use and which lowered the construction costs.

Salient statistics on gypsum and gypsum products in the United States, 1928–32

	1928	1929	1930	1931	1932
Crude gypsum:					
Mine production ____short tons__	5, 102, 250	5, 016, 132	3, 471, 393	2, 559, 017	1, 355, 219
Imports ____do____	1, 028, 816	1, 036, 385	902, 358	713, 880	374, 072
Value ____	$1, 340, 920	$1, 060, 874	$916, 663	$713, 313	$346, 766
Sales by domestic plants: [1]					
Crude gypsum ____short tons__	1, 120, 751	1, 149, 378	1, 083, 106	851, 443	509, 148
Value ____	$2, 351, 280	$2, 428, 758	$2, 277, 404	$1, 882, 557	$1, 200, 532
Average value per ton ____	$2. 10	$2. 11	$2. 10	$2. 21	$2. 36
Gypsum products:					
For building purposes ____short tons__	4, 198, 478	[2] 3, 926, 784	[2] 2, 641, 837	[3] 2, 058, 121	[3] 1, 078, 242
Value ____	$35, 877, 860	[2] $35,229, 772	[2] $31,740, 539	[3] $26,227, 225	[3] $15,540, 820
Average value per ton ____	$8. 55	$8. 97	$12. 01	$12. 74	$14. 41
For manufacturing uses ____short tons__	248, 827	255, 533	197, 665	74, 265	64, 511
Value ____	$1, 913, 729	$1, 808, 941	$1, 636, 528	$610, 882	$581, 109
Average value per ton ____	$7. 69	$7. 08	$8. 28	$8. 23	$9. 01
Total sales ____short tons__	4, 447, 305	4, 182, 317	2, 839, 538	2, 132, 386	1, 139, 694
Value ____	$37, 791, 589	$37, 038, 713	$33, 377, 067	$26, 838, 107	$16, 188, 733
Average value per ton ____	$8. 50	$8. 86	$11. 75	$12. 59	$14. 12
Gypsum products imported:					
Short tons ____	7, 508	5, 409	7, 708	7, 364	3, 302
Value [4] ____	$200, 876	$152, 509	$174, 456	$113, 198	$47, 313
Gypsum products exported: [5]					
Short tons ____	18, 788	28, 809	23, 611	11, 275	4, 919
Value ____	$416, 748	$512, 186	$420, 728	$234, 540	$91, 025

[1] Produced from rock of both domestic and imported origin.
[2] Includes some imported rock sold "For manufacturing uses."
[3] Includes calcined gypsum sold to other manufacturers and for miscellaneous uses.
[4] Includes value of manufactured plaster of paris.
[5] Does not include plaster board and wall board.

Figure 66 shows the trends in the production, imports, and sales of crude gypsum and calcined-gypsum products for 1917–32, inclusive. Of special interest is the level of prices for calcined gypsum during the past 2 years following the severe price competition of 1926–28. Increases in crude-gypsum prices are also noted.

Prices.—Despite adverse business conditions, particularly in building, the gypsum industry maintained prices on crude and calcined gypsum products in 1932, and in specific instances prices were slightly increased. According to reports submitted to the Bureau of Mines crude gypsum was valued at $2.10 per short ton, f.o.b. mines. The unit value of calcined-gypsum products sold by producers advanced to $13.74 per ton and represented an increase of $1.67 over the previous record value reported for 1931.

Trade-journal quotations during 1932, however, showed little or no change over the preceding year. According to Metal and Mineral Markets (Engineering and Mining Journal quotations), crushed crude gypsum ranged from $2.50 per short ton f.o.b. mill Iowa to $3 f.o.b. mill New York. Ground gypsum was quoted at $4 (Ohio) to $6 per ton (Iowa), while agricultural gypsum was priced at $6 to $7 per ton f.o.b. mill, depending on location.

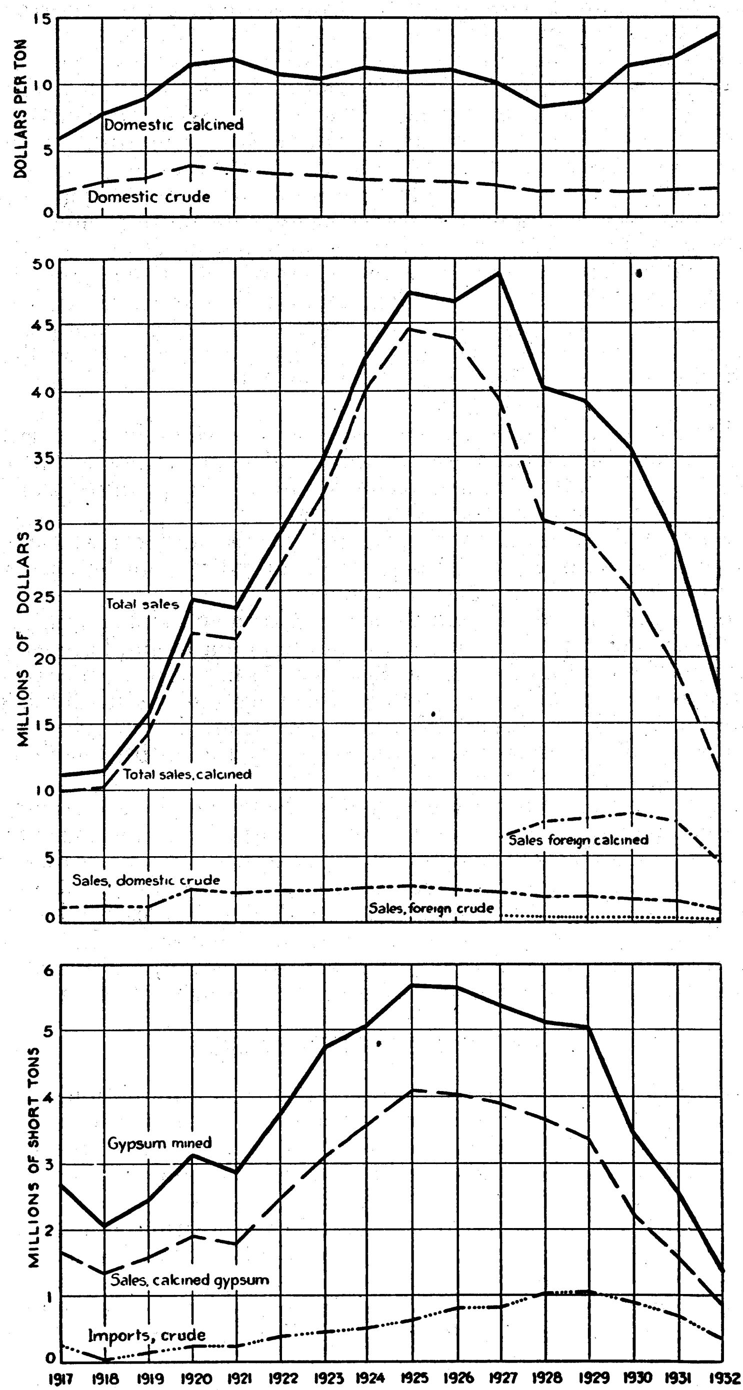

FIGURE 66.—Trends in production, imports, and sales of gypsum and gypsum products, 1917–32.

Imported crude gypsum, mainly from Canada, was reported by importers at $0.93 per short ton for 1932.

Development of new uses.—Considerable interest has been shown during the past few years in utilization of the physical properties of anhydrite or the calcium sulphate which is its essential constituent. Recent research on the use of anhydrite (the anhydrous form of gypsum) in the manufacture of commercial plasters has had encouraging results. The resulting plasters are reported to compare favorably with many of the better grades of gypsum plasters now on the market as regards "setting" qualities and tensile strength.[2] They have greater density than gypsum plasters, are strong, and easily worked, and promise to be cheaper in that they do not require calcination, the most costly step in the manufacture of gypsum plasters. Moreover, they may be used as a final or finishing coat on walls, for which purpose only lime plasters have hitherto been considered suitable.

Anhydrite has replaced gypsum to a great extent in the fertilizer industry, some 30,000 tons of this material being imported into the South Atlantic States from Canada for fertilizing peanuts and as a constituent in some commercial fertilizers.

Recent investigations in the United States and elsewhere have indicated that as much as 50 percent of anhydrite can be used with gypsum as a retarder in portland cement.

Considerable interest is being evidenced in the possible manufacture of sulphuric acid and the conversion of ammonia to sulphate by gypsum upon the completion of the Boulder Dam.[3] Both processes are in commercial use to a great extent in Germany and to a smaller degree in England. It has been estimated that there is enough gypsum within a 50-mile radius of the dam to supply the entire Pacific coast market for at least 50 years.

A new method of preparing gypsum plaster employs a single mill which completes in one operation the drying of the raw gypsum, its conversion into plaster of paris, fine grinding, and pneumatic delivery.[4] Among the advantages reported for this system are an increase in the speed of calcination by constant removal of the moisture-laden air layer that otherwise accumulates above the calcining rock, a continuous rather than intermittent process of fabrication, and installation and operating costs that may be lower than in present plants.

PRODUCTION AND SALES

Crude gypsum.—The sharp curtailment in the production of crude gypsum in the United States in 1932 resulted in a mined output of 1,355,219 short tons, a decrease of 1,203,798 tons, or 47 percent, as compared with 1931. The number of operators reporting in 1932 was 53, or 1 less than in 1931.

New York State continued to maintain its position as the leading producer of gypsum, but like most other States showed a decrease in 1932. Nine producers reported 347,153 tons, or 26 percent of the total output during the year. Other important States in the production of crude gypsum in 1932 in order of importance were Michigan,

[2] Chemical Age, Some New Uses for Anhydrite: vol. 27, no. 696, Oct. 29, 1932, p. 406.
[3] Carpenter, J. A., and Smith, A. M., Electrochemical Industries at Hoover Dam: Min. Rev. (Salt Lake) vol. 34, no. 37, Sept. 13, 1932, pp. 7-10.
[4] Laeger, Horst, Combined Process for Burning Stucco Gypsum: Tonindustrie-Ztg., vol. 56, Mar. 10, 1932, pp. 293-294.

248,542 tons (383,123 tons in 1931); Iowa, 178,087 tons (321,627 tons in 1931); Texas, 110,360 tons (239,391 tons in 1931); and Nevada, 80,938 tons (131,079 tons in 1931). These four States with New York reported 71 percent of the total production for 1932.

During 1931, 437,828 tons of uncalcined gypsum, valued at $919,085, and 836,428 tons of calcined gypsum, valued at $11,488,534, were marketed. These tonnages represent decreases of 43 percent in uncalcined and 48 percent in calcined, compared with 1931; the values represent decreases of 41 percent and 40 percent, respectively.

Gypsum mined and uncalcined and calcined gypsum sold or used by producers in the United States, 1928–32

Year	Number of operators	Total quantity mined (short tons)	Sold or used by producers				
			Without calcining		Calcined		Total value
			Short tons	Value	Short tons	Value	
1928	58	5,102,250	999,412	$1,902,034	3,641,385	$30,134,129	$32,036,163
1929	59	5,016,132	1,065,697	2,096,779	3,361,580	29,196,190	31,292,969
1930	56	3,471,393	989,591	1,886,254	2,191,376	25,165,230	27,051,484
1931	54	2,559,017	773,185	1,565,367	1,593,753	19,235,990	20,801,357
1932	53	1,355,219	437,808	919,085	836,428	11,488,534	12,407,619

Gypsum mined and uncalcined and calcined gypsum sold or used by producers in the United States in 1932, by States

State	Number of operators	Total quantity mined (short tons)	Sold or used by producers				
			Without calcining		Calcined		Total value
			Short tons	Value	Short tons	Value	
California	4	49,997	14,145	$55,825	(1)	(1)	$55,825
Iowa	7	178,087	63,931	91,267	105,788	$1,377,147	1,468,414
Michigan	5	248,542	79,107	150,328	89,658	1,146,918	1,297,246
Nevada	4	80,938	32,344	89,991	41,963	340,007	429,998
New York	9	347,153	127,258	271,559	217,047	3,443,567	3,715,126
Texas	5	110,360	21,412	63,835	82,435	1,030,257	1,094,092
Other States [2]	19	340,142	99,631	196,280	[3] 299,537	[3] 4,150,638	4,346,918
	53	1,355,219	437,828	919,085	836,428	11,488,534	12,407,619

[1] Included under "Other States."
[2] Arizona, Colorado, Indiana, Kansas, Montana, Ohio, Oklahoma, South Dakota, Utah, Virginia, and Wyoming.
[3] This figure also includes sales from California.

With portland-cement production in 1932, 39 percent below that of the previous year, shipments of crude gypsum by producers for use as cement retarder were 379,278 tons, valued at $741,168 in 1932, compared with 664,305 tons, valued at $1,266,146 in 1931, or decreases of 43 percent in quantity and 41 percent in value. These figures, however, do not include the crude gypsum imported from Canada and sold or used by the cement industry, which in 1932 amounted to 35,545 tons, valued at $80,875. The average value per ton for domestic sales was $1.95 in 1932 and $1.91 in 1931.

Sales of domestic crude gypsum for use as a fertilizer amounted to 15,664 tons, valued at $89,086, or $5.69 per ton, in 1932. These figures, likewise, do not include imported material, principally in the form of anhydrite, which was reported as 31,760 tons, valued at $166,944.

Calcined gypsum.—The quantity of calcined-gypsum products sold by producers in 1932 was 836,428 tons, valued at $11,488,534, representing decreases of 48 percent and 40 percent, respectively, compared with the previous year. Of the above amount 778,083 tons, valued at $10,947,134 (93 percent of the quantity and 95 percent of the value of the total calcined-gypsum products sold or used), were destined for building purposes.

For manufacturing uses the industry sold 53,593 tons, valued at $481,070, or 6 percent of the total quantity and 4 percent of the total value of all calcined-gypsum products. Sales of calcined gypsum, principally to other manufacturers and for miscellaneous uses, were 4,752 tons, valued at $60,330 in 1932.

Domestic crude gypsum sold as crude, and sales of gypsum products made from domestic crude gypsum in the United States, 1931–1932

Use	1931		1932	
	Short tons	Value	Short tons	Value
Without calcining:				
To portland-cement mills	664,305	$1,266,146	379,278	$741,168
For agriculture	28,350	138,725	15,664	89,086
For other purposes [1]	80,530	160,496	42,886	88,831
Total without calcining	773,185	1,565,367	437,828	919,085
Calcined:				
For building purposes:				
Base-coat plasters	759,784	6,070,031	428,526	3,684,791
Sanded plasters	99,449	591,761	43,226	332,345
Finished plasters	82,371	794,289	39,341	445,930
Molding plasters	58,773	541,857	23,592	313,454
Keenes cement	27,449	394,219	14,607	217,549
Plaster board and lath	[2] 133,329	2,411,730	[2] 66,247	1,254,062
Wall board	[3] 219,367	6,735,040	[3] 116,032	4,247,563
Partition tile	[4] 102,232	716,873	[4] 29,574	211,787
Insulating materials	4,688	76,211	1,688	26,589
Other building purposes [5]	28,929	304,836	15,250	213,064
Total for building purposes	1,516,371	18,636,847	778,083	10,947,134
For manufacturing uses:				
To plate-glass works	24,865	122,127	12,173	99,672
To terra-cotta works	6,160	43,299	1,588	12,615
For other manufacturing uses [6]	18,255	249,251	39,832	368,783
Total for manufacturing uses	49,280	414,677	53,593	481,070
For other purposes [7]	28,102	184,466	4,752	60,330
Total calcined	1,593,753	19,235,990	836,428	11,488,534
Grand total value		20,801,357		12,407,619

[1] Includes gypsum sold for filler, for insulating materials, and rock dust.
[2] 1931, 166,684,196 square feet; 1932, 82,821,679 square feet.
[3] 1931, 270,416,778 square feet; 1932, 150,981,024 square feet.
[4] 1931, 19,478,632 square feet; 1932, 5,317,278 square feet.
[5] Includes joint filler, pyrofill, "roof tile" and "other tile," structolite, and stucco for roof construction
[6] Includes gypsum for casting and for dental work, hydrocal, and "orthopedic" gypsum.
[7] Includes calcined gypsum sold to other manufacturers and for miscellaneous uses.

Keenes cement sold by producers in the United States, 1928–32

Year	Manufacturers	Short tons	Value	Year	Manufacturers	Short tons	Value
1928	6	54,020	$848,504	1931	5	27,449	$394,219
1929	6	52,330	767,621	1932	4	14,607	217,549
1930	4	39,446	571,044				

Calcined gypsum used in products by producers in the United States in 1932, by States and uses, in short tons

State	Board	Tile	Plaster	Other products	Total
Iowa			58,206	(1)	[2] 58,206
Michigan			86,624	(1)	[2] 86,624
New York	68,935	16,728	99,669	(1)	185,332
Texas	11,694		65,499		77,193
Other States [3]	84,688	17,201	203,850	[4] 28,966	334,705
	165,317	33,929	513,848	28,966	742,060

[1] Included under "Other States."
[2] Figure covers plaster only; "Other products" included under "Other States."
[3] Arizona, California, Colorado, Indiana (crude gypsum from Michigan), Kansas, Montana, Nevada, Ohio, Oklahoma, South Dakota, Utah, Virginia, and Wyoming.
[4] This figure includes also gypsum used in States as indicated by "1" and "2" above.

Kettles and kilns in operation.—The number of producers reporting these two items increased from 43 in 1931 to 44 in 1932. The number of kettles in operation decreased from 164 to 150, with a corresponding decrease in daily capacity from 20,003 to 19,368 tons. The number of rotary and vertical kilns in operation decreased from 25 in 1931 to 21 in 1932 and the daily capacity from 8,140 to 6,875 tons. The total daily capacity, based on a 24-hour operating schedule, of both kettles and kilns decreased from 28,143 tons in 1931 to 26,243 tons in 1932.

Calcining kettles and kilns reported by gypsum producers in the United States in 1932, by States

State	Number of producers	Kettles		Rotary kilns [1]		Total daily capacity (short tons)
		Number	Daily capacity (short tons)	Number	Daily capacity (short tons)	
California	3	8	790			790
Iowa	6	28	4,844			4,844
Michigan	6	25	3,316	2	1,040	4,356
New York	5	15	2,365	8	3,260	5,625
Texas	4	23	1,968			1,968
Other States [2]	20	51	6,085	11	2,575	8,660
Total, 1932	44	150	19,368	21	6,875	26,243
Total, 1931	43	164	20,003	25	8,140	28,143

[1] Includes vertical kilns in Utah.
[2] Arizona, Colorado, Indiana (crude gypsum from Michigan), Kansas, Montana, Nevada, Ohio, Oklahoma, South Dakota, Utah, Virginia, and Wyoming.

FOREIGN TRADE

Imports.—As the statistical summary at the beginning of this chapter shows, imports of gypsum in all forms for consumption in the United States declined considerably in 1932. The decrease for crude gypsum from 1931 was 48 percent in quantity and 51 percent in value, while for gypsum products the decline was 55 percent in quantity and 58 percent in value.

Canada was, as usual, the chief foreign source of supply, furnishing 358,589 short tons, valued at $332,908 (96 percent of both total quantity and total value of the crude gypsum imported); Mexico furnished virtually all the remainder. The following tables indicate the trends in imports of crude gypsum and manufactured products during recent years.

Crude gypsum imported into the United States, 1930–32, by countries

[General imports]

Country	1930		1931		1932	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada	824, 964	$837, 296	667, 614	$671, 985	358, 589	$332, 908
Hong Kong			1	20		
Italy					6	39
Mexico	77, 394	79, 367	46, 265	41, 308	15, 477	13, 819
	902, 358	916, 663	713, 880	713, 313	374, 072	346, 766

Gypsum imported for consumption in the United States, 1928–32

Year	Crude		Ground or calcined		Manufactured plaster of paris (value)	Keenes cement		Total value
	Short tons	Value	Short tons	Value		Short tons	Value	
1928	1, 028, 816	$1, 340, 920	6, 907	$99, 833	$87, 314	601	$13, 729	$1, 541, 796
1929	1, 036, 385	1, 060, 874	4, 979	69, 703	71, 479	430	11, 327	1, 213, 383
1930	902, 358	916, 663	6, 562	75, 959	61, 322	1, 146	37, 175	1, 091, 119
1931	713, 880	713, 313	7, 236	73, 361	36, 825	128	3, 012	826, 511
1932	374, 072	346, 766	3, 250	28, 323	17, 948	52	1, 042	394, 079

During the year a more thorough canvass of the importers and consumers of crude gypsum was undertaken, which resulted in the addition of five names of consumers to the list, representing manufacturers of portland cement and fertilizers who import their requirements of crude gypsum.

In 1932, 14 importers with 17 plants in 12 States—California, Connecticut, Florida, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Vermont, Virginia, and Washington—reported to the Bureau of Mines that they imported 351,723 short tons of crude gypsum. In 1931, eight importers reported 630,892 tons.

The following table shows the crude gypsum imported and the uncalcined and calcined gypsum made therefrom and sold or used in the United States from 1928 to 1932.

Crude gypsum imported and uncalcined and calcined gypsum from imported rock, sold in the United States, 1928–32, as reported to the Bureau of Mines by the importers

Year	Number of importers	Crude imported (short tons)	Sold				
			Without calcining		Calcined		Total value
			Short tons	Value	Short tons	Value	
1928	8	954,000	121,339	$449,246	805,920	$7,657,460	$8,106,706
1929	8	1,017,791	83,681	331,979	820,737	7,842,523	8,174,502
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	281,447	303,266	4,600,199	4,881,646

The crude gypsum imported from Canada is destined mainly for anufacture at plants along the Atlantic seaboard, although approxiately 10 percent is sold or used as a retarder in the manufacture of portland cement and 9 percent (mainly in the form of anhydrite) as agricultural gypsum. The Mexican rock from San Marcos Island, Lower California, goes to plants at Long Beach, Calif., and Seattle, Wash.

The accompanying table shows the distribution by uses of the imports of crude gypsum for 1931 and 1932 as reported to the Bureau of Mines by the importers. The amount sold or used crude during 1932 declined 9 percent in quantity and 11 percent in value compared with 1931. The sales of imported crude gypsum, with their respective percentage increases or decreases from the preceding year, were as follows: To portland-cement mills, 35,545 tons, valued at $80,875 (decreases of 26 percent and 50 percent in quantity and value, respectively); for agriculture, 31,760 tons, valued at $166,944 (increases of 83 percent in quantity and 78 percent in value); and for other purposes, 4,015 tons, valued at $33,628 (decreases of 68 percent in quantity and 46 percent in value). In interpreting the foregoing figures it should be noted that the 1932 canvass was more complete than in immediately preceding years. For example, the statistics cover several fertilizer plants for which figures have not heretofore been included, and this doubtless accounts for part of the increase reported in sales of imported gypsum for agricultural purposes. On the other hand, the sales of imported gypsum to cement mills declined despite the addition of reports for several portland-cement companies not previously included.

The total sales of imported gypsum in calcined form decreased 44 percent in quantity and 39 percent in value in 1932 from 1931, while the total value of all sales decreased 38 percent from the preceding year.

Imported crude gypsum sold or used as crude, and sales of gypsum products made from imported crude gypsum in the United States, 1931–32 [1]

Use	1931		1932	
	Short tons	Value	Short tons	Value
Without calcining:				
To portland cement mills	48,326	$161,563	35,545	$80,875
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	281,447
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 [2]	109,128	3,091,595	66,951	2,175,925
Total for building purposes	513,648	7,405,912	295,407	4,533,356
For manufacturing uses [3]	24,985	196,205	7,859	66,843
Total calcined	538,633	7,602,117	303,266	4,600,199
Grand total value		7,919,307		4,881,646

[1] As reported to the Bureau of Mines by importers.
[2] Includes plaster board and lath, wall board, partition tile, other tile, insulating materials, and other building purposes.
[3] Includes gypsum sold to terra-cotta works, to potteries, for other manufacturing uses, and to other gypsum manufacturers.

Exports.—Exports of gypsum and gypsum products during 1932 declined considerably compared with 1930. The largest decline with respect to tonnage was registered by "Plaster, calcined and manufactures, n.e.s." (80 percent), followed by "Plaster board and wall board" (69 percent) and "Crude, crushed or ground" (20 percent), with respective decreases in value of 63, 71, and 50 percent.

Gypsum and gypsum products exported from the United States, 1928–32

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
1928	2,365	$23,764	15,216,727	$403,227	16,423	$392,984
1929	4,230	30,870	18,420,455	442,983	24,579	481,316
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

WORLD PRODUCTION

The following table shows the output of gypsum by various countries from 1928 to 1932, as far as statistics are available.

World production of gypsum, 1928–32, by countries, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country [1]	1928	1929	1930	1931	1932
Algeria	79,874	107,221	94,780	91,120	(2)
Argentina [3]	41,606	36,630	49,458	39,473	(2)
Australia:					
New South Wales	12,761	10,585	2,914	1,766	(2)
South Australia	93,004	97,148	41,482	24,596	45,684
Victoria	10,728	13,407	(4)	(4)	(2)
Western Australia	4,282	5,374	1,606	226	(2)
Austria [5]	45,000	43,000	37,350	48,000	(2)
Canada	1,189,895	1,111,956	997,942	800,938	(6)
Chile	9,113	15,434	17,178	13,173	(2)
China	[7] 50,000	51,500	62,100	71,500	(2)
Cuba	23,950	25,400	27,200	(4)	(2)
Cyprus [8]	11,609	12,757	10,452	9,934	(2)
Egypt [7]	130,000	130,000	130,000	130,000	130,000
Estonia	7,982	8,093	1,963	7,851	8,299
France	2,202,730	2,558,050	3,055,420	(4)	(2)
Germany:					
Bavaria	54,482				
Prussia	452	[9] 845,000	[9] 705,000	[9] 490,000	[9] 398,500
Other States	(2)				
Greece	----------	----------	1,365	3,200	(2)
India, British	59,998	53,572	57,220	54,493	(2)
Italy	640,587	683,755	685,530	587,845	(2)
Japan	68,515	(4)	(4)	(4)	(2)
Latvia [10]	28,020	26,875	35,272	31,431	36,812
Luxemburg	2,506	7,206	10,619	9,263	(2)
New Caledonia	15,000	7,116	3,131	(4)	(2)
Palestine	1,341	1,499	1,661	491	(2)
Peru	20,148	[11] 15,299	[11] 14,000	8,000	(2)
Poland	(2)	(2)	40,000	24,000	(2)
Rumania	47,785	76,625	51,252	53,003	(2)
Russia [12]	411,365	(4)	(4)	(4)	(2)
Spain	1,054,018	975,662	1,582,604	827,282	(2)
Sweden	116	122	135	50	(2)
Tunisia	16,000	19,540	20,000	(4)	(2)
Union of South Africa	14,871	17,245	17,098	14,847	(2)
United Kingdom:					
Great Britain	644,831	981,566	851,468	767,011	(2)
Northern Ireland	17	1,453	193	(4)	(2)
United States	4,628,659	4,550,535	3,149,178	2,321,489	1,229,428
Yugoslavia [13]	1,170	2,340	1,463	771	(2)
	11,600,000	13,000,000	12,000,000	10,000,000	(2)

[1] Gypsum is also produced in Switzerland, where large beds are privately worked, but no statistics are available.
[2] Data not available.
[3] Rail and river shipments.
[4] Data not available; estimate included in world total.
[5] Estimate furnished by Bundesministerium für Handel und Verkehr.
[6] Data for crude gypsum mined not available. Shipments of crude (lump, crushed, and ground) and calcined gypsum amounted to 397,915 tons.
[7] Approximate production.
[8] Exports of crude and calcined gypsum.
[9] Figures supplied by Deutscher Gips-Verein, E. V., Berlin, Germany.
[10] Exports.
[11] Sales and shipments.
[12] Year ended Sept. 30.
[13] Serbia only.

Canada.—Both Canadian production and exports of gypsum dropped sharply during 1932. The output (shipments) of crude gypsum in 1932 were 438,629 short tons, valued at $1,080,379, and comprised the following items: Lump, or run-of-mine, 98,672 tons, valued at $114,504 (increases of 109 and 11 percent, respectively, compared with 1931); crushed, 268,645 tons, valued at $314,336 (decreases of 61 and 60 percent from 1931); fine ground, 1,826 tons, valued at $10,459 (decreases of 59 and 51 percent); and calcined, 69,486 tons, valued at $641,080 (decreases of 41 and 46 percent). The total output decreased 49 percent in both quantity and value in 1932; the unit value, however, increased from $2.44 in 1931 to $2.46 in 1932.

During the year Nova Scotia, as usual, produced the larger part of the Canadian output, shipping 341,508 tons, valued at $398,861 (78 percent of the total quantity and 37 percent of the total value of all shipments). Most of this output is exported raw to the United States. Production in this province has been sharply curtailed for 2 years or more. Shipments during 1932 represented only 48 percent of the quantity and 45 percent of the value of the total shipments during 1931.

Gypsum trade in Canada, 1930–32 [1]

	1930		1931		1932	
	Short tons	Value	Short tons	Value	Short tons	Value
Production (shipments):						
By classes:						
Crude:						
Lump or run-of-mine	56,628	$116,401	47,147	$103,396	98,672	$114,504
Crushed	845,210	973,623	693,764	791,810	268,645	314,336
Fine ground	8,160	38,894	4,418	21,392	1,826	10,459
Calcined	160,970	1,689,870	118,423	1,194,819	69,486	641,080
	1,070,968	2,818,788	863,752	2,111,517	438,629	1,080,379
By Provinces:						
Nova Scotia	827,063	982,287	707,817	878,487	341,508	398,861
New Brunswick	82,674	513,677	58,957	451,264	(2)	(2)
Ontario	94,946	776,069	53,358	374,469	(2)	(2)
Manitoba	34,157	298,297	23,076	231,124	(2)	(2)
British Columbia	32,128	248,458	20,544	176,173	(2)	(2)
	1,070,968	2,818,788	863,752	2,111,517	438,629	1,080,379
Imports:						
Crude gypsum	898	25,882	484	13,491	55	1,381
Ground, not calcined	219	5,352	158	4,476	171	3,434
Calcined	16,608	190,832	11,050	120,516	1,384	31,165
	17,725	222,066	11,692	138,483	1,610	35,980
Exports:						
Crude gypsum	719,381	871,567	618,765	741,376	372,314	470,247
Plaster of paris, prepared wall plaster	7,281	119,092	3,086	50,774	799	13,979
	726,662	990,659	621,851	792,150	373,113	484,226

[1] Preliminary Report on the Mineral Production of Canada, Ottawa.
[2] Not available.

LIME

By Paul Hatmaker and A. T. Coons

Sales of lime in 1932 were affected seriously by the subnormal activity throughout the field of building construction and by further curtailment in the many manufacturing industries consuming lime. The demand, however, proved greater than was expected from generally adverse business conditions. The degree to which sales of lime were affected is indicated in the following table:

Salient statistics for the lime industry in the United States, 1931–32

	1931	1932 [1]	Percent of change
Total lime sold by producers:			
Short tons	2,707,614	1,956,000	−28
Value	$18,674,913	$12,108,000	−35
Per ton	$6.90	$6.19	−10
Sales of hydrated lime:			
Short tons	1,119,266	841,000	−25
Value	$7,729,047		
Per ton	$6.91		
Imports (exclusive of dead-burned dolomite):			
Short tons	14,458	8,777	−39
Value	$181,867	$96,035	−47
Exports:			
Short tons	11,924	3,579	−70
Value	$129,943	$56,479	−57
Per ton	$10.90	$15.78	+45
Distribution of sales:			
For buildings:			
Short tons	947,085	666,000	−30
Value	$6,940,250		
Per ton	$7.33		
For agriculture:			
Short tons	297,312	220,000	−26
Value	$1,924,149		
Per ton	$6.47		
For chemical uses:			
Short tons	1,463,217	1,070,000	−27
Value	$9,810,514		
Per ton	$6.70		

[1] Preliminary figures; subject to revision.

Normally about two thirds of the annual production of lime is sold for building purposes and for use in the iron and steel industries. The decline of 28 percent in quantity and 35 percent in value of all lime sold in 1932, compared with 1931, therefore is not such a poor showing in view of the fact that construction contracts awarded, according to the F. W. Dodge Corporation, fell off 57 percent in floor space and 55 percent in value. Similarly, according to the Bureau of Labor Statistics, building permits declined 63 percent in value. Production of steel ingots declined 48 percent, and the Federal Reserve Board index of industrial production decreased 21 percent.

A comparison of conditions in 1932 with those prevailing from 1923 to 1925 shows even more strikingly the extent of the business decline.

Gross income from sales of lime in 1932 was 70 percent less and total tonnage 54 percent less than the 1923–25 average. Concurrently, there were declines of 72 percent in the value of construction contracts awarded, 87 percent in the value of building permits, and 69 percent in the production of steel ingots.

The price of lime continued to decline during 1932 in line with that of other commodities. The average price of all lime sold was 10 percent less than in 1931. All commodity prices, according to the Bureau of Labor Statistics, declined 9 percent, all building materials 8 percent, and raw materials as a class 16 percent.

Lime producers generally were able to operate at somewhat lower out-of-pocket costs during 1932 despite curtailed production and further price recessions. Wages were less, in some regions labor being available at rates prevailing 20 or 25 years ago, and prices of supplies were somewhat lower. Cost of fuel, however, showed a tendency to hold fairly firm.

Capital and fixed charges, on the other hand, imposed a tremendous burden upon the relatively smaller tonnage of lime sold. More or less inflexible items such as overhead, depreciation of plant equipment, and capital charges, in many instances more than wiped out savings in out-of-pocket costs. Some operators were forced to suspend all activity; others produced at a loss to hold favored customers or to maintain their organizations intact; while a few reported exceedingly small profits.

Conditions can be realized better by considering a few of the significant changes in the lime industry during the past 20 or 25 years.

Production of lime in 1929 was about 4¼ million tons, or about ¾ million tons more than in 1909. By 1932 production was about 1½ million tons less than in 1909. The average production per plant increased from 2,828 tons in 1909 to 11,207 tons in 1929, while the number of plants decreased from 1,232 in the former year to 381 in 1929. In 1909 about 27,626 horsepower were reported in use by the lime industry,[1] compared with 90,276 in 1929. A considerable part of the capital and other fixed charges involved in this increase of energy equipment and in the consolidation of operating units has had to be borne by the decreased tonnage sold at lower prices since 1929. The situation is ameliorated by the greater productivity of the wage earner, which, according to available data, increased 50 percent or more from 1923 to 1929.

The benefits accruing from larger operating units and lower costs, through improvements in plant practice and reduction of other expenses as a result of larger capital outlay, can be realized only when the rate of production is again more nearly normal.

PRODUCTION BY STATES

Estimated sales of lime in 1932 by States are listed in the following table, with similar data for 1931. Figure 67 shows these production data graphically, compared with 1925, the peak year of lime production for the United States. It will be noted that declines from 1925 to 1931 were not distributed equally among the States; production in Maine and Wisconsin declined sharply, whereas that in Illinois in

[1] Bureau of the Census, Department of Commerce, Manufactures: 1929, Lime, Marble, Granite, Slate, and other Stone Products: p. 1.

1931 was slightly more than in 1925. Comparing 1932 with 1931 the losses ranged from 4 percent in Vermont to 50 percent in West Virginia. The greatest declines were recorded in West Virginia, Massachusetts, and Alabama. On the other hand, production in

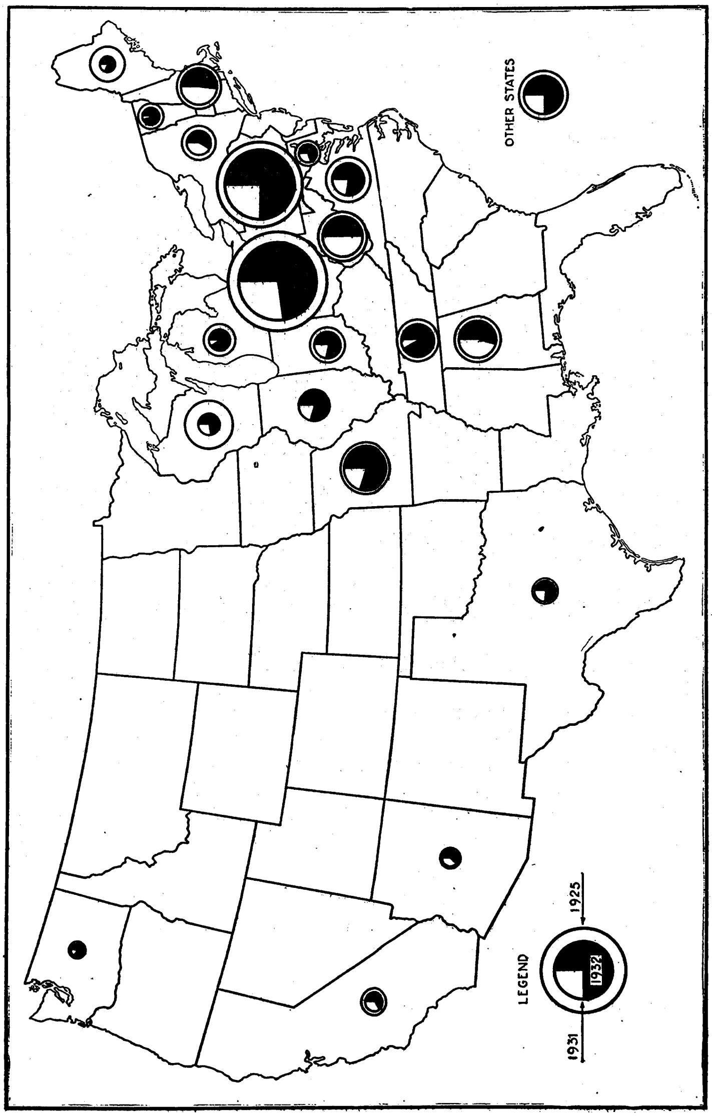

FIGURE 67.—Production of lime by States, 1925, 1931, and 1932. The outer circles are proportional to the 1925 production, the inner circles to production in 1931, and the shaded sectors represent production in 1932. Illinois production in 1931 was slightly more than in 1925 and only one circle is shown. It will be noted that the shaded sectors start at what would be 12 o'clock and proceed clockwise. West Virginia production in 1932, for example, was virtually half of that for 1931, whereas sales in Vermont fell off only slightly.

Vermont, Tennesse, Michigan, and Washington declined least in 1932.

Approximately 43 percent of the lime sold in 1932 was hydrated, the proportion having increased from only a little more than 11 percent in 1912. The importance of this form of lime has gained steadily, as shown in figure 68. Hydrated lime is displacing quicklime for many uses other than building, and since 1930 the quantity sold has exceeded that sold for building.

Sales of hydrated lime and total lime by States, 1931–32

	1931				1932 (estimated)			
	Lime sold, short tons			Average value per ton	Lime sold, short tons			Average value per ton
	Hydrated	Other	Total		Hydrated	Other	Total	
Ohio [1]	426,144	230,297	656,441	$6.10	286,000	191,000	477,000	$5.20
Pennsylvania [1]	183,795	313,463	497,258	6.79	155,000	219,000	374,000	6.44
Missouri	87,389	137,027	224,416	6.60	76,000	104,000	180,000	6.01
Tennessee	32,168	81,100	113,268	5.00	27,000	77,000	104,000	4.37
West Virginia	47,515	122,905	170,420	5.78	34,000	51,000	85,000	5.25
Virginia	36,544	64,115	100,659	6.50	26,000	52,000	78,000	5.60
Illinois	28,169	67,936	96,105	7.48	17,100	58,900	76,000	7.20
Alabama	19,754	117,669	137,423	5.99	16,000	59,000	75,000	4.93
Massachusetts	25,782	97,825	123,607	8.96	24,000	40,000	64,000	7.28
Indiana	43,534	38,391	81,925	6.13	34,000	30,000	64,000	5.34
Michigan	8,777	37,939	46,716	7.15	10,400	31,600	42,000	7.17
Texas	24,265	21,288	45,553	8.44	23,000	12,000	35,000	8.17
Wisconsin	8,397	34,224	42,621	8.73	7,000	24,000	31,000	7.42
New York	20,673	28,901	49,574	8.32	11,500	17,500	29,000	7.90
Vermont	8,659	21,567	30,226	8.98	6,700	22,300	29,000	6.97
California	12,727	28,644	41,371	9.42	9,000	18,000	27,000	9.11
Maryland	24,928	11,517	36,445	7.36	16,000	9,000	25,000	6.40
Maine	(2)	28,157	28,157	8.88	(2)	23,000	23,000	7.96
Washington	(2)	20,619	20,619	10.43	(2)	17,400	17,400	10.06
Arizona	(2)	22,567	22,567	9.87	(2)	14,000	14,000	10.43
Other States	80,046	62,197	142,243	9.34	62,300	44,300	106,600	8.60
Total	1,119,266	1,588,348	2,707,614	6.90	841,000	1,115,000	1,956,000	6.19

[1] In 1931 the average value per ton of hydrated lime sold in Ohio was $5.54 and in Pennsylvania $7.89, whereas in 1932 Ohio hydrated lime was sold for $4.54 and Pennsylvania hydrated material for $7.16.
[2] Hydrated lime sold in Maine, Washington, and Arizona is included under "Other States."

CONSUMING INDUSTRIES

The many industries consuming lime differ in behavior from periods of expansion to periods of deflation. The building and iron and steel industries, for example, fluctuate widely, whereas such industries as leather, paper, and agriculture are more constant from year to year. Market conditions relating to lime sales therefore can be appraised only by examining the several markets on which the lime producer must depend for disposal of his product.

Current market barometers are available monthly in Survey of Current Business.[2] Information of interest to lime producers includes data on building construction, iron and steel production, consumption and shipments of chemical wood pulp, and prices. Use is made in this report of the more important items relating to lime markets.

Lime-production figures so far available for 1932 do not include a detailed break-down into uses; however, long-time trends by use are shown in figure 68.

Building construction.—The building industries consumed 47 percent of the lime sold from 1925 to 1929, but only about 34 percent in 1932. Since 1928 building construction has declined to such an extent that the quantity of floor space let in 1932 was 82 percent less than in 1926. Building lime sold in 1932 was 71 percent less than in 1926.

[2] Published every month by the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D.C. The subscription price is $1.50 a year, which includes the 12 monthly numbers, the 1932 annual supplement, and the 52 weekly supplements. Orders accompanied by remittance should be sent to the Superintendent of Documents, Washington, D.C.

The relationship between floor space of construction contracts and sales of building lime is shown in figure 69, which portrays the annual trends of both, also the quarterly fluctuation of building contracts. Data are plotted from index numbers, with the average of 1926 taken

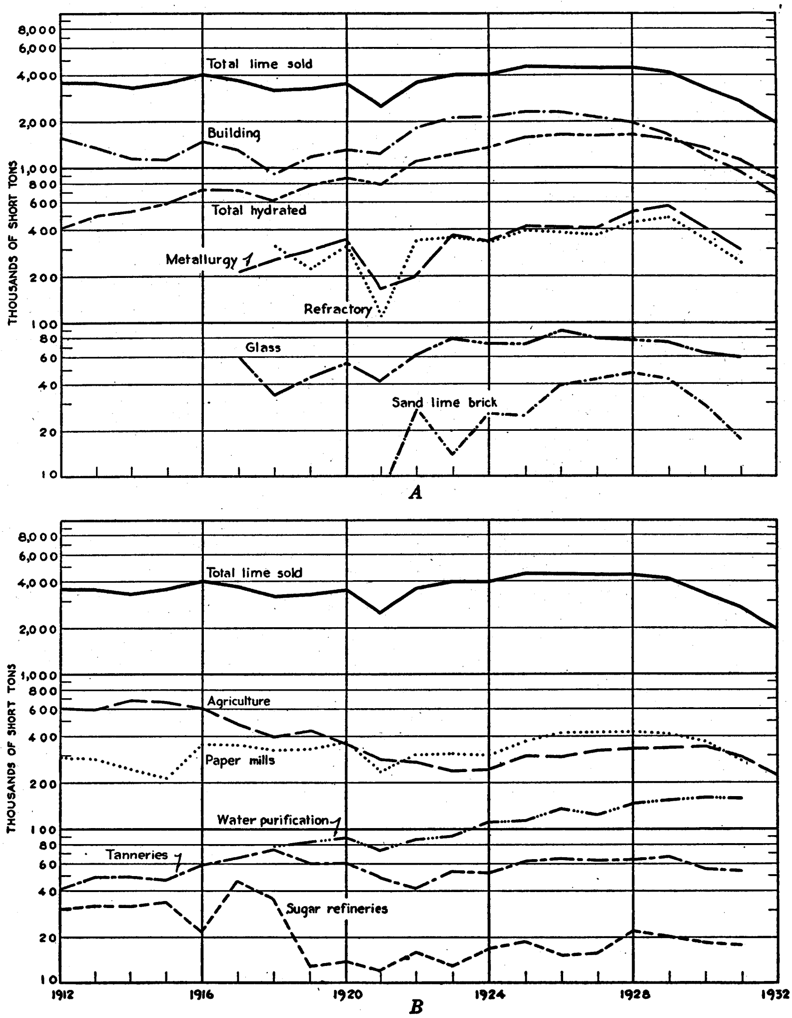

FIGURE 68.—Sales of lime by uses, 1912–1932: *A*, Lime which is sold to industries producing relatively durable goods; *B*, lime used in the manufacture of nondurable goods. It will be noted that the curves in *A* fluctuate much more than those in *B*, because in times of depression people defer purchase of durable things, such as new homes and automobiles. On the other hand, food, paper and paper products, and leather goods are constantly being consumed. The vertical logarithmic scale facilitates comparison of large and small quantities, and the slopes of the curves indicate the percentage increase or decrease.

as 100. Data for other years are expressed in percentages of that year.

It will be noted that sales of building lime and floor space held together closely from 1925 to 1927, but that the former lost ground in 1928. Since then building lime has declined less than building construction. The cause of this apparent relative gain was probably multiple. Fewer factories have been built since 1929, and this class of construction, although large in floor space, consumes relatively less mortar or plaster. During the past few years the ratio of alterations and repairs to total building has increased greatly; such work

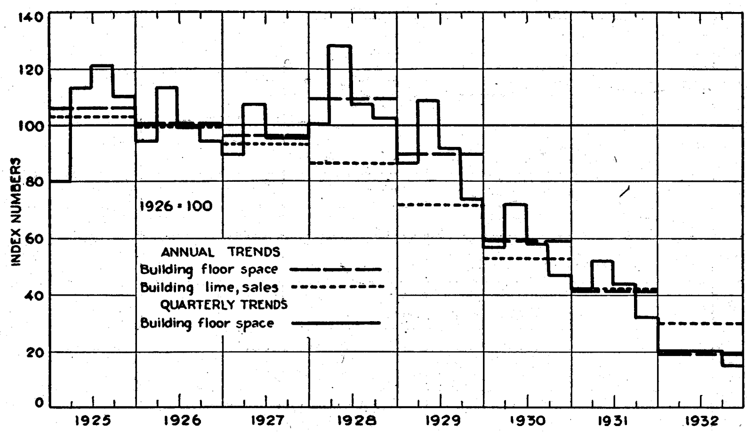

FIGURE 69.—Floor space of construction contracts awarded and sales of building lime, 1925–32. Indexes of floor space of construction contracts awarded have been calculated from data of F. W. Dodge Corporation, as published in Survey of Current Business, Annual Supplement, 1932, pp. 30 and 31, taking1926 as 100. The series cover 37 States, for which data are not available prior to 1925.

does not appear in the figures of new construction, yet considerable lime is consumed therein. Dealers' stocks may be a factor. If each of the 30,000 or more building-material dealers increased or decreased

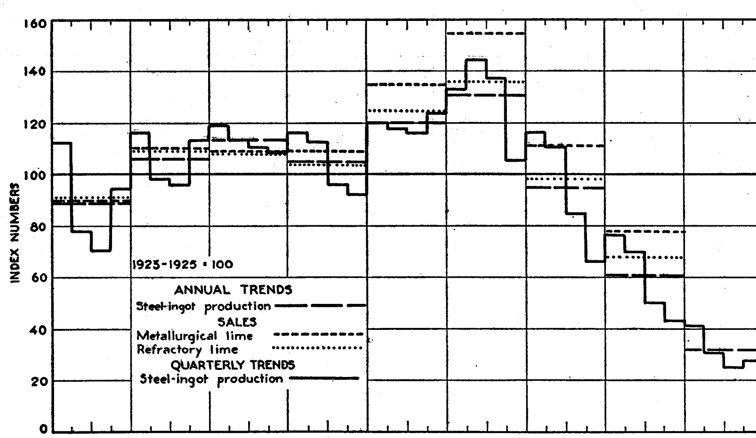

FIGURE 70.—Production of steel ingots and sales of metallurgical and refractory lime, 1924–32. Indexes of steel-ingot production are calculated from data appearing in Survey of Current Business, Annual Supplement, 1932, pp. 212 and 213, and subsequent monthly issues. The period 1923–25 is taken as 100 to conform with the many available business indexes using this base, notably those of the Federal Reserve Board.

his stock of lime 1 or 2 tons, the relationship between construction barometers and building lime sold would be affected appreciably.

In addition to purely technical market conditions, however, lime has gained ground in the building field through efforts of the producers to have more lime used in mortar and plaster work. The lime producers and the National Lime Association serving the industry keenly appreciate the fact that sales of building lime do not depend rigidly upon the amount of current building and that the market for building lime is subject to expansion through active sales promotion.

Iron and steel.—Normally one fifth of the lime produced is used for metallurgical and refractory purposes, but no data are available yet on such consumption in 1932. Production of steel ingots, however, declined 48 percent from 1931 and dropped 69 percent below the 1923–25 average. Figure 70 shows the relationship between steel-ingot production and sales of metallurgical and refractory lime from 1924 to 1932.

Periods of depression cause drastic curtailment in iron and steel production, because such products are durable goods, purchase of which can be deferred for longer or shorter periods. Nevertheless, steel production is sensitive to renewed industrial activity and re-

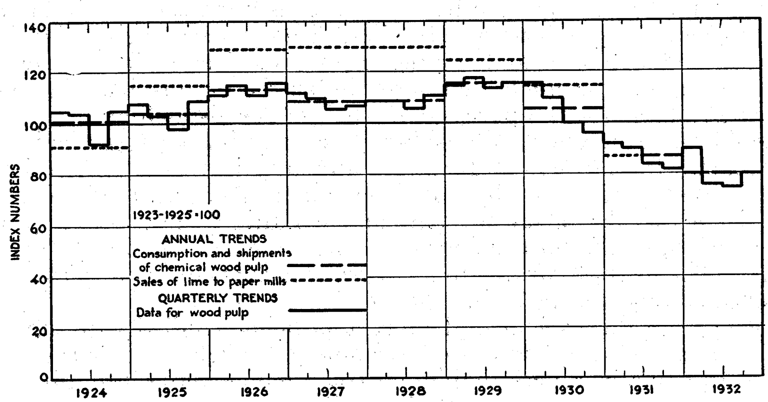

FIGURE 71.—Consumption and shipments of chemical wood pulp and sales of lime to paper mills, 1924–32. Index numbers of chemical wood pulp are calculated from data published in Survey of Current Business, Annual Supplement, 1932, pp. 234 and 235, and in subsequent monthly issues.

sponds quickly to automobile, railroad, and building-construction revival.

A few recent cross currents in the iron and steel industry are of interest to lime producers. A number of companies have increased their purchases of metallurgical lime and cut down on the quantity of raw limestone used, because the relatively low price of steel scrap has encouraged an open-hearth charge containing less pig iron and more scrap. Under these conditions more fluxing lime is used, but a countertrend toward the use of less refractory lime is reported. A charge using a smaller percentage of pig iron is easier on the furnaces, requiring less flushing slag and resulting in a reduced cutting of the banks. Moreover, scrap is not so hard upon the furnace bottom as pig iron. Some steel companies however, report an increased use of patented burnt refractories with a dolomite base, which possibly explains why sales of refractory lime show up satisfactorily in figure 70.

Paper mills.—The paper industry consumed 9 percent of the total sales of lime from 1925 to 1929. Production of chemical wood pulp generally is steadier than either building construction or steel production; in 1932 it was only 20 percent less than the 1923–25 average, which contrasts sharply with the 69 percent decline in steel output. Nevertheless, the industry has felt the effects of decreased demand for newsprint and other paper products.

Some pulp producers, moreover, have decreased their use of lime through installation of new causticizing equipment. For example, one manufacturer reports that he cut his lime requirements per ton of soda pulp 20 percent in the last half of 1932 compared with 1929. From reports of other pulp manufacturers it appears that a reduction of 20 to 25 percent in lime requirements may eventually be realized throughout the industry.

Figure 71 shows the quarterly and annual trends in the consumption and shipments of chemical wood pulp and the annual trend in lime sold to paper mills.

Agriculture.—The demand for agricultural lime during 1932 was relatively better than that for building or chemical lime. Nevertheless, sales of agricultural lime have suffered because of the decreased purchasing power of farmers, which is 41 percent less than in 1929, according to the Bureau of Agricultural Economics. Thus, the plight of agriculture has had its repercussions upon the lime industry. The farmers, wedged between stabilized fixed charges such as interest rates on indebtedness and a greater rate of decline in the return received for their products than other industrial groups, have had less money available for the purchase of such materials as lime.

Lime producers reported considerable sales resistance to agricultural lime among the farmers in 1932 and difficulty in making collections. This market, which usually consumes about 7 percent of the total lime, is below normal at present, and conditions may not improve materially until the purchasing power of farmers is restored to higher levels. The use of hydrated lime for truck farmers or home gardeners, however, is reported to be increasing.

Meanwhile, the agricultural market is being studied carefully by many operators who heretofore have not sold much lime for this purpose. In some instances individual trade names have been given to a particular lime product. An increasing number of producers are catering to farmers and are prepared to supply pulverized limestone, quicklime, or hydrated lime.

Water purification and sewage disposal.—Lime used for treating water, although only about 3 percent of the total output in recent years, has shown a steady upward trend since statistics were first available in 1918. This market is little affected by depression periods, which seem to check its rate of growth only temporarily. Final data for 1932 are not yet available, but lime producers report a fairly steady volume of business for last year; some operators, in fact, relied almost entirely upon this market for their sales.

Although sewage disposal as yet is a small outlet for lime, it is reported to have made considerable progress during 1932. The field is one of the most promising from the standpoint of potential tonnage, and developments are being watched carefully by the lime industry.

Other uses.—The building, iron and steel, paper, agriculture, and water-purification industries normally account for about 86 percent of the total lime sales. The remaining 14 percent is distributed widely among a large number of chemical and industrial uses. Certain trends among some of these minor consuming industries are worthy of mention, although they cannot be discussed in detail.

Sales of lime to glassworks have slumped since 1927 (see fig. 68) due partly to a tendency in the glass industry to drift toward the use of raw limestone instead of burnt lime.

Tanners generally report that, while they have bought less lime because of depressed conditions, no change has occurred in their requirements traceable to altered plant practice or installation of new equipment.

Sales of lime to sugar refineries dropped during the war due partly to changed methods of sugar refining. The tonnage sold also has declined since 1928, but the long-time trend since 1919 seems to be rising slightly. However, sugar refining is no longer a significant market for lime producers.

Sand-lime brick provided a promising market for lime during the recent building boom, but sales have declined sharply since 1929.

PRICES

Preliminary data indicate that the average price of lime sold in 1932 was about 10 percent less than in 1931. Price deflation has continued to affect lime as well as other raw materials. Operators

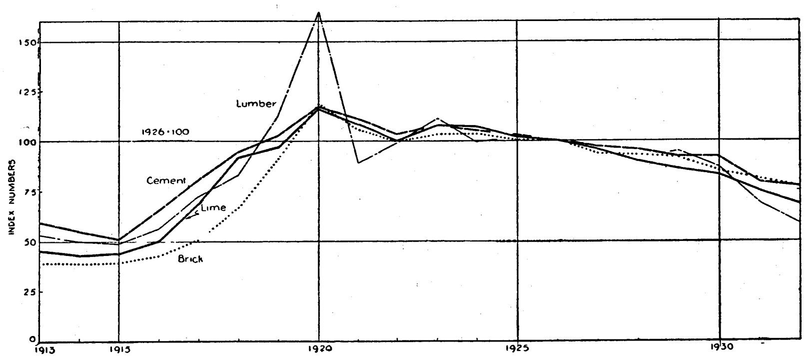

FIGURE 72.—Trend of wholesale prices of lime, cement, brick, and lumber, 1913–32. Indexes for cement, lumber, and brick are those of the Bureau of Labor Statistics, published monthly in the Wholesale Price Bulletins. The index for lime is calculated from Bureau of Mines statistics. Note the general decline since 1920.

generally reported lower prices for their product, and many complaints have been made of prices slashed to the point where sales were below costs of production. Figure 72 shows the recent trends in prices of cement, brick, lumber, and lime.

It must be remembered that price recessions have not been confined to any single industry. The Department of Labor price index for all commodities in 1932, based on 1926 as 100, was 64.8. The average price index for all building materials was 71.4, that for all commodities other than farm products and foods 70.2, and that for common and hydrated lime 78.1.

This index for lime is somewhat higher than the index calculated from Bureau of Mines statistics, which is 68 for 1932. The Department of Labor index, however, is an average of only 15 plants, whereas the Bureau of Mines figure is the average for the entire industry. Moreover, actual sales frequently are made at lower figures than originally quoted.

CLAY

By R. H. Kudlich and K. V. Herlihy

Trends in production and value.—Trends in the annual production and value of clay since 1909 are shown in figures 73 and 74. The general trend in the production of clay during this period conforms with general economic conditions of the country. From 1909 to 1914, prior to the World War, there were no violent fluctuations. From 1914 to 1916, before the United States entered the war, the iron and steel industry, whose requirements take a large proportion of the fire-clay output, increased its production to meet the Allies' demands for munitions. This increase was reflected in a large increase in the production of fire clay, with little change in that of the other clays. During 1917–18, when the United States participated in the war, the production of fire clay continued to increase to meet further expansion in requirements for the metallurgical and allied industries, while the production of other clays decreased because the industries in which they are consumed catered principally to household and luxury demands and did not have war-time priority. Subsequent industrial depressions and booms are all reflected in decreases and increases in the production of clay, especially fire clay.

A noteworthy feature is the increased production of kaolin since 1919, due principally to its increased use as filler and coating in the paper, rubber, and textile industries and to a decline in the quantity of kaolin imported. Before the war the United States depended almost entirely on imports for its supply of high-grade kaolin suitable for the finer ceramics and fillers. Shortage of supplies from abroad during the war induced domestic producers to give more attention to correct preparation of the clays. Interest along these lines has continued, and the preparation of kaolin has been improved so that now the quality of American kaolin equals that of imported grade, and it has been substituted satisfactorily in virtually all industries where it is used. The bulk of the kaolin now imported is used mainly along the northern Atlantic seaboard, where it has the benefit of low ocean freight rates.

Output in 1932.—Continuation of the industrial depression throughout 1932 caused continued decrease in both the quantity and value of clay produced. Total production fell from 2,519,495 tons in 1931 to 1,618,380 tons in 1932, and total value from $8,352,185 to $5,636,302. This represents a decrease of 36 percent in tonnage and 33 percent in value. Clay declined 62.8 percent in quantity and 62 percent in value from the peak in 1929. The average value per ton increased slightly from $3.32 per ton in 1931 to $3.48 per ton in 1932 because of the increased production of certain high-priced clays included under "Miscellaneous clay."

Only clay which is shipped from the point where it is produced in unwrought condition is considered in this discussion. The vast

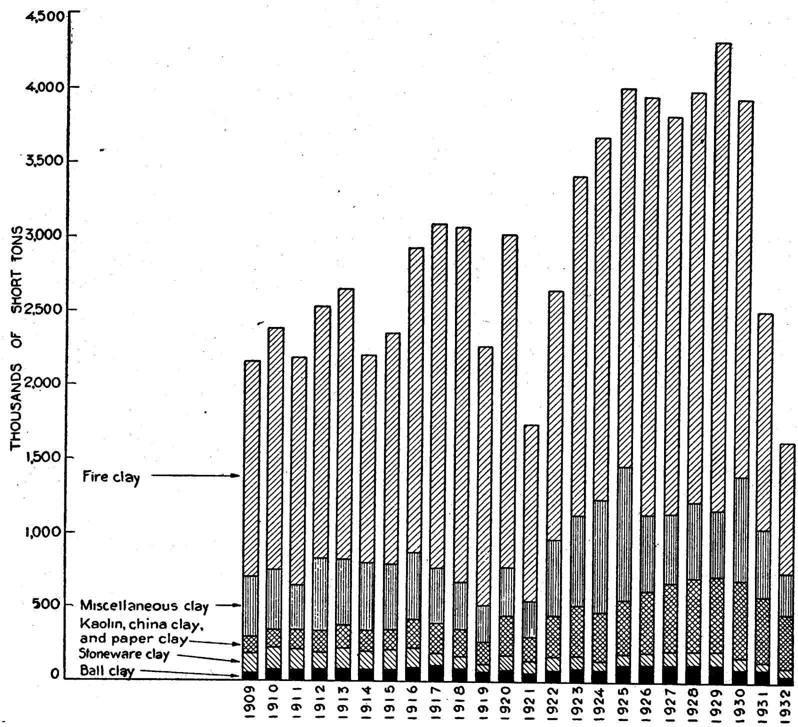

FIGURE 73.—Trends in sales of clay, 1909–32, by classes.

tonnage manufactured by the original producer into brick, hollow tile, sewer and drain pipe, firebrick, etc., is not included unless mined on royalty or shipped unwrought from one State to another. The comparatively small quantity sold as clay by the producer is used as fillers in the paper, textile, rubber, and paint industries for making high-grade pottery and tile, for refractory products, and for certain specialized purposes, such as in the chemical and pharmaceutical trades. The values given herein are f.o.b. mines or works.

