# Minerals yearbook 1934. Year 1933 1934

Kiessling, O. E.
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U.S. DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, Secretary
BUREAU OF MINES
SCOTT TURNER, Director

# MINERALS YEARBOOK

# 1934

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UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1934

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# FOREWORD

The Minerals Yearbook, 1934, of the United States Bureau of Mines, is the second of the new series; it carries forward the statistical information and economic discussions of mining printed in various former publications, including Mineral Resources of the United States which was issued annually for half a century. The purpose in assembling basic information on minerals into one convenient volume, the reasons for changing the method of publication, and the position the volume occupies in relation to research in mining economics were set forth in the foreword to the Minerals Yearbook, 1932–33.

Last year, the first volume of this new series was published. The demand for it was immediate and brisk. Over 6,300 copies were printed and distributed, and many orders were received by the Government Printing Office after all editions had been exhausted and the book was no longer available.

It will be remembered that the idea behind the shift from the old method of publishing somewhat comparable data was to serve those engaged in the mineral and allied industries more promptly and effectively, at a lower cost, as necessitated by curtailed Bureau funds. Time, expense, convenience, and usefulness are the controls in this new venture.

Although the 1934 volume is slightly larger than its immediate predecessor, more convenient arrangement for reference and betterment of the individual chapters are the principal improvements. The Bureau is indebted to many engineers in the mineral industry who volunteered constructive suggestions.

Greater facility for reference is achieved in three ways; in addition to a general index, at the beginning of each chapter there is a summary of principal topics, with page references. Those desiring general data on world mineral production should first turn to the chapter, Mineral Production in Foreign Countries, which lists the page numbers of tables showing foreign mineral output, collected by the Bureau from original sources.

As the market for many minerals is wide, interest in world-production data often arises in a study of supply, demand, and price for a certain mineral; hence, readers ordinarily find the world-production figures with the commodity discussions necessary for complete understanding, and this arrangement is followed herein. Sometimes, it may be of interest to ascertain the names and aggregate quantities of minerals produced in a certain country. To publish recapitulation tables each year merely requires assembly of data in the world tables of the various chapters. This involves duplication; however, to meet the needs of the occasional student interested in this aspect, every half decade the Bureau prepares such tables covering the past 5 years and publishes them as a separate chapter in the annual volume.

A chapter on Helium appears in this volume for the first time, and the discussions of gem minerals and of technical aspects of the mineral-fuels industries are expanded. The reviews of metal mining in the various States are more complete than in the preceding year. Certain developments under the National Recovery Administration are noted in the commodity discussions. The space allotted a few subjects has been curtailed, to eliminate year-to-year repetition; in these fields, events of unusual importance or interest occur infrequently, and complete reviews every 3 or 5 years seem adequate.

In most instances, final statistics are given herein; where annual canvasses are not complete, figures are subject to slight revision, as indicated in footnotes. All final chapters will 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 will be issued later and can be obtained separately or in bound form as the Statistical Appendix to the Minerals Yearbook, 1934.

The Bureau's printing funds are now about one-third what they have been in the past. This volume, together with separate chapters and statistical appendixes, makes heavy demands on its slender financial resources, but its importance seems to justify the use for this purpose of over one-third of the Bureau's total annual printing fund. The Bureau buys copies to distribute free to certain educational institutions and reference libraries; beyond that it cannot go, but the book may be bought from the Superintendent of Documents, Government Printing Office, Washington, D.C., at a low price; last year the 819-page bound volume sold for $1.25. It should be remembered that the Government Printing Office is in no way connected with the Bureau of Mines, and that no money derived from the sale of the book, or any other publication, comes to the Bureau.

In the Minerals Yearbook, the Bureau seeks above all to serve the mining industry effectively; suggestions for improvement of the volume to attain this objective better will be welcome.

Scott Turner, *Director*.

June 10, 1934.

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# INTRODUCTION

Fifty years ago the United States was just emerging from a state of lusty industrial infancy as it slowly began to participate in world markets, although the country still presented a mixed picture of the relatively well populated East and the large, and in some instances unexplored, thinly inhabited area west of the Mississippi. The search for mineral wealth had been a powerful influence in the opening of the West after gold was found at Sutter's mill in 1848, and the period from 1850 to 1900 was characterized by a series of important mineral discoveries. So startling were the resources of this new country that they drew world attention, and for many years mineral developments within our own borders fully absorbed the interest of American producers. It was during this period that the Federal Government undertook its first mineral statistical surveys, and the somewhat tardy publication of annual statistical reviews—limited largely to domestic production—represented the last word in statistical service on minerals that the business interests of the period required.

The concept that minerals were destined to play a major role in American economic history requiring the early collection of accurate annual data was due almost solely to the energy of a few far-sighted men.[1] Their efforts, as explained in the Minerals Yearbook, 1932–33 (pp. IX–XIII), resulted in firmly establishing annual canvasses of the mineral industries as a Government function, and these canvasses are continued today with the benefit of experience, development, and improvement over more than half a century.

During the period of development the scope of the annual reviews was expanded as producers found new types of information necessary for adequate appraisal of important trends in the mineral markets. The surveys, confined at first principally to production data, soon were extended to cover statistics on sales, stocks, uses, distribution, and technological developments of economic interest. Later the addition of statistical information on minerals in foreign countries was necessary as completion of the world transportation network at the beginning of the twentieth century made available hitherto inaccessible resources of relatively undeveloped countries in competition with American producers who had become increasingly important in world markets. The full need for the foreign data, however, was not fully realized until the World War, when the Government—faced with the lack of adequate knowledge of foreign resources at a time when such information had vital importance—organized a statistical service on foreign mineral production in the Mineral Resources Division of the United States Geological Survey (now the Mineral Statistics Division, United States Bureau of Mines). This service has continued to the present as a necessary supplement to the domestic studies, and an account of its growth is given on pages 13 and 14 of this volume.

Although the Minerals Yearbook, issued on October 15, with its 72 chapters presenting the detailed results of yearly statistical canvasses, marks a record in speedy publication, mineral producers are supplied summaries of essential statistics long before the volume

[1] King, Clarence, First Annual Report of the United States Geological Survey to the Hon. Carl Shurz: Washington, 1880, pp. 52–53, 76, 78–79.

becomes available. For most minerals this service consists of publication of preliminary annual statistics within 3 months following the year covered; the preliminary figures are superseded by final data within 3 to 7 months following the year covered. Both preliminary and final statements are released in mimeographed form under the title "Mineral Market Reports" as rapidly as the figures are completed in the workshop. For example, preliminary 1933 statistics on the lead [2] and copper [3] industries were released on January 12 and January 18, respectively; the final statistics for lead [4] were issued on May 24 and those for copper [5] on July 13.

With the annual record of production established on an accurate basis and available at an early date, the interest of the mineral industry has turned to rapid-fire measurements of the current changes in supply and demand.

Where there are only a few producers in an industry—such as the making of byproduct coke—it is a simple matter to arrange a system of direct reports in which each company supplies a confidential monthly statement of its operations, to be consolidated in totals for the industry. But in many American industries the bounty of nature has encouraged thousands of concerns to enter the field. In quarrying, in the production of sand and gravel, and in the winning of oil and gas direct reports from the original producers are both too expensive and too slow to be of value in analyzing short-time movements of the market. Here some method of sampling or of indirect measurement must be devised.

Such an industry is the mining of bituminous coal. In normal times soft coal is produced by some 4,600 separate companies operating 6,000 mines of commercial size, not to mention other thousands of wagon mines, "snowbirds", and country coal banks. Here even sample reports from selected large producers are impracticable, for there is no way of telling how far the experience of the lesser companies may differ from that of their larger competitors. In this industry the solution was to measure production through railroad car-loadings, taking advantage of the fact that the great bulk of the output is loaded directly into railroad cars for immediate shipment. Originated by C. E. Lesher, the first report on current movements of coal was issued August 15, 1916. It covered cars loaded on 49 selected roads and was only a sample of the 188 railroads and 10 waterways on which coal was then originated, yet it was enough to indicate whether the trend of production was up or down.

The new service came at a critical time. The munitions demand had increased the consumption of coal, and signs of the shortage that was to become so acute the following year were already apparent. When America itself entered the war, coal threatened to be a limiting factor in the military effort of the Nation, and the newly formed Committee on Coal Production of the Council of National Defense was in urgent need of trustworthy barometers of the market. With the help of the American Railway Association the system of reporting was rapidly extended. All the important coal-originating roads were induced to cooperate. The mail gave place to the telegram. A weekly schedule replaced the initial monthly one. On July 21, 1917,

[2] U.S. Bureau of Mines, Lead Industry in 1933: Mineral Market Report 253, Jan. 12, 1934.
[3] U.S. Bureau of Mines, Copper Industry in 1933: Mineral Market Report 256, Jan. 18, 1934.
[4] U.S. Bureau of Mines, Lead Industry in 1933: Mineral Market Report 286, May 24, 1934.
[5] U.S. Bureau of Mines, Copper Industry in 1933: Mineral Market Report 292, July 13, 1934.

appeared the first Weekly Coal Report. It is interesting to quote from the first issue:

Weekly statistics showing what the soft-coal miners of the country are doing, and why they are not doing more, are now being collected by the United States Geological Survey under Secretary of the Interior Lane. In these strenuous times it is essential that the Government, particularly the Committee on Coal Production, as well as the general coal-consuming public, be kept informed of exactly what the miners are bringing forth and what is more important, what is hindering greater output of the basic product, coal. * * * With this information before it, the Committee on Coal Production is able to concentrate its efforts where the greatest stringency lies * * *.

For the first few weeks the new report was confined to sample reports of car-loadings from the railroads and of mine-operating conditions from coal-trade associations, but by October 11 the flow of information was established sufficiently to make possible a rough weekly estimate of the total national production moving from all mines and over all routes.

From this small beginning has developed the present elaborate system of weekly estimates of output in each State or district. Methods of recording the movement by river were set up. Electric lines and private roads were drawn into the system. Arrangements were made for telegraphic reports of cars of beehive coke loaded, in order to measure the tonnage not shipped as raw coal but charged direct into coke ovens at the mines. Consumption of mine-mouth power plants was recorded to indicate the trend of local sales, and details furnished by many railroads traced the origin of the coal loaded back to each major field.

The statistical formulas devised to convert these primary records of car- and barge-loadings into tons of coal raised involve more than 400 variable factors, each of which is being continually reviewed by the statistician in charge and readjusted in the light of the current trend of the market. The accuracy of the weekly estimates is put to the acid test of independent check; for months after the estimates are published the annual reports of the operators come in, and the sum of the 52 weekly estimates is then checked against the final result as determined by actual count. In recent years the estimates have come within 1 or 2 percent of the actual, the results for the last 3 years being as follows:

| | 1930 | 1931 | 1932 |
|---|---|---|---|
| Sum of 52 weekly estimates published currently | 461,630,000 | 378,110,000 | 305,667,000 |
| Actual production for the year as later reported by all mine operators | 467,526,299 | 382,089,396 | 309,709,872 |
| Percent estimate was of actual | 98.7 | 98.9 | 98.7 |

No sooner was the production factor measured in this way than the coal industry began to ask for the consumption factor, the distribution factor, and the all-important factor of stocks. To meet this demand other systems of reporting have been developed, each adapted to the peculiar problems of the industry, and all resting on the pioneer work of Lesher. Without discussing details, they have culminated in a monthly report on the Distribution of Coal Shipments, based largely on railroad traffic records and tracing the movement from field of origin to point of use. Consumption and stocks of industrial buyers are now reported monthly in cooperation with the National Association of Purchasing Agents, the American Railway Association, and other consumer groups.

A parallel service has been developed for the oil industry. For crude petroleum, of which there are thousands of primary producers, the method of measurement developed was the record of pipe-line runs. The first monthly oil report was developed by J. D. Northrop of the United States Geological Survey and appeared in February 1917. Like the first coal report, it was based on incomplete returns from sample companies, which later expanded into estimates of total national production and stocks. Meanwhile, a current report on the operations of petroleum refineries was being developed in the Bureau of Mines, and in July 1925 the two were combined into the Monthly Petroleum Statement. As subsequently improved, the petroleum statement covers production by States and fields, stocks, imports, exports, and indicated demand, for crude oil, for all the major refined products, and for natural gasoline. Supplementary data cover the percentage of refinery capacity utilized, activity of cracking plants, initial production of new wells, and other data indispensable to analysis of the factors of supply and demand in the oil industry.

As fast as funds available permit the Bureau has added similar services for other of the mineral industries. During the war weekly reports on the production and stocks of nonferrous metals were obtained for the confidential use of the war agencies, but they were discontinued thereafter as the American Bureau of Metal Statistics and other trade organizations expanded to cover the metallic field. In the field of the fuels and nonmetals, however, the demand for current data on supply and requirements is insistent. Using methods appropriate to the industry concerned, services have been inaugurated for byproduct and beehive coke, gypsum, cement, and the great group of mineral aggregates, including sand, gravel, crushed stone, and slag. In all of these the objective is a system as rapid and as comprehensive as that developed for coal and petroleum. It is the policy of the Bureau to establish similar reports where the leaders of industry indicate the need and where the necessary expenses can be met.

To be of value to the business man, current reports must be issued as speedily as the minimum requirements of accuracy permit. Thus, the estimates of coal production are issued within 7 days of the period covered, and in times of stress daily reports have been made. Monthly coke output is published on a 20-day schedule and petroleum. refinery products, cement, and coal stocks on a 30-day schedule. If the mineral producer will use the current report to give the short-time changes of the market and the annual report to give details and long-time trends, he will have before him a comprehensive picture of the supply and demand for his particular commodity.

In addition to drafting the chapters on Cement and on Sand and Gravel for the 1934 volume, H. H. Hughes served as editorial associate, and Chas. W. Henderson supplied many helpful suggestions for improvement of the State metal-mine reviews. M. B. Clark supervised statistical presentation and M. Abel the presentation 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 Claude Galiher.

O. E. KIESSLING.

JUNE 6, 1934.

# PART I. REVIEW OF THE MINERAL INDUSTRY

## THE STATUS OF THE MINERAL INDUSTRIES

By Scott Turner

In 1933 the protracted decline of the mineral industries of the world as a whole was sharply checked; moderate recovery of those

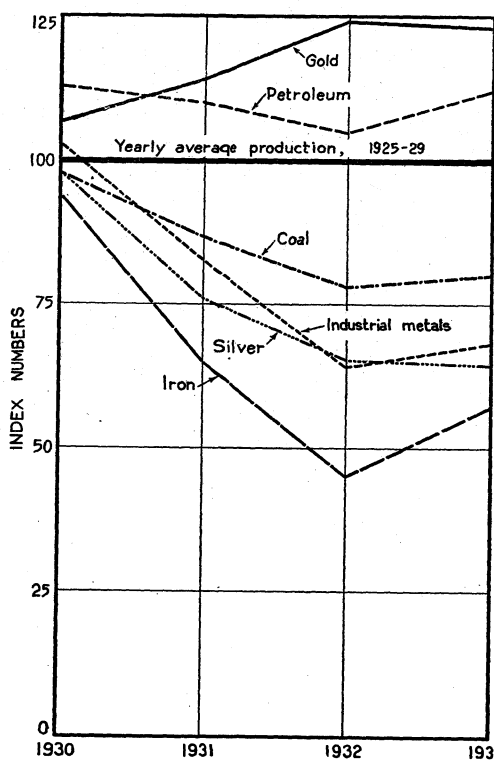


FIGURE 1.—World quantity production of principal mineral commodities, 1930–33, compared with average production for the 5-year period, 1925–29. Industrial metals include copper, lead, zinc, aluminum, tin, and nickel.

industries had been effected by the end of the year, so that world production and most price averages slightly exceeded those of the previous year.

By the end of 1932 mineral production of the world, except that of gold and petroleum, had receded steadily and rapidly through a period of 3 years, so that in 1932 the combined production of the chief industrial metals—copper, lead, zinc, aluminum, tin, and nickel—had fallen in quantity to 64 percent of its average amount during the 5 years from 1925 to 1929, immediately before the decline began. (See fig. 1.) Production of the chief structural metal—iron—as measured by production of pig iron had shrunk in that year even more decidedly, to a mere 45 percent of its average from 1925 to 1929.

*World quantity production of important metals and fuels, 1930–33, compared with averages for the 5 years, 1925–29*

| 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 (average) | 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 | 3, 565, 000 | 64 | 42, 958, 000 | 45 | 24, 141, 000 | 124 |
| 1933 [1] | 3, 750, 000 | 68 | 54, 000, 000 | 57 | 23, 869, 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 (average) | 254, 377, 000 | 100 | 1, 596, 000, 000 | 100 | 1, 248, 000, 000 | 100 |
| 1930 | 248, 708, 000 | 98 | 1, 559, 000, 000 | 98 | 1, 412, 000, 000 | 113 |
| 1931 | 192, 710, 000 | 76 | 1, 385, 000, 000 | 87 | 1, 373, 000, 000 | 110 |
| 1932 | 164, 757, 000 | 65 | 1, 239, 000, 000 | 78 | 1, 311, 000, 000 | 105 |
| 1933 [1] | 162, 000, 000 | 64 | 1, 272, 000, 000 | 80 | 1, 400, 000, 000 | 112 |

[1] Subject to revision.

Even coal production amounted to only 78 percent of its former average, although the demand for coal is sustained largely by many uses that cannot be suspended or deferred, such as for heating and the generation of power for electric lights and street-railway service.

The increase of gold production to 124 percent of its former average, of course, merely reflected its higher purchasing power in a time of disaster when commodity prices had collapsed and was therefore consistent with and complementary to the decline of other mineral commodities. The output of silver, on the contrary, being largely a byproduct of the production of the chief industrial metals, did not parallel that of gold but stood at 65 percent of its former amount.

Besides gold, petroleum alone had exhibited a sustained record of production; in 1932, it was 105 percent of its average from 1925 to 1929. Nevertheless, petroleum had not escaped the drastic recession of market value experienced by most mineral commodities. Its average price in 1932 was only 60 percent of its average for the 5-year base period, or nearly the same as the weighted average of metal prices for the year, which was 63 percent of the average for the 5-year period.

These declines in quantity and unit-value of minerals and metals brought about a shrinkage in the total value of the production for the entire world in 1932 to only 46 percent of the average during the 5-year period; as the figures given are averages for the whole year and the ebb continued to its end, conditions at the beginning of 1933 were even worse than these figures suggest.

Beginning thus in the extreme depths of depression, 1933 was broadly characterized by expanding markets and improved prices that raised the quantity of production and world total of value for the year as a whole slightly above corresponding figures for 1932; that is, the general trend of mineral industries was unmistakably upward. In fact, the total value of world production increased from 46 to 54 percent of that during the base period.