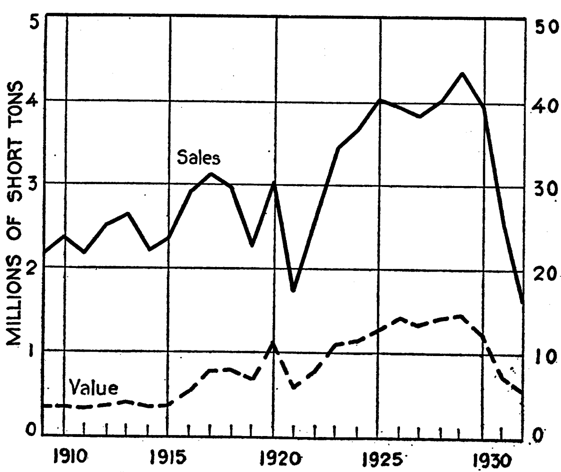

FIGURE 74.—Sales and value of clay, 1909–32.

The salient statistics on clay sold by producers in the United States in 1932 appear in the following table:

Salient statistics on clay sold by producers in the United States in 1932, by States and kinds [1]

State	Number of operators reporting sales	Kaolin or china clay and paper clay		Ball clay		Fire clay		Stoneware clay		Miscellaneous clay [2]		Total	
		Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	11					33,629	$47,155			119	$24	33,748	$47,179
Arizona	2									(3)	(3)	(3)	(3)
Arkansas	1					(3)	(3)			(3)	(3)	(3)	(3)
California	41	244	$3,191	200	$2,400	68,770	180,612	2,667	$8,385	74,712	164,865	146,593	359,453
Colorado	13					26,283	41,214			16,992	15,238	43,275	56,452
Connecticut	1					53	954					53	954
Delaware	2	(3)	(3)							(3)	(3)	(3)	(3)
Florida	2	(3)	(3)									(3)	(3)
Georgia	16	247,676	1,321,751					90	90			247,766	1,321,841
Idaho	3					456	5,401					456	5,401
Illinois	15			1,021	9,506	35,620	90,783	9,544	17,100			46,185	117,389
Indiana	12					45,900	42,060	200	270	50,448	24,619	96,548	66,949
Iowa	6					858	7,255			2,575	2,099	3,433	9,354
Kentucky	15			18,259	154,689	58,605	185,751					76,864	340,440
Maine	3					(3)	(3)			(3)	(3)	(3)	(3)
Maryland	12	1,000	1,500	(3)	(3)	5,165	24,908			5,820	8,238	19,460	64,214
Massachusetts	8					(3)	(3)			215	888	434	5,274
Michigan	3					40	281			36	623	76	904
Minnesota	3							6,425	14,082	204	619	6,629	14,701
Mississippi	1							(3)	(3)			(3)	(3)
Missouri	30	150	1,145	810	7,070	127,776	508,590	500	875			129,236	517,680
Montana	2					250	1,673			949	618	1,199	2,291
Nebraska	5									5,787	6,748	5,787	6,748
Nevada	2									641	3,891	641	3,891
New Jersey	31			1,070	5,408	49,370	214,478	2,870	15,113	8,804	13,583	62,114	248,582
New Mexico	3					266	1,559					266	1,559
New York	4					(3)	(3)			(3)	(3)	4,294	27,095
North Carolina	5	12,660	202,016					(3)	(3)	(3)	(3)	12,946	202,552
North Dakota	2	2	30			2	43			1	8	5	81
Ohio	46					222,609	242,324	11,615	14,055	223	1,875	234,447	258,254
Oklahoma	2									6,097	69,875	6,097	69,875
Oregon	2					(3)	(3)	(3)	(3)			(3)	(3)
Pennsylvania	60	13,417	54,082			195,310	524,520	(3)	(3)	12,119	20,208	237,391	615,413
South Carolina	8	71,874	460,305			1,557	47,061					73,431	507,366
South Dakota	1									330	2,475	330	2,475
Tennessee	9			19,602	112,102	8,415	31,831			7,770	7,794	35,787	151,727
Texas	8					968	6,250			17,577	122,854	18,545	129,104

[1] Subject to revision.
[2] Includes adobe, shale, etc. Slip clay and bentonite are also included in this column as a matter of statistical convenience.
[3] Included under "Undistributed."

Salient statistics on clay sold by producers in the United States in 1932, by States and kinds—Continued

State	Number of operators reporting sales	Kaolin or china clay and paper clay		Ball clay		Fire clay		Stoneware clay		Miscellaneous clay		Total	
		Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Utah	6					1,563	4,530			(3)	(3)	12,706	$119,564
Vermont	1	(3)	(3)									(3)	(3)
Virginia	3	(3)	(3)			(3)	(3)			(3)	(3)	3,186	11,771
Washington	4					(3)	(3)	(3)	(3)	9,497	$8,488	10,257	9,920
West Virginia	5					12,018	$16,437					12,018	16,437
Wyoming	8					10	10			13,482	108,167	13,492	108,177
Undistributed		17,921	$199,456	7,475	$29,568	3,828	22,179	17,680	$18,814	19,689	151,643	22,685	215,235
1932 Total	417	364,944	2,243,476	48,437	320,743	[4] 899,321	[4] 2,247,859	51,591	88,784	[5] 254,087	[5] 735,440	1,618,380	5,636,302
1932 Average value per ton			6.15		6.62		2.41		1.72				3.48
1931 Total	435	443,300	2,946,953	83,007	639,798	[6] 1,473,161	[6] 3,741,038	57,466	131,915	[7] 462,561	[7] 892,481	2,519,495	8,352,185
1931 Average value per ton			6.65		7.71		2.54		2.30				3.32

[3] Includes under "Undistributed."
[4] These totals include 5,726 tons of diaspore and burley clay, valued at $32,597, from Missouri.
[5] These totals include 1,788 tons of slip clay, valued at $13,063, from Michigan and New York and 96,176 tons of bentonite, valued at $550,152, from Arizona, California, Nevada, Oklahoma, South Dakota, Texas, Utah, and Wyoming. Of the total bentonite, California reported 54,704 tons, valued at $136,210; Nevada, 150 tons, valued at $700; Oklahoma, 5,798 tons, valued at $68,382; South Dakota, 330 tons, valued at $2,475; and Wyoming, 12,632 tons, valued at $107,567.
[6] These totals include 19,662 tons of diaspore and burley clay, valued at $103,507 from Missouri.
[7] These totals include 1,916 tons of slip clay, valued at $13,613, and 78,815 tons of bentonite, valued at $472,045

Production, by States, and kinds.—Although the same 43 States reported sales of clay as such in 1931 and 1932, incomplete returns indicate that the total number of operators declined from 435 to 417. The number of operators increased in 11 States and decreased in 18, the decreases being mainly in States which are large producers of fire clay. The 10 States having the largest productions of clay during 1932 were: Georgia (15.3 percent of the total production), Pennsylvania (14.7 percent), Ohio (14.5 percent), California (9.1 percent), Missouri (8.0 percent), Indiana (6.0 percent), Kentucky (4.7 percent), South Carolina (4.5 percent), New Jersey (3.8 percent), and Illinois (2.8 percent). These States reported 83 percent of the total production in the United States in 1932. Georgia displaced Pennsylvania from the position of leading producer which it had held since it displaced Missouri in 1923. The rise of Georgia to first in rank and virtually all other changes in rank among important producers are due to the large falling off in the production of fire clay compared with that of other clays.

As usual, fire clay leads in tonnage and value of output. Ohio, Pennsylvania, and Missouri, in the order given, are the largest producers of fire clay, accounting for 61 percent of the total production.

Kaolin is a close second to fire clay in value, although the tonnage produced is less than one half as much. Georgia produced 68 percent of the tonnage of kaolin, an increase of 5 percent over 1931. In addition to Georgia, South Carolina, Pennsylvania, and North Carolina were the only States producing an appreciable tonnage. North Carolina producing the highest-grade clay, increased slightly both the tonnage and value of its output over that in 1931 in contrast with a considerable decrease in virtually all other States. Pennsylvania showed a reduction of about two thirds in tonnage and value of kaolin produced. Tennessee and Kentucky continued to be the largest producers of ball clay, the combined output of both States accounting for a little more than 78 percent of the total. Yield fell off heavily in Maryland and New Jersey, which in 1931 produced 18 percent of the total.

Ohio, Illinois, and Minnesota continued to be the three largest sources of stoneware clay. This class decreased least in tonnage, but its value per ton fell off proportionately more than that of any other class.

A greater decrease in the production of low-grade clays included under "miscellaneous clays" than in that of the higher-grade clays caused a decline of only 18 percent in their value, compared with a 45 percent decrease in their tonnage. The average value increased from $1.90 per ton in 1931 to $2.89 per ton in 1932, enough to overcome the reduced value per ton of all other classes of clay products and to increase the average value per ton of the total production of clay 16 cents.

Uses.—Clay is a fine-textured earthly substance resulting from decomposition of igneous rocks. It is plastic when wet with the proper quantity of water, retains its shape when dried, and becomes stone hard when heated enough to drive off its chemically combined water. Chemically, it consists of a base of hydrous aluminum silicate with quartz, feldspar, iron oxide, mica, and other mineral and organic materials which may have been present in the orignal rock or which may have become mixed with it during its transportation and sedimentation. The varying proportions of the base materials and the different impurities determine the suitability of clay for different purposes and set its value in commerce.

Clays range from low-grade widely distributed varieties suited only for brick, tile block, and sewer pipe, to high-grade clays such as kaolin, ball clay, highly refractory fire clay, etc., which occur only in certain localities and are suited by their peculiar properties or characteristics to specific purposes. Although the high-grade clays usually are sold by the producers as unfinished materials and appear in commerce as raw materials, low-grade clays ordinarily do not warrant shipment in the raw state, as a rule being manufactured into finished articles by the producers at their point of origin.

In this discussion clay is considered under the following headings: (1) Kaolin, including china clay and paper clay; (2) ball clay; (3) fire clay; (4) stoneware clay; and (5) miscellaneous clay, which includes all clay of which a comparatively small tonnage was sold by producers and clay which cannot properly or definitely be classified under the other general headings.

Kaolin, ball clay, stoneware clay, and fire clay are adapted to the finer ceramic industry by their properties of being readily molded, retaining their shape when dried, and firing at comparatively low temperatures. They are all used in the pottery and finer ceramic industries in the manufacture of china and porcelain tableware and sanitary ware, floor and wall tile, electrical porcelain fittings, etc. These clays have different characteristics as to bond, ease of molding, shrinkage, and firing temperatures, and two or more clays usually are blended to obtain the desired features in manufacture and appearance and texture of the fired product.

Kaolin, to a large extent, and ball clay, to a rather small extent, find use in the paper, rubber, textile, and paint industries as fillers or extenders and coatings because they grind readily to extreme fineness and are soft in texture.

Fire clays are characterized by their resistance to high temperatures without fluxing or fusing. Although a high degree of plasticity is desirable it is not necessary, as deficiency in this property can be overcome by the addition of some other plastic, low-fusing clay as a binder. The bulk of the production of fire clay appearing in commerce is used for the manufacture of fire brick; as fire-clay mortar for furnace, retort, crucible, and ladle linings; and for similar purposes where high temperatures must be withstood. Fire clay marketed unwrought constitutes over half the total commercial production of clay, but it is only a fraction of the total production of fire clay, as most fire-brick plants operate their own fire-clay mines and purchase only a small part of their requirements from other producers.

Fire clay includes diaspore and burley clay, also special fire clays high in alumina and capable of withstanding extremely high temperatures such as are encountered in cement and lime kilns, high-temperature boiler settings, and nonferrous metallurgy.

Miscellaneous clays include clays having special properties or uses of which comparatively small quantities are marketed. They include such clays as slip clay, a low-melting-point clay used as a glaze and as a binder for artificial abrasives; bentonite, a peculiar clay which can absorb several times its volume of water and swells greatly when wet, and is used for medical purposes, as a purifying agent in oil refining, and for sealing oil wells; and adobe and shale dust, used for rock-dusting coal mines, etc. Clay used for brickmaking, which has been mined on royalty or sold raw, is listed under "Miscellaneous clays" as the quantity is negligible compared with the total quantity used for brick and block making.

Imports and exports.—Total imports of clay in 1932 decreased 33 percent in quantity and 43 percent in value compared with 1931. Imports of kaolin, or china clay, which constituted 79 percent of the total quantity of clay imported in 1932, decreased 34 percent in quantity and 56 percent in value.

Clay imported for consumption in the United States, 1928–32

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
1928	307, 304	$2, 962, 269	10, 259	$90, 742	51, 163	$429, 788	1, 653	$23, 564	370, 379	$3, 506, 363
1929	279, 981	2, 700, 296	28, 008	268, 011	49, 324	420, 689	12, 283	154, 158	369, 596	3, 543, 154
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

[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; not separately classified prior to change in tariff; 1932, 7,328 tons, $267,560.

Exports of domestic clays in 1932 decreased 24 percent in quantity compared with 1931. Exports of fire clay, constituting 27 percent of the total quantity and 22 percent of the total value of clay exported in 1932, decreased 51 percent in quantity and 31 percent in value.

Domestic clay exported from the United States, 1928–32

Year	Fire clay		All other		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1928	60, 138	$494, 241	60, 911	$896, 350	121, 049	$1, 390, 591
1929	76, 561	588, 770	76, 789	1, 117, 312	153, 350	1, 706, 082
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

ABRASIVE MATERIALS

By Paul Hatmaker and A. E. Davis

Further decline in manufacturing activity during 1932 resulted in a corresponding decrease in the demand for abrasive materials. The total quantity of natural and artificial abrasives produced in 1932 was about 21 percent less than in 1931, which corresponds with a 21 percent decline in the Federal Reserve Board index of industrial production. Natural abrasives (excluding grinding and polishing sand) dropped approximately 22 percent in total tonnage, whereas artificial abrasives declined only 12.3 percent.

Natural products have been widely supplanted by silicon carbide and synthetic aluminum oxide, where an abrading agent softer than diamond but harder than quartz usually is demanded. For example, natural abrasives such as garnet, emery, and silica constituted 80 percent and artificial abrasives 20 percent of the abrading agents used in abrasive paper and cloth products in 1919, but in 1930 natural abrasives comprised only 54 percent, while artificial abrasives constituted 46 percent, according to the Abrasive Paper and Cloth Manufacturers' Exchange. Artificial abrasives, which can be manufactured into a great variety of shapes, are displacing also quarry products hewn from rock ledges.

Natural materials, however, have not been dislodged from the narrow field of superhard abrasives, where the diamond still predominates, or from the field of mild abrasives, where abradants as soft as or softer than quartz are used. Although special products, such as tungsten or other metallic carbides, are challenging the diamond for certain work, the latter still is recognized as the hardest substance known and is considered indispensable for some purposes. Talc, whiting, pumice and pumicite, and quartz, which may be in pulverized or sand-grain form, likewise have not yet been affected seriously by the more costly artificial products.

Broad relationships in the field of abrasive products over the past 21 years are shown graphically in figure 75. The natural abrasive materials are grouped into three divisions to show long-time trends.

Natural siliceous abrasives.—The long-time trend of natural siliceous abrasives is definitely upward, as to both the quantity produced and the sales value. Increased demand has resulted not only from expansion in general manufacturing activities but also from new markets outside the abrasive field, which have been developed by the producers. Diatomite, for example, has found wide use as a filtering agent, particularly in the sugar industry; as an insulating medium for furnaces, ovens, and similar equipment; and as a filler in certain manufactured products. So much progress has been made in these fields that only a small percentage of the diatomite produced today is used for abrasive purposes.

Pumice and pumicite are used extensively in cleansing and scouring compounds, the demand for which has increased with wider use of sanitary fixtures and generally improved hygienic conditions. Markets for pumice and pumicite and for tripoli have been developed in the field of construction. Sales of quartz, sand, and sandstone (pulverized or in the form of sand grains) have increased more slowly in quantity, but their gross value has more than doubled since the pre-war period.

Special stone products.—Substantial declines in special quarry products are noted from 1918 to 1922 and again since 1926. The brief prosperity indicated from 1923 to 1925 is attributed partly to higher post-war prices. The long-time trend, however, in the production of these specialized quarry products has been definitely downward.

The decline has been caused partly by gradual evolution in the grinding and milling processes in the grain, paint, and other industries,

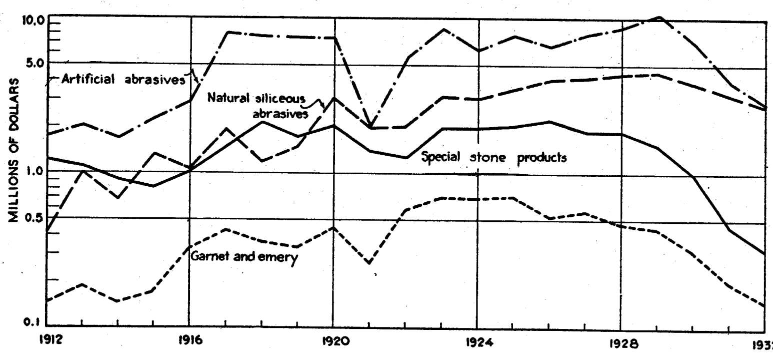

FIGURE 75.—Annual values of production of major abrasive groups, 1912–32. Artificial abrasives include silicon carbide, synthetic aluminum oxide, and various metallic abrasives, such as crushed steel, steel shot, and steel wool. Natural siliceous abrasives include pulverized quartz, sand and sandstone, diatomite, tripoli, and pumice and pumicite. In this group, figures for diatomite are incomplete for 1915–18; also, 3-year averages are used since 1926, which tend to stabilize somewhat the composite curve over recent years. Grinding and polishing sand (unpulverized) is not included; statistics appear in the sand and gravel chapter. Special stone products include grindstones, pulpstones, millstones, oilstones and related quarry products, and grinding pebbles and flint lining for tube mills. Gross value is used rather than tonnage because complete data as to quantity are not available. Interpretation of the curves, therefore, must include proper allowance for changes in price levels. Garnet and emery, for example, show a rise in gross value since the World War. Although gross income yielded an actual gain to the producers, the domestic tonnage of this group sold from 1926 to 1929 was less than 50 percent of that sold from 1916 to 1919; however, garnet itself showed some increase. On the other hand, reduced manufacturing costs have had an opposite effect upon artificial abrasives. Comparing again the period 1926–29 with that of 1916–19, artificial abrasives more than doubled in quantity, but the average value per ton declined about 39 percent. The curve of total value, therefore, shows little relative gain, although production increased substantially.

many of which no longer employ buhrstones and chaser mills. Moreover, artificial abrasives have entered the field and are used widely for the manufacture of oilstones and other sharpening or grinding equipment. Special quarry products, therefore, are faced not only with diminished demand but also with competition from synthetic products that are highly efficient and easily adaptable to changing industrial requirements.

Garnet and emery.—Production of both garnet and emery also has been decreasing for a number of years. These minerals, although highly efficient abrasives, are so hard as to be in direct competition with artificial products. As new uses outside the abrasive field have not compensated for the business thus lost, the domestic industry has declined to a point where it is no longer of major importance, and imports likewise have shown a downward trend.

Artificial abrasives.—Production of artificial abrasives has declined since 1929, although up to that year the trend was decidedly upward. In common with other relatively new abrasives, vigorous market expansion has been aided by lower selling prices, brought about by progress in manufacturing practice.

Artificial abrasive products were made possible by cheap hydroelectric power, a prime consideration in the manufacture of both silicon carbide and synthetic aluminum oxide. Great impetus was given the industry by war-time activities, but growth has been substantial since the business slump of 1921.

Artificial abrasives have several advantages over natural products for certain industrial purposes. They are much harder than such minerals as quartz and garnet and rival corundum, which is next to the diamond in Moh's scale. Artificial abrasive grains can be bonded and manufactured into many special types of grinding equipment essential to the exacting requirements of industry. Special grain size, cutting speed, and odd sizes of wheels or stones can be provided on demand for any particular job. Uses developed outside the strictly abrasive industry, such as refractory material, floor tile, and stair treads, also are important.

To summarize, the utilization of artificial abrasives and the group composed of natural siliceous products is growing with the expansion of the manufacturing industries and the intensive development of new markets. On the other hand, special quarry products and garnet and emery have lost many old markets and gained few new ones. The following sections give more detailed current data in regard to the individual commodities.

NATURAL SILICEOUS ABRASIVES

Diatomite.—The Bureau of Mines is not at liberty to publish the annual production figures on diatomite since 1926. Permission has been obtained, however, to combine the data into 3-year periods. The total production for the period 1930–32 was 248,273 short tons valued at $3,902,126.

A large market for diatomite has been developed in the sugar-refining industry. Sugar meltings declined only 14 percent in 1930–32 compared with 1927–29 and only 10 percent in 1932 compared with 1931. Detailed data are not available on the quantity of diatomite consumed in the refining of sugar, that used as insulating material, or that sold to battery manufacturers (reported to be the three major uses), but these markets are comparatively new and account for the rapid growth in the use of diatomite for other than abrasive purposes.

The economic importance of diatomite depends mainly upon its unusual physical properties—fineness and uniformity of texture, light weight, high porosity, and relative chemical inertness. Dry lump material weighs about 28 pounds per cubic foot. Dry, loose powder usually ranges in weight from 7 to 16 pounds per cubic foot, depending upon the character of the material and the type of the deposit.

Diatomite (known also as diatomaceous earth, infusorial earth, and kieselguhr) is a fine-grained hydrous or opaline fossil form of silica composed of skeletal remains of diatoms. Deposits may be of marine or fresh-water origin. The organic structure of the particles, which is plainly visible under a microscope of moderately high power, affords a definite and simple means of identification. Diatomite thus can be distinguished from tripoli, which shows no organic structure.

Diatomite is carefully pulverized and graded for use as a filtering agent. As an insulating medium it may be employed as cut or sawed brick or as prepared brick. During the past few years diatomite has been used to an increasing extent as a filler in the manufacture of battery boxes. The quantity so used in 1929, for example, was estimated conservatively at 15,000 tons. Material for this purpose must be very low in acid-soluble substances, iron, manganese, and other foreign material.

Relatively minor quantities of diatomite are used as an abrasive for polishing metals, glass, furniture, and enamel and in cosmetics. Its value as a polishing agent depends upon hardness, fineness, uniformity of grain size, and ability to absorb grease. Certain fresh-water varieties are said to have superior cutting qualities, because many such particles are relatively smaller, harder, or sharper. Several years ago an appreciable quantity of diatomite was used as an admixture in concrete, but the quantity so used is reported to have declined.

At one time diatomite was produced almost entirely in eastern localities, notably Maryland and Virginia. The bulk of the production now comes from western localities, especially from the enormous deposits near Lompoc, Calif. Lately, however, new interest has been shown in the Maryland-Virginia material, and this interest may result in renewed production when business conditions permit.

Available figures of output since 1926 are shown in the following table.

Diatomite sold or used by producers in the United States, 1927–32 [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

[1] Bureau of Mines not at liberty to publish annual figures separately.

The companies reporting production and sales of diatomite in the United States in 1931 or 1932, with the location of the deposits from which the diatomite was obtained, are as follows:

Adirondack Diatomaceous Earth Co., Herkimer, N.Y. Deposit at Ohio, Herkimer County, N.Y.

Atomite Corporation, 1021 Pacific Building, Portland, Oreg. Deposit at Terrebonne, Deschutes County, Oreg.

Celite Corporation, Lompoc, Calif. Deposit at Lompoc, Santa Barbara County, Calif. (Now, Johns-Manville Products Corporation.)

Chaffin, George H., 216 East Fourth South, Provo, Utah. Deposit at Gooding, Gooding County, Idaho.

Dicalite Co., 756 South Broadway, Los Angeles, Calif. Deposit at Walteria, Los Angeles County, Calif.

Electro-Silicon Co., 22 Cliff Street, New York, N.Y. Deposit at Virginia City, Storey County, Nev.

Floatstone Industries, Ltd., 124 West Fourth Street, Los Angeles, Calif. Deposit at Walteria, Los Angeles County, Calif.

Kittitas Diatomite Co., Ellensburg, Wash. Deposit at Kittitas, Kittitas County, Wash.

Mineral Products Manufacturing Co., 1735 Ventura Avenue, Fresno, Calif. Deposit at Mendota, Fresno County, Calif.

National Silica Products Co., 1201 Bryant Street, Palo Alto, Calif. Deposit at Lompoc, Santa Barbara County, Calif.

Pacatome, Ltd., 814 Kohl Building, San Francisco, Calif. Deposit near Bradley, Monterey County, Calif.

Pacific Coast Diatom Co., Harper, Oreg. Deposit at Harper, Malheur County, Oreg.

Pacific Coast Silica Corporation, 3080 Andover Street, Seattle, Wash. Deposit at Kamiah, Idaho County, Idaho.

Superdent Co., box 794, Reno, Nev. Deposit at Mina, Nye County, Nev.

U. S. Diatom Co., 800 Santa Fe Avenue, Los Angeles, Calif. Deposit at Mount Montgomery, Mineral County, Nev.

Washington Silica & Fire Clay Co., 3205 Hewitt Avenue, Everett, Wash. Deposit at Roza, Kittitas County, Wash.

Webley, E. J., Quincy, Wash. Deposit at Quincy, Grant County, Wash.

Tripoli.—The production of tripoli and related materials in 1932 was 14,775 short tons valued at $232,700. Although the quantity produced declined 45 percent from that in 1931 the average value per ton increased about 36 percent. Markets for tripoli depend largely upon conditions in the iron and steel and the construction industries. The drop of 45 percent in tripoli production from 1931 to 1932 conforms with the decline of 47 percent in the production of steel ingots, 57 percent in the floor space of construction contracts awarded, and 26 percent in the value of paint sales.

Tripoli is an extremely fine-grained porous form of silica, of the chalcedony variety, which by some authorities is believed to have been formed by the decomposition of siliceous limestone. Rottenstone is related to tripoli but is somewhat more earthy and less siliceous. The chemical and physical characteristics of tripoli from different localities may vary greatly—a fact prospective consumers should bear in mind.

Tripoli from the Missouri-Oklahoma district is used extensively for abrasive purposes, in scouring and polishing powders, and in polishing compositions and pastes. An important use is for foundry partings. Much attention has been given to promoting the use of tripoli as an admixture in concrete construction. Subnormal building activity during 1932, however, had an adverse effect upon sales for this purpose. The market for filter blocks of natural stone has declined during recent years because of gradual improvements in municipal water systems and invasion of the market by synthetic stone. However, tripoli is still so used in small isolated communities. Other uses are as a filler in hard rubber and substitute compositions and as a pouncing powder.

The Illinois product generally is known simply as "silica", and although employed to some extent as an abrasive for metal polishes, in soaps, and in cleansers, it is used largely in paint and fillers, in making glass, in the body and enamel of ceramic wares, and in the facing of foundry molds.

Rottenstone is used as a mild abrasive in wood and metal finishing, as, for example, in the scouring of metal surfaces prior to plating. Pennsylvania rottenstone is reported to be used also in the manufacture of phonograph records.

The chief sources of production of tripoli and related materials in 1932, as in previous years, were a small area lying in Newton County, Mo., and Ottawa County, Okla., and the Alexander-Union County area in southern Illinois. Output was reported from Tennessee also. Rottenstone is produced in Lycoming County, Pa.

The statistics in the 5-year table that follows, as well as those reported for earlier years in Mineral Resources, do not make a precise comparison between States or years. It always has been impossible to obtain from producers uniform reports on the quantity and value of their crude material, as they sell a large part of the product in a prepared or manufactured form. An attempt made in 1931 to acquire information on the yearly sales of tripoli for distinct purposes failed completely; only three producers could supply the data requested. The values given as "sold" are the gross returns, as reported by producers, and include receipts from sales of both crude and ground (or otherwise finished) material.

Tripoli (including Pennsylvania rottenstone) sold or used by producers in the United States, 1928–32

Year	Illinois			Other States [1]			Total		
	Short tons	Value		Short tons	Value		Short tons	Value	
		Crude (estimated)	As sold (crude and finished)		Crude (estimated)	As sold (crude and finished)		Crude (estimated)	As sold (crude and finished)
1928	(2)	(2)	(2)	(2)	(2)	(2)	34,043	$73,689	$555,576
1929	12,889	$27,597	$139,557	25,122	$46,878	$406,101	38,011	74,475	545,658
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

[1] 1928: Missouri, Oklahoma, Pennsylvania, and Tennessee; 1929, 1931, and 1932: Arkansas, Missouri, Oklahoma, Pennsylvania, and Tennessee; 1930: Arkansas, Georgia, Missouri, Oklahoma, Pennsylvania, and Tennessee.
[2] Bureau of Mines not at liberty to publish figures.

The companies reporting production and sales of tripoli (including Pennsylvania rottenstone) in the United States in 1931 and 1932, with the location of the deposits from which the material was obtained, were as follows:

American Minerals Corporation, 206 Bank Street, Burlington, Vt. Deposits near Cleveland, Bradley County, Tenn.; and near Tamms, Alexander County, Ill.

Barnsdall Tripoli Co. (successors to the American Tripoli Co.), Seneca, Mo. Deposits at Seneca, Newton County, Mo.; and in Ottawa County, Okla., near Seneca, Mo.

Corona Silica, Inc., Rogers, Ark. Deposit at Rogers, Benton County, Ark.

Hileman, C. H., R. F. D. 1, Box 65, Jonesboro. Deposit at Millcreek, Union County, Ill.

Independent Gravel Co., 220½ West Fourth Street, Joplin, Mo. Deposit at Racine, Newton County, Mo.

International Silica Co., Cairo, Ill. Deposit at Elco, Alexander County, Ill.

Mepham, Geo. S., & Co., East St. Louis, Ill. Deposit at Delta, Alexander County, Ill.

Miller & Allen, Elco, Ill. Deposit at Millcreek, Union County, Ill.

Olive Branch Mineral Products Co., Olive Branch, Ill. Deposit at Olive Branch, Alexander County, Ill.

Penn Paint & Filler Co. (successors to the Penn Keystone Co.), Antes Fort, Pa. Deposit at Antes Fort, Lycoming County, Pa.

Tri-State Quarries Co., Inc., Junction City, Kans. Deposit near Peoria, Ottawa County, Okla.

Pumice and pumicite.—Pumice and pumicite, the only domestic abrasive minerals to show an increased tonnage in 1931 over 1930, declined 23 percent in output and 10 percent in average value a ton in 1932 from the preceding year. The production of 53,214 short tons in 1932 was lower than that for any year since 1925, when production amounted to 40,380 short tons, valued at $179,020.

In addition to a fairly steady market for cleansing and scouring compounds, which is the mainstay of the domestic industry, noteworthy progress has been made in recent years in the development of new uses in the construction field. A rather large tonnage of pumicite is used as an admixture in concrete; and an increasingly important quantity of pumice is employed in acoustic plasters.

The following table shows the distribution of the domestic production in the only years for which such data are available.

Sales of pumice and pumicite, by uses, 1931 and 1932

	1931			1932		
	Short tons	Value		Short tons	Value	
		Total	Per ton		Total	Per ton
Cleansing and scouring compounds and hand soaps	54,934	$207,792	$3.78	41,912	$147,274	$3.51
Other abrasive uses	895	12,863	14.37	1,142	12,740	11.16
Concrete admixture and concrete aggregate	9,242	66,376	7.18	7,165	35,879	5.01
Acoustic plaster	3,088	48,720	15.78	2,401	35,033	14.59
Miscellaneous uses [1]	660	2,835	4.30	594	4,278	7.20
Total	68,819	338,586	4.92	53,214	235,204	4.42

[1] Miscellaneous uses include material used as insecticide, floor sweep, heat or cold insulation, in linoleum manufacture, for filtering, as dental material, and in asphalt.

The declines in the production and value of pumice and pumicite shown in the foregoing table, while conforming with the general trends in industrial production, are much less than the loss in building activity (floor space of contracts awarded), which was 57 percent lower in 1932 than in 1931. Pumice and pumicite sold for concrete admixture, concrete aggregate, and acoustic plaster, therefore, made relative gains in their respective fields, if conditions as a whole are considered.

Pumice and pumicite are used for very different purposes and are separate commodities, virtually noncompetitive. Both pumice and pumicite are siliceous volcanic substances similar in chemical composition but very different in manner of formation and mode of occurrence. Pumice usually occurs near active or extinct volcanoes in solid coherent masses; however, some deposits are fragmental. The color is generally white to light gray. Pumice is formed by sudden expansion of included gases in molten lava, followed by relatively quick cooling. It thus contains innumerable vesicules or chambers separated by thin glasslike walls. Pumicite, known also as volcanic ash and volcanic dust, is composed of small, sharp, angular, or platy particles of volcanic glass spumed from volcanoes during violent eruptions and subsequently transported and deposited by air currents.

Lump pumice is used as an abrasive for polishing various metals; for rubbing down wood surfaces in the manufacture of high-grade furniture, such as pianos, phonographs, and radios; to a limited extent in the automobile industry; and for working, cleaning, and polishing stone and glass. Fine lump pumice is used as a toilet article. Ground pumice is used in the electroplating industry; in tumbling barrels; in cleansing, scouring, and polishing compounds; in dental preparations; and as an abrasive in rubber erasers. Pumice is used in construction as a lightweight concrete aggregate, in the manufacture of bricks and other building units, as building blocks having fireproof and earthquake-proof qualities, and as an ingredient in acoustic plasters. It is used also as a heat- and sound-insulating medium.

Pumice is reported to be used in Japan in the pottery industry and in Armenia as a raw material in the manufacture of green bottle glass, the alkali present effecting economies in the use of soda and sulphates.

Pumicite is used in making cleansing and scouring compounds, abrasive hand soaps, and, to a limited extent, metal polishes. It is used in construction as an admixture in concrete, as an absorbent for oiled-road surfaces, and to a smaller extent as an insulating material for packing steam and water pipes, lagging boilers, and lining cold-storage rooms, in filter cells, and as a filler or absorbent in paints, sweeping compounds, and fertilizers.

Production from the Middle Western States consists entirely of pumicite, much of which is sold for cleansing and scouring compounds and as an admixture in concrete. Production from the Far Western States includes both pumice and pumicite. Imports of pumice, chiefly from the Island of Lipari, have retarded the development of pumice in the Western States for use in eastern markets. (See the table of imports under the section entitled "Foreign Trade" for current data.) The total domestic production for the last 5 years is stated in the following table.

Pumice and pumicite sold or used by producers in the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	57,430	$278,516	1931	68,819	$338,586
1929	67,013	353,064	1932	53,214	235,204
1930	56,843	336,099			

The companies reporting production and sales of pumice and pumicite in the United States in 1931–32, with the location of the deposits from which the pumice and pumicite were obtained, are as follows:

Brown, Chas., Shoshone, Calif. Deposit at Shoshone, Inyo County, Calif.

California Quarries Corporation, 1300 Quinby Building, Los Angeles, Calif. Deposit near Laws, Mono County, Calif.

Cudahy Packing Co., 111 Monroe Street, Chicago, Ill. Deposits at Fowler, Meade County, Kans., and at Saltdale, Kern County, Calif.

Davidson Pumice Co., Norton, Kans. Deposit at Calvert, Norton County, Kans.

Earlonite Mining Co., Box 474, Selma, Calif. Deposit near Friant, Fresno County, Calif.

Glendenning, R. W., 1134 Western Pacific Building, Los Angeles, Calif. Deposit at Shoshone, Inyo County, Calif.

Golden State Cleaner Mine (M. L. Francis), R.F.D., Creston, Calif. Deposit near Paso Robles, San Luis Obispo County, Calif.

Hill Brothers Chemical Co., 2159 Bay Street, Los Angeles, Calif. Deposit at Barstow, San Bernardino County, Calif.

Kalite Co., Ltd., 90 South Oak Knoll Avenue, Pasadena, Calif. Deposit near Calipatria, Imperial, Calif.

Klenit Corporation, Winner, S.Dak. Deposit at Winner, Tripp County, S.Dak.

La Rue Axtell Pumice Co., Eustis, Nebr. Deposit at Eustis, Frontier County, Nebr.

McKenzie Estate, Griffith-McKenzie Building, Fresno, Calif. Deposit near Friant, Fresno County, Calif.

Mid-Co. Products Co., Kansas City, Mo. Deposits at Edison, Furnas County, Nebr.; near Gate, Beaver County, Okla.; and at Meade, Meade County, Kans.

Mineral Milling Co. (successors to Flynt Silica & Spar Co.), 1081 Richmond Street, Los Angeles, Calif. Deposit at Niland, Imperial County, Calif.

Pumicite Co., 4025 Clara Avenue, St. Louis, Mo. Deposit at Fowler, Meade County, Kans.

Yuma Products Manufacturing Co., 3648 Humboldt Street, Denver, Colo. Deposit at Bouse, Yuma County, Ariz.

Victorville Lime Rock Co., 2149 Bay Street, Los Angeles, Calif. Deposit at Little Lake, Inyo County, Calif.

Zimmermann, H. H., Belle Plaine, Kans. Deposit near Satanta, Grant County, Kans.

Quartz.—The production of quartz, from pegmatite dikes or veins or from quartzite, in the United States in 1932 was 7,487 short tons, valued at $59,158. This output was 5 percent less than that in 1931. About three fifths of the material sold in 1932 was crude or crushed, and about two fifths was ground.

Quartz is used in the manufacture of fused-quartz glass and ferrosilicon; as a flux in certain metallurgical processes; as a packing in acid towers and water filters; for refractory purposes; as a filler; and as the abrading agent in certain kinds of sandpaper, soaps and scouring compounds, metal polishes, and safety matches. An important use is in the manufacture of white ware and enamel. Exceptionally clear crystals of quartz are used in optical instruments and for various purposes in the electrical industry.

Production data are given in the following tables.

Quartz sold or used by producers in the United States, 1928–32

Year	Crude [1]		Ground [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1928	15,363	$79,229	6,835	$130,104	22,198	$209,333
1929	13,104	59,257	7,877	146,502	20,981	205,759
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

[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, 1930–32, by States

State	1930		1931		1932	
	Short tons	Value	Short tons	Value	Short tons	Value
California	[2] 2,895	[2] $22,762	1,553	$16,654	253	$4,897
Maryland	[2] 1,584	[2] 4,123	444	4,928	347	5,200
Massachusetts	765	5,500			373	2,170
New Hampshire	132	396	(3)	(3)		
North Carolina	2,981	23,838	1,807	11,460	1,535	7,045
Undistributed [4]	4,799	64,670	[2] 4,047	[2] 36,061	[2] 4,979	[2] 39,846
	13,156	121,289	[2] 7,851	[2] 69,103	[2] 7,487	[2] 59,158

[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] Partly estimated.
[3] Included under "Undistributed."
[4] 1930: Maine, New York, Washington, and Wisconsin; 1931: Arizona, New Hampshire, New York, Ohio, and Wisconsin; 1932: Arizona, New York, Ohio, and Wisconsin.

Following is a list of some recent producers and sellers of crude quartz:

Apex Engineering Co., 609 Rookery Building, Spokane, Wash.
Apex Quartz Co., Inc., St. Clair, Mo.
Canaan Feldspar Co., Fairlee, Vt.
P. Carmean, Le Grand, Calif.
Carolina Minerals Co., Spruce Pine, N.C.
Charlotte Chemical Laboratories, Inc., Charlotte, N.C.
Consolidated Feldspar Corporation, Trenton, N.J.
J. W. Cummings Feldspar Co., Bath, Maine.
Day Quartz Co., Sykesville, Md.
Eureka Flint & Spar Co., Trenton, N.J.
F. B. Fortner, Spruce Pine, N.C.
Golding-Keene Co., Keene, N.H.
C. L. Graber, 15701 Detroit Avenue, Lakewood, Ohio.
John T. Hanley, R.F.D., West Rumney, N.H.
Oscar Lauger, Escondido, Calif.
Minnesota Mining & Manufacturing Co., St. Paul, Minn.
W. H. O'Dell, Randallstown, Md.
Perris Mining Co., Perris, Calif.
Anthony Presente, Woodbury, Conn.
J. C. Pitman, Penland, N.C.
William Retallick, Roxbury Station, Conn.
C. L. Roesbery, Yermo, Calif.
H. P. Scheel Eversharp Pulp-Burr Co., 520 North G Street, Tacoma, Wash.
Galen Sparks, Spruce Pine, N.C.
Spicky Polish Corporation, 1401 Third Street, San Francisco, Calif.
N. M. Sweetser, 4235 Monroe Street, Los Angeles, Calif.
John Wallen, Marriottsville, Md.
George W. Wheatley, Moneta, Va.
Whitehall Co., Inc., 17 Battery Place, New York, N.Y.
W. M. Yox, Reisterstown, Md.

Following is a list of producers of "crushed" quartz:

Consolidated Feldspar Corporation, Trenton, N.J.
Day Quartz Co., Sykesville, Md.
Ohio Quartz Products Co., Jackson, Ohio.
Spicky Polish Corporation, 1401 Third Street, San Francisco, Calif.

Following is a list of manufacturers of ground quartz:

American Encaustic Tiling Co., Ltd., 2030 East Fifty-second Street, Los Angeles, Calif.
Behr-Manning Corporation, Troy, N.Y.
Charlotte Chemical Laboratories, Inc., Charlotte, N.C.
Consolidated Feldspar Corporation, Trenton, N.J

Eureka Flint & Spar Co., Trenton, N.J.
Harford Talc & Quartz Co., 4 Reckord Building, Towson, Md.
Mineral Milling Co., 1081 Richmond Street, Los Angeles, Calif.
Minnesota Mining & Manufacturing Co., St. Paul, Minn.
H. P. Scheel Eversharp Pulp-Burr Co., 520 North G Street, Tacoma, Wash.
Spicky Polish Corporation, 1401 Third Street, San Francisco, Calif.
Standard Flint & Spar Corporation, Trenton, N.J.

Ground sand and sandstone.—Production in the United States of ground sand and sandstone, known in some localities as silica flour, in 1932 declined 18 percent from that in 1931; the average value per ton decreased about 10 percent.

Commercially important 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.

Recent production data are shown in the following tables:

Ground sand and sandstone sold or used by producers in the United States, 1928–32 [1]

Year	Short tons	Value	Year	Short tons	Value
1928	280,402	$1,966,296	1931	183,880	$1,195,425
1929	302,139	2,039,144	1932	150,109	875,749
1930	241,947	1,566,815			

[1] Includes only finely ground material. Figures probably incomplete.

Ground sand and sandstone sold or used by producers in the United States, 1931 and 1932, by States [1]

	1931		1932	
	Short tons	Value	Short tons	Value
Illinois and Missouri	58,311	$349,560	42,400	$230,801
New Jersey	48,257	194,116	58,721	252,141
Ohio	18,633	146,922	(2)	(2)
Undistributed [3]	58,679	505,827	48,988	392,807
	183,880	1,196,425	150,109	875,749

[1] Includes only finely ground material. Figures probably incomplete.
[2] Included under "Undistributed."
[3] 1931: California, Delaware, Pennsylvania, West Virginia, and Wisconsin; 1932: California, Delaware, Ohio, Pennsylvania, West Virginia, and Wisconsin.

The following companies reported production of ground sand and sandstone in 1931 and 1932.

Cape Henlopen Sand Co., drawer 496, Lewes, Del.
Central Silica Co., Glass Rock, Ohio.
Del Monte Properties Co., 401 Crocker Building, San Francisco, Calif.
Eureka Flint & Spar Co., Trenton, N.J.
Michigan Quartz Silica Co., Milwaukee, Wis.
National Pulverizing Co., Millville, N.J.
National Silica Co., Oregon, Ill.
National Silica Works, Berkeley Springs, W.Va.
New Jersey Pulverizing Co., Millville, N.J.
Ottawa Silica Co., Ottawa, Ill.
Pennsylvania Glass Sand Co. (grinds in New Jersey, Pennsylvania, and West Virginia), Lewistown, Pa.

Pioneer Silica Products Co., Pacific, Mo.
Potters Mining & Milling Co., East Liverpool, Ohio.
Standard Flint & Spar Corporation, Trenton, N.J.
Standard Silica Co., 120 South La Salle 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.—In spite of the general depressed conditions and competition from artificial products, the output of grindstones and pulpstones declined only slightly in 1932 compared with that in 1931. The demand for pulpstones was at practically the same in 1932 as in 1931. Sales dropped 4 percent in tonnage, and the number of pieces sold was virtually the same as in 1931. The average value per ton, however, declined about 23 percent. Sales of grindstones in 1932 were 14 percent less in tonnage than in 1931, and the average value a ton was about 16 percent less.

Sandstone quarries in northeastern Ohio, western Virginia, eastern Michigan, and Pierce County, Wash., are the sources of the natural grindstones and pulpstones. Grindstones, in 1930 and 1931, were produced from quarries in Illinois, but they were not marketed by the producing companies.

The following 5-year table contrasts the present low level of production with that of the years immediately preceding:

Grindstones and pulpstones sold by producers in the United States, 1928–32

Year	Grindstones		Pulpstones		
	Short tons	Value	Pieces	Short tons	Value
1928	24,222	$606,408	2,461	9,016	$902,429
1929	21,071	617,618	1,834	6,665	623,928
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

The companies producing grindstones and pulpstones for commercial purposes in the United States in 1931–32, with the location of the quarries from which the stone was obtained, are as follows:

Briar Hill Stone Co., Glenmont, Ohio (grindstones). Quarry at Glenmont, Holmes County, Ohio.

Cleveland Quarries Co., Cleveland, Ohio (grindstones). Quarries at Amherst, Lorain County, Ohio; at Berea, Cuyahoga County, Ohio; at Grindstone City, Huron County, Mich.; and at Marietta, Washington County, Ohio.

Columbia Stone Co., Columbia Station, Ohio (grindstones). Quarry at Columbia Station, Lorain County, Ohio.

Constitution Stone Co., Constitution, Ohio (grindstones). Quarry at Constitution, Washington County, Ohio; and at Ravenswood, Jackson County, W.Va.

General Stone Co., Amherst, Ohio (pulpstones). Quarry at Opekiska, Monongalia County, W.Va.

Hall Grindstone Co., Marietta, Ohio (grindstones). Quarry at Marietta, Washington County, Ohio.

The International Pulpstone Co., Elyria, Ohio. Quarries in Jefferson and Columbiana Counties, Ohio; and Boone County, W.Va. Quarries idle, 1932. Sales of pulpstones from stock.

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., Marietta, Ohio (grindstones). Quarry at Marietta, Washington County, Ohio.

Smallwood-Low Stone Co., Fairmont, W.Va. (pulpstones). Quarry near Fairmont, Monongalia County, W.Va.

Smallwood Stone Co., Union Trust Building, Cleveland, Ohio (pulpstones). Quarries at Empire, Jefferson County, Ohio; and at Opekiska, Monongalia County, W.Va. No output in Ohio in 1932.

Uffington Stone Co., Uffington, W.Va. (pulpstones). Quarry 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 other whetstones, scythestones, rubbing stones, and similar products.—The group of special quarry products comprising small-size natural abrasive stones includes oilstones and other whetstones, hones, rubbing stones, and scythestones cut or otherwise shaped in a great variety of forms for the special uses indicated by their names.

In spite of the development of artificial abrasive products, natural stones are still popular for certain uses. The best natural material, though costly because of the high percentage of waste involved in the quarrying of select stones, is used for sharpening the fine edges of the tools of surgeons, engravers, wood and ivory carvers, and dentists. Other grades are used by many craftsmen in the wood and metal trades.

Oilstones are produced in the United States from novaculite quarried in Arkansas, other whetstones, chiefly from sandstone quarried in Indiana and Ohio, scythestones from sandstone quarried in Ohio and from schist quarried in Vermont, and rubbing stones from sandstone quarried in Indiana and Ohio.

Recent production data appears in the following table:

Oilstones and other whetstones, hones, scythestones, and rubbing stones sold by producers in the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	956	$228,245	1931	370	$81,951
1929	838	212,017	1932	331	63,960
1930	651	137,184			

The manufacturers of oilstones and other whetstones, scythestones, and rubbing stones from natural stone in 1931 and 1932, 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 Co., Belleville, Newark, N.J. (oilstones and whetstones). Has no quarries. Sometimes manufactures stone purchased in various localities. No production in 1932.

Chaillaux, J. A. Quarries at West Baden, Ind. Sells this stone to Norton Pike Co. Buys Arkansas and Ohio stone and manufactures it.

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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).

Pike Manufacturing Co., Pike, 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.; name now Norton Pike Co. Quarries owned are in Arkansas and Vermont. Stone from Ohio and Indiana is purchased.

Millstones.—The value of millstones, buhrstones, and related products, such as chasers and dragstones, sold in the United States in 1932, decreased only 16.5 percent from that in 1931. This decrease contrasts sharply with the decline in value in 1931 of 70 percent from the value in 1930.

The production of millstones (as shown by value) has decreased from a yearly average of $200,000 in the eighties to less than $5,000 in 1932. Two major slumps occurred, one between 1880 and 1900 and one between 1929 and 1931. It is interesting to note that the value of the production in 1900 was $32,858, whereas the average value for the 10 years between 1920 and 1930 was $33,921, and that the value in 1929 was still as high as $31,407. The real recession in the period since 1900 came during the last 3 years.

Only 7 operators reported production of millstones in 1932 compared with 20 in 1928. The number in New York State, which has been the chief source of production, dropped in the same period from 14 to 5. The other producing States in 1932 were North Carolina and Virginia. Since 1922, production occasionally has been recorded from Alabama, Maine, Minnesota, and New Hampshire.

Data regarding the production of millstones and related products are presented in the following table:

Value of millstones, chasers, and dragstones sold by producers in the United States, 1928–32

Year	New York		Other States [1]		Total	
	Producers	Value	Producers	Value	Producers	Value
1928	14	$26,224	6	$16,662	20	$42,886
1929	11	18,147	5	13,260	16	31,407
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

[1] 1928 and 1930: New Hampshire, North Carolina, and Virginia; 1929, 1931, and 1932: North Carolina and Virginia.

PEBBLES FOR GRINDING AND FLINT LINING FOR TUBE MILLS

The decline of 52 percent in the production of grinding pebbles and flint lining for tube mills in 1932 compared with 1931 is greater than the average decrease in output of the other abrasive materials. This loss in business may prove to be temporary, because siliceous pebbles and liners still are used in grinding operations where contamination by iron is to be avoided; however, steel balls have displaced flint pebbles extensively in ordinary work.

The commercial production in the United States of pebbles used for grinding minerals, ores, cement, and for other purposes, together with the output of quartzite blocks for tube-mill liners, includes, so far as is known to the Bureau of Mines, only the output of beach pebbles in southern California and of cut cubes and cut liners of quartzite in Minnesota. The figures in the following table appear to cover the entire commercial output, but doubtless additional production for local use or use by companies other than those reporting was unrecorded.

The following table contains production data for the past 5 years:

Pebbles for grinding and flint lining for tube mills sold or used by producers in the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	6,288	$89,321	1931	2,024	$26,211
1929	4,630	66,178	1932	976	13,070
1930	3,480	50,816			

GARNET AND EMERY

Garnet.—In 1932 the production of garnet decreased 62 percent from the 4-year average for 1928–31, compared with a decline of 51 percent in shipments of abrasive paper and cloth during the same period.

The bulk of the domestic garnet production is used by the abrasive paper and cloth industries. Garnet constituted 39 percent of the abrasives used in the manufacture of these products in 1919 but only 23 percent in 1930, whereas the quantity of artificial abradants so used increased from 20 to 46 percent. Some garnet is used for grinding plate glass where competition with emery and various grades of grinding and polishing sand exists.

According to price quotations the price of garnet has changed little during the last 3 years. Nevertheless, the average value of the mineral per ton, as reported to the Bureau of Mines for 1932, increased almost 15 percent from 1931, owing, no doubt, to the fact that a greater part of the sales were of higher-grade material.

New York, producing a quality of mineral recognized as standard, holds chief place in the output of abrasive garnet. New Hampshire ranks second. Other States in which deposits of past or future commercial importance are known to exist are Connecticut, Pennsylvania, North Carolina, Georgia, Virginia, Colorado, California, Idaho, Montana, Nevada, Arizona, Utah, and other Western States.

Total production of garnet for the past 5 years is listed in the following table:

Abrasive garnet sold or used by producers in the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	6,617	$459,307	1931	2,946	$193,015
1929	5,961	435,420	1932	1,950	147,350
1930	5,003	314,129			

The companies producing garnet in the United States in 1931 and 1932, with the location of the deposits from which the garnet was obtained, are as follows:

Barton Mines Corporation, North Creek, N.Y. Deposit at North Creek, Warren County, N.Y.

Ford Motor Co., Dearborn, Mich. Deposit at Danbury, Merrimack County, N.H.

Garnet Products Co., South Danbury, N.H. Deposit 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 in the metal trades, is being replaced extensively by artificial products. The value of the domestic production of emery declined 72 percent in 1932 from the yearly average for 1928–31. The slump in imports of emery, which far exceed domestic production, shows even more the effect of the substitution of artificial abrasives. In 1932 the value of imported emery ore was $5,524, a decrease of 92 percent from the average of $70,884 for the 4 preceding years.

The mineral corundum, a natural aluminum oxide surpassed in hardness only by the diamond, has been supplanted largely for abrasive use by synthetic products. No production of corundum in the United States has been recorded since 1918, but an appreciable tonnage is imported. The quantity of corundum ore imported during 1932, however, compared to the average for 1928–31, declined 93 percent, the value dropping to $8,258.

The following table gives the production of domestic emery for the past 5 years:

Emery sold or used by producers in the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	1,341	$16,787	1931	512	$5,557
1929	924	10,722	1932	250	2,781
1930	555	5,996			

The companies reporting sales of emery in the United States in 1931 and 1932, with the location of the deposits from which the material was obtained, are:

Keystone Emery Mills, 4329 Paul Street, Frankford, Philadelphia, Pa. Deposit near Peekskill, Westchester County, N.Y.

Smith & Ellis, Peekskill, N.Y. Deposit near Peekskill, Westchester County, N.Y.

ARTIFICIAL ABRASIVES

In 1931 the production of artificial abrasives was only slightly more than one half of that reported for 1930. In 1932 the production of silicon carbide was about 41 percent more than it was in 1931, although the production of the group as a whole declined 12.3 percent.

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 metallic abrasives are used chiefly in loose form as cutting agents in sawing or drilling rock and other hard materials.

A very important use of silicon carbide and aluminum oxide is in the manufacture of bonded abrasive wheels. The abrasive grains graded into uniform size are bonded together into wheels of varying degrees of coarseness and hardness. A fusible clay is used as the bonding material in vitrified grinding wheels. Sodium silicate, shellac, rubber, and bakelite also are employed as bonding materials. Much progress has been made in recent years in the development of highly efficient abrasive wheels, which are being used more and more as substitutes for natural abrasive products, such as emery wheels, grindstones, and pulpstones.

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.

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, 1928–32

Year	Silicon carbide		Aluminum oxide		Metallic abrasives		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1928	22,162	$2,286,518	59,103	$5,640,901	18,466	$904,629	99,731	$8,832,048
1929	30,309	3,060,401	72,614	6,471,373	23,789	1,289,922	126,712	10,821,696
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

MISCELLANEOUS ABRASIVE MATERIALS

In addition to the natural and artificial abrasives several other mineral products deserve mention. Detailed description of even the more important commodities, such as abrasive diamonds and abrasive sand, is not included, because the production of diamonds is not an important domestic industry, and the production of abrasive sand is included with related materials in the chapter on Sand and Gravel.

Abrasive diamonds.—The production of diamonds in the United States is limited to one locality. A number of gem and bort stones have been recovered in the course of exploration and development work on the property of the Arkansas Diamond Co., near Murfreesboro, Pike County, Ark., under the direction of John C. Peay. About 300 carats of gem stones and bort were produced in 1932. No details are available as to the value of the stones.

Imports of abrasive diamonds, which were valued at more than $4,000,000 in 1929, were only slightly over $1,000,000 in value in 1932, a decline of nearly 56 percent from the value of 1931.

Abrasive, or industrial, diamonds are of two types—the black diamond (or carbonado) and bort. The black diamond is reputed to be the hardest substance known, the claim being made that it is 3 percent harder than the gem diamond. It is lacking in cleavage, is opaque, and resembles a piece of lava or coal. Black diamonds are found chiefly in the State of Bahia (Brazil). The second variety (bort) consists of cull stones from the gem-diamond industry, most of which are obtained from South Africa. Unlike the black diamond, bort has a distinct cleavage. Although the diamond is extremely hard it is also brittle and is easily shattered if subjected to a sudden shock or blow.

Industrial diamonds are widely used in drill bits for rock drilling and boring. Black diamonds are generally used for this work, although bort bits having as many as 56 small diamonds set in the cutting face are cheaper and are coming into more extensive use.

Diamonds cut more quickly, are more durable, and can finish material with greater precision than steel. Diamond tools therefore are especially adapted for the production of large numbers of pieces of exact and uniform sizes. Diamond saws are used extensively for sawing rock, such as marble and limestone. Bort diamonds set and held in special tools are used for truing abrasive wheels, for cutting or machining hard rubber, rubber composition, paper rolls, bakelite, fiber, papier mâché, ivory, graphite, mica, brass, bronze, aluminum, and other metals, and for grinding cylinder walls. Perforated diamonds are used as dies through which to draw fine wire to accurate and uniform cross section. Although this use has decreased somewhat because of the substitution of special alloys, small diamond dies are still widely used, especially in connection with the radio industry. Small diamonds are used in many kinds of glaziers' tools. Fragments of bort are pulverized into diamond dust, which is used for cutting and polishing precious stones, as an abrasive for drilling diamonds to make diamond dies, and in sawing porcelain and similarly hard materials.

Abrasive sand.—Production data for grinding and polishing sand are included in the chapter on Sand and Gravel because much of such material is produced as a coproduct of glass sand and other special sands. Normally, 1,500,000 or more tons of sand, valued at about $2,000,000, are used for abrasive purposes.

Abrasive sand is used extensively in sawing and rubbing stone, such as granite, limestone, marble, slate, and soapstone. Both gang saws and wire saws employ sand as a cutting medium. "Chats" (tailings from the Joplin, Mo., lead-zinc district) are used to some extent in the Indiana limestone district as a substitute for sand. The particles, being mostly ground chert, are very angular and sharp and produce a surface desirable for certain types of work.

Abrasive sand is used also for removing surface inequalities in crude-rolled plate glass before grinding and polishing processes are applied; 2 or 3 tons of sand are required to grind 1 ton of plate glass. Carefully graded sand used for the second stage of grinding and for beveling glass has been displaced largely by artificial abrasives.

Sand propelled by compressed air has a strong abrading action and is so used to remove inequalities from rough castings, to clean paint from old surfaces, to clean or renovate stone and brick work, to cut glass, to prepare the surfaces of metal for electroplating or enameling, and to carve and engrave designs and inscriptions on monuments.

Other miscellaneous abrasives.—A number of other mineral products are used to some extent as abrading media, although their importance is relatively small. 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. Asbestos has been suggested as a polishing medium for silverware or other articles.

FOREIGN TRADE

Imports and exports.—The value of all abrasive materials imported for consumption in the United States in 1932 was $1,330,905, or about four and one half times that of material exported. Virtually 80 percent of the imports, however, were abrasive diamonds. Excluding abrasive diamonds, exports exceeded imports by $27,984 in 1932.

The following tables state the value of abrasive materials imported for consumption in the United States, 1928 to 1932; the quantity and value of abrasive materials imported for consumption in the United States, 1931 and 1932, by kinds; and the value of domestic abrasive materials exported from the United States, 1928 to 1932:

Value of abrasive materials imported for consumption in the United States, 1928–32

Material	1928	1929	1930	1931	1932
Millstones and burrstones	$6,354	$6,564	$7,050	$2,435	$1,794
Grindstones	114,874	119,264	66,677	39,171	14,196
Hones, oilstones, and whetstones	45,303	48,207	40,612	24,881	15,543
Emery and corundum	272,533	494,174	329,752	151,501	106,999
Garnet	115			149	356
Diatomaceous earth, tripoli, and rottenstone [1]	21,883	23,183	46,478	53,581	39,055
Pumice	159,430	143,944	94,387	77,168	51,062
Diamond:					
Dust and bort	31,222	89,363	90,945	20,292	12,860
Glaziers' and engravers', unset, and miners'	2,756,895	4,067,674	2,756,630	2,400,879	1,061,823
Flint, flints, and flint stones, unground	144,313	127,457	62,463	54,623	27,217

[1] Beginning June 18, 1930 classification reads "Tripoli and rottenstone."

Abrasive materials imported for consumption in the United States, 1931 and 1932, by kinds

Kind	1931 Quantity	1931 Value	1932 Quantity	1932 Value
Millstones and burrstones:				
Rough or unmanufactured ____ short tons	15	$1,332	2	$200
Bound up into millstones ____ do	15	1,103	18	1,594
Grindstones, finished or unfinished ____ do	640	39,171	310	14,196
Hones, oilstones, and whetstones ____ do	93	24,881	71	15,543
Emery:				
Ore ____ do	2,355	34,187	674	5,524
Grains, ground, pulverized, or refined ____ pounds	(1)	(1)	(1)	(1)
Paper and cloth of emery or corundum ____ do	(2)	33,910	(2)	60,054
Wheels, files, and other manufactures of which emery or corundum is the material of chief value ____ pounds	73,186	40,001	77,327	32,226
Corundum (see also "Emery"):				
Ore ____ short tons	716	37,039	188	8,258
Grains, ground, pulverized, or refined ____ pounds	[1] 125,933	[1] 6,364	[1] 21,348	[1] 937
Garnet in grains or ground, pulverized, etc ____ short tons	2	149	5	356
Diatomaceous earth, tripoli, and rottenstone [3] ____ do	4,088	53,581	2,098	39,055
Pumice:				
Crude or unmanufactured ____ do	6,548	59,152	4,438	35,464
Manufactures of, or of which pumice is the component material of chief value ____ short tons	(4)	18,016	(4)	15,598
Diamond:				
Bort ____ carats	1,075	17,849	962	12,460
Dust ____ pounds	(4)	2,443	(4)	400
Glaziers' and engravers', unset, and miners' ____ carats	224,970	2,400,879	163,704	1,061,823
Flint, flints, and flint stones, unground ____ short tons	6,291	54,623	3,755	27,217
	____	2,824,680	____	1,330,905

[1] Emery included with corundum; not separately classified.
[2] 6,389 reams in 1931 and 9,394 reams in 1932; weight not recorded.
[3] Beginning June 18, 1930 classification reads "Tripoli and rottenstone."
[4] Quantity not recorded.