Considering the most important metals and fuels, it is seen that in 1933 the combined production of the chief industrial metals rose to 68 percent of the yearly average during the base period compared with 64 percent in 1932. The production of pig iron advanced from 45 to 57 percent, that of coal from 78 to 80 percent, and that of petroleum from 105 to 112 percent. Only the output of gold and silver decreased, gold from 124 to 123 percent, and silver from 65 to 64 percent.

The weighted average United States prices of the metals and nonmetals for 1933 likewise increased—metals from 63 to 71 percent, and nonmetals from 76 to 83 percent. The price of bituminous coal advanced slightly (from 67 to 70 percent) and that of natural gas from 111 to 113 percent. The price of anthracite fell, however, from 84 to 81 percent. The most severe recession of any important mineral commodity was that from 60 to 42 percent in the price of petroleum.

On the whole, these data suggest that 1933 will prove to be the first year of recovery and appear to indicate the start of an upward trend in the mineral industry; however, this observation should not be understood as prediction, which is outside the purpose of this review.

There next arises a question as to how the mineral industry of the United States fared in comparison with that of the rest of the world. Comparison of world totals of production that include commodities so diverse in their nature and uses as gold, iron, and coal, the produced tonnage of which may have some such ratio as 1 to 100,000 to 2,000,000, and their values for a given weight some such ratio as 400,000 to 50,000 to 1 must obviously be based upon value.

The total value of world production cannot, however, be accurately ascertained wholly by compilation, because of lack of complete data, so the estimates are based in part upon assumptions that are deemed adequate only for indicating broad trends. The totals are given in United States currency.

*Trends in total mineral production, measured by value, in the world and the United States, 1930–33, compared with averages for 1925–29*

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

| Year | 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 | 6.5 | 46 | 2.5 | 44 | 4.0 | 48 |
| 1933 [1] | 7.5 | 54 | 2.5 | 44 | 5.0 | 60 |

[1] Subject to revision.

The value of world mineral production rose from approximately 6.5 billion dollars in 1932 to 7.5 billions in 1933, an increase from 46 to 54 percent of the annual average during the period 1925–29. This gain was due to the increased value of foreign production, as that of the United States output remained the same as in 1932—2.5 billion dollars. During the base period the United States had produced 41 percent of the total value of world production but the corresponding figures for 1932 and 1933 were 38 and 33 percent. United States production during the base period had an average worth of 5.7 billion dollars annually; the 2.5-billion output in 1932 and 1933 represented 44 percent of this mean.

Production in the rest of the world had dropped in 1932 to 48 percent of that in the base period, but in 1933 it had mounted to 60 percent of the 5-year average; that is, the maximum recession in value of mineral production of the United States, attained in 1932 and 1933, was considerably greater than in the rest of the world.

Although the quantity of minerals produced by the United States and the rest of the world cannot be shown in parallel because of the lack of any common denominator other than value, such comparison can of course be made with respect to certain individual commodities. Some of the most important of these are presented in the table following.

*Index numbers comparing quantity-production of important metals and fuels in the United States with the rest of the world, 1930–33*

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

| Commodity | 1930 | | 1931 | | 1932 | | 1933 [1] | |
|---|---|---|---|---|---|---|---|---|
| | United States | Rest of world | United States | Rest of world | United States | Rest of world | United States | Rest of world |
| Copper | 78 | 120 | 58 | 115 | 30 | 87 | 25 | 100 |
| Lead | 87 | 109 | 59 | 97 | 39 | 86 | 39 | 86 |
| Zinc | 83 | 124 | 50 | 96 | 35 | 78 | 52 | 92 |
| Gold | 100 | 108 | 105 | 116 | 108 | 127 | 107 | 125 |
| Silver | 82 | 103 | 50 | 84 | 39 | 73 | 36 | 73 |
| Aluminum | 130 | 115 | 101 | 102 | 59 | 71 | 49 | 66 |
| Pig iron | 79 | 106 | 47 | 81 | 22 | 66 | 38 | 76 |
| Coal and lignite | 89 | 103 | 73 | 95 | 60 | 89 | 62 | 90 |
| Petroleum | 103 | 136 | 98 | 138 | 90 | 140 | 103 | 132 |

[1] Subject to revision.

The most striking fact in this comparison is that the rest of the world made much greater advance toward recovery than the United States. In the rest of the world, 3 of the 9 commodities listed equaled or exceeded their average annual production during the base period in 1933, while only 2 of the 9 commodities did this in the United States. Domestic production of gold and petroleum in 1933 exceeded by 7 and 3 percent, respectively, their average annual of the base period, but the corresponding excess for the rest of the world was 25 and 32 percent. In 1933, furthermore, the rest of the world equaled its annual production of copper during the base period, but that of the United States remained at 25 percent; and the output of four other chief mineral commodities by the United States amounted to less than half that in the base period, the yield of silver standing at 36 percent, of pig iron at 38 percent, of lead at 39 percent, and of aluminum at 49 percent. These quantities were largely exceeded in the rest of the world, the corresponding figures being 73, 76, 86, and 66 percent, respectively.

Domestic production of zinc and coal was 52 and 62 percent, respectively, of their amounts in the base period, while foreign production had recovered to 92 and 90 percent.

Considering next the production of the United States alone, its broadest aspects are shown by the following table, illustrated by figure 2.

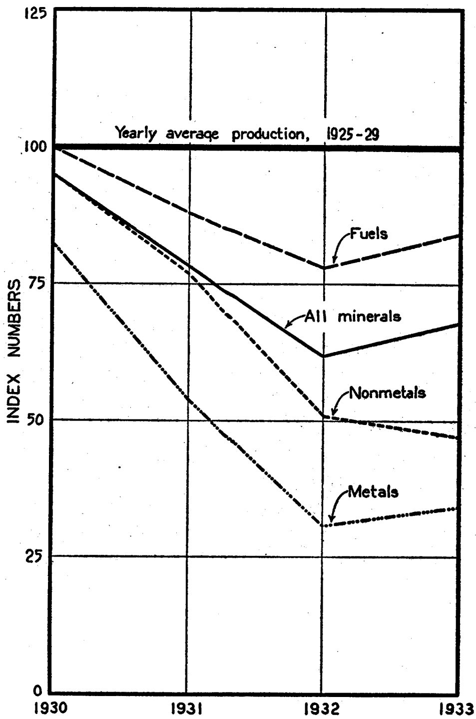


FIGURE 2.—Quantity production of metals, nonmetals, fuels, and all minerals in the United States, 1930–33, compared with averages for the 5-year period, 1925–29.

*Index numbers comparing production trends of metals, nonmetals, and fuels in the United States, 1930–33*

| Year | Total | | Metals | | Nonmetals | | Fuels | |
|---|---|---|---|---|---|---|---|---|
| | Quantity [1] | Value | Quantity [1] | Value | Quantity [1] | Value | Quantity [1] | 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 | 62 | 43 | 31 | 21 | 51 | 35 | 78 | 55 |
| 1933 [2] | 68 | 44 | 39 | 30 | 47 | 37 | 84 | 52 |

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

It will be noted that the maximum recession in production of fuels has been least, amounting to 22 percent in 1932, while that of nonmetals was 53 percent in 1933 and that of metals 69 percent in 1932. The moderately increased production of metals and fuels in 1933 was not matched, however, by nonmetals, which continued to decline. The total quantity, however, advanced substantially from 62 to 68 percent.

The following table gives the trends of quantity-production for individual chief mineral commodities.

*Index numbers showing trends in quantity-production of principal mineral commodities in the United States, 1930–33*

[Yearly average, 1925-29=100]

| | 1930 | 1931 | 1932 | 1933 [1] | | 1930 | 1931 | 1932 | 1933 [1] |
|---|---|---|---|---|---|---|---|---|---|
| Metals: | | | | | Nonmetals: | | | | |
| Gold | 100 | 105 | 108 | 107 | Salt | 103 | 94 | 82 | 98 |
| Zinc | 83 | 50 | 35 | 52 | Sulphur | 131 | 109 | 46 | 72 |
| Aluminum | 130 | 101 | 59 | 49 | Crushed stone | 100 | 83 | 59 | 57 |
| Lead | 87 | 59 | 39 | 39 | Sand and gravel | 100 | 78 | 61 | 53 |
| Pig iron | 79 | 47 | 22 | 38 | Lime | 76 | 61 | 44 | 50 |
| Silver | 82 | 50 | 39 | 36 | Building stone | 93 | 66 | 51 | 42 |
| Copper | 78 | 58 | 30 | 25 | Slate | 67 | 53 | 41 | 38 |
| Fuels: | | | | | Portland cement | 95 | 74 | 46 | 37 |
| Petroleum | 103 | 98 | 90 | 103 | Gypsum | 65 | 48 | 26 | 25 |
| Natural gas | 131 | 113 | 105 | 100 | | | | | |
| Anthracite | 92 | 79 | 66 | 66 | | | | | |
| Bituminous coal | 88 | 72 | 59 | 62 | | | | | |

[1] Subject to revision.

In 1933, only gold, petroleum, and natural gas equaled or exceeded their production in the base period. Among the metals the largest increase (73 percent) was made by pig iron—from 22 to 38 percent of its base-period average. Zinc increased 48 percent—from 35 to 52 percent of the base average. Both aluminum and copper, however, declined 17 percent in quantity.

Among the fuels, production of petroleum increased 15 percent and that of bituminous coal 5 percent, but natural gas declined 5 percent.

Of the nonmetals, sulphur and lime alone made pronounced increases—56 and 14 percent, respectively. Cement and building stone decreased 20 and 18 percent.

The actual quantities of the principal mineral commodities discussed above are shown in the following table:

*Quantity-production of principal mineral commodities in the United States, 1930–33, compared with averages for 1925–29*

| Commodity | Average, 1925–29 | 1930 | 1931 | 1932 | 1933 [1] |
|---|---|---|---|---|---|
| Metals: | | | | | |
| Copper short tons | 893,000 | 697,000 | 521,000 | 272,000 | 225,000 |
| Lead do | 661,000 | 574,000 | 390,000 | 255,000 | 260,000 |
| Zinc do | 590,000 | 489,000 | 292,000 | 207,000 | 306,000 |
| Gold ounces | 2,277,000 | 2,286,000 | 2,396,000 | 2,449,000 | 2,435,000 |
| Silver do | 61,820,000 | 50,748,000 | 30,932,000 | 23,981,000 | 22,141,000 |
| Pig iron long tons | 37,943,000 | 29,905,000 | 17,813,000 | 8,518,000 | 14,353,000 |
| Aluminum short tons | 88,000 | 115,000 | 89,000 | 52,000 | 43,000 |
| Fuels: | | | | | |
| Petroleum barrels | 869,000,000 | 898,000,000 | 851,000,000 | 782,000,000 | 899,000,000 |
| Natural gas M cubic feet | 1,487,000,000 | 1,943,000,000 | 1,686,000,000 | 1,556,000,000 | 1,480,000,000 |
| Bituminous coal short tons | 529,383,000 | 467,526,000 | 382,089,000 | 309,710,000 | 327,940,000 |
| Anthracite do | 75,105,000 | 69,385,000 | 59,646,000 | 49,900,000 | 49,399,000 |
| Nonmetals: | | | | | |
| Sulphur long tons | 1,951,000 | 2,559,000 | 2,129,000 | 890,000 | 1,406,000 |
| Portland cement barrels | 169,000,000 | 161,000,000 | 125,000,000 | 77,000,000 | 63,000,000 |
| Lime short tons | 4,457,000 | 3,388,000 | 2,708,000 | 1,960,000 | 2,224,000 |
| Sand and gravel do | 196,849,000 | 197,052,000 | 153,479,000 | 120,000,000 | 104,000,000 |
| Building stone cubic feet | 32,365,000 | 30,169,000 | 21,461,000 | 16,624,000 | 13,584,000 |
| Slate short tons | 690,000 | 464,000 | 368,000 | 284,000 | 260,000 |
| Gypsum do | 5,356,000 | 3,471,000 | 2,559,000 | 1,416,000 | 1,335,000 |
| Crushed stone do | 87,425,000 | 87,111,000 | 72,624,000 | 52,000,000 | 50,000,000 |
| Salt do | 7,791,000 | 8,054,000 | 7,358,000 | 6,408,000 | 7,605,000 |

[1] Subject to revision.

The price trends of the principal mineral commodities are shown in the following table:

*Index numbers showing trends in prices of principal mineral commodities in the United States, 1930–33*

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

| | 1930 | 1931 | 1932 | 1933 [1] |
|---|---|---|---|---|
| Metals: | | | | |
| Gold | 100 | 100 | 100 | 124 |
| Aluminum | 93 | 91 | 91 | 91 |
| Pig iron | 90 | 81 | 73 | 79 |
| Zinc | 69 | 56 | 46 | 62 |
| Silver | 62 | 47 | 46 | 57 |
| Lead | 74 | 57 | 43 | 52 |
| Copper | 88 | 55 | 38 | 48 |
| Weighted average | 87 | 72 | 63 | 71 |
| Fuels: | | | | |
| Natural gas | 96 | 104 | 111 | 113 |
| Anthracite | 96 | 93 | 84 | 81 |
| Bituminous coal | 87 | 79 | 67 | 70 |
| Petroleum | 83 | 45 | 60 | 42 |
| Weighted average | 87 | 70 | 71 | 65 |

| | 1930 | 1931 | 1932 | 1933 [1] |
|---|---|---|---|---|
| Nonmetals: | | | | |
| Sulphur | 102 | 102 | [2] 102 | [2] 102 |
| Building stone | 104 | 104 | 96 | 94 |
| Salt | 93 | 88 | 93 | 88 |
| Crushed stone | 97 | 93 | 87 | 86 |
| Sand and gravel | 97 | 95 | 80 | 83 |
| Gypsum | 82 | 86 | 89 | 82 |
| Portland cement | 88 | 68 | 62 | 80 |
| Lime | 87 | 80 | 73 | 73 |
| Slate | 92 | 79 | 69 | 59 |
| Weighted average | 92 | 83 | 76 | 83 |

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

There were no decreases in the prices of commodities of the metals group, and the weighted average of their quotations advanced 63 to 71 percent of the average of the base period. Likewise, the weighted average of prices for the nonmetals group advanced 9 percent, although this was compounded of declines in the prices of stone, salt, gypsum, and slate and advances in sand and gravel and cement. That for cement amounted to 29 percent. The weighted average price index for fuels, however, dropped from 71 to 65 due chiefly to the pronounced slump in the quotation for petroleum, amounting to 30 percent, from 60 to 42 percent of its average of the base period. The quantity of petroleum produced is so large that any change in its price influences appreciably the total value of United States production.

The less common metals also require some comment, as they often show trade movements not so readily apparent in the common metals. Thus, the price of tungsten in world markets increased from $1.49 per unit in February 1933 to $6.29 per unit at the close of the year. The world production of tungsten in that year of industrial depression was apparently about 12,000 metric tons, substantially the amount required for a normal peace-time year, and it was all absorbed. Stocks of vanadium were held that apparently would last for 2 years, but they were largely sold by the end of December; moreover, molybdenum was mined and sold in record quantities, and antimony was reported moving with the metals named.

Some economists may interpret this increased demand for metals chiefly used as alloys as a good omen for the future of the mineral industry, because it suggests that the need for them is increasing, although their importance may not be generally known. Man discerned the importance of metals enough to identify past ages with bronze and iron, but the extent of our present dependence upon metals has become so great as to be comprehended with difficulty.

In former times, the scant stocks of only a few metals may have been prized more highly in proportion than we do our present bountiful supplies. Since the beginning of man, only six metals—gold, silver, iron, copper, lead, and tin—were generally utilized or even known until a few centuries ago. The industrial use of other metals than the first six began less than a couple of centuries ago; yet, by the beginning of the present century metals had become indispensable and exceedingly diverse in application, and the quantity produced relatively enormous. Nevertheless, the output of many of them has been doubled in the past 30 years.

There are now recognized 72 chemical elements that may be classed as metals. In addition to the metals, however, there is an increasing number of valuable alloys. Recent advance of knowledge regarding the constitution of alloys, their working, and heat treatment is making possible combinations having almost any properties industry may require. Instead of the few anciently known metals or the metal elements of the present periodic table, industry in future should have, in effect, thousands of mixtures of metals from which to select those precisely meeting specific requirements for almost any purpose.

Because the fuels and metals are so intimately related in utilization that they are complementary, the increased production of mineral fuels, required for the provision of power, has paralleled in its general pattern the increased production of metals needed for its transmission and utilization.

The metals and the power derived from mineral fuels are thus equally necessary factors in the creation and maintenance of industrial civilization; hence it seems obvious that the present age is not merely one of metals, coal, oil, or power, as has been variously suggested, but one associated with mineral utilization in the production and application of power.

Metals and other minerals have made possible the unprecedented high standards of living attained in the present century and permitted some partial realization of the ages-old dream of democracy. Failure of the supply of metals and minerals would close our factories, halt transportation, silence communication, darken our cities, and limit production and distribution of food. The magnitude of the mining industry and our complete dependence on mineral commodities are definitely demonstrated by the statistical and other information contained in this volume. It is believed that basic itemization of this kind, in form readily available, will prove of value to all concerned with the production of minerals.