Value of domestic abrasive materials exported from the United States, 1928–32

Material	1928	1929	1930	1931	1932
Grindstones	$560,975	$391,239	$246,512	$104,602	$85,528
Abrasive wheels, emery and other	254,493	286,360	203,371	115,076	64,069
All other natural abrasives, hones, whetstones, etc	453,055	423,363	361,055	232,196	147,469

Tariff.—Emery and corundum ore and crude artificial abrasives are on the free list in the Tariff Act of 1930 (par. 1672), whereas prepared garnet, emery, corundum, and artificial abrasives are dutiable under paragraph 1514, which reads as follows:

PAR. 1514. Emery, corundum, garnet, and artificial abrasives, in grains, or ground, pulverized, refined, or manufactured, 1 cent per pound; emery wheels, emery files, and manufactures of which emery, corundum, garnet, or artificial abrasive is the component material of chief value, not specially provided for; and all papers, cloths, and combinations of paper and cloth, wholly or partly coated with artificial or natural abrasives, or with a combination of natural and artificial abrasives; all the foregoing, 20 per centum ad valorem. Any of the foregoing, if containing more than one tenth of 1 per centum of vanadium, or more than two tenths of 1 per centum of tungsten, molybdenum, boron, tantalum, columbium or niobium, or uranium, or more than three tenths of 1 per centum of chromium, 60 per centum ad valorem.

Pumice stone also, by paragraph 206, is subject to import duty.

PAR. 206. Pumice stone, unmanufactured, valued at $15 or less per ton, one tenth of 1 cent per pound; valued at more than $15 per ton, one fourth of 1 cent per pound; wholly or partly manufactured, three fourths of 1 cent per pound; manufactures of pumice stone or of which pumice stone is the component material of chief value, not specially provided for, 35 per centum ad valorem.

The metallic abrasives likewise are dutiable under the Tariff Act of 1930, as follows:

PAR. 334. Steel wool, 10 cents per pound; steel shavings, 5 cents per pound; and in addition thereto, on all the foregoing, 30 per centum ad valorem.

PAR. 335. Grit shot, and sand of iron or steel; in any form, three fourths of 1 cent per pound.

The following abrasive materials are admitted free of duty under the act of 1930: Hones, whetstones, and grindstones (par. 1692); buhrstones, manufactured or bound into millstones (par. 1640); buhrstones in blocks (rough or unmanufactured), rottenstone, tripoli, sand (crude or unmanufactured), and silica (par. 1775); natural flint, flints, and flint stones, unground (par. 1679); diamonds (rough or uncut), glaziers' diamonds, engravers' diamonds, and miners' diamonds (par. 1668).

SULPHUR AND PYRITES

By R. H. Ridgway and A. W. Mitchell

A further decrease in the world consumption and market demand for sulphur was noted during the year. The decline, however, was in line with that in general industrial activity. World production of sulphur dropped substantially from that in 1931 due to curtailed operations by American producers. Despite the small increase in production and stocks in Italy, shipments exceeded production in the United States, resulting in the reduction of sulphur stocks in producers' hands.

The marketing agreement between the American exporters and the Sicilian Sulphur Consortium which had been in effect since 1923 was nullified by the dissolution of the consortium on July 31, 1932. The consortium's stock of sulphur, amounting to 200,000 metric tons, was taken over by the Bank of Sicily to avoid depressing the market. Although reports indicate some instability in the European markets, the price of sulphur as quoted by the domestic trade journals remained unchanged throughout the year.

Notwithstanding the drastic curtailment in American production, the United States remained by far the largest sulphur producer in the world. Italy, with a slightly increased production, was again the second largest producer, while Japan, the third largest producer, increased its output materially. Norway, a new producer, entered the market as a significant factor during the year. The Norwegian sulphur was extracted from pyrites. Increased production was noted from Chile and Netherland East Indies.

Spain continued to be the most important producer of pyrites in the world, while more stable labor conditions in Norway permitted a return to nearly normal production in that country.

In the United States the consumption of both sulphur and pyrites declined materially due to industrial inactivity. In the sulphur industry the year was characterized by curtailed production, decreased shipments (both domestic and export), decreased stocks, and a steadily maintained price. The following table outlines the principal features of the domestic situation during the last 2 years.

The progress of the sulphur and pyrites industries in the United States during the present century is shown in figures 76 and 77. Prior to 1900 the production of sulphur in this country was very small.

Salient statistics of the sulphur industry in the United States, 1931 and 1932

	1931	1932
Sulphur:		
Production of crude sulphur .... long tons	2,128,930	890,440
Shipments of crude sulphur:		
For domestic comsumption .... do	968,940	756,242
For export .... do	407,586	352,610
Total .... do	1,376,526	1,108,852
Exports of treated sulphur .... do	12,142	7,270
Producers' stocks at end of year .... do	3,249,669	3,031,257
Price of crude sulphur f.o.b. mines .... per long ton	$18	$18
Pyrites:		
Production .... long tons	330,848	186,485
Imports .... do	352,066	253,248
Exports .... do	26,604	
Price of imported pyrites c.i.f. Atlantic ports .... cents per long-ton unit	12-13	12-13
Sulphuric acid: Production of byproduct sulphuric acid at copper and zinc plants, 60° B .... short tons	862,729	600,334

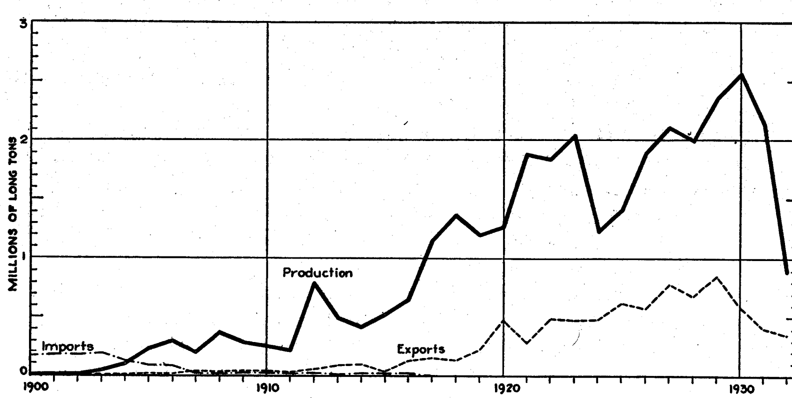

FIGURE 76.—Domestic production, exports, and imports of crude sulphur, 1900–1932.

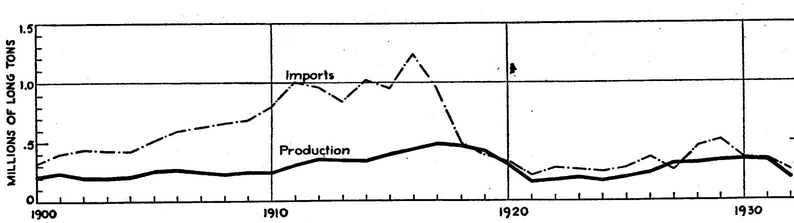

FIGURE 77.—Domestic production and imports of pyrites, 1900–1932.

SULPHUR

Domestic production.—The production of sulphur in the United States in 1932 totaled 890,440 long tons, a decrease of 1,238,490 tons (58 percent) from the preceding year. The curtailed production was borne by all the principal producers in the United States. Shipments decreased less than output and amounted to 1,108,852 tons valued at $20,000,000, compared with 1,376,526 tons valued at $24,800,000 in 1931, a decline of 19 percent in both quantity and value; they were the smallest recorded since 1921. Shipments exceeded production for the first time since 1929; consequently, stocks at the mines decreased.

Such stocks amounted to 3,031,257 tons at the end of the year, or 218,412 tons below the record reserve at the close of 1931.

The average quoted price for sulphur as reported by the trade journals was unchanged at $18 a ton f.o.b. mines throughout the year. Open prices were $1 to $3 a ton higher, and prices for sulphur exported were given as $22 a ton f.a.s. Atlantic ports.

The following table records American sulphur production from 1928 to 1932.

Sulphur produced and shipped in the United States, 1928–32

Year	Produced (long tons)	Shipped		Year	Produced (long tons)	Shipped	
		Long tons	Approximate value			Long tons	Approximate value
1928	1,981,873	2,082,924	$37,500,000	1931	2,128,930	1,376,526	$24,800,000
1929	2,362,389	2,437,238	43,800,000	1932	890,440	1,108,852	20,000,000
1930	2,558,981	1,989,917	35,800,000				

The bulk of the domestic sulphur reported for 1932 came from Texas, but two other States—Louisiana and California—reported production in 1932 for the first time in a number of years. One Colorado producer mined 100 tons of sulphur material containing 45 percent sulphur, of which 27 tons were shipped. This material, however, is not included in the sulphur production or shipment figures for the United States.

The following table lists the sulphur mines operating in the United States in 1932.

Sulphur mines operating in the United States in 1932

Operating company	Name of mine	Location of mine
Sanger & Albertoli	Crater	Bigpine, Inyo County, Calif.
T. N. Wade	Gulch Group	Do.
Jefferson Lake Oil Co., Inc.	Lake Peigneur	Lake Peigneur, Iberia Parish, 8 miles from East Abbeville, Vermilion Parish, La.
Texas Gulf Sulphur Co.	Long Point Dome	Long Point, Fort Bend County, Tex.
Do.	Big Hill Dome	Gulf, Matagorda County, Tex.
Do.	Boling Dome	Newgulf, Wharton County, Tex.
Freeport Sulphur Co.	Bryan Mound	Freeport, Brazoria County, Tex.
Do.	Hoskins Mound	Do.
Duval Texas Sulphur Co.	Palangana Dome	Benavides, Duval County, Tex.

Byproduct sulphur.—A large quantity of sulphur is recovered each year as a byproduct from copper- and zinc-mining operations. This sulphur is recovered in the form of sulphuric acid and is not included in the sulphur-production figures for the United States.

Concentration of some copper and zinc ores yields, in addition to copper and zinc concentrates, a pyrites concentrate which is an important source of sulphur. The production of this commodity is discussed under the pyrites section of this report. In the smelting of copper and zinc concentrates the sulphur content is driven off in the form of sulphur dioxide gas, which is used in the manufacture of sulphuric acid at many smelters. Approximately 220,000 tons of sulphur have been recovered annually during the 5 years ended in 1931.

Figures for the production of sulphuric acid as a byproduct at smelting plants during the last 5 years follow. The table gives the output at both copper and zinc plants and comprises virtually all of the byproduct acid produced in the United States. At many plants in the zinc industry, the SO_2 content of the gas from the roasters is raised by burning sulphur; the acid reported in the following table, however, is only that made from the sulphur content of the sulphide ores. The figures also include the sulphuric acid made from the pyrites concentrates in Tennessee and Wisconsin.

Byproduct sulphuric acid (expressed as 60° B.) produced at copper and zinc plants in the United States, 1928–32, in short tons

	1928	1929	1930	1931	1932
Copper plants	603, 100	633, 438	651, 702	436, 111	258, 994
Zinc plants	558, 537	627, 018	536, 614	426, 618	341, 340
	1, 161, 637	1, 260, 456	1, 188, 316	862, 729	600, 334

There is also a small annual production (2,500 tons) of byproduct sulphur resulting from the purification of manufactured fuel gas. Only part of the output is marketed; the remainder accumulates in dumps at various plants. This output is not included in the total sulphur production of the United States.

Consumption.—The apparent consumption of sulphur during the year was lower than in 1931, but the decline was not as pronounced as in the preceding year. The basic nature of the use of sulphur in diversified industries serves to preserve a minimum consumption commensurate with the general rate of business activity. The market for sulphur was slow throughout the year.

The trend of sulphur consumption in the United States for the last 5 years is shown in the following table, in which it is assumed that stocks in consumers' hands are small and constant.

Apparent consumption of sulphur in the United States, 1928–32, in long tons

	1928	1929	1930	1931	1932
Shipments	2, 082, 924	2, 437, 238	1, 989, 917	1, 376, 526	1, 108, 852
Imports	4, 787	1, 163	29		
	2, 087, 711	2, 438, 401	1, 989, 946	1, 376, 526	1, 108, 852
Exports (crude)	685, 051	855, 183	593, 312	407, 586	352, 610
Exports (refined)	19, 882	17, 663	16, 014	12, 142	7, 270
	704, 933	872, 846	609, 326	419, 728	359, 880
Apparent consumption	1, 382, 778	1, 565, 555	1, 380, 620	956, 798	748, 972

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, 1928–32, by uses, in long tons

Use	1928	1929	1930	1931	1932
Heavy chemicals	520,000	560,000	471,000	327,000	298,000
Fertilizer and insecticides	345,000	415,000	418,000	254,000	155,000
Pulp and paper	250,000	265,000	235,000	178,000	153,000
Explosives	60,000	67,000	48,000	39,000	27,000
Dyes and coal-tar products	42,000	47,000	41,000	39,000	34,000
Rubber	40,000	43,000	31,000	23,000	18,000
Electrochemicals	21,000	23,000	20,000	16,000	13,000
Fine chemicals	14,000	15,000	13,000	12,000	10,000
Paint and varnish	5,000	5,000	4,500	4,000	4,000
Food products	5,000	5,000	4,500	4,700	4,000
Miscellaneous	124,000	136,700	110,600	72,000	40,000
	1,426,000	1,581,700	1,396,600	968,700	756,000

The production of sulphuric acid, the chief use of sulphur in the United States, decreased materially in 1932, due mainly to the large drop in the consumption of acid in the fertilizer, iron and steel, and coal-products industries. Consumption in the rayon and textile industries held up well during the year. The following table, which shows the consumption of sulphuric acid by industries from 1928–32, is based largely on estimates by Chemical and Metallurgical Engineering. The figures on acid consumed in the fertilizer industry are those given by the Bureau of the Census.

Sulphuric acid (expressed as 50° B.) consumed in the United States, 1928–32, by industries, in short tons [1]

Industry	1928	1929	1930	1931	1932
Fertilizer [2]	2,474,000	2,446,000	2,477,000	1,351,000	771,000
Petroleum refining	1,350,000	1,570,000	1,420,000	1,348,000	1,240,000
Chemicals	745,000	890,000	820,000	760,000	655,000
Coal products	740,000	935,000	800,000	570,000	365,000
Iron and steel	670,000	800,000	660,000	480,000	260,000
Other metallurgical	570,000	675,000	560,000	410,000	300,000
Paints and pigments	205,000	225,000	200,000	180,000	160,000
Explosives	170,000	195,000	177,000	175,000	120,000
Rayon and cellulose film	[3] 105,000	[3] 150,000	145,000	175,000	155,000
Textiles	78,000	90,000	78,000	81,000	75,000
Miscellaneous	292,000	390,000	330,000	270,000	220,000
	7,399,000	8,366,000	7,667,000	5,800,000	4,321,000

[1] Figures, except those for the fertilizer industry, from Chem. and Met. Eng., January 1933, p. 32, and from earlier annual review issues.
[2] Bureau of the Census, Department of Commerce.
[3] Reported as rayon only.

Foreign trade.—The imports of sulphur into the United States reached a peak of nearly 189,000 long tons in 1903. With the rapid increase in American production, however, imports have declined and since 1917 have been of little consequence. No imports of "sulphur or sulphur ore" were reported for 1931 and 1932.

The export business in American crude sulphur was started in 1904, when a cargo of 3,000 long tons was shipped from Louisiana. Exports in 1932 declined to 352,610 tons compared with 407,586 tons in 1931, a decrease of over 13 percent.

The following table shows the sulphur imported into and exported from the United States from 1928 to 1932.

Sulphur exported from and imported into the United States, 1928–32

Year	Imports for consumption [1]		Exports			
			Crude		Crushed, ground, refined, sublimed, and flowers of	
	Long tons	Value	Long tons	Value	Long tons	Value
1928	4,787	$21,320	685,051	$14,345,075	19,882	$706,766
1929	1,163	6,616	855,183	17,628,813	17,663	649,240
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

[1] Classified as "sulphur and sulphur ore."

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 1932 were 16,285,095 pounds, valued at $266,210, a decrease of 10,912,604 pounds (40 percent) from the total in 1931. The average value in 1932 was 1.63 cents a pound or about $36 per long ton.

Exports to all countries that receive important quantities of American crude sulphur, except Australia and New Zealand, decreased in 1932. The most notable drop among the large consumers of crude sulphur was in shipments to Germany, which were only 31,275 tons in 1932 compared with 82,218 tons in 1931 (a decline of 62 percent). During the 5-year period 1927 to 1931 Germany has received on an average nearly 135,000 tons of American crude sulphur annually. The 1932 slump does not necessarily reflect the condition of the German sulphur-consuming industries, because German ports are often utilized in the trade as transfer points for sulphur consigned to other European countries. This trade may have decreased due to lessened demand by the minor consuming countries and to increased exports of sulphur to some of these countries from Norway. Other factors that affected the imports of sulphur into Germany from the United States were increased imports from other countries, increased domestic production of sulphur as a byproduct in the processing industries, and the use of substitutes for sulphur.

Exports to Australia in 1932 increased 185 percent over those in 1931, and exports to New Zealand increased 97 percent in 1932. Canada was again the best customer for American crude sulphur, taking 95,800 tons (27 percent of the total exports) compared with 111,958 tons in 1931.

In 1932 Canada was also the largest importer of American treated sulphur, taking 4,800,282 pounds (29 percent of the total); Australia ranked second with 2,458,844 pounds (15 percent). Mexico, United Kingdom, and Brazil followed in order, each requiring more than 1,000,000 pounds in 1932. The exports of treated sulphur to Germany like those of crude sulphur decreased sharply in 1932.

The following table shows the exports of crude sulphur and treated sulphur from the United States in 1932 by countries of destination:

Sulphur exported from the United States in 1932, by destinations

Destination	Sulphur or brimstone		Crushed, ground, refined, sublimed, and flowers of	
	Long tons	Value	Pounds	Value
North America:				
Canada	95,800	$1,727,492	4,800,282	$89,457
Central America	146	4,860	119,415	3,048
Mexico	6,326	137,846	1,469,069	26,475
Newfoundland and Labrador	4,932	91,006	406	13
West Indies and Bermudas	6,306	138,808	94,395	3,143
	113,510	2,100,012	6,483,567	122,136
South America:				
Argentina	5,900	123,500	133,915	3,117
Brazil	2,290	47,836	1,131,117	14,970
Colombia			152,186	3,758
Uruguay			560,000	6,874
Other	143	3,604	130,439	2,414
	8,333	174,940	2,107,657	31,133
Europe:				
Belgium	1,607	36,720	206,875	2,456
France	60,591	1,309,366	267,600	3,958
Germany	31,275	721,016	707,259	8,992
Netherlands	13,959	312,861	254,539	2,976
Spain	4,252	97,941		
United Kingdom	18,129	392,087	1,168,437	15,010
Other			625,604	9,144
	129,813	2,869,991	3,230,314	42,536
Asia	2,555	50,625	1,097,735	16,280
Africa:				
Algeria and Tunisia	3,936	89,272		
Canary Islands			377,900	6,871
Mozambique			95,000	1,610
Union of South Africa			317,358	5,748
Other			40,060	777
	3,936	89,272	830,318	15,006
Oceania:				
Australia	60,809	1,216,989	2,458,844	37,668
New Zealand	33,654	676,737	76,660	1,451
	94,463	1,893,726	2,535,504	39,119
	352,610	7,178,566	16,285,095	266,210

INDUSTRY IN 1932, BY STATES

TEXAS

The bulk of the output in 1932 was mined in Texas, and virtually all of the production in recent years has come from this State. The progressive curtailment of sulphur production in Texas during 1932 is shown in the following table, compiled from information issued by the Texas State comptroller's office.

Sulphur produced in Texas in 1932, by companies, in long tons

Company	First quarter	Second quarter	Third quarter	Fourth quarter	Total
Texas Gulf Sulphur Co.	168,652	154,223	129,124	116,019	568,018
Freeport Sulphur Co.	79,090	82,525	57,795	65,920	285,330
Duval Texas Sulphur Co.	3,168	5,210	7,552	6,669	22,599
	250,910	241,958	194,471	188,608	875,947

Texas Gulf Sulphur Co.—This company operated its Boling Dome property at Newgulf, Wharton County, throughout the year on a reduced basis, while the older property at Gulf, Matagorda County, was shut down in September after continuous production since 1919. The smaller property at Longpoint, Fort Bend County, maintained normal production during the year. No shipments were made from the latter property.

Freeport Sulphur Co.—Production was continued at the two plants of this company throughout the year but at a reduced rate. Due to depletion of reserves at Bryan Mound, which has been in production since 1912, this company has been very active in its endeavor to locate new deposits. Prospecting during the year has developed an important sulphur deposit on the Grande Ecaille Dome, Plaquemines Parish, southern Louisiana. The property is on marsh land about 50 miles south of New Orleans and 10 miles west of the Mississippi River on the west bank of which are a railroad and a highway. Plans for construction of a plant and development of the property, estimated to cost $3,000,000, are under way. A canal is being dredged from the river, and shipments will be made in this canal from the mines to the river, where facilities can be constructed for loading the sulphur into ocean-going vessels, river barges, or railroad cars. Production and shipments are expected to begin early in 1934. The problems arising in the construction and operation of a sulphur-producing plant situated on the marsh lands characteristic of southern Louisiana have been pointed out by Pollard.[1]

Duval Texas Sulphur Co.—Sulphur was produced at a reduced rate by this company at Palangana Dome, Duval County. The company is a small producer having an installed boiler capacity rated at 2,200 horsepower.

LOUISIANA

Jefferson Lake Oil Co.—The property of the Jefferson Lake Oil Co. in Iberia Parish, La., was put into operation in the latter part of October. A production of 13,401 long tons was reported by this company, but no shipments were made.

The sulphur occurs in the cap rock of a dome beneath the bed of Lake Peigneur and has been drilled from piers and a steel drilling barge. The sulphur is mined by the Frasch process. The plant, which was constructed during 1932, has a boiler rated at 1,800 horsepower; the buildings are fireproof throughout. The water supply is obtained from a deep well equipped with an electrically driven pump which has a capacity of a million gallons per day and which discharges into a large fresh-water reservoir of 50,000,000 gallons capacity. Orders for additional boilers and other equipment were placed early in 1933.

Other operations.—Prospecting for sulphur in the Gulf Coast belt of Louisiana and Texas continued in 1932. During the year the States Production, Inc., abandoned prospecting operations at Donner Dome in La Fourche Parish. Several salt domes in the tidewater marsh section of Louisiana were investigated, and at least one was proved to contain sulphur in commercial quantities—the Grand Ecaille Dome in Plaquemines Parish developed by the Freeport Sulphur Co. (See Texas.)

[1] Pollard, J. H., Looking Forward in Sulphur Mining Chem. and Met. Eng., vol. 39, no. 7, July 1932, p. 394.

A State constitutional amendment adopted by the voters at the November elections provides that there shall be no ad valorem taxes levied on sulphur deposits in the State. The severance tax on sulphur, however, was fixed by the legislature at 27 cents per long ton.

CALIFORNIA

Production of sulphur in California was reported for the first time in a number of years. The output amounted to 745 tons and came from two producers in Inyo County. The larger producer, known as the Crater Group, started work on the property last October, and production came entirely from development. The mine-run sulphur which was shipped averaged 97 percent and was used mostly for experimental and test work.

During the year it was reported that the United Verde Extension Mining Co. was developing under option a sulphur deposit at the Leviathan mine in an old crater 40 miles south of Lake Tahoe, Alpine County.

UTAH

No production of sulphur was reported from Utah in 1932. During the past year the Utah Sulphur Industries has been installing new equipment and making other improvements at its properties at Sulphurdale, Beaver County. The sulphur deposit occurs in the crater of an old volcano, and sulphur is recovered from the ore by flotation. Thoenen [2] has estimated the cost of 85 percent sulphur concentrates at Sulphurdale as $7 to $12.90 per short ton. The company expects to start production and shipments early in 1933.

COLORADO

A small quantity of sulphur-bearing material was produced by the P. T. & S. Chemical Co. near Austin, Delta County. The material, which contains 45 percent sulphur, is dug from opencuts by hand and sold to farmers in the vicinity as a fertilizer.

NEW MEXICO

In 1932 an act was passed which was designed to extend the development of sulphur on the public domain in New Mexico. The act was an amendment to that entitled "An act to promote the production of sulphur upon the public domain within the State of Louisiana", which was approved April 17, 1926. The measure provides for a prospecting permit and later a leasing permit at a certain royalty on the value of the sulphur output.

WORLD PRODUCTION

The World production of sulphur in 1932 is estimated at 1,400,000 long tons, a decline of 1,170,000 tons from the preceding year. The following table shows the production of sulphur in the principal producing countries during the last 5 years.

[2] Thoenen, J. R., Economics of Potash Recovery from Wyomingite and Alunite: Rept. of Investigations 3190, Bureau of Mines, November 1932, p. 9.

Production of sulphur in the principal producing countries, 1928–32, in long tons

Year	United States (sulphur)	Italy		Japan		Chile (sulphur)	Spain (sulphur)
		Sulphur	Ore	Sulphur	Ore		
1928	1,981,873	291,430	31,051	68,956	13,109	15,423	10,199
1929	2,362,389	318,722	21,149	64,430	14,849	16,043	11,715
1930	2,558,981	345,026	19,409	61,375	14,392	18,184	11,557
1931	2,128,930	348,132	19,502	59,469	(1)	5,018	10,867
1932	890,440	350,264	17,717	75,868	(1)	[2] 9,000	[2] 10,000

[1] Data not available. [2] Estimate.

ITALY

The production of sulphur in Italy in 1932 totaled 350,264 long tons, an increase of 2,132 tons over that in 1931 and the largest output since 1915. It is estimated that the mines on the Continent produced 114,600 tons, while those on the Island of Sicily contributed the remaining 235,664 tons. Besides the crude sulphur listed above, which contains 2 to 11 percent impurities, Italy also produces ground crude-sulphur ore, which is used in agriculture. In 1932, Italy produced 17,717 tons of this ground ore compared with 19,502 tons in 1931.

During 1932 Italian sulphur producers again were faced with the problem of overproduction. The decreased consumption due to general industrial conditions and the unrestricted production and exports from mainland producers, chiefly the Montecatini Co., caused serious difficulties among the Sicilian producers. The production, sales, and exports of the continental mines were not controlled by the Consortium, which had an agreement with the American exporters permitting a total export for all Italian raw sulphur. When the agreement between the Sicilian Sulphur Consortium and the American exporters was consummated annual production on the continent was about 40,000 tons, while exports from this group were nil. With the rise of the sulphur industry on the mainland, production increased to 100,000 tons in 1931, while exports amounted to nearly 60,000 tons. For the Sicilian industry to maintain its market agreement with the Americans it was forced to decrease its exports directly by quantities exported from the mainland. The large number of small independent mines in Sicily makes restriction of production difficult, particularly since the enactment of recent legislation restricting licenses and dispossessing royalty holders. After the failure of several attempts during the last few years to extend the Consortium to include the mainland output, the Sicilian producers applied for its dissolution, which was granted, effective July 31, 1932. The stock of nearly 200,000 tons of sulphur on hand at the time of dissolution was taken over by the Bank of Sicily for liquidation over 6 years to avoid depressing the market. After dissolution of the Consortium the Sicilian producers lacked organization, and it was reported that many mines had closed. Late in 1932 negotiations were in progress between the American and Italian sulphur interests with a view to the consummation of a new agreement. However, it was necessary for the Italian industry to present a unified front through some sort of commercial integration. Accordingly the Premier presented the

Italian Parliament a new bill, dated November 23, 1932, which provided:

1. Disciplinary action through the formation of a special national sulphur consortium.
2. Prohibition of grinding raw sulphur ore with certain allowances for concerns already grinding raw sulphur ore.

The production of sulphur in Sicily during the fiscal year ended July 31, 1932 was 257,509 long tons, an increase of 12,155 tons over the preceding fiscal year. Of the total production 38,422 tons were superior yellow, 110,626 tons inferior yellow, 81,392 tons good thirds, 25,670 common thirds, and 1,399 tons dark common thirds. Improvements in melting methods are increasing production of the better grades of yellow. Exports of sulphur from Sicily during the fiscal year totaled 183,576 tons, of which 33,302 tons were refined sulphur, compared with 195,407 tons of which 50,138 were refined sulphur, during the preceding fiscal year.

JAPAN

Preliminary figures indicate a production of 75,868 long tons of sulphur in Japan during 1932 compared with 59,469 tons in 1931. Most of the Japanese sulphur comes from the Island of Hokkaido.

Exports of sulphur from Japan were 25,589 tons in 1932, or nearly double the 13,966 tons exported in 1931. Exports in 1932 went principally to New Zealand, China, and Hong Kong.

SPAIN

Spain's output of sulphur, which was estimated at 10,000 long tons in 1932, does not fill its own requirements. The bulk of the sulphur mined in Spain comes from Teruel, Murcia, and Albacete. Smaller quantities of sulphur come from the mines in Almeria where the Tigon Mining & Finance Corporation, Ltd., is operating.

CHILE

Figures for the 1932 production of sulphur in Chile are not available, but it is estimated that the output was 9,000 long tons compared with 5,018 tons in 1931. The closing of the nitrate plants and the disturbed domestic agricultural conditions were responsible for curtailment of consumption in the domestic market, previously the principal outlet. The difficulties facing the sulphur producers and the limited extent of the domestic sulphur market prompted the passing of a new law (no. 5108), effective April 20, 1932, which authorizes the payment of 100 pesos per metric ton of refined sulphur and 30 pesos per ton of sulphur ore exported. Previously the Government had helped the industry by loans through the Mining Credit Bureau. Exchange conditions favored the entrance of sulphur into the world markets, as sulphur may now be mined and refined at a much lower price than was possible when exchange was relatively stable. Exports of sulphur from Chile were 9,407 metric tons in 1932 compared with 4,091 tons in 1931. About half the exports went to Latin America, while the other half went to Europe.

NORWAY

In 1932 Norway started producing sulphur on a commercial scale. The sulphur was produced in the treatment of pyrites. (See p. 685.)

OTHER COUNTRIES

Less important quantities of sulphur are produced in China, Netherland East Indies, Greece, New Zealand, Russia, Southern Rhodesia, Mexico, and elsewhere in regions of volcanic activity. Perhaps the most important producer of this group is China, with an output of 5,000 to 10,000 long tons per year. According to preliminary reports the output of Netherland East Indies increased to 7,578 long tons compared with 1,788 tons in 1931. Mexico has a small annual production, chiefly from San Luis Potosi and Lower California. During the year exploration for sulphur was carried on at Tamaulipas, where deposits similar to those of the Gulf coast region are reported to exist. Activities in sulphur exploration are also reported from Nicaragua and New Guinea.

PYRITES

Domestic production.—The production of pyrites (ores and concentrates) amounted to 186,485 long tons in 1932, a decrease of 44 percent from the production of 330,848 tons in 1931. The following table gives the production of pyrites (ores and concentrates) in the United States during the last 5 years.

Pyrites produced in the United States, 1928–32

Year	Quantity		Value	Year	Quantity		Value
	Gross weight (long tons)	Sulphur content (percent)			Gross weight (long tons)	Sulphur content (percent)	
1928	312,815	36.2	$1,081,758	1931	330,848	36.7	$974,820
1929	333,465	36.1	1,250,141	1932	186,485	34.8	492,043
1930	347,512	35.7	1,028,680				

Of the total production in 1932, 78,582 long tons were lump and the remainder fines, the bulk of the latter being in the form of flotation concentrates. The sulphur content of the pyrites produced was 34.8 percent (64,826 tons of sulphur) compared with 36.7 percent (121,503 tons) in 1931.

The quantity of pyrites (ores or concentrates) sold or consumed by the producing companies totaled 185,654 long tons compared with 330,145 tons in 1931. In 1932 only 29,936 tons were sold, all of which went 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 price was 12 to 13 cents per long-ton unit throughout the year.

Tennessee was the largest producing State in 1932. Other States producing pyrites in 1932 were California, Colorado, Missouri, New York, Virginia, and Wisconsin. Colorado and Missouri reported production for the first time in a number of years.

REVIEW OF PRODUCTION, BY STATES

Tennessee.—The production of pyrites in Tennessee in 1932 came from the operations of the Tennessee Copper Co. and the Ducktown Chemical & Iron Co., both in the Ducktown Basin, Polk County.

The Tennesse Copper Co., a subsidiary of the Tennessee Corporation, operated the Burra Burra and Eureka mines in 1932. The concentrating plant is equipped with a 900-ton flotation mill where pyrites is produced as a flotation concentrate containing pyrrhotite and pyrite. The pyrite and pyrrhotite concentrates are roasted at the smelter, and the SO_2 gas evolved is mixed with gases from the copper blast furnace and converter and conducted to chamber acid plants where it is converted into sulphuric acid. The Tennessee Corporation has curtailed operations at its acid plant pending betterment of the fertilizer market, the chief outlet for the acid.

The production of pyrites by the Ducktown Chemical & Iron Co. comes from the mill at the Isabella mine where a pyrite concentrate and a pyrrhotite concentrate are made by selective flotation. An iron concentrate of a third type is made with a Dings magnetic separator. The three types of iron concentrates are mixed and sent to the roasters. The Mary mine, the old producing property of this company, was abandoned in April 1931.

The pyrites mined in Tennessee does not enter the market, as both companies use all of their product in the manufacture of sulphuric acid.

Virginia.—The only pyrites produced in Virginia in 1932 came from the Gossan mine at Cliffview, Carroll County. The mine, which produces both lump and fines, is operated by the General Chemical Co. The ore which is mined by opencut and underground methods is used for the manufacture of sulphuric acid at the company plant at Pulaski.

California.—The Leona Chemical Co., Ltd., was the only company producing pyrites in California in 1932, but shipments were made from stock by the Mountain Copper Co., Ltd.

The Leona Heights mine, operated by the Leona Chemical Co., Ltd., is within the municipal limits of Oakland, Alameda County. The ore, which is lump ore, contains about 47 percent sulphur and carries $1 to $2 per ton in gold and about 1 percent copper. After crushing, the ore is shipped to the Stege plant of the Stauffer Chemical Co. where it is roasted for the manufacture of sulphuric acid. The sintered material is then leached for the recovery of some of its metal content.

There was no production from the Hornet mine of the Mountain Copper Co., Ltd., during 1932, but shipments were made from the reserve stock pile. The mine, which is located in Shasta County, was closed down most of the year but is expected to reopen early in 1933. The pyrites is roasted in the company plant at Martinez and at other chemical plants for the manufacture of acid. The small percentage of copper from the sintered pyrites is recovered at the company leaching plant.

New York.—During 1932 the St. Joseph Lead Co. produced 16,871 long tons of pyrites concentrates at its Balmat mine, St. Lawrence County. The pyrites was produced as a flotation concentrate in the treatment of ore in which zinc is the principal value.

Mining at the Balmat mine is chiefly by open stopes with pillars, with some production from shrinkage stopes. Knaebel[3] has described the mining methods at the nearby Edwards mine, of the same company, which are similar to those used at the Balmat.

The ore is treated in an all-flotation mill designed to handle 500 tons per day. Three kinds of concentrates are made by selective flotation in the order named: Lead, zinc, and pyrites. During 1932 the pyrites averaged better than 51 percent sulphur. The mill has been described by Knaebel.[4]

Wisconsin.—The only company reporting pyrites production in Wisconsin in 1932 was the Vinegar Hill Zinc Co., which merged with the National Zinc Separating Co. in 1932. The company makes a pyrites concentrate at its magnetic separation plant at Cuba City from raw zinc concentrates, obtained from several mines in the Platteville district. The roasting plant and the magnetic separating plant were operated at a reduced rate during the year.

Missouri.—The Evans-Wallower Lead Co. produced 3,958 long tons of pyrites at its Rueppele mine near Sullivan, Franklin County, in 1932, the first production recorded for Missouri since 1920. The ore, which is predominantly marcasite, is shipped to the company plant in East St. Louis, Ill., where it is roasted; the SO_2 gas is sold to the Monsanto Chemical Co., which manufactures sulphuric acid in an adjoining plant.

Colorado.—W. E. Bowden reports shipments of 1,496 long tons of pyrites in 1932 from the mill-tailings dump of the Colorado Zinc Lead Mill in Lake County. The pyrites, which averages 39 percent sulphur, was shipped to the Denver plant of the General Chemical Co., where it was used for the manufacture of sulphuric acid. This is the first production reported from Colorado for a number of years.

FOREIGN TRADE

The imports of pyrites in 1932 amounted to 253,248 long tons compared with 352,066 tons in 1931, a decrease of 28 percent. The following table shows the imports of pyrites from 1928 to 1932.

Pyrites or sulphide of iron, containing more than 25 percent sulphur, imported into the United States, 1928–32, by sources

[General imports]

Country	1928		1929		1930		1931		1932	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
Canada	56,956	$192,864	68,243	$240,411	42,117	$145,645	24,245	$109,440	12,070	$53,618
Norway	7,468	15,611								
Soviet Russia in Europe					5	20	50	300		
Spain	393,840	932,261	446,093	1,267,237	325,992	891,352	327,771	1,386,457	241,178	637,526
	458,264	1,140,736	514,336	1,507,648	368,114	1,037,017	352,066	1,496,197	253,248	691,144

The customs districts into which pyrites has been imported during the last 5 years are shown in the following table:

[3] Knaebel, J. B., Mining Practice at the Edwards Mine of the St. Joseph Lead Co., St. Lawrence County, N.Y.: Inf. Circ. 6586, Bureau of Mines, 1932, pp. 1-25.

[4] Knaebel, J. B., Milling Methods at the Balmat Mill of the St. Joseph Lead Co., Balmat, St. Lawrence County, N.Y.: Inf. Circ. 6574, Bureau of Mines, 1932, pp. 1-28.

Pyrites or sulphide of iron, containing more than 25 percent sulphur, imported into the United States, 1928–32, by customs districts, in long tons

Customs district	1928	1929	1930	1931	1932
Buffalo	120	413	90	114	----------
Chicago	28	----------	----------	----------	----------
Georgia	5,915	----------	5,554	5,628	----------
Maine and New Hampshire	----------	25,751	----------	----------	----------
Maryland	140,090	182,249	175,611	125,559	100,434
Massachusetts	14,907	----------	----------	----------	----------
New York	70,231	54,331	42,145	55,225	33,596
Philadelphia	153,644	166,056	87,178	128,650	95,640
San Francisco	50,147	52,514	7,990	----------	----------
South Carolina	11,792	5,696	7,322	5,053	4,008
Vermont	6,554	17,326	19,591	24,131	12,070
Virginia	4,729	10,000	8,187	7,706	7,500
Washington	107	----------	14,446	----------	----------
	458,264	514,336	368,114	352,066	253,248

Considering the recoverable sulphur content of the imported pyrites as 45 percent, the quantity of sulphur available in imported pyrites was 113,962 long tons.

WORLD PRODUCTION

The following table shows the world production of pyrites and the quantity of sulphur it is supposed to replace in the market. Most of the figures are taken from the 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), 1928–32, in metric tons

Country [1]	1928	1929	1930	1931	1932
Algeria:					
Gross weight	13,825	16,804	16,628	21,325	21,660
Sulphur content	6,498	7,730	7,483	(2)	(2)
Australia (Tasmania):					
Gross weight	----------	----------	----------	515	278
Sulphur content	----------	----------	----------	(2)	(2)
Austria:					
Gross weight	10,000	----------	----------	----------	(2)
Sulphur content	2,000	----------	----------	----------	(2)
Canada:					
Gross weight	62,447	70,087	48,619	57,418	47,210
Sulphur content	[3] 35,007	[3] 39,949	25,163	28,822	23,547
Cyprus: [4]					
Gross weight	243,913	295,772	242,316	202,993	(2)
Sulphur content	121,956	147,886	121,158	101,496	(2)
Czechoslovakia:					
Gross weight	23,626	23,005	21,669	20,694	(2)
Sulphur content	9,332	9,087	8,559	8,174	(2)
France:					
Gross weight	198,454	202,189	196,320	192,730	(2)
Sulphur content	91,670	91,468	89,660	(2)	(2)
Germany:					
Gross weight	342,179	351,909	289,741	223,997	(2)
Sulphur content	145,866	149,983	124,123	96,550	(2)
Greece:					
Gross weight	94,270	134,399	177,808	141,442	(2)
Sulphur content	45,360	64,434	85,403	67,356	(2)
Hungary:					
Gross weight	4,222	1,023	1,069	(2)	(2)
Sulphur content	(2)	(2)	(2)	(2)	(2)
India, British:					
Gross weight	----------	299	23	(2)	(2)
Sulphur content	----------	(2)	(2)	(2)	(2)
Italy:					
Gross weight	558,390	664,543	717,270	645,759	515,000
Sulphur content	256,683	305,847	314,790	(2)	(2)

See footnotes at end of table.

World production of pyrites (including cupreous pyrites), 1928–32, in metric tons—Continued

Country	1928	1929	1930	1931	1932
Japan:					
Gross weight	593,972	618,743	561,400	(2)	(2)
Sulphur content	(2)	(2)	(2)	(2)	(2)
Norway:					
Gross weight	738,535	739,597	730,951	359,951	(2)
Sulphur content	321,630	323,844	324,084	160,071	(2)
Poland:					
Gross weight	10,668	9,410	11,046	3,591	(2)
Sulphur content	(2)	(2)	4,860	1,580	(2)
Portugal:					
Gross weight	242,122	384,350	400,224	287,118	(2)
Sulphur content	(2)	(2)	(2)	(2)	(2)
Rumania:					
Gross weight	23,715	23,851	24,264	24,784	(2)
Sulphur content	(2)	(2)	(2)	(2)	(2)
Russia: [5]					
Gross weight	152,041	(2)	241,718	(2)	(2)
Sulphur content	(2)	(2)	(2)	(2)	(2)
Spain:					
Gross weight	3,624,819	3,867,250	3,416,465	2,593,933	(2)
Sulphur content	1,439,747	1,496,756	1,517,789	1,089,000	(2)
Sweden:					
Gross weight	19,996	72,055	60,441	57,610	(2)
Sulphur content	12,394	32,082	27,733	25,900	(2)
Union of South Africa:					
Gross weight	3,754	4,116	3,603	3,768	3,436
Sulphur content	(2)	(2)	(2)	(2)	(2)
United Kingdom:					
Gross weight	4,440	4,441	5,585	2,011	(2)
Sulphur content	(2)	(2)	(2)	(2)	(2)
United States:					
Gross weight	317,836	338,817	353,090	336,158	189,478
Sulphur content	115,124	122,303	126,220	123,453	65,866
Yugoslavia:					
Gross weight	64,273	61,153	50,345	29,495	(2)
Sulphur content	(2)	(2)	(2)	(2)	(2)

1 In addition to the countries listed, Chosen reports production as follows: 1928, 60 kilograms; 1929, 60 kilograms; 1930, 50 kilograms. Belgium also reports production, but figures are not shown separately.
2 Data not available.
3 Includes estimated quantity of sulphur in smelter gases used for acid making.
4 Exports.
5 Year ended Sept. 30.

Spain.—The figures for the production of pyrites in 1932 for Spain, the principal world producer, are not available, but the decline in exports indicates that production was at a lower rate. Exports of iron pyrites from Spain declined from 1,396,795 metric tons in 1931 to 1,324,000 tons in 1932. Cupreous iron pyrites declined from 510,982 tons to 352,000 tons in the same period. The Rio Tinto Co. has over 6 million tons of pyrites in process.

For several years the Rio Tinto Co. has been studying the problem of extracting sulphur from pyrites. Recently, more extensive experiments have been carried on to develop a process covered by Spanish patents 109102 and 110351. In this process a properly proportioned mixture of pyrites, coke, limestone, and siliceous flux are charged into a Rio Tinto blast furnace, which is so constructed that gas, vapors, and dust do not escape in charging. The sulphur- and dust-laden gases from the furnace are conducted to a dust collector, where the heavier particles remain. From the dust collector the gases go to four Cottrell precipitating chambers in series of two, where the sulphur is deposited on the plates. An agitating device on the top of each chamber removes the sulphur, which settles to the bottom and is withdrawn through a suitable opening. The heated gases are then cooled below the temperature at which sulphur condenses, and the condensed liquid sulphur formed in the boilers is removed at the bottom through steam-heated pipes. Steam is generated in the boilers upon cooling of the gases. From here the gases pass through a second set of electric precipitation chambers where the final precipitation of sulphur is accomplished, and the clean gas is expelled into the atmosphere. Considerable arsenic came out with the sulphur during the first runs, and attempts were being made later to obtain arsenic-free sulphur.

Norway.—The production of pyrites constitutes the principal mining industry of Norway, the second largest world producer of this commodity. It is estimated that during 1932 production amounted to 710,000 metric tons, of which 500,000 tons were cupreous pyrites. This large production, however, did not find a market, and it was reported that large stocks of ore had accumulated at the mines. The depressed condition of the German industry, normally Norway's largest market for pyrites, undoubtedly contributed to the building of stocks at Norwegian mines. Exports of pyrites from Norway amounted to 472,703 tons in 1932 compared with 391,755 tons in 1931.

The Orkla Metal Co., a subsidiary of the Orkla Mining Co., operated its plant at Thamshaven for producing sulphur from pyrites during the year, but not at full capacity. Although the figure for the production of sulphur is not available the exports of sulphur from Norway in 1932 are reported to be 46,856 metric tons.

The Orkla process,[5] used by the Orkla Metal Co., consists of first smelting the pyrites with coke, quartz, and limestone, causing a large part of the iron content of the pyrites to slag, while the copper and other valuable substances combine with some sulphur to form a matte. The gases obtained from the furnace contain gaseous sulphur, sulphurous acid, and carbon disulphide. With the aid of suitable catalysts these various gaseous compounds are made to react, forming carbon dioxide and free sulphur. The latter is solidified through condensation and subsequently treated by a nodulizing process which eliminates dust and produces a granular product. The sulphur is of high purity, entirely free from bituminous matter, and seldom contains more than 0.01 percent ash. A recovery of 85 to 90 percent of the sulphur and copper content is obtained. Heat recovered in cooling the furnace gases and condensation of the sulphur supplies enough steam to run the entire plant.

Canada.—The production of pyrites in Canada amounted to 47,210 metric tons in 1932 compared with 57,418 tons in 1931. The pyrites produced in 1932 contained 50 percent of sulphur, approximately the same proportion as in 1931. British Columbia and Quebec contributed the total output in 1932. The output of British Columbia decreased from 30,975 tons in 1931 to 14,334 tons in 1932. The pyrites from British Columbia, which contained 50.6 percent of sulphur, came from the Britannia mill, where a pyrites concentrate is produced in the treatment of ores for the extraction of copper.

The output of Quebec increased from 26,443 metric tons in 1931 to 32,876 tons in 1932. The principal producer in Quebec is Eustis mine of the Consolidated Copper & Sulphur Co., where pyrites is produced as a flotation concentrate in the treatment of ore in which copper is the principal value. The pyrites concentrate is exported to

[5] Tidskrift for Kjemi og Bergvesen: Orkla Grube-Aktiebolag, Lokken Verk. 12, Argang 9, 1932, pp. 164–167.

the United States for acid fabrication. In December 1931 the Aldermac Mines, Ltd., began producing pyrites at its properties about 10 miles west of Noranda in Boichastel Township, northwestern Quebec. The valuable constituents of the ore were recovered in an all-flotation mill which was completed in December 1931. The concentrator, which has a capacity of 500 tons of ore per day, recovers 60 to 70 percent of the ore as a pyrites concentrate containing 50 percent of sulphur. The mill has been described by Rowe.[6] After shipping several cars of pyrites flotation concentrates in 1932 to the St. Lawrence Paper Mills, Three Rivers, Quebec, the properties closed down in February 1932 awaiting the development of additional markets.

The principal potential market for pyrites in Canada is in the manufacture of pulp and paper, of which Canada is a large producer. The demands of sulphur for sulphuric acid are met by acid plants operating on sulphurous gases from the nonferrous smelters at Trail, British Columbia, and Copper Cliff, Ontario. Preliminary figures for 1932 indicate that 24,690 metric tons of sulphur were recovered from smelter fume as sulphuric acid, 21,667 tons coming from British Columbia and 3,023 from Ontario. The application of pyrites to the manufacture of pulp and paper in Canada has so far been hampered by technical difficulties in the roasting of pyrites, and the sulphur requirements of this industry have been met by imports of sulphur from the Gulf Coast region of the United States. Considerable attention has been given recently to the possibility of domestic pyrites replacing imported native sulphur because of the new roasting equipment developed by Freeman.[7] Up to the present time only two such burners have been installed.

[6] Rowe, R. C., The New Mill of the Aldermac Mines, Ltd.: Canadian Min. Jour., vol. 53, no. 4, April 1932, pp. 149–153.

[7] Freeman, Horace, The Utilization of Pyrites in Pulp and Acid Manufacture: Canadian Inst. Min. and Met., Bull. 216, April 1930, pp. 471–476.

SALT, BROMINE, CALCIUM CHLORIDE, AND IODINE

By A. T. Coons

SALT

Salt produced for sale or use by operators of salt mines, wells, and ponds in the United States in 1932 totaled 6,447,351 short tons, valued at $19,468,096, a decrease of 12 percent in quantity and 10 percent in value compared with 1931. The output of evaporated salt in 1932 (2,061,215 tons valued at $13,166,795) represented 32 percent of the total quantity of salt produced and indicated a decrease of 6 percent in quantity and 7 percent in value compared with 1931. The salt content (2,769,821 tons) of the brine produced and used by producers in the manufacture of chemicals represented 43 percent of the total salt output and a decrease of 16 percent in quantity. Rock salt produced (1,616,315 tons valued at $4,928,622) represented 25 percent of the total output and a decrease of 13 percent in quantity and 14 percent in value. The average value of all salt was $3.02 a short ton in 1932 (9 cents more than in 1931); that of evaporated salt, including pressed blocks from evaporated salt, was $6.39 (4 cents less than in 1931); and that of rock salt was $3.05 (4 cents less than in 1931).

Seventy-two plants (59 companies) reported operations in 1932 compared with 74 plants (62 companies) in 1931.

Salt sold or used by producers in the United States, 1928–32

Year	Short tons				Value [1]	
	Manufactured (evaporated)	In brine	Rock salt	Total	Total	Average
1928	2,430,050	3,426,870	2,217,780	8,074,700	$26,772,568	$3.32
1929	2,546,390	3,884,160	2,113,010	8,543,560	27,334,695	3.20
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	2,061,215	2,769,821	1,616,315	6,447,351	19,468,096	3.02

[1] The values are f.o.b. mine or refinery and do not include cost of cooperage or containers.

Figure 78 gives the tonnage and value of salt sold or used by producers, 1923–32.

Figure 79 shows the tonnage of salt sold or used by producers in the United States, 1923–32, by classes. The brine salt represents the salt content of brine produced and used by chemical manufacturers.

Michigan continued to be the leading salt-producing State, followed by New York, Ohio, Kansas, Louisiana, and California. Michigan also retained first rank as a producer of evaporated salt, followed in

1932 by New York, Ohio, California, and Kansas. In 1932 Louisiana led in output of rock salt, followed by Kansas, New York, and

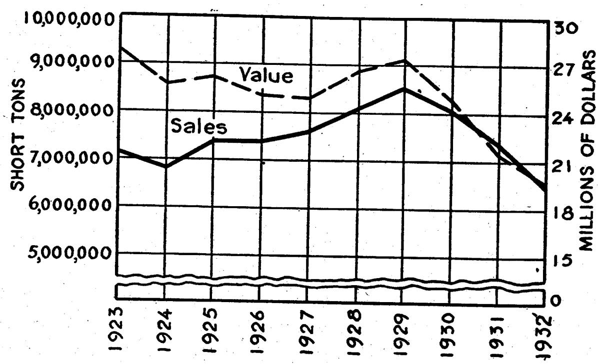

FIGURE 78.—Quantity and value of salt sold or used by producers in the United States, 1923–32.

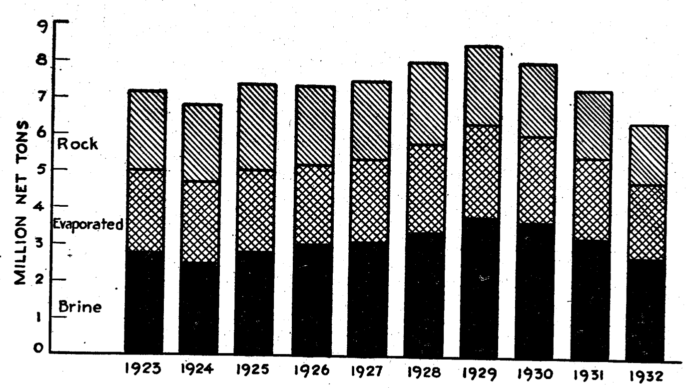

FIGURE 79.—Trends in the quantity of rock salt, evaporated salt, and brine (in terms of salt content) sold or used by producers in the United States, 1923–32.

Salt sold or used by producers in the United States, 1930–32, by States

State	1930		1931		1932	
	Short tons	Value	Short tons	Value	Short tons	Value
California	350,370	$2,080,133	334,900	$2,000,567	281,349	$1,824,021
Kansas	759,800	3,148,728	691,160	3,003,756	688,178	2,876,239
Louisiana	535,250	2,164,365	529,280	1,962,690	488,805	1,919,773
Michigan	2,558,290	7,884,072	2,053,980	5,760,001	1,715,304	4,845,379
New York	2,009,280	5,837,103	1,788,940	5,293,470	1,556,642	4,490,792
Ohio	1,311,440	3,015,206	1,398,000	2,526,952	1,196,993	2,429,613
Puerto Rico	(1)	(1)	11,560	19,878	7,342	13,725
Texas	(1)	(1)	103,040	468,562	139,730	482,118
Utah	85,240	188,983	74,010	159,778	61,230	132,930
West Virginia	28,670	184,327	35,480	218,762	49,629	243,185
Undistributed [2]	416,100	506,563	337,720	126,596	262,149	210,321
	8,054,440	25,009,480	7,358,070	21,541,012	6,447,351	19,468,096

[1] Included under "Undistributed."
[2] 1930, Nevada, New Mexico, Oklahoma, Puerto Rico, Texas, and Virginia; 1931 and 1932, Nevada, New Mexico, Oklahoma, and Virginia.

Michigan, and Ohio. Michigan, New York, Virginia, and West Virginia produced brine from which various chemical products are manufactured.

Salt is used 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, 1931–32, by methods of manufacture

Method of manufacture	1931		1932	
	Short tons	Value	Short tons	Value
Evaporated in open pans or grainers	589,130	$4,540,095	594,852	$4,434,605
Evaporated in vacuum pans	1,158,190	7,504,399	1,075,643	6,940,383
Solar evaporated	326,500	1,148,970	268,690	943,613
Pressed blocks from evaporated salt	129,870	983,652	122,030	848,194
Rock	1,819,700	5,542,281	1,587,112	4,775,371
Pressed blocks from rock salt	34,470	192,926	29,203	153,251
Salt in brine (sold or used as such)	3,300,210	1,628,689	2,769,821	1,372,679
	7,358,070	21,541,012	6,447,351	19,468,096

Evaporated salt sold or used by producers in the United States, 1931–32, by States

State	1931		1932	
	Short tons	Value	Short tons	Value
California	310,360	$1,912,090	268,728	$1,773,422
Kansas	270,630	1,977,097	262,432	1,934,148
Michigan	787,040	4,408,451	691,911	3,831,751
New York	350,440	3,126,179	340,294	2,858,163
Ohio	319,450	2,016,032	305,689	1,978,016
Puerto Rico	11,560	19,878	7,342	13,725
West Virginia [1]	35,480	218,762	49,629	243,185
Undistributed [2]	118,730	498,627	135,190	534,385
	2,203,690	14,177,116	2,061,215	13,166,795

[1] Includes a quantity of salt content of brine for chemical use reported as evaporated salt with value as evaporated salt.
[2] 1931, Nevada, New Mexico, Oklahoma, Texas, and Utah; 1932, Louisiana, Nevada, New Mexico, Oklahoma, Texas, and Utah.

Louisiana, Kansas, New York, and Michigan together produced about 93 percent of the rock salt mined in 1932 compared with 95 percent in 1931. Other States producing rock salt were Texas, California, Utah, and Nevada.

On account of the small number of producers in certain States, of rock salt and salt in brine for chemical manufacture, and of rock salt and evaporated salt it has been found 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, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	2,217,780	$6,923,827	1931	1,854,170	$5,735,207
1929	2,113,010	7,127,681	1932	1,616,315	4,928,622
1930	1,977,370	6,391,775			

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. Pressed blocks from evaporated salt are made chiefly by salt producers in Kansas and Michigan but are also produced in Ohio, Texas, Utah, California, Oklahoma, and Louisiana. Pressed blocks from rock salt are made chiefly by salt producers in Kansas and Louisiana, and small amounts are made in Texas and Utah.

Pressed-salt blocks sold by original producers of the salt in the United States, 1928–32

Year	From evaporated salt		From rock salt		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1928	145,720	$1,205,794	34,930	$293,626	180,650	$1,499,420
1929	172,120	1,392,427	40,920	331,397	213,040	1,723,824
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	122,030	848,194	29,203	153,251	151,233	1,001,445

Shipments.—Requests to producers for a statement of their shipments of salt by States in 1932 were complied with by all but 5 producers; 2 in Kansas, 2 in Ohio, and 1 in Michigan. These companies stated that their records did not show shipments by States. The information received, however, covered 88 percent of the evaporated salt and 95 percent of the rock salt shipped. The results are indicated in the following table. No account was taken of reshipment beyond the original point of 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.

Distribution (shipments) of evaporated and rock salt in the United States in 1932, by States, in short tons

Destination	Evaporated	Rock	Destination	Evaporated	Rock
Alabama	6,653	27,812	New Hampshire	4,212	14,949
Arizona	4,739	2,249	New Jersey	40,578	64,674
Arkansas	7,470	19,760	New Mexico	4,921	5,594
California	184,829	12,091	New York	155,458	221,039
Colorado	19,109	9,818	North Carolina	21,206	37,826
Connecticut	12,060	3,117	North Dakota	10,354	1,310
Delaware	3,140	7,254	Ohio	89,959	45,489
District of Columbia	4,674	1,921	Oklahoma	19,884	19,093
Florida	3,967	17,583	Oregon	23,017	225
Georgia	10,934	33,648	Pennsylvania	89,292	74,282
Idaho	12,049	527	Rhode Island	7,132	5,026
Illinois	183,799	122,831	South Carolina	5,686	12,239
Indiana	51,363	46,316	South Dakota	10,753	11,480
Iowa	57,852	62,309	Tennessee	23,973	31,550
Kansas	36,742	112,094	Texas	46,043	97,010
Kentucky	23,000	15,208	Utah	10,917	928
Louisiana	2,514	46,659	Vermont	6,032	947
Maine	7,623	9,372	Virginia	32,751	12,648
Maryland	20,205	14,733	Washington	46,575	494
Massachusetts	50,157	26,811	West Virginia	49,768	14,360
Michigan	124,146	27,567	Wisconsin	76,692	24,400
Minnesota	62,854	56,724	Wyoming	6,270	2,431
Mississippi	2,548	25,300	Other [1]	32,687	38,379
Missouri	54,662	54,398			
Montana	12,059	925	Total shipments reported	1,809,260	1,536,686
Nebraska	33,126	43,010	Total sales	2,061,215	1,616,315
Nevada	2,826	276			

[1] Includes production of Puerto Rico (evaporated salt) and shipments to Alaska, Puerto Rico, and Hawaii, and to Australia, Canada, Central America, Cuba, Japan, and Mexico and countries not specified.

LOCALITIES PRODUCING SALT IN THE UNITED STATES IN 1932

The salt deposits in the United States that furnish salt for commercial purposes are, with the exception of 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 69 percent of the total salt sold or used by producers in 1932 compared with 71 percent in 1931. Kansas and Louisiana, in the central belt of States, are the next largest producers, and California is chief among 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 residue from some of the salt works, is sold to chemical manufacturers for further treatment and for the recovery of bromine and calcium chloride.

The companies reporting in 1932, the location of their plants, and the nature of the salt sold or used by them, as reported to the Bureau of Mines, are given by States on the following pages to supply information often requested regarding the operation of salt properties.

California.—In California salt is obtained from sea water, from salt springs, lakes, etc., 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 1932 from the following:

Alameda County:
- Alvarado—Leslie-California Salt Co. (address, 149 California 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.

Inyo County: Keeler (Saline Valley)—Sierra Salt Corporation (address, 321 West Third Street, Los Angeles); solar evaporation. Plant idle in 1932.

Kern County: Saltdale (Ceneda)—Consolidated Salt Co. of California (address, Long Beach). On a playa known as Cane Lake; solar evaporation.

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.

San Diego County: San Diego (south end of San Diego Bay).—Western Salt Co.; solar evaporation.

San Mateo County:
- Leslie—Leslie-California Salt Co. (address, 149 California Street, San Francisco); evaporated salt (solar, vacuum pans), pressed blocks from evaporated salt.
- 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 magnesium chloride, other magnesium salts, and insulating material. Iodine is extracted from brine obtained from oil wells.