# STATISTICAL SUMMARY OF MINERAL PRODUCTION

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

*Mineral products of the United States, 1932–33* [1]

| Product | 1932 | | 1933 | |
|---|---|---|---|---|
| | Quantity | Value | Quantity | Value |
| METALLIC | | | | |
| Aluminum pounds | 104, 885, 000 | $20, 453, 000 | 85, 126, 000 | $16, 174, 000 |
| Antimonial lead short tons (2,000 pounds) | [2] 21, 024 | (2) | [2] 17, 805 | (2) |
| Antimony: | | | | |
| Metal do | [3] 1, 776 | (3 4) | (3 4) | (3 4) |
| Ore and concentrates do | 900 | (5) | 1, 133 | (5) |
| Bauxite long tons (2,240 pounds) | 96, 349 | 548, 168 | 154, 176 | 923, 259 |
| Cadmium pounds | 799, 501 | (6) | 2, 276, 933 | (6) |
| Chromite long tons | 155 | 2, 160 | 843 | 11, 585 |
| Copper,[7] sales value pounds | 544, 009, 948 | 34, 273, 000 | 449, 999, 143 | 28, 800, 000 |
| Ferro-alloys long tons | 218, 646 | 14, 003, 672 | 421, 423 | 28, 653, 794 |
| Gold troy ounces | 2, 449, 032 | [8] 50, 626, 000 | 2, 556, 246 | [9] 65, 337, 648 |
| Iron: | | | | |
| Ore [4] long tons | 5, 331, 201 | [4] 12, 898, 011 | 24, 624, 285 | [4] 63, 776, 033 |
| Pig do | 8, 518, 400 | 126, 032, 714 | 14, 353, 197 | 213, 347, 583 |
| Lead (refined),[7] sales value short tons | 255, 337 | 15, 320, 000 | 259, 616 | 19, 212, 000 |
| Manganese ore (35 percent or more Mn) long tons | 17, 777 | 377, 222 | 18, 558 | 452, 173 |
| Manganiferous ore (5 to 35 percent Mn) long tons | 25, 434 | 92, 135 | 191, 631 | 529, 204 |
| Mercury: | | | | |
| Metal flasks (76 pounds net) | 12, 622 | 731, 129 | 9, 402 | 556, 852 |
| Ore short tons | (10) | (11) | (10) | (11) |
| Nickel do | 195 | 88, 515 | 126 | 62, 913 |
| Ores (crude), old tailings, etc.: | | | | |
| Copper do | 12, 319, 000 | (11) | (12) | (11) |
| Copper-lead and copper-lead-zinc do | 167, 000 | (11) | (12) | (11) |
| Dry and siliceous (gold and silver) do | 8, 226, 000 | (11) | (12) | (11) |
| Lead do | 4, 454, 000 | (11) | (12) | (11) |
| Lead-zinc do | 3, 336, 000 | (11) | (12) | (11) |
| Zinc do | 1, 884, 000 | (11) | (12) | (11) |
| Platinum and allied metals (value at New York City) troy ounces | 17, 616 | 592, 000 | 51, 539 | 1, 631, 000 |
| Silver do | 23, 980, 773 | 6, 762, 578 | 23, 002, 629 | 8, 050, 920 |
| Tin (metallic equivalent) short tons | (13) | 220 | 3 | 2, 100 |
| Titanium ore: | | | | |
| Ilmenite do | (6) | (6) | (6) | (6) |
| Rutile do | (6) | (6) | (6) | (6) |
| Tungsten ore (60 percent concentrates) do | 396 | 218, 394 | 895 | 514, 234 |
| Uranium and vanadium ores do | (6) | (6) | 105 | 4, 119 |
| Zinc,[7] sales value do | 207, 148 | 12, 429, 000 | 306, 010 | 25, 705, 000 |
| Total value of metallic products (approximate) | | 283, 700, 000 | | 411, 300, 000 |

[1] In this general statement certain of the figures represent shipments rather than quantity mined, and some of the figures for 1933 are preliminary and subject to revision.
[2] Figures represent antimonial lead produced at primary refineries from both domestic and foreign primary and secondary sources; no figures for value of antimonial lead available. Estimate of value of primary antimony and lead contents of antimonial lead from domestic sources included in total value of metallic products.
[3] All from foreign ore; Bureau of Mines not at liberty to publish value for 1932 and figures for 1933.
[4] Value not included in total value.
[5] Bureau of Mines not at liberty to publish figures. Value for 1932 excluded from metallic total as duplicated in content of antimonial lead; that for 1933 included in total value of metallic products.
[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] Includes $52,842,300, calculated by Bureau of the Mint at legal coinage value ($20.67+ per ounce), plus $12,495,348 premium, calculated by Bureau of Mines at average weighted price ($25.56 per ounce). For details regarding premium on newly mined gold see chapter of this volume on Gold and Silver.
[10] Figures not available.
[11] Figures showing values not available.
[12] Figures for 1933 not yet available.
[13] 1,000 pounds.

*Mineral products of the United States, 1932–33*—Continued

| Product | 1932 | | 1933 | |
|---|---|---|---|---|
| | Quantity | Value | Quantity | Value |
| NONMETALLIC | | | | |
| Arsenious oxide — short tons | 12,483 | $650,902 | 11,797 | $636,132 |
| Asbestos — do | 3,559 | 105,292 | 4,745 | 130,677 |
| Asphalt: | | | | |
| Native — do | 340,019 | 1,942,943 | 313,135 | 1,705,310 |
| Oil (including road oil) [4] — do | 2,308,785 | [4] 14,898,492 | 2,122,458 | [4] 15,946,191 |
| Barite (crude) — do | 129,854 | 745,955 | 167,880 | 852,611 |
| Borates (naturally occurring sodium borates) short tons | 181,915 | 3,023,844 | 188,047 | 3,436,377 |
| Bromine — pounds | 5,727,561 | 1,182,569 | 10,147,960 | 2,040,352 |
| Calcium-magnesium chloride — short tons | 66,286 | 1,163,385 | 57,813 | 893,442 |
| Cement — barrels (376 pounds net) | 81,368,031 | 82,718,197 | [14] 64,086,000 | [14] 83,965,000 |
| Clay: | | | | |
| Products [15] | | 89,024,341 | | ([15]) |
| Raw [4] — short tons | 1,391,816 | [4] 5,201,609 | 1,840,173 | [4] 6,840,617 |
| Coal: | | | | |
| Bituminous [16] — do | 309,709,872 | 406,677,000 | 327,940,000 | 445,998,000 |
| Pennsylvania anthracite — do | 49,855,221 | 222,375,129 | 49,399,000 | 213,400,000 |
| Coke [4] — do | 21,788,730 | [4] 104,336,616 | 27,555,378 | [4] 122,844,027 |
| Diatomite and tripoli [17] — do | 14,775 | 232,700 | 20,878 | 350,383 |
| Emery — do | 250 | 2,781 | 1,056 | 12,283 |
| Feldspar (crude) — long tons | 104,715 | 539,641 | 150,633 | 778,826 |
| Fluorspar — short tons | 25,251 | 392,499 | 72,930 | 1,039,178 |
| Fuller's earth — do | 252,902 | 2,440,736 | 251,158 | 2,315,974 |
| Garnet for abrasive purposes — do | 1,950 | 147,350 | 2,794 | 224,717 |
| Gems and precious stones | | ([18]) | | ([18]) |
| Graphite: Amorphous — short tons | ([19]) | ([19]) | ([19]) | ([19]) |
| Grindstones and pulpstones — do | 7,668 | 247,440 | 14,176 | 444,250 |
| Gypsum — do | 1,416,274 | 12,906,286 | 1,335,192 | 11,927,478 |
| Helium — cubic feet | ([20]) | ([20]) | ([20]) | ([20]) |
| Lime — short tons | 1,959,990 | 12,302,231 | 2,224,000 | 14,006,000 |
| Magnesite (crude) — do | 38,462 | 283,304 | 108,187 | 840,000 |
| Mica: | | | | |
| Scrap — do | 7,040 | 83,777 | 8,751 | 98,159 |
| Sheet — pounds | 338,997 | 45,882 | 364,540 | 53,179 |
| Millstones | | 4,450 | | 8,387 |
| Mineral paints: | | | | |
| Natural pigments [21] — short tons | ([21]) | ([21]) | ([21]) | ([21]) |
| Zinc and lead pigments [22] — do | 92,812 | 9,821,267 | 129,355 | 13,193,627 |
| Mineral waters — gallons sold | ([18]) | ([18]) | ([18]) | ([18]) |
| Natural gas — M cubic feet | 1,555,990,000 | 384,632,000 | 1,480,000,000 | 375,000,000 |
| Natural gasoline — gallons | 1,523,800,000 | 49,244,000 | 1,411,600,000 | 53,640,000 |
| Oilstones, etc — short tons | 331 | 63,960 | 587 | 96,597 |
| Peat — do | ([18]) | ([18]) | ([18]) | ([18]) |
| Petroleum — barrels (42 gallons) | 785,159,000 | 680,460,000 | 898,874,000 | 540,000,000 |
| Phosphate rock — long tons | 1,706,904 | 5,738,493 | 2,490,312 | 7,872,362 |
| Potassium salts — short tons | [23] 55,620 | 2,102,590 | [23] 139,067 | 5,296,793 |
| Pumice — do | 53,214 | 235,204 | 61,220 | 241,834 |
| Pyrites — long tons | [24] 189,703 | [24] 498,570 | 284,311 | 769,942 |
| Salt — short tons | [24] 6,407,973 | [24] 19,938,830 | 7,604,972 | 22,318,086 |
| Sand: | | | | |
| Glass — do | 1,370,255 | 2,266,564 | 1,820,000 | ([25]) |
| Molding, building, etc., and gravel — do | 118,667,642 | 55,255,512 | 102,180,000 | ([25]) |
| Sand-lime brick [15] — thousands | 52,853 | 433,118 | ([15]) | ([15]) |

[4] Value not included in total value.
[14] Figures for 1933 represent portland cement only; estimate of value of natural cements included in total value of nonmetallic products.
[15] Figures obtained through cooperation with Bureau of the Census. Figures for 1933 not yet available; estimate of value included in total value of nonmetallic products.
[16] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.
[17] Figures represent tripoli only. Value of diatomite included in total value of nonmetallic products; Bureau of Mines not at liberty to publish figures.
[18] No canvass. Estimate of value included in total value of nonmetallic products.
[19] Value included in total value of nonmetallic products; Bureau of Mines not at liberty to publish figures.
[20] Value included in total value of nonmetallic products. For details of production in fiscal years see chapter of this volume on Helium.
[21] Canvass discontinued after 1915. Value of iron ore sold for paint included under last item ("Unspecified").
[22] Sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.
[23] Equivalent as $K_2O$.
[24] Revised figures.
[25] Estimate of value included in total value of nonmetallic products.

*Mineral products of the United States, 1932–33*—Continued

| Product | 1932 | | 1933 | |
|---|---|---|---|---|
| | Quantity | Value | Quantity | Value |
| NONMETALLIC—continued | | | | |
| Silica (quartz) short tons | 7,487 | $59,158 | 11,153 | $71,048 |
| Slate do | 284,240 | 3,104,300 | 259,620 | 2,696,185 |
| Stone [26] do | 70,644,310 | 89,063,608 | 76,000,000 | 87,400,000 |
| Sulphur long tons | 1,108,852 | 20,000,000 | 1,637,368 | 29,500,000 |
| Sulphuric acid (60° Baumé) from copper and zinc smelters short tons | 600,334 | 4,028,738 | 656,102 | 4,337,983 |
| Talc and soapstone [27] do | 123,221 | 1,361,633 | 160,554 | 1,681,324 |
| Total value of nonmetallic products (approximate) | | 2,172,000,000 | | 2,076,900,000 |
| SUMMARY | | | | |
| Total value of metallic products | | 283,700,000 | | 411,300,000 |
| Total value of nonmetallic products (exclusive of mineral fuels) | | 428,400,000 | | 448,700,000 |
| Total value of mineral fuels | | 1,743,600,000 | | 1,628,200,000 |
| Total value of "unspecified" (metallic and nonmetallic) products (partly estimated) [28] | | 6,000,000 | | [28] 10,800,000 |
| Grand total approximate value of mineral products | | 2,461,700,000 | | 2,499,000,000 |

[26] Figures include soapstone used as dimension stone; such soapstone in earlier years included under "Talc and soapstone."

[27] Figures represent talc in 1932 and talc and ground soapstone in 1933. Value of ground soapstone in 1932 included in total value of nonmetallic products; Bureau of Mines not at liberty to publish figures. In both years soapstone used as dimension stone included in figures for stone.

[28] Includes for 1933 the value of bismuth, cadmium compounds, chats, flint lining for tube mills and pebbles for grinding ($47,011), iodine, iron ore sold for magnets, iron ore sold for paint ($8,435), lithium minerals ($12,970), new ingot magnesium ($377,181), natural magnesium salts ($1,097,042), calcareous marl ($34,865), greensand marl ($206,985), micaceous minerals ($58,813), molybdenum ($4,316,000), selenium, silica sand and sandstone (finely ground) ($1,106,410), sodium salts (carbonates and sulphates) from natural sources ($1,163,535), tantalum ore ($180), tellurium, and an estimate of the value of miscellaneous mineral products, statistics for which are not collected annually by the Bureau of Mines.

# MINERAL PRODUCTION IN FOREIGN COUNTRIES

By O. E. Kiessling and L. M. Jones

SUMMARY OUTLINE



Nations must go beyond their own boundaries to secure a balanced complement of raw materials, particularly minerals, to meet the needs of what is ordinarily thought of as modern industrialism. The same incentives followed in the pre-Christian era by the Phoenician metal merchants in searching for metals throughout the known world from Britain to India [1] and by the Romans in Italy, Spain, and Britain [2] still exist. Present-day demands are, however, more insistent than those of antiquity for a "mineral civilization" as an essential requirement for a nation maintaining status as a world power. After measurement of the great sources of world mineral supplies, Furness found that they were too few and irregularly distributed to give each nation its desired quota.[3] This fact raises problems that cut across tariffs, export regulations, governmental subventions, domestic mineral policy, economic nationalism, international agreements,[4] and national defense,[5] and students of politics and economics as well as observers in the mineral industry show a constant interest in accurate and reliable statistics of world mineral production and movement.

*Development of foreign mineral statistical service.*—The impetus for more adequate information on foreign mineral exploitation and production was largely an outgrowth of lessons taught by the war period. Prior to 1914 much of the foreign mineral data used in publications of the Federal Government was drawn from domestic commercial compilations and from official published statements of foreign nations, principally those of Great Britain. When the World War broke out, information from both of these sources was drastically curtailed, and the Government found itself with inadequate records on foreign minerals just when such information was of vital importance. Moreover, as the war drew to a close it became increasingly clear that the post-war international commercial competition would be keen, that American producers required more adequate information on minerals in order to maintain their competitive position in world markets,

[1] Rickard, T. A., Man and Metals; vol. 1, 1932, pp. 232–287.
[2] Work cited, pp. 454–503.
[3] Furness, J. W., Jones, L. M., and Blumenthal, F. H., Mineral Raw Materials: Bureau of Foreign and Domestic Commerce Trade Promotion Series 76, 1929, pp. 1–8.
[4] Rawles, William P., Provision for Minerals in International Agreements: Political Sci. Quart., vol. 48, no. 4, December 1933, pp. 513–533.
[5] The Mineral Inquiry (C. K. Leith, Chairman), Elements of a National Mineral Policy: New York, 1925, pp. 4–22.

and that control of adequate supplies of basic mineral raw materials was one of the strongest undercurrents in world diplomacy, as shown by the post-war partition of territory and allocation of mandates.

In 1917 a small staff in the Mineral Resources Division, United States Geological Survey (now the Mineral Statistics Division, U.S. Bureau of Mines), was assigned to develop detailed studies of foreign mineral production and resources, and this service has continued and expanded to the present. As originally envisaged the work covered the study of foreign mineral production, stocks, and consumption; actual and potential reserves, with special reference to coal, iron, and petroleum; labor; transportation facilities; methods of mining, milling, smelting, and refining of metals in relation to output; and problems arising from the commercial and political control of mineral deposits. Although lack of sufficient funds has prevented completion of the original program, certain phases of the work have provided the Government with a reliable and regular statistical service on foreign minerals and produced other interesting results that have been incorporated in the various annual chapters on minerals published in Mineral Resources of the United States and in the Minerals Yearbook.

As an aid to research, the Bureau of Mines maintains a current bibliographical service on all phases of the foreign mineral industry. The bibliographical material is collected weekly from all books and from about 160 foreign and domestic periodicals received in the libraries of the Bureau of Mines and Geological Survey as well as from the manuscript reports made by the American diplomatic and consular services. The references are arranged in two permanent bibliographical files—one classifies the material alphabetically under countries, while the second gives references in chronological order of publication under specific minerals without regard to geographic distribution. In addition to reference data, a file of consular reports—available only in manuscript form—is maintained. The Bureau's specialists almost daily have occasion to refer to this bibliography, but it is also available for use by the general public. As lack of printing funds does not permit publication of the reference cards, the bibliography must be consulted at Washington, and mineral producers have frequently requested copies of all reference cards on a subject of special interest, all work being done at their own expense.

*Collection of data from original sources.*—The canvass for data on foreign mineral production is made annually by means of specially prepared questionnaires, which conform in language and statistical form to the mineral data issued by the respective countries to which they are addressed. This canvass was inaugurated in 1919 under agreements with the various foreign governments, negotiated through the American Diplomatic Service. In some instances the questionnaire is sent directly to the foreign government; in others, by arrangement, it is presented through the medium of the Diplomatic or Consular Service. By this method early returns are obtained; these are followed later by an exchange of preliminary and final annual mineral reports issued by the various foreign governments.

*Two methods of presenting foreign statistics.*—As the market for many minerals is world-wide the chief current interest of domestic producers in world production data is in the need for constant study of world supply, demand, and price for a given mineral. Another consideration of considerable importance, however, is the fact that for certain minerals, such as tin and nickel, industry in the United States depends almost completely on foreign sources, as domestic production is either negligible or nonexistent. Most observers find inclusion of the world production figures in the commodity discussions necessary to complete perspective and understanding, and this arrangement of data is followed in the Minerals Yearbook.

There are instances, on the other hand, when it is of interest to determine the variety and aggregate quantity of minerals produced in a certain country. To meet the needs of the occasional student interested in this aspect, every half decade the Bureau prepares such summary tables covering the past 5 years, which are then published as a separate chapter in the annual volume. The latest available report of this kind summarized data for the years 1924 to 1929, inclusive.[6] Sharply limited printing funds do not permit publication of yearly recapitulation tables, but to assist those who may wish to carry forward some of the compilations given in the 5-year summary, the following list of the principal tables on world production presented in this volume, with the page numbers, will serve as a convenient reference.



In most chapters the basic statistical tables on foreign production occupy only a small portion of the space devoted to discussion of mineral development abroad, as they are usually supplemented by text and often by additional detailed compilations. For a few minerals the publication of annual world production tables is not necessary, and authors present all current available information in the text.

So far as possible, the mineral products covered in the tables have been restricted to the primary form in which the mineral first comes on the market. Where no actual production data are available for some countries, the exports of mineral products are used to indicate the mineral possibilities of the country. The quantities given in the tables are in metric units, the figures as reported having been converted by the use of the factors listed on page 860, Mineral Resources of the United States, 1930, part I.

*Foreign mineral commerce.*—The compilations on world output in the separate chapters are supplemented by special tables on the import and export trade of foreign nations whenever this information is essential to the author's argument. Moreover, complete statistics on the foreign trade of the United States in individual minerals, compiled from the records of the Bureau of Foreign and Domestic Com-

[6] Jones, L. M., Mineral Production of the World, 1924–29: Mineral Resources of the United States, 1930, pt. I, Bureau of Mines, pp. 859–962.

merce, will be found in the volume. These figures cover all shipments across the borders of the country, regardless of method of shipment, and are familiar to most students of mining economics.