Kansas.—In 1932 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 1932 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—Western Ice & Utilities Co. (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, La Salle 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 1932 again ranked fifth in quantity of salt produced. Both rock salt and evaporated salt were produced in 1932. The firms reporting in 1932 were:

Iberia Parish:
 Avery Island—Avery Salt Co. (address, Scranton, Pa.); evaporated salt (open pans or grainers), rock salt.
 Jefferson Island—Jefferson Island Salt Mining Co., Inc. (address, Columbia Building, Louisville, Ky.); evaporated salt (vacuum pans), pressed blocks from evaporated salt, rock salt, pressed blocks from rock salt.
 Weeks Island—Myles Salt Co., Ltd. (address, 1007 Camp 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 1932 again ranked first among the salt-producing States. The output is obtained from both rock salt and natural brine. In 1932 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, 132 Dock Street, 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.
Midland County: Midland—The Dow Chemical Co.; evaporated salt (vacuum pans), also bromine, and calcium chloride.
Saginaw County:
 Carrollton—Mershon, Eddy, Parker Co. (address, Saginaw); evaporated salt (open pans or grainers).
 ——— Saginaw Salt Products Co. (address, Saginaw); evaporated salt (open pans or grainers).
 Saginaw—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 1932 the Nevada Pure Salt Co. produced solar salt at Fallon, Churchill County.

New Mexico.—Production of salt in 1932 was reported in Torrance County by New Mexico Salt Co., Willard.

New York.—New York in 1932 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 1932 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 and Tully—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 1932 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 plant idle in 1932.
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 1932 the Texaco Salt Products Co. (address, c/o The Texas Co., Houston, Tex.) produced evaporated salt 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 1932 Y. L. Stockman reported sales of such salt from near Vinson, Harmon County.

Puerto Rico.—In 1932 three plants reported production, as follows:

Cabo Rojo—F. Carrera & Hno. (address, Mayaguez); solar evaporation.
Guanica—José Couto Miniño (address, Ensenada); solar evaporation.
Lajas—Miguel Antonio Ramirez Dominguez (address, San German); solar evaporation.

Texas.—Salt was produced in Texas in 1932 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) (successor to Houston Salt Co.); rock salt.
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 1932 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.
Tooele County: Burmester—Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); solar evaporation, pressed blocks from evaporated salt.

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 1932 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; bromine manufactured from bittern of this plant by J. Q. Dickinson & Co., Malden.
Mason County:
  Hartford—Liverpool Salt & Coal Co.; evaporated salt (open pans or grainers), also bromine; calcium chloride manufactured from bittern of this plant by American Calcium Chloride Works, Hartford. (Idle in 1932.)
  Mason—Ohio River Salt Corporation; evaporated salt (open pans or grainers), also bromine and calcium chloride. (Idle in 1932.)

IMPORTS, EXPORTS, AND WORLD PRODUCTION

Imports of salt for consumption in the United States in 1932—28,018 short tons valued at $66,043—decreased 16 percent in quantity and 22 percent in value compared with 1931 and represent the smallest importation of salt recorded.

Exports of salt amounted to 63,581 short tons valued at $478,435, a decrease of 36 percent in quantity and 38 percent in value from 1931.

Salt imported for consumption in the United States, 1928–32

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
1928	14,710	$34,777	3,605	$52,877	24,541	$61,905	42,856	$149,559
1929	8,812	23,258	4,385	48,353	23,253	60,105	36,450	131,716
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	30,953	28,018	66,043

Salt imported into the United States, 1931–32, by countries

[General imports]

Country	1931		1932	
	Pounds	Value	Pounds	Value
North America:				
Canada	5,403,269	$8,883	8,117,066	$10,597
Mexico	57,663	194	112,560	316
West Indies:				
British:				
Jamaica	21,410,090	21,260	11,313,485	13,908
Other British	3,831,810	4,051	88,200	279
Dominican Republic			19,200	32
Netherland	7,171,842	9,027	12,851,357	12,370
Europe:				
France			66	34
Germany	2,935,842	10,711	2,744,349	7,833
Italy			234	16
Spain	24,040,000	15,477	28,087,360	14,831
Sweden			4,727	212
United Kingdom	2,176,200	13,656	2,068,090	12,932
Africa:				
Algeria and Tunisia	1,104	23		
Portuguese, other			2,301,000	2,477
	67,027,820	83,282	67,707,694	75,837

Salt exported from the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	145,396	$1,185,682	1931	98,710	$775,490
1929	109,222	1,008,842	1932	63,581	478,435
1930	70,478	715,575			

Salt exported from the United States, 1932, by countries

Country	1932 Pounds	1932 Value
North America:		
Bermudas	99,031	$1,657
British Honduras	167,181	1,344
Canada	65,985,789	184,558
Central American States:		
Costa Rica	44,097	527
Guatemala	225,372	1,843
Honduras	2,034,747	17,739
Nicaragua	697,443	7,637
Panama	1,162,109	11,305
Salvador	4,860	58
Mexico	3,210,831	23,899
Miquelon, Langley, etc	156	4
Newfoundland and Labrador	10,330	302
West Indies:		
British:		
Jamaica	2,940	50
Other British	9,838	261
Cuba	36,474,655	165,576
Dominican Republic	424,146	2,481
Haiti	75,301	930
Netherland	33,087	554
Virgin Islands of the United States	5,841	166
South America:		
Argentina	110,676	643
Chile	240	9
Colombia	31,280	388
Guiana, British	200	1
Uruguay	30	2
Europe:		
Albania	12	$1
Belgium	975	38
Denmark	1,350	42
France	2,334	31
Germany	390	15
Netherlands	47,683	1,884
Portugal	372	7
Sweden	735	59
United Kingdom	22,790	235
Asia:		
Ceylon	240	25
China	27,752	1,105
East Indies:		
India, British	3,711	185
Netherland	34,122	852
Hong Kong	44,008	985
Indo-China, French	720	49
Japan	13,934,257	21,523
Kwantung	2,880	96
Philippine Islands	299,043	6,170
Siam	360	36
Syria	96	3
Africa:		
South (Union of) British	975	38
Egypt	975	37
Oceania:		
British:		
Australia	1,100,800	13,249
New Zealand	528,725	6,405
Other British	6,800	128
French	289,658	3,303
	127,161,943	478,435

World production of salt, 1927–31, in metric tons

Country [1]	1927	1928	1929	1930	1931
North America:					
Canada	245,756	273,525	299,518	242,787	231,885
Cuba	411	2,359	14,515	24,947	22,680
Guatemala	46,253	(2)	(2)	7,915	(2)
Mexico [3]	67,000	67,000	67,000	67,000	67,000
Panama	1,149	835	935	366	1,035
United States:					
Rock salt	1,944,867	2,011,926	1,916,880	1,793,831	1,682,066
Other salt	4,921,297	5,313,281	5,833,666	5,512,996	4,993,028
West Indies:					
British:					
Bahamas [4]	1,923	725	799	3,193	12,447
Grenada (Windward Islands) [4]	(2)	37	70	155	131
Leeward Islands [4]	1,214	1,586	1,310	1,541	2,353
Turks and Caicos Islands [4]	28,371	50,846	62,135	42,208	27,361
Netherland [4]	8,218	9,778	4,677	4,820	6,352
South America:					
Argentina [5]	153,213	167,617	197,799	144,593	159,372
Chile	71,549	34,746	37,422	39,623	(2)
Colombia [3]	29,000	29,000	29,000	29,000	29,000
Ecuador:					
Rock salt	628	333	69	126	148
Other salt	16,100	10,051	17,377	24,433	28,858
Peru	29,997	32,669	30,000	30,000	28,000
Venezuela	20,803	26,228	25,443	20,722	(2)
Europe:					
Albania	6,600	5,283	(2)	(2)	(2)
Austria:					
Rock salt	2,675	1,607	3,041	1,063	862
Other salt	145,405	152,212	175,442	156,559	122,612
Bulgaria:					
Rock salt	3,982	4,108	3,653	1,704	(2)
Other salt	30,980	42,709	25,194	(2)	(2)
Czechoslovakia	122,202	154,243	166,361	177,693	190,179

See footnotes at end of table.

World production of salt, 1927–31, in metric tons—Continued

Country	1927	1928	1929	1930	1931
Europe—Continued					
France:					
Rock salt and salt from springs	1,518,000	1,707,506	1,746,076	1,750,880	1,403,449
Other salt	432,500	407,768	443,685	248,160	(2)
Germany:					
Rock salt	2,268,807	2,399,669	2,541,489	2,455,605	2,086,884
Other salt	533,984	509,663	501,024	501,258	490,975
Greece	104,378	[3] 100,000	[3] 100,000	[3] 100,000	[3] 100,000
Italy:					
Rock salt [6]	364,850	341,107	346,479	332,001	(2)
Other salt	686,124	562,281	563,970	520,099	(2)
Malta	(2)	587	482	587	859
Netherlands—Rock salt [7]	37,796	41,470	44,914	49,807	56,141
Poland	498,435	548,377	569,488	534,260	561,089
Portugal [4]	49,552	46,777	15,317	27,236	17,010
Rumania:					
Rock salt	328,028	340,212	318,802	304,877	254,808
Other salt	3	2,567	2,698	2,155	----------
Russia [8]	2,216,136	2,548,106	(2)	(2)	(2)
Spain:					
Rock salt	110,839	146,147	164,837	164,532	155,448
Other salt	868,381	836,912	914,639	872,966	733,860
Switzerland	78,262	79,982	86,476	80,830	85,016
United Kingdom:					
Great Britain:					
Rock salt	22,809	24,254	28,786	21,377	18,134
Other salt	1,985,250	1,938,575	1,962,024	2,066,386	1,897,376
Ireland, Northern:					
Rock salt	7,262	7,598	7,954	4,048	3,764
Other salt	(2)	7,130	7,093	8,938	(2)
Yugoslavia	54,765	52,128	44,564	54,636	52,745
Asia:					
Ceylon	26,080	44,275	25,482	9,686	45,539
China (including Kwantung)	[9] 2,067,269	[3] 2,000,000	[3] 2,000,000	[3] 2,000,000	[3] 2,000,000
Chosen	(2)	134,516	138,000	(2)	(2)
Cyprus [3]	3,000	3,000	3,000	3,000	3,000
India:					
British (including Aden):					
Rock salt	173,489	157,846	181,164	178,283	164,491
Other salt	1,464,328	1,381,824	1,555,367	1,560,532	1,704,431
Portuguese [3]	12,000	12,000	12,000	12,000	12,000
Indo-China [4]	27,701	35,816	25,636	42,471	32,880
Iraq [10]	5,791	6,251	7,803	8,919	7,299
Japan:					
Japan proper [11]	619,138	637,888	644,151	628,682	521,125
Taiwan	113,400	134,515	164,357	163,217	199,049
Netherland India	264,197	253,162	486,907	313,579	212,373
Palestine:					
Rock salt	----------	1,654	2,508	1,395	1,259
Other salt	7,014	(2)	5,233	6,102	(2)
Philippine Islands	66,669	71,475	46,876	40,572	42,570
Russia [8]	209,830	257,635	(2)	(2)	(2)
Siam	115,356	119,332	[12] 177,070	[12] 181,003	[12] 196,400
Syria [3]	10,000	10,000	10,000	10,000	10,000
Turkey [3]	100,000	100,000	100,000	100,000	100,000
Africa:					
Algeria	36,936	10,975	15,305	58,443	36,161
Belgian Congo [3]	80	80	80	80	80
Canary Islands [3]	2,000	2,000	2,000	2,000	2,000
Cape Verde Islands	(2)	(2)	10,490	11,075	(2)
Egypt [4]	222,535	167,874	149,023	154,852	102,873
Eritrea	68,000	75,700	115,000	123,083	(2)
Ethiopia—Rock salt	25,000	20,000	10,000	10,000	20,000
French West Africa	4,300	4,000	4,000	2,200	(2)
Libia (Italian Africa):					
Cyrenaica	----------	[3] 10,000	[3] 10,000	[3] 10,000	[3] 10,000
Tripolitania [3]	20,000	20,000	20,000	20,000	20,000
Mauritius [3]	1,500	1,500	1,500	1,500	1,500
Morocco, French	3,600	8,000	8,000	8,000	(2)
Nigeria [3]	400	400	400	400	400
Portuguese West Africa (Angola)[3]	9,000	9,000	9,000	9,000	9,000
Somaliland:					
British [3]	15,000	15,000	15,000	15,000	15,000
French	18,444	39,000	38,972	25,369	(2)
Italian	----------	1,656	4,347	77,970	240,000
South-West Africa—rock salt	343	146	334	511	1,093
Sudan, Anglo-Egyptian	9,872	12,481	14,951	14,308	(2)
Tanganyika Territory	4,852	5,134	7,387	6,664	6,845
Tunisia	144,788	114,045	120,165	120,345	(2)
Uganda	2,049	2,067	2,280	1,779	1,908
Union of South Africa [13]	80,416	83,735	88,857	89,338	(2)

See footnotes at end of table.

World production of salt, 1927–31, in metric tons—Continued

Country	1927	1928	1929	1930	1931
Oceania:					
Australia:					
Northern Territory (North Australia)				120	(2)
South Australia	80,559	72,574	77,684	59,709	69,768
Victoria	36,503	52,181	(2)	(2)	(2)
Western Australia [3]	8,000	8,000	8,000	8,000	8,000

[1] In addition to the countries listed salt is produced in Arabia, Bolivia, Brazil, Gold Coast, Kenya Colony, Madagascar, and Southern Rhodesia, but figures of production are not available.
[2] Data not available.
[3] Estimated annual production.
[4] Exports.
[5] Railway shipments.
[6] Includes following quantities of salt previously reported under other salt: 1927, 298,000 tons; 1928, 273,920 tons; 1929, 283,440 tons; 1930, 258,908 tons (Relazione sul Servizio Minerario, Rome).
[7] Sales.
[8] Year ended Sept. 30.
[9] Figures of production as published by the Geological Survey of China, Peiping.
[10] Salt issued by the Government for sale.
[11] 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.
[12] Year ended Mar. 31 of year following that stated.
[13] 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 potassium and sodium bromide, ethylene dibromide, and other bromine compounds. In 1932 the bromine produced amounted to 5,727,561 pounds valued at $1,182,561, a decrease of 36 percent in both quantity and value from 1931.

The companies that produce bromine are: 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 (idle, 1932); J. Q. Dickinson & Co., Malden, W.Va.; Liverpool Salt & Coal Co., Hartford, W.Va.; and Ohio River Salt Corporation, Mason, W.Va. (idle, 1932).

Bromine and bromine in compounds sold or used by producers in the United States, 1928–32

Year	Pounds	Value	Year	Pounds	Value
1928	2,164,000	$649,475	1931	8,935,330	$1,854,650
1929	6,414,620	1,759,325	1932	5,727,561	1,182,569
1930	8,462,800	2,109,974			

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 1932 was 21 cents a pound, the same as in 1931. 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 1931 and 1932 was 36 to 38 cents.

Bromine and bromine compounds imported for consumption in the United States, 1928–32

Product	1928		1929		1930		1931		1932	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Bromine			17,573	$5,804	1,123	$347	25	$24	27	$27
Ammonium bromide	(1)	(1)	(1)	(1)	[2] 7,717	[2] 2,209	220	63	52	10
Potassium bromide	23,231	$7,918	28,310	9,834	64,399	16,439	58,411	18,983	37,480	9,039
Sodium bromide			110	51	20,774	4,991			2,205	453
Ethylene dibromide	283,205	86,966	443,004	104,917	3,023,484	648,455	1,570,840	358,082	950,610	191,991
Other bromine compounds	27,730	2,857	643	572	21,594	13,378	43,636	23,053	16,153	7,311

[1] Not separately recorded prior to tariff of June 18, 1930.
[2] June 18 to Dec. 31. Not separately recorded prior to change in tariff.

CALCIUM CHLORIDE

The calcium chloride reported in the following table is 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 further large output of calcium chloride made by manufacturing processes is not reported. The calcium chloride reported includes an output of mixed calcium and magnesium chlorides and other salts.

Production in 1932 was reported as 66,286 short tons valued at $1,163,385, a decrease of 23 percent in quantity and 31 percent in value.

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.; The Dow Chemical Co., Midland, Mich.; Pomeroy Salt Corporation (address, Pomeroy, Ohio), Minersville, Ohio (idle, 1932); The Excelsior Salt Works, Inc., Pomeroy, Ohio (idle, 1932); Texaco Salt Products Co., West Tulsa, Okla.; J. Q. Dickinson & Co., Malden, W.Va.; American Calcium Chloride Works (using bittern from the Liverpool Salt & Coal Co.), Hartford, W.Va. (idle, 1932); and Ohio River Salt Corporation, Mason, W.Va.

Calcium (calcium-magnesium) chloride from natural brines sold by producers in the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	102,090	$1,995,603	1931	86,156	$1,687,166
1929	114,240	2,097,061	1932	66,286	1,163,385
1930	116,160	2,207,800			

Calcium chloride imported for consumption in the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	9,263	$100,223	1931	4,916	$74,546
1929	8,236	113,573	1932	3,569	48,865
1930	6,641	95,921			

Calcium chloride exported from the United States, 1929–32

Year	Short tons	Value	Year	Short tons	Value
1929	15,425	$362,658	1931	24,351	$566,573
1930	21,350	513,577	1932	17,747	378,130

IODINE

Until 1932 very little naturally occurring iodine had been produced in the United States. During the war there was a small output of iodine from kelp at plants on the Pacific coast, but these are no longer in operation. 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 two plants recovering iodine from oil-well brines at Long Beach, Calif. These plants are operated by the General Salt Co., Long Beach, and the Jones Chemical Co., Midland, Mich. The Jones Chemical Co. also established a plant at Shreveport, La., where the iodine is recovered from salt brine.

As the total output in 1932 represents that of but two producers the Bureau of Mines is not at liberty to publish production figures.

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. 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. Part of the increased imports in 1932 was presumably for storage.

Iodine imported for consumption in the United States, 1928–32

Year	Crude		Resublimed		Year	Crude		Resublimed	
	Pounds	Value	Pounds	Value		Pounds	Value	Pounds	Value
1928	720,766	$2,429,076	3	$15	1931	278,713	$998,079		
1929	627,162	2,249,266			1932	631,669	2,225,661	100	$269
1930	493,587	1,797,754							

PHOSPHATE ROCK

By Bertrand L. Johnson

The phosphate-rock industry in 1932 experienced continuation of the unfavorable trends of 1931. There were marked declines in mine production, shipments, exports, and consumption, and stocks increased. From the viewpoint of the domestic producers the only favorable factors were a slight decrease in imports and apparent progress toward restricting future importations from certain foreign sources. The set-backs in both quantity and value of shipments in 1931 and 1932 are the greatest the domestic phosphate-rock industry has ever experienced. The output in Tennessee dropped to about the 1897 level, while that in Florida declined to about the 1916 figure.

Salient statistics of the phosphate-rock industry in United States, 1930–32

	1930	1931	1932 [1]
Mine production long tons	3,951,353	2,577,535	1,711,051
Shipments:			
United States:			
Long tons	3,926,392	2,534,959	1,700,568
Value	$13,996,830	$9,288,485	$5,504,996
Florida, total:			
Long tons	3,248,071	2,061,466	1,486,573
Value	$10,790,305	$7,202,086	$4,652,275
Florida, land pebble:			
Long tons	[2] 3,166,318	1,990,806	[3] 1,453,779
Value	[2] $10,273,076	$6,756,428	[3] $4,490,129
Florida, hard rock:			
Long tons	81,753	57,224	32,794
Value	$517,229	$380,540	$162,146
Tennessee:			
Long tons	611,045	343,622	169,026
Value	$2,938,525	$1,545,607	$673,636
Idaho:			
Long tons	59,932	60,978	23,392
Value	$234,543	$234,781	$87,755
Montana:			
Long tons	6,005	67,893	20,158
Value	$27,457	$301,511	$80,290
Wyoming and Virginia:			
Long tons	[4] 1,339	[4] 1,000	1,419
Value	[4] $6,000	[4] $4,500	$11,040
Imports:			
Long tons	32,658	[5] 13,496	[5] 12,982
Value	$377,177	[5] $162,517	[5] $93,847
Exports:			
Long tons	1,225,722	951,305	613,035
Value	$5,630,547	$4,277,070	$2,795,654
Consumption, apparent long tons	2,733,328	1,597,150	1,100,515
Stocks, Dec. 31, total do	968,750	943,000	1,139,826
Stocks, Dec. 31, Florida do	798,000	733,400	918,000
Stocks, Dec. 31, Tennessee do	168,000	207,650	218,570

[1] Preliminary figures.
[2] Includes small quantity of soft rock.
[3] Includes small quantity of soft rock and tailings.
[4] Wyoming only.
[5] Includes imports of Russian apatite.

The accompanying chart (fig. 80) presents the general trends of various phases of the domestic phosphate-rock industry from pre-World War times to the present on a ratio basis. Certain features are common to many of the phases. The World War adversely affected production, exports, imports, and consumption. Stocks and per-capita consumption, however, increased. The post-war boom of 1920 increased production, consumption, exports, and per capita consumption, while stocks decreased and imports remained at the low level of the war period. In the depression the following year only stocks and imports increased. The succeeding 9 years, 1922–30, inclusive, saw a gradual increase in production, consumption, per capita consumption, and imports to above pre-war levels. Exports

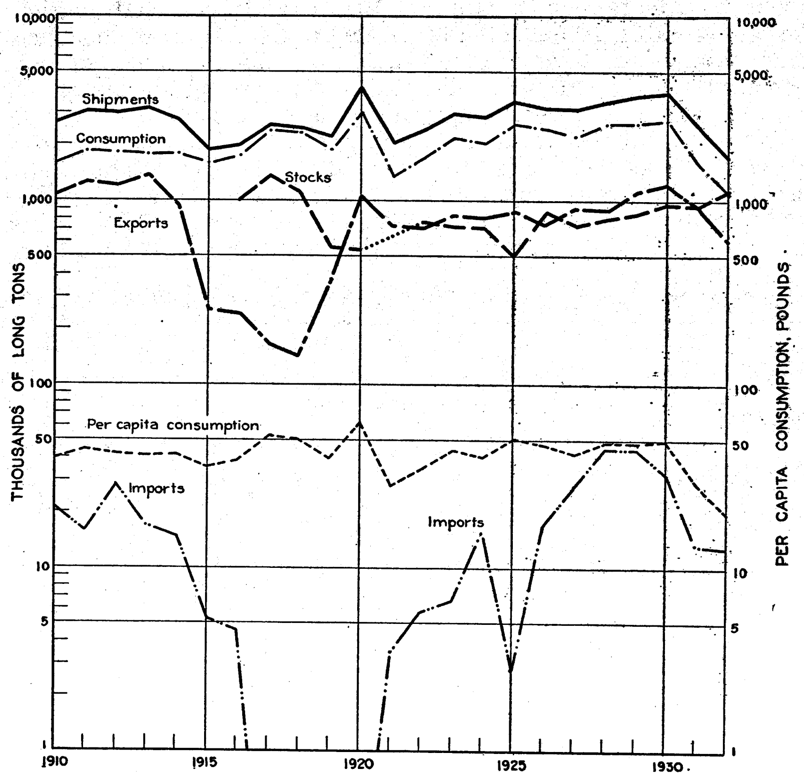

FIGURE 80.—Salient features of the phosphate-rock industry of the United States, 1910–32.

increased but not quite to the pre-war high point. Stocks on hand at the end of the year climbed gradually to between 900,000 and 1,000,000 tons, but did not reach the large size of the World War period. The last 2 years, 1931 and 1932, showed a sharp decline, not as rapid as that in 1921 following the 1920 boom, but much greater, in all phases of the industry except stocks on hand. These rose to a new post-war high level in 1932 of over a million tons and were greater than the current annual domestic consumption. The decline in imports and exports was not as rapid or as great, however, as that which followed the opening of the World War, when the American foreign trade in phosphate rock was virtually eliminated.

Prices.—Prices quoted by the Engineering and Mining Journal for Florida land-pebble rock for export and domestic delivery were the same in 1932 as in 1931. Somewhat lower quotations were reported weekly by the Oil, Paint, and Drug Reporter. These quotations were unchanged throughout the year except that Florida land pebble, 75 percent minimum grade, had a slightly lower price range in the latter part of the year than in the first 9 months.

Prices of Florida and Tennessee phosphate rock in 1932 [1] *per long ton, f.o.b. mine*

Grade of rock, percent:	
Florida land pebble:	
68 minimum	\$3. 10–\$3. 25
70	3. 75– 3. 90
72	4. 25– 4. 35
75 basis, 74 minimum	5. 25– 5. 50
75 minimum (Jan. 1–Sept. 18)	5. 75
75 minimum (Sept. 18–Dec. 31)	5. 50– 5. 75
77 basis, 76 minimum	6. 25
Florida hard rock: 77	6. 50
Tennessee brown rock:	
72	5. 00
75	5. 50

REVIEW BY STATES

Florida.—In Florida, the leading phosphate-rock producing State, the quantity and value of phosphate-rock shipments in 1932 fell to about the level of the World War period. Land-pebble shipments were less than in any year since 1915, and their value was less than in any year since 1916. The quantity and value of hard-rock shipments were smaller than in any year since 1917. The rate of decrease in land-pebble shipments was slightly less than in 1931, while the rate of decrease in value was about the same. The rate of decrease both in quantity and value of hard-rock shipments was greater in 1932 than in 1931. All seven large land-pebble producing companies were in operation in 1932. In the hard-rock field of northwestern Florida, about 100 miles north of the land-pebble field, only two companies were producing. C. & J. Camp operated the Felicia Mine near Dunnellon, and the Dunnellon Phosphate Mining Co., Savannah, Ga., a new producer, owned and operated by some of the directors of the Mutual Mining Co. (reported as no longer in the phosphate-rock business), commenced operations on a hard-rock phosphate deposit near Hernando, Citrus County, early in 1932. The wet rock produced by this concern was sent to Fernandina for drying. J. Buttgenbach & Co. shipped from stock.

The Colloidal Phosphate Sales Co., Dunnellon, Fla., dried, pulverized, and sold for fertilizer use finely divided waste-pond phosphatic debris from hard-rock phosphate-washing operations.

Idaho.—Phosphate-rock production in Idaho in 1932 came from both the Conda and Paris Districts as in the past, returns indicating operations by one company in each district. In the Conda District, the Anaconda Copper Mining Co. operated its Conda No. 1 Mine. In the Paris District, the Solar Development Co. operated the Star Mine during the first quarter of the year but ceased operations in March, and on April 5, 1932 dropped the option on the property.

[1] Weekly quotations of Oil, Paint and Drug Reporter for 1932.

Throughout most of the year, therefore, only one phosphate-rock producer was in operation in Idaho.

Montana.—The Anderson Mine near Garrison, operated by William Anderson, is reported to have furnished, as in 1931, nearly all the phosphate rock commercially mined in Montana in 1932. Its production, however, was much less than in the previous year.

Small shipments were made by three other companies. The Garrison Mining & Phosphate Co., Trail, British Columbia, reports the shipment of a few tons of phosphate rock from Deer Lodge, Powell County, Mont., from a lease held under assignment from W. P. Janney. The Northwestern Improvement Co. mined and shipped a small tonnage to Trail. The Washington Phosphate & Silver Co., Colfax, Wash., operating a mine at Maxville, Granite County, Mont., also mined and sold a small tonnage of phosphate rock.

In addition to the quantities reported to the Bureau of Mines by producers, the annual report of the Consolidated Mining, Smelting & Power Co. of Canada, Ltd., Trail, British Columbia, shows 21,935 tons of phosphate rock produced by their Montana subsidiary and underground development work totaling 1,448 feet on the Janney lease.

Tennessee.—In Tennessee, second only to Florida as a phosphate-rock producing State, the output in 1932 declined sharply. Returns from producers indicate a smaller production than in any year since 1897, and a smaller value than in any year since 1898. Only five large companies mined phosphate rock during the year, but there were several small operations. Two other companies sold from stocks on hand. Only one large company produced blue rock.

The mining operations were all in the west-central part of the State as usual. The greater part of the production was "brown rock;" the remainder was "blue rock."

Virginia.—The new plant of the Southern Mineral Products Corporation (subsidiary of the Vanadium Corporation of America) at Piney River, Nelson County, Va., was operated part time. The nelsonite raw material worked by this corporation contains a substantial percentage of apatite, which is recovered as a byproduct, converted into calcium acid phosphate, and sold direct to the manufacturers of self-raising flour and baking powder.

Wyoming.—As in recent years, the only marketed production of phosphate rock in Wyoming came from the property of the Cokeville Phosphate Co., Cokeville, Wyo.

DEVELOPMENTS IN TECHNOLOGY

A rather complete description of the present practice in the washing and drying of Florida land-pebble phosphate rock was given in a recent article [2] on the plant of the International Agricultural Corporation at Mulberry, Fla. The overburden of the phosphate-rock deposits at the several pits is removed by drag lines. Recovery of the phosphate-rock matrix is accomplished by hydraulicking, and the resultant phosphate-rock sludge is pumped by electrically driven centrifugal pumps to the washing plants. The plus 1-mm wet rock from the washers is stored in bins pending delivery by the company's electric railway to the drying plant. Minus 1-mm material is sent

[2] Pit and Quarry, Progress in Phosphate-Rock Industry Is Reflected in New Florida Plant: Vol. 23, no. 7, December 1931, pp. 19–25.

to the flotation plant for recovery. At the drying plant the railroad-trestle type of stock piling is used for the wet rock, with a tunnel belt-conveyor system for recovery and transportation to two large electrically driven, oil-fire, rotary-kiln driers. The dried rock is stored in loading bins pending shipment or pulverized and delivered direct to railroad cars. The dust from the driers is collected in enclosed bins in the storage and loading building.

The utilization of Hardinge conical scrubbers for the reduction of clay balls and the release of clean phosphate rock from the clay matrix in land-pebble phosphate-rock washers is described by J. K. Towers.[3]

The flotation of phosphate rock is discussed in two recent papers by C. E. Heinrichs [4] and H. S. Martin.[5] The first of these papers emphasizes the importance of flotation in the economics and technology of the phosphate-rock industry, referring to the benefits obtained by its use, such as greater flexibility in grade of product, decreased over-all production costs, increased recoveries, doubling of available reserves, and reduction of capital investment for a given producing capacity; it also presents data to illustrate some of these points. Flotation, by reclaiming the valuable part of the fines formerly run to waste, is said to practically double the recovery of phosphate rock. The second paper describes the operations and costs at the no. 2 flotation plant of the Phosphate Recovery Corporation near Mulberry, Fla.

A detailed description by N. K. Karchmer [6] of the flotation of apatite in Russia has current domestic interest because of an investigation by the United States Tariff Commission (referred to under the section on imports). The apatite-bearing nepheline-syenites mines are in the western part of the Kola Peninsula in northwestern arctic Russia. The flotation plant is about 4 miles from the mine. The principal crushing of the apatite rock is followed by two-stage grinding, conditioning of the flotation feed, roughing and cleaning, thickening, filtering, and drying. Oleic acid and peat tar are used as flotation agents. A detailed flow sheet of the flotation plant accompanies the description.

Comprehensive papers by B. G. Klugh [7] and W. H. Waggaman,[8] published during the year, discuss in considerable detail the production of phosphoric acid from phosphate rock by the volatilization or furnace process.

FOREIGN TRADE

Exports.—The downward trend in both quantity and value of exports, which began in 1931, continued in 1932 at an increased rate. All groups participated in the decline. Land-pebble (and other) phosphate-rock exports fell from 846,012 long tons valued at $3,663,113 in 1931 to 547,026 long tons valued at $2,390,122 in 1932. Ex-

[3] Towers, J. K., Improvements in Mineral Scrubbing: Eng. and Min. Jour., vol. 133, no. 3, March 1932, p. 174.

[4] Heinrichs, C. E., Phosphate Flotation, Its Place in the Technology and Economics of the Phosphate Industry: Paper read at the New York meeting, February 1933, of the American Institute of Mining and Metallurgical Engineers.

[5] Martin, H. S., Milling Methods and Costs at the No. 2 Concentrator of the Phosphate Recovery Corporation: Paper read at the New York meeting, February 1933, of the American Institute of Mining and Metallurgical Engineers.

[6] Karchmer, N. K., Flotation of Apatite in Russia: Eng. and Min. Jour., vol. 133, no. 8, August 1932, pp. 429–432.

[7] Klugh, B. G., Thermal Production of Phosphoric Acid: Ind. and Eng. Chem., vol. 24, no. 4, April 1932, pp. 371–374.

[8] Waggaman, W. H., Present Status and Future Possibilities of Volatilization Process for Phosphoric Acid Production: Ind. and Eng. Chem., vol. 24, no. 9, September 1932, pp. 983–988.

ports of high-grade hard rock fell from 105,293 long tons valued at $613,957 in 1931 to 66,009 long tons valued at $405,532 in 1932. In 1932 the Florida district exported 36,540 long tons of high-grade hard rock with a value of $248,880, or only 1,760 tons less than in 1931. The exports of high-grade hard rock from the Montana-Idaho district, however, were only 29,263 long tons valued at $154,255, due to the lessened demand from Canada. This represents a decrease of 54 percent in quantity and 53 percent in value from 1931. Exports from other customs districts totaled only 206 long tons.

Imports.—Relatively small quantities of phosphatic materials are imported into the United States. In 1932 imports amounted to 12,982 long tons valued at $93,847. The 1932 imports were slightly less in quantity than those in 1931 but considerably lower in value than in the preceding year, because of the low valuation placed upon a shipment of apatite from Russia.

The imports of crude phosphate rock were 6,375 long tons ($70,039) and had an average value of $10.98 per ton. They included 6,300 long tons from French Oceania entering Hawaii, 50 tons from United Kingdom into Baltimore, and 25 tons from Germany into Los Angeles. Imports of Russian apatite totaled 6,607 long tons ($23,808) with an average value of $3.60 per ton; 6,600 tons entered at Baltimore and 7 tons at New York.

Invasions of the American market by various phosphatic materials from different countries, offered at low prices, have led to several attempts to exclude these and similar material through recourse to the antidumping act of 1921 and the Tariff Act of 1930.

In 1928 the antidumping law was invoked with respect to imports of phosphate rock from French Morocco. The phosphate rock in question was entered at Baltimore between July 18, 1927 and January 19, 1928, at invoice prices ranging from $6.50 to $7 per ton, less freight which ranged from $2.05 to $2.50 per ton. The Baltimore customs appraiser, suspecting that the purchase price thereof was less than the foreign market value, notified the Secretary of the Treasury of such fact and withheld appraisement. Thereafter on February 9, 1928, the Secretary of the Treasury made a finding of dumping pursuant to the antidumping act (T.D. 42577). The customs appraiser then fixed the foreign value at $7.52 per ton and applied the antidumping law. From this judgment of the appraiser an appeal was taken and heard by a single judge of the United States Customs Court at Baltimore; at this hearing the foreign market value, based on sales by the Government in Morocco to farmers, cooperative societies, and manufacturers in that country, was fixed at $3.98 per ton. The court held that sales by the Government in the home market (purchasers being prohibited from exporting the article) created a foreign market value within the meaning of the act, and the entered value was sustained. Judgment was entered accordingly on March 29, 1929. (T.D. 43,306.) An appeal was taken from this judgment by the Government to the Third Division of the United States Customs Court, which affirmed the judgment of the trial judge. (Circ. 1478.) Appeal was taken from this judgment to the Court of Customs and Patent Appeals, which reversed the judgment of the Third Division (United States *v.* J. H. Cottman & Co., 18 C.C.P.A. 132—T.D. 44,095) on one item, namely, that the trial court erred in not admitting certain evidence.

The cause was thereby remanded to the lower court for a new trial. The evidence referred to was admitted at the new trial, but in decision rendered on January 27, 1931 (T.D. 44,581) the United States Customs Court adhered to its former holding that the foreign market value on the date of purchase was $3.98 per ton, and that there was not any dumping within the provisions of the antidumping act, and again sustained the entered value.

The cause was again taken on review to the Third Division, where it was held that the evidence in the record showed a controlled market; that there was no foreign market value established as required; that there was no cost of production shown in the record; and that the appeal to the single judge should have been dismissed for failure to make sufficient proof. The judgment was reversed and the cause remanded for further proceedings consistent with the decision. It was then brought, on cross appeals, to the United States Court of Customs and Patent Appeals, which on December 19, 1932, affirmed (T.D. 46,114) the judgment of the lower court, thereby sustaining the original action of the customs authorities in applying the provisions of the antidumping act.

Two investigations are now in progress by the United States Tariff Commission, one a general inquiry as to costs of production of phosphates and superphosphates and the other an inquiry into allegedly unfair practices in the importation of apatite from Soviet Russia.

The Tariff Commission was directed by Senate Resolution 298, December 8, 1932, introduced by the late Sen. T. J. Walsh of Montana, to investigate, under the authority conferred by section 336 of the Tariff Act of 1930, the differences in the foreign and domestic costs of production of phosphates and superphosphates and similar articles. On December 15, 1932, the Tariff Commission announced the institution of an investigation to carry out the requirements of the Walsh resolution.

In an attempt to bar importation of apatite from Soviet Russia the International Agricultural Corporation, Phosphate Recovery Corporation, and the American Cyanamid Co. filed a complaint with the United States Tariff Commission on October 21, 1932, after consideration of which the Tariff Commission instituted on December 15, 1932, an investigation, under section 337 of the Tariff Act of 1930, "into the allegedly unfair methods of competition or unfair acts in violation of said section in the importation or sale in the United States of phosphates and apatite, and combinations thereof, or of either, with any other substance or substances, all the foregoing concentrated or floated by any process described in U.S. Letters Patent Nos. 1547732, 1780022, and 1795100." Notices were served on the Standard Wholesale Phosphate and Acid Works, Inc., of Baltimore, and the Amtorg Trading Co., of New York City.

FULLER'S EARTH

By W. W. Adams and C. Galiher

Production of fuller's earth in the United States has increased almost phenomenally during the 38 years for which annual figures are available. In every year but 10 during that period the output has been larger than in the preceding year; however, 1932 and 1931 were 2 of 10 exceptions. The quantity produced [1] in 1932 was 252,902 short tons valued at $2,440,736, an average of $9.65 per ton. Compared with 1931 these figures represent a decline of 12 percent in total output, 20 percent in total value, and 9 percent in average value per ton.

Twenty-one plants in 10 States reported production; 11 of these plants in 5 States east of the Mississippi River produced 178,477 tons having a total value of $1,737,643, or $9.74 per ton. Contributing to this tonnage, in the order of output, were Georgia, Florida, Illinois, Massachusetts, and Alabama. Ten plants in five States (Texas, Utah, Nevada, Colorado, and California) west of the Mississippi River produced 74,425 tons valued at $703,093, or $9.45 a ton. Because of the small number of companies operating in certain States separate figures for each State cannot be revealed without disclosing the production of individual companies.

Salient statistics of the fuller's earth industry in the United States, 1931–32

	1931	1932	Percent change
Sold or used by producers:			
Short tons	288,400	252,902	−12.3
Value	$3,055,570	$2,440,736	−20.1
Per ton	$10.59	$9.65	−8.9
Distribution of domestic production, by uses:			
Bleaching, clarifying, decolorizing, or filtering:			
Mineral oils:			
Short tons	272,177	233,028	−14.4
Percent of total	94.4	92.2	
Vegetable oils and animal fats:			
Short tons	14,133	17,528	+24.0
Percent of total	4.9	6.9	
Miscellaneous uses:			
Short tons	2,090	2,346	+12.2
Percent of total	.7	.9	
Imports:			
Unwrought or unmanufactured:			
Short tons	136	96	−29.4
Value	$1,534	$1,040	−32.2
Wrought or manufactured:			
Short tons	3,877	3,789	−2.3
Value	$47,430	$32,927	−30.6
Total imports:			
Short tons	4,013	3,885	−3.2
Value	$48,964	$33,967	−30.6
Exports:			
Short tons	8,368	14,194	+69.6
Value	$77,945	$128,157	+64.4

[1] Wherever production is mentioned in this paper reference is to quantities shipped, delivered, or used by producers.

Fuller's earth is a mineral substance that resembles clay and has physical qualities giving it a high capacity for absorbing basic colors and removing these colors from solution in mineral, vegetable, or animal oils. For statistical purposes the United States Bureau of Mines classes as fuller's earth all natural bleaching or filtering claylike materials, provided the earth requires no chemical treatment to activate it.

Uses.—Approximately 95 percent of all fuller's earth produced in the United States during the past 3 years has been used for decolorizing mineral oils, and 5 percent has been employed in similarly treating vegetable oils and animal fats. Less than 1 percent was utilized for fulling cloth, as a binder, as a filler, or for other purposes. Production in 1932 and the 5 preceding years, classified by use, is given in the table given below. Similar figures for years before 1927 are not available.

Fuller's earth was originally used by fullers to full or scour and cleanse cloth of grease and by furriers to remove grease from fur. These early uses have long ceased to be important in the United States.

Fuller's earth sold or used by producers in the United States, 1927–32, by uses

Year	Bleaching, clarifying, decolorizing, or filtering				Miscellaneous uses		Total	
	Mineral oils		Vegetable oils and animal fats		All other uses			
	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	233,028	2,244,772	17,528	180,208	2,346	15,756	252,902	2,440,736
PERCENT OF TOTAL PRODUCTION AND TOTAL VALUE								
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	92.2	92.0	6.9	7.4	.9	.6	100	100

[1] Not available.

Long-time trends in the industry.—Figure 81 and the second table on page 712 show the number of tons of fuller's earth produced in the United States each year from 1895 to 1932, the entire period for which data are available.

The earliest discovery of fuller's earth in the United States was in Arkansas in 1891, and the next discovery was in Florida in 1893. Actual figures of production, however, begin with 1895 when the entire reported output in the United States was 6,900 tons, all obtained from deposits near Quincy, Fla.

It will be observed from figure 81 that domestic production reached a maximum in quantity and value in 1930.

Notwithstanding the decline in domestic production in 1932, the year's output was larger than at any time before 1927, although the average value per ton ($9.65) has not been so low since 1913 when it was $9.58.

Doubtless small quantities of fuller's earth were produced in several States other than Arkansas and Florida before 1895 as a result of active and widespread search for new deposits following the discovery in Florida in 1893. Such quantities probably were consumed locally or used for experimental purposes.

In 1895 and 1896 the entire reported output of fuller's earth in the United States was from Florida. In 1897 small quantities were produced in Colorado and New York. Utah first reported production in 1898. Although fuller's earth was discovered in Arkansas in 1891, that State did not appear among the reporting States until 1901.

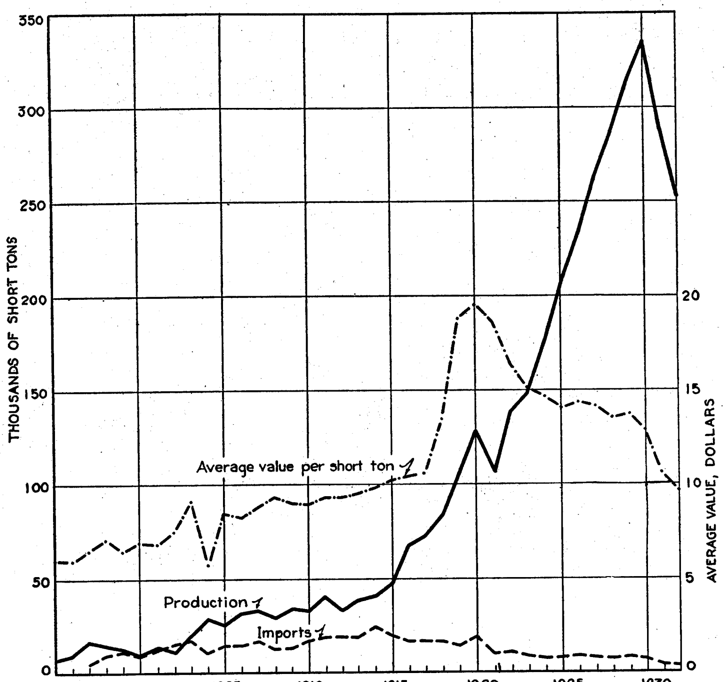

FIGURE 81.—Trends in production, imports, and average value per short ton of fuller's earth, 1895–1932.

Alabama and Massachusetts first reported production in 1904; Georgia, South Carolina, and Texas in 1907; California in 1908; Illinois and Pennsylvania in 1922; Arizona in 1927; and Idaho in 1931.

States reporting production of fuller's earth at any time since 1895, whose output has been included in annual statistics of production in the United States, are Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Illinois, Massachusetts, Nevada, New York, Pennsylvania, South Carolina, Texas, and Utah.

The following table and figure 82 show the entire quantity of fuller's earth produced in each State since the first recorded output in 1895, as far as figures for individual States may be revealed. In preparing the chart and table it was necessary to estimate the yield of several States from 1898 to 1906 because, although production in those States was reported at the time, separate figures are no longer obtainable.

Total production and value of fuller's earth, by States, since first year of production in each State, to and including 1932

State	Short tons	Value
Florida	1,613,082	$22,610,179
Georgia	1,172,495	16,222,660
Texas	393,542	4,045,548
Illinois, Pennsylvania, New York, and Massachusetts	282,553	3,198,230
Nevada	196,972	1,909,636
Colorado, Utah, Arizona, and Idaho	45,459	556,406
Arkansas	34,045	301,460
Alabama and South Carolina	6,610	71,898
California	5,137	51,113
	3,749,895	48,967,130

Production, imports, and exports of fuller's earth, 1895–1932

[Value of production in United States and of exports therefrom represents value at mines; value of imports represents value at foreign port from which the material was shipped]

Year	United States production				Imports				Exports		
	Operators reporting sales	Short tons	Value at mines		Unwrought or unmanufactured		Wrought or manufactured		Operators reporting exports	Short tons	Value
			Total	Average	Short tons	Value	Short tons	Value			
1895	(1)	6,900	$41,400	$6.00	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1896	(1)	9,872	59,360	6.01	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1897	(1)	17,113	112,272	6.56	[2] 2,585	[2] $14,283	[2] 2,395	[2] $20,037	(1)	(1)	(1)
1898	(1)	14,860	106,500	7.17	2,283	15,921	7,073	55,123	(1)	(1)	(1)
1899	(1)	12,381	79,644	6.43	4,192	23,194	7,366	46,446	(1)	(1)	(1)
1900	(1)	9,698	67,535	6.96	2,723	14,750	6,431	50,047	(1)	(1)	(1)
1901	(1)	14,112	96,835	6.86	3,266	17,230	8,792	63,467	(1)	(1)	(1)
1902	(1)	11,492	98,144	8.54	4,239	26,635	10,895	75,945	(1)	(1)	(1)
1903	(1)	20,693	190,277	9.20	4,260	28,339	12,840	92,332	(1)	(1)	(1)
1904	(1)	29,480	168,500	5.72	1,975	9,546	8,247	64,460	(1)	(1)	(1)
1905	(1)	25,178	214,497	8.52	1,705	12,798	12,858	93,199	(1)	(1)	(1)
1906	(1)	32,040	265,400	8.28	2,905	20,129	11,920	88,566	(1)	(1)	(1)
1907	(1)	32,851	291,773	8.88	2,490	16,833	13,916	105,388	(1)	(1)	(1)
1908	(1)	29,714	278,367	9.37	2,363	16,242	9,803	77,171	(1)	(1)	(1)
1909	15	33,486	301,604	9.01	1,802	12,492	10,950	88,659	(1)	(1)	(1)
1910	17	32,822	293,709	8.95	2,160	14,399	14,427	118,146	(1)	(1)	(1)
1911	13	40,697	383,124	9.41	1,881	10,877	16,343	132,717	(1)	(1)	(1)
1912	13	32,715	305,522	9.34	1,970	11,619	17,139	133,718	(1)	(1)	(1)
1913	10	38,594	369,750	9.58	1,916	12,344	16,712	133,657	(1)	(1)	(1)
1914	14	40,981	403,646	9.85	1,468	9,283	23,509	185,800	(1)	(1)	(1)
1915	12	47,901	489,219	10.21	850	5,176	18,591	147,317	(1)	(1)	(1)
1916	10	67,822	706,951	10.42	1,132	7,742	15,669	131,922	(1)	(1)	(1)
1917	11	72,567	772,087	10.64	1,441	11,718	15,553	164,699	(1)	(1)	(1)
1918	14	84,468	1,146,354	13.57	1,085	12,636	15,837	213,599	(1)	(1)	(1)
1919	10	106,145	1,998,829	18.83	373	4,301	13,500	185,410	(1)	(1)	(1)
1920	12	128,487	2,506,189	19.51	1,518	19,793	17,497	202,100	(1)	(1)	(1)
1921	12	105,609	1,973,848	18.69	483	6,172	9,261	113,243	(1)	(1)	(1)
1922	15	138,944	2,289,719	16.48	607	7,413	9,962	128,282	(1)	(1)	(1)
1923	15	149,134	2,247,523	15.07	642	8,252	7,905	105,692	(1)	(1)	(1)
1924	13	177,994	2,632,342	14.79	296	3,385	7,006	89,103	5	3,700	(1)
1925	14	206,574	2,923,965	14.15	215	2,619	7,800	108,676	5	6,319	$97,691
1926	14	234,152	3,356,482	14.33	158	2,290	8,940	121,384	5	6,195	91,975
1927	16	264,478	3,767,038	14.24	550	5,679	7,030	103,602	5	6,650	105,641
1928	17	287,012	3,895,991	13.57	354	6,710	7,239	125,293	6	12,287	191,835
1929	17	315,983	4,309,723	13.64	608	11,583	7,694	140,849	8	16,494	198,374
1930	15	335,644	4,326,705	12.89	386	5,805	6,849	150,715	7	21,264	258,408
1931	22	288,400	3,055,570	10.59	136	1,534	3,877	47,430	7	14,237	161,128
1932	21	252,902	2,440,736	9.65	96	1,040	3,789	32,927	6	8,368	77,945
									8	14,194	128,157

[1] Figures not available.

[2] July to December only.

REVIEW BY STATES

Alabama.—Fuller's earth produced in Alabama in 1932 was entirely from Barbour County. It was the first report from this State since 1924, when the output was from De Kalb County.

California.—Production in 1932 was from Inyo County. Output in 1931 was reported by Inyo and San Bernardino Counties, but before 1931 no fuller's earth had been produced in California since 1926, when the output was fron Kern County.

Colorado.—Mineral County reported production in 1932 and has been a consistent producer since 1928. Before 1928 no output from Colorado had been reported since 1914, when the production was from Washington County.

Florida.—Fuller's earth was produced in Gadsden and Marion Counties in 1932. With this production Florida ranked second among the 10 States that produced fuller's earth during the year. Until

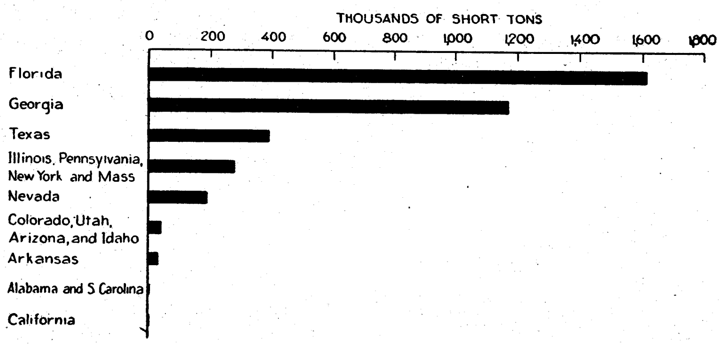

FIGURE 82.—Cumulative production of fuller's earth since the year of earliest reported output in each State.

1924 Florida had a larger annual production than any other State, but in that year its output was exceeded by that of Georgia.

Georgia.—Production was reported from Decatur, Twiggs, and Wilkinson Counties. Georgia has been the largest producer of fuller's earth since 1924, when its output for the first time surpassed that of Florida, the leader since 1895.

Illinois.—All of the Illinois production was from Pulaski County.

Massachusetts.—Norfolk and Worcester Counties produced fuller's earth in 1932.

Nevada.—All production from Nevada in 1932 was reported by Nye County.

Texas.—Bexar, Gonzales, and Walker Counties produced fuller's earth in Texas in 1932.

Utah.—The entire production from this State was reported by Sevier County.

Other States.—States that did not produce fuller's earth in 1932 but that have nevertheless reported production at some time during the preceding 10 years (1922–31) are Arizona, Arkansas, Idaho, and Pennsylvania.

FOREIGN TRADE

Imports.—Records of imports are available for 1867 to 1883 and 1897 to 1932; no figures can be obtained for 1884 to 1896 because the Government's published records of imports for these years do not show fuller's earth as a separate item, the imports having been included with articles "not otherwise classified."

Fuller's earth imported into the United States in 1932 totaled less than 2 percent of the quantity produced within the country. Compared with 1931 the tonnage of imports declined 3 percent and the total value 31 percent. The quantity imported in 1932 was smaller than in any preceding year for which continuous records are available.

Imports have been declining for more than 15 years, having reached their highest level in quantity in 1914 and in value in 1918.

The amount and value of fuller's earth imported into the United States since 1897 are shown in the table on page 712.

Exports.—Relatively small quantities of domestic fuller's earth are exported. Producers' reports to the United States Bureau of Mines indicate that exports in 1932 were only 14,194 short tons valued at $128,157, an average of $9.03 a ton. This quantity was exported by eight producers, chiefly to Canada, but smaller amounts were shipped to Mexico, Venezuela, Peru, Argentina, Germany, and the Union of Soviet Socialist Republics. Exports during the past 10 years are shown in the table on page 712.

TALC AND GROUND SOAPSTONE

By Alden H. Emery and B. H. Stoddard

For many years talc and soapstone have been included in a single chapter of Mineral Resources because talc is present in varying amounts in all true soapstones and because there is some similarity in the uses of the two minerals. A small amount of massive talc (steatite) is shaped into insulators, crayons, and other forms comparable with soapstone products, and a limited tonnage of soapstone is pulverized and sold for the same uses as low-grade ground talc. Aside from these activities, which use a very small fraction of the total output, the two industries are quite diverse. About 95 percent of all talc mined is sold pulverized whereas at least an equal precentage of all soapstone is marketed as slabs, blocks, or other structural products. Therefore, for the first time, soapstone, except that ground and sold in competition with impure talc, is considered in the chapter of this yearbook on Dimension Stone and Slate. Production of pyrophyllite, a mineral resembling talc in color, luster, and feel and employed as a substitute for it in many products, is included herein. As the major commercial production of ground soapstone may not be shown separately the figures in this report represent only talc and a small amount of ground soapstone marketed as talc.

The total quantity of talc sold by producers in the United States in 1932 was 123,221 short tons valued at $1,361,633. The industry continued in 1932 the downward trend begun in 1930. In that year the value of sales of domestic production of talc decreased 19.8 percent compared with 1929. This rapid rate of decline was partly arrested in 1931, when the value dropped only 12.1 percent. In 1932 an even more rapid reduction was recorded—26.5 percent—making the average decline for the 3 depression years about the same as the pace set in 1930. In a similar manner, tonnage fell off 18.4 percent in 1930, strengthened to an 8.7 percent decline in 1931, and dropped 24.8 percent in 1932, an average decrease similar to that of 1930. The total quantity sold and its value, as reported by 24 producers, were the lowest recorded since 1921.

As shown in the following table giving the sales of talc by domestic producers from 1928 to 1932 the material is sold in three forms—crude, sawed and manufactured, and ground. Although the distribution of the tonnage between these forms has varied from year to year, since 1928 the ground material has accounted for 94 percent or more of the annual sales of talc. In 1932 the distribution was: Crude 4.6 percent; sawed and manufactured, 0.1 percent; and ground, 95.3 percent.

Talc sold by producers in the United States, 1928–32, by classes

Year	Crude		Sawed and manufactured		Ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1928	6,360	$48,031	936	$70,394	195,680	$2,419,569	202,976	$2,537,994
1929	11,228	87,820	473	140,928	208,082	2,399,914	219,783	2,628,662
1930	4,972	48,913	385	90,370	174,028	1,969,055	179,385	2,108,338
1931	6,673	47,382	181	51,740	156,898	1,753,350	163,752	1,852,472
1932	5,635	51,657	107	17,749	117,479	1,292,227	123,221	1,361,633

Prices.—Talc is marketed in various forms, and the price depends principally on the kind and grade of material. In 1932 the average price of crude talc for the United States ranged from $3 to over $35 a short ton. High-grade massive crude talc suitable for the manufacture of crayons, pencils, and lava tips sold at the highest figure; it was produced in Georgia, Maryland, North Carolina, and Vermont. Sawed and manufactured talc, including crayons, pencils, and other products, ranged in price from about $100 to $300 a ton. The average value of ground talc in the United States was about $11 a ton. High-grade ground talc from California for use in toilet powder averaged about $15 a ton. Some of the highest grade, however, was quoted at $60 a ton. New York talcs, which were all sold ground, ranged from $10 to $12 a ton, f.o.b. mine shipping point, without containers. The value of ground talc sold from Vermont ranged from about $7 to $10 a ton.

Uses.—Ground talc is used extensively as a filler in paper, paint, rubber, textiles, and various other products. It is employed also for foundry facings, lubricants, and various toilet preparations, such as talcum powder; in ceramics and glass making; as a polishing agent for glass, peanuts, and rice; as an insecticide; and as an insulating material for underground conduits. Large quantities of low-grade talc are used in the manufacture of composition roofing, both as surface material to increase weather-resisting qualities and as a nonadhesive coating to prevent sticking. It is used also in rubber factories to prevent rubber compounds from adhering to hot rollers.

Because of their electrical resistance and remarkable property of hardening under heat treatment certain massive talcs free from iron oxide or grit and without cracks or cleavage planes are used for manufacture of the so-called "lava" products. The material, which is easily carved in its natural soft state, is fashioned into innumerable electrical fittings, such as bushings, blocks, tubes, disks, or threaded cores. The articles are then heated to about 1,100° C., such calcination having the peculiar effect of rendering the product hard enough to cut glass; yet the expansion, contraction, and distortion resulting from heating and subsequent cooling are so minute that the shapes, sizes, and even the accuracy of the milling remain unimpaired. The purer forms of massive talc are employed chiefly for electrical insulation. Massive talc is used also in the manufacture of crayons, pencils, and French chalk (tailor's chalk).

Off-color talc and soapstone are consumed in increasing amounts for rock-dusting coal mines to reduce the explosion hazard. The chief of the Department of Mines of West Virginia believes that almost as much soapstone as limestone is being used in his State. The choice between these two dusts is based largely on economic considerations. In the Pocahontas field, for example, limestone is cheaper than soapstone, while in the Logan and Boone County fields the condition is reversed.

Laboratory tests by the Pittsburgh Experiment Station of the Bureau of Mines show that soapstone dust has the least tendency to cake after wetting of any rock-dusting materials tested. On the other hand, laboratory physiological tests indicate that, if inhaled, soapstone dust tends to produce a fibrotic condition in the lungs. While the Bureau cannot recommend its use in comparison with limestone, for example, it is thought that the health hazard of its use for rock-dusting is small except to motor and switch men on dusty roads, and these men can protect themselves by using breathing masks.

In Bureau of Mines Bulletin 213, by Ladoo,[1] 60 uses are listed for powdered talc and soapstone.

REVIEW BY STATES

As shown in the following table, New York continued as the leading State in sales of talc. In 1932 New York sold 62,833 tons of material valued at $764,692, representing 51.0 percent of the total sales tonnage and 56.2 percent of the value for the year. Vermont was second in importance, with sales of about 24.6 percent of the tonnage and 18.4 percent of the value. California added 8.1 percent of the tonnage and 10.2 percent of the value; 16.2 percent of the tonnage and 15.2 percent of the value came from Georgia, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, and Wyoming.

Talc sold by producers in the United States, 1930–32, by States

State	1930		1931		1932	
	Short tons	Value	Short tons	Value	Short tons	Value
California	14,993	$219,246	11,605	$180,582	9,979	$139,322
Georgia	(a)	(a)	(a)	(a)	(a)	(a)
Maryland	(a)	(a)	(a)	(a)	(a)	(a)
Nevada	50	600				
New Jersey and Pennsylvania	(a)	(a)	(a)	(a)	(a)	(a)
New York	93,216	1,192,604	84,977	1,059,790	62,833	764,692
North Carolina	(a)	(a)	15,283	170,250	(a)	(a)
Vermont	45,881	399,548	38,424	318,322	30,361	250,130
Virginia	(a)	(a)	(a)	(a)	90	1,260
Wisconsin	1,078	3,499	3,583	11,646		
Undistributed	24,167	292,841	9,880	111,882	19,958	206,229
	179,385	2,108,338	163,752	1,852,472	123,221	1,361,633

[a] Included under "Undistributed."

[1] Ladoo, Raymond B., Talc and Soapstone, Their Mining, Milling, Products and Uses: Bull. 213, Bureau of Mines, 1923, 133 pp.

Producers of talc and soapstone in the United States in 1932

Producer	Material	Product	Location of mine
CALIFORNIA			
W. S. McLean, 1919 San Bruno Avenue, San Francisco.	Soapstone	Ground	Butte County.
Pacific Coast Talc Co., 2149 Bay Street, Los Angeles.	Talc	do	7 miles north of Silver Lake station, San Bernardino County.
Sierra Talc Co., 428 Union League Building, Los Angeles.	do	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	do	Near Jamestown, Tuolumne County.
GEORGIA			
Cohutta Talc Co., Dalton	Talc	Crayons, ground	Chatsworth, Murray County.
Georgia Talc Co., Asheville, N.C.	do	do	Foot of Cohutta Mountain, 3¼ miles southeast of Chatsworth, Murray County.
MARYLAND			
Harford Talc & Quartz Co., 4 Reckford Building, Towson.	Talc, massive steatite, or "lava" grade.	Rough	Near Dublin, Harford County.
Herbert I. Oursler, Marriottsville	Talc schist	do	Near Henryton, Carroll County.
NEW JERSEY			
Rock Products Co., 403 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	Ground	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			
Nantahala Co., Andrews	do	Rough, blanks, crayons.	Hewitt, Swain County.
Notla Talc Co., Murphy	do	Rough, crayons, ground.	Near Murphy, Cherokee County.
Standard Mineral Co., Inc., Hemp	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 13th Street, Easton.	Talc and serpentine.	do	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.
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, 153 West 23d Street, New York, N.Y.	Soapstone	Furnace blocks, special products, ground.	Schuyler, Nelson County.
WYOMING			
Labbe Manufacturing Co., 1235 South Broadway Street, Denver, Colo.	Talc	Ground	Near Wheatland, Platte County.