Another type of analysis of our foreign trade in minerals, not so well known to those in the industry, consists of the Government's compilations of water-borne mineral imports and exports (excluding coastwise shipping). These figures are not strictly comparable to those of the Bureau of Foreign and Domestic Commerce, as they are compiled on a somewhat different basis for the greatest usefulness to shipping companies; in summary form, however, they convey a good idea of the total tonnage of minerals either entering our ports from overseas or shipped to overseas destinations in a given year. Through the courtesy of the Division of Shipping Research, United States Shipping Board Bureau, the following tables summarizing this overseas movement of minerals for the fiscal year 1932–33 are published for the first time.

## METALS

*Imports of metallic minerals (excluding manufactures) in fiscal year ended June 30, 1933, by commodities and trade districts*

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Steel and iron | 11,611 | | | 564 | | 12,175 |
| Iron | 788 | 166 | 114 | 1,816 | | 2,884 |
| Iron ore | 275,402 | | 1,602 | 7,873 | 20 | 284,897 |
| Ilmenite | 11,794 | | 21,020 | | | 32,814 |
| Pig iron | 111,484 | | 304 | 1,846 | 1,630 | 115,264 |
| Iron and steel scrap | 126 | | | | 9,117 | 9,243 |
| Tin-plate scrap | | | | 784 | | 784 |
| Steel | 41,970 | 531 | 9,647 | 6,852 | | 59,000 |
| Steel balls | 71 | | | 26 | | 97 |
| Steel bars | 642 | 61 | 464 | 7,574 | | 8,741 |
| Iron bars | 131 | | 47 | 2,795 | | 2,973 |
| Ferrosilicon | 9 | | | | | 9 |
| Ferro-alloying metals | 414 | | | | | 414 |
| Manganese | 54,569 | | 2,147 | 150 | | 56,866 |
| Manganese silicon | 212 | | | 250 | | 462 |
| Ferromanganese | 3,626 | | 1,825 | 62 | | 5,513 |
| Spiegeleisen | 560 | | 1,570 | 658 | 113 | 2,901 |
| Ferrochrome | 12 | | | | | 12 |
| Chrome | 79,462 | | | | | 79,462 |
| Zirconium | 247 | | | | | 247 |
| Wolfram ore | 87 | | | | | 87 |
| Ferrophosphorus | 91 | | | | | 91 |
| Titanium | 10 | | | | | 10 |
| Aluminum | 1,379 | | | | 45 | 1,424 |
| Bauxite | 36,433 | | 110,479 | | | 146,912 |
| Antimony | 1,220 | | | 215 | | 1,435 |
| Antimony regulus | 371 | | | | | 371 |
| Cobalt | 25 | | | 105 | | 130 |
| Copper | 27 | | | | | 27 |
| Copper concentrates | 24,219 | | | 5,283 | | 29,502 |
| Copper ore | 16,920 | | | 20,939 | | 37,859 |
| Copper matte | 218 | | | | | 218 |
| Copper slag | 19 | | | | | 19 |
| Copper-silver ore | 164 | | | 2,452 | | 2,616 |
| Copper-gold ore | 1,131 | | | 481 | | 1,612 |
| Copper blister | 447 | | | 9,440 | | 9,887 |
| Copper ingots | 1,001 | | | | | 1,001 |
| Copper bars | 44,299 | | | 470 | | 44,769 |
| Copper bullion | 4,965 | | | 4 | | 4,969 |
| Copper scrap | 37 | | | | | 37 |
| Brass | 280 | | | 123 | | 403 |
| Brass scrap | 12 | | | 22 | | 34 |
| Lead ingots | 16 | | | | | 16 |
| Lead pigs and bars | 1,312 | | | 274 | | 1,586 |
| Lead concentrates | | | | 24,809 | | 24,809 |
| Lead-silver concentrates | | | | 535 | | 535 |
| Lead ore | | | | 466 | | 466 |

*Imports of metallic minerals (excluding manufactures) in fiscal year ended June 30, 1933, by commodities and trade districts*—Continued

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Quicksilver | 637 | | | | | 637 |
| Nickel ore | 309 | | | | | 309 |
| Nickel bars | 100 | | | | | 100 |
| Gold | | | | 2 | | 2 |
| Gold bullion | 5 | | | | | 5 |
| Gold bars | 1 | | | 3 | | 4 |
| Gold concentrates | 3,289 | | | 14,052 | | 17,341 |
| Gold and silver ore | 1,929 | | | 41,599 | | 43,528 |
| Silver ore | 4 | | | 83 | | 87 |
| Silver concentrates | 16 | | | 693 | | 709 |
| Silver bars | 845 | | | 435 | | 1,280 |
| Silver bullion | 17 | | | 10 | | 27 |
| Tin | 430 | | | | | 430 |
| Tin bars | 33,199 | | | 1,647 | | 34,846 |
| Tin ingots | 5,886 | | | | | 5,886 |
| Tin scrap | | | | 496 | | 496 |
| Zinc | 634 | | | 38 | | 672 |
| Zinc ore and concentrates | | | 9,115 | | | 9,115 |
| Metals and alloys, n.e.s. | 466 | | | 9 | | 475 |
| Metal scrap | 265 | | | 11 | 800 | 1,076 |
| Miscellaneous ores | 1 | | | 11 | | 12 |
| Total | 775,846 | 758 | 158,334 | 155,957 | 11,725 | 1,102,620 |

*Exports of metallic minerals (excluding manufactures) in fiscal year ended June 30, 1933, by commodities and trade districts*

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Steel and iron | 509 | | | | | 509 |
| Iron | 284 | | 25 | 1,850 | | 2,159 |
| Iron ore | 35 | | | | 61,091 | 61,126 |
| Pig iron | 1,143 | | 196 | 156 | | 1,495 |
| Iron and steel scrap | 240,071 | 25,223 | 74,221 | 62,255 | 22,818 | 424,588 |
| Tin-plate scrap | 3,434 | | | 1,329 | | 4,763 |
| Steel | 17,156 | | 199 | 1,827 | 3,348 | 22,530 |
| Steel balls | 174 | | | 10 | | 184 |
| Steel ingots | 25 | | | | | 25 |
| Steel billets | 98 | | | | 126 | 224 |
| Steel bars | 3,812 | 206 | 2,117 | 559 | | 6,694 |
| Iron bars | 348 | | 198 | | | 546 |
| Ferrosilicon | 177 | | | | | 177 |
| Ferro-alloying metals | 181 | | | | | 181 |
| Manganese | 564 | | | 80 | | 644 |
| Ferromanganese | 2 | | | | | 2 |
| Ferrochrome | 6 | | | | | 6 |
| Chrome | 34 | | | | | 34 |
| Tungsten | 152 | | | | | 152 |
| Ferrotungsten | 100 | | | | | 100 |
| Vanadium | 2 | | | | | 2 |
| Wolfram ore | 32 | | | 13 | | 45 |
| Molybdenum | 957 | | 1,398 | 206 | | 2,561 |
| Titanium | 28 | | | | | 28 |
| Aluminum | 137 | | 4 | 29 | | 170 |
| Bauxite | | | 715 | | | 715 |
| Aluminum scrap | 808 | | 5 | 512 | | 1,325 |
| Aluminum bars | 27 | | | | | 27 |
| Aluminum ingots | 402 | | | 50 | | 452 |
| Antimony | 10 | | | | | 10 |
| Copper | 36,831 | | | 352 | | 37,183 |
| Copper concentrates | 52 | | | 16 | | 68 |
| Copper ore | 48 | | | 7 | | 55 |
| Copper matte | 531 | | 51 | | | 582 |
| Copper blister | | | | 1,663 | | 1,663 |
| Copper ingots | 2,775 | | 1,995 | 4,432 | | 9,202 |
| Copper bars | 35,558 | | 1,409 | 29,963 | | 66,930 |
| Copper bullion | | | | 4,735 | | 4,735 |
| Copper scrap | 4,697 | 137 | 1,268 | 1,303 | | 7,405 |
| Brass | 1,732 | | 123 | 358 | | 2,213 |

*Exports of metallic minerals (excluding manufactures) in fiscal year ended June 30, 1933, by commodities and trade districts*—Continued

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Brass scrap | 6,868 | 63 | 696 | 2,231 | | 9,858 |
| Lead ingots | 5 | | | | | 5 |
| Lead pigs and bars | 410 | | 23,333 | 22,899 | | 46,642 |
| Lead concentrates | | | | 56 | | 56 |
| Quicksilver | 19 | | 6 | | | 25 |
| Nickel ore | 16 | | | | | 16 |
| Nickel bars | 734 | | | | | 734 |
| Silver bars | 95 | | | | | 95 |
| Tin | 22 | | | | | 22 |
| Tin bars | 2,815 | | 3 | 39 | | 2,857 |
| Tin ingots | 6 | | | | | 6 |
| Tin scrap | 415 | | | 6,051 | | 6,466 |
| Zinc | 324 | | 22,863 | 182 | | 23,369 |
| Zinc dross | 677 | | 1 | 26 | | 704 |
| Zinc ore and concentrates | | | 368 | 110 | | 478 |
| Zinc scrap | 115 | | | 143 | | 258 |
| Babbitt metal | 141 | | 2 | | | 143 |
| Monel metal | 52 | | | | | 52 |
| Metals and alloys, n.e.s | 1,974 | | | 4 | | 1,978 |
| Magnesium | 26 | | | | | 26 |
| Bismuth | 75 | | | | | 75 |
| Metal scrap | 8,712 | 11 | 258 | 102 | | 9,083 |
| Miscellaneous ores | | | 14 | | | 14 |
| Total | 376,433 | 25,640 | 131,468 | 143,548 | 87,383 | 764,472 |

## NONMETALS

*Imports of nonmetallic minerals in fiscal year ended June 30, 1933, by commodities and trade districts*

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Arsenious oxide | 1,718 | | 329 | 465 | | 2,512 |
| Asbestos: | | | | | | |
| Asbestos | 2,984 | | | | 2,949 | 5,933 |
| Asbestos waste | 36 | | | | 4,288 | 4,324 |
| Total, asbestos | 3,020 | | | | 7,237 | 10,257 |
| Asphalt | 10,628 | | 4,303 | 78 | 108 | 15,117 |
| Asphalt oil | 10 | | | | | 10 |
| Barite (crude) | 34,843 | 9 | 5 | | | 34,857 |
| Borates | | | | 1 | | 1 |
| Calcium-magnesium chloride | 38 | | | | | 38 |
| Cement | 44,967 | 210 | 51 | 3,073 | | 48,301 |
| Clay products: | | | | | | |
| Porcelain | 17,562 | | 2 | 10,832 | | 28,396 |
| Terra cotta | 3 | | | | | 3 |
| Stoneware | 8 | | | 14 | | 22 |
| Earthenware | 9,040 | 1 | 173 | 2,495 | 1 | 11,710 |
| Sanitary ware | 8 | | | | | 8 |
| Crockery ware | 7,630 | 1 | 179 | 242 | 5 | 8,057 |
| Brick | 12 | | | 16 | | 28 |
| Bath brick | 11 | | 1 | | | 12 |
| Fire-clay bricks and shapes | 37 | | | 337 | | 374 |
| Tiles | 553 | 164 | 241 | 94 | | 1,052 |
| Roofing tiles | | | | 27 | | 27 |
| Paving tiles | | | 4 | | | 4 |
| Crucibles | 2 | | | | | 2 |
| Clay products, n.e.s | 309 | | | 38 | | 347 |
| Total, clay products | 35,175 | 166 | 600 | 14,095 | 6 | 50,042 |

*Imports of nonmetallic minerals in fiscal year ended June 30, 1933, by commodities and trade districts*—Continued

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Clay, raw: | | | | | | |
| Clays | 10,233 | 99 | 1,062 | 474 | | 11,868 |
| Blue clay | 55 | | | | | 55 |
| Kaolin | 93,891 | 87 | 57 | 3,281 | 2,476 | 99,792 |
| Fire clay | 708 | | | 35 | | 743 |
| Ball clay | 458 | | | 474 | 355 | 1,287 |
| Total clay, raw | 105,345 | 186 | 1,119 | 4,264 | 2,831 | 113,745 |
| Coal: | | | | | | |
| Anthracite | 447,936 | | | 1,285 | | 449,221 |
| Bituminous | | | | 11,397 | | 11,397 |
| Montan wax | 1,924 | | | | | 1,924 |
| Briquets | 65,618 | | | | | 65,618 |
| Other | 3,799 | | | 848 | 1 | 4,648 |
| Total, coal | 519,277 | | | 13,530 | 1 | 532,808 |
| Coke | 100,203 | | | 19,880 | | 120,083 |
| Diatomite and tripoli: | | | | | | |
| Diatomite | 675 | | | | | 675 |
| Tripoli | 4 | | | | | 4 |
| Total, diatomite and tripoli | 679 | | | | | 679 |
| Emery and corundum: | | | | | | |
| Emery | 628 | | | | | 628 |
| Corundum | 544 | | | | | 544 |
| Borocarbone | 199 | | | | | 199 |
| Total, emery and corundum | 1,371 | | | | | 1,371 |
| Feldspar | | | | | 306 | 306 |
| Fluorspar | 6,684 | | | 180 | | 6,864 |
| Fuller's earth | 1,562 | | 905 | 206 | 280 | 2,953 |
| Graphite | 2,402 | | | 221 | | 2,623 |
| Grindstones and pulpstones: | | | | | | |
| Grindstones | 190 | | 1 | | | 191 |
| Whetstones | 104 | | | 9 | | 113 |
| Silver sand | 6,754 | | | 16,359 | | 23,113 |
| Total, grindstones and pulpstones | 7,048 | | 1 | 16,368 | | 23,417 |
| Gypsum | 298,003 | | | 11,286 | | 309,289 |
| Lime: | | | | | | |
| Quicklime | | | | 6,231 | | 6,231 |
| Lime hydrated | 15 | | | 1,275 | | 1,290 |
| Total, lime | 15 | | | 7,506 | | 7,521 |
| Magnesite (crude) | 5,840 | | | | | 5,840 |
| Mica | 455 | | | | | 455 |
| Mineral paints, natural pigments: | | | | | | |
| Mineral earth pigments | 2,462 | | 53 | 80 | | 2,595 |
| Sienna | 341 | | 24 | | | 365 |
| Iron oxide | 2,546 | | 187 | 113 | 22 | 2,868 |
| Umber | 431 | | 20 | 38 | | 489 |
| Whiting | 632 | | | 160 | | 792 |
| Ocher | 2,921 | | 294 | 69 | | 3,284 |
| Total, mineral paints, natural pigments | 9,333 | | 578 | 460 | 22 | 10,393 |

*Imports of nonmetallic minerals in fiscal year ended June 30, 1933, by commodities and trade districts*—Continued

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Mineral paints, zinc and lead pigments: | | | | | | |
| Putty | 5 | | 33 | | | 38 |
| Zinc oxide | 631 | | | | | 631 |
| Red lead | 1 | | | 13 | | 14 |
| Litharge | 46 | | | | | 46 |
| White lead | 15 | | | 22 | | 37 |
| Total, mineral paints, zinc and lead pigments | 698 | | 33 | 35 | | 766 |
| Mineral waters | 6,879 | 1 | 74 | 163 | | 7,117 |
| Gasoline | 9,001 | 2 | 10,560 | | 16,909 | 36,472 |
| Petroleum and petroleum products: | | | | | | |
| Crude oil | 3,938,079 | 60,815 | 62,041 | 10 | | 4,060,945 |
| Petroleum products | 391 | | | | | 391 |
| Kerosene | 7,799 | | | | | 7,799 |
| Benzine | 1 | | | | | 1 |
| Naphtha | 36,542 | | | | 12,585 | 49,127 |
| Distillate | | | | | 4,134 | 4,134 |
| Fuel oil | 1,909,695 | 66,879 | | | 12,772 | 1,989,346 |
| Gas oil | 5,124 | | | | | 5,124 |
| Lubricating oils | 3,177 | 1 | 195 | 271 | | 3,644 |
| Paraffin oil | 540 | | 15 | 19 | | 574 |
| Lubricating grease | 14 | | | | | 14 |
| Paraffin wax | 3,747 | | 2 | 260 | | 4,009 |
| Paraffin scale wax | 2,277 | | | 5,466 | | 7,743 |
| Total, petroleum and petroleum products | 5,907,386 | 127,695 | 62,253 | 6,026 | 29,491 | 6,132,851 |
| Phosphate rock | 8,700 | | | | | 8,700 |
| Potassium salts: | | | | | | |
| Chloride of potash | 45,254 | 7,015 | 3,825 | 1,950 | 5,150 | 63,194 |
| Sylvinite of potash | 13,700 | 24,770 | 1,284 | | | 39,754 |
| Sulphate of potash | 13,184 | 11,069 | 1,537 | 3,535 | | 29,325 |
| Kainite | 24,819 | 23,269 | 3,909 | | | 51,997 |
| Manure salts | 27,713 | 11,428 | 3,316 | 107 | | 42,564 |
| Total, potassium salts | 124,670 | 77,551 | 13,871 | 5,592 | 5,150 | 226,834 |
| Pumice: | | | | | | |
| Pumice stone | 3,290 | | | | | 3,290 |
| Ground pumice | 3,020 | | | 2 | | 3,022 |
| Total, pumice | 6,310 | | | 2 | | 6,312 |
| Pyrites | 223,696 | 4,008 | | 1,670 | | 229,374 |
| Salt: | | | | | | |
| Crude | 15,944 | 908 | 290 | 458 | | 17,600 |
| Refined | 1,674 | | 50 | 15 | | 1,739 |
| Rock | 1,701 | | | | | 1,701 |
| Total, salt | 19,319 | 908 | 340 | 473 | | 21,040 |
| Sand and gravel: | | | | | | |
| Sand | 42 | | | 271 | 96,149 | 96,462 |
| Gravel | 2 | | | 5,048 | 17,570 | 22,620 |
| Total, sand and gravel | 44 | | | 5,319 | 113,719 | 119,082 |
| Quartz and silica: | | | | | | |
| Silica | 45 | | | 100 | | 145 |
| Flint | 1,727 | | 213 | 71 | 1,427 | 3,438 |
| Quartzite | 10 | | | | 41,200 | 41,210 |
| Total, quartz and silica | 1,782 | | 213 | 171 | 42,627 | 44,793 |
| Slate: | | | | | | |
| Roofing slate | 60 | | | | | 60 |
| Manufactures of slate | | | 15 | 14 | | 29 |
| Other | 7 | | 20 | 14 | | 41 |
| Total, slate | 67 | | 35 | 28 | | 130 |

*Imports of nonmetallic minerals in fiscal year ended June 30, 1933, by commodities and trade districts*—Continued