California.—In 1932 the total marketed production of talc and soapstone in California was produced in Butte, Inyo, San Bernardino, and Tuolumne Counties. The total quantity sold (9,979 short tons), was valued at $139,322, an average value per ton of $13.96. Five producers contributed the entire output, the lowest since 1921. Ninety-three percent of the total commercial output was sold ground for use in the cosmetic, ceramic, rubber, and paint and paper trades. The mine and plant of the Pacific Coast Talc Co. have been described in the literature.[2]

Georgia.—Commercial activities in the talc industry in Georgia in 1932 were reduced materially, owing partly to discontinuance in July of operations by one of the former largest producers—the Georgia Talc Co. Two grades of material were marketed—talc crayons and ground talc. Decreases of 32 percent in quantity and 60 percent in value were recorded compared with 1931.

Maryland.—The high-grade refractory talc produced in Maryland is used in the manufacture of lava tips for gas burners, of electrical insulation, and of heat-resisting parts. The sole producer was the Harford Talc & Quartz Co., formerly the Harford Talc Co. The product of the Oursler property near Henryton, Carroll County, is an impure talc schist used principally for foundry facings.

New Jersey and Pennsylvania.—Operations in New Jersey were conducted, as usual, by the Rock Products Co. at Phillipsburg, N.J., and in Pennsylvania by C. K. Williams & Co., at Easton.

New York.—New York has been the leading producer of talc in the United States for many years. In 1932 three producers supplied over 62,000 short tons, constituting 51 percent of the total commercial production in the United States for that year, and the value ($764,692) was 56 percent of the total for the country. Two varieties of talc were mined in this State—fibrous talc from St. Lawrence County, mined by the International Pulp Co. and the W. H. Loomis Talc Corporation, and granular talc produced near Natural Bridge by the Carbola Chemical Co. (Inc.). Ground talc was the only grade shipped, and the average value a ton was $12.17.

North Carolina.—The total commercial production of talc and pyrophyllite in North Carolina in 1932 was about 10 percent below that of 1931; the value decreased about 12 percent. North Carolina has produced some high-grade talc for pencils, crayons, and gas tips, but by far the largest part of the output in 1932 was pyrophyllite, which was sold ground. The Talc Mining & Milling Corporation, Jersey City, N.J., a new producer, operated a talc property at Glendon, N.C. The output was sold in ground form.

Vermont.—Almost the entire production of talc in Vermont in 1932 was sold ground. The Eastern Magnesia Talc Co. produced talc crayons, as usual, and a small amount of talc was sold crude by another company. The average selling price per ton of Vermont ground talc was $8.19.

Virginia.—One producer of talc and two producers of soapstone contributed the total output of talc and soapstone in Virginia in 1932. The Virginia Alberene Co. at Schuyler, Nelson County, Va., is the major producer. The greater part of the company's product (soapstone), used for structural purposes, is reported in the chapter on Dimension Stone and Slate.

[2] Wicks, Frank R., Crystalline Talc: Mining in California, Rept. 27 of State Mineralogist, vol. 27, no. 1, January 1931, pp. 100-104; Eng. and Mining World, vol. 2, 1931, pp. 37-39.

Wyoming.—In 1932 commercial production of talc in Wyoming was reported by the Labbe Manufacturing Co., Denver, Colo., which operated a mine near Wheatland. The product, which is adapted to use in certain manufacturing industries, including rubber and roofing goods, also is reported to be manufactured by the company into a product of its own called "Slip-er-e", which is used as a dance-floor powder. The raw material is said to withstand a temperature of 1,850° F. without signs of disintegration.

IMPORTS, EXPORTS, AND WORLD PRODUCTION

The following table shows gradually declining importations of talc for consumption in the United States. In 1930 and 1931 the decline in tonnage of imports paralleled the decline in tonnage of domestic sales of talc. In 1930 the quantity imported fell 17.3 percent, sales 18.4 percent; in 1931, imports declined 8.9 percent, sales 8.7 percent. In 1932, however, imports held up better than domestic sales, dropping 14.4 percent compared with a reduction of 24.8 percent in sales. In other words, in 1930 and 1931 imports amounted to 14.4 percent of domestic sales, while in 1932 they increased to 16.3 percent of domestic sales. The same relationship does not hold true for the value of the material, since the decline in value of imports has been slightly less each year—21.1 percent in 1930, 18.1 percent in 1931, and 17.0 percent in 1932—while the value of sales of domestic talc has declined approximately parallel with the decline in tonnage—19.8 percent, 12.1 percent, and 26.5 percent in 1930, 1931, and 1932, respectively.

Talc imported for consumption in the United States, 1928–32

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
1928	459	$33,276	26,590	$546,639	27,049	$579,915
1929	1,228	74,840	29,949	596,789	31,177	671,629
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

Of the total imported for consumption in the United States in 1932, 5,635 tons valued at $51,657 were crude material.

The highest-grade talc in the World is mined in Italy. Its superior color, freedom from grit and impurities, and fineness of grain make it especially well suited for cosmetics. For this reason 53.2 percent of the value of the total imports of talc and ground soapstone in 1932 was from Italian material. In tonnage, 34.6 percent of the total is from this source.

France is an important producer of toilet and lava grades of talc. French (tailor's) chalk also is mined. Of the total imports France furnished 21.4 percent of the value and 29.8 percent of the amount.

Canadian talcs generally command a slightly higher price than those of the eastern United States, since some are suitable for certain grades of toilet powder. Most of the tonnage, however, is used in industries demanding a medium high-grade material. For this reason the average value per ton is less than that of the French material. Canada supplied 31.9 percent of the tonnage of imports and 16.3 percent of their value in 1932.

Italy, France, and Canada account for 96.3 percent of the 1932 imports (tonnage) into the United States of talc and ground soapstone, as shown in the following table. The value of their products makes up 90.9 percent of the total.

The discrepancy between the relative importance of the tonnage and value of imports from this group of countries is due to material from China. Although imports from this section of the Orient in 1932 were only 147 tons (0.7 percent) the value ($24,649) is 6.9 percent of the total. This high-value material probably is stone for carving rather than grinding, although it is not known definitely. Massive talc or high-grade soapstone has been mined for years in China for the manufacture of carved utensils, images, and ornaments. Much of the material, though ideal for carving, is too highly colored for ground talc.

Talc, steatite or soapstone, and French chalk, crude, manufactured, or ground, imported into the United States, 1931–32, by countries

[General imports]

Country	1931		1932	
	Short tons	Value	Short tons	Value
Africa:				
British:				
Union of South Africa	99	$3,071	29	$765
Austria	34	994	33	896
Canada	6,829	67,817	6,379	58,097
China	326	50,447	147	24,649
Cuba	29	1,435		
France	8,020	94,556	5,952	76,436
Germany	29	1,406	(1)	29
Hong Kong	(1)	98	1	96
India (British)	(1)	166		
Italy	7,707	207,542	6,917	190,068
Japan	394	8,450	368	4,979
Kwantung			34	360
Norway			44	296
Soviet Russia in Europe	20	162	74	438
Spain	4	160		
United Kingdom	57	494		
	23,548	436,798	19,978	357,109

[1] Less than 1 ton.

General imports and imports for consumption for any period will differ to the extent that the value of entries for warehouse for the period differs from the value of withdrawals from warehouse for consumption. The term "entry for consumption" is the technical name of the import entry made at the customhouse and implies that the goods have been delivered into the custody of the importer and that the duties have been paid on the dutiable portion. Some of them may be exported afterwards, accounting for the slight discrepancies between the two foregoing tables.

Exports of talcum and other powders from the United States are given in the following table. Unfortunately the figures for different years are described in various ways and may not be entirely comparable.

Exports of talcum and other powders from the United States, 1928–32

Year	Description	Short tons	Value
1928	Talcum and other toilet powders	1,568	$1,605,630
1929	Powders—talcum, face, compact, bath, and other toilet powders	(1)	1,592,301
1930	Talcum, in bulk	478	36,410
	Powders—talcum (in packages), face, and compact toilet powders	(1)	1,447,928
1931	Powders—talcum, face, and compact	(1)	1,244,525
1932	Powders—talcum, face, and compact	(1)	646,605

[1] Quantity not recorded.

The following table gives the world production of talc and soapstone, 1928 to 1932, insofar as figures are available.

World production of talc and soapstone, 1928–32, by countries, in metric tons

Country [1]	1928	1929	1930	1931	1932
Australia:					
New South Wales	674	555	280	230	(2)
South Australia	641	776	811	817	(2)
Tasmania	33	23	14	15	5
Austria (exports)	19,755	19,603	18,530	16,979	(2)
Canada	14,567	[3] 14,069	[3] 10,742	[3] 10,710	[3] 10,980
Finland	4,725	2,848	2,800	3,000	(2)
France	89,500	105,560	85,900	(2)	(2)
Germany (Bavaria)	7,872	6,805	5,794	4,208	(2)
Great Britain	164	29	188	163	(2)
Greece	30	150	256	484	(2)
India (British)	5,628	7,333	6,967	5,217	(2)
Italy	33,030	40,810	38,131	38,620	(2)
Morocco, French (exports)	535	610	561	35	(2)
Norway	7,822	8,332	7,690	4,127	(2)
Rumania	2,164	1,077	3,353	3,068	(2)
Russia [4]	5,568	(2)	(2)	(2)	(2)
Spain	5,302	5,164	5,438	6,585	(2)
Sweden	4,876	7,026	5,117	4,837	(2)
Union of South Africa (Transvaal)	541	464	380	336	251
United States [5]	184,136	199,383	162,734	148,553	111,784
Uruguay (exports)	985	786	1,463	1,789	(2)

[1] In addition to the countries listed, Argentina and Brazil produce a small quantity of talc, but data of production are not available. Rail and river shipments in Argentina for 1928 were reported as 440 kilograms.
[2] Data not available.
[3] Exceeding soapstone, which is only recorded by value and was as follows: 1929, $47,986; 1930, $50,168; 1931, $34,439; 1932, $46,751. Probably the soapstone is mostly block, rather than ground material.
[4] Year ended Sept. 30.
[5] Figures represent talc only. Bureau of Mines not at liberty to publish figures for soapstone.

FLUORSPAR AND CRYOLITE

By H. W. Davis

FLUORSPAR

Low activity in the industries using fluorspar and liquidation of the large stocks accumulated by consumers are reflected in shipments of only 25,251 short tons of domestic fluorspar (the lowest since 1901) and imports of only 13,236 short tons of fluorspar (the lowest since 1921). Keen competition for the small volume of business offered, production in excess of requirements during the last few years, and the low-cost output of considerable fluorspar from shallow workings in Kentucky resulted in drastic reductions in the selling prices of all grades of domestic fluorspar. During 1932 the selling prices f.o.b. Illinois-Kentucky mines of metallurgical-gravel fluorspar declined from \$15 to \$9 a ton and that of acid-lump fluorspar declined from \$28 to \$20 a ton.

Trends in production, imports, consumption, and average value of fluorspar over a series of years are shown in figure 83.

Salient statistics of the fluorspar industry in the United States, 1931–32

	1931		1932	
	Short tons	Value	Short tons	Value
Domestic shipments:				
Gravel	44,463	\$668,016	19,140	\$232,351
Lump	1,666	33,103	1,291	22,155
Ground	7,355	230,156	4,820	137,993
Total	53,484	931,275	25,251	392,499
Stocks at mines or shipping points:				
Ready to ship	62,541		55,211	
Crude	43,186		41,999	
Total	105,727		97,210	
Imports:				
Containing more than 97 percent CaF_2	8,504	110,271	6,152	87,854
Containing not more than 97 percent CaF_2	12,205	101,164	7,084	44,811
Total	20,709	211,435	13,236	132,665
Exports	311	5,599	25	553
Consumption (by industries):				
Metallurgical	71,200		39,500	
Ceramic	10,800		9,500	
Chemical	12,000		7,000	
Total	94,000		56,000	
Stocks at consumers' plants Dec. 31:				
Metallurgical	69,500		56,400	
Ceramic	2,000		1,600	
Chemical	14,000		11,000	
Total	85,500		69,000	

Shipments of fluorspar in 1932 amounted to 25,251 short tons, a decline of 28,233 tons compared with 1931 and 84,511 tons below the average for the 5-year period 1927 to 1931. Imports in 1932 were 13,236 short tons, a decline of 7,473 tons compared with 1931 and 38,495 tons below the average from 1927 to 1931. The average price per ton of fluorspar sold to steel plants by domestic producers was $12.13, a decline of $2.03 from 1931 and $3.89 below the average for the preceding 5 years. Consumption of fluorspar in the United States was 56,000 short tons, a decline of 38,000 tons from 1931 and 103,900 tons below the average for the preceding 5 years. Stocks of fluorspar

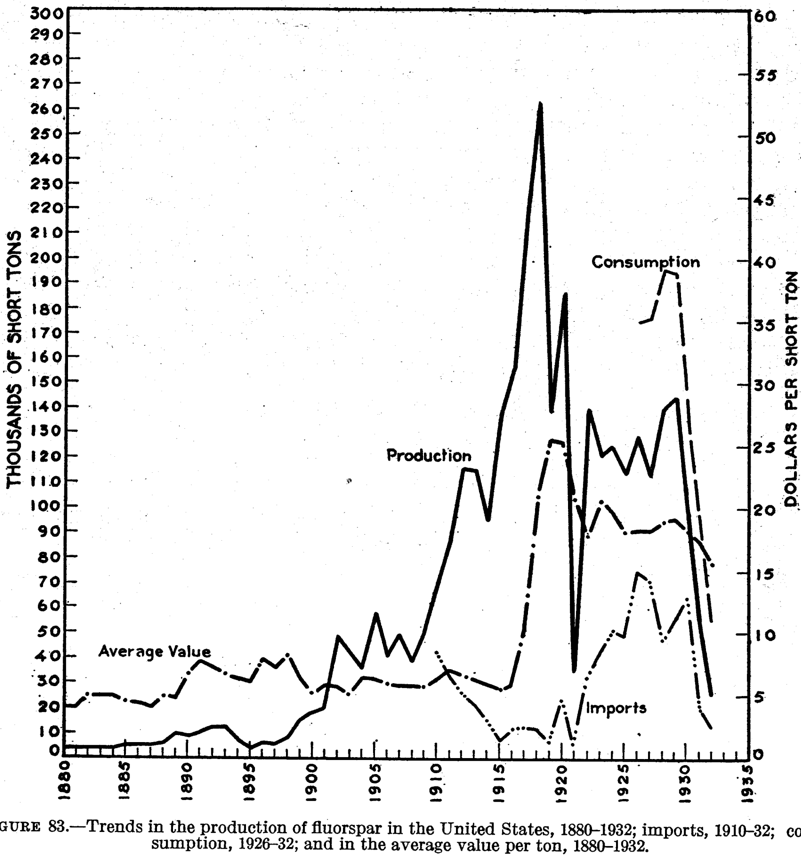

FIGURE 83.—Trends in the production of fluorspar in the United States, 1880–1932; imports, 1910–32; consumption, 1926–32; and in the average value per ton, 1880–1932.

at consumers' plants were 69,000 short tons, a decline of 16,500 tons from 1931 and 26,500 tons below the average from 1927 to 1931.

Production and shipments.—In 1932 fluorspar was produced at 40 mines or prospects which yielded an equivalent of about 17,000 short tons of merchantable fluorspar. In 1931, 48 mines or prospects were worked, yielding about 55,000 tons of merchantable fluorspar.

Shipments of fluorspar from domestic mines aggregated 25,251 short tons, valued at $392,499, a decrease of 53 percent in quantity and 58 percent in total value compared with 1931. The general average value for all grades was $15.54 a ton, $1.87 less than the 1931 average. The value recorded for domestic fluorspar is the price paid

Fluorspar shipped from mines in the United States, 1929–32

State	Gravel			Lump			Ground			Total		
	Short tons	Value		Short tons	Value		Short tons	Value		Short tons	Value	
		Total	Average		Total	Average		Total	Average		Total	Average
1929												
Illinois	59,101	$1,046,748	$17.71	2,926			4,982	$358,147	$32.38	67,009	$1,284,834	$19.17
Kentucky	60,393	1,087,593	18.01	4,356			6,078			70,827	1,390,603	19.63
Colorado	4,508			300	$201,725	$24.23	----	----	----	4,808	56,607	11.77
New Mexico	2,295	96,913	12.82	143			----	----	----	2,438	59,082	15.57
Nevada	757			600			----	----	----	1,357		
	127,054	2,231,254	17.56	8,325	201,725	24.23	11,060	358,147	32.38	146,439	2,791,126	19.06
1930												
Illinois	38,702	680,211	17.58	2,107			3,325	216,979	33.52	44,134	836,473	18.95
Kentucky	34,129	608,313	17.82	1,903			3,149			39,181	763,370	19.48
Colorado	9,198			50	98,672	23.05	----	----	----	9,248	101,758	11.00
New Mexico	2,188	142,468	11.62	124			----	----	----	2,312	45,042	13.71
Nevada	877			97			----	----	----	974		
	85,094	1,430,992	16.82	4,281	98,672	23.05	6,474	216,979	33.52	95,849	1,746,643	18.22
1931												
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		
Colorado	500	5,533	11.07	29	388	13.38	----	----	----	529	5,921	11.19
	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												
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		
Colorado	333	3,330	10.00	----	----	----	----	----	----	333	3,330	10.00
	19,140	232,351	12.14	1,291	22,155	17.16	4,820	137,993	28.63	25,251	392,499	15.54

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 $12.17 in 1932 compared with $14.23 in 1931.

The foregoing table presents such details of the shipments of fluorspar from 1929 to 1932, by States, as may be published without revealing, except by permission, data supplied by individual producers.

Shipments, by uses.—The two following tables show the relative dependence of the domestic 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, 1931–32, by uses

Use	1931				1932			
	Percentage	Short tons	Value		Percentage	Short tons	Value	
			Total	Average			Total	Average
Steel	74.48	39,832	$563,842	$14.16	74.77	18,881	$228,933	$12.13
Foundry	2.10	1,123	18,075	16.10	2.08	524	7,636	14.57
Glass	9.87	5,279	162,292	30.74	14.24	3,596	101,765	28.30
Enamel and vitrolite	3.73	1,996	65,458	32.79	4.99	1,261	36,318	28.80
Hydrofluoric acid and derivatives	8.20	4,386	108,136	24.65	2.92	738	14,603	19.79
Miscellaneous	1.04	557	7,873	14.13	.90	226	2,691	11.91
	99.42	53,173	925,676	17.41	99.90	25,226	391,946	15.54
Exported	.58	311	5,599	18.00	.10	25	553	22.12
	100.00	53,484	931,275	17.41	100.00	25,251	392,499	15.54

Fluorspar shipped from mines in the United States, 1928–32, 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
1928	108,064	$15.19	3,694	$17.93	6,499	$30.14	4,713	$30.23
1929	118,904	17.08	3,498	19.93	5,742	31.98	3,879	32.39
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

Year	Hydrofluoric acid and derivatives		Miscellaneous		Exported		Total	
	Short tons	Average value	Short tons	Average value	Short tons	Average value	Short tons	Average value
1928	15,946	$36.69	1,176	$16.23	398	$16.55	140,490	$18.91
1929	12,906	27.45	1,004	14.96	506	22.97	146,439	19.06
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

Consumption—stocks at consumers' plants.—Figures on the consumption of fluorspar in 1931 and 1932 and on stocks at consumers' plants at the close of these years are given in the following table:

Fluorspar consumed and in stock in the United States, 1931–32, by industries, in short tons

[Partly estimated by Bureau of Mines]

Industry	1931		1932	
	Consumption	Stocks at consumers' plants Dec. 31	Consumption	Stocks at consumers' plants Dec. 31
Basic open-hearth steel	66,200	67,600	36,300	55,000
Electric furnace steel	3,100	900	2,100	700
Foundry	1,000	600	600	500
Ferro-alloys	300	200	200	100
Hydrofluoric acid and derivatives	12,000	14,000	7,000	11,000
Enamel and vitrolite	3,000	700	2,400	600
Glass	7,100	1,000	6,700	700
Miscellaneous	1,300	500	700	400
	94,000	85,500	56,000	69,000

The following table shows the relation of the consumption of fluorspar to the production of basic open-hearth steel from 1928 to 1932 and the stocks at such steel plants at the close of each of these years.

Consumption and stocks of fluorspar at basic open-hearth steel plants, 1928–32

	1928	1929	1930	1931	1932
Production of basic open-hearth steel long tons	43,200,483	47,232,419	34,268,316	22,130,398	[1] 11,742,682
Consumption of fluorspar in basic open-hearth steel production short tons	152,000	155,600	109,000	66,200	36,300
Consumption of fluorspar per ton of steel made pounds	7.0	6.6	6.3	6.0	6.2
Stocks of fluorspar on hand at steel plants at end of year short tons	76,000	70,700	89,000	67,600	55,000

The average 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 next table shows the variation in average consumption of fluorspar per ton of basic open-hearth steel in certain plants that make about 88 percent of the total over a period of 5 years.

Average consumption of fluorspar per ton of steel, 1928–32, in pounds

1928	1929	1930	1931	1932	1928	1929	1930	1931	1932
12.211	14.727	16.931	16.111	14.176	6.156	5.822	6.276	6.219	6.646
6.761	6.043	6.559	5.781	4.572	10.766	10.470	10.651	7.784	6.056
5.640	4.825	4.768	4.613	5.122	6.953	5.569	5.311	2.437	2.636
6.253	6.674	6.544	2.431	6.136	12.261	11.510	9.720	5.774	6.356
4.181	3.815	2.545	4.867	6.281	5.272	6.589	6.118	5.822	6.118
8.204	7.215	5.661	5.856	5.171	5.988	7.880	6.606	3.791	6.260
5.875	6.237	5.555	4.978	6.842	6.906	6.622	7.087	7.049	6.322
7.648	7.344	7.705	6.590	5.302					

New uses.—A new use[1] is rapidly being developed for acid fluorspar in the manufacture of a refrigerating medium. Chemically it is dichloro-difluoro

[1] Hatmaker, Paul, and Davis, H. W., The Fluorspar Industry in the United States (unpublished report).

methane, a synthetic organic compound, in the preparation of which anhydrous hydrofluoric acid plays an important part.

This refrigerant is nonexplosive, noninflammable, and practically nontoxic. A study of its physiological effects is the subject of Bureau of Mines Report of Investigations 3013, Toxicity of Dichloro-Difluoro Methane: A New Refrigerant, May 1930. Results of experiments as to its stability, nonflammability, behavior when exposed to flame and hot-metal surfaces, and corrosive action on common metals are embodied in National Board of Fire Underwriters Technical Paper 6, Report of Underwriters' Laboratories on Dichloro-Difluoro Methane.

This field promises to have considerable ultimate importance to fluorspar producers, potential demand being estimated at several thousand tons of acid fluorspar annually. The ultimate market may even be greater than is anticipated. This refrigerating medium is intended not only for household and larger mechanical refrigerating units used as cold storage for perishable products but also for units applicable to air conditioning and sharp freezing. Railroads are installing refrigerating units for air conditioning of passenger cars.

In addition another compound (trichloro-monofluoro methane), is being produced commercially. A number of other halogenated hydrocarbons containing one or more fluorine atoms, which have properties especially applicable to certain uses, also will be marketed.

The uses and specifications for fluorspar are discussed in much detail in Mineral Resources, 1926, part II, pages 30 to 34.

Quoted prices.—The following table shows the quoted prices on domestic fluxing-gravel fluorspar at mines in the Illinois-Kentucky district and in Colorado and on imported fluorspar at seaboard in 1932, also the quoted prices on domestic foundry-lump and ground fluorspar. These prices are for carload lots. Prices quoted for smaller lots are generally somewhat higher than prices for large tonnages sold on contract.

Quoted prices per short ton of fluorspar in the United States in 1932

Month	Illinois-Kentucky (f.o.b. mines)			Colorado (f.o.b. mines)	Imported (at seaboard, duty paid)
	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)	Ground (bulk) (95 to 98 percent CaF_2 and not over 2½ percent SiO_2) [1]	Fluxing gravel (82 percent CaF_2 and not over 5 percent SiO_2) [1]	Fluxing gravel (not less than 85 percent CaF_2 and not over 5 percent SiO_2) [2]
January	$15.00	$18.50	$30.00	$10.00	$17.00
February	15.00		30.00	10.00	17.00-17.40
March	14.00		30.00	10.00	17.00-17.40
April	12.50		30.00	10.00	17.00-17.40
May	11.50		30.00	10.00	17.00-17.40
June	11.25	12.50	30.00	10.00	17.00-17.40
July	10.25		30.00	10.00	16.00-17.40
August	10.25		30.00	10.00	16.00-16.75
September	9.50		30.00	10.00	16.00-16.75
October	9.75		30.00	10.00	16.00-16.75
November	9.00	11.00	30.00	10.00	16.00-16.75
December	9.00	10.25	30.00	10.00	16.00-16.75

[1] Metal and Mineral Markets, vol. 3, 1932.
[2] Iron Age, vols. 129 and 130, 1932.

INDUSTRY IN 1932, BY STATES

COLORADO

Only 333 short tons of fluorspar, from one mine in Colorado—the Ranch, near Brown Canyon, Chaffee County—were produced and shipped in 1932.

Some development was reported at the deposit near Cowdrey, Jackson County, and at the Gilpin prospect near Longview, Jefferson County.

ILLINOIS

Approximately 7,500 short tons of fluorspar-bearing rock, equivalent to about 3,800 tons of merchantable fluorspar, were mined at 6 mines or prospects in Illinois. Of the crude ore mined, 6,169 tons were from the Spar Mountain and Daisy mines and the remainder from the Crystal and Eureka No. 4 mines and the Dimick and Taylor prospects. No ore was mined at the Hillside, Victory, Empire-Knight, and Douglas mines, but shipments were made from stock pile. The Hillside mill treated 14,921 tons of discarded tailings. Some development was reported at the Crystal mine and at the Taylor prospect. Some high-grade ore from the Crystal mine was jigged at the old Haffaw plant, Mexico, Ky., to determine the possibilities of producing acid-grade fluorspar. The flotation mill of the Franklin Fluorspar Co. was inactive in 1932. The quantity of fluorspar-bearing material milled in Illinois was 24,000 tons from which 6,646 tons of merchantable fluorspar were recovered—a loss of 17,354 tons in milling and a ratio of 3.611:1. The low recovery in 1932 was due to the milling of 14,921 tons of tailings from the Hillside mine.

Shipments from Illinois were 9,615 short tons, a decrease of 66 percent from the previous year; of this total, 3,315 tons were moved to their destination by the Ohio River.

KENTUCKY

Fluorspar-bearing rock equivalent to approximately 11,000 short tons of merchantable fluorspar was mined at 30 mines or prospects in Kentucky; shipments of fluorspar from Kentucky were 14,725 short tons, a decrease of 37 percent from 1931. During 1932, 50 ounces of optical fluorspar were sold.

Caldwell County.—Fluorspar mining in Caldwell County was confined chiefly to the properties of the S. L. Crook Corporation and the newly opened deposit of the Princeton Fluor Spar Co. The latter property was equipped with a crusher, a washer, and jigs.

Crittenden County.—Mining in Crittenden County was largely confined to properties where fluorspar occurs near the surface. During 1932 development work was practically suspended, and few additions and improvements were made to milling equipment. Shaft sinking was in progress at the L. F. White and Hayshed properties, and the property of the Pepper Box mine was prospected without success. Jigs were installed at the Hodge and Brown mines. The Tabb No. 1 and Wheatcroft shafts were relined, and minor repairs were made at the Lafayette mill.

Livingston County.—The results of work begun in 1931 and continued in 1932 on a property in Livingston County, across the Ohio River from the Fairview-Rosiclare deposits in Illinois, are noteworthy. Shaft no. 1 was sunk 220 feet, and 200 feet of drifts along the vein disclosed an average width of 5 feet of fluorspar between the walls. According to E. C. Clark, this development is on the probable extension of the Rosiclare fault.

Shaft no. 2 is 1,500 feet from shaft no. 1; it is 125 feet deep. At 112 feet shaft no. 2 passed through a blanket vein of fluorspar. At this shaft 125 feet of drifting in ore averaging 6 feet in width were done. About 600 tons of high-grade ore were produced in the course of development. According to E. C. Clark, this deposit is unusual in that it is in the Renault formation and above the Rosiclare sandstone, whereas the blanket deposits around Cave in Rock are under the Rosiclare sandstone.

NEVADA

Only 49 short tons—from the Baxter mine—were shipped from Nevada in 1932.

A plant consisting of a concentrating and a grinding unit (capacity 1½ to 2 tons an hour) was installed at the Daisy mine during 1932.

NEW HAMPSHIRE

Deposits of fluorspar near Westmoreland, Cheshire County, were examined during 1932 by Wm. Spence Black who leased the Stoddard property; some development was done, but no fluorspar was mined.

NEW MEXICO

The small shipments of fluorspar (529 short tons) from New Mexico were chiefly from near Las Cruces, Dona Ana County.

Operations at the Alamo mine were confined to some development, to mining and milling 120 tons of ore, and to shipping a carload of ground fluorspar.

The La Purisima Fluorspar Co. leased a property near Deming, Luna County, and was engaged in developing ore, building a mill for the production of ceramic-grade fluorspar, and shipping a carload of ground fluorspar.

STOCKS AT MINES OR SHIPPING POINTS

According to the reports of producers the total quantity of fluorspar in stock at mines or shipping points at the close of 1932 was 97,210 short tons, a decrease of 8 percent. These stocks consisted of 42,000 tons of crude fluorspar (calculated to be equivalent to 21,000 tons of ready-to-ship fluorspar) and 55,211 tons of ready-to-ship fluorspar.

Stocks of fluorspar at mines or shipping points in the United States, 1931–32, by States, in short tons

State	1931			1932		
	Crude [1]	Ready-to-ship	Total	Crude [1]	Ready-to-ship	Total
Colorado	235	40	275	235	40	275
Illinois	8,943	37,135	46,078	8,021	33,054	41,075
Kentucky	33,552	25,344	58,896	33,570	21,856	55,426
Nevada	408		408	125	209	334
New Mexico		22	22		52	52
Texas	48		48	48		48
	43,186	62,541	105,727	41,999	55,211	97,210

[1] The greater part of this crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

IMPORTS AND EXPORTS

The total imports of fluorspar into the United States in 1932 were 13,236 short tons (6,152 tons containing more than 97 percent and 7,084 tons containing not more than 97 percent of calcium fluoride), valued [2] at $132,665, a decrease of 36 percent in quantity and 37 percent in total value from 1931. The value assigned to the foreign fluorspar averaged $10.02 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.

The imports were equivalent to 52 percent of the total shipments of domestic fluorspar in 1932 compared with 39 percent in 1931.

If the following table is compared with that on page 726 it is noted that manufacturers of ceramics and hydrofluoric acid purchased a considerably larger proportion of fluorspar from importers in 1932 than in 1931. For example, in 1932 ceramic manufacturers purchased 4,036 tons from importers and 4,857 tons from domestic producers, whereas in 1931 their purchases were 3,882 tons and 7,275 tons, respectively. Similarly, in 1932 hydrofluoric acid manufacturers purchased 3,494 tons from importers and 738 tons from domestic producers compared with 6,556 tons and 4,386 tons, respectively, in 1931.

The following table was compiled chiefly from data courteously furnished the Bureau of Mines by importers; it shows the distribution of the fluorspar imported into the United States in 1931 and 1932.

Distribution of fluorspar imported into the United States, 1931–32

[Distribution partly estimated by Bureau of Mines]

Industry	1931			1932		
	Short tons	Selling price at tidewater, including duty		Short tons	Selling price at tidewater, including duty	
		Total	Average		Total	Average
Steel	8,340	$141,657	$16.99	4,253	$70,139	$16.49
Foundry	96	1,681	17.51			
Glass	2,963	95,563	32.25	2,963	83,582	28.21
Enamel	919	30,469	33.15	1,073	29,797	27.77
Hydrofluoric acid	6,556	168,962	25.77	3,494	88,864	25.43
Cement	300	5,289	17.63	110	2,200	20.00
	19,174	443,621	23.14	11,893	274,582	23.09
Optical				1	(a)	(a)
Undistributed	295	(a)	(a)			
Unsold	1,240			1,342		
	20,709			13,236		

[a] Data not available.

[2] "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." As defined in sec. 402 of the tariff act of 1930.

The following tables show the imports of fluorspar into the United States by countries in 1931 and 1932, by countries and districts in 1932, and by countries from 1928–32.

Fluorspar imported into the United States, 1931–32, by countries

[General imports]

Country	1931		1932	
	Short tons	Value	Short tons	Value
Australia			(1)	$196
Belgium	11	$170		
Canada	280	2,313		
China	202	1,811	112	671
France	4,462	33,646	1,578	9,588
Germany	6,491	77,067	5,842	70,294
Italy	1,523	24,267	1,457	11,848
Spain	4,068	31,786	2,659	24,881
Union of South Africa	3,672	40,375	1,587	14,809
United Kingdom			[2] 1	378
	20,709	211,435	13,236	132,665

[1] Less than 1 ton of optical fluorspar.
[2] Optical fluorspar.

Fluorspar imported into the United States in 1932, by countries and districts

[General imports]

Country	District	Containing more than 97 percent of calcium fluoride		Containing not more than 97 percent of calcium fluoride	
		Short tons	Value	Short tons	Value
Australia	New York	(1)	$196		
China	Washington			112	$671
France	Buffalo			1,052	5,193
	Maryland			526	4,395
				1,578	9,588
Germany	Los Angeles	39	639	112	495
	Maryland	1,521	24,676	1,155	3,959
	New York	17	378		
	Philadelphia	2,309	36,934	560	2,407
	San Francisco	17	311	112	495
		3,903	62,938	1,939	7,356
Italy	Philadelphia	66	537	1,391	11,311
Spain	Maryland	183	2,946	916	8.050
	New York	187	2,684	2	10
	Philadelphia	225	3,366	1,146	7,825
		595	8,996	2,064	15,885
Union of South Africa	New York	459	5,219		
	Philadelphia	1,128	9,590		
		1,587	14,809		
United Kingdom	Philadelphia	[2] 1	378		
		6,152	87,854	7,084	44,811

[1] Less than 1 ton of optical fluorspar.
[2] Optical fluorspar.

Fluorspar imported into the United States, 1928–32, by countries

[General imports]

Year	Africa		Canada		France		Germany		Italy	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1928	2,661	$36,471			15,072	$141,434	17,601	$150,872	1,033	$9,600
1929	6,387	75,856			16,850	159,059	16,488	140,860	1,258	10,528
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

Year	Spain		United Kingdom		All other		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1928	680	$5,178	9,360	$56,585	776	$8,560	47,183	$408,700
1929	7,168	52,039	4,828	30,580	1,366	12,053	54,345	480,975
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

Producers of fluorspar reported exports of 25 short tons valued at $553 in 1932 compared with 311 tons valued at $5,599 in 1931. Of the exports in 1932, 20 tons went to Peru and 5 tons to Canada.

Fluorspar reported by producers as exported from the United States, 1928–32

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1928	398	$6,586	$16.55	1931	311	$5,599	$18.00
1929	506	11,621	22.97	1932	25	553	22.19
1930	281	6,160	21.92				

WORLD PRODUCTION

The following table was compiled by the Bureau of Mines from official sources as far as possible.

World production of fluorspar, 1928–32, by countries, in metric tons

Country	1928	1929	1930	1931	1932
Australia:					
New South Wales		96	205	12	(1)
Queensland	1,143	602	763	529	(1)
Canada		16,211	73	36	29
Chosen	950	1,470	2,297	(1)	(1)
France	46,650	52,968	(1)	(1)	(1)
Germany: [2]					
Bavaria	48,552	50,797	48,063	26,780	(1)
Prussia	37,365	37,717	30,272	12,842	(1)
Saxony	16,422	18,491	11,871	6,937	(1)
Great Britain	47,614	42,432	30,266	20,242	(1)
Italy	4,520	5,740	6,655	5,850	(1)
Norway [3]	310	101	382	275	(1)
Russia [4]	5,551	(1)	(1)	(1)	(1)
South-West Africa	872	565			(1)
Spain	2,082	13,478	11,296	6,017	(1)
Union of South Africa	5,582	2,715	1,520	2,197	(1)
United States	127,450	132,847	86,952	48,520	22,907

[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] Production from the Tveitstå Mine.
[4] Year ended Sept. 30.

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. Most of the cryolite shipped to the United States is used in the metallurgy of aluminum and in making opaque glass.

According to the Bureau of Foreign and Domestic Commerce the United States imported 3,782 long tons of cryolite valued at $291,357 in 1932 compared with 7,908 tons valued at $580,621 in 1931.

FELDSPAR

By H. O. Rogers and C. Galiher

A sharp contraction of activity in the ceramic industries was responsible for the further decline in the production of feldspar in 1932. The total output of crude feldspar for the year, including both potash and lime-soda spars, was 104,715 long tons, 28.8 percent less than in 1931 and 50.3 percent less than in 1928, the year of peak

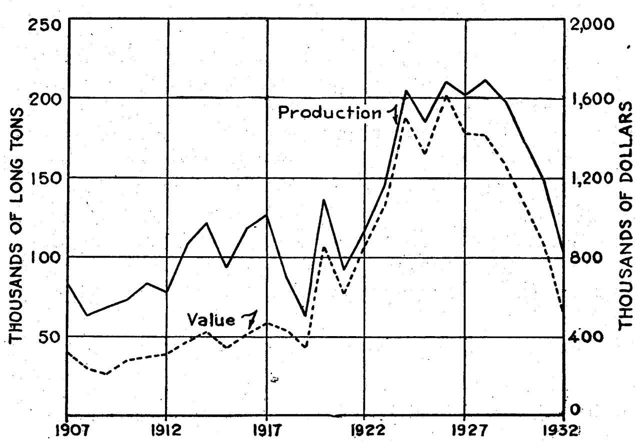

Figure 84.—Trends in production and value of crude feldspar in the United States, 1907-32.

production. The value of crude feldspar produced in 1932 was reported at $539,641, which represents an average of $5.15 per ton. In 1931 the average value of the crude feldspar produced was $5.85 per ton.

All producing States except Colorado, Arizona, Nevada, and New York shared in the decline. Especially heavy losses in tonnage were reported by producers in both New Hampshire and Virginia. Production in North Carolina, the leading producer, decreased 32.4 percent compared with the preceding year.

Production of ground feldspar also declined sharply in 1932. Sales by the merchant mills of domestic ground spar dropped from 132,542 tons in 1931 to 104,289 tons in 1932. Prices of the ground product likewise declined, the average for 1932 being $11.27 per ton compared with $12.30 in 1931. The total value of the ground feldspar sold in 1932 amounted to $1,174,833, a decrease of 28 percent from the previous year.

Figure 84 pictures trends in production and value of crude feldspar in the United States.

Salient statistics of the feldspar industry in the United States, 1931–32

	1931	1932
Crude feldspar sold or used by producers:		
Quantity .... long tons..	147,119	104,715
Value .... dollars..	861,059	539,641
Average value per long ton .... do....	5.85	5.15
Ground feldspar sold by merchant mills:		
Quantity .... short tons..	143,924	107,749
Value .... dollars..	1,853,393	1,240,492
Domestic:		
Quantity .... short tons..	132,542	104,289
Value .... dollars..	1,630,917	1,174,833
Average value per short ton .... do....	12.30	11.27
Canadian:		
Quantity .... short tons..	11,382	3,460
Value .... dollars..	222,476	65,659
Average value per short ton .... do....	19.55	18.98
Feldspar imported for consumption:		
Crude:		
Quantity .... long tons..	10,719	1,872
Value .... dollars..	95,096	14,346
Ground:		
Quantity .... short tons..	79	28
Value .... dollars..	1,500	218

Uses.—Feldspar is used chiefly as a flux in the manufacture of glass, pottery, enamel and sanitary ware, brick, and tile. Its usefulness in the ceramic industry is due to the fact that it melts without becoming entirely fluid and when cool forms a strong, colorless, or only slightly colored glass. In most forms of pottery it is a constituent of both the body and the glaze. Feldspar is one of the essential ingredients of opalescent glass, which is being used widely in modern building construction. Electrical insulators and similar forms of porcelain also contain feldspar as one of the principal ingredients. A summary of the consumption of feldspar, by principal uses, is given below:

Consumption of feldspar, by uses

	Percent of total output
Ceramic and glass industries	87
Scouring soaps and abrasives	7
Binder for abrasive wheels	2
Poultry grit, roofing, stucco, and other minor uses	4

A more detailed discussion of the uses of feldspar appears in Mineral Resources of the United States, 1930, part II, pages 138 and 139.

Trend of prices.—Although sales realizations of the producers in 1932 declined 8.4 percent compared with the previous year, spot quotations remained relatively firm. One exception appears in quotations on Virginia No. 1 glassmaker's feldspar, which early in the year dropped from $11 per ton, f.o.b. plant, to $9.50 per ton. About midsummer quotations on North Carolina white granular "glasspar" were weak, but prices on this grade were brought back to their previous level by improved demand in the early fall. Quotations on other grades remained substantially unchanged throughout the year, although it was generally known in the trade that concessions were made to stimulate purchases, especially during the first half of 1932. The closing months were characterized by a much stronger undertone, and concessions virtually disappeared.

Factors restricting output.—The decline in feldspar production in 1932 largely reflects the marked recession in practically all branches of the ceramic industry during the year. Of outstanding significance to the feldspar producers was the prostration of the construction industry. Compared with the previous year the value of building contracts awarded in 1932 decreased nearly 56 percent. As a result of this decline the consumption of feldspar in the production of sanitary ware, electric porcelain, tile, and other ceramic products used in the building trades was curtailed sharply. Shipments of bathroom accessories, for example, were only about a third of what they were in 1931, while shipments of porcelain enameled flatware fell off 29 percent. Moreover, the use of feldspar in glass manufacture, which was fairly well maintained in both 1930 and 1931, likewise dropped during 1932. One indicator of the trend of feldspar consumption in the glass industry is afforded by the output of illuminating glassware, which in 1932 fell 37 percent below the 1931 level.

Another factor that continued to influence the feldspar industry was the spirited competition that domestic producers of pottery and chinaware have experienced recently from foreign products. In 1932 the total value of pottery imports was 44 percent less than in the previous year. The actual number of pieces of ceramic ware imported, however, did not decline by anything like the same proportion. To illustrate, the actual quantity of household china and porcelain products imported during the past year declined only 7 percent, while imports of earthenware crockery and stoneware were only 5 percent below the 1931 level. On the whole, however, the effect of foreign competition has been somewhat exaggerated. In fact, exports of ceramic products have about offset imports. Even in 1932, with foreign trade reduced to incredibly low levels and with the additional handicap of meeting prices of foreign products selling at depreciated currencies, the total value of exports of clay and clay products and glass and glass products came within $1,886,000 of balancing imports.

Kyanite as a potential competitor.—Of more direct concern to the feldspar producers is the recent interest manifested in kyanite as a source of alumina for glass manufacture. For some time the use of feldspar in the glass industry has been expanding, and the prospects for further progress in this field have been distinctly hopeful. If, however, the properties of kyanite as determined by laboratory tests are confirmed by actual commercial practice, the future use of feldspar in glass manufacture may be materially curtailed.

Investigations seem to indicate that kyanite imparts to glass increased viscosity, more rapid solidification, increased resistance to both physical impact and thermal shock, and reduced devitrification, but the glass technologists are by no means agreed on all these points. On the other hand, feldspar in its raw form, has the advantage of being a natural flux. Kyanite, also, is considerably higher in price, being approximately $25 a ton.

Imports.—In spite of the reduced duty which went into effect January 1, 1932, imports of crude feldspar during the year were the lowest on record, amounting to only 1,872 long tons. Compared with the 10,719 tons imported in 1931, this is a decrease of 83 percent. The value of the crude imports during 1932 was $14,346, as against $95,096 in 1931.

Imports of ground feldspar declined from 79 short tons in 1931 to 28 tons in 1932. The value of the ground feldspar imported during the year was reported at $218, compared with a declared value of $1,500 on the imports in 1931.

Surplus productive capacity.—Like many other mining industries, the feldspar industry is burdened with a large excess productive capacity, which in the past has resulted in price cutting and other forms of sharp competition. In milling plants the maintenance of capacity in excess of requirements has been especially pronounced. Moreover, the situation has not been relieved by the adverse business conditions of the last 3 years; milling capacity has actually been augmented during the depression. In addition to the plant of the Consolidated Feldspar Corporation at Kingman, Ariz., which was placed in operation late in 1931, plans for the construction of two more grinding mills were formulated in 1932. According to announcements one of the new mills is to be located near Goodes, Va., and the other at Alarka, N.C.

With the advantage of more modern equipment the newer mills have turned out a product which has enabled them to make serious inroads in the markets of the older companies. Evidence of this is seen in the drastic reduction in the output of the New England producers. For the country as a whole production of ground feldspar in 1932 was 49 percent below the 1928 peak, but New England's share of the total decreased 76 percent. During the past year at least one important New England producer was forced into receivership.

The output of ground feldspar in 1932 probably did not exceed 20 percent of the total grinding capacity. In 1931 the mills operated at about 30 percent of their estimated capacity.

PROGRESS IN TECHNOLOGY

Several noteworthy contributions were made in the field of technology in 1932. Of these, probably the most interesting is the study made at the University of Illinois by C. W. Parmelee and T. N. McVay in cooperation with the Consolidated Feldspar Corporation. The results of the investigation clarify the behavior of typical feldspars in ceramic bodies. Briefly, the conclusions are as follows: [1]

> The soda feldspars and the potash feldspars are distinguished by various characteristic properties; among these are specific gravity, refractoriness, influence upon viscosity, and, therefore, the rate of maturing of bodies as indicated by changes in porosity and shrinkages, also the strength of the bodies. Neither the modified Klein-Booze method nor the specific-gravity determinations serve to differentiate safely between the two types of feldspars. Feldspars of intermediate soda-ash contents have a longer range of temperature change with less volume change than either the pure potash or soda feldspars. This useful characteristic is conferred upon body mixtures in which such intermediate feldspars are used, and such compositions are given a longer "burning range." By suitable selections of feldspars it is possible to produce with American ball clays bodies having the valuable burning range peculiar to some English clays. The change in the feldspar particles in body mixtures is characteristic and definite for each range of temperature. The conduct of casting slips containing feldspars may be notably influenced by the degree of "solution" used. No evidence of a feldspar-silica deformation eutectic was found within the range of composition investigated, and the influence of additions of silica upon the thermal expansion was slight but well defined.

Gases from commercial feldspars.—Of equal importance from the standpoint of practical operation was the investigation conducted jointly by the Bureau of Standards and the engineering experiment

[1] Parmelee, C. W., and McVay, T. N., An Investigation of the Properties of Some Feldspars: Eng. Exper. Sta., Univ. of Illinois, Bull. 233, 1932, pp. 47–48.

station of Ohio State University for the purpose of determining the nature and quantity of gases obtained from a number of typical ground feldspars when heated in a vacuum.[2]

For some time it has been considered probable that gases derived from feldspars or the minerals commonly associated with feldspars during the firing process have a significant influence on the physical properties of bodies and glazes in which feldspar is one of the principal ingredients. A summary of the findings of the investigations is given below:

Water vapor began to come off as soon as the samples were heated above the drying temperature; the maximum amount was obtained between 800° and 900° C. The evolution of acid gases started at about 500° C., the speed of the evolution increasing rapidly between 600° and 900° C. No hydrogen and only small quantities of carbon monoxide were found.

At 1,000° C. the gases were found to consist by weight of 32 to 96 percent water vapor, of 0 to 59 percent acid gases, and of 0 to 36 percent unabsorbed gases. Volume calculations indicated that 1 ml of feldspar would yield 16 to 40 ml of water vapor and 0 to 15 ml of acid gases (calculated as CO_2) measured at 1,000° C.

Feldspathic flux for porcelain.—Another outstanding accomplishment in 1932 was the development of a process for preparing feldspathic flux for porcelain manufacturers. Previously, makers of porcelain purchased feldspars of different grades and made their own flux by adding quartz, alkali, or pure feldspar. Under the new process the manufacturer can purchase a definite flux composition which is ready for use. The process was developed by C. H. Peddrick and P. W. Lewis and is to be used by the United Feldspar Corporation.

Flotation experiments.—Some progress was also made during the past year toward the development of a cheap and efficient mechanical method of removing quartz from feldspar. Laboratory experiments, conducted by H. G. Iverson at the engineering experiment station of the University of Utah, tend to show that almost complete separation of quartz and feldspar by flotation is possible.[3]

Advantages of standard classification.—After more than 2 years of operation the commercial standard classification of feldspar (SC 23–30) has been found to be distinctly beneficial to both producers and consumers. Standardization has enabled producers to give better values, more uniform quality, and improved service. For the consumer the advantages are obvious; since the standard classification has been in effect the manufacturer has been able to compare prices of feldspars of known particle size, fusing point, and silica content.

Classification of feldspar is scheduled for further consideration by the standards committee of the American Ceramic Society.

REVIEW OF INDUSTRY BY STATES

The term "crude feldspar" is applied to the lump spar shipped from the mine or quarry, as contrasted with ground spar, which is the finished product of the crushing and pulverizing mill. Statistics of production are presented separately for crude and ground spar, and 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.

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[2] Shelton, G. R., and Holscher, H. H., Gases Obtained from Commercial Feldspars Heated in Vacuo: Bureau of Standards Research Paper 420, 1932, p. 356.

[3] Iverson, H. G., Separation of Feldspar from Quartz: Eng. and Min. Jour., vol. 133, no. 4, April 1932, pp. 227–229.

In years of normal business activity, the quantity of ground spar produced from domestic crude has averaged about 87 percent of the crude-spar output; the remaining 13 percent includes spar used for purposes not requiring fine grinding and that lost or discarded during the grinding process. In 1931, however, sales of ground spar were only about 80 percent of the crude output, indicating that a considerable tonnage of crude spar must have been added to stocks. During 1932 part of the tonnage that had been added to stocks in 1931 apparently was withdrawn as the sales of ground spar represented nearly 89 percent of the production of crude feldspar.

Crude feldspar.—Crude feldspar sold or used by producers in the United States in 1932 amounted to 104,715 long tons, valued at $539,641, a decrease of 28.8 percent in quantity and 37.3 percent in value compared with 1931. The average value of crude feldspar in 1932 at the mine or the nearest shipping point was $5.15 a long ton, or 70 cents lower than in 1931, $1.06 lower than in 1930, and $2.50 lower than the peak in 1926. The average value for crude feldspar as reported by individual producers ranged from $2 to $12.88 a long ton. For New England the value ranged from $2 to $9.13; for New York, Pennsylvania, and Virginia, from $3.84 to $10.64; for North Carolina, from $4.26 to $6.12; and for the Western States, from $2.64 to $7.78.

Crude feldspar sold or used by producers in the United States, 1928–32

Year	Long tons	Value		Year	Long tons	Value	
		Total	Average			Total	Average
1928	210,811	$1,418,975	$6.73	1931	147,119	$861,059	$5.85
1929	197,699	1,276,640	6.46	1932	104,715	539,641	5.15
1930	171,788	1,066,636	6.21				

Crude feldspar was produced in 14 States in 1932, 1 more than in 1931. Maryland, which reported no production in 1931, reentered the list of producers in 1932 with a small output. North Carolina remained by far the most important producer with an output of 58,465 tons, 56 percent of the total. New Hampshire with 8,718 tons held second place, and Maine with 8,345 tons ranked third. The other producing States, arranged in order of importance, were Virginia, New York, South Dakota, Colorado, California, Arizona, Connecticut, Minnesota, Maryland, Nevada, and Pennsylvania.

The decline in production during 1932 was shared by all of the important producing States, but some of the minor producers reported substantial gains. In Colorado, for example, the output practically doubled, while production in Nevada advanced 25 percent. Smaller gains were also reported by producers in Arizona and New York. The greatest declines in production in 1932 were reported by Pennsylvania, Minnesota, and California. In North Carolina production during the year was 32 percent below the 1931 level.

Crude feldspar sold or used by producers in the United States, 1930–32, by States

[Value is at mine or nearest shipping point]

State	1930		1931		1932	
	Long tons	Value	Long tons	Value	Long tons	Value
Arizona			(1)	(1)	(1)	(1)
California	6,519	$54,941	4,465	$30,857	(1)	(1)
Colorado	1,933	10,575	2,953	14,927	5,612	$20,304
Connecticut	(1)	(1)	(1)	(1)	(1)	(1)
Maine	22,738	161,631	10,220	65,417	8,345	41,874
Maryland					(1)	(1)
Minnesota			(1)	(1)	(1)	(1)
Nevada			(1)	(1)	(1)	(1)
New Hampshire	16,517	132,342	12,573	102,140	8,718	61,416
New York	5,556	37,790	6,160	29,959	(1)	(1)
North Carolina	103,163	593,552	86,429	505,525	58,465	300,877
Pennsylvania	(1)	(1)	(1)	(1)	(1)	(1)
South Dakota	(1)	(1)	11,062	39,013	(1)	(1)
Virginia	6,760	38,048	9,331	48,545	6,759	31,990
Undistributed	8,602	37,757	3,926	24,676	16,816	83,180
	171,788	1,066,636	147,119	861,059	104,715	539,641

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, for "chicken grits", 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 the past 10 years for statistics of ground feldspar.

The quantity of ground feldspar sold by the commercial mills in 1932 was 107,749 short tons, valued at $1,240,492, a decrease of 25.1 percent in tonnage and 33.1 percent in value compared with 1931. In 1932 there were 21 producing companies operating in 14 States. Twenty-seven mills were in operation during the year, one less than 1931. Of the mills reporting 25 handled domestic spar exclusively and 2 used imported (Canadian) spar exclusively. Of the total quantity ground nearly 97 percent (104,289 tons) was from domestic spar and only 3 percent (3,460 tons) from imported spar. In 1931 Canadian spar comprised about 8 percent of the total.

The average value of the ground feldspar from domestic crude in 1932—$11.27 per ton—was the lowest on record, being $1.03 less than in 1931 (the previous low) and $5.57 less than in 1924, when the sales realizations of the producers were highest. The value of the ground product, however, varied widely in the different States, ranging from a low of $7.50 a ton to as high as $20.48. The average value of ground feldspar from imported crude in 1932 was $18.98, 57 cents less than in 1931.

Except for Connecticut, Nevada, Pennsylvania, and Maryland, feldspar grinding plants were operated during 1932 in each of the 14 States producing crude spar. In addition, grinding mills also were operated in four other States: Illinois, New Jersey, Ohio, and Tennessee.

Ground feldspar sold by merchant mills [1] in the United States, 1928–32

Year	Number of mills	Domestic			Canadian [2]			Total	
		Short tons	Value		Short tons	Value		Short tons	Value
			Total	Average		Total	Average		
1928	29	202,844	$2,951,281	$14.55	[2] 24,813	[2] $507,747	$20.46	227,657	$3,459,028
1929	29	209,808	2,880,824	13.73	20,774	415,428	20.00	230,582	3,296,252
1930	30	167,380	2,167,352	12.95	14,161	283,563	20.02	181,541	2,450,915
1931	28	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

[1] Does not include potters or others who grind for consumption in their own plants.
[2] Figures for 1927–28 include some Cornwall stone.

North Carolina led in the output of ground spar as in that of crude spar by a wide margin. Tennessee held second place, and New York ranked third. These three States together accounted for two thirds of the ground feldspar produced in 1932. The remaining third was accounted for chiefly by Maine, Virginia, New Jersey, South Dakota, Colorado, New Hampshire, California, and Arizona. Comparatively small tonnages of ground spar were milled in Ohio, Minnesota, and Illinois in 1932.

During 1932 the production of ground feldspar in Colorado and Arizona showed substantial gains over that in 1931, while a small increase was reported for Tennessee. However, the increases in these States failed to offset the heavy losses elsewhere. In North Carolina production decreased 22 percent below that in 1931, and even more severe declines were reported by many other producing States. The most pronounced decline occurred in Ohio, where the production of ground spar in 1932 was 71 percent less than in 1931.

Ground feldspar sold by merchant mills [1] in the United States, 1931–32, by States

State	1931					1932				
	Number of mills	Domestic		Canadian		Number of mills	Domestic		Canadian	
		Short tons	Value	Short tons	Value		Short tons	Value	Short tons	Value
California	2	(2)	(2)			2	(2)	(2)		
Maine	3	11,225	$164,035			4	7,334	$95,369		
New Jersey	3	9,244	171,985			3	5,967	108,679		
New York	4	(2)	(2)	(2)	(2)	4	(2)	(2)	(2)	(2)
Ohio	2	(2)	(2)	(2)	(2)	1	(2)	(2)		
North Carolina	5	70,558	760,080			5	59,225	614,936		
Tennessee	1					1				
Undistributed [3]	8	41,515	534,817	11,382	$222,476	7	31,763	355,849	3,460	$65,659
	28	132,542	1,630,917	11,382	222,476	27	104,289	1,174,833	3,460	65,659

[1] Does not include potters or others who grind for consumption in their own plants.
[2] Included under "Undistributed."
[3] 1931: Arizona, California, Colorado, Illinois, Minnesota, New Hampshire, New York, Ohio, South Dakota, and Virginia. 1932: Arizona, California, Colorado, Illinois, Minnesota, New Hampshire, New York, Ohio, South Dakota, and Virginia.

WORLD PRODUCTION

The following tables show the most recent figures of production of feldspar in the chief producing countries. Aside from the United States and Canada, these are Czechoslovakia, Norway, and Sweden. Although Great Britain has an immense pottery industry, it appears to have produced no feldspar in recent years. Cornwall stone, a more or less decomposed natural mixture of feldspar and quartz, is used extensively as a flux in the British pottery industry.

World production of feldspar, 1928–32, by countries, in metric tons

Country [1]	1928	1929	1930	1931	1932
Argentina (shipments)	410	427	196	172	(2)
Australia:					
New South Wales [3]	49	58	86	103	(2)
South Australia [3]	115	------	------	------	65
Western Australia (exports)	------	21	------	106	(2)
Canada (shipments)	28,936	34,044	24,309	16,640	6,279
Finland (exports)	720	460	620	67	(2)
France	23,000	12,300	12,800	(2)	(2)
Germany (Bavaria)	6,230	7,697	5,150	5,000	(2)
India (British)	------	------	------	339	(2)
Italy	4,960	6,800	5,750	4,750	(2)
Norway (exports)	24,075	26,524	19,922	15,105	(2)
Rumania	2,835	2,479	1,963	3,068	(2)
Russia [4]	20,308	(2)	(2)	(2)	(2)
Sweden	39,921	39,092	38,596	33,113	(2)
Union of South Africa	30	------	------	------	(2)
United States (shipments)	214,195	200,872	174,545	149,480	106,396

[1] In addition to the 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 Ceramic Society.)
[2] Data not available.
[3] Includes some china stone.
[4] Year ended Sept. 30.

Feldspar, produced in Canada, sold in 1928–32

Year	Long tons	Value	Year	Long tons	Value
1928	28,479	$284,942	1931	16,378	$186,961
1929	33,506	340,471	1932	6,179	81,107
1930	23,925	268,469			

ASBESTOS

By Oliver Bowles and B. H. Stoddard

Asbestos, a fibrous mineral used for fireproof textiles, packings, and heat-insulating products, is mined in relatively small quantities in the United States. Domestic mines supplied only about 3½ percent of consumers' requirements during 1932. As shown in the summary of statistical data, commercial production in 1932 increased about 10 percent in quantity but decreased about 11 percent in value compared with 1931. The increase in volume of production was due to a moderate enlargement of activity in the plant at Hyde Park, Vt. Although asbestos mining is a restricted industry, the manufacture of asbestos products is an activity of large proportions.

Salient statistics of the asbestos industry, 1931–32

	1931		1932	
	Short tons	Value	Short tons	Value
Domestic asbestos sold or used by producers:				
Chrysotile	2,857	$111,708	(1)	(1)
Amphibole	371	7,259	(1)	(1)
Total	3,228	118,967	3,559	$105,292
Imports (unmanufactured)	136,361	3,749,340	96,754	2,250,200
Exports (unmanufactured)	1,714	122,391	1,707	94,936
Apparent consumption	137,875	3,745,916	98,606	2,260,556
Exports, asbestos products		2,606,166		1,608,880

1 Bureau of Mines not at liberty to publish figures.

While production figures show no striking departure from those of 1931, domestic supplies form so small a part of total consumption that a true picture of the asbestos industry as a whole may be gained only by considering imports and exports. As the accompanying figures show, imports decreased greatly compared with 1931, the drop in tonnage amounting to about 29 percent and that in value to 40 percent. Exports have always been small.

If stocks of asbestos in consumers' hands, for which the Bureau of Mines has no data, are disregarded, a fair measure of activity in the manufacture of asbestos products can be gained from a determination of apparent consumption—arrived at by adding production to imports and subtracting exports. The following table of domestic consumption, value of manufactured products, and exports of products shows major trends in the asbestos-products industry of the United States during recent years:

Raw asbestos consumed in the United States and asbestos products manufactured in and exported from the United States, 1923–32

Year	Apparent consumption of raw asbestos (short tons)	Asbestos [1] products (value)	Exports of manufactured-asbestos products (value)
1923	211,967	$69,811,681	$2,850,387
1924	182,280		2,529,795
1925	230,669	80,144,936	2,383,325
1926	257,875		3,481,814
1927	226,365	87,200,889	2,687,086
1928	231,984		3,999,022
1929	264,873	101,597,171	4,640,599
1930	212,152		4,193,510
1931	137,875	60,574,579	2,606,166
1932	98,606		1,608,880

[1] Figures obtained from Bureau of the Census.