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Stone: | | | | | | |
| Marble | 5,972 | | 1,191 | 151 | | 7,314 |
| Marble waste | 1,487 | | 20 | | | 1,507 |
| Onyx | 53 | | | 26 | | 79 |
| Granite | 2,799 | | 35 | 242 | | 3,076 |
| Marble chips | 6,194 | | 141 | | | 6,335 |
| Marble slabs | 987 | | | | | 987 |
| Sandstone | 12 | | | | | 12 |
| Crushed stone | 10 | | | | | 10 |
| Cleft stone | 470 | | | | | 470 |
| Marble manufactures | 1,197 | | 33 | 1 | | 1,231 |
| Limestone | 20 | | 18 | 30 | | 68 |
| Manufactures of stone, n.e.s. | 44 | | | | | 44 |
| Other | 2,095 | | 64 | 31 | | 2,190 |
| Total stone | 21,340 | | 1,502 | 481 | | 23,323 |
| Sulphur | 70 | | | 1,097 | | 1,167 |
| Sulphuric acid | 64 | | | | | 64 |
| Talc and soapstone: | | | | | | |
| Talc | 8,909 | 1,017 | 1,490 | 306 | 776 | 12,498 |
| Soapstone ware | 4 | | | | | 4 |
| Total talc and soapstone | 8,913 | 1,017 | 1,490 | 306 | 776 | 12,502 |
| Othe nonmetallic minerals, n.e.s. | 145 | 94 | | 18 | | 257 |
| Grand total | 7,527,700 | 211,847 | 98,262 | 112,994 | 219,463 | 8,170,266 |

*Exports of nonmetallic minerals in fiscal year ended June 30, 1933, by commodities and trade districts*

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Arsenious oxide | 612 | | 55 | 1,167 | | 1,834 |
| Asbestos: | | | | | | |
| Asbestos | 5,030 | | 29 | 121 | | 5,180 |
| Asbestos waste | 291 | | | | | 291 |
| Asbestos cement | 29 | | | | | 29 |
| Asbestos shingles | 51 | | 38 | | | 89 |
| Asbestos roofing | 785 | | 171 | 39 | | 995 |
| Manufactures of asbestos, n.e.s. | 260 | | 9 | | | 269 |
| Total asbestos | 6,446 | | 247 | 160 | | 6,853 |
| Asphalt and bitumen: | | | | | | |
| Asphalt | 44,655 | 58 | 57,506 | 61,710 | | 163,929 |
| Bitumen | 334 | | 5,343 | 1,796 | | 7,473 |
| Total asphalt and bitumen | 44,989 | 58 | 62,849 | 63,506 | | 171,402 |
| Barite (crude) | 512 | | 2,312 | | 18 | 2,842 |
| Borates (borax) | 15 | | 32 | 71,274 | | 71,321 |
| Calcium-magnesium chloride | 10 | | | | | 10 |
| Cement | 19,585 | 125 | 20,573 | 47,228 | | 87,511 |
| Clay products: | | | | | | |
| Porcelain | 41 | | | 5 | | 46 |
| Earthenware | 74 | | | | | 74 |
| Sanitary ware | 267 | | | | | 267 |
| Sewer pipe | 55 | | | | | 55 |
| Crockery ware | 48 | | 1 | 15 | | 64 |
| Brick | 296 | 10 | 129 | 9 | | 444 |
| Fire-clay bricks and shapes | 1,560 | 13 | 3,820 | 653 | 254 | 6,300 |

*Exports of nonmetallic minerals in fiscal year ended June 30, 1933, by commodities and trade districts*—Continued

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Clay products—Continued. | | | | | | |
| Tiles | 453 | 66 | 12 | 56 | | 587 |
| Roofing tiles | | | 718 | 36 | | 754 |
| Paving tiles | 7 | | 12 | 12 | | 31 |
| Clay pipe | 1,581 | | 32 | 28 | | 1,641 |
| Crucibles | 23 | | | | | 23 |
| Clay products, n.e.s. | 374 | | | 58 | | 432 |
| Total clay products | 4,779 | 89 | 4,724 | 872 | 254 | 10,718 |
| Clay, raw: | | | | | | |
| Clays | 5,639 | 3,660 | 583 | 1,962 | | 11,844 |
| Kaolin | 70 | | | 51 | | 121 |
| Fire clay | 1,609 | 193 | 485 | 205 | 56 | 2,548 |
| Total raw clay | 7,318 | 3,853 | 1,068 | 2,218 | 56 | 14,513 |
| Coal: | | | | | | |
| Anthracite | 47,059 | | | | 50,222 | 97,281 |
| Bituminous | 315,749 | 18,086 | 5,939 | 6,579 | 4,911,449 | 5,257,802 |
| Montan wax | 5 | | | | | 5 |
| Other | 17,824 | 36 | 10,759 | 316 | 1,800 | 30,735 |
| Total coal | 380,637 | 18,122 | 16,698 | 6,895 | 4,963,471 | 5,385,823 |
| Coke | 2,613 | | 122,698 | 28 | 346,229 | 471,568 |
| Diatomite and tripoli: | | | | | | |
| Diatomite | 85 | | 255 | 6,910 | | 7,250 |
| Tripoli | | | 2,346 | | | 2,346 |
| Total diatomite and tripoli | 85 | | 2,601 | 6,910 | | 9,596 |
| Emery and alundum: | | | | | | |
| Emery wheels | 5 | | | | | 5 |
| Alundum | 1,278 | | | | | 1,278 |
| Total emery and alundum | 1,283 | | | | | 1,283 |
| Feldspar (crude) | 254 | 9 | | | | 263 |
| Fluorspar | 40 | | | | 500 | 540 |
| Fuller's earth | 804 | 1,034 | 808 | 45 | | 2,691 |
| Graphite | 95 | | | | | 95 |
| Grindstones and pulpstones: | | | | | | |
| Grindstones | 37 | | 1 | 101 | | 139 |
| Whetstones | 114 | | 23 | | | 137 |
| Silver sand | 10 | | | | | 10 |
| Total grindstones and pulpstones | 161 | | 24 | 101 | | 286 |
| Gypsum | 2,338 | | | 1,000 | | 3,338 |
| Lime: | | | | | | |
| Quicklime | 278 | | | 616 | | 894 |
| Lime, hydrated | 445 | | | 216 | | 661 |
| Total lime | 723 | | | 832 | | 1,555 |
| Magnesite | | | | 25 | | 25 |
| Mica | 371 | | | | | 371 |
| Mineral paints and natural pigments: | | | | | | |
| Mineral earth pigments | 250 | | 80 | | | 330 |
| Iron oxide | 38 | | | | | 38 |
| Whiting | 128 | | | | | 128 |
| Ocher | 1,484 | 23 | | 205 | | 1,712 |
| Total mineral paints and natural pigments | 1,900 | 23 | 80 | 205 | | 2,208 |
| Mineral paints, zinc and lead pigments: | | | | | | |
| Putty | 16 | | 22 | | | 38 |
| Zinc oxide | 387 | | 306 | 5 | | 698 |
| Red lead | 79 | | 23 | | | 102 |
| Litharge | 12 | | | | | 12 |
| White lead | 547 | | | 79 | | 626 |
| Total mineral paints, zinc and lead pigments | 1,041 | | 351 | 84 | | 1,476 |
| Mineral waters | 64 | | 13 | 27 | | 104 |
| Gasoline | 528,004 | 1,518 | 1,102,995 | 1,185,535 | 38,430 | 2,856,482 |

*Exports of nonmetallic minerals in fiscal year ended June 30, 1933, by commodities and trade districts*—Continued

[In cargo tons of 2,240 pounds]

| Commodity | North Atlantic district | South Atlantic district | Gulf district | Pacific district | Great Lakes district | Total, all districts |
|---|---|---|---|---|---|---|
| Petroleum and petroleum products: | | | | | | |
| Crude oil | 10,356 | | 1,483,491 | 1,376,366 | 79,633 | 2,949,846 |
| Case oil | 40 | | 950 | | | 990 |
| Petroleum products | 2,082 | 87 | 66 | 2,326 | | 4,561 |
| Flotation oil | 100 | | | 7 | | 107 |
| Kerosene | 145,115 | 470 | 566,445 | 556,869 | 72 | 1,268,971 |
| Benzine | 7,986 | | | | | 7,986 |
| Butane | 21 | | 6,380 | | | 6,401 |
| Propane | | | 100 | | | 100 |
| Pyrofax | 901 | | | | | 901 |
| Naphtha | 68,848 | | 115,576 | 18 | | 184,442 |
| Distillate | 11 | | 789 | 3,880 | | 4,680 |
| Fuel oil | 21,324 | 41 | 224,852 | 924,197 | 3 | 1,170,417 |
| Gas oil | 18,009 | | 402,819 | 14,890 | | 435,718 |
| Diesel oil | 2,385 | | 75,645 | 518,208 | | 596,238 |
| Transformer oil | 1,267 | | | | | 1,267 |
| Lubricating oils | 595,238 | 3,117 | 324,695 | 63,171 | | 986,221 |
| Paraffin oil | 84 | | 328 | | | 412 |
| Lubricating grease | 17,664 | 119 | 5,502 | 993 | | 24,278 |
| Paraffin wax | 40,272 | | 21,298 | 2,305 | | 63,875 |
| Total petroleum and petroleum products | 931,703 | 3,834 | 3,228,936 | 3,463,230 | 79,708 | 7,707,411 |
| Phosphate rock | 45 | 30,705 | 556,811 | | | 587,561 |
| Potassium salts: | | | | | | |
| Chloride of potash | 2,632 | | 198 | 12,934 | | 15,764 |
| Sulphate of potash | | | 90 | | | 90 |
| Manure salts | 37 | | | | | 37 |
| Total potassium salts | 2,669 | | 288 | 12,934 | | 15,891 |
| Salt: | | | | | | |
| Crude | | | 108 | 6,674 | | 6,782 |
| Refined | 105 | | 11,839 | 18,355 | | 30,299 |
| Rock | | | | 32 | 3,442 | 3,474 |
| Total salt | 105 | | 11,947 | 25,061 | 3,442 | 40,555 |
| Sand and gravel: | | | | | | |
| Sand | 2,665 | | | 346 | 11,090 | 14,101 |
| Gravel | 151 | | 418 | | | 569 |
| Total sand and gravel | 2,816 | | 418 | 346 | 11,090 | 14,670 |
| Silica | 183 | | 5 | 179 | | 367 |
| Silica bricks | | | | 9 | | 9 |
| Slate: | | | | | | |
| Slate | 133 | | 35 | | | 168 |
| Slate, manufactures | 60 | | 1 | | | 61 |
| Total slate | 193 | | 36 | | | 229 |
| Stone: | | | | | | |
| Marble | 130 | 270 | 47 | 65 | | 512 |
| Onyx | 18 | | | 31 | | 49 |
| Granite | | | 60 | | | 60 |
| Marble chips | 5 | | | | | 5 |
| Marble slabs | 15 | | | | | 15 |
| Limestone | | | | | 4,498 | 4,498 |
| Lithographic stone | 98 | | | | | 98 |
| Other | 2,148 | | 5 | 26 | | 2,179 |
| Total stone | 2,414 | 270 | 112 | 122 | 4,498 | 7,416 |
| Sulphur | 1,452 | | 337,642 | 889 | 1,423 | 341,406 |
| Sulphuric acid | 596 | | 497 | 27 | | 1,120 |
| Talc | 932 | | | 194 | | 1,126 |
| Other nonmetallic minerals, n.e.s. | 929 | | 15 | 430 | | 1,374 |
| Grand total | 1,948,716 | 59,640 | 5,474,835 | 4,891,533 | 5,449,119 | 17,823,843 |

# PART II. METALS

## GOLD AND SILVER

By Chas. W. Henderson

SUMMARY OUTLINE



## GOLD

*United States suspends gold standard.*—On April 19, 1933, closely following the bank holiday, March 6–13, for the second [1] time in its history the United States was off the gold standard. Although Great Britain, followed by many other countries,[2] was off the gold standard in September 1931 and gold was sold in London above the old par of 85 shillings per fine ounce, there would have been no immediate or, at that time, anticipated profit to United States gold producers had they sold abroad before April 19. The following table shows that the exchange value in New York on London averaged monthly under the United States statutory price of gold per fine ounce, \$20.67+, until April.

[1] From shortly after the outbreak of the Civil War to Jan. 1, 1879, specie payment was suspended, and gold was at a premium.

[2] Countries remaining on the gold standard throughout 1933 were France, Italy, Belgium, Holland, and Switzerland. Germany, with reserves of about 8 percent gold ,remained nominally on the gold standard.

*London gold quotations, average by months, 1933, per fine ounce*

| | Average [1] | | Average in pounds | Average monthly exchange, New York on London [2] | Dollars per fine ounce |
|---|---|---|---|---|---|
| | *S.* | *d.* | | *Dollars per £* | |
| January | 122 | 5.90 | £6.1246 | 3.3614 | $20.5872 |
| February | 120 | 8.58 | 6.0358 | 3.4221 | 20.6551 |
| March | 120 | 3.62 | 6.0151 | 3.4329 | 20.6492 |
| April | 120 | 7.70 | 6.0321 | 3.5793 | 21.5907 |
| May | 123 | 4.54 | 6.1689 | 3.9324 | 24.2586 |
| June | 122 | 3.48 | 6.1145 | 4.1356 | 25.2871 |
| July | 123 | 11.88 | 6.1995 | 4.6499 | 28.8271 |
| August | 125 | 8.79 | 6.2866 | 4.5027 | 28.3067 |
| September | 131 | 4.27 | 6.5678 | 4.6647 | 30.6368 |
| October | 131 | 6.58 | 6.5774 | 4.6683 | 30.7053 |
| November | 128 | 8.87 | 6.4370 | 5.1497 | 33.1486 |
| December | 126 | 2.62 | 6.3109 | 5.1159 | 32.2859 |
| Average | 124 | 10.40 | 6.2433 | 4.2179 | 26.3337 |

[1] Source: Samuel Montagu & Co. [2] Source: United States Bureau of the Mint.

After April 19 there would have been profit in selling gold abroad, but President Roosevelt's Executive orders of April 5 forbade the hoarding of gold coin, gold bullion, and gold certificates. This was followed by the Presidential Executive order of April 20, 1933, relating to foreign exchange and earmarking and export of gold coin, bullion, or currency, that forbade the export of gold bullion.

*Premiums on newly mined gold in the United States in 1933.*—The newspapers on July 27 announced a decision of the Attorney General, effective August 9, that allowed the continuation of exporting of gold in ore and in concentrates and exporting of gold in unretorted amalgam bullion and in unrefined cyanide precipitates. This order permitted export to 75 percent of the United States gold-mine production but made it impracticable for the remaining 25 percent, a situation which would have soon resulted in the closing of many smelters (even then working only on part capacity).

Owing to the difficulties of quickly contacting reliable purchasers abroad, relatively very little of the above classified material was exported, although in the interim preparations had been made by some producers and were being made by other producers to ship abroad, when the President on August 29 issued an Executive order, coupled with an antihoarding clause, that the United States Government would act as agent for producers of newly mined gold to obtain the world price through the United States Mint and Federal Reserve banks; regulations were promulgated to pay the producer by Federal Reserve bank check (when sale was consummated) at the world price received by the Federal Reserve bank. All sales were handled by the Federal Reserve Bank of New York. This bank made a small quantity of sales internally to commercial companies for industrial purposes at world prices but sold the large amount abroad. The period covered by the internal sales was September 8 to October 27; the period covered by sales abroad was September 13 to November 1.

On October 25 the Reconstruction Finance Corporation began buying newly mined gold at arbitrarily fixed and periodically rising prices, the day-by-day price generally being above the world price; payment to the producer was in Reconstruction Finance Corporation notes payable in principal and interest on February 1, 1935. On October 27 the Reconstruction Finance Corporation was authorized by Presidential order to extend Government purchase of gold by entering foreign markets and began to bid for gold in Paris and London markets, offering $32.36 an ounce. On January 16, 1934, the Federal Reserve Bank of New York began paying depositors by check the United States price of $34.45 per ounce, less a small commission, coincident with the President's message of January 15 to Congress recommending that the upper limit of permissible revaluation of the dollar be 60 percent. Payment for deposits was resumed on February 1 by the Bureau of the Mint, following passage of the Gold Reserve Act of 1934 on January 30, 1934, and the President's proclamation of January 31 acting under the powers granted by title 3 of the act approved May 12, 1933 (Thomas amendment to the Farm Relief Act), fixing the weight of the gold dollar at 15 5/21 grains, nine-tenths fine. This is 59.06+ percent of the former weight of 25 8/10 grains, nine-tenths fine, as fixed by section 1 of the act of March 4, 1900. The value of gold per fine ounce immediately became $35. Throughout 1933 the organization of the Bureau of the Mint was used for receiving, weighing, assaying, and calculating the content of gold deposits but not for payment where otherwise indicated, and excepting exports of unrefined material during the period August 9–29.

*Gold prices Oct. 25, 1933, to June 1, 1934*

[The following tabulation compares the price of gold as established by the United States Treasury with the quotation fixed in the open market in London. The dollar equivalent for the London price will vary with the fluctuations in dollar-sterling exchange. The last two columns therefore give the dollar equivalent for the London gold price based on the dollar rate in London at the time gold price is fixed and the dollar equivalent at the close of the day in New York, based on the close for the sterling rate in New York. (Wall Street Journal.)]

| | Gold prices | London gold price | | Dollar rate in London [1] | Pound rate in New York [2] |
|---|---|---|---|---|---|
| 1933 | | S. | d. | | |
| Oct. 25 | $31.36 | 130 | 1 | $30.99 | $30.79 |
| Oct. 26 | 31.54 | 130 | 9½ | 31.03 | 31.01 |
| Oct. 27 | 31.76 | 131 | 2 | 31.02 | 30.79 |
| Oct. 28 | 31.82 | 129 | 8 | 30.38 | 30.63 |
| Oct. 30 | 31.96 | 131 | 2½ | 31.52 | 31.18 |
| Oct. 31 | 32.12 | 130 | 7 | 31.07 | 31.16 |
| Nov. 1 | 32.26 | 131 | 9 | 31.58 | 31.62 |
| Nov. 2 | 32.36 | 133 | 3 | 32.08 | 32.24 |
| Nov. 3 | 32.57 | 133 | 2 | 32.22 | 32.24 |
| Nov. 4 | 32.67 | 132 | 4½ | 32.13 | 32.18 |
| Nov. 6 | 32.84 | 131 | 10 | 32.16 | 32.24 |
| Nov. 7 | 32.84 | 129 | 11½ | (3) | (3) |
| Nov. 8 | 33.05 | 131 | 10 | 32.46 | 32.81 |
| Nov. 9 | 33.15 | 130 | 11 | 32.70 | 33.51 |
| Nov. 10 | 33.20 | 129 | 8 | 33.47 | 33.09 |
| Nov. 11 | 33.32 | 130 | 1½ | 33.05 | 33.14 |
| Nov. 13 | 33.45 | 129 | 1½ | 33.19 | 33.31 |
| Nov. 14 | 33.56 | 128 | 7 | 33.53 | 33.84 |
| Nov. 15 | 33.56 | 129 | ½ | 34.45 | 34.90 |
| Nov. 16 | 33.56 | 128 | 6 | 35.05 | 33.85 |
| Nov. 17 | 33.56 | 128 | 2 | 34.32 | 33.45 |
| Nov. 18 | 33.56 | 128 | 2 | 33.80 | 33.62 |
| Nov. 20 | 33.66 | 127 | 7 | 33.78 | 33.83 |
| Nov. 21 | 33.76 | 127 | -- | 34.07 | 34.44 |
| Nov. 22 | 33.76 | 126 | 6 | 34.41 | 34.07 |
| Nov. 23 | 33.76 | 125 | 8 | 33.84 | 33.17 |
| Nov. 24 | 33.76 | 126 | 1 | 33.35 | 32.67 |
| Nov. 25 | 33.76 | 126 | 6 | 32.92 | 32.90 |
| Nov. 27 | 33.76 | 125 | 3½ | 32.75 | 31.98 |
| Nov. 28 | 33.85 | 125 | 6 | 31.85 | 32.60 |

[1] London in dollars based on dollar rate at the fixing.
[2] London in dollars based on pound at close in New York.
[3] Holiday

*Gold prices Oct. 25, 1933, to June 1, 1934*—Continued

| | Gold prices | London gold price | | Dollar rate in London | Pound rate in New York |
|---|---|---|---|---|---|
| | | *S.* | *d.* | | |
| 1933—Continued | | | | | |
| Nov. 29 | $33.93 | 125 | 6 | $32.63 | $32.44 |
| Nov. 30 | (3) | 125 | 1½ | (3) | (3) |
| Dec. 1 | 34.01 | 125 | 2 | 32.79 | 32.55 |
| Dec. 2 | 34.01 | 124 | 11½ | 32.40 | 32.41 |
| Dec. 4 | 34.01 | 124 | 8 | 32.23 | 32.03 |
| Dec. 5 | 34.01 | 125 | 6 | 32.07 | 32.74 |
| Dec. 6 | 34.01 | 126 | 11 | 32.81 | 32.45 |
| Dec. 7 | 34.01 | 126 | -- | 32.13 | 32.31 |
| Dec. 8 | 34.01 | 126 | 9 | 32.43 | 32.67 |
| Dec. 9 | 34.01 | 126 | 6 | 32.61 | 32.73 |
| Dec. 11 | 34.01 | 127 | -- | 32.73 | 32.32 |
| Dec. 12 | 34.01 | 126 | 4½ | 32.19 | 31.97 |
| Dec. 13 | 34.01 | 126 | 1 | 31.87 | 31.77 |
| Dec. 14 | 34.01 | 126 | 1 | 31.88 | 32.26 |
| Dec. 15 | 34.01 | 126 | 7 | 32.58 | 32.34 |
| Dec. 16 | 34.01 | 126 | 4 | 32.34 | 32.34 |
| Dec. 18 | 34.06 | 126 | 9 | 32.54 | 32.64 |
| Dec. 19 | 34.06 | 126 | 9 | 32.64 | 32.57 |
| Dec. 20 | 34.06 | 126 | 9 | 32.50 | 32.29 |
| Dec. 21 | 34.06 | 126 | 2 | 32.16 | 31.92 |
| Dec. 22 | 34.06 | 126 | 3 | 32.18 | 32.23 |
| Dec. 23 | (3) | 126 | 4 | 32.23 | 32.28 |
| Dec. 26 | 34.06 | (3) | -- | (3) | (3) |
| Dec. 27 | 34.06 | 126 | 5 | 32.52 | 32.28 |
| Dec. 28 | 34.06 | 126 | 3 | 32.13 | 32.04 |
| Dec. 29 | 34.06 | 126 | 2 | 32.11 | 32.01 |
| Dec. 30 | (3) | 126 | 6 | 32.29 | 32.58 |
| 1934 | | | | | |
| Jan. 2 | 34.06 | 127 | -- | 32.88 | 32.70 |
| Jan. 3 | 34.06 | 127 | 6 | 32.91 | 32.61 |
| Jan. 4 | 34.06 | 127 | 6 | 32.51 | 32.88 |
| Jan. 5 | 34.06 | 127 | 6 | 32.83 | 32.54 |
| Jan. 6 | 34.06 | 126 | 11 | 32.41 | 32.49 |
| Jan. 8 | 34.06 | 126 | 8 | 32.24 | 32.24 |
| Jan. 9 | 34.06 | 126 | 8½ | 32.26 | 32.18 |
| Jan. 10 | 34.06 | 127 | 1 | 32.36 | 32.44 |
| Jan. 11 | 34.06 | 127 | 1 | 32.44 | 32.31 |
| Jan. 12 | 34.06 | 127 | 2 | 32.40 | 32.33 |
| Jan. 15 [4] | 34.06 | 128 | 6 | 32.86 | 32.99 |
| Jan. 16 | 34.45 | 131 | 9 | 33.78 | 33.45 |
| Jan. 17 | 34.45 | 131 | 6 | 33.35 | 33.15 |
| Jan. 18 | 34.45 | 132 | 10 | 33.34 | 32.94 |
| Jan. 19 | 34.45 | 132 | 10 | 33.13 | 33.39 |
| Jan. 20 | 34.45 | 132 | 9 | 33.25 | 33.19 |
| Jan. 22 | 34.45 | 132 | 11 | 33.33 | 33.25 |
| Jan. 23 | 34.45 | 132 | 9 | 33.25 | 33.19 |
| Jan. 24 | 34.45 | 132 | 10 | 33.24 | 33.08 |
| Jan. 25 | 34.45 | 132 | 1 | 32.94 | 32.78 |
| Jan. 26 | 34.45 | 132 | 8 | 33.00 | 32.91 |
| Jan. 27 | 34.45 | 132 | 3 | 32.83 | 32.80 |
| Jan. 29 | 34.45 | 132 | 5½ | 33.06 | 33.30 |
| Jan. 30 | 34.45 | 132 | 10 | 33.34 | 33.32 |
| Jan. 31 | 34.45 | 133 | 1 | 33.30 | 33.08 |
| Feb. 1 | 35.00 | 135 | 6 | 34.10 | 33.72 |
| Feb. 2 | 35.00 | 139 | 6 | 34.60 | 34.02 |
| Feb. 3 | 35.00 | 138 | 3 | 34.04 | 34.22 |
| Feb. 5 | 35.00 | 140 | -- | 34.51 | 34.55 |
| Feb. 6 | 35.00 | 139 | 3 | 34.39 | 34.54 |
| Feb. 7 | 35.00 | 136 | 6 | 34.36 | 34.09 |
| Feb. 8 | 35.00 | 136 | 9 | 34.26 | 34.32 |
| Feb. 9 | 35.00 | 137 | 4 | 34.47 | 34.47 |
| Feb. 10 | 35.00 | 137 | 1 | 34.44 | 32.48 |
| Feb. 12 | 35.00 | 137 | 2 | 34.51 | (3) |
| Feb. 13 | 35.00 | 136 | 11 | 34.50 | 34.45 |
| Feb. 14 | 35.00 | 137 | 5 | 34.59 | 34.59 |
| Feb. 15 | 35.00 | 137 | 5 | 34.59 | 34.77 |
| Feb. 16 | 35.00 | 136 | 4 | 34.54 | 34.70 |
| Feb. 17 | 35.00 | 135 | 10 | 34.59 | 34.60 |
| Feb. 19 | 35.00 | 134 | 9 | 34.56 | 34.60 |
| Feb. 20 | 35.00 | 135 | 9 | 34.62 | 34.28 |
| Feb. 21 | 35.00 | 136 | 5 | 34.62 | 34.68 |
| Feb. 22 | 35.00 | 136 | 1 | 34.66 | (3) |
| Feb. 23 | 35.00 | 136 | 5½ | 34.64 | 34.63 |
| Feb. 24 | 35.00 | 136 | 6 | 34.65 | 34.68 |
| Feb. 26 | 35.00 | 136 | 5 | 34.67 | 34.69 |
| Feb. 27 | 35.00 | 136 | 7 | 34.74 | 34.59 |
| Feb. 28 | 35.00 | 137 | 1 | 34.73 | 34.72 |
| Mar. 1 | 35.00 | 137 | 1 | 34.72 | 34.82 |

[3] Holiday.

[4] R.F.C. price before Jan. 16.

*Gold prices Oct. 25, 1933, to June 1, 1934*—Continued

| | Gold prices | London gold price S. | d. | Dollar rate in London | Pound rate in New York |
|---|---|---|---|---|---|
| 1934—Continued | | | | | |
| Mar. 2 | $35.00 | 136 | 7 | $34.76 | $34.66 |
| Mar. 5 | 35.00 | 136 | 10 | 34.72 | 34.69 |
| Mar. 6 | 35.00 | 137 | 2 | 34.73 | 34.81 |
| Mar. 7 | 35.00 | 136 | 10 | 34.70 | 34.78 |
| Mar. 8 | 35.00 | 136 | 8 | 34.74 | 34.70 |
| Mar. 9 | 35.00 | 136 | 10 | 34.72 | 34.76 |
| Mar. 10 | 35.00 | 136 | 10½ | 34.75 | 34.75 |
| Mar. 12 | 35.00 | 136 | 10 | 34.74 | 34.92 |
| Mar. 13 | 35.00 | 136 | 3½ | 34.72 | 34.75 |
| Mar. 14 | 35.00 | 136 | 2 | 34.72 | 34.73 |
| Mar. 15 | 35.00 | 136 | 4 | 34.75 | 34.76 |
| Mar. 16 | 35.00 | 136 | 5 | 34.74 | 34.71 |
| Mar. 17 | 35.00 | 136 | 6 | 34.74 | 34.76 |
| Mar. 19 | 35.00 | 136 | 6 | 34.74 | 34.83 |
| Mar. 20 | 35.00 | 136 | 2 | 34.71 | 34.81 |
| Mar. 21 | 35.00 | 136 | -- | 34.73 | 34.77 |
| Mar. 22 | 35.00 | 136 | 2 | 34.79 | 34.81 |
| Mar. 23 | 35.00 | 136 | -- | 34.75 | 34.68 |
| Mar. 24 | 35.00 | 136 | 3 | 34.76 | 34.72 |
| Mar. 26 | 35.00 | 136 | 5 | 34.77 | 34.82 |
| Mar. 27 | 35.00 | 136 | 3½ | 34.75 | 34.75 |
| Mar. 28 | 35.00 | 136 | 3 | 34.74 | 34.79 |
| Mar. 29 | 35.00 | 135 | 5½ | 34.65 | 34.69 |
| Mar. 30 | (3) | (3) | -- | (3) | (3) |
| Mar. 31 | 35.00 | (3) | -- | (3) | (3) |
| Apr. 2 | 35.00 | (3) | -- | (3) | (3) |
| Apr. 3 | 35.00 | 135 | 2 | 34.75 | 35.08 |
| Apr. 4 | 35.00 | 134 | 3 | 34.87 | 34.65 |
| Apr. 5 | 35.00 | 134 | 8½ | 34.75 | 34.73 |
| Apr. 6 | 35.00 | 135 | 1 | 34.81 | 34.85 |
| Apr. 7 | 35.00 | 134 | 7 | 34.79 | 34.84 |
| Apr. 9 | 35.00 | 134 | 4 | 34.77 | 34.78 |
| Apr. 10 | 35.00 | 134 | 6 | 34.79 | 34.73 |
| Apr. 11 | 35.00 | 134 | 10½ | 34.79 | 34.83 |
| Apr. 12 | 35.00 | 134 | 10 | 34.82 | 34.82 |
| Apr. 13 | 35.00 | 134 | 9 | 34.79 | 34.71 |
| Apr. 14 | 35.00 | 134 | 11½ | 34.77 | 34.79 |
| Apr. 16 | 35.00 | 134 | 10½ | 34.75 | 34.78 |
| Apr. 17 | 35.00 | 134 | 8½ | 34.73 | 34.76 |
| Apr. 18 | 35.00 | 135 | 4 | 34.76 | 34.76 |
| Apr. 19 | 35.00 | 135 | 3 | 34.76 | 34.81 |
| Apr. 20 | 35.00 | 135 | 2½ | 34.84 | 35.00 |
| Apr. 21 | 35.00 | 135 | 8 | 35.10 | 35.01 |
| Apr. 23 | 35.00 | 135 | 7½ | 34.92 | 34.95 |
| Apr. 24 | 35.00 | 135 | 11 | 35.02 | 35.02 |
| Apr. 25 | 35.00 | 135 | 6½ | 34.87 | 34.83 |
| Apr. 26 | 35.00 | 135 | 7 | 34.83 | 34.82 |
| Apr. 27 | 35.00 | 135 | 11 | 34.90 | 34.95 |
| Apr. 28 | 35.00 | 135 | 9 | 34.92 | 34.94 |
| Apr. 30 | 35.00 | 135 | 8 | 34.89 | 34.83 |
| May 1 | 35.00 | 135 | 11½ | 34.88 | 34.74 |
| May 2 | 35.00 | 136 | 3½ | 34.83 | 34.91 |
| May 3 | 35.00 | 136 | -- | 34.83 | 34.87 |
| May 4 | 35.00 | 135 | 10 | 34.82 | 34.73 |
| May 5 | 35.00 | 136 | -- | 34.82 | 34.86 |
| May 7 | 35.00 | 136 | 2 | 34.84 | 34.77 |
| May 8 | 35.00 | 136 | 1½ | 34.76 | 34.89 |
| May 9 | 35.00 | 135 | 11½ | 34.86 | 34.81 |
| May 10 | 35.00 | 136 | -- | 34.80 | 34.77 |
| May 11 | 35.00 | 136 | 1 | 34.79 | 34.80 |
| May 12 | 35.00 | 135 | 10 | 34.75 | 34.73 |
| May 14 | 35.00 | 135 | 11½ | 34.75 | 34.73 |
| May 15 | 35.00 | 136 | ½ | 34.76 | 34.78 |
| May 16 | 35.00 | 136 | -- | 34.76 | 34.75 |
| May 17 | 35.00 | 136 | 1 | 34.77 | 34.78 |
| May 18 | 35.00 | 136 | 2 | 34.80 | 34.78 |
| May 19 | 35.00 | 136 | 2½ | 34.80 | 34.80 |
| May 21 | 35.00 | (3) | -- | (3) | (3) |
| May 22 | 35.00 | 136 | 3 | 34.82 | 34.81 |
| May 23 | 35.00 | 136 | 6½ | 34.82 | 34.72 |
| May 24 | 35.00 | 136 | 9 | 34.78 | 34.83 |
| May 25 | 35.00 | 136 | 6½ | 34.78 | 34.78 |
| May 26 | 35.00 | 136 | 6 | 34.78 | 34.73 |
| May 28 | 35.00 | 136 | 8½ | 34.79 | 34.80 |
| May 29 | 35.00 | 136 | 9 | 34.78 | 34.73 |
| May 30 | (3) | 137 | ½ | 34.79 | (3) |
| May 31 | 35.00 | 136 | 11½ | 34.77 | 34.68 |
| June 1 | 35.00 | 137 | 1½ | 34.77 | 34.74 |

[3] **Holiday.**

*Gold Reserve Act of 1934 and Presidential proclamation fixing weight of gold dollar at 15 5/21 grains nine-tenths fine.*—On January 15, 1934 President Roosevelt delivered to Congress the following message relating to the reduction in weight of the gold dollar.

In conformity with the progress we are making in restoring a fairer price level and with our purpose of arriving eventually at a less variable purchasing power for the dollar, I ask the Congress for certain additional legislation to improve our financial and monetary system. By making clear that we are establishing permanent metallic reserves in the possession and ownership of the Federal Government, we can organize a currency system which will be both sound and adequate.

The issuance and control of the medium of exchange which we call "money" is a high prerogative of government. It has been such for many centuries. Because they were scarce, because they could readily be subdivided and transported, gold and silver have been used either for money or as a basis for forms of money which in themselves had only nominal intrinsic value.

In pure theory, of course, a government could issue mere tokens to serve as money—tokens which would be accepted at their face value if it were certain that the amount of these tokens were permanently limited and confined to the total amount necessary for the daily cash needs of the community. Because this assurance could not always or sufficiently be given, governments have found that reserves or bases of gold and silver behind their paper or token currency added stability to their financial systems.

There is still much confusion of thought which prevents a world-wide agreement creating a uniform monetary policy. Many advocate gold as a sole basis of currency; others advocate silver; still others advocate both gold and silver whether as separate bases, or on a basis with a fixed ratio, or on a fused basis.

We hope that, despite present world confusion, events are leading to some future form of general agreement. The recent London agreement in regard to silver was a step, though only a step, in this direction.

At this time we can usefully take a further step, which we hope will contribute to an ultimate world-wide solution.

Certain lessons seem clear. For example, the free circulation of gold coins is unnecessary, leads to hoarding, and tends to a possible weakening of national financial structures in times of emergency. The practice of transferring gold from one individual to another or from the Government to an individual within a nation is not only unnecessary but is in every way undesirable. The transfer of gold in bulk is essential only for the payment of international trade balances.

Therefore it is a prudent step to vest in the government of a nation the title to and possession of all monetary gold within its boundaries and to keep that gold in the form of bullion rather than in coin.

Because the safe-keeping of this monetary basis rests with the Government, we have already called in the gold which was in the possession of private individuals or corporations. There remains, however, a very large weight in gold bullion and coins which is still in the possession or control of the Federal Reserve banks.

Although under existing law there is authority, by Executive act, to take title to the gold in the possession or control of the Reserve banks, this is a step of such importance that I prefer to ask the Congress by specific enactment to vest in the United States Government title to all supplies of American-owned monetary gold, with provision for the payment therefor in gold certificates. These gold certificates will be, as now, secured at all times dollar for dollar by gold in the Treasury—gold for each dollar of such weight and fineness as may be established from time to time.

Such legislation places the right, title, and ownership to our gold reserves in the Government itself; it makes clear the Government's ownership of any added dollar value of the country's stock of gold which would result from any decrease of the gold content of the dollar which may be made in the public interest. It would also, of course, with equal justice, cast upon the Government the loss of such dollar value if the public interest in the future should require an increase in the amount of gold designated as a dollar.