Market conditions.—Market demands for asbestos products, and therefore for raw asbestos, were small throughout the year. As the total value of building contracts awarded in 1932 was only 28 percent of the 1923 to 1925 average, there was very little demand for asbestos paper, other heat-insulating products, and millboard. Automobile production was also so low that brake-band requirements were small. Even the replacement trade, which is more stabilized than the requirements for new cars, failed to maintain the asbestos-products industry at a level higher than the average of 1921 and 1923. Future market conditions will be controlled to some extent by new developments in uses, some of which are covered in the following section.

New developments in uses.—The well-known uses of asbestos may be enumerated briefly. The principal asbestos of commerce is known as chrysotile. The longer fibers, roughly three eighths inch or more, are spun chiefly into yarn, which is woven into textile products, such as brake-band linings, theater curtains, packings, and fireproof suits and gloves. Shorter grades are used for compressed sheets, asbestos paper, asbestos-cement shingles, and millboard. The shortest fibers are used in asbestos cement, fireproof paints, packings, and insulating materials.

Amphibole fiber produced in the United States is too weak and brittle for spinning or for manufacture of asbestos paper or roofing. Special grades of domestic amphibole are used for acid filters, and other types are used for fillers and insulation.

According to Bureau of the Census figures there is a marked tendency toward a more extensive use of molded brake bands in automobiles. Of the brake bands made in 1929 about 83 percent were woven and 17 percent molded. In 1931, 73 percent were woven and 27 percent molded. This trend indicates a relatively wider use of nonspinning asbestos at the expense of spinning grades.

A short fiber known as "microasbestos," obtained in Austria, has given satisfactory results in that country when mixed in proportions of 4 to 6 percent with asphalt for surfacing roads. This application suggests a possible use of short fibers for road-surfacing purposes in the United States.

Asbestos-cement pipe is finding successful use for water mains and for conveyance of various liquids and gases, particularly for solutions that must be kept free from iron rust.

Asbestos has been found to be a satisfactory polishing agent. A rough asbestos cloth is used for common scouring and an acid-refined asbestos cloth for imparting a high luster.

Perhaps the most important technical development of the year is the perfecting of a process whereby asbestos may be cemented to steel by means of metallic adhesives.

Prices.—Prices of Canadian asbestos as quoted in Mineral and Metal Markets were almost constant throughout 1932. Quotations per ton at Quebec mines, tax and bags included, were as follows: Crude no. 1, $400 to $450; crude no. 2, $200; spinning fibers, $75 to $125; magnesia and compressed sheet fibers, $70 to $90; shingle stock, $45 to $60; paper stock, $27.50 to $35; cement stock, $15 to $20; and floats, $10 to $15. The only exceptions to these uniform quotations were magnesia and compressed sheet fibers and shingle stock, which were quoted somewhat higher in January. Rhodesian crude no. 1 quotations, c.i.f. New York, dropped from $300 a ton in January to $250 in February and to $170 for the remainder of the year. Rhodesian crude no. 2 likewise dropped from $200 in January to $175 in February and to $120 thereafter. Vermont shingle stock was quoted at $40 to $45 a ton, paper stock at $30 to $35, and cement stock at $18 to $22 f.o.b. mines.

Foreign sources of supply.—Aside from a comparatively small but increasing supply from Vermont practically the entire United States requirements of short fibers are obtained from Canada. For many years Canada was the chief source of spinning fibers also, but since 1916 Africa has supplied large quantities, and since 1927 Russia has also become an important source; however, according to import figures, very little Russian asbestos reached America in 1932. Imports of asbestos by classes and countries of shipment are shown in the following table. Asbestos obtained from the United Kingdom is chiefly of African origin, and that shipped from Germany comes principally from Russia.

Asbestos (unmanufactured) imported into the United States in 1932, by countries and classes

[General imports]

Country	Crude (including blue fiber)		Mill fiber		Stucco and refuse		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Africa:								
British:								
Union of South Africa	212	$23,890					212	$23,890
Other	1,114	93,884					1,114	93,884
Canada	305	60,298	30,759	$1,225,501	63,606	$827,744	94,670	2,113,543
Germany	(1)	30					(1)	30
Italy	18	8,365	67	1,262	629	7,719	714	17,346
United Kingdom	1	399			43	1,108	44	1,507
	1,650	186,866	30,826	1,226,763	64,278	836,571	96,754	2,250,200

1 Less than 1 ton.

Export trade.—As indicated previously, very little unmanufactured asbestos is exported. However, the foreign trade in manufactured asbestos products is considerable. The various types of asbestos products exported, with the quantity and value of each, are shown in the following table.

Manufactured asbestos products exported from the United States, 1931 and 1932, by kinds

Grade	1931 Quantity	1931 Value	1932 Quantity	1932 Value
Brake lining:				
Molded and semimolded .... linear feet	(1)	$419,763	(1)	$396,543
Not molded .... do	3,791,500	720,360	1,959,796	299,220
Paper, millboard, and roll board .... short tons	635	125,833	293	61,062
Pipe covering and cement .... do	1,050	119,810	1,226	136,140
Textile yarn and packing .... do	636	662,030	452	431,218
Magnesia and manufactures .... do	1,453	200,543	610	91,117
Asbestos roofing .... squares	26,556	109,767	30,886	59,306
Other manufactures, except roofing .... short tons	1,196	248,060	647	134,274

[1] Quantity not recorded.

REVIEW BY STATES AND TERRITORIES

Alaska.—Deposits of amphibole asbestos of uncertain quality have been developed to a limited extent on Admiralty Island, at Chitina on the Copper River, and at other points. A deposit at Shungnak on the Kobuk River in northwestern Alaska was described as early as 1910, but the material found at that time was of poor quality. Further exploration in this locality has uncovered veins of long-fibered chrysotile of high quality. Specimens sent to the Bureau for examination were of the finest quality ever observed from undeveloped deposits. According to data supplied by Stewart [1] the fiber occurs in serpentine and parallels the vein walls, therefore it appears to be a slip fiber rather than the ordinary cross fiber found in replacement veins in Canada, Rhodesia, and Russia. Several thin veins have been found over a distance of about 2 miles.

Arizona.—No production is recorded for Arizona in 1932. Sales were made from stocks on hand by the Johns-Manville Products Corporation at Chrysotile and by the Bear Canyon Asbestos Co. at Globe. A new highway recently completed shortens the distance to the railroad and greatly reduces the cost of transportation. This will be of great advantage to Arizona producers in the future.

Georgia.—Small shipments of mass-fiber anthophyllite (amphibole) were made by the Clayton Paving Co., 220 Capitol Boulevard, Nashville, Tenn., from stock on hand. No asbestos was mined in 1932 at the company property near Helen, White County, Ga.

Maryland.—A high-grade anthophyllite suitable for chemical filters was produced in Maryland by the Powhatan Mining Corporation, Woodlawn, Baltimore, from the Jenkins mine near Pylesville.

Vermont.—The Vermont Asbestos Corporation, 82 Devonshire Street, Boston, Mass., which began operation in 1929 at its property near Hyde Park, Lamoille County, was fairly active during the year. High-quality mill fibers of various grades were marketed.

[1] Stewart, B. D., Mining Investigations and Mine Inspection in Alaska: Rept. to Governor of Alaska for Biennium Ending Mar. 31, 1933, pp. 21-22.

Washington.—The Asbestos-Talc Products of Washington, Inc., Burlington, Wash., reported the use of several tons of asbestos from the company's property at Burlington in the manufacture of insulating, building, and roofing products.

PRODUCTION IN FOREIGN COUNTRIES

As the United States produces so small a proportion of the domestic demand for unmanufactured asbestos, foreign sources of supply have unusual interest. World production by countries for a series of years, insofar as figures are available, is shown in the following table:

World production of asbestos, 1928–32, in metric tons

Country [1]	1928	1929	1930	1931	1932
Africa:					
Portuguese East Africa			[2] 16	(3)	(3)
Southern Rhodesia	36,251	38,677	34,260	21,810	14,302
Union of South Africa	21,821	29,970	17,491	14,221	10,951
Australia:					
New South Wales				8	(3)
South Australia		1		6	(3)
Western Australia	12	259	144	116	(3)
Canada [4]	247,690	277,647	219,641	149,047	111,562
China	(3)	277	315	264	(3)
Cyprus [2]	11,765	14,017	5,487	3,628	(3)
Finland	1,462	1,563	1,188	581	(3)
France	730	750	503	(3)	(3)
Greece	(3)	(3)	2	10	(3)
India, British	159	324	34	(6)	(3)
Italy	4,950	2,847	851	632	(3)
Japan [5]	1,000	1,000	1,000	1,000	1,000
Russia	[6] 26,492	[6] 29,520	54,083	64,674	(3)
United States	2,031	2,862	3,848	2,928	3,229

[1] In addition to the countries listed, Bolivia, Brazil, and Madagascar are reported to produce small quantities of asbestos. Statistics of production are not available for Bolivia and Brazil, but exports reported are considerably less than a ton. Production in Madagascar is reported as follows: 1928, 108 kilograms; 1929, 545 kilograms.
[2] Exports.
[3] Data not available.
[4] Exclusive of sand and gravel, the production of which is reported as follows: 1928, 20,672 tons; 1929, 17,215 tons; 1930, 36,949 tons; 1931, 6,540 tons; 1932, 3,151 tons.
[5] Approximate production.
[6] Year ended Sept. 30.

CANADA

Asbestos production in Canada fell to a very low level in 1932. The tonnage produced was 25 percent less than in 1931, and the value decreased 37 percent. Price levels fell considerably below the already low average of 1931. The principal markets for Canadian asbestos are in the United States where, as mentioned heretofore, manufacturers' requirements in 1932 were very small.

Until the recent business decline Canada was becoming increasingly important as a manufacturer of asbestos products. According to the Dominion Bureau of Statistics 13 asbestos-products plants were in operation in 1931. Their output was valued at about $1,308,000, which was approximately $1,000,000 less than the value reported in 1930.

Owing to unsatisfactory results obtained from the testing machine used for many years in Quebec, the Canadian National Research Council after exhaustive tests has developed a new standard testing machine which will make it possible to guarantee the grades of the several mill products. It is reported that the new machine has the unanimous approval of Quebec producers.

Production figures for 1932, taken from the preliminary report of the Quebec Bureau of Mines, are quoted in the following table:

Production of asbestos in the Province of Quebec for 1932

Designation of grade	Shipments and sales		Average value per ton	Stocks on hand Dec. 31, 1932	
	Tons	Value		Tons	Value [1]
Crude no. 1	144	$57,159	$396.94	207	$82,167
Crude no. 2	313	60,230	192.43	3,115	599,419
Other crudes	14	1,832	130.86	85	11,123
Spinning fiber	6,004	548,510	91.36	13,558	1,238,659
Shingle fiber	6,625	328,895	49.64	7,131	353,983
Paper fiber	32,694	1,008,436	30.84	5,307	163,668
Waste, stucco, or plaster	3,984	92,800	23.29	511	11,901
Refuse or shorts	73,199	941,859	12.87	13,350	171,815
Total	122,977	3,039,721	24.72	43,264	2,632,735
Sand, gravel, and stone (waste rock only)	3,473	3,369	.97		
Total	126,450	3,043,090			

[1] Values calculated at average price of each grade. These figures are given merely as a guide to approximate valuation of stocks on hand.

NOTE.—Quantity of rock mined during the year 1932, 1,145,340 tons; quantity of rock milled during the year 1932, 1,029,709 tons; quantity of tailings re-treated during the year 1932, 709,094 tons.

AFRICA

Rhodesia.—Asbestos production in Rhodesia in 1932 decreased 34 percent in volume and 49 percent in value compared with 1931, due in part to a decidedly lessened demand by consuming industries and in part to increasing competition with Russia. However, an agreement has been reached between Rhodesian and Russian producers and European consumers for an apportionment of orders, and this arrangement has been helpful to the Rhodesian industry. Turner & Newall, Ltd., the principal producing company, paid a dividend of 3¾ percent for the year ended September 30, 1932, as against 5 percent for the year ended September 30, 1931. Earnings were in excess of the dividend.

The following table shows Rhodesian production for 10 years:

Asbestos produced in Rhodesia, 1923–32

Year	Short tons	Value	Year	Short tons	Value
1923–27 (average)	29,475	£703,547	1930	37,765	£1,070,847
1928	39,960	970,327	1931	24,042	386,493
1929	42,634	1,186,627	1932	15,766	197,092

Union of South Africa.—Recession during 1932 in the asbestos industry of the Union of South Africa was not as great as had been forecast in the press. Tonnage declined about 23 percent and value 47 percent from 1931 figures, both decreases being somewhat smaller than those recorded for Rhodesia. Maintenance of the industry at a relatively higher level in the Union of South Africa than in Rhodesia is difficult to explain in view of the handicap created in the former country through adherence to the gold standard. A 10 percent subsidy granted by the Government on asbestos exports to meet this difficulty was insufficient to permit competition on a parity with countries like Rhodesia which were not on the gold standard. A more favorable export situation developed when the Union of South Africa went off the gold standard in December 1932.

It was reported late in the year that all but one of the properties owned by the Cape Asbestos Co. had closed and that the New Amianthus chrysotile mine in the Transvaal had also suspended operations. Production for several years is shown in the following table.

Asbestos produced in the Union of South Africa, 1923–32

Year	Short tons				Total value
	Transvaal	Cape Province	Natal	Total	
1923–27 (average)	8,672	3,736		12,408	£188,682
1928	18,976	5,078		24,054	399,550
1929	26,984	6,030	23	33,037	497,393
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	130,704

The Union of South Africa is unique in that it produces three types of asbestos—chrysotile, the principal asbestos of commerce; amosite, a long-fibered amphibole used to some extent for spinning; and crocidolite, or blue asbestos, used both for spinning and nonspinning purposes. The following table shows the tonnage and value of the different varieties of asbestos produced.

Asbestos produced in the Union of South Africa, 1930–32, by varieties

	1930		1931		1932	
	Short tons	Value	Short tons	Value	Short tons	Value
Amosite (Transvaal)	3,281	£36,885	2,087	£20,608	1,391	£13,906
Chrysotile (Transvaal)	10,519	160,381	9,938	125,439	7,715	60,194
Blue (Cape)	5,481	143,529	3,651	100,536	2,964	56,604
	19,281	340,795	15,676	246,583	12,070	130,704

RUSSIA

As the following table shows, production of asbestos in Russia is steadily increasing. Figures for 1932 are not yet available, but the general statement has been made that they were considerably higher than those for 1931. A fiber-concentration plant equipped with modern machinery began operation in 1931, and a new and much larger plant with a capacity of 40,000 metric tons of asbestos a year began activity in 1932.

It is significant that the ratio of exports to production is constantly decreasing—a condition that reflects the great expansion in the manufacture of asbestos products in the Soviet Union. It is reported that four new plants for the manufacture of insulating products began operations on a large scale about the middle of 1932. Thus, Russia is attaining prominence both as a producer of raw asbestos and as a manufacturer of asbestos products.

As noted previously, very little Russian asbestos entered the United States in 1932, due doubtless to orders forbidding entry of Russian asbestos except under bond pending an investigation by the Tariff Commission on possible violation of section 337 of the Tariff Act of 1930. As a report of the Commission favorable to Russia has been approved by the President, restrictions on imports have been lifted. This decision may have a definite influence on imports during 1933.

Production and exports of Russian asbestos, 1929–31,[1] in metric tons

Year	Production	Exports
1929	39, 942	12, 603
1930	54, 083	15, 749
1931	64, 674	13, 239

[1] Figures quoted from Economic Review of the Soviet Union, vol. 7, Oct. 15, 1932.

OTHER COUNTRIES

Italy.—The most important asbestos deposits of Italy are centered around Balangero in Piedmont. The fiber is a chrysotile comparable with that obtained in Canada. Amphibole asbestos is produced at Valtellina. Total production ranges from 2,000 to 5,000 short tons a year.

Cyprus.—The Cyprus Asbestos Co. has been reorganized as the Cyprus & General Co. Sales of short-fiber chrysotile produced on the island have been decreasing steadily during recent years. Business was conducted at a considerable loss during the year ending June 30, 1932.

Finland.—One company in east-central Finland produces 1,000 to 1,500 metric tons of amphibole asbestos a year.

Ireland.—It is reported that an asbestos deposit at Avoca, County Wicklow, Ireland, discovered in 1931, will probably be developed in the near future.

Mexico.—An interesting specimen of "mountain cork" consisting of interlaced amphibole asbestos fibers has been received by the Bureau from San Luis Potosi, San Luis Potosi, Mexico. There is said to be a large deposit of the material which may have possibilities for insulation uses. No definite data on location or extent of the deposit are available.

BARITE AND BARIUM PRODUCTS

By R. M. Santmyers and B. H. Stoddard

In accord with the trend of general business conditions production, shipments, and prices of crude barite in the United States declined in 1932.

The lithopone industry, consuming the greater part of both the domestic and imported material, particularly felt the adverse effect

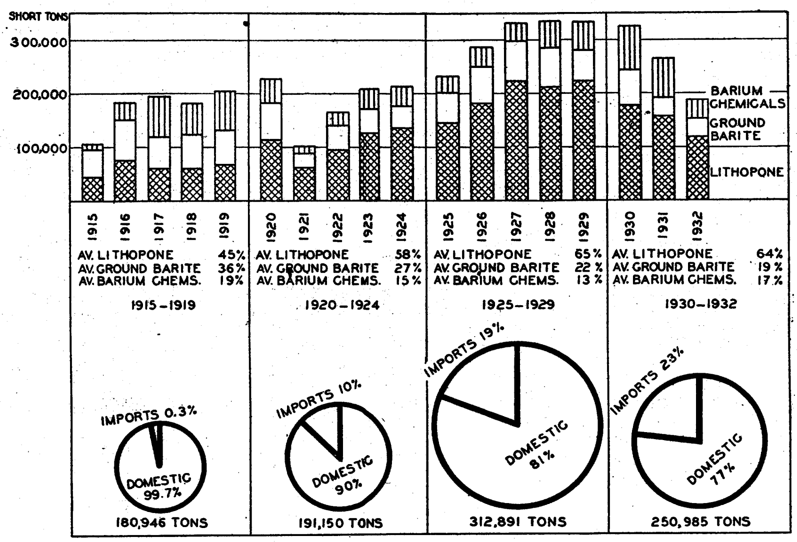

Figure 85.—Consumption and sources of supply of crude barite, 1915–32.

of business conditions, and sales during 1932 amounted to a little more than half the record figures for 1929. Since lithopone is used principally as a pigment in paints, enamels, and lacquers, the drastic curtailment in building construction and automobile output, affected materially the sales of this commodity. Although the floor-coverings and textiles industries consumed about 15 percent less lithopone in 1932 than in 1931 they used only 47 percent as much as in 1929. The rubber industry, another consumer of lithopone, likewise felt the economic depression, as evidenced by a decline of 68 percent in consumption of rubber in 1932 compared with 1929 and of 45 percent in purchases of lithopone compared with 1929.

Domestic sales of ground barite increased slightly in tonnage during 1932 compared with 1931.

Barium chemicals, which in 1931 formed the only bright spot in the barium industry, showed the most drastic decline of all the barium products during 1932. In this group large decreases in sales were registered by blanc fixe and precipitated barium carbonate. The latter product is used primarily in the brick and other heavy clayware industries.

Figure 85 shows the sources of supply and the consumption of crude barite by 5-year periods from 1915 to 1932, inclusive. Except for the past 3 or 4 years, consumption, domestic output, and imports of crude barite have increased gradually since 1921. The imports, principally from Germany and Netherlands, have increased from less than 1 percent of domestic consumption for the period 1915 to 1919 to 23 percent for 1930 to 1932, inclusive.

Apparently the barite industry in foreign countries did not feel the effects of the World-wide depression to the same degree as did the domestic industry. German imports of witherite from England in 1932 more than doubled compared with 1931 and British exports of barite and witherite increased approximately 20 percent over 1931. Italian production and shipments of crude barite and lithopone were reported as only slightly under those in 1931.

Salient statistics on barite and barium products in the United States, 1928–32

	1928	1929	1930	1931	1932
Crude barite:					
Produced __________ short tons	259,761	275,945	237,505	210,930	133,572
Sold or used by producers:					
Short tons	269,544	277,269	234,932	174,520	129,854
Value: [1]					
Total	$1,754,924	$1,850,706	$1,538,171	$994,655	$745,955
Average	$6.51	$6.67	$6.55	$5.70	$5.74
Imports for consumption:					
Short tons	61,765	85,729	52,111	73,080	45,758
Value: [2]					
Total	$190,756	$284,436	$179,579	$329,114	$177,954
Average	$3.09	$3.32	$3.45	$4.50	$3.89
Apparent new supply [3] ____ short tons	331,309	362,998	287,043	247,600	223,712
Domestic __________ percent	81.4	76.4	81.8	70.5	79.5
Reported consumption (total) short tons	334,695	334,406	325,195	265,270	187,561
Barium products:					
Sold or used by producers:					
Short tons	298,862	299,225	250,712	228,326	177,836
Value	$22,451,298	$23,154,685	$18,793,515	$16,365,522	$12,191,374
Imports for consumption:					
Short tons	28,349	23,311	18,201	12,912	10,561
Value	$1,314,780	$1,168,760	$905,091	$624,272	$385,651
Exports of lithopone:					
Short tons	3,326	4,556	3,665	3,821	3,212
Value	$337,565	$463,235	$380,047	$341,257	$270,195

[1] F.o.b. mine shipping point.
[2] Declared value f.o.b. foreign market.
[3] Barite sold or used by producers plus imports.

Markets and prices.—Trade-journal quotations for crude barite, which normally represent prices f.o.b. mines in the principal producing areas, were considerably lower in 1932 than in 1931. Moreover, it has been reported that even these exceptionally low prices were shaded somewhat in individual transactions. For instance, in the Missouri field shipments were reported at $4 per ton f.o.b. cars. The average as reported to the Bureau of Mines by producers was $5.74, and the range was from $4.65 in North Carolina to $7.11 in California.

In 1932 quoted prices for ground barite remained unchanged, but average valuations of sales reported by producers were somewhat under those of the preceding year. In the Midwestern area average prices for ground barite ranged from $13 to $20 per ton. The general range for the United States was $13 to $25 per ton.

Lithopone nominally held its own throughout most of the year, although the actual valuations of sales reported by producers declined considerably.

Due to the slump in demand, barium chemicals declined more in proportion than did lithopone or crude barite, and quoted prices were reported to have been shaded somewhat.

According to trade publications, prices of barite and barium products in foreign markets held up fairly well despite general trade conditions. Crude barite on the French market ranged in price from 80 to 100 francs per metric ton ($3.14 to $3.92) during 1930 and the first half of 1931. In the second half of 1931 and the first 2 months of 1932 it was quoted at 85 francs ($3.34). From March 10 to December 31 it remained at 80 francs ($3.14).

Prices of English ground barite based upon London quotations, opened the year 1932 at £7 to £8 10s. per long ton ($24.50 to $29.75) according to quality and held fairly steadily at these figures throughout the year.

Lithopone (30 percent grade) was quoted at £20 to £22 per long ton ($70 to $77) during the latter part of 1931; for the first half of 1932 it was quoted at £20 ($70) and for the last half advanced to £21 ($73.50).

Range of quotations on barite and barium products, 1930–32 [1]

	1930	1931	1932
Metal and mineral markets [1]			
Crude barite, f.o.b., mines, California .... short ton	....	....	$6.00 –$7.00
Crude barite, f.o.b. mines, Georgia .... long ton	$6.50 –$9.00	$6.00 –$6.50	6.00 – 6.50
Crude barite, f.o.b. mines, Missouri [2] .... short ton	7.00 – 8.00	6.00 – 6.50	5.00 – 6.00
Crude barite, f.o.b. mines, Missouri [3] .... do	[4]6.50 – 7.00	5.50 – 6.00	4.50 – 5.50
Ground barite, bbl., St. Louis .... do	23.00	23.00	23.00
Ground witherite, 90 percent through 100 mesh, f.o.b. works .... do	44.00	39.00 –44.00	37.00 –39.00
Ground witherite, 90 percent through 200 mesh, f.o.b. works .... do	47.00	[5]42.00 –47.00	[6]40.00 –42.00
Chemical markets [1]			
Lithopone, 400 lb., bbl, l.c.l .... pound	.04¾– .05¾	.04¾– .05	.04¾– .05–
Barium carbonate, 200 lb., bags, f.o.b. works .... short ton	58.00 –60.00	56.50 –60.00	47.00 –57.00
Barium chlorate, 112 lb., kegs, New York .... pound	.14 – .15	.14 – .15	.13¾– .15
Barium chloride, 600 lb., bbl., f.o.b. works .... short tons	63.00 –69.00	63.00 –69.00	63.00 –69.00
Barium dioxide, 88 percent, 690 lb., drums .... pound	.12 – .13	.12 – .13	.11 – .13
Barium hydrate, 500 lb., bbl .... do	.04¾– .05½	.04¾– .05½	.04¾– .05½
Barium nitrate, 700 lb., casks .... do	.07½– .08¼	.07¼– .08¼	.07 – .08
Blanc fixe, 400 lb., bbl., f.o.b. works .... short ton	75.00 –90.00	75.00 –90.00	60.00 –80.00

[1] Metal and Mineral Markets, Eng. and Min. Jour. (weekly). Chemical Markets, New York (monthly).
[2] 93 percent barium sulphate, not to exceed 1 percent iron, January–August 1930; 93 percent barium sulphate, less than 1 percent iron, September–December 1930 and January–February 1931; 95 percent barium sulphate, less than 1 percent iron, March–December 1931 and January–December 1932.
[3] 1 percent iron and 93 percent barium sulphate.
[4] August to December.
[5] 90 percent through 300 mesh, October–December 1931.
[6] 90 percent through 300 mesh, January–December 1932.

Development of new uses.—While there have been no new developments in methods of mining and milling barite, except for some experimental work indicating its susceptibility to concentration by flotation, some new uses have been discovered, and considerable effort has been expended in devising cheaper and better processes for the manufacture of barium products.

In the pigments field most of the research work has been on methods of preparing lithopone, which is perfectly light stable, even in the presence of relatively large quantities of chlorine gas.

Much attention has been given recently to the removal of soluble sulphates from boiler water and water for sugar refineries, paper mills, tanneries, laundries, and dyeing. A new compound, barium aluminate, used for water purification, of which the manufacturing process is patented, is now produced on a commercial scale.

Closely allied with this use is the use of air-floated natural barium carbonate to replace the more expensive barium chloride in the removal of calcium sulphate from salt brine. Neither of these barium compounds, however, can be used where the resultant product is destined for human consumption, as barium salts are poisonous in comparatively small quantities.[1]

Patented mixtures of barium compounds have had some previous use in glass batch melts. More recently, ground barite has been added direct to the glass mixture. It is reported that one principal advantage is that it lowers the fusion point of the glass with consequent savings in fuel, wear on furnace refractories, and repairs.[2]

Only within the last few years has barium carbonate been considered a valuable addition to enamel batches. It functions as a flux, and the advantages claimed are low cost, higher gloss, improved coefficient of expansion, elasticity, and resistance to organic acids.[3]

CRUDE BARITE

Sales.—Virtually all States producing crude barite registered appreciable reductions in the quantities sold or used in 1932 compared with 1931. The decrease in sales in 1932 ranged from about 9 percent for Missouri to approximately 72 percent for Tennessee. North Carolina, which has not reported any sales of crude barite since 1925, sold 100 tons during 1932. Due to the relatively small decline in its output, Missouri contributed 65.8 percent of the total sales in 1932 compared with only 53.5 percent in 1931.

Crude barite sold or used by producers in the United States, 1931–32, by States

State	1931				1932			
	Short tons	Percent of total	Value f.o.b. at mine		Short tons	Percent of total	Value f.o.b. at mine	
			Total	Average			Total	Average
Arizona	2,139	1.2	$14,275	$6.67	1,271	1	$8,896	$7.00
California	17,500	10.0	102,085	5.83	7,789	6	55,346	7.11
Georgia	(a)	(a)	(a)		(a)	(a)	(a)	
Missouri	93,417	53.5	539,152	5.77	85,458	66	463,347	5.42
Nevada	1,400	.8	9,600	6.86	(a)	(a)	(a)	
North Carolina					100		465	4.65
South Carolina					(a)	(b)	(a)	
Tennessee	10,170	5.9	62,903	6.19	2,825	2	15,702	5.56
Virginia	(a)	(a)	(a)		(a)	(a)	(a)	
Other States [c]	49,894	28.6	266,640		32,411	25	202,199	
	174,520	100.0	994,655	5.70	129,854	100	745,955	5.74

[a] Included under "Other States".
[b] Less than 1 percent.
[c] 1931: Figures cover Georgia and Virginia; 1932: Georgia, Nevada, South Carolina, and Virginia.

[1] Meyer, H. Conrad, Witherite, Its Occurrence and Uses. Foote-Prints, Foote Mineral Co., vol. 5, no. 1, 1932, pp. 15–16.
[2] Weigel, H. M., The Nonmetallic Mineral Industry in 1931. Min. and Met., vol. 13, January 1932, pp. 23–24.
[3] Meyer, H. Conrad, Witherite, Its Occurrence and Uses. Foote-Prints, Foote Mineral Co., vol. 5, no. 1, 1932, p. 19.

Consumption by uses.—During 1932 the barite-consuming industries of the United States used 187,561 short tons of domestic and imported barite compared with 265,270 tons in 1931, a decrease of 29 percent. This consumption was apportioned as follows: For the manufacture of ground barite, 34,554 tons, a decrease of 2 percent compared with 1931; for lithopone, 120,378 tons, a decrease of 23 percent; and for barium chemicals, 32,629 tons, a decrease of 55 percent.

Thirty-one plants in 13 States consumed crude barite in 1932, compared with 30 plants in 13 States in 1931. West Virginia had 2 plants and Missouri 1 plant more in operation, while California had 2 plants less in 1932 than in 1931.

Crude barite (both domestic and imported) used in the manufacture of barium products in the United States, 1928–32, in short tons

Year	In manufacture of—			Total	Year	In manufacture of—			Total
	Ground barite	Lithopone	Barium chemicals			Ground barite	Lithopone	Barium chemicals	
1928	74, 814	211, 592	48, 289	334, 695	1931	35, 393	157, 181	72, 696	265, 270
1929	58, 770	223, 188	52, 448	334, 406	1932	34, 554	120, 378	32, 629	187, 561
1930	69, 426	178, 944	76, 825	325, 195					

Domestic and imported crude barite used in the manufacture of barium products in the United States in 1932, by States, in short tons

State	Product manufactured	Plants [1]	Barite used
Missouri	Ground barite and chemicals	5	39, 050
Illinois	Ground barite, lithopone, and chemicals	6	38, 481
Delaware and Maryland	Lithopone	2	31, 076
New Jersey	Lithopone and chemicals	3	28, 798
Pennsylvania	do	2	23, 028
California	Ground barite, lithopone, and chemicals	4	14, 555
West Virginia	Chemicals	3	14, 421
Kansas	Lithopone	1	
New York	Ground barite and chemicals	2	
Georgia	Ground barite	1	
South Carolina	do	1	
Texas	do	1	
		31	189, 409

[1] A plant producing more than one product is counted but once in computing State totals.

Imports.—Imports of crude barite for consumption in the United States in 1932 were 45,758 short tons, valued at $177,954, a decrease of 37 percent in quantity and 46 percent in value compared with 1931 and the smallest tonnage imported in any year since 1925. The average declared or foreign-market value per ton decreased from $4.50 in 1931 to $3.89 in 1932 (14 percent).

Crude barite imported into the United States, 1931–32, by countries

Country	1931		1932	
	Short tons	Value [1]	Short tons	Value [1]
Germany	41,117	$136,677	35,915	$113,135
Italy	11	173	28	111
Netherlands	18,553	109,180	8,181	55,006
Soviet Russia in Europe	13,399	83,084	1,634	9,702
	73,080	329,114	45,758	177,954

[1] Value at port of shipment on which duty is levied. Does not include railroad and ship freight charges to this country or import duty.

World production.—The following table shows the output of barite by various countries from 1928 to 1932, as far as statistics are available.

World production of barite, 1928–32, in metric tons

Country	1928	1929	1930	1931	1932
Algeria	------	1,200	2,403	944	(1)
Australia:					
New South Wales	20	154	176	124	(1)
South Australia	2,404	2,001	1,560	1,468	1,543
Tasmania	------	10	------	------	(1)
Western Australia	------	2	------	------	(1)
Austria	2,243	300	496	87	(1)
Belgium	740	------	------	60	(1)
Canada	115	95	60	15	------
France	30,050	41,625	32,650	(1)	(1)
Germany:					
Bavaria	23,872	23,406	17,778	7,835	(1)
Prussia	232,858	260,811	217,925	160,482	(1)
Saxony	1,401	1,870	480	2,534	(1)
Great Britain	50,702	58,011	59,647	46,312	(1)
India (British)	3,146	3,810	6,906	5,745	(1)
Irish Free State	------	41	1,524	864	(1)
Italy	27,116	25,955	23,420	24,326	22,130
Portugal	------	------	------	80	(1)
Rhodesia, Southern	77	264	249	------	------
Russia [2]	3,937	(1)	(1)	(1)	(1)
Spain	[3] 6,163	5,806	5,552	8,539	(1)
United States	244,525	251,533	213,126	158,321	117,801

[1] Data not available.
[2] Year ended Sept. 30.
[3] Includes 2,300 tons produced from quarries.

BARIUM PRODUCTS

Sales.—The total quantity of barium products sold or used by producers in 1932 was 177,836 short tons, a decrease of 22 percent from 1931. The aggregate value was $12,191,374, a decrease of 26 percent compared with 1931.

To avoid duplication, the barium chemicals reported herein 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.

Barium products sold or used by producers in the United States, 1928–32 [1]

Year	Ground barite			Lithopone			Blanc fixe (precipitated barium sulphate)		
	Plants	Short tons	Value	Plants	Short tons	Value	Plants	Short tons	Value
1928	8	64,425	$1,332,228	12	200,468	$19,073,914	4	(2)	(2)
1929	8	54,472	914,516	12	206,315	19,773,864	4	(2)	(2)
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

Year	Artificial barium carbonate (chemically precipitated)			Barium chloride			Other barium chemicals [3]		
	Plants	Short tons	Value	Plants	Short tons	Value	Plants	Short tons	Value
1928	3	7,626	$416,227	3	5,224	$301,490	5	21,119	$1,327,439
1929	4	7,902	450,041	5	6,545	412,902	7	23,991	1,603,362
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

[1] To avoid duplication, the barium chemicals reported here to 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."
[3] Figures cover chemicals as follows—1928–29: Binoxide, hydroxide, sulphate, and sulphide; 1930: Binoxide, chloride, hydroxide, monoxide, oxide crystals, sulphate, and sulphide; 1931: Binoxide, chloride, oxide, and sulphide; 1932: Binoxide, hydroxide, oxide, and sulphide.

The apparent sales of ground barite increased about 5 percent, amounting to 33,842 tons in 1932. The value, however, declined sharply. The total value as reported was $563,902, a decrease of 14 percent, and the unit value decreased from $20.34 per ton in 1931 to $16.66 in 1932. While Missouri, as usual, was the center of the grinding industry of the United States, its proportion of the total sales declined from 83 percent in 1931 to 71 percent in 1932. California, on the other hand, increased its proportion of the total sales of this commodity from 7 percent in 1931 to 15 percent in 1932.

Lithopone, a chemical precipitate containing barium sulphate and zinc sulphide in the usual ratio of about 70 to 30, is the principal outlet for crude barite. The 11 plants in operation in 1932 produced and sold 121,667 tons of lithopone, valued at $10,176,856, which represented declines of 20 percent in quantity and 22 percent in value compared with 1931. The value per ton declined from $85.61 in 1931 to $83.65 in 1932, the lowest value since 1915.

Although the total quantity of lithopone consumed, among the three major consuming industries declined during the year under review, the floor-coverings and textiles industries increased their proportion of the total from 13.7 percent in 1931 to 14.5 percent in 1932. The total quantity consumed by these industries, however, declined 15 percent. The other major consuming industries decreased their consumption as follows: Paints, enamels, and lacquers, 22 percent, and rubber, 32 percent. "Other industries", however, increased their consumption of lithopone 15 percent over 1931.

Lithopone sold or used by producers, 1930–32, by consuming industries

Industry	1930		1931		1932	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paints, enamels, and lacquers	126,076	76.8	119,446	78.7	93,465	76.8
Floor coverings and textiles	23,656	14.4	20,780	13.7	17,601	14.5
Rubber	5,997	3.7	5,833	3.8	3,955	3.2
Other	8,336	5.1	5,791	3.8	6,646	5.5
	164,065	100.0	151,850	100.0	121,667	100.0

The following table gives the annual data on barium (lithopone and blanc fixe), lead, and zinc pigments sold or used in the United States since 1927. The large decline in the sales of blanc fixe may be due to the replacement of the barium base by calcium in titanium pigments.

The barium chemicals industry, which in 1931 showed increases despite general conditions, in 1932 experienced marked decreases in sales. Blanc fixe registered a large loss (54 percent in quantity and 49 percent in value), although the unit value advanced from $58.67 per ton in 1931 to $64.55 in 1932. Barium carbonate, chemically precipitated, declined 42 percent in quantity and 41 percent in value, while the unit value increased from $44.52 per ton in 1931 to $45.48 in 1932. "Other barium chemicals" showed large declines in both quantity and value.

Barium, lead, and zinc pigments sold or used by producers in the United States, 1928–32, in short tons

Year	Lithopone	Barium sulphate (blanc fixe)	Lead pigments [1]	Zinc pigments [2]	Year	Lithopone	Barium sulphate (blanc fixe)	Lead pigments [1]	Zinc pigments [2]
1928	200,468	(3)	169,974	185,127	1931	151,850	31,151	106,158	114,277
1929	206,315	(3)	162,611	187,760	1932	121,667	14,454	72,382	86,555
1930	164,065	(3)	112,448	136,421					

[1] White lead (dry and in oil) and white lead sulphate.
[2] Zinc oxide and leaded zinc oxide.
[3] Bureau of Mines not at liberty to publish figures.

Imports and exports.—Except for natural barium carbonate (witherite) and barium chloride, imports of barium compounds for consumption in the United States decreased in quantity in 1932 compared with 1931. Previously, Germany was the principal source of these compounds, but in 1932 United Kingdom and Netherlands (doubtless German transshipments) furnished more than one half of the imports. Witherite is furnished almost solely by United Kingdom.

Exports of lithopone in 1932 decreased 17 percent in quantity and 37 percent in value from 1931. Of the 3,212 short tons, valued at $270,195, exported during 1932, Canada purchased 2,883 tons, valued at $237,266, or 90 percent of the total quantity and 88 percent of the total value. The United Kingdom, Australia, and Cuba took most of the remainder in nearly equal quantities. The unit value of the exports of lithopone during 1932 was $84.12 per ton compared with $89.31 in 1931.

Barium compounds imported for consumption in the United States, 1928–32

[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
1928	3,098	$33,378	9,885	$808,200	6	$1,310	3,680	$168,923	5,222	$116,241
1929	2,924	34,619	8,409	725,554	(1)	21	3,501	168,367	3,206	69,236
1930	2,331	26,905	7,018	595,597	(2)	28	2,994	133,260	2,662	52,427
1931	1,851	22,415	5,674	428,523	(3)	11	930	38,083	1,110	20,839
1932	1,594	16,757	4,724	271,678	(4)	27	656	24,100	303	5,630

Year	Natural barium carbonate (witherite)		Barium chloride		Barium nitrate		Barium hydroxide		Barium oxide	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1928	4,311	$82,434	1,172	$25,253	789	$69,010	186	$10,031	(5)	(5)
1929	4,376	99,335	78	3,049	615	56,770	202	11,809	(5)	(5)
1930	[6] 2,562	[6] 52,282	7	372	407	31,985	220	12,235	(5)	(5)
1931	[6] 2,352	[6] 39,964	6	201	423	29,796	345	25,570	221	$18,870
1932	[6] 2,680	[6] 34,336	39	1,208	330	21,421	235	10,494	(7)	11

[1] 133 pounds.
[2] 222 pounds.
[3] 122 pounds.
[4] 328 pounds.
[5] Not separately recorded prior to 1931.
[6] Beginning June 18, 1930, imports recorded as "Witherite, crude, unground."
[7] 22 pounds.

Lithopone exported from the United States, 1928–32

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1928	3,326	$337,565	$101.49	1931	3,821	$341,257	$89.31
1929	4,556	463,235	101.68	1932	3,212	270,195	84.12
1930	3,665	380,047	103.70				

POTASH

By J. H. Hedges

The year 1932 witnessed continued shrinkage in world potash markets in response to declining agricultural income and the drying up of farm buying power. World production and sales fell to a new low, estimated at about 1,280,000 metric tons of potash (K_2O), compared with 1,500,000 tons in 1931, 2,018,300 tons in 1930, and 2,118,000 in 1929.

Nine tenths of all potash materials sold find their way to farms as ingredients of commercial fertilizer to replace the potash annually withdrawn from the soil by harvested crops. In many farming areas and for certain crops a profitable yield per acre can be obtained only with the help of fertilizer. In the old Cotton Belt of the South, for example, where cotton has been grown in the same fields for generations, virtually no crop can be raised if fertilizer is not used. In fact, the farmers of the Eastern, Southern, and Central States must have potash and other fertilizer ingredients, and the potash industry rises or falls with agricultural demands. In the United States, farm income shrank from $11,900,000,000 in 1929 to $5,240,000,000 in 1932; fertilizer sales dropped from the 1930 peak of 8,200,000 tons to 4,250,000 tons in 1932; and potash consumption declined from 390,000 short tons in 1930 to 167,665 in 1932.

In the face of these adverse conditions the domestic potash industry continued production at virtually the 1931 level and materially improved its position by winning a larger share of the domestic market and greatly increasing its productive capacity. It is estimated that within a year potential production will be well over 200,000 tons of K_2O annually.

Low costs have enabled shippers of crude and refined salts from New Mexico deposits to overcome the handicap of high freight charges and compete on the Atlantic seaboard with European producers. To what extent domestic producers will supply future American potash requirements is a matter of conjecture, but the competitive basis now established and the facilities and reserve that will presently be available have definitely freed this country from dependence on foreign sources.

Interest in the New Mexico deposits continued during the year. The mine near Carlsbad was a steady shipper of crude muriate, and operation of the refinery was begun in September. Drilling in the Carlsbad area by another company was successful in finding an extensive body of sylvinite at a depth of about 1,000 feet, and a shaft has been begun. Potash from cement-kiln dust again entered the market. This is the product of a new process, the commercial success of which might foreshadow general resumption of byproduct potash recovery from this source, with a potential annual production variously estimated at 50,000 to 100,000 tons of K_2O.

The improved position of domestic producers in relation to the domestic market is apparent from figure 86, showing domestic sales and consumption for the decade 1923–32 in short tons of available K_2O.

Salient statistics of the potash industry in the United States in 1931–32

[Production, sales, exports, and imports of crude potash materials, 1931 and 1932]

	1931	1932		1931	1932
Production.......short tons..	133,920	143,120	Imports..........short tons..	577,195	330,964
Sales...................do....	133,430	121,390	Value........................	$16,500,482	$8,841,838
Value.........................	$3,086,955	$2,102,590	Exports..........short tons..	32,460	2,034
Average value per ton....	$23.14	$17.32	Value........................	$1,267,109	$70,028

Prices.—Firm, but somewhat lower, prices prevailed in 1932. A number of concessions advantageous to the fertilizer industry were

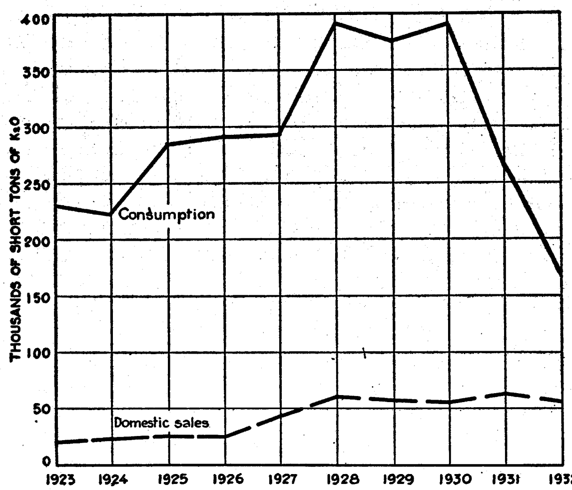

FIGURE 86.—Trends in domestic sales and consumption of potash (K_2O), 1923–32.

made in the new price list of foreign potash materials for the 1932 season (May 1, 1932, to Apr. 30, 1933) issued in May 1932 by N. V. Potash Export My., Inc., sales agents for French and German producers. The list price of sulphate in bags was reduced from $48.25 to $47.50; and 20 percent kainite in bulk was lowered 65 cents to $12. Other base prices were unchanged, but the extra charge formerly made if salts tested above the guaranteed minimum was discontinued, and a pro-rata allowance for undertest was established. This is equivalent to a price reduction that might amount to $1 or more per ton, since potash salts frequently test well above the minimum.

Summer discounts were increased 1 percent; a special discount of 2 percent was allowed on orders placed prior to June 1, 1932, for shipment May to September 1932, inclusive, and on orders placed prior to July 1 for shipment from Europe any time between July 1, 1932, and April 30, 1933. Regular discounts ranged downward from 12 percent on orders placed prior to June 1, 1932, for prompt shipment to 2 percent on orders placed prior to December 1, 1932, for shipment during December, January, and February, and net list on orders placed on or after December 1, 1932, for shipment between that date and April 30, 1933.

Prices were guaranteed against reduction until May 1, 1933. Purchasers of quantity requirements under contract were protected against underselling by other responsible producers of substantial quantities of potash salts of the same grade and quality by an arrangement whereby the selling company agreed either to meet the lower price or cancel part or all of the contract.

Base prices of foreign potash materials prevailing from 1926 to 1932, as supplied by N. V. Potash Export My., Inc., are given in the following table.

Quoted prices of different grades of potassium salts, 1925–32

[Per ton of 2,000 pounds, c.i.f. Atlantic and Gulf ports]

		Oct. 1, 1925, to Nov. 30, 1926	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
Sulphate, 90 to 95 percent K_2SO_4	in bags	$45.85	$47.30	$47.75	$48.25	$47.50
	in bulk	44.60	45.70	46.15	[1] 46.65	----------
Muriate, 80 to 85 percent KCl	in bags	34.90	36.40	36.75	37.15	37.15
	in bulk	33.65	34.80	35.15	35.55	35.55
Potash-magnesia sulphate (double manure salts), 48 to 53 percent K_2SO_4	in bags	26.35	27.25	27.50	27.80	27.80
	in bulk	25.10	25.65	25.90	[1] 26.20	----------
Manure salts, 30 percent K_2O	in bags	20.00	21.75	21.95	[1] 22.15	----------
	in bulk	18.00	18.75	18.95	19.15	19.15
Kainite, 20 percent K_2O	in bags	13.35	15.40	15.50	[1] 15.65	----------
	in bulk	11.35	12.40	12.50	12.65	12.00
Kainite, 14 to 16 percent K_2O	in bags	10.50	12.50	12.60	[1] 12.70	----------
	in bulk	8.50	9.50	9.60	9.70	9.70
Kainite, 12.4 percent K_2O	in bags	10.00	12.00	12.10	----------	----------
	in bulk	8.00	9.00	9.10	----------	----------

[1] Price not quoted after May 1, 1931.

Prices for domestic potash materials per short ton, c.i.f. Atlantic and Gulf ports, for the 1932 season, were announced by producers in June, as follows:

Manure salts, 25 percent K_2O minimum	in bulk	$15.00
Manure salts, 30 percent K_2O minimum [1]	do	19.15
Potash muriate, 95.98 percent KCl (equivalent to 60.62 percent K_2O) [1]	do	40.50
	in bags	42.30

These base prices were subject to a discount of 5½ percent throughout the season. A contract discount of 10½ percent was allowed on material ordered for June-April delivery, subject to the buyers' taking a minimum of 20 percent of estimated requirements during the June-October period; 10 percent in November; 15 percent in December; 25 percent in January; and the balance as required. Prices were guaranteed against decline. There was no charge for overtest, and a pro-rata allowance was made for potash content below the specified minimum.

Discounts on California muriate were allowed as follows: For shipment in June, 14 percent; July, 7 percent; August, 6 percent; September, 5 percent; October, 4 percent; November, 3 percent; December, 2 percent. Wharfage, handling, and delivery charges on shipments to inland points were the same as those for imported potash.

Consumption and uses.—The consumption of potash in the United States measured by imports plus domestic sales less exports, was 449,433 short tons of crude salts, equivalent to 167,665 tons of K_2O valued at $10,633,221 in 1932 compared with 678,165 short tons of

[1] Delivery after September.

material containing 262,000 tons of K_2O valued at $17,949,393 in 1931. The amounts represent a decrease of 36 percent in the quantity of K_2O and 40.8 percent in value from 1931, and a drop of 57 percent in the quantity of K_2O consumed compared with the all-time peak reached in 1928 and nearly equaled in 1930. Of the quantity consumed approximately 27 percent of the crude material, containing 33 percent of the K_2O and representing 23 percent of the total value, was produced in this country. About 90 percent of the total supply was used in the manufacture of fertilizers.

Falling prices and surplus stocks of agricultural commodities were reflected in greatly decreased sales of fertilizers, which slumped to a new low in 1932. Ten crops normally divide 95 percent of our fertilizer consumption, as follows: Cotton, 31.4 percent; corn, 22.5 percent; potatoes, 10.3 percent; wheat, 10.2 percent; tobacco, 7 percent; oats, 4.9 percent; citrus fruits, 3.6 percent; hay, 2.7 percent; sweet potatoes, 1.7 percent; and tomatoes, 1.2 percent. All others take the balance (4.5 percent).[2] The inevitable effect of 6-cent cotton, 20-cent corn, and 33-cent wheat on the potash market is apparent from these figures.

Contraction in the chemical market amounted to only about 16 percent compared with a shrinkage of about 38 percent in the agricultural market.

PRODUCTION AND SALES

Potash salts produced in the United States in 1932 totaled 143,120 short tons, containing the equivalent of 61,990 short tons of potash (K_2O), an increase of 9,200 tons (6.9 percent) in the salts produced and a decrease of 1,890 tons (3 percent) in the equivalent potash content compared with 1931. The average content of the salts produced calculated as potash was 43.3 percent compared with 47.7 percent in 1931 and 57.9 percent in 1930. The decrease for 2 successive years in the average grade of material produced was due to increasing shipments of crude salts from a mine in New Mexico that started regular production in 1931 and increased its output in 1932. At this property a refinery was completed during the year and began manufacturing refined salts.

Sales of domestic potash material dropped 12,040 tons—from 133,430 tons equivalent to 63,770 tons of potash in 1931 to 121,390 tons equivalent to 55,620 tons of potash in 1932, a decrease of 9 percent in gross tonnage and 12.8 percent in potash content. Sales were 21,730 tons less than production, and stocks increased by a like amount to approximately 41,000 tons of material equivalent to 28,000 tons of potash. The drop of 12.8 percent (in terms of equivalent K_2O) in sales of domestic potash compares with a decrease of 36 percent in total consumption of potash from domestic and imported salts. The total value of domestic potassium salts sold ($2,102,590) was $984,365 less than in 1931, a drop of 31.8 percent. The value per unit (20 pounds) of K_2O was 37.8 cents compared with 48.4 cents in 1931 and 52.7 cents in 1930.

Production and sales by States and by sources cannot be given without disclosing individual output. A summary of production and sales of potassium salts, and stocks in the hands of producers, for the past 5 years is given in the following table:

[2] Brand, Chas. J., Influence of Agricultural Prospects on Chemical Industry: Chem. and Met. Eng., vol. 40, no. 1, January 1933, pp. 18-22.

Potassium salts produced, sold, and in stock in the United States, 1928–32

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)
1928	9	104,129	59,910	5	105,208	60,370	$3,029,422	7	6,260	2,100
1929	5	107,820	61,590	4	101,370	57,540	2,988,448	5	12,650	6,200
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

REVIEW BY STATES

Potassium salts were produced in 1932 from natural brines in California; from bedded saline deposits in New Mexico; from distillery waste and cement-kiln dust in Maryland; and from cotton-boll and cotton-hull ashes in Oklahoma and Texas. A few small lots of crude alunite were shipped from Marysvale, Utah, and Sulphur, Nev., for experimental purposes, mostly direct application of the ground material to the soil as a fertilizer for citrus crops. Material recovered from natural brines and that mined from bedded salt deposits accounted for 93 percent of the total potash produced.

The principal producers were the American Potash & Chemical Corporation, 233 Broadway, New York, and Trona, Calif.; the United States Potash Co., Inc., 342 Madison Avenue, New York, and Carlsbad, N.Mex.; the United States Industrial Chemical Co., 110 East Forty-Second Street, New York, and Baltimore, Md.; and the North American Cement Corporation, 1004 Baltimore Trust Building, Baltimore, and Security, Md. The F. W. Brodé Corporation, 119 Madison Avenue, Memphis, Tenn., sold small lots of cotton-boll ashes, reported to average about 25 percent K_2O, purchased from gins in Texas and Oklahoma.

California.—The American Potash & Chemical Corporation recovered potassium salts, as well as borax at its plant at Trona, Calif., from the natural brines of Searles Lake, San Bernardino County. The potash product sold by this company is very high-grade potassium chloride (muriate). Shipments for 1932 were reported to average 63.17 percent K_2O, equivalent to practically pure KCl.

New Mexico.—The United States Potash Co. Inc., continued during 1932 regular shipments, begun in 1931, of crude sylvinite from a saline deposit near Carlsbad, N.Mex. The ore as mined and shipped averaged about 26 percent K_2O. During the year a refinery was completed and operated 3½ months, producing potassium chloride (muriate) averaging 61 percent K_2O.

The Potash Co. of America has drilled 15 core tests and several churn-drill holes on leases in the Carlsbad area, proving up a large tonnage of commercial-grade sylvinite. This company started sinking a shaft in February 1933 and expects to begin production of crude salts before the end of the year.

According to H. I. Smith, chief of the Mineral Leasing Division, United States Geological Survey, the proven area of commercial salts in New Mexico covers 33 square miles, comprising a reserve of more than 100,000,000 tons of soluble potash salts. The reserve of salts containing 26 to 28 percent K_2O, or twice the content of the average German salts, is ample for many years. The area in which sylvite, carnallite, or langbeinite has been found covers about 3,000 square miles, and the area in which potash mineral is found covers about 40,000 square miles.

Marketing on a substantial scale of products from these extensive potash-bearing salt deposits, long known to exist in the great Permian Basin embracing west Texas and eastern New Mexico, is significant. It is the first fruit of many years' investigation by Government and private agencies, and marks an important forward step in the development of a potash industry capable of completely supplying American needs.

Maryland.—At Baltimore the United States Industrial Chemical Co. continued to manufacture potash material by incineration of waste residue resulting from distillation of alcohol from fermented molasses. In this process two products are obtained—clinker drawn from the bottom of the incinerator, called "vegetable ash," containing about 33½ percent potash; and dust settled out of the fumes coming from the top of the incinerator, known as "sulphate muriate," averaging about 54.5 percent potash. Sales of this company for 1932 slightly exceeded output.

At Security near Hagerstown the North American Cement Corporation began in 1932 the recovery of potash from cement-kiln fume by a process involving fractional precipitation of the flue dust. The recovery plant consists of multiclones in series with an electrical precipitator. The coarse material, containing very little potash, is removed by the multiclones. The lower size limit is 3 to 5 microns although very heavy material as small as 1 micron may be removed. The potash fume, in general finer than 1 micron, passes through the multiclone and is collected by the electrical precipitator after the gases are humidified enough to cause the precipitator to work efficiently. The product is reported to contain about 22 percent K_2O, chiefly as sulphate. The raw material fed to the kilns is said to contain about 0.9 percent K_2O, which is not unusually high.

Under the stimulus of high prices resulting from war-time shortage, the problem of recovering potash from cement dust was studied, and a number of methods were devised for recovering the potash-bearing dust and for extracting the potash to obtain a concentrated product. With the post-war return to normal prices the business became unprofitable, and no potash from this source has been reported since 1925. However, experimentation has continued, and the reentry of the flue-dust product into the market signalizes technical advances that may foreshadow more general utilization of this waste product and add another important commercial source of domestic potash.

The normal production of portland cement is about 160,000,000 barrels a year. A potash-recovery process successfully applied to all cement plants in the country might product 100,000 tons of K_2O annually. An output of 25 to 50 percent of that amount might conceivably be attained within the next few years.

GOVERNMENT ACTIVITIES

The Bureau of Mines continued its study of methods of recovering potash from polyhalite (sulphate of potash, lime, and magnesia), the most abundant of the potash minerals found in cores from Government tests in Texas and New Mexico. Processes for the manufacture of potassium sulphate, potassium-magnesium sulphate, potassium chloride, and potassium sulphide have been developed and tested in the Bureau's engineering laboratory at New Brunswick, N.J. The investigators believe that polyhalite may soon find a place in the potash industry as raw material for the manufacture of potassium sulphate, and development of valuable byproducts may eventually enable this complex mineral to compete in other fields with higher grade salts. Chemical processes for treating wyomingite and greensand have likewise been studied, although the possibility of utilizing them commercially seems more remote.

The Bureau of Chemistry and Soils of the Department of Agriculture studied volatilization of potash from wyomingite, greensand, shale, and feldspar, in a blast furnace and in a cement kiln. By various processes developed, potassium chloride and different byproducts may be obtained. Simultaneous volatilization of potash and phosphorus from a mixture of potash silicate and phosphate rock in a blast furnace to produce potassium phosphate was also investigated. This process has special interest because of the close proximity of large deposits of phosphate rock, wyomingite (leucite), and coal for fuel in the Green River Valley, Wyo., although heavy transportation charges to present markets will discourage its early commercial application.

The United States Geological Survey, through administration of the mineral leasing laws, supervised potash production from public land in New Mexico and likewise continued its study of potash resources.

IMPORTS AND EXPORTS

Imports of potash materials in 1932 totaled 330,964 short tons containing 113,505 tons (34.3 percent) of potash compared with 577,195 tons containing 214,785 tons (37.2 percent) of potash in 1931, a decrease of 246,231 tons (42.7 percent) in gross tonnage and 101,280 tons (47.2 percent) in potash content. Of the total gross imports 87 percent was classified as used chiefly in the fertilizer industry compared with 92 percent in 1931 and 95 percent in 1930.

Imports of crude salts used chiefly in fertilizers declined 45.5 percent and the contained potash 50 percent, reflecting both the depressed condition of the fertilizer industry and the increased domestic production of crude and refined salts. The value of imports for agricultural use dropped 53.3 percent—from $12,225,733 in 1931 to $5,711,347 in 1932.

Potassium salts imported chiefly for use in the chemical industries fell off 11.1 percent and the equivalent potash 16.2 percent from the 1931 figure, while the total value declined 26.8 percent. Crude nitrate (saltpeter) alone increased. Imports of nitrate rose from 16,250 short tons containing 6,500 tons of potash valued at $646,269 in 1931 to 19,115 tons containing 7,646 tons of potash valued at $830,647, an increase of 17.6 percent in quantity and 28.5 percent in value.

The quantity, value, and grade of the different potash salts imported in 1931–32 are shown in the following table:

Potash materials imported for consumption in the United States, 1931–32

Material	Approximate equivalent as potash (K_2O) (per cent)	1931 Short tons	1931 Approximate equivalent as potash (K_2O) Short tons	1931 Approximate equivalent as potash (K_2O) Per cent of total	1931 Value	1932 Short tons	1932 Approximate equivalent as potash (K_2O) Short tons	1932 Approximate equivalent as potash (K_2O) Per cent of total	1932 Value
Used chiefly in fertilizers:									
Kainite	14.0	61,750	8,650	4.0	$502,671	55,299	7,440	6.6	$457,318
Manure salts	24.0	200,600	48,140	22.4	2,573,397	113,038	27,130	23.9	1,254,720
Muriate (chloride)	52.0	202,204	105,150	49.0	6,517,606	87,761	45,640	40.2	2,794,979
Sulphate	50.0	63,663	31,830	14.8	2,628,316	31,440	15,720	13.8	1,201,571
Other potash fertilizer material [1]	60.0	547	330	.2	3,743	391	240	.2	2,759
	--------	528,764	194,100	90.4	12,225,733	287,929	96,170	84.7	5,711,347
Used chiefly in chemical industries:									
Bicarbonate	46.0	184	85		20,334	151	69		15,316
Bitartrate (argols)	20.0	9,657	1,931		1,604,875	9,054	1,811		996,003
Bitartrate (cream of tartar)	25.0	42	11		16,398	15	4		3,448
Bromide	39.6	29	11		18,983	19	8		9,039
Carbonate, crude	61.0								
Carbonate, crude or black salts	50.0	7,583	4,626		664,059	5,228	3,189		428,576
Carbonate, refined	67.0								
Caustic	80.0	4,315	3,452		451,605	2,490	1,992		258,416
Chlorate and perchlorate	36.0	6,960	2,506		495,542	5,751	2,070		418,978
Chromate and bichromate	40.0	2	1		769	(2)	(2)		172
Citrate	43.0	5	2	9.6	2,429	2	1	15.3	1,198
Cyanide	70.0	47	33		34,219	27	19		18,533
Ferricyanide (red prussiate)	42.0	59	25		28,265	43	18		22,545
Ferrocyanide (yellow prussiate)	44.0	7	3		1,941	19	8		4,190
Iodide	28.0	[3] 1	(3)		3,830	3	1		12,045
Nitrate (saltpeter), crude	40.0	16,250	6,500		646,269	19,115	7,646		830,647
Nitrate (saltpeter), refined	46.0	3,059	1,407		237,791	963	443		76,121
Permanganate	29.0	96	28		15,882	89	26		15,871
Rochelle salt	22.0	13	3		3,281	11	2		2,230
All other	50.0	122	61		28,277	55	28		17,163
	--------	48,431	20,685	9.6	4,274,749	43,035	17,335	15.3	3,130,491
Grand total	--------	577,195	214,785	100.0	16,500,482	330,964	113,505	100.0	8,841,838

[1] Chiefly wood ashes from Canada.
[2] Quantity of bichromate imported was 786 pounds; approximate equivalent as K_2O is 314 pounds.
[3] In 1931 quantity of iodide imported was 1,305 pounds; approximate equivalent as K_2O is 365 pounds.