The title to all gold being in the Government, the total stock will serve as a permanent and fixed metallic reserve which will change in amount only so far as necessary for the settlement of international balances or as may be required by a future agreement among the nations of the world for a redistribution of the world stock of monetary gold.

With the establishment of this permanent policy, placing all monetary gold in the ownership of the Government as a bullion base for its currency, the time has come for a more certain determination of the gold value of the American dollar. Because of world uncertainties, I do not believe it desirable in the public interest that an exact value be now fixed. The President is authorized by present legislation to fix the lower limit of permissible revaluation at 50 percent. Careful study leads me to believe that any revaluation at more than 60 percent of the present statutory value would not be in the public interest. I, therefore, recommend to the Congress that it fix the upper limit of permissible revaluation at 60 percent.

That we may be further prepared to bring some greater degree of stability to foreign exchange rates in the interests of our people, there should be added to the present power of the Secretary of the Treasury to buy and sell gold at home and abroad, express power to deal in foreign exchange as such. As a part of this power, I suggest that, out of the profits of any devaluation, there should be set up a fund of $2,000,000,000 for such purchases and sales of gold, foreign exchange, and Government securities as the regulation of the currency, the maintenance of the credit of the Government, and the general welfare of the United States may require.

Certain amendments of existing legislation relating to the purchase and sale of gold and to other monetary matters would add to the convenience of handling current problems in this field. The Secretary of the Treasury is prepared to submit information concerning such changes to the appropriate committees of the Congress.

The foregoing recommendations relate chiefly to gold. The other principal precious metal—silver—has also been used from time immemorial as a metallic base for currencies as well as for actual currency itself. It is used as such by probably half the population of the world. It constitutes a very important part of our own monetary structure. It is such a crucial factor in much of the world's international trade that it cannot be neglected.

On December 21, 1933, I issued a proclamation providing for the coinage of our newly mined silver and for increasing our reserves of silver bullion, thereby putting us among the first nations to carry out the silver agreement entered into by 66 governments at the London Conference. This agreement is distinctly a step in the right direction and we are proceeding to perform our part of it.

All of the 66 nations agreed to refrain from melting or debasing their silver coins, to replace paper currency to small denominations with silver coins, and to refrain from legislation that would depreciate the value of silver in the world markets. Those nations producing large quantities of silver agreed to take specified amounts from their domestic production and those holding and using large quantities agreed to restrict the amount they would sell during the 4 years covered by the agreement.

If all these undertakings are carried out by the governments concerned, there will be a marked increase in the use and value of silver.

Governments can well, as they have in the past, employ silver as a basis for currency, and I look for a greatly increased use. I am, however, withholding any recommendation to the Congress looking to further extension of the monetary use of silver because I believe that we should gain more knowledge of the results of the London agreement and of our other monetary measures.

Permit me once more to stress two principles. Our national currency must be maintained as a sound currency which, insofar as possible, will have a fairly constant standard of purchasing power and be adequate for the purposes of daily use and the establishment of credit.

The other principle is the inherent right of government to issue currency and to be the sole custodian and owner of the base or reserve of precious metals underlying that currency. With this goes the prerogative of government to determine from time to time the extent and nature of the metallic reserve. I am confident that the Nation will well realize the definite purpose of the Government to maintain the credit of that Government and, at the same time, to provide a sound medium of exchange which will serve the needs of our people.

On January 30, 1934 Congress passed the Gold Reserve Act of 1934.[3]

On January 31, 1934 the President issued the following statement relative to the reduction of the weight of the gold dollar and to new regulations of the Secretary of the Treasury announcing the price to be paid after January 30, 1934.

[3] For details of this act, see Federal Reserve Bulletin, February 1934, pp. 63–67, and other Government documents covering acts of Congress.

(1) Acting under the powers granted by title 3 of the act approved May 12, 1933 (Thomas amendment to the Farm Relief Act), the President today issued a proclamation fixing the weight of the gold dollar at 15 5/21 grains nine tenths fine. This is 59.06 plus percent of the former weight of 25 8/10 grains, nine tenths fine, as fixed by section 1 of the act of Congress of March 4, 1900. The new gold content of the dollar became effective immediately on the signing of the proclamation by the President.

Under the Gold Reserve Act of 1934, signed by the President Tuesday, January 30, title to the entire stock of monetary gold in the United States, including the gold coin and gold bullion heretofore held by the Federal Reserve banks and the claim upon gold in the Treasury represented by gold certificates, is vested in the United States Government and the "profit [of $2,883,800,000]" from the reduction of the gold content of the dollar, made effective by today's proclamation, accrues to the United States Treasury. Of this "profit" two billion dollars, under the terms of the Gold Reserve Act and of today's proclamation, constitutes a stabilization fund under the direction of the Secretary of the Treasury. The balance will be covered into the general fund of the Treasury.

Settlement for the gold coin, bullion, and certificates taken over from the Federal Reserve banks on Tuesday upon the approval of the act was made in the form of credits set up on the Treasury's books. This credit due the Federal Reserve banks is to be paid in the new form of gold certificates now in course of production by the Bureau of Engraving and Printing.

* * * * * * *

In his proclamation of today the President gives notice that he reserves the right by virtue of the authority vested in him, to alter or modify the present proclamation as the interest of the United States may seem to require. The authority by later proclamations to accomplish other revaluations of the dollar in terms of gold is contained in the Gold Reserve Act signed on Tuesday.

(2) The Secretary of the Treasury, with the approval of the President, issued a public announcement that beginning February 1, 1934 he will buy through the Federal Reserve Bank of New York as fiscal agent, for the account of the United States, any and all gold delivered to any United States mints or the assay offices in New York or Seattle, at the rate of $35 per fine troy ounce, less the usual mint charges and less one fourth of 1 percent for handling charges. Purchases, however, are subject to compliance with the regulations issued under the Gold Reserve Act of 1934.

(3) The Secretary of the Treasury today promulgated new regulations with respect to the purchase and sale of gold by the mints. Under these regulations, the mints are authorized to purchase gold recovered from natural deposits in the United States or any place subject to its jurisdiction, unmelted scrap gold, gold imported into the United States after January 30, 1934, and such other gold as may be authorized from time to time by rulings of the Secretary of the Treasury. No gold, however, may be purchased which has been held in noncompliance with previous acts or orders, or noncompliance with the Gold Reserve Act of 1934, or these regulations. Affidavits as to the source from which the gold was obtained are required, except in the case of nuggets or dust of less than 5 ounces, where a statement under oath will suffice. In the case of imported gold, the mints may purchase only that which has been in customs custody after its arrival in the continental United States.

The price to be paid for gold purchased by the mints is to be $35 per troy ounce of fine gold, less one fourth of 1 percent and less mint charges. This price may be changed by the Secretary of the Treasury at any time without notice.

The mints are authorized to sell gold to persons licensed to acquire it for use in the industries, professions, or arts, but not to sell more than is required for a 3 months' supply for the purchaser. The price at which gold is to be sold by the mints will be $35 per troy ounce, plus one fourth of 1 percent. This price also may be changed by the Secretary of the Treasury without notice.

## BY THE PRESIDENT OF THE UNITED STATES OF AMERICA

## A PROCLAMATION

Whereas, by virtue of section 1 of the act of Congress approved March 14, 1900 (31 Stat. L. 45), the present weight of the gold dollar is fixed at 25.8 grains of gold nine tenths fine; and

Whereas, by section 43, title III of the act approved May 12, 1933 (Public, No. 10, 73d Cong.), as amended by section 12 of the Gold Reserve Act of 1934, it is provided in part as follows:

Whenever the President finds, upon investigation, that (1) the foreign commerce of the United States is adversely affected by reason of the depreciation in the value of the currency of any other government or governments in relation to the present standard value of gold, or (2) action under this section is necessary in order to regulate and maintain the parity of currency issues of the United States, or (3) an economic emergency requires an expansion of credit, or (4) an expansion of credit is necessary to secure by international agreement a stabilization at proper levels of the currencies of various governments, the President is authorized, in his discretion—

(a) To direct the Secretary of the Treasury to enter into agreements with the several Federal Reserve banks and with the Federal Reserve Board whereby the Federal Reserve Board will, and it is hereby authorized to, notwithstanding any provisions of law or rules and regulations to the contrary, permit such reserve banks to agree that they will (1) conduct, pursuant to existing law, throughout specified periods, open-market operations in obligations of the United States Government or corporations in which the United States is the majority stockholder, and (2) purchase directly and hold in portfolio for an agreed period or periods of time Treasury bills or other obligations of the United States Government in an aggregate sum of $3,000,000,000 in addition to those they may then hold, unless prior to the termination of such period or periods the Secretary shall consent to their sale. No suspension of reserve requirements of the Federal Reserve banks, under the terms of section 11 (c) of the Federal Reserve Act, necessitated by reason of operations under this section, shall require the imposition of the graduated tax upon any deficiency in reserves as provided in said section 11 (c). Nor shall it require any automatic increase in the rates of interest or discount charged by any Federal Reserve bank, as otherwise specified in that section. The Federal Reserve Board, with the approval of the Secretary of the Treasury, may require the Federal Reserve banks to take such action as may be necessary, in the judgment of the Board and of the Secretary of the Treasury, to prevent undue credit expansion.

(b) If the Secretary, when directed by the President, is unable to secure the assent of the several Federal Reserve banks and the Federal Reserve Board to the agreements authorized in this section, or if operations under the above provisions prove to be inadequate to meet the purposes of this section, or if for any other reason additional measures are required in the judgment of the President to meet such purposes, then the President is authorized—

* * * * * * *

(2) By proclamation to fix the weight of the gold dollar in grains nine tenths fine and also to fix the weight of the silver dollar in grains nine tenths fine at a definite fixed ratio in relation to the gold dollar at such amounts as he finds necessary from his investigation to stabilize domestic prices or to protect the foreign commerce against the adverse effect of depreciated foreign currencies, and to provide for the unlimited coinage of such gold and silver at the ratio so fixed, or in case the Government of the United States enters into an agreement with any government or governments under the terms of which the ratio between the value of gold and other currency issued by the United States and by any such government or governments is established, the President may fix the weight of the gold dollar in accordance with the ratio so agreed upon, and such gold dollar, the weight of which is so fixed, shall be the standard unit of value, and all forms of money issued or coined by the United States shall be maintained at a parity with this standard and it shall be the duty of the Secretary of the Treasury to maintain such parity, but in no event shall the weight of the gold dollar be fixed so as to reduce its present weight by more than 50 per centum. Nor shall the weight of the gold dollar be fixed in any event at more than 60 per centum of its present weight. The powers of the President specified in this paragraph shall be deemed to be separate, distinct, and continuing powers, and may be exercised by him, from time to time, severally or together, whenever and as the expressed objects of this section in his judgment may require; except that such powers shall expire two years after the date of enactment of the Gold Reserve Act of 1934 unless the President shall sooner declare the existing emergency ended, but the President may extend such period for not more than one additional year after such date by proclamation recognizing the continuance of such emergency"; and

Whereas, I find, upon investigation, that the foreign commerce of the United States is adversely affected by reason of the depreciation in the value of the currencies of other governments in relation to the present standard value of gold, and that an economic emergency requires an expansion of credit; and

Whereas, in my judgment, measures additional to those provided by subsection (a) of said section 43 are required to meet the purposes of such section; and

Whereas, I find, from my investigation, that, in order to stabilize domestic prices and to protect the foreign commerce against the adverse effect of depreciated foreign currencies, it is necessary to fix the weight of the gold dollar at 15 5/21 grains nine tenths fine.

Now, therefore, be it known that I, Franklin D. Roosevelt, President of the United States, by virtue of the authority vested in me by section 43, title III of said act of May 12, 1933, as amended, and by virtue of all other authority vested in me, do hereby proclaim, order, direct, declare, and fix the weight of the gold dollar to be 15 5/21 grains nine tenths fine, from and after the date and hour of this proclamation. The weight of the silver dollar is not altered or affected in any manner by reason of this proclamation.

This proclamation shall remain in force and effect until and unless repealed or modified by act of Congress or by subsequent proclamation; and notice is hereby given that I reserve the right by virtue of the authority vested in me to alter or modify this proclamation as the interest of the United States may seem to require.

In witness whereof I have hereunto set my hand and have caused the seal of the United States to be affixed.

Done in the City of Washington at 3:10 o'clock in the afternoon, eastern standard time, this 31st day of January, in the year of our Lord one thousand nine hundred and thirty-four, and of the Independence of the United States the one hundred and fifty-eighth.

FRANKLIN D. ROOSEVELT.

Although under the Gold Reserve Act of 1934, "No gold shall hereafter be coined, and no gold coin shall hereafter be paid out or delivered by the United States", the following table showing the weight, fineness, and value of the coins of the United States is given for reference purposes:

*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.

*Monetary relationships.*—United States coinage laws from April 2, 1792, to March 4, 1900, show the development of the establishment and the continuation of the value of $20.671834625323 per troy ounce of gold to February 1, 1934. 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 (thousandths) | Fine gold content (grains) | Value per fine ounce, troy (480 grains) | Value per grain |
|---|---|---|---|---|---|
| Apr. 2, 1792 | 720 | 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 |
| Mar. 4, 1900 | 258 | 900.0000 | 232.2 | 20.671835 | .04306632 |

The value of the dollar by the act of January 30, 1934, is 59.06+ percent of 25.8 grains of 0.900 fine, or 15 5/21 grains of 0.900 fine, or 13.714286 grains (fine gold content) at $35 per fine ounce (480 grains). The value per grain is, therefore, $0.0729166 plus.

*United States monetary stock.*—The Federal Reserve Bulletin of the Federal Reserve Board for May 1934 gives the analysis of changes in monetary gold stock of the United States from October 1932 to April 1934, inclusive, as follows:

*Analysis of changes in monetary gold stock*

[In millions of dollars]

| Month | Gold stock at end of month | Analysis of changes | | | |
|---|---|---|---|---|---|
| | | Increase in gold stock | Net gold import | Net release from earmark [1] | Other factors |
| | *$1=25 8/10 grains of gold nine tenths fine; i.e., an ounce of fine gold=$20.67* | | | | |
| **1932** | | | | | |
| October | 4,264 | 70.8 | 20.6 | 45.8 | 4.5 |
| November | 4,340 | 75.6 | 21.7 | 48.6 | 5.3 |
| December | 4,513 | 173.5 | 100.9 | 71.0 | 1.6 |
| Total (12 months) | | 52.9 | −446.2 | 457.5 | 41.6 |
| **1933** | | | | | |
| January | 4,553 | 40.0 | 128.5 | −91.5 | 3.0 |
| February | 4,380 | −173.4 | 17.8 | −178.3 | −12.9 |
| March | 4,282 | −97.2 | −22.1 | −100.1 | 25.0 |
| April | 4,312 | 29.5 | −10.0 | 33.7 | 5.7 |
| May | 4,315 | 3.6 | −21.1 | 22.1 | 2.6 |
| June | 4,318 | 2.2 | −3.2 | 3.5 | 1.9 |
| July | 4,320 | 2.7 | −83.9 | 84.5 | 2.1 |
| August | 4,328 | 7.5 | −80.4 | 79.5 | 8.4 |
| September | 4,324 | −3.8 | −56.7 | 49.3 | 3.6 |
| October | 4,323 | −0.7 | −32.4 | 26.9 | 4.8 |
| November | 4,323 | | −1.1 | 0.6 | 0.4 |
| December | 4,323 | −0.5 | −9.1 | 11.8 | −3.1 |
| Total (12 months) | | −190.4 | −173.7 | −58.0 | 41.4 |
| **1934** | | | | | |
| January | [2] 4,033 | [2] −289.3 | −2.8 | 12.2 | [2] −298.7 |
| | *$1=15 5/21 grains of gold nine tenths fine; i.e., an ounce of fine gold=$35* | | | | |
| February | 7,438 | 3,405.0 | 452.6 | 68.7 | 2,883.8 |
| March | 7,695 | 256.8 | 237.6 | −.8 | 20.0 |
| April [3] | 7,756 | 60.8 | 50.9 | −1.1 | 11.0 |

[1] Gold released from earmark at Federal Reserve banks less gold placed under earmark (with allowance when necessary for changes in gold earmarked abroad for account of Federal Reserve banks).
[2] Decrease during January reflects primarily omission from gold stock for end of January of "gold coin in circulation."
[3] Preliminary figures.

*World monetary stock.*—At the end of 1933 the monetary stock of 50 countries of the world, including United States, Canada, Austria, Belgium, Bulgaria, Czechoslovakia, Denmark, England, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Rumania, Spain, Sweden, Switzerland, Union of Soviet Socialist Republics, Yugoslavia, and 6 other countries in Europe; 10 countries in Latin America; 4 countries in Asia and Oceania; and 4 countries in Africa totaled $11,964,000,000 calculated at $20.67+ per fine ounce.

## UNITED STATES GOLD-MINING OPERATIONS

The total gold production in the 13 Western States and Alaska in 1933 increased 0.1 percent over that of 1932. Decreases were made in Colorado, Nevada, Texas, Utah, and Washington. Increases were made in Alaska, Arizona, California, Idaho, Montana, New Mexico, Oregon, South Dakota, and Wyoming. Causes for increases and decreases follow no empirical formula, and changes in output must be considered not only State by State but also district by district. Since the variation in total output of gold in continental United States and Alaska from 1922 to 1932 has been relatively small, the following source table shows the effect on gold production of the decreased copper-ore production in 1930, 1931, and 1932. The influence of copper-ore production was less than usual in 1933 but accounted for part of the increase in Arizona and for part of the loss in Nevada and Utah. The details of other influences are given under each State, but briefly gold production in the United States in 1933 was maintained by the increase of price after August, which allowed previously unprofitable ore to be mined. There was a quickening of the industry in the placer and dry-ore areas from September through December, which has continued and will be reflected in an increase for 1934 over 1933.

*Gold produced in the United States, by percent of sources, as reported by mines, 1922–32, and total fine ounces* [1]

| Year | Placers | Dry and siliceous ore | Copper ore | Lead ore | Zinc ore | Copper-lead and copper-lead-zinc ores | Lead-zinc ore | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Fine ounces [2] | Percent |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | | |
| 1922 | 23.46 | 68.06 | 5.71 | 1.54 | 0.12 | 0.11 | 1.00 | 2,293,251 | 100 |
| 1923 | 22.95 | 62.79 | 11.30 | 1.58 | .14 | .16 | 1.08 | 2,404,913 | 100 |
| 1924 | 18.44 | 65.56 | 12.70 | 1.63 | .01 | .08 | 1.58 | 2,444,331 | 100 |
| 1925 | 18.91 | 61.30 | 15.08 | 2.18 | .02 | .24 | 2.27 | 2,307,374 | 100 |
| 1926 | 20.50 | 58.03 | 16.36 | 2.05 | .05 | .15 | 2.86 | 2,232,526 | 100 |
| 1927 | 21.42 | 55.17 | 17.45 | 1.97 | .07 | .12 | 3.80 | 2,107,032 | 100 |
| 1928 | 19.41 | 55.67 | 19.31 | 1.67 | .01 | .32 | 3.61 | 2,148,064 | 100 |
| 1929 | 19.83 | 52.17 | 22.24 | 1.81 | .06 | .19 | 3.70 | 2,058,993 | 100 |
| 1930 | 20.59 | 59.27 | 15.57 | 1.24 | .02 | .15 | 3.16 | 2,138,724 | 100 |
| 1931 | 20.36 | 66.16 | 9.65 | .79 | -------- | .05 | 2.99 | 2,224,729 | 100 |
| 1932 | 23.37 | 69.53 | 4.24 | .68 | -------- | ---------- | 2.18 | 2,330,020 | 100 |

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

*Alaska.*—Gold production in Alaska has become stabilized. Excepting the Kennecott copper mine (now idle) and small placers the production of gold for several years past has come chiefly from the low-grade Alaska Juneau lode mine and the 5 modern floating dredge boats of the Fairbanks Exploration Co. in the Yukon district and the 3 modern dredges of the Hammon Consolidated Gold Fields at Nome, both subsidiaries of the United States Smelting, Refining & Mining Co. Fluctuations in dredge output come about through weather conditions. Operations begin in May, unless delayed by a late spring, and close in October, unless stopped by an early winter. Early springs and late winters also have their effect. Weather does not affect the operations of the Alaska Juneau. The following excerpts from the annual report for the calendar year 1933 of the Alaska Juneau Gold

Mining Co. (dated Feb. 28, 1934) review its history and give a clue to its future.

The profit earned during the year was $1,846,105.75 before deductions for depreciation and income tax, but after including payments for gold in excess of the old statutory price of $20.67 per ounce received after August 29.

Resumption of prospecting work in the lower levels of the North Ore Body, temporarily suspended in 1932, is awaiting partial completion of work required to prepare for stoping the block of ground lying below the Gold Creek Tunnel level and above the 1,000-foot level. During the year, therefore, there was no development in new areas, and the underground situation, with the exception of preparatory work, is the same as it was this time last year, and for this reason no mine maps accompany the report. The main shaft and its new hoist equipment will be completed and in operation by July of this year, and thereafter the 53 and 91 winzes, now being used for hoisting ore and for service, will be available for prospecting and developing the North Ore Body below the 1,000-foot level and the South Ore Body below the Gold Creek Tunnel level.

When the new main shaft and hoist go into operation in July mine preparatory work at that time will permit a production of 2,000 tons per day from the lower levels of the North Ore Body. Thereafter production will increase with the progress of mine preparatory work and should rise to 3,000 tons per day by July 1935.

*Gold content of ore—Alaska Juneau Gold Mining Co., Alaska, 1933*

| Month | Tons of rock to mill from mine | | Gold recovery per ton fine milled | | Gold losses per ton tailings | | Gold content of rock per ton from mine to mill [1] |
|---|---|---|---|---|---|---|---|
| | Tons of ore fine milled | Tons coarse tailings rejected | In bullion | In galena concentrates | Fine | Coarse | |
| January | 196,250 | 141,420 | $1.03 | $0.24 | $0.24 | $0.17 | $0.95 |
| February | 190,469 | 124,691 | .96 | .27 | .24 | .17 | .96 |
| March | 212,398 | 142,302 | 1.16 | .33 | .25 | .18 | 1.11 |
| April | 202,718 | 132,312 | 1.07 | .27 | .24 | .17 | 1.02 |
| May | 210,813 | 119,127 | .94 | .27 | .24 | .17 | .98 |
| June | 206,231 | 121,339 | 1.06 | .31 | .25 | .18 | 1.08 |
| July | 202,097 | 133,393 | .98 | .30 | .24 | .17 | .99 |
| August | 211,443 | 125,857 | .96 | .28 | .23 | .17 | .99 |
| September | 204,815 | 145,315 | 1.00 | .30 | .25 | .17 | .97 |
| October | 214,409 | 145,651 | 1.15 | .14 | .25 | .18 | .99 |
| November | 211,927 | 145,403 | 1.05 | .14 | .24 | .17 | .91 |
| December | 203,262 | 142,318 | 1.02 | .09 | .23 | .17 | .86 |
| Total and average | 2,466,832 | 1,619,128 | 1.03 | .24 | .24 | .17 | .98 |

[1] Based on $20.67 per ounce.

*Gold content of ore—Alaska Juneau Gold Mining Co., Alaska, 1893–1933*

| Year | Tons of rock to mill from mine | | Gold recovery per ton fine milled | | Gold losses per ton tailings | | Gold content of rock per ton from mine to mill [1] |
|---|---|---|---|---|---|---|---|
| | Tons of ore fine milled | Tons coarse tailings rejected | In bullion | In galena concentrates | Fine | Coarse | |
| 1893–1913 | 330,278 | 176,976 | $2.14 | $0.20 | $0.40 | $0.15 | $1.71 |
| 1914 | 60,026 | 2,410 | .92 | .18 | .27 | .16 | 1.32 |
| 1915 | 179,892 | ---- | .73 | .30 | .30 | ---- | 1.33 |
| 1916 | 180,113 | ---- | .47 | .14 | .30 | ---- | .94 |
| 1917 | 677,410 | ---- | .34 | .31 | .23 | ---- | .86 |
| 1918 | 574,285 | 17,933 | .58 | .17 | .19 | .15 | .92 |
| 1919 | 616,302 | 76,593 | .64 | .18 | .28 | .19 | .99 |
| 1920 | 637,321 | 305,549 | .91 | .25 | .34 | .22 | 1.08 |
| 1921 | 904,323 | 709,277 | .87 | .20 | .30 | .20 | .86 |
| 1922 | 1,108,559 | 1,201,991 | .91 | .24 | .30 | .20 | .81 |
| 1923 | 1,134,759 | 1,341,481 | 1.03 | .23 | .29 | .19 | .81 |
| 1924 | 1,367,528 | 1,700,662 | 1.10 | .29 | .30 | .20 | .87 |
| 1925 | 1,537,884 | 1,943,896 | 1.02 | .30 | .33 | .22 | .85 |
| 1926 | 1,649,678 | 2,180,022 | .91 | .26 | .30 | .20 | .75 |
| 1927 | 1,839,695 | 2,428,115 | .97 | .30 | .28 | .19 | .77 |
| 1928 | 1,795,191 | 1,922,949 | 1.34 | .41 | .32 | .21 | 1.11 |
| 1929 | 2,020,470 | 1,815,970 | 1.29 | .39 | .28 | .19 | 1.12 |
| 1930 | 2,066,239 | 1,858,221 | 1.20 | .42 | .28 | .19 | 1.10 |
| 1931 | 2,298,998 | 1,863,352 | 1.25 | .37 | .27 | .18 | 1.12 |
| 1932 | 2,414,469 | 1,587,161 | 1.02 | .28 | .24 | .17 | 1.00 |
| 1933 | 2,466,832 | 1,619,128 | 1.03 | .24 | .24 | .17 | .98 |
| Total and average | 25,860,252 | 22,751,686 | 1.05 | .30 | .28 | .19 | .96 |

[1] Based on $20.67 per ounce.

*Gold, silver, and lead recoveries—Alaska Juneau Gold Mining Co., Alaska, 1893–1933*

| | Gold | | Silver | | Lead | | Total value recovered |
|---|---|---|---|---|---|---|---|
| | Fine ounces | Value | Fine ounces | Value | Pounds | Value | |
| 1893–1913 | 34,239.49 | $707,730.15 | (1) | (1) | (1) | (1) | $707,730.15 |
| 1914–15 | 12,174.90 | 251,655.27 | 6,191.63 | $2,889.89 | 117,031 | $6,781.10 | 261,326.26 |
| 1916 | 5,564.70 | 115,022.32 | 2,843.86 | 2,014.75 | 61,068 | 4,341.61 | 121,378.68 |
| 1917 | 20,767.41 | 429,262.38 | 12,247.71 | 10,492.53 | 296,179 | 20,910.88 | 460,665.79 |
| 1918 | 20,809.10 | 430,124.00 | 11,827.84 | 11,704.47 | 273,297 | 17,616.54 | 459,445.01 |
| 1919 | 24,141.34 | 499,001.55 | 16,431.24 | 19,366.95 | 359,762 | 24,345.49 | 542,713.99 |
| 1920 | 35,455.72 | 732,869.71 | 23,347.57 | 23,394.66 | 487,574 | 35,125.62 | 791,389.99 |
| 1921 | 46,913.53 | 969,702.73 | 40,619.27 | 40,371.39 | 550,913 | 25,176.53 | 1,035,250.65 |
| 1922 | 62,707.16 | 1,296,156.95 | 49,404.56 | 49,089.86 | 687,315 | 43,432.46 | 1,388,679.27 |
| 1923 | 69,046.87 | 1,427,198.78 | 41,875.96 | 32,079.58 | 755,423 | 55,495.78 | 1,514,774.14 |
| 1924 | 92,277.39 | 1,907,373.55 | 63,191.25 | 42,501.72 | 1,256,857 | 105,906.62 | 2,055,781.89 |
| 1925 | 98,213.22 | 2,030,067.16 | 55,971.17 | 38,672.49 | 1,288,974 | 115,644.43 | 2,184,384.08 |
| 1926 | 93,422.91 | 1,931,051.65 | 52,333.59 | 31,268.69 | 1,300,915 | 105,516.26 | 2,067,836.60 |
| 1927 | 112,653.11 | 2,328,539.72 | 61,232.30 | 34,695.75 | 1,513,306 | 100,026.91 | 2,463,262.38 |
| 1928 | 152,046.84 | 3,142,808.12 | 77,590.94 | 45,272.35 | 2,038,655 | 127,938.52 | 3,316,018.99 |
| 1929 | 164,993.15 | 3,410,408.33 | 90,635.49 | 46,964.67 | 2,501,832 | 169,874.31 | 3,627,247.31 |
| 1930 | 163,312.00 | 3,375,659.01 | 97,606.71 | 35,004.12 | 2,640,771 | 141,286.90 | 3,551,950.03 |
| 1931 | 179,532.04 | 3,710,927.34 | 118,508.16 | 33,452.37 | 3,309,176 | 135,459.59 | 3,879,839.30 |
| 1932 | 151,578.25 | 3,133,122.39 | 94,519.21 | 25,867.31 | 2,509,263 | 77,193.36 | 3,236,183.06 |
| 1933 | 150,966.84 | [2] 3,829,044.81 | 109,482.71 | 40,488.46 | 2,299,777 | 90,632.19 | 3,960,165.46 |
| | 1,690,815.97 | 35,657,725.92 | 1,025,861.17 | 565,592.01 | 24,248,088 | 1,402,705.10 | 37,626,023.03 |

[1] Lost in tailings.
[2] Includes payments received after September in excess of the old statutory price of $20.67 per ounce.

*Historical summary of operations—Alaska Juneau Gold Mining Co., Alaska, 1893–1933*

| Year | Tons trammed | Gross values recovered | Operating and marketing costs | Gross operating profit |
|---|---|---|---|---|
| 1893–1913 | 507,254 | $707,730.15 | $707,675.92 | $54.23 |
| 1914 | 62,436 | 58,690.64 | 118,045.54 | [1] 59,354.90 |
| 1915 | 179,892 | 214,877.52 | 303,765.97 | [1] 88,888.45 |
| 1916 | 180,113 | 110,443.01 | 297,199.94 | [1] 186,756.93 |
| 1917 | 677,410 | 459,359.56 | 660,370.91 | [1] 201,011.35 |
| 1918 | 592,218 | 459,445.01 | 686,579.96 | [1] 227,134.95 |
| 1919 | 692,895 | 542,713.99 | 703,226.60 | [1] 160,512.61 |
| 1920 | 942,870 | 791,389.99 | 720,050.38 | 71,339.61 |
| 1921 | 1,613,600 | 1,035,250.65 | 1,004,644.87 | 30,605.78 |
| 1922 | 2,310,550 | 1,388,679.27 | 1,160,299.44 | 228,379.83 |
| 1923 | 2,476,240 | 1,514,774.14 | 1,344,713.67 | 170,060.47 |
| 1924 | 3,068,190 | 2,055,781.89 | 1,609,919.25 | 445,862.64 |
| 1925 | 3,481,780 | 2,184,384.08 | 1,826,903.46 | 357,480.62 |
| 1926 | 3,829,700 | 2,067,836.60 | 1,893,342.72 | 174,493.88 |
| 1927 | 4,267,810 | 2,463,262.38 | 2,206,850.23 | 256,412.15 |
| 1928 | 3,718,140 | 3,316,018.99 | 2,159,219.49 | 1,156,799.50 |
| 1929 | 3,836,440 | 3,627,247.31 | 2,233,071.71 | 1,394,175.60 |
| 1930 | 3,924,460 | 3,551,950.03 | 2,289,356.14 | 1,262,593.89 |
| 1931 | 4,162,350 | 3,879,839.30 | 2,394,948.19 | 1,484,891.11 |
| 1932 | 4,001,630 | 3,236,183.06 | 2,154,730.72 | 1,081,452.34 |
| 1933 | 4,085,960 | 3,960,165.46 | 2,179,547.34 | 1,780,618.12 |
| | 48,611,938 | 37,626,023.03 | 28,654,462.45 | 8,971,560.58 |

| Year | Nonoperating expense and revenue net | Depreciation and Federal taxes | Net (before depletion) | Dividends paid |
|---|---|---|---|---|
| 1893–1913 | $9,852.37 | $11,585.48 | [1] $21,383.62 | |
| 1914 | 31,410.75 | | [1] 90,765.65 | |
| 1915 | [2] 17,547.11 | | [1] 71,341.34 | |
| 1916 | [2] 37,659.25 | | [1] 149,097.68 | |
| 1917 | 19,562.58 | | [1] 220,573.93 | |
| 1918 | 98,364.86 | | [1] 325,499.81 | |
| 1919 | 93,468.13 | | [1] 253,980.74 | |
| 1920 | 138,790.68 | | [1] 67,451.07 | |
| 1921 | 199,337.62 | | [1] 168,731.84 | |
| 1922 | 206,238.40 | 166,679.63 | [1] 144,538.20 | |
| 1923 | 200,143.27 | 167,825.67 | [1] 197,908.47 | |
| 1924 | 186,368.81 | 169,213.48 | 90,280.35 | |
| 1925 | 191,592.25 | 176,724.33 | [1] 10,835.96 | |
| 1926 | 208,648.20 | 183,947.18 | [1] 218,101.50 | |
| 1927 | 223,424.29 | 189,553.08 | [1] 156,565.22 | |
| 1928 | 176,700.29 | 198,993.08 | 781,106.13 | |
| 1929 | 129,243.66 | 239,723.51 | 1,025,208.43 | |
| 1930 | 170,860.61 | 260,647.46 | 831,085.82 | |
| 1931 | 85,346.21 | 329,153.93 | 1,070,390.97 | $584,950 |
| 1932 | [2] 6,595.46 | 267,676.93 | 820,370.87 | 720,000 |
| 1933 | [2] 65,487.63 | 348,852.71 | 1,497,253.04 | 1,101,750 |
| | 2,373,038.79 | 2,710,576.47 | 4,018,920.58 | 2,406,700 |

[1] Deficits. [2] Net revenue.

The Twenty-eighth Annual Report of the United States Smelting Refining & Mining Co. for the year ended December 31, 1933 (dated Mar. 22, 1934), contains the following comments on its Alaskan operations:

At Fairbanks, Alaska, the five dredges operated throughout the season. Grade was about the same as in the previous year. Yardage of gravel handled was greater and the gold output was increased. While the water conditions were less satisfactory than in previous years, the reserves of stripped and thawed ground ahead of the dredges were fully maintained. A large new area of gold-dredging ground in the Fairbanks district was prospected and acquired during the year. The work of equipping and preparing this area for operation has been started and will be diligently prosecuted with the aim of bringing it into production as soon as possible. The operation of this area will require at least two new dredges. Values shown by the prospecting already done are satisfactory. As to Nome, it was stated in the report for last year that exploration having failed to develop additional pay ground, it was planned to discontinue operations in that field at the end of the 1933 season. As a result of that plan only 2 of the 3 dredges operated and for only part of the season. While output was reduced, the results for the year were better than in 1932 because of the increased price for gold. However, in view of the increase in the price of gold certain lower grade areas in the Nome fields owned and leased by the company, which could not be profitably dredged under the old statutory price for gold, have become available for future dredging. To these existing areas there have been added, by recent purchase, certain additional areas which provide reserves for the Nome dredges for a number of years. As most of these areas, however, are not prepared for immediate dredging, the output from these fields will necessarily be limited during the next year or two.

*Arizona.*—The increase in gold output in 1933 over 1932 came from the gains at the Lake Superior and Arizona lease at Superior, at the Arizona Gold Mines in the Katherine district of Mohave County, and from the increase from the copper ore of the United Verde Extension. Seventy percent of the gold output of Arizona came from the refinement of copper matte from the three copper smelters at Douglas, Clemenceau, and Superior, which treated custom as well as company ore. New gold production came mainly from lessees' operation of treating by amalgamation oxidized ore from the upper levels of the old Vulture mine in the Vulture Mountains, Maricopa County, from treating by cyanidation the Vulture tailing dump, and from operation of the old Katherine cyanidation mill northwest of Kingman by the Arizona Gold Mines Co.

*California.*—The California gold output came chiefly from the lode mines of the Grass Valley-Nevada City district and from the floating dredge boats of the Sacramento Valley.

*Colorado.*—The Colorado output came chiefly from Cripple Creek, Alma, and the San Juan region. The decrease in Colorado's output is plainly in the falling off of output from one mine—the American—a spectacular producer in 1932 from a 600-foot claim near Alma.

*Idaho.*—Idaho, not a large producer of gold since the early sixties, produced 63,228 ounces in 1933, chiefly from floating dredge boats—2 at Warren, 1 at Pierce, and 1 in Owyhee County—and from lode mines at Stibnite, Orogrande, and Atlanta.

*Montana.*—Montana in 1933 increased its gold production from 40,602 to 57,500 ounces, chiefly from the production of the Jardine, Boss Tweed-Clipper, Liberty-Montana, Story dredge boat, Anaconda Copper Co. at Butte, Gold Coin, and Southern Cross, despite the fact that several Montana mines productive in 1932 either were idle in 1933 or decreased their output.

*Nevada