In 1913, the last normal pre-war year, the United States imported 272,457 tons of K_2O. Imports did not again rise to this level until 1928, when 330,493 tons were received. The peak reached in 1930 (342,454 tons) was followed by an abrupt decline to the low level of 113,505 tons recorded in 1932. Imports for the last 5 years, in terms of equivalent potash (K_2O), are shown in the following table:

Approximate equivalent as potash (K_2O) of potash-bearing materials imported for consumption in the United States, 1928–32, in short tons

Year	Short tons	Year	Short tons
1928	330,493	1931	214,785
1929	324,638	1932	113,505
1930	342,454		

Potash materials imported into the United States in 1932, in short tons

[General imports. The figures in parentheses in the column headings indicate in percent the approximate equivalent as potash (K_2O)]

Country	Muriate (chloride) (52)	Sulphate (50)	Manure salts (24)	Kainite (14)	Bitartrate		Caustic (80)
					Argols or wine lees (20)	Cream of tartar (25)	
Africa: Algeria and Tunisia					815		
Argentina					500		
Belgium	10,256	2,352	2,118	14,140			
Canada	1,075	64	7		2		
Chile					247		
Czechoslovakia	167						
France		529		4,835	2,517		
Germany	51,439	20,164	91,487	24,567		2	2,433
Greece					128		
Italy			112		2,705	17	
Japan		1,833					
Netherlands	9,682	6,080	15,171	11,757			
Palestine	500						
Poland and Danzig			1,060				
Portugal					1,225		
Spain	14,642		3,083		915		
Sweden							57
United Kingdom		418					
	87,761	31,440	113,038	55,299	9,054	19	2,490
Approximate equivalent as potash (K_2O)	45,640	15,720	27,130	7,440	1,811	5	1,992

Country	Carbonate (61)	Cyanide (70)	Nitrate (saltpeter), crude (40)	Chlorate and perchlorate (36)	All other (50)	Total	
						Short tons	Value
Africa: Algeria and Tunisia						815	$81,412
Argentina						500	45,270
Austria					11	11	3,846
Belgium						28,866	548,433
Canada			459			1,607	72,249
Chile			4,833			5,080	149,782
Czechoslovakia	598				43	808	58,455
Finland				(1)		(1)	40
France			56	525	26	8,488	393,837
Germany	3,808	27	13,573	4,930	1,216	213,646	5,370,826
Greece						128	12,576
Hong Kong	1					1	115
India, British			35			35	1,419
Italy						2,834	332,520
Japan					3	1,836	71,889
Netherlands	809				37	43,536	899,130
Norway			112			112	6,101
Palestine						500	13,286
Poland and Danzig						1,060	8,465
Portugal						1,225	125,287
Spain						18,640	565,963
Sweden	8			115		180	30,443
Switzerland				132		132	15,268
United Kingdom	4		47		10	479	21,959
	5,228	27	19,115	5,702	1,346	330,519	8,828,571
Approximate equivalent as potash (K_2O)	3,189	19	7,646	2,070	673	113,335	

[1] Less than 1 ton.

The above table gives amounts of the different potash salts imported and the countries from which the last shipment was made. From data available the country of origin cannot be definitely determined, but the greater part of both crude and refined salts imported

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originated in Germany and France. Muriate recovered from the Dead Sea in Palestine and manure salts from the mines of Poland entered the American market for the first time.

Exports of potash material not classed as fertilizer decreased 23.4 percent in quantity and 35 percent in value compared with 1931.

Potassium salts (not fertilizer) exported from the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	2,619	$609,018	1931	1,158	$370,935
1929	1,523	583,668	1932	887	241,179
1930	1,256	498,774			

Exports of potash fertilizer material fell to the lowest point recorded since statistics on this classification have been available. The decline was 93.7 percent in quantity and 94.5 percent in value compared with 1931. Total exports in 1931 and 1932 and the receiving countries are shown in the following table:

Potash fertilizer material exported from the United States, 1931–32, by destinations

Destination	1931					
	Chloride o r muriate		Other potash fertilizer		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada	5,417	$194,116	774	$23,386	6,191	$217,502
Colombia			13	659	13	659
Dominican Republic	1	22	3	159	4	181
Guatemala			7	641	7	641
Haiti			4	198	4	198
Honduras	1	40			1	40
Japan	25,872	1,034,406	336	11,872	26,208	1,046,278
Mexico			19	916	19	916
Venezuela			2	136	2	136
West Indies ("Other British")			11	558	11	558
	31,291	1,228,584	1,169	38,525	32,460	1,267,109

Destination	1932					
	Chloride or muriate		Other potash fertilizer		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada	319	$11,052	281	$8,209	600	$19,261
Cuba	92	2,936	161	7,236	253	10,172
Honduras	2	222	2	201	4	423
Japan	1,176	40,013			1,176	40,013
Venezuela			1	159	1	159
	1,589	54,223	445	15,805	2,034	70,028

WORLD PRODUCTION

Available figures for world production of potash materials during the past 5 years are given in the following table. The output of crude salts, in metric tons, and the approximate K_2O equivalent are shown for each producing country. The list of producing countries differs materially from that of importing countries shown in the table of imports, because most of the countries shipping potash material to the United States do not themselves produce potash but receive their supply from other countries. The bulk of potash material imported from other European countries originates in Germany or France, which together produce over 90 percent of the world's potash. The United States was the third largest producer of potash in 1931, with Poland fourth and Spain fifth. These five countries accounted for about 98 percent of the 1931 total. The growing importance of Russia and Palestine and the enlarged productive capacity of the United States may change the picture materially in the next few years.

World production of potash minerals and equivalent K_2O, 1928–32, in metric tons

Country and mineral	1928		1929	
	Output	Equivalent K_2O	Output	Equivalent K_2O
Australia: Western Australia, alunite			39	3
Chile, perchlorate of potash [2]	297	(1)	1,259	(1)
Chosen, alunite	13,798	(1)	10,812	(1)
Ethiopia, potassium salts	1,300	650	[3] 650	(1)
France (Alsace), crude potassium salts	2,580,196	[4] 406,640	3,124,816	[4] 492,097
Germany, crude potassium salts:				
Carnallite [5]	2,057,760	200,488	2,317,940	222,506
Kainite, sylvinite, and hartsalz	10,431,310	1,490,640	10,998,278	1,565,269
India (British), nitrate of potash [6]	4,800	2,000	5,000	2,300
Italy:				
Alunite	185	19	105	11
Leucite rock	39,200	3,200	37,727	(1)
Poland, crude potassium salts:				
Kainite	146,692	14,669	137,858	14,062
Sylvinite	194,964	40,942	220,770	49,673
Russia: [8]				
Alum stone	1,131	(1)	(1)	(1)
Alunite clays	1,812	(1)	(1)	(1)
Carbonate of potash [9]	6,057	(1)	6,980	(1)
Spain:				
Alunite	826	(1)	1,599	(1)
Crude potassium salts	243,233	24,323	243,949	24,395
Potassic earth	850	(1)	850	(1)
United States, crude potassium salts	94,464	54,349	97,812	55,873

See footnotes at end of table.

World production of potash minerals and equivalent K_2O, 1928–32, in metric tons—Continued

Country and mineral	1930 Output	1930 Equivalent K_2O	1931 Output	1931 Equivalent K_2O	1932 Output	1932 Equivalent K_2O
Australia: Western Australia, alunite					(1)	(1)
Chile, perchlorate of potash [2]	2,409	(1)	(1)	(1)	(1)	(1)
Chosen, alunite	11,708	(1)	(1)	(1)	(1)	(1)
Ethiopia, potassium salts	[3] 1,500	(1)	(1)	(1)	(1)	(1)
France (Alsace), crude potassium salts	3,135,170	[4] 506,370	2,197,481	[4] 368,870	(1)	(1)
Germany, crude potassium salts:						
Carnallite [5]	1,867,548	179,087	1,059,278	100,985	(1)	(1)
Kainite, sylvinite, and hartsalz	10,094,703	1,429,427	6,992,122	976,657	(1)	(1)
India (British), nitrate of potash [6]	4,700	2,200	6,600	3,100	(1)	(1)
Italy:						
Alunite	825	83	990	102	(1)	(1)
Leucite rock	41,200	(1)	16,000	(1)	(1)	(1)
Palestine, crude potassium salts [7]	6,000	1,200	13,000	2,600	19,800	3,960
Poland, crude potassium salts:						
Kainite	100,783	10,209	59,120	7,165	299,000	(1)
Sylvinite	204,826	45,021	202,199	45,576		
Russia: [8]						
Alum stone	(1)	(1)	(1)	(1)	(1)	(1)
Alunite clays	(1)	(1)	(1)	(1)	(1)	(1)
Carbonate of potash [9]	(1)	(1)	(1)	(1)	(1)	(1)
Spain:						
Alunite	3,864	(1)	23,985	(1)	(1)	(1)
Crude potassium salts	286,436	28,644	250,087	28,116	409,888	54,811
Potassic earth	900	(1)	1,100	(1)	(1)	(1)
United States, crude potassium salts	95,989	55,583	121,490	57,951	129,836	56,236

[1] Data not available.
[2] Produced at nitrate plants from caliche.
[3] Muriate of potash produced in Eritrea from crude salts mined in Ethiopia.
[4] Figures relate to merchantable products.
[5] Includes some natural kieserite.
[6] Estimated production (Imperial Institute, London).
[7] Extracted from waters of the Dead Sea.
[8] Year ended Sept. 30.
[9] Made from sunflower ash.

The outstanding developments in foreign countries in 1932 are given below.[3]

Germany.—Total sales of potash reported by the German Potash Syndicate declined from 964,000 metric tons of K_2O in 1931 to 847,000 tons in 1932. The shrinkage in sales volume was 5 percent in domestic business and 15 percent in exports. Stocks were reduced 30,000 tons to 120,000 tons on December 31, 1932. A cargo of approximately 500 tons of potash salts was shipped from Germany to Kenosha, Wis., by the all-water route through the Welland Canal and the Great Lakes, eliminating the costly rail haul from the Atlantic seaboard.

France.—During the first 10 months of 1932 production in Alsace fell to 1,595,000 metric tons of crude potash compared with 1,828,000 tons in the corresponding period of 1931 and 2,690,000 tons in 1930. The decline was due largely to decreased sales for export. Domestic consumption has been maintained at a fairly high level through active promotional work and lower prices for the home market. At the end of October the working staff was reported to number 7,434 and operations were on a 40-hour-week basis. Later reports stated that the outlook for autumn and spring sales was not bright and mining operations had been limited to 18 days a month.

[3] Bureau of Foreign and Domestic Commerce, World Trade Notes.

Poland.—A 5-year commercial agreement between the German Potash Syndicate and the Polish "Tesp" (Society for the Exploitation of Potassium Salts) was concluded March 17, 1932. By its terms the Polish producers will receive a quota of 4 percent in the world market, which is now dominated by the Franco-German interests. The German syndicate will control Polish production but will relinquish competition in the Polish market. Production of potash from the mines at Kalusz and Stebnik declined sharply in 1932 due to accumulated stocks and reduced domestic sales. Exports of Polish potash dropped from 68,800 tons in 1931 to 60,000 tons in 1932.

Spain.—The Dirección General de Minas y Combustibles was reported to have fixed the minimum production of potash for 1932 at 50,000 tons of potassium chloride, 80–84 percent, and the maximum at 250,000 tons of chloride or its equivalent in other salts. Potassas Ibericas, S.A., announced that its first operating shaft reached the sylvinite stratum May 20, 1932. The company estimates that its deposit contains 75,000,000 metric tons of sylvinite and 112,000,000 tons of carnallite at depths ranging from 200 to 240 meters and concentrated enough to justify commercial exploitation.

Russia.—Steady progress is reported in development of the extensive potash deposits in the Ural district; 61,000 tons of potash were produced in the first half of 1931, and 135,000 tons were estimated for the entire year. The production program for 1932 was said to call for an output of 1,000,000 tons. A potash refinery at Solikamsk has been completed under the direction of German engineers, with equipment supplied by leading German industrial concerns. It is reported that the Russian Potash Trust does not contemplate entering foreign markets until the urgent needs of Russian agriculture have been satisfied.

Palestine.—Recovery of potash from the Dead Sea in Palestine has increased steadily since operations were begun in April 1930. Output for 1932 has been estimated at 3,960 tons K_2O and 300 to 400 workmen were employed. Most of the product is shipped to England, although a cargo of 500 tons was received at Baltimore in September. Production of 10,000 to 12,000 tons in 1933 is planned. It has been estimated that the waters of the Dead Sea contain over 2,000,000,000 tons of muriate of potash. Operations are conducted by Palestine Potash, Ltd., under a 75-year concession covering an area of about 1½ square miles. Solar evaporation is employed, followed by refining of the potash salts.

Japan.—The manufacture of potassium chlorate was begun in April 1932 in a plant at Hirota, Fukushima Prefecture, leased for 10 years from the Japan Chemical Co. by the Japan Iodine Co. New machinery and equipment were installed, and production is reported as 220 barrels of 50 kilos each per day. It is anticipated that production will be increased to 300 barrels per day, enough to supply the Japanese market. Imports of potassium chlorate have been 1,000 to 2,300 tons per year. Approximately 3,000 tons of European potassium sulphate were reshipped from Japan in 1932 to Pacific coast ports in the United States.

MAGNESIUM AND ITS COMPOUNDS

By E. P. Partridge and A. E. Davis

MAGNESITE

Steel production languishing at 19 percent of capacity during 1932 and building likewise at low ebb had an inevitable adverse effect upon the magnesite industry in the United States. The two concerns that mined crude magnesite during the year reported a production 47.7 percent below the 1931 figure. Sales of domestic dead-burned magnesite correspondingly dropped 47.4 percent and of domestic caustic calcined magnesite 42.8 percent from 1931 to 1932. Imports of both of these materials also decreased from 1931 to 1932. However, the quantity of dead-burned magnesite imported for consumption was only 26.4 percent lower, indicating increased foreign competition for the restricted markets in the United States.

Salient statistics for the magnesite industry in the United States, 1928–32

	1928	1929	1930	1931	1932
Crude:					
Mined:					
Short tons	127,200	187,660	129,320	73,602	38,462
Value	$1,098,550	$1,500,000	$1,033,130	$499,239	$283,304
Sales by producers:					
Short tons	620		1,120	1,325	575
Average value per ton [1]	$9.18		$12.87	$11.21	$9.52
Imports for consumption .... short tons	762	300	842	499	9
Apparent new supply .... do	1,382	300	1,962	1,824	584
Domestic .... percent	44.9		57.1	72.6	98.0
Caustic calcined:					
Sales by producers:					
Short tons	13,310	11,390	8,580	5,900	3,374
Average value per ton [1]	$34.17	$35.56	$30.30	$30.68	$30.59
Imports for consumption .... short tons	5,474	6,500	3,911	2,891	1,777
Apparent new supply .... do	18,784	17,890	12,491	8,791	5,151
Domestic .... percent	70.9	63.7	68.7	67.1	65.5
Dead-burned:					
Sales by producers:					
Short tons	45,230	78,700	49,460	28,231	14,836
Average value per ton [1]	$23.80	$19.60	$18.27	$19.31	$20.78
Imports for consumption .... short tons	57,007	50,379	41,417	10,349	7,613
Apparent new supply .... do	102,237	129,079	90,877	38,580	22,449
Domestic .... percent	44.2	61.0	54.4	73.2	66.0

[1] Average receipts f.o.b. mine shipping point.

Reports from abroad show that the established producers are facing conditions similar to those in the United States. Austria, the largest producer in the past, in 1932 dropped to 30.7 percent of its peak production of the crude mineral in 1929, while the United States output has correspondingly fallen to 20.5 percent. Mining of magnesite in Greece and Czechoslovakia has been similarly curtailed over the same period, but production has increased in China, Yugoslavia, and especially in Russia. Soviet figures for 1931 show an output of 246,000 metric tons of crude magnesite, with an increase to 685,000 tons set as the goal for 1932. Although the exports in 1930 and 1931 averaged only 17,000 metric tons, the future effect of Russian magnesite upon the world industry must be considered.

Magnesite products, whether used as refractories or as building materials, are subject to intense commodity competition. It seems

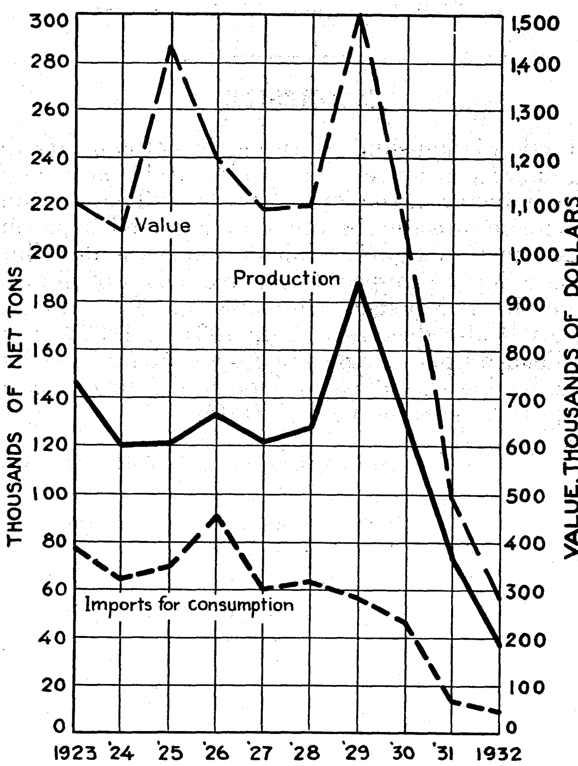

FIGURE 87.—Trends in production, value, and imports for consumption of magnesite, 1923–32.

probable that the producers will not be able to maintain their position without the assistance of intensive technical research directed toward improved utilization in existing markets and the development of new outlets.

Three mines operated by two companies in Washington and California produced 38,462 short tons of magnesite in the United States during 1932. Of this amount, which was valued at $283,304, only 575 short tons with a value of $5,474 were sold crude. The activity of the domestic magnesite mining industry since 1923 is indicated in figure 87.

Sales of domestic calcined-magnesite materials were as follows: Dead-burned, 14,836 short tons valued at $308,327, a decrease of 47.4 percent in quantity and 43.4 percent in value; caustic calcined, 3,374 short tons valued at $103,196, a decrease of 42.8 percent in quantity and 43 percent in value. Additional data for each year since 1928 are given in the statistical summary at the beginning of this chapter.

Crude magnesite mined in the United States, 1928–32

Year	California		Washington		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1928	41,300	$454,300	85,900	$644,250	127,200	$1,098,550
1929	[1] 187,660	[1] 1,500,000	(1)	(1)	187,660	1,500,000
1930	[1] 129,320	[1] 1,033,130	(1)	(1)	129,320	1,033,130
1931	[1] 73,602	[1] 499,239	(1)	(1)	73,602	499,239
1932	[1] 38,462	[1] 283,304	(1)	(1)	38,462	283,304

[1] Washington included with California. Bureau of Mines not at liberty to publish figures.

Prices.—The following prices were quoted in trade journals during 1932:

Quoted prices of magnesite products per short ton, 1932, in dollars

	F.o.b. California mines					F.o.b. Chewelah, Wash.: Dead-burned magnesite
	Dead-burned magnesite			Caustic calcined magnesite		
	Standard grade	93 percent grade (artificial periclase)	88 percent grade	Ground, 95 percent grade	90 percent grade	
Jan. 6 to May 19	$25		$35			$22
Jan. 6 to June 23	25	$68	35	$45	$40	22
May 26 to June 16	25	68	35	45	40	21
June 30 to Sept. 15	25	65	35	38	35	21
June 23	25	65	35	38	35	22
June 30 to Aug. 18	25	65	35	38	35	21
Aug. 25 to Dec. 29	25	65	35	38	35	22
Sept. 22	25	68	35	45	40	22
Sept. 29 to Dec. 29	25	65	35	38	35	22

California.—The Sierra Magnesite Co., Ltd., was the only concern which mined and sold magnesite in California during 1932. Operations were carried on at its Bald Eagle Mine near Gustine in Stanislaus County and also at the Western Mine near Livermore in Santa Clara County, formerly operated by the C. S. Maltby Co.

Nevada.—The United States Brucite Corporation reported no production during 1932 from its brucite deposits near Luning in Nye County, Nev.

Washington.—The Northwest Magnesite Co., operating its Finch Mine near Chewelah in Stevens County, was the only magnesite producer in Washington during 1932.

Imports.—The quantities of all forms of magnesite imported for consumption decreased again from 1931 to 1932, as they did from 1930 to 1931. Data for 1928 to 1932 are given in the statistical summary at the beginning of this chapter. The following table indicates the changes in imports from various countries during the same period. In contrast to the general decrease in imports the initial appearance of magnesite from Yugoslavia and Albania is worthy of note.

Magnesite imported into the United States, 1928–32, by countries, in short tons

[General imports]

Country	1928	1929	1930	1931	1932
Austria	34,997	31,908	26,304	10,214	4,540
Belgium	25	22	32	54	
Canada	45		83	289	47
Czechoslovakia	21,876	12,520	19,080	5,635	2,393
Germany	358	59	264	95	55
Greece	760	310	976	779	77
India, British	3,426	4,259	2,563	1,305	1,127
Italy		1,634	5	14	
Netherlands	1,959	2,055	1,102	713	427
Soviet Russia in Europe		276	714	4,714	
United Kingdom	56	139	72	93	25
Yugoslavia and Albania					229
	63,502	53,182	51,195	23,905	8,920

Magnesite imported into the United States in 1932, by countries and classes

[General imports]

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
Austria							4,540	$65,046
Canada	9	$372					38	2,884
Czechoslovakia							2,393	35,299
Germany					4	$194	51	930
Greece					77	1,728		
India, British	112	1,236	1,015	$10,972				
Netherlands			23	608	404	10,670		
United Kingdom					25	915		
Yugoslavia and Albania					229	4,264		
	121	1,608	1,038	11,580	739	17,771	7,022	104,159

WORLD PRODUCTION

The world production of magnesite for 1927 to 1931, by countries, is shown in the following table:

World production of magnesite, 1927–31, by countries, in metric tons [1]

Country	1927	1928	1929	1930	1931
Australia:					
New South Wales	10,178	10,840	9,097	8,794	3,480
South Australia	335	46	137	37	
Victoria	73	73	27	(2)	(2)
Austria	356,000	310,000	438,000	304,396	179,440
Canada	18,523	33,311	39,216	25,073	24,348
China	[3] 21,400	(2)	32,189	29,482	30,000
Czechoslovakia [4]	84,563	87,396	101,118	71,388	38,903
France		600			(2)
Greece	84,484	104,421	84,023	68,509	49,642
India, British	19,953	24,798	23,874	16,788	5,419
Italy	16,304	11,690	17,172	4,122	3,470
Norway	1,090	932	1,809	2,206	1,580
Russia [5]	[6] 106,583	[6] 119,985	132,710	152,000	246,000
Turkey			196	357	2,197
Union of South Africa	1,839	1,481	1,709	1,910	1,357
United States	110,213	115,393	170,241	117,317	66,770
Yugoslavia	[7] 1,680	[7] 6,267	[7] 6,615	13,068	(2)

[1] Unless otherwise stated, quantities in this table represent crude magnesite mined.
[2] Data not available.
[3] As estimated by the Geological Survey of China. (General Statement of the Mining Industry, Peiping.)
[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] Exclusive of magnesite sand, as follows: 1927, 77,211 tons; 1928, 8,799 tons.
[7] Serbia only.

Austria.[1]—The Austrian output of crude magnesite decreased from 179,440 metric tons in 1931 to 134,400 metric tons in 1932, a drop of 25 percent. At the same time the production of dead-burned and caustic calcined magnesite decreased 26 and 11 percent, respectively. Of the crude magnesite production, the two smaller concerns, Steirische Magnesitindustrie A.G. and Alpenländische Bergbaugesellschaft m.b.H., contributed only 26,050 metric tons, all of the amorphous variety.

Only the two larger companies, Veitscher Magnesitwerke A.G. and Oesterreichisch-Amerikanische Magnesit A.G., produced dead-burned magnesite. During 1932 the output of the former was 19,452 and of the latter 9,300 metric tons. The latter company also produced 58 percent of the 30,900 metric tons of caustic calcined magnesite reported for the year.

The production of magnesite brick, which is included in the tonnage of dead-burned magnesite, dropped from 23,817 metric tons in 1931 to 15,528 metric tons in 1932, a decrease of 35 percent.

Austrian exports of dead-burned magnesite have dropped greatly in the past 2 years. The figures for 1930, 1931, and 1932 are 58,039, 27,491, and 14,930 metric tons, respectively.

About one half the Austrian output of caustic calcined magnesite is used within Austria, the exports (15,615 metric tons) going mainly to Germany, with significant quantities also to France and Czechoslovakia.

Price agreements covering both domestic and foreign sales of dead-burned magnesite and domestic sales of caustic calcined magnesite remained effective, aside from slight adjustments.

No changes in political or commercial control were revealed during 1932, although the German stockholders of the Veitsch concern were reported to have protested acquisition of control by the French group, which purchased shares released when the Austrian bank was in difficulty in 1931.

British India.[2]—Magnesite deposits are worked near Salem about 230 miles south of Madras and nearly midway between Madras and Calicut. The magnesite is in veins ranging up to 4 or 5 feet in thickness. To produce 2,000 to 3,000 tons of magnesite a month it may be necessary to remove more than 40,000 tons of earth and rock.

Canada.—The output of "calcined or clinkered" magnesite in Quebec dropped from 11,411 short tons valued at $295,579 in 1931 to 8,892 short tons valued at $262,860 in 1932, following serious declines in preceding years. Canadian exports of dead-burned magnesite amounted to 1,194 short tons valued at $33,103 in 1932 compared to 1,610 short tons valued at $45,257 in 1931. The 1932 exports to the United States were only 47 tons.

A large, conveniently situated deposit of crystalline magnesite was discovered near Cranbrook, British Columbia, during the field season of 1932 by Dr. C. E. Cairnes of the Geological Survey, Department of Mines, Ottawa. The aggregate thickness is at least 30 feet; the formation is 150 feet wide and has been traced for more than 4 miles. These deposits and occurrences of hydromagnesite have been recently described.[3]

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[1] Harris, E. L., Am. consul general, Vienna, Mar. 15, 1933.
[2] Lebeter, F., Magnesite in India (notes on its occurrence and methods of mining): Iron and Coal Trades Rev. (London), vol. 125, no. 3375, Nov. 4, 1932, pp. 689-690.
[3] Richmond, A. M., Magnesite and Hydromagnesite in British Columbia: British Columbia Dept. Mines, Nonmetallic Mineral Investigations, Rept. 5, Victoria, March 1933, 21 pp.

Chosen.[4]—A previously discovered magnesite deposit near Taikwayodo was re-examined during 1932. The main mass is a huge lens 8,000 meters long and 100 meters wide, apparently quite pure, since 13 analyses showed 44 to 46 percent MgO.

Greece.—During 1932 Greece exported 13,002 metric tons of crude magnesite with an average value of 398 drachmas per ton, the distribution in percent being as follows: Great Britain, 43; Italy, 35.5; Germany, 16; Netherlands, Belgium, Luxemburg, and France, 5.5. The exports of calcined magnesite, amounting to 10,563 metric tons with an average value of 1,050 drachmas per ton, were distributed as follows: Netherlands, 35 percent (3,704 tons), valued at 4,000,730 drachmas; France, 35 percent (3,696 tons), valued at only 2,759,250 drachmas; Germany, 15 percent; Great Britain, 13 percent.

Japan.—While magnesite occurrences have been noted in Japan they apparently have not warranted commercial development.[5] Domestic requirements are supplied principally from deposits in Manchuria controlled by the South Manchurian Railway and to a smaller extent from China. Analyses of material from the principal Manchurian deposit at Taisekkyo show 47 to 48 percent MgO, indicating practically pure magnesite. Several hundred million tons of magnesite are estimated to occur in this deposit and in one other at Tapingshan.

Russia.[6]—The magnesite industry is being developed rapidly in Russia. Soviet figures for 1931 show the following outputs in metric tons: Crude magnesite, 246,000; caustic calcined magnesite, 14,000. The mines and plant at Satka have been expanded. Deposits in the Aktubinsk district in the South Urals about 50 kilometers north of Orsk, containing 46 percent MgO, have been examined. Large deposits have also been discovered in the Biro-Bidzhan district about 6 kilometers from Biroksan on the Ussirsk Railway.

Yugoslavia.[7]—The Ste. Minière de la Choumadiya (elsewhere reported as Sunadiji) holds a concession covering the important deposit of amorphous magnesite near Cacak, roughly 100 kilometers from Belgrade. With indicated reserves ample to meet French requirements for several decades, the company has installed modern equipment intended to furnish a substantial tonnage over a long period.

DOLOMITE

Patents bearing on the utilization of dolomite have increased in number in recent years both in the United States and other countries. These patents describe the production of refractories, magnesian cements, magnesium chemicals, and metallic magnesium and indicate that dolomite, because of its wide-spread occurrence, must be considered an increasingly important competitor of magnesite.

Sales of dolomite for uses that may be considered competitive with magnesite have been segregated so far as possible from other uses it shares with limestone or other stone.

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[4] Kinosaki, Y., Magnesite Deposits in the Vicinity of Taikwayodo, Tansen-Gun, S. Kankyo-Do: Chosen Mineral Survey, vol. 7, no. 1, Keijo, 1932, 19 pp. geol. map, 5 plates (in Japanese; English summary, pp. 17–19).

[5] Dowd, W. S., Am. asst. commercial attaché, Tokyo, Magnesite in Japan: Bureau of Mines, Foreign Files 427, Jan. 27, 1933.

[6] Economic Review of the Soviet Union, Soviet Magnesite: Vol. 7, nos. 23–24, Dec. 1932, p. 423.

[7] L'Echo des Mines et de la Metallurgie, L'exploitation et traitement de la magnesite en Yougoslavie: Vol. 60, no. 3099, Paris, 1932, pp. 287–290.

Dolomite and dolomitic lime sold or used by producers in the United States for specified purposes, 1928–32

	1928	1929	1930	1931	1932 [1]
Dolomite for—					
Basic magnesium carbonate:					
Short tons	94, 200	84, 750	111, 740	80, 820	57, 000
Value	$122, 260	$129, 383	$189, 219	$122, 525	$68, 000
Carbon dioxide	(2)	(2)	(2)	(2)	(2)
Dead-burned dolomite or refractory stone:					
Short tons	522, 850	516, 400	453, 350	268, 500	135, 000
Value	$509, 502	$461, 444	$356, 025	$183, 020	$90, 000
Dolomitic lime for—					
Refractory (dead-burned dolomite):					
Short tons	448, 761	488, 032	351, 740	243, 769	133, 000
Value	$4, 283, 036	$4, 261, 942	$3, 045, 082	$1, 866, 971	$1, 020, 000
Sulphite pulp:					
Short tons	46, 000	51, 000	38, 400	32, 000	27, 000
Value	$359, 000	$398, 000	$295, 000	$233, 000	$168, 000
Total (calculated as raw stone)—short tons	1, 605, 000	1, 654, 000	1, 360, 000	922, 000	530, 000

[1] Subject to revision.
[2] Bureau of Mines not at liberty to publish figures after 1926.

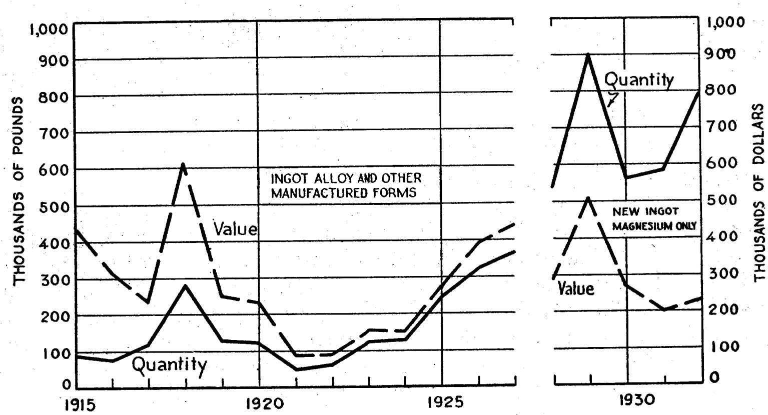

FIGURE 88.—Quantity and value of metallic magnesium of domestic origin produced and sold or used in the United States, 1915–32. The break in the graph between 1927 and 1928 is made to indicate a change in the type of data. For 1927 and prior years the quantity of ingot alloys and other manufactured products is shown, since fabrication of the metal into rods, tubing, castings, powder, and other semifinished and finished forms was conducted almost exclusively in the same establishment in which the virgin ingot was produced. Beginning with 1928 the production and value of new ingot magnesium only is depicted as fabricators turned to sources outside of their own plants for supplies of new ingot.

MAGNESIUM

In contrast to the prevailing industrial trend the sales of magnesium increased in 1932, exceeding the record for any previous year except 1929, as indicated by figure 88.

Prices.—Following the sharp reduction in price of metallic magnesium to 30 cents a pound in September 1931 it remained unchanged during 1932, although the selling price for various fabricated items was further reduced. For certain commercial uses sand castings have been sold as low as 60 cents a pound, while extruded shapes, depending on their cross-sectional area, ranged from 50 to 90 cents a pound.

New magnesium ingot produced in the United States and sold or used by the producer, 1928–32

Year	Produced (pounds)	Sold or used by the producer	
		Pounds	Value
1928	521,075	530,782	$289,658
1929	1,329,669	908,351	512,313
1930	1,173,557	559,631	268,864
1931	(1)	580,463	199,633
1932	(1)	791,699	228,653

[1] Figures not available.

Magnesium products other than ingot magnesium manufactured and sold or used by producers in the United States, 1928–32, in pounds

Product	1928	1929	1930	1931	1932
Alloy ingot	16,210	13,145	12,297	65,314	128,751
Castings	55,861	116,350	99,443	127,398	132,049
Powder and shavings	28,104	36,663	30,832	23,924	19,825
Wire and ribbon	7,695	7,736	7,898	2,906	4,650
Rod and tubing [1]	719	1,864	115	194	171
Sheet	8,425	8,512	1,348	9,433	17,796
Other [2]	20,218	12,051	13,558	26,945	39,106
Total	121,022	183,176	153,194	190,800	213,597

[1] Exclusive of extruded rods or ingots sold for metallurgical purposes.
[2] Includes forgings, extruded shapes, etc.

Uses.—Progress in the fabrication of magnesium and its alloys featured 1932. The average weight of sand castings advanced from 1 to 3 pounds, and castings as large as 150 pounds have been made successfully. The combined lightness and strength of magnesium-base alloys have led to their use in the manufacture of aircraft, motion-picture machines, quick-oscillating machinery such as bread slicers, high-speed cutting lathes, pneumatic tools, portable typewriters, ticket-vending equipment, and textile-machine parts. Castings have entered the low-price automobile field on an experimental basis, while sheet and extruded structural shapes including standard 5-inch I-beams weighing about 2.5 pounds per foot are being used in bus, truck, and trailer construction. The use of magnesium alloys in foundry flask, patterns, and core boxes has also increased.

The die-casting of alloys specially developed for this purpose made marked progress during 1932. The claim is made that while the cost of producing die castings from these magnesium alloys is not as low as from aluminum, it is considerably below that of any other foundry method.

The commercial progress of magnesium-base alloy as an engineering material is indicated by new specifications added by the American Society for Testing Materials covering "Magnesium-base alloy sheet" and "Magnesium-base alloy wrought shapes other than sheet."

In the nonstructural field ribbon and wire sales recovered much of the loss in 1931, but sales of powder continued to decline due to decreased Government purchases.

Imports.—Imports of magnesium amounted to 182,939 pounds, valued at $54,448, in 1922, but subsequently they have dwindled to insignificant proportions, amounting to only 935 pounds, valued at $1,049, in 1932.

In France the Société Générale de Magnesium was formed during 1932 to carry on the joint business of the Cie. Alais, Frogues, et Camargne and the Société d'Électro-Chimie, d'Électro-Metallurgie, et des Acieres Électriques d'Ugine. The joint arrangement between the Aluminum Co. of America and the principal foreign magnesium producer, the I. G. Farbenindustrie, was continued. Various Japanese enterprises are reported to be under way.[8]

Magnesium imported for consumption in the United States, 1931–32, by classes

Class	1931		1932	
	Pounds	Value	Pounds	Value
Metallic and scrap	140	$190		
Alloys (magnesium content)	30	81	101	$84
Powder (magnesium content)	2,199	2,191	772	821
Sheets, tubing, ribbons, wire, and other n.s.p.f. (magnesium content)	85	118	62	144
	2,454	2,580	935	1,049

MAGNESIUM SALTS

The production of magnesium salts—including magnesium sulphate, chloride, and carbonate—from natural salt and bittern waters in the United States in 1932 was 59,466,257 pounds, valued at $896,085, compared with 66,137,418 pounds, valued at $982,814, in 1931. As there were less than three producers of each of these compounds, the Bureau of Mines is not at liberty to publish production figures separately.

New developments during the year included the recovery of magnesium hydroxide and its conversion into Epsom salts by the Texaco Salt Products Co. at West Tulsa, Okla.,[9] and the erection of a plant near Medicine Bow, Wyo., by the Magnesium Properties Co. to refine magnesium salts.

Uses.—The chief uses of technical magnesium sulphate in the order of their importance are tanning of sole leather, general manufacturing ingredient in stock remedies, and mordant assist in dyeing and printing textiles. It is also used in ceramics, explosives, matches, fertilizers, paper sizing, motion-picture snow, and plastic magnesia cements.

Magnesium chloride is utilized largely in the manufacture of metallic magnesium and of plastic magnesia cements. It is also used in floor-sweeping compounds.

[8] Chemical Age (London), Magnesium Manufactured in Japan: Vol. 27, No. 697, Nov. 5, 1932, p. 26.
[9] Smith, O. M., Salt, a Byproduct of Condenser Cooling: Ind. and Eng. Chem., vol. 24, pp. 547–548, 1932.

Magnesium compounds imported for consumption in the United States, 1928–32

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
1928	5,799,750	$41,712	10,459,596	$61,600	300,897	$60,325	283,264	$17,512	355,917	$17,675
1929	3,291,856	23,120	13,541,189	82,416	471,545	83,866	517,414	29,902	212,503	12,856
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

[1] No anhydrous reported.

Foreign sources.—Germany, by virtue of its large potassium-salts industry, is the largest foreign producer of magnesium sulphate and magnesium chloride. The production of magnesium sulphate as a byproduct of the Polish potassium-salts industry has recently been proposed.

MICA

By F. W. Horton and B. H. Stoddard

The mica industry in the United States continued to experience unfavorable trade conditions in 1932 and declined severely in production, imports, and consumption. Prices also dropped 10 to 35 percent during the year. The mining of mica in this country is limited almost entirely to muscovite; no phlogopite or amber mica is produced and only a small quantity of biotite, which is used as ground mica. Over 90 percent of the commercial production of domestic sheet mica is confined to States on the Atlantic seaboard. New Hampshire and North Carolina were the outstanding producers in 1932, followed by Connecticut, Virginia, New Mexico, South Dakota, and Georgia, in order of total quantity sold. In value of output of sheet mica these States ranked the same except that the order of New Hampshire and North Carolina was reversed.

During the 5-year period 1928–32, inclusive, domestic marketed production has supplied only 16 to 36 percent by quantity and 17 to 39 percent by value of the requirements of sheet mica larger than punch and less than 5 percent of the consumption of mica splittings. On the other hand, the United States produces virtually all the punch muscovite and most of the scrap mica it consumes. India furnishes the greater part of the sheet muscovite larger than punch and almost all the muscovite splittings required by the United States. Canada and Madagascar supply phlogopite in the form of splittings and sheet mica.

In 1932 demand for all classes of sheet mica and splittings was less than one quarter of that in 1929. The steady decline in demand since 1929 parallels the decrease in the electrical industry, the principal consumer of these classes of mica. Prices dropped notably due to this lessened demand and were pushed down further by large bankrupt stocks and by marked declines in the exchange rates of the rupee and pound sterling.

One encouraging feature of the mica industry during 1932 was a considerable demand for dry-ground mica by the roofing trade during the latter part of the year. This demand moved such large tonnages of scrap that existing stocks were well absorbed, and sales of domestic scrap in 1932 exceeded those in any of the 3 previous years, although the value of the sales decreased due to much lower prices.

The value of the total sales of domestic production decreased 44 percent (from $211,245 in 1931 to $118,806 in 1932), and the value of imports dropped 54 percent (from $620,784 to $287,667).

The following table summarizes the principal statistics of the mica industry in the United States from 1929 to 1932, inclusive:

Summary of statistics of the mica industry in the United States, 1929–32

	1929	1930	1931	1932 [1]
Domestic mica sold or used by producers:				
Uncut sheet:				
Punch or circle:				
Pounds	1,752,044	1,253,782	757,647	231,623
Value	$98,989	$61,230	$33,317	$8,060
Average per pound	$0.055	$0.05	$0.04	$0.03
Larger than punch or circle:				
Pounds	283,084	211,703	205,306	71,881
Value	$187,332	$116,077	$78,513	$32,098
Average per pound	$0.66	$0.55	$0.38	$0.45
Total uncut sheet:				
Pounds	2,035,128	1,465,485	962,953	303,504
Value	$286,321	$177,307	$111,830	$40,158
Average per pound	$0.14	$0.12	$0.12	$0.13
Scrap:				
Short tons	6,253	6,732	6,621	7,183
Value	$117,901	$109,100	$99,415	$78,648
Average per ton	$18.86	$16.21	$15.02	$10.95
Total sheet and scrap:				
Short tons	7,271	7,465	7,102	7,335
Value	$404,222	$286,407	$211,245	$118,806
Ground:				
Dry-ground:				
Pounds	3,637,192	[2] 11,912,232	[2] 10,724,952	[2] 9,231,884
Value	$62,029	[2] $190,635	[2] $168,783	[2] $117,957
Average per pound	$0.017	$0.016	$0.016	$0.013
Wet-ground:				
Pounds	5,395,005	3,149,545	4,888,100	4,793,962
Value	$328,332	$161,623	$267,653	$179,726
Average per pound	$0.06	$0.05	$0.05	$0.038
Total ground:				
Pounds	9,032,197	15,061,777	15,613,052	14,025,846
Value	$390,361	$352,258	$436,436	$297,683
Consumption of splittings:				
Pounds	3,782,287	3,035,880	2,046,090	902,985
Value	$2,449,889	$1,265,137	$764,672	$268,830
Imports for consumption:				
Unmanufactured: [3]				
Pounds	1,283,472	4,549,461	4,549,122	2,970,742
Value	$729,158	$405,760	$132,865	$78,496
Manufactured:				
Cut:				
Pounds	118,224	72,402	16,707	23,097
Value	$201,632	$100,498	$19,774	$16,824
Splittings: [4]				
Pounds	5,052,848	2,326,780	1,527,656	944,628
Value	$1,277,555	$767,414	$463,928	$184,920
Built-up:				
Pounds	13,655	6,001	1,787	12,956
Value	$9,805	$8,499	$3,483	$6,871
Ground:				
Pounds	1,020	688	1,200	111,771
Value	$43	$57	$36	$383
All other manufactured mica: [5]				
Pounds	6,446	2,813	1,947	1,287
Value	$5,215	$1,388	$698	$173
Total manufactured:				
Pounds	5,192,193	2,408,684	1,549,297	1,093,739
Value	$1,494,250	$877,856	$487,919	$209,171
Total imports:				
Pounds	6,475,665	6,958,145	6,098,419	4,064,481
Value	$2,223,408	$1,283,616	$620,784	$287,667
Exports (all classes of mica):				
Pounds	6,187,270	4,732,864	5,239,007	3,098,737
Value	$329,322	$262,826	$258,135	$132,755

[1] Subject to revision.
[2] Includes fine unground mica recovered in washing kaolin but not mica recovered by milling mica schist.
[3] Waste and scrap not included prior to June 18, 1930.
[4] Includes films cut or stamped to dimensions after June 18, 1930.
[5] Includes washers prior to June 18, 1930.

PRODUCTION

The total quantity of mica, including sheet and scrap, sold by producers in the United States in 1932 was 7,335 short tons, valued at $118,806, compared with 7,102 short tons, valued at $211,245, in 1931. The slight increase in quantity was due to increased sales of scrap which more than offset the decreased sales of sheet mica. The total production was composed of 303,504 pounds of uncut sheet, valued at $40,158, and 7,183 tons of scrap, valued at $78,648. Of this amount, North Carolina produced 104,661 pounds of sheet, valued at $15,562, and 5,002 tons of scrap, valued at $52,177, and New Hampshire 125,607 pounds of sheet, valued at $14,385, and 421 tons of scrap, valued at $6,616.

Uncut sheet mica.—Total sales of sheet mica decreased 68 percent in quantity and 64 percent in value, compared with those in 1931.

Punch and circle mica sold by producers amounted to 219,783 pounds, valued at $7,153, a reduction of 71 percent in quantity and 79 percent in value, compared with sales in 1931. Sales of larger sizes were 71,881 pounds, valued at $32,098, a decrease of 65 percent in quantity and 59 percent in value from those in 1931. Total sales of uncut sheet of all classes were only about 15 percent in both quantity and value of those in 1929.

Scrap mica.—Sales of scrap by producers increased 8.5 percent in quantity in 1932, compared with those in 1931, but due to a heavy decline in average price the total value of the sales decreased 21 percent. The figures for scrap mica include a considerable tonnage of fine mica recovered as a byproduct in washing kaolin in North Carolina but exclude mica schist.

Ground mica.—Ground mica sold by domestic producers in 1932 amounted to 14,025,846 pounds, valued at $297,683, compared with 15,613,052 pounds, valued at $436,436, in 1931. Sales consisted of 9,231,884 pounds of dry-ground mica, valued at $117,957, and 4,793,962 pounds of wet-ground mica, valued at $179,726. The total quantity sold was only slightly less than that sold in 1930 and 1931, indicating that the demand for ground mica has been sustained in spite of the depression. The figures given for dry-ground mica include sales of fine mica recovered as a byproduct in washing kaolin by the Harris Clay Co. and the General Mica Co. in Mitchell County, N.C., but do not include the output of fine mica of the Victor Mica Co. of Spruce Pine, N.C., the only grinder of muscovite schist in the country.

Following is a list of companies that ground mica in 1932:

	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	Wet and dry.
General Mica Co., Inc., Pueblo, Colo	Dry.
Philip S. Hoyt, Franklin, N.C	Do.
Keene Mica Co., Keene, N.H	Do.
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.
Vance-Barrett, Inc., Plumtree, N.C	Wet.
Western Elaterite Roofing Co., 841 Equitable Building, Denver, Colo	Dry.

Mica splittings.—The Western Electric Co., Kearney, N.J., and the New England Mica Co., Waltham, Mass., produced splittings in 1932. Their output, however, was almost negligible compared with total domestic requirements.

Built-up mica.—The manufacture of built-up mica continued to be the major branch of the mica industry in the United States, although it declined more than one half in 1932, compared with 1931. Domestic consumption of splittings in 1932 was 902,985 pounds, valued at $268,830, compared with 2,046,090 pounds, valued at $764,672, in 1931, a decrease of 56 percent in quantity and 65 percent in value. All splittings were of foreign origin except the small domestic production already mentioned.

The splittings consumed were from the following sources: India, 671,647 pounds of muscovite splittings, valued at $193,854 (includes the small quantity of domestic splittings referred to above); Canada, 73,810 pounds of phlogopite splittings, valued at $13,655 (includes a small tonnage of Canadian phlogopite split by machine in the

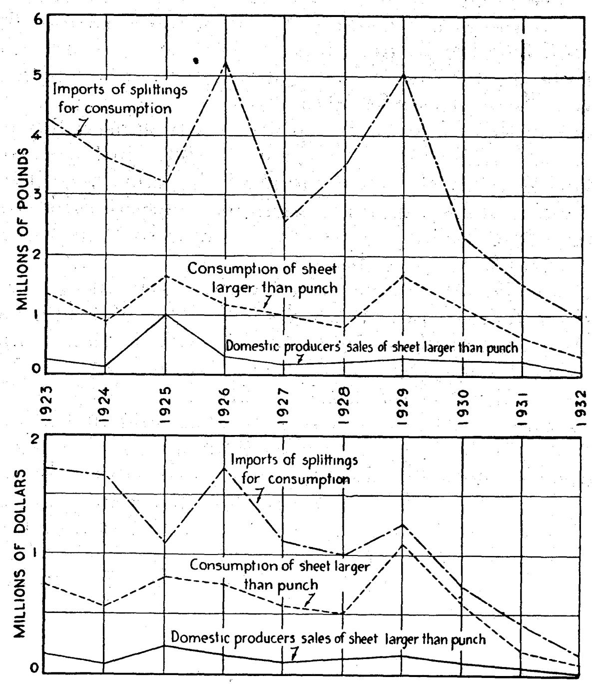

FIGURE 89.—Comparison of the consumption of mica splittings and the consumption and domestic production of sheet mica larger than punch in the United States, 1923–32

United States); and Madagascar, 157,528 pounds of phlogopite splittings, valued at $61,321.

Figure 89 shows the quantity and value of mica splittings and sheet mica larger than punch consumed in the United States during the past 10 years. The graph shows clearly the preponderance of splittings in the domestic market, compared with sheet mica and the adverse effects of the business depression during the last 3 years on the consumption of both these classes of mica. The commercial production of domestic sheet mica larger than punch also is compared in both quantity and value with the total consumption of these sizes.

The principal consumers of mica splittings in the United States in 1932 were as follows: Allis-Chalmers Manufacturing Co., Milwaukee, Wis.; Continental Fibre Co., Valparaiso, Ind.; Ford Radio and Mica Corporation, 830 Fourth Avenue, Brooklyn, N.Y.; General Electric Co., Schenectady, N.Y.; The Macallen Co., 16 Macallen Street, Boston, Mass.; Mica Insulator Co., 200 Varick Street, New York, N.Y.; New England Mica Co., 66 Woerd Avenue, Waltham, Mass.; Western Electric Co., Kearney, N.J.; and Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

USES

Sheet and built-up mica.—Mica has many diversified uses, but its most important use is in the electrical industries, where it occupies an unassailable position as the best electrical insulator known. Its preeminent dielectric strength and insolubility in water and oils, combined with its capacity to withstand fairly high temperatures, make it indispensable as an insulator in many types of electrical equipment. It is used in the form of sheets, washers, disks, and multishaped punchings of both sheet and built-up mica in dynamos, magnetos, motors, electric irons, toasters, X-ray apparatus, electric-light sockets, fuse plugs, and many other electrical devices. Split into thin films, it finds a large use in electric condensers in radio circuits and magnetos.

The use of built-up mica, made by cementing mica splittings with suitable binders under heat and pressure into sheets and tubes, has far outstripped that of sheet mica. Important factors in extending the uses of the built-up product are as follows: Its adaptability; the ease with which it can be cut, molded, and pressed into shape; and the development of binders, such as glyptal and other synthetic resins which are claimed to be superior to shellac for cementing mica splittings for certain uses, and of inorganic binders which are principally employed in making built-up mica for heating elements.

Mica papers and mica cloth (made by bonding 1 to 3 layers of mica splittings on or between special papers or cloth) are employed for insulation in armature slots, commutator cores, magnets, etc. Mica tape made similarly is used extensively for wrapping and winding coils and armatures.

Mica is used in place of porcelain in spark plugs designed to withstand unusual thermal and mechanical shocks, especially in airplane motors where conditions are exceptionally severe and in high-compression motors. The plugs are made by wrapping an inner electrode or spindle with thin and particularly flexible mica sheets to form an inclosing tube over which mica washers are placed and compacted with a suitable bond under pressure. The mica then is turned to proper dimensions on a lathe and fitted with a metal shell which forms the seat and outer electrode of the plug.

Where mica is subject to temperatures above 500° or 600° C. phlogopite is used, as it resists heat better than muscovite. It also is less elastic than muscovite and therefore molds more readily when employed in built-up mica. Because it wears at about the same rate as copper phlogopite is preferred by some manufacturers both as sheet and built-up mica for making commutator segments.

Mica is irreplaceable in many of its uses as an electrical insulator, and ample supplies of it are essential to the maintenance and development of electrical industries. It is estimated that 75 percent of all domestic sheet mica, 90 percent of all imported sheet, and 95 percent of all built-up mica is consumed in the manufacture of electrical goods.

The first commercial use of mica was for glazing. Its transparency, noninflammability, and resistance to shock led to its early adoption for stove windows and chimneys and shades for open-flame lights. Due to the decline in the use of stoves for househeating and to the large replacement of oil and gas by electricity for lighting, the consumption of mica for glazing is much less than formerly. However, there is still a fair demand for mica for windows in oil, gasoline, and coal stoves, chimneys for gasoline lanterns, and shades for open-flame lights. Moreover, the market for built-up mica for use in torchiere chimneys, lamp shades, and panels is sufficient to warrant quantity production of special art micas for these and other decorative purposes.

Besides being used for insulation and glazing, sheet mica, because of its elasticity, is used for diaphragms in acoustical apparatus, but its consumption for this purpose has declined greatly due to the abandonment of mica diaphragms in phonographs.

Ground mica.—Dry-ground mica finds its principal use in the manufacture of rolled roofing and asphalt shingles, where it is employed to prevent adhesion of adjacent surfaces of the finished goods. The flaky nature of the mica prevents its absorption, and it is not affected by the acid in the asphalt or by weathering. Roofing mica usually is ground to pass a 5- to 20-mesh screen and should contain a minimum of fines. Finely ground mica combined with proper bonding agents is the principal constituent of many plastic wall finishes which are exceptionally receptive to textural effects. Larger sizes of dry ground mica are used extensively for ornamental purposes, particularly for Christmas-tree snow.

Other uses are for surfacing stucco and concrete to give stone finishes and in the manufacture of artificial stone. Ground mica is also an excellent thermal insulator and, as such, is used in a variety of ways, particularly in the heat treatment of steel. Mixed with greases it makes a good lubricant. Bonded with lead borate it forms an excellent electric insulator known as "mycalex" which may be molded at dull-red heat and can be drilled and machined. This product has high mechanical and dielectric strength and is suitable for aerial insulators, bases for radio tubes, etc. Ground mica has been used to a limited extent as a filler in rubber, but it cannot compete with talc, silica, asbestos, and other cheaper materials.

The principal use of wet-ground mica is in the wall-paper trade where, with proper binders, it is used as a decoration. It is also used to a considerable extent in the rubber trade for painting the water bags used in vulcanizing automobile tires. It prevents sticking and gives the goods an excellent finish.

PRICES

Domestic sheet mica.—Demand was poor for all classes of sheet mica throughout 1932. The average price of domestic punch mica as reported by producers was $0.03 per pound compared with $0.04 in 1931. The price of 1-inch punch ranged from $0.02 to $0.03 and of 2-inch punch from $0.03 to $0.06 per pound, depending upon quality and preparation. Prices for sizes larger than punch dropped 25 to 35 percent during the year, but due to sales of a greater proportion of larger sizes than in 1931 the average price increased to $0.45 per pound, compared with $0.38 in the previous year. The decline in prices was due principally to lack of demand and to sales by many small miners at whatever price their mica would bring. To a certain extent, however, particularly with some sizes of the clearer qualities, decreased prices were due to foreign competition. The average price of all domestic uncut sheet sold during the year was $0.13 per pound, compared with $0.12 in 1931.

Indian sheet mica.—Prices of sheet mica did not recede notably in India during 1932, but due to declines in the dollar value of the rupee and pound sterling. Indian sheet mica could be bought more cheaply in London and India; moreover, ad valorem duties were lessened correspondingly, and in December 1932 New York prices were 10 to 20 percent under those current at the beginning of the year.

Amber sheet.—The demand for amber sheet was unusually small, but prices rose slightly due to closing of the mines in Madagascar which created a scarcity.

The accompanying table gives approximate average New York prices in 1932 for the principal grades of Indian and domestic sheet mica.

Approximate average prices per pound of uncut sheet mica in New York in 1932

Domestic			Indian (duty paid)					
Size, inches	Nos. 1 and 2 stove mica	Spotted and black spotted	Size no.	Clear and slightly stained	Fair stained	Good stained	Stained	Black spotted
1½ by 2	$0.18	$0.13	6	$0.43	$0.35	$0.19		
2 by 2	.35	.16	5½	.91	.52	.47		
2 by 3	.56	.25	5	1.30	1.02	.81	$0.53	$0.25
3 by 3	.77	.38	4	2.34	1.24	1.08	.81	.49
3 by 4	1.00	.57	3	2.77	1.68	1.46	1.19	.73
3 by 5	1.17	.73	2	3.32	2.01	1.84	1.68	1.06
4 by 6	1.50	.95	1	3.98	2.67	2.34	2.17	1.41
6 by 8	1.75	1.32	1-A	6.05	3.98	3.87	2.99	1.68
			Special	6.27	4.96	4.42	3.87	1.90

Mica splittings.—The prices of all grades of Indian splittings decreased 15 to 25 percent during 1932 in keeping with the decline in Indian and British exchange. Sales of considerable bankrupt stocks also tended to reduce prices. As usual, the largest sales were of the cheaper grades. Average prices per pound of Indian splittings, duty paid in New York, in 1932 were approximately as follows: No. 4, book-packed, $0.875; loose, $0.55—no. 5, book-packed, $0.66; loose, $0.33—no. 5½, book-packed, $0.55 loose, $0.255—no. 6, book-packed, $0.43; first-quality loose, $0.20; second-quality loose, $0.145; third quality loose, $0.09.

The demand for amber (phlogopite) splittings was extremely limited, as the larger users were overstocked. Grade no. 6 constituted at least three fourths of the total sales. The price range per pound remained practically the same as in 1931 and was as follows: no. 4 amber, $0.72 to $0.82; no. 5, $0.31 to $0.36; no. 6, $0.26 to $0.30.

The average price of Indian splittings consumed in the United States in 1932 was $0.29 per pound and that of the Madagascan splittings $0.39 per pound.

Scrap mica.—The average price of scrap mica sold by domestic producers in 1932 was $10.95 per short ton, compared with $15.02 in 1931. Although the price has decreased steadily since 1929, when it averaged $18.86 per ton, sales have increased. The recession in price apparently has been due to the invasion of the market for scrap by mica recovered as a byproduct in washing kaolin and by mica milled from mica schist.

Ground mica.—The average prices of both wet- and dry-ground mica decreased considerably in 1932. The average price for the dry-ground product was $0.0125 per pound, compared with $0.016 in 1931, and that for wet-ground mica fell to $0.0375 from $0.05 in 1931. Demand for both grades was good considering general business conditions, and the quantities sold (particularly of wet-ground mica) were only slightly less than those sold in 1931.

IMPORTS AND EXPORTS

Total imports of mica have decreased rapidly in the last 4 years and in 1932 were valued at only $287,667, or 13 percent of their valuation in 1929. Imports for consumption in 1932 were as follows: Waste and scrap, 2,720,731 pounds, valued at $11,908; untrimmed phlogopite punch mica, 34,308 pounds, valued at $2,166; and other unmanufactured mica, essentially untrimmed sheet, 215,703 pounds, valued at $64,422—total imports of 2,970,742 pounds of unmanufactured mica valued at $78,496. The principal items of manufactured imports were 23,097 pounds of cut mica, valued at $16,824, and 944,628 pounds of films and splittings, valued at $184,920. Total imports of manufactured mica were 1,093,739 pounds, valued at $209,171.

Mica stocks in bonded warehouses on December 1, 1931, were 95,118 pounds of unmanufactured mica, valued at $57,523, and 1,244,369 pounds of manufactured mica (practically all mica splittings), valued at $313,002.

Exports of mica also decreased notably in 1932, totaling 3,098,737 pounds, valued at $132,755.

The summary of mica statistics given in the table on page 788 shows the imports of the various classes of mica and total exports of mica from 1929 to 1932, inclusive.

NATURAL SODIUM COMPOUNDS AND BORON MINERALS

By A. T. Coons

The outstanding feature of the natural sodium compounds industry since the World War has been its steady growth. From an annual output of only 42,683 short tons in 1920 production increased to a peak of 297,440 tons in 1930. Compared with this record the out-

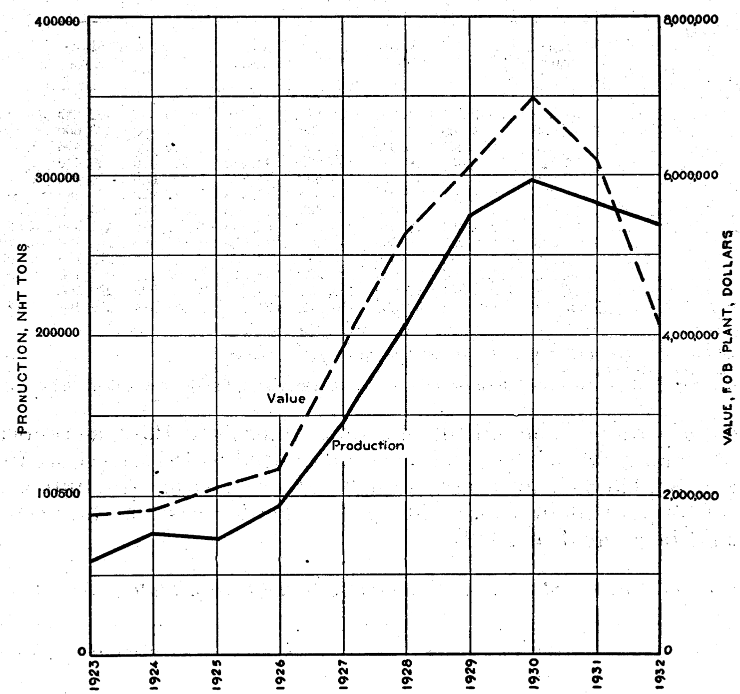

Figure 90.—Quantity and value of natural sodium compounds produced in the United States, 1923–32.

put of 269,496 tons in 1932 was a drop of only 9 percent, a notable showing in view of the much sharper decreases recorded by most important mineral raw materials over the same period.

The pronounced strength of the market for sodium compounds with reference to tonnage required during the past 3 years of business depression has been of special interest. The accompanying statistical analyses show that while the output of carbonates declined 39 percent between 1930 and 1932, the production of borates increased successively in 1930 and 1931 and established a record of 181,915 tons in 1932. Over the same period the output of sulphates varied only a few hundred tons.

Although production has been maintained on a relatively stable plane, price declines have been unavoidable, returns to producers being particularly low in 1932.

The output of sodium compounds, not including common salt, from natural salines and brines in the United States in 1932, as indicated by sales or shipments by producers, amounted to 269,496 short tons, valued at $4,122,238, compared with 289,590 short tons, valued at $6,352,971, in 1931. These figures include 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).

Figure 90 gives the quantity and value of natural sodium compounds produced in the United States for the past decade.

Salient statistics on natural sodium compounds sold or used by producers in the United States, 1920–32

Year	Carbonates [1]		Sulphates [2]		Borates [3]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1920	25,392	$961,574	14,851	$221,123	2,440	$330,482	42,683	$1,513,179
1921	17,400	602,800	4,900	8,500	2,700	282,700	25,000	894,000
1922	33,537	690,021	5,015	36,155	6,854	689,598	45,406	1,415,774
1923	35,440	751,850	10,080	100,000	13,920	924,090	59,440	1,775,940
1924	44,890	835,170	16,200	174,600	15,330	816,080	76,420	1,825,850
1925	45,910	922,760	9,940	84,380	17,450	1,087,970	73,300	2,095,110
1926	56,750	1,154,840	19,620	166,800	17,110	1,005,110	93,480	2,326,750
1927	67,240	1,253,352	23,080	168,882	55,450	2,412,090	145,770	3,834,324
1928	79,830	1,578,256	6,580	42,485	119,970	3,651,487	206,380	5,272,228
1929	102,930	1,916,632	7,540	41,199	164,720	4,149,835	275,190	6,107,666
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

[1] Soda ash, bicarbonate, and trona; 1923–26 and 1930 also includes sal soda.
[2] Salt cake and Glauber's salt.
[3] 1920–26, borax; 1927–30, borax and kernite; 1931–32, borax, kernite, and boric acid (calculated as borax).

Boron minerals.—The output of boron minerals in 1932, as reported to the Bureau of Mines by producers, amounted to 181,915 short tons, valued at $3,023,844, an increase of 2 percent in quantity but a decrease of 39 percent in value (due to a large decrease in the price of borax and boric acid in 1932).

Boron minerals [1] sold or used by producers in the United States, 1920–32

Year	Short tons	Value	Year	Short tons	Value
1920	120,320	$2,173,000	1927	109,080	$3,473,399
1921	50,000	1,600,000	1928	131,000	3,999,773
1922	85,220	2,705,140	1929	169,870	4,515,375
1923	136,650	3,994,790	1930	177,360	5,351,999
1924	116,110	3,183,910	1931	178,550	4,931,295
1925	113,700	3,085,660	1932	181,915	3,023,844
1926	115,970	3,128,110			

[1] 1920–26, borax and colemanite; 1927–29, borax, kernite, and colemanite; 1925 and 1927–30 also include boric acid; 1931–32, borax, kernite, and boric acid (calculated as borax).

The boron minerals included in the figures for 1932 were confined, as in 1931, to the sodium borates known as borax and kernite. Prior to 1927, all the borax except that made at Searles Lake and Owens Lake was made from colemanite (calcium borate) mined in California and Nevada. In 1927, kernite, mined in Kern County, Calif., replaced colemanite, production of which practically ceased in 1927, although small shipments were made through 1930.

Review of operations.—In 1932 most of the material included under sales of sodium carbonates was soda ash—normal sodium carbonate (Na_2CO_3)—and was produced in California from the waters of Owens Lake, Inyo County, by the Natural Soda Products Co., at Keeler, and the Pacific Alkali Co., at Bartlett, and from the waters of Searles Lake, San Bernardino County, by 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 Camp Verde, Yavapai County, Ariz., by the Arizona Chemical Co., and near Mina, Mineral County, Nev., by the Rhodes Alkali & Chemical Corporation. Sodium sulphate was also produced at Wabuska, Lyon County, Nev., by the American Sodium Co., but none was shipped. Hydrated sodium sulphate ($Na_2SO_4.10H_2O$) (Glauber's salt) was produced near Casper, Laramie County, Wyo., by W. E. Pratt and by the Columbian Hog & Cattle Powder Co. The Iowa Soda Products Co. mined Glauber's salt near Rawlins, Carbon County, Wyo., and shipped it to Council Bluffs, Iowa, for refining. No output of sodium sulphate was reported from Texas, Utah, or Washington, although deposits in these States were reported as under development.

The production of sodium borate in 1932 included 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 by 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; by the Suckow Borax Mines Consolidated, near Muroc; and by the Western Borax Co., Ltd., near Kramer. Boric acid was produced at Trona, Inyo County, Calif., by the American Potash & Chemical Co. In the figures for sales in 1931 and 1932 this product, calculated as borax, was included with sodium borate.

Exports and imports.—The 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 the manufactured sodium salts and would not be comparable with the figures for natural salts recorded in this report.

Sodium sulphate exported from the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	(1)	(1)	1931	4,652	$75,784
1929	1,666	$53,176	1932	1,435	24,155
1930	4,436	113,253			

[1] Not reported separately.

Sodium sulphate imported for consumption in the United States, 1928–32

Year	Glauber's salt (hydrous sodium sulphate)		Salt cake (anhydrous sodium sulphate)	
	Short tons	Value	Short tons	Value
1928	1,550	$17,651	3,578	$79,742
1929	1,161	9,517	5,552	116,935
1930	1,156	9,241	9,934	200,143
1931	924	9,615	10,315	193,041
1932	304	2,848	8,855	153,612

Sodium borate (borax) exported from the United States, 1928–32

Year	Short tons	Value	Year	Short tons	Value
1928	67,851	$3,454,171	1931	86,938	$3,358,609
1929	79,884	2,934,660	1932	89,641	2,677,626
1930	82,931	3,057,794			

Sodium borates imported for consumption in the United States, 1928–32

Year	Crude		Refined	
	Short tons	Value	Pounds	Value
1928	5,040	$145,353	210,534	$4,906
1929	5,090	157,793	7,504	1,323
1930	----------	----------	16,681	1,993
1931	570	16,507	1,516	251
1932	----------	----------	610	128

PRECIOUS AND SEMIPRECIOUS STONES (GEM MINERALS)

By M. W. von Bernewitz

Although a number of men are employed in the search for gem minerals and in their mining and cutting in the United States, the industry is irregular and of small importance. This country is a large importer of precious and semiprecious stones, receiving annually from foreign nations at least 100 times the domestic output. Like nickel, platinum, and tin domestic production is small, but importations are large, yet what is won from the domestic deposits is varied and of good grade.

This review of gem minerals is revived after being omitted from the Bureau's annual statistical and economic reports for 12 years. During this interim, however, the United States Bureau of Mines has issued 13 publications on precious and semiprecious stones.[1] These cover the following: Occurrence; mode of prospecting, development, and mining; identification; characteristics; grading; production; and domestic and foreign trade. Each paper has a short, selected list of references. Readers are referred to these publications for many details that cannot be given here.

A precious stone is one that has high commercial value because of its beauty, rarity, and permanence. Strictly, the trade regards only the diamond, emerald, opal, pearl, ruby, and sapphire as precious. A semiprecious stone is one that is precious to a lesser degree. This class includes agate, beryl, coral, feldspar gems, fossil wood, garnet, jade, jasper, jet, malachite, quartz gems (as amethyst, hiddenite, and kunzite), serpentine, topaz, tourmaline, turquoise, zircon, and many others. In its mineral museum at Washington, D.C., the Bureau of Mines has a small collection of the stones mentioned and a few others of interest. Many specimens can be seen at the National Museum.

Most of the precious and semiprecious stones make desirable gems when properly cut and mounted as jewelry or in the form of other ornaments. Furthermore, investment in stones of high value has been an age-old method of storing wealth. It has been estimated that the diamonds alone owned by the people of the United States represent resources of 4 billion dollars or more. While gold and currency bow to the rules of prevailing monetary systems, reserves of gems usually are untouched and have a cash value for those who need money.

Production.—Although reliable production figures are available for most foreign countries there has been little attempt to collect them for the United States since 1923. From 1880 to 1924 the output of crude precious and semiprecious stones (largely the latter) in the United States was valued at $9,800,000. The value of the production was highest in 1909 ($534,000) and lowest in 1923 ($60,000). The value of the output has ranged as follows: 1886–92, $119,000 to $312,000 a year; 1897–1909, $130,000 to $534,000 a year; 1911–19, $344,000 to $112,000 a year. In 1921 the value of the production was $518,000.

[1] For a list of these publications see Bibliography on p. 806.

The production of sapphires in Montana has contributed the greater part of the value of the domestic gem output. In 1920 the value of gem stones produced in the United States was $265,000, of which $223,000 represented the value of Montana's production. Six States reported values of several thousand dollars each, and production in 15 States totaled only a few thousand dollars worth of various stones. In all, about 50 varieties of gem stones were reported.

Occurrence.—In the past Alaska has yielded garnet; Arizona, agate, copper-ore gems (azurite, malachite, and chrysocolla), garnet, jasper, obsidian, opal, peridot, and turquoise; Arkansas, diamond, the largest being 11, 17.85, and 40.2 carats (the last was found in the spring of 1924); California ($27,000 in 1929, mostly quartz), beryl, diamond, epidote, kunzite, lapis lazuli, obsidian, quartz, rhodanite, spodumene, topaz, tourmaline, and vesuvianite; Colorado, amazon stone, aquamarine, calamine, fluorite, garnet, hematite, opal, pyrite, quartz, satinspar, topaz, and turquoise; Hawaii, peridot in decomposed lava; Maine, amethyst, beryl, garnet, rock crystal, topaz, and tourmaline; Montana, agate (moss), chalcedony, garnet, iceland spar, sapphire, and topaz; Nevada, opal, turquoise, and variscite; New Mexico, turquoise; New York, garnet; North Carolina, corundum gems, diamond, garnet, zircon, and others; South Carolina, beryl; Texas, agate, opal, and topaz; and Utah, topaz, variscite, or utahlite.

MARKETING CONDITIONS

The marketing of precious stones differs from that of most other materials.[2] First, their value denotes wealth in exceedingly small bulk. Secondly, there is a wonderful variety of precious stones, found over a wide territory and obtained with difficulty, hence the supply is uncertain. After the stones are found, the actual marketing processes depend largely on the special methods of treatment and preparation suitable to the fashions of the time.

For the past 3 years the trend in prices for all gems and precious cut stones has been steadily downward. According to a close observer of the trade, prices were at their lowest ebb during February 1933. The drop in values was reported as a reaction to falling sales. Jewelry was not in demand, and dealers and many private owners found it necessary to dispose of their stones. Since March 1933 much of this distress merchandise has been absorbed, and there appears to have been a slight improvement in prices.

Jewelry manufacturing.—According to a report of the United States Bureau of the Census issued in November 1932, the value of jewelry produced in 1931 decreased 52 percent compared with its value in 1929. For the purposes of the census the jewelry industry embraces the manufacture of articles of precious and semiprecious metals (some plated) as well as the fabrication of articles for personal adornment, such as those requiring gems. As the latter represent considerably higher individual values than most other forms of jewelry stock the effect of the depression on sales of these higher-priced goods probably was more severe than is indicated by the average census figure.

The Jewelers' Circular for March 1933 states that despite the curtailment in buying there is a decided trend toward marked individuality in jewelry styles for 1933 that will distinguish the new styles from those of former years. The decided changes in dress and sil-

[2] Spurr, J. E., and Wormser, F. E., The Marketing of Metals and Minerals (chapter by G. F. Kunz): McGraw-Hill Book Co., New York, 1925, pp. 338-362.

houette and in political, social, and economic conditions have been factors in this trend. The bizarre French creations in precious stones and platinum mountings have little sale in the United States.

Artificial "precious" stones.—Synthetic rubies, sapphires, and spinels now are made in large numbers. Patents have been granted in the United States and Europe for the manufacture of artificial stones and for the surfacing of others. The basis of the synthetic stones is alumina and the coating is fused borax. The substance of nearly every species of transparent gem is essentially colorless, the color being produced by small proportions of impurity. The methods by which these stones are made and the technique for distinguishing them from natural stones is well known.[3] In 1932 German cutters and dealers arranged with a joint sales organization of synthetic jewel manufacturers in Germany, Switzerland, and France to handle the marketing of their artificial gem products.

Industrial diamonds.—The diamond is the important industrial gem stone, and its use is growing. In the United States there are about 40 dealers in industrial diamonds, and imports are increasing. Sales in 1932, however, were subnormal, but large stocks have not accumulated.

Two types of diamonds are used industrially, borts (diamonds of the gem variety but unfit for cutting into gems) and carbons or black diamonds. Borts are used for cutting and drilling glass and porcelain, for fine engraving and drilling tools, for turning tools, and for bearings in watches and meters. Pulverized borts are used for cutting and polishing diamonds and other precious stones. Carbons or black diamonds are used mainly in diamond drills, for truing abrasive wheels, for wire-drawing dies, and for stone saws. Competition from tungsten carbide and other superhard materials has reduced the use of diamonds for wire-drawing and extruding dies for fine copper wire.

Prior to 1928 the world demand for diamonds for drilling purposes was exceeding production. Those from Brazil ranked first for the purpose. In that year African diamonds were sent for trial to the United States. As only one lot proved to be suitable subsequent shipments were subjected to special tests before they were imported. The African stones are alike in appearance and size and weigh one twentieth to one third carat. As many as 56 of them can be set in a drill crown, a larger number than is usual with Brazilian borts. The African stones are cheaper than those from Brazil, and their drilling performance is satisfactory.[4]

Two publications of the United States Bureau of Mines give additional information on diamond drilling in ore formations and petroleum-bearing strata.[5] The report by Hansen describes the types of diamonds used and the setter's work, illustrates bit and reamer settings, tabulates the loss of diamonds per foot of drilling, and gives the cost of drilling. The mining company concerned has done 258,000 feet of drilling in schist, diorite, jasper, and other rock in 23 years, and in the period 1917–31 carbons cost 40 cents per foot drilled, or 22 percent of the total drilling cost.

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[3] Wade, F. B., The Manufacturing Jeweler, Oct. 8, 1931.
[4] Hanifen, J., African Borts Attain Increasing Use in Diamond Drilling: Eng. and Min. Jour. vol., 131 1931, pp. 75–76.
[5] Hansen, M. G., Diamond Drilling at the United Verde: Inf. Circ. 6708, Bureau of Mines, 1933, 18 pp. Edson, F. A., Diamond Drilling with Especial Reference to Oil-Field Prospecting and Development: Bull. 243, Bureau of Mines, 1926, 170 pp.

Taxes.—Another condition that must be considered in the marketing of gem stones is the extent to which such goods are affected by general taxes levied upon both dealers and purchasers. Section 605 of the Revenue Act of 1932 specifies the taxes payable on diamonds and mountings by retail jewelers and customers and should be consulted by those interested.

IMPORTS AND DOMESTIC TARIFF

Diamonds represent 93 percent of the gem imports into the United States. In 1932 the United States purchased 65 to 70 percent of the world output compared with 75 to 80 percent in 1930. The value of diamond importations since 1913 totals nearly $700,000,000. Gem stones imported since 1922 are valued as follows:

Value of gem stones imported into the United States, 1922–32

Year	Value	Year	Value	Year	Value	Year	Value
1922	$65, 615, 937	1925	$73, 915, 422	1928	$67, 964, 278	1931	$21, 126, 319
1923	74, 147, 897	1926	78, 290, 971	1929	75, 317, 358	1932	12, 771, 091
1924	71, 263, 730	1927	64, 949, 943	1930	38, 641, 693		

Importations by classes for 1929–32 are given in the following table:

Gem stones imported into the United States, by classes, 1929–32

Class	1929		1930		1931		1932	
	Carats	Value	Carats	Value	Carats	Value	Carats	Value
Diamonds:								
Rough or uncut	349, 023	$9, 588, 137	201, 031	$5, 769, 566	85, 249	$3, 851, 698	40, 153	$1, 512, 959
Cut but unset	414, 884	41, 828, 581	297, 063	23, 405, 415	201, 620	11, 939, 291	182, 991	7, 816, 297
Bort and dust	4, 567	89, 363		90, 915		20, 292		
Glaziers', engravers', etc	46, 949	4, 067, 674	145, 862	2, 756, 630	224, 970	2, 400, 879	163, 704	1, 061, 823
Other precious stones, rough or uncut		217, 759		90, 357		106, 127		42, 080
Pearls, not strung or set		10, 345, 420		2, 648, 042		1, 281, 019		552, 908
Other precious and semiprecious stones, cut but not set				[1] 1, 661, 593		1, 200, 155		532, 450
Agate, unmanufactured pounds	11, 255	1, 342	[2] 85	91				
Agate, rock crystal, and other semiprecious stones, unsuitable for jewelry, manufactures of		291, 490		229, 370		109, 731		63, 912
Corals, rubies, cameos, and precious and semiprecious stones, cut but not set		5, 327, 839		853, 625				
Coral, marine, uncut and unmanufactured pounds	1, 859	198	1, 254	193	5, 922	393	1, 779	272
Imitation precious and semiprecious stones:								
Cut or faceted		3, 772, 811		1, 697, 092		1, 454, 679		897, 013
Not cut or faceted, mounted or unmounted		58, 316		51, 980		66, 490		43, 847
Imitation of opaque stones, not faceted				[2] 6, 865		7, 740		5, 137
Half pearls and bottom or filled pearls partly pierced		68, 655		25, 941		17, 114		9, 426
Solid pearls wholly or partly pierced, mounted or unmounted		30, 015		[1] 28, 409				
Solid pearls (n.e.s)				[2] 1, 569		3, 425		1, 367
Emeralds:								
Rough or uncut	2, 304	17, 168	18, 312	72, 240	170, 876	270, 384	14, 830	11, 625
Cut but not set	25, 433	2, 452, 585	11, 244	1, 053, 694	4, 242	182, 350	1, 345	63, 441
Marcasite:								
Real				90, 264		68, 396		105, 037
Imitation				17, 248		34, 034		50, 867
Iridescent solid pearls						[3] 238		528

[1] Jan.–June 17, 1930. Change in tariff June 22. [2] June 22–Dec. 31, 1930. [3] First importation.

Tariff on gem stones.—The rates of duty on gem stones imported into the United States are as follows, according to schedule A, "Statistical Classification of Imports into the United States," Bureau of Foreign and Domestic Commerce, effective January 1, 1933:

Tariff on gem stones

Class	*Rate of duty, percent*
Diamonds:	
Rough or uncut	Free
Cut but not set, suitable for jewelry	10
Glaziers' and engravers', unset, miners'	Free
Pearls and parts, not strung or set	10
Emeralds, rough or uncut	Free
Other precious and semiprecious stones, rough or uncut	Free
Emeralds, cut but not set	10
Other precious and semiprecious stones, cut but not set	10
Imitation precious stones, not cut or faceted, and imitation semiprecious stones, not faceted	60
Imitation precious stones, cut or faceted, and imitation semiprecious stones, faceted	20
Imitation of opaque precious or semiprecious stones, with flat backs and tops, cut and polished but not faceted	60
Imitation pearls, according to make and size	40 to 90
Marcasites ("sulphur diamonds"):	
Real	20
Imitation	20

FOREIGN PRODUCTION

According to Meisner (see Bibliography), 92 percent of the World production of precious stones from 1870 to 1925 was diamonds, 3 percent rubies and sapphires, 2.5 percent emeralds, 0.75 percent each opals and amber, and the remaining 1 percent all other gems combined. South Africa was the most important producer throughout the period due to the preponderance of its diamond output. The following table, summarized from Meisner's study, indicates the effect on production for 1913–26 of the World War, the business recession of 1920–21, and the rise of such producers as the Belgian Congo, Gold Coast, and British Guiana.

World diamond production, 1913–26 [1]

Year	Carats	Year	Carats	Year	Carats	Year	Carats
1913	6,750,000	1917	3,400,000	1921	1,500,000	1925	4,250,000
1914	4,230,000	1918	3,140,000	1922	1,435,000	1926	5,000,000
1915	185,000	1919	3,402,000	1923	3,605,000		
1916	2,650,000	1920	3,615,000	1924	3,840,000		

[1] The total carats listed for the period are equivalent to 10½ short tons.

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Meisner also gives the estimated World production of precious and semiprecious stones (theoretical) for a normal or average year as follows:

World production of gem stones in a normal year

Class	Value (marks [1])	Percent of total	Class	Value (marks [1])	Percent of total
Diamond	300,000,000	85.0	Agate	300,000	
Sapphire	7,500,000		Garnet	280,000	
Ruby	1,500,000		Spinel	85,000	
Emerald	2,700,000		Topaz	80,000	
Turquoise	1,000,000		Olivine (peridot)	70,000	
Opal	800,000		Rose quartz	50,000	
Chrysoberyl	210,000		Calc-spar (calcite)	20,000	
Lapis-lazuli	515,000		Moonstone	20,000	
			Others	400,000	
Total precious	314,225,000	89.0	Total semiprecious	6,085,000	2.0
Amber	2,000,000		Art jewels (possibly artificial)	6,000,000	1.8
Jade	1,200,000		Coral	4,000,000	1.3
Rock crystal (quartz)	450,000		Pearl	20,000,000	5.9
Tourmaline	380,000				
Amethyst	350,000				
Beryl	400,000		Grand total	350,310,000	100.0

[1] The mark as used in this calculation represents about 24 cents. On this basis the grand total is therefore estimated to be roughly $90,000,000.

According to Sydney H. Ball [6] the world output of diamonds in 1932 declined 15 percent in weight and 49 percent in value compared with that in 1931. Of the 1932 production underground mines accounted for 5.4 percent of the total weight and 10 percent of the total value, the remainder being produced from alluvial workings. The estimated production in 1932 is shown in the following table:

Estimated world diamond production in 1932, in carats

Country	Underground mines	Alluvial mines	Country	Underground mines	Alluvial mines
South Africa	327,476	481,040	Brazil		20,000
Belgian Congo		3,541,500	Borneo, Australia, French Congo, Venezuela, India, Tanganyika		11,300
Angola		375,000			
South-West Africa		68,000			
Gold Coast		1,126,100			
British Guiana		80,000		327,476	[1] 5,702,940

[1] Roughly equivalent to 1¼ short tons.

AFRICA

Gold Coast.—All diamonds exported from the Gold Coast are sent to England. The total shipments for 1932 declined below those in 1931, the year of record shipment (880,479 carats). The value of the stones exported in 1931 was not as great as that of the 861,119 carats exported in 1930. The industry has made remarkable growth in the past decade; exports were 102 carats 12 years ago. Diamond recovery from the gravels and clays in Gold Coast Colony is described by E. D. Candlish in The Mining Magazine for June 1931, pages 333–342. These diamonds are found over a wide area, are small (many of them being 0.1 to 0.5 carat), but are of good quality.

South Africa.—The African diamond industry for the first half of 1932 was reviewed in The South African Mining and Engineering

[6] Ball, Sydney H., The Diamond Review for 1932: Nat. Jewelers' Publicity Assoc., Newark, N.J., 1933 49 pp.

Journal (Dec. 31, 1932, pp. 289, 291–292). In this review it is estimated that the value of production during 1932 decreased 58 percent for mined diamonds and 43 percent for alluvial stones. The highest output from the underground mines, valued at £12,290,000, was reported in 1920 and from the alluvial mines, £11,062,000, in 1928. The respective figures in 1931 were £2,244,000 and £1,937,000. During the 2½ years ended December 31, 1932, all diamonds produced amounted to 5,829,248 carats, but only 60 percent of these stones were sold; this excess of production over sales has been a feature of the diamond market for sometime past. The increased supplies have been due partly to new developments such as the astonishing expansion in alluvial production since the Lichtenburg discoveries in 1926 and later operations on the Namaqualand coast.

Except in State properties and alluvial mines all production in South Africa has ceased. Producers outside of the Union, including Belgian Congo, have curtailed production and deliveries of diamonds. The Government of South Africa cooperated in this contingency. The Diamond Corporation succeeded the Old Diamond Syndicate of London and is the sole outlet for South African diamonds. It has adopted a standard assortment and fixed standard prices in gold. Effort has been made toward better stabilization in the industry, and in October 1932, according to the Jewelers' Circular for December 1932, the London diamond trade was optimistic; prices and sales advanced, and there was a scarcity of many small sizes and qualities. The Netherlands market also improved.

SOUTH AMERICA

Brazil.—Industrial diamonds (carbons) account for about nine tenths of all diamonds shipped from Brazil. The price of these stones increased steadily for the period 1922–29, after which users in the United States began to substitute other materials. As a result of falling demand there has been a decided decline in the mining of precious and industrial diamonds in Brazil. Diamond exports in 1930 were valued at $432,729 compared with $1,112,000 in 1929, $484,000 in 1928, $145,000 in 1927, and $391,000 in 1926. Carbonados exported were 20,925 carats in 1928, 24,608 carats in 1927, and 21,313 carats in 1926. The value of exports averaged about $62 a carat.

Colombia.—According to P. W. Ranier and others,[7] the Chivor emerald field is on the eastern slope of the Andes, Colombia, at an altitude of 8,000 feet. The emeralds occur irregularly in 3-inch veins in a thick bed of shales and are picked out by hand after the veins have been exposed. The emeralds are classified according to colors, ranging from color 1, the darkest green, to color 5, a very pale green. A very dark green emerald may bring hundreds of dollars a carat, whereas a very pale green stone of 5 carats may bring only $5. Colors 2 and 3 sell for good prices. Few emeralds have color 1, a fifth have color 5, a quarter each have colors 3 and 4, and a tenth have color 2. Europe and India are good markets for emeralds of the cheaper quality and lighter colors; the United States is the best market for the fine stones.

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[7] Ranier, P. W., and others, The Chivor-Somondoco Emerald Mines of Colombia: Tech. Pub. 258, Am. Inst. Min. and Met. Eng., 1930, 21 pp.

AUSTRALIA

Accurate figures on precious stones produced in Australia are difficult to obtain according to the Official Year Book of the Commonwealth of Australia. Most of the diamonds come from certain gold gravels of New South Wales. This State also is the most important opal producer of the world. During 1928 three fire opals were found which weighed 790, 590, and 232 carats, respectively. Queensland is the largest producer of sapphires. The tin gravels of Tasmania yield small sapphires, but these are scarcely worth recovering.

EUROPE

Russia.—The precious and ornamental stones of Russia are reviewed by Lavrov.[8] The Ural, Transbaikalia, Altai, and other districts produce gems and ornamental stones.

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[8] Lavrov, S. E., Precious and Ornamental Stones of Russia: Econ. Geol., June–July, 1931, pp. 432–436.
[9] An Information Circular on amber awaits publication, and a Bulletin on diamonds is in preparation.

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PART IV. MINE SAFETY

SAFETY IN MINING IN 1932

By D. HARRINGTON

Final figures are not yet available on the occurrence of accidents in mining in 1932, but preliminary data indicate that in general the excellent safety performance of the mining industry in 1931 was at least equaled and in parts of the industry improved. From preliminary data it appears that accident-frequency rates in anthracite as well as bituminous-coal mining and nonmetallic mining (other than coal) were reduced; there was little change in the accident-frequency rates for mills, smelters, and stone quarries, and rates for metal mines probably increased slightly in 1932 compared with 1931. Man-hours of exposure in anthracite and bituminous mines appear to have decreased about 17 percent in 1932 compared with 1931, the decreases in exposure for other branches of the industry being approximately 38 percent for metal mining, 34 percent for nonmetallic mining, and 28 percent for quarries.

COAL MINING

Tentative figures available on coal-mine fatalities in 1932 place the total at 1,166, compared with 1,463 (final figures) in 1931. West Virginia had the largest number of fatalities, 263, a decided improvement over the 351 in 1931. Pennsylvania (anthracite) came second with 245 fatalities—a much better showing than the 383 in 1931. Pennsylvania (bituminous) was third with 158, or considerably fewer than the 210 in 1931. Illinois was fourth with 114, an increase over the 92 of 1931, and Kentucky fifth with 101, a decrease from the 110 of the previous year.

Falls of roof and side in mines caused 598 out of the 1,166 fatalities in 1932—160 in West Virginia, 142 in Pennsylvania (anthracite), 92 in Pennsylvania (bituminous), 51 in Kentucky, 34 in Illinois, and 23 in Ohio. Of the smaller producing States, Colorado with 14 fatalities from falls of roof and side had the poorest showing; Alaska, Georgia, North Carolina, and Michigan had no fatalities from falls in 1932.

Underground haulage caused 180 fatalities in 1932, 54 being in West Virginia, 33 in Pennsylvania (anthracite), 33 in Pennsylvania (bituminous), 12 in Kentucky, 11 in Illinois, and 9 in Colorado. The following coal-mining States escaped haulage fatalities in 1932: Alaska, Arkansas, Georgia, North Carolina, Kansas, Maryland, Missouri, North Dakota, Oklahoma, and Texas.

Gas or dust explosions caused 167 fatalities—54 in Virginia, 54 in Illinois, 23 in Kentucky, 14 in New Mexico, 7 in West Virginia, 7 in Pennsylvania (anthracite), 3 in Pennsylvania (bituminous), 2 in Washington, and 1 each in Colorado, Maryland, and Oklahoma.

Explosives caused 32 fatalities (to which, however, should be added at least as many more if explosions due to explosives are included). Pennsylvania (anthracite) had 14 fatalities due to explosives, Pennsylvania (bituminous) 4, Illinois 3, Kansas and Ohio 2 each, and each of the following 1—Arkansas, Iowa, Missouri, North Dakota, Oklahoma, Virginia, and West Virginia.

Electricity (excluding explosions started by electric arcs) caused 48 fatalities underground in United States coal mines during 1932. Thirteen occurred in West Virginia, 6 in Pennsylvania (bituminous), 6 in Kentucky, 5 in Pennsylvania (anthracite), 4 in Alabama, 2 each in Colorado, Indiana, New Mexico, Virginia, and Washington, and 1 each in Arkansas, Michigan, Ohio, and Tennessee.

Mining machines caused 19 fatalities in coal mines in 1932—7 in West Virginia, 5 in Pennsylvania (bituminous), 3 in Kentucky, 2 in Illinois, 1 in Indiana, and 1 in Virginia.

Shaft accidents caused 11 deaths in 1932 in the coal mines of the United States—2 in West Virginia, 2 in Iowa, and 1 each in Colorado, Illinois, Indiana, Kentucky, Missouri, Ohio, and Oklahoma. Surface fatalities at coal mines numbered 63 in 1932—15 in West Virginia, 13 in Pennsylvania (anthracite), 10 in Pennsylvania (bituminous), 7 in Illinois, 4 in Kentucky, 3 each in Iowa and in Utah, 2 each in Kansas, Oklahoma, and Virginia, and 1 each in Ohio and Wyoming.

Total underground fatalities in coal mines in 1932 numbered 1,092, shaft fatalities 11, and surface fatalities 63.

There was much gratification at the close of 1931 when it became known that the coal-mining industry, the division of the mineral industries of the United States employing the largest number of men, had established a new low fatality and injury rate based on hours of exposure and time worked.

The preliminary figures for 1932 indicate that compared with 1931 about 297 lives were saved in spite of the three major coal-mine disasters during December 1932 in New Mexico, Kentucky, and Illinois, which resulted in the loss of 91 lives. The largest contribution to this safety achievement in 1932 comes from Pennsylvania (anthracite), which had only 245 fatalities (preliminary figures) in 1932 as against 383 in 1931, a decrease of 138, showing that the safety campaign of the Pennsylvania State Department of Mines in the anthracite region was effective. West Virginia had 88 fewer fatalities in 1932 than in 1931 according to the preliminary figures, and Pennsylvania (bituminous) had 52 less. Hence Pennsylvania and West Virginia coal mines are responsible for 278 of the 297 lives saved in 1932 compared with 1931.

States that had fewer coal-mine fatalities in 1932 than in 1931 were Alabama, Arkansas, Georgia, North Carolina, Indiana, Kentucky, Maryland, Missouri, Montana, North Dakota, Ohio, Pennsylvania (anthracite), Pennsylvania (bituminous) Tennessee, Utah, West Virginia, and Wyoming. States that had the same number of coal-mine fatalities both years were Texas and Washington.

Coal mines in Alaska, Georgia, and North Carolina operated without a fatality in 1932, Alaska having the distinction of not having had a fatal accident in its coal mines since 1927.

From preliminary figures on both fatalities and tonnage it appears that the number of fatalities in coal mines of the United States in 1932 per million tons of coal produced was about 3.29, or slightly lower than the final figure of 3.31 for 1931. Notwithstanding the very poor record of December 1932, with its numerous mine explosions resulting in more than 90 fatalities, 1932 (on preliminary figures at least) therefore had a better fatality rate per million tons of coal produced than 1931, and the rate in 1931 represented the best record of any year in the present century.

The preliminary figures for 1932 indicate that coal-mining States with the lowest fatality rate per million tons produced were, in order: Michigan, Montana, Wyoming, and Texas. The States with the poorest rates were New Mexico, Virginia, Oklahoma, Kansas, Washington, Colorado, and Iowa. The average rate (tentative) for the United States was 3.29 fatalities per million tons produced, and States having rates which approximate that figure are West Virginia (3.14), Pennsylvania (3.21), Utah (3.51), and Illinois (3.52). The anthracite rate was 4.96 and the bituminous rate 3.02.

The coal-mining accident-frequency rate (number of fatal and nonfatal accidents per million hours of exposure) for 1931 (the last year for which complete exposure records are available) was 101.707, the anthracite rate being 128.384 and the bituminous rate 92.377. The States with the most favorable rates were, in order: Alaska, 28.191; Arkansas, 53.634; Tennessee, 58.556; North Dakota, 60.901; Alabama, 63,099; Kansas, 66.044; New Mexico, 66.314; Missouri, 68.965; and Kentucky, 74.286. The States with the poorest rates were, in order: Utah, 156.200; Illinois, 153.609; Texas, 141.542; Indiana, 133.076; Pennsylvania (anthracite), 128.384; Oklahoma, 122.621; Washington, 115.111; Iowa, 101.110; Colorado, 97.120; Pennsylvania (bituminous), 90.775; Michigan, 85,798; and West Virginia, 84.557.

The large producing States which had the best fatality rate per million man-hours in 1931 were, in order: Alabama, Iowa, Pennsylvania, Illinois, and Colorado; the States with the best nonfatal injury rate per million man-hours were, in order: Alabama, Kentucky, Ohio, Virginia, and West Virginia.

During the past 25 years there have been at least four major financial depressions—that of 1907–8, the war-depression panic of 1914–15, the primary post-war panic of 1920–22, and the present or second post-war panic of 1930–32. Naturally, coal production fell off in each; in 1908 the tonnage was 409,000,000 as against an average of 451,000,000 for the 5-year period 1906–10, inclusive; in 1914 the tonnage was 513,000,000 compared with 570,000,000 in 1913 and 529,000,000 as the average for the 5 years 1911–15, inclusive; in 1922 the tonnage was 477,000,000 as against an average of 569,000,000 for the 5 years 1921–25, inclusive; and in 1931 it was 441,750,000 compared with an average of 595,000,000 tons for the 5-year period 1926–30, inclusive. In all of these panic years, *except 1931*, the fatality rate per million tons of coal produced was higher than the average for the 5-year period in which it occurred; 1931 on the other hand, with only about 1,463 fatalities and with a production of approximately 441,750,000 tons had a fatality rate per million tons of only 3.31 compared with 3.75 for the 5-year period 1926–30, inclusive. Since only tentative rates for 1932 are known, the 1931 data are given for purposes of comparison.

The rate of 3.31 workers killed per million tons produced is by all odds the lowest in the past 25 years; the next best rate was 3.45 in 1920, when the production of 658,000,000 tons was one of the largest in the history of coal mining in the United States. In number of coal-mine fatalities, 1931, with 1,463, had 521 fewer deaths than 1922 with 1,984—another depression year which previously held the record for the smallest number of fatalities in any single year, but had a fairly high rate, 4.18. The 1,463 coal-mine fatalities in 1931 are 946 fewer than the average of 2,409 fatalities annually for the 25 years 1906–30, inclusive, and the rate of 3.31 is much below the average rate of about 4.45 annually for the 25-year period 1906–30, inclusive.

There were numerous contributing factors to the excellent coal-mine fatality record of 1931. First, only 86 were killed in explosions in 1931 compared with 264 in 1930 and an average of 341 annually from 1922 to 1931, inclusive. Unquestionably, several hundred lives were saved by rock dust; it stopped at least three explosions which started in mines having dangerous gas or dust conditions, or both, in which under normal conditions a slight explosion ordinarily would cause wide-spread disaster. There is no doubt that with a minimum of work available employees are much more amenable to discipline and follow safety suggestions better than they do in prosperous times. The labor turnover was practically nil, hence the numerous inefficiencies from taking on new employees were eliminated. Mining companies as well as employees are learning that accidents cost money, hence are waste to all concerned. This phase of the situation was stressed much more in 1931 than ever before and unquestionably had a good effect. In addition, 1931 was undoubtedly the most active year in the past quarter of a century in organizing mines, mining personnel, and mining communities and educating them in safety.

In 1932 essentially the same factors helped to establish a good safety record (except for the 167 fatalities from explosions of gas or dust in 1932 as against 86 in 1931); as in 1931, rock dusting probably prevented the loss of between 200 and 300 lives in 1932.

That coal mines can be operated relatively free from accidents is seen from the following records of coal-mine operation without lost-time accidents for which the Joseph A. Holmes Safety Association gave certificates of award in a meeting in Washington, D.C., March 6, 1933. The following coal mines were given awards, chiefly for working without lost-time accidents:

Rockvale No. 3 mine, Colorado Fuel & Iron Co., Canon City, Colo.—Operated without a fatality from June 1904 to December 31, 1932, with production of 594,160 tons of coal; and operated without a lost-time accident from June 22, 1931, to June 24, 1932, with a production of 41,154 tons of coal.

Orenda mine, Davis Coal & Coke Co., Boswell, Pa.—Operated without a lost-time accident from December 14, 1931, to January 31, 1933, employing an average of 180 men working 279,393 man-hours and producing 129,841 tons of coal, about 60 percent from pillars in a bed about 6 feet thick with average pitch upward of 10 percent. This mine had its last fatality on August 10, 1929.

Steubenville mine, Consumers Mining Co., Steubenville, Ohio.—Operated without a lost-time injury during 744 days, from January 4, 1931, to January 9, 1933, employing an average of 84 men working 230,732 man-hours and producing 128,630 tons of coal from a 3½-foot bed; 85 percent was taken from pillars.

Dehue mine, Youngstown Mines Corporation, Dehue, W.Va.—Operated 602 days without a lost-time accident from January 7, 1931, to August 31, 1932, with an average of 214 men working 531,382 man-hours and producing 356,805 tons of coal.

Alloy mine, Electro-Metallurgical Co., Alloy, W.Va.—Operated without a fatality or lost-time accident from March 14, 1931, to March 1, 1933, handling 385,068 net tons of material, including 234,977 net tons of bituminous coal, with an average of 130 employees working 541,185 labor hours.

Black Diamond Coal Mining Co., Birmingham, Ala.—Operated the Mossboro mine without a lost-time accident from October 1, 1931, to December 31, 1932, with 144,925 man-hours of exposure and production of 44,436 tons of coal; and the Benoit mine from August 15, 1931, to December 31, 1932, with one lost-time accident in 235,770 man-hours with production of 74,987 tons of coal. The four mines of this company operated without a lost-time accident in October 1932.

Imboden mine, Stonega Coke & Coal Co., Imboden, Va.—Operated without a fatality or a lost-time accident from March 20, 1931, to July 8, 1932, or 15 months and 19 days, with an average force of 178 underground and 20 on the surface and producing 231,469 tons of coal in 509,232 man-hours of exposure.

Block No. 1 mine, Block Coal & Coke Co., Block, Tenn.—Operated without a lost-time accident from May 26, 1931, to July 1, 1932, employing an average of 115 persons in the production of 67,832 tons of coal.

Weyanoke mine, Weyanoke Coal & Coke Co., Lowe, W.Va.—Operated without a lost-time accident during 1932 with an average of 100 men working 146,589 man-hours in the production of 125,000 tons of coal.

In addition, 22 other awards were given coal mines or mining companies for long-time operation without fatal accidents, for large tonnages produced without fatal accidents, or for other meritorious safety performance.

METAL AND NONMETALLIC MINING

Accident figures for metal and nonmetal mining in 1932 are as yet fragmentary. Reports from 148 identical metal-mining properties show a production of 63,355,894 tons in 1931 and only 30,795,168 tons in 1932, a decrease of 51.4 percent; man-hours of exposure were 73,804,002 in 1931 and 45,811,077 in 1932, a decrease of 37.9 percent. The number killed per million man-hours was 0.908 in 1931 and was reduced to 0.655 in 1932, a reduction of 27.9 percent. The number injured per million man-hours was 47.328 in 1931 and 50.097 in 1932, an increase of 5.9 percent. Forty-seven identical nonmetal (noncoal) mining properties reporting in both 1931 and 1932 produced 5,062,964 tons in 1931 and 3,491,288 in 1932, a decrease of 31.0 percent, with 6,487,494 man-hours of exposure in 1931 and 4,277,670 in 1932, a decrease of 34.1 percent. The fatalities per million man-hours were 0.462 in 1931 and 0.468 in 1932, an increase of 1.3 percent and the nonfatal injuries per million man-hours were 41.310 in 1931 and 39.975 in 1932, a decrease of 3.2 percent.

A total of 277 identical quarries reporting in both 1931 and 1932 produced 49,476,740 tons in 1931 and 31,966,899 in 1932, a decrease of 35.4 percent; man-hours of exposure in 1931 were 56,748,108 and 40,917,499 in 1932, a decrease of 27.9 percent. The number of fatal accidents per million man-hours aggregated 0.388 in 1931 and 0.391 in 1932, an increase of 0.8 percent, while the number of injuries per million man-hours amounted to 29.710 in 1931 and 29.303 in 1932, a decrease of 1.4 percent.

The latest complete figures on accidents in metal and nonmetallic mineral mines, those of 1931, indicate that 328 mines producing nonmetallic minerals had 0.61 fatality and 46.88 nonfatal injuries per million man-hours of exposure; 201 mines producing iron ore had 0.72

death and 19.78 nonfatal injuries per million man-hours; 2,514 mines producing gold, silver, and miscellaneous metals had 1.19 fatalities and 78.65 nonfatal injuries per million man-hours; 100 lead-and-zinc mines in the Mississippi Valley States had 1.06 fatalities and 72.81 nonfatal accidents per million man-hours; and 223 copper mines had 1.24 fatalities and 62.90 nonfatal accidents per million man-hours.

There were 3,366 metal and nonmetallic mineral mines operating in 1931; these employed 80,940 persons, with 156,177,859 man-hours of exposure, and had 158 fatalities and 8,709 nonfatal accidents; the rate per million man-hours was 1.01 for fatalities and 55.76 for nonfatal accidents.

The States which had the lowest or best combined fatality and injury rate per million man-hours in 1931 were, in order: Minnesota, 13.12; Tennessee, 21.64; Alabama, 21.76; Florida, 36.48; Michigan, 40.86; Alaska, 41.19; South Dakota, 41.63; Texas, 47.01; Missouri, 49.10; Arizona, 51.60; and Virginia, 55.91. The States with the poorest accident rate in 1931 (fatal plus nonfatal accidents per million man-hours) were: Colorado, 113.80; California, 109.24; Oklahoma, 108.92; Utah, 89.95; Kansas, 81.19; Idaho, 77.55; New York, 74.99; Montana, 73.88; New Jersey, 69.53; New Mexico, 61.35; and Nevada, 60.09. The average for all States was 56.75.

Of the States having the heaviest exposure, Minnesota, Alabama, Michigan, Alaska, and Arizona had accident-frequency rates lower than the average for the noncoal mines of the country, while Montana, Idaho, Utah, and California had higher rates than the average for the country. Minnesota, Tennessee, Alabama, Florida, and Michigan had the best frequency rates; Colorado, California, Oklahoma, Utah, and Kansas in order had the poorest or worst rates; and Virginia, Nevada, New Mexico, and New Jersey had accident-frequency rates approximating the average for the noncoal mines of the country.

The Joseph A. Holmes Safety Association at its meeting in Washington, D.C., March 6, 1933, gave numerous awards to metal and nonmetal mines for safety performance, and the following awards were given chiefly for long-time operation without any lost-time accidents:

Hiawatha mine, Hanna Iron Ore Co., Iron River, Mich.—Operated an underground mine without a fatality or lost-time injury from August 6, 1930 to January 1, 1933, with an average of 155 men working 490,986 man-hours, producing 253,511 tons of iron ore, removing 12,773 cubic yards of rock, and handling 190,793 cubic yards of gravel in filling a large stope.

Richmond mine, Richmond Iron Co., Palmer, Mich.—Operated an open-pit mine without a lost-time accident from January 1, 1928 to January 1, 1933, with an average of 30 men working 228,033 man-hours, producing 616,578 tons of iron ore and removing 80,276 cubic yards of stripping material. This mine has not had a fatality for 34 years.

No. 6 shaft, Underground Department, Montreal Mining Co., Montreal, Wis.—Operated without a fatality or lost-time accident from December 12, 1931 to December 31, 1932, or 385 days, with 102,696 man-hours of exposure in production of 107,923 tons of iron ore and rock, and in driving of 3,922 feet of drift and crosscut and 2,976 feet of raises.

Bennett mine, Bennett Mining Co., Keewatin, Minn.—Operated an open-pit mine with no fatalities and no lost-time injuries from June 1928 to January 1, 1933, or 55 months, with an average of 52 men working 621,029 man-hours and producing 1,121,990 tons of iron ore and 638,284 tons of rock and stripping.

Newport mine, Youngstown Mines Corporation, Ironwood, Mich.—Operated an underground mine with no fatalities from August 20, 1927, to December 31, 1932, or 64 months, with an average of 281 men working 3,424,523 man-hours and producing 2,391,544 tons of iron ore and 116,682 tons of rock. This mine operated 4 months of 1928 without a lost-time accident, 9 months of 1929, 7 of 1930, 3 of 1931, and 10 of 1932.

Plymouth mine, Plymouth Mining Co., Wakefield, Mich.—Operated an open-pit mine with no fatalities and no lost-time injuries from December 23, 1929 to December 31, 1932, or 36 months, with an average of 66 men working 547,504 man-hours and producing 707,978 tons of iron ore and 1,164,356 tons of rock.

Gardner-Mackinaw mine, Cleveland-Cliffs Iron Co., Gwinn, Mich.—Operated an underground mine with no lost-time accidents from May 19, 1930 to January 1, 1933, or 957 days, with an average of 80 men working 417,301 man-hours, producing 178,967 tons of iron ore and removing 3,323 tons of rock. This mine now has a record of over 1,500 days with but 1 lost-time accident.

Townsite mine, Townsite Mining Co., Ironwood, Mich., operated by Republic Steel Corporation.—Operated an underground mine without a fatality or lost-time accident from January 14, 1931, to January 14, 1933, with an average of 39 men working 90,491 man-hours in 1931 and 61,721 man-hours in 1932, producing 61,330 tons of ore and 6,250 tons of rock and stripping.

No. 5 shaft, Underground Department, Montreal Mining Co., Montreal, Wis.—Operated without a fatality or lost-time accident from May 28, 1930, to December 31, 1932, or 948 days, with 604,304 man-hours of exposure in production of 692,555 tons of iron ore and rock and in driving 11,528 feet of drift and crosscut and 4,769 feet of raises.

Mahoning mine, Mahoning Ore & Steel Co., Hibbing, Minn.—Operated an open-pit mine with no fatalities and no lost-time injuries from May 1930 to January 1, 1933, or 32 months, with an average of 111 men working 842,877 man-hours and producing 2,721,406 tons of iron ore and 1,904,601 tons of stripping.

Mahnomen mine, Cuyuna Ore Co., Ironton, Minn.—Operated an open-pit mine with no fatalities and no lost-time injuries from January 1, 1930, to January 1, 1933, or 36 months, with an average of 28 men working 275,161 man-hours, producing 193,879 tons of manganiferous iron ore and 460,161 tons of stripping.

Sagamore mine, Sagamore Ore Mining Co., Ironton, Minn.—Operated an open-pit mine with no fatalities and no lost-time injuries from August 1929 to January 1, 1933, or 41 months, with an average of 32 men working 387,933 man-hours, producing 409,986 tons of manganiferous iron ore and 1,049,655 tons of stripping.

Tilden mine, Cleveland-Cliffs Iron Co., Ishpeming, Mich.—Operated an open-pit mine with no lost-time accidents from December 14, 1929, to January 1, 1933, or 1,113 days, with an average of 42 men working 211,410 man-hours, producing 440,010 tons of iron ore and removing 19,605 tons of rock.

In addition the following awards were made to nonmetallic mines or organizations for no-lost-time operation for long periods:

Ironton mine, Alpha Portland Cement Co., Ironton, Ohio.—Operated an underground limestone mine from September 21, 1926, to January 1, 1933, working 1,030 days with 617,907 man-hours of exposure and mining 1,066,939 tons of stone without a lost-time accident.

United States Gypsum Co., Plasterco, Va.—Operated a mine and surface plant at Plasterco, Va., through the year 1932 without a lost-time accident with an average of 50 underground and 60 surface employees, producing and processing approximately 450 tons of gypsum per day.

Certain-teed Products Corporation, Akron, N.Y.—Worked with an average of 150 employees in a gypsum-products plant, including an underground mine, from July 17, 1931, to December 31, 1932, a total of 419,758 man-hours, without a lost-time accident. From January 8, 1931, to December 31, 1932, the mine worked a total of 219,568 man-hours without a lost-time accident.

Avery plant, Avery Salt Co., Avery Island, La.—Operated from July 3, 1931, to January 1, 1933, with 410,248 man-hours of exposure without a lost-time accident. The mine, with an average of 20 underground employees, worked 847 days without a lost-time accident.

The health and safety of the approximately 1,000,000 persons in the United States engaged in the mining and quarrying industries unquestionably are improving during recent years despite the numerous unsatisfactory conditions now confronting those industries. The mining industry of the United States in 1931 had the most favorable fatal-accident rate in any year of the present century and probably since mining in the United States became a major industry. Figures for 1932 are not yet complete, but there is good reason to believe that the good record established in 1931 has almost, if not quite, been equaled.

It is interesting to attempt to locate the cause of the present unexpectedly favorable situation insofar as mine-accident occurrence is concerned. Numerous theories are advances as to the influences responsible for the welcome improvement; they usually vary largely with the viewpoint of the person or agency advancing them. Unquestionably, many factors have influenced the progress of the past few years in mine-accident reduction or prevention, but probably the four outstanding ones are as follows:

First, the myth has been exploded that mining is so inherently hazardous that many accidents, some of a very severe nature, must occur wherever mining operations are pursued. The Joseph A. Holmes Safety Association and the National Safety Competition have assembled and given to the public in the past 5 or 6 years numerous instances of safe operation of mines, proving that not only metal and nonmetallic mineral mines but also coal mines (both anthracite and bituminous) can be operated with fewer than half the present deaths and injuries in the mines of the country as a whole.

The mining men of 10 or more years ago held tenaciously and almost unanimously to the belief that mines and mining were inherently hazardous, that mine accidents were "bound" to occur, and that the expenditure of any considerable amount of effort or money with a view to bringing mining operations within the accident limitations of other industrial occupations would be useless. The well-informed mining people of today know that mining can be conducted with few, if any, more accidents than in railroading, the operation of cement plants, and other industries formerly held to be hazardous but now doing wonderful work in the prevention of accidents.

The second factor influencing mine-accident reduction, and a decidedly powerful one, is that the depression has forced not only virtually all industries but also practically all individuals to make searching inquiries as to what can be done to reduce costs; those in charge of mining operations who are really wide-awake have found that the various factors affecting the cost of accidents in mining constitute 10 or more percent of the entire cost of production. Many progressive companies have reduced the cost of accidents 50 or more percent by giving the right kind and the right amount of attention to accident prevention.

One coal mine in West Virginia, by intensive, intelligent endeavor to prevent accidents, reduced its compensation-insurance rate from \$4.20 per hundred dollars of pay roll to \$1.88. The compensation, hospital, and medical costs of a Pennsylvania coal mine were 8 cents per ton in 1930; definite attention was given to prevention of accidents, with the result that in 1931 these costs were only 1.2 cents per ton and in 1932 less than 1 cent per ton. A well-informed coal-mining engineer in an article published in September 1932 stated that a properly functioning safety organization at a coal mine should reduce compensation costs to 1 cent per ton, and that another cent per ton should cover the cost of the safety department and additional equipment necessary to bring about the reduction.

A third influence in the relatively rapid reduction in mine accidents and mine-accident rates in the past few years is the fact that safety educational work has been given much more attention in and around mines. In the past 5 years more than 450,000 persons in the mining and allied industries have been given the full Bureau of Mines course in first aid to the injured, and it is estimated that at least 200 lives are saved every year and probably several thousand accidents prevented through the various influences of this work. Since 1929 more than 3,000 persons in the mining and allied industries have qualified to act as instructors in first aid, and their influence in the prevention of accidents is by no means negligible. More than 3,000 officials of coal mines in the United States have taken the new accident-prevention course of the Bureau of Mines since 1930, and its influence is being shown in the much better accident records which mines almost invariably have afterwards. Numerous mining institutes have been organized in the past 5 or 6 years, and in many of the institutes safety is the principal subject of discussion. There are numerous other manifestations of an increase in educational work in safety in mining during the past few years, such as the forming and functioning of mine-safety organizations, the establishment of mining-community safety organizations such as the Holmes safety chapters, the dissemination of good safety records by the Joseph A. Holmes Safety Association, the establishment of safety competitions of various kinds, etc.

A fourth influence which has forwarded safety in mining in recent years is the recognition by many State mine inspectors and mining officials that the State mining laws establish only minimum safety requirements (many if not most of them being decidedly inadequate even as to these minimum requirements) and that real safety in mining demands taking far more precautions than the strict letter of the law requires.

Ten years ago the operating officials of relatively few plants in the mining and allied industries thought of accidents other than in terms of fatalities or partial or total disabilities, although numerous more or less serious accidents occurred every week or month; the mining company or mine which escaped without at least one fatal accident in any calendar year was considered fortunate, and few mines were found in the "lucky" class. In the last few years hundreds of progressive mining companies have abandoned the idea of expecting serious accidents and not only have taken measures to prevent fatalities or partial or total disability accidents (temporary or permanent) but also have tried to operate without any lost-time accidents. Where this effort has been made with intelligence, determination, and persistence, mines and mining plants have been worked for unbelievably long periods and have produced large tonnages without accidents. So many instances of long-time operation of mines or mining plants without accidents are now known that unquestionably mining can be done with little if any less safety than in many if not most major industries.

Coal-mining companies, metal-mining companies, nonmetallic mineral-mining operations, cement plants, quarries, and petroleum plants during the past 5 or 6 years have given numerous instances of long-time operation without fatalities, without accidents of a serious nature, and even without any lost-time accident. Although it is difficult to believe, each of the above divisions of the mining and allied industries has achieved within the past few years numerous instances of operation of an entire mine or plant for a full year or more without even one lost-time accident and with a relatively large number of man-hours of exposure and a large production. These good records have been made not only in essentially all divisions of the mining and allied industries but also in many different States and in mining regions having almost every type of natural mining condition. That the good records are not merely good fortune is evidenced by the fact that in almost every instance where an exceptionally fine safety record has been made and an accident of some kind occurs, the organization affected usually makes a new start and achieves another and possibly better record.

The following awards to individuals by the Joseph A. Holmes Safety Association at its meeting in Washington, D.C., March 6, 1933, indicate that mine employees can work long periods in and around mines without accidents:

Joseph Peterson, East Pittsburgh, Pa.—Worked in coal mines 68 years without incurring a lost-time injury.

Alexander Moffat, Steubenville, Ohio.—Worked over 60 years in coal mines of the United States and Scotland as a loader, driver, and timberman without incurring a lost-time injury.

Joseph Duke Mellor Chadwick, Sr., Steubenville, Ohio.—Worked 55 years in coal mines of the United States and England without incurring a lost-time injury, having been employed as driver, loader, track layer, motorman, timberman, pumper, and fire boss.

Daniel Thomas, Amsterdam, Ohio.—Worked over 58 years in practically all phases of underground coal mining without incurring a lost-time injury.

James Pierce Butler, Nellis, W.Va.—Worked 50 years in coal mines without the loss of a day due to personal injury.

Eph Hudson, Coal Fork, W.Va.—Worked 54 years continuously in West Virginia coal mines without incurring a lost-time accident.

Wes Light, Spring Fork, W.Va.—Worked 54½ years continuously in West Virginia coal mines without incurring a lost-time accident.

John Wesley Smithers, Sipsey, Ala.—Worked 49 years in coal mining without a lost-time injury to himself or to persons under his supervision.

Michael McNamara, Ishpeming, Mich.—Worked 50 years in and around mines without a lost-time accident, and efficiently supervised the safety of those in his charge.

Thomas Whalen, Wainwright, Ohio.—Worked in coal mines 58 years with but one lost-time accident. From 1883 until retirement in 1931, or 48 years, he incurred no lost-time accidents.

Edmund Goulder, New Philadelphia, Ohio.—Worked nearly 55 years in coal mining during which time he sustained but one slight injury causing 5 days lost time.

Henry C. Lichtenfeld, Centralia, Ill.—Worked 44 of the past 50 years without a lost-time accident, chiefly as a coal loader in solid-shooting coal mines, this record continuing to date.

Robert Sloan, Sr., Soldier, Pa.—Worked 48 years in bituminous-coal mines without a lost-time accident.

Numerous awards of a more or less similar nature have been given other individuals in previous years.

The mining and allied industries have been forced to consider various phases of the cost of mine accidents recently due to several influences, chiefly the wide-spread adoption of State compensation laws, the increasing cost of compensation, hospitalization, etc., and the decreasing rate of production. The increasing charges in connection with accidents have caused numerous studies to be made of items which go into the cost of accidents (chiefly, however, with respect to compensation), and when the various amounts have been added and the summation placed against output many mining companies have been surprised to learn that approximately 10 percent of the cost of production (and in some cases much more than 10 percent) has been due to accidents. When the full realization has been made evident to some operating companies that 10 percent or more of the cost of mining is due to accidents, they have made a determined, well-directed attempt to reduce accidents as the best and most logical method of reducing the cost of accidents, with the result that accident costs have been reduced in some instances more than 50 percent within one year. In fact, it is now fairly well-established that the cost of accidents in the mining and allied industries need not exceed 5 percent of the total cost of production and in many cases can be kept below 2 percent. Moreover, the logical place to reduce the cost of accidents is to reduce or virtually eliminate accident occurrence rather than to attempt the much more difficult and much less humane method of reducing the benefits allowed victims of accidents.

If those engaged in the mining and allied industries of the United States would assemble all of the data which can be obtained as to costs of accidents (including fatal, nonfatal, and no-lost-time accidents), would carry daily, weekly, monthly, or yearly accident costs on the same unit-cost basis as timbering, haulage, ventilation, drilling, blasting, etc., and would exert as much effort to hold accident cost per unit of production to a minimum as to hold other items of cost within reason, not only cost of accidents but also occurrence of accidents in the mining and allied industries could be reduced much more than 50 percent compared with the record of the best year in the history of mining in the United States. The United States Census figures for the operating cost of producing the coal of the United States in 1929 have been given as $1,083,637,347. If the accident cost has been at least 10 percent (as seems probable from fragmentary data now available), then the coal industry of the United States paid out considerably over $100,000,000 for or because of accidents in 1929; if through reasonable effort in accident prevention 50 or more percent of this amount could have been saved, the money benefit to the coal-mining companies would have been $50,000,000 or more, and the benefits of various kinds to the mine workers would undoubtedly have been equivalent to several times $50,000,000.

While metal mining (including nonmetallic mineral mines) had a much better accident-frequency rate in 1931 (the last year for which complete figures are available) than coal mining (the accident-frequency rate for metal mining being 56.75 for the country as a whole and for coal mining 101.71), nevertheless the metal and nonmetallic mineral mines of the country are by no means as free from accidents as they should be or as they can be made. Unquestionably, the accident-frequency rate for mining should not be higher than 15.00 or at least 20.00 instead of the 56.75 in metal mining or the 101.71 in coal mining in 1931, the banner year in safety in the mines of the United States. That this goal is not impossible is proved by the fact that scores of mines now are operating within this limit and are finding that safe operation pays, not only in the saving of lives, limbs, and human happiness but also in dollars and cents.

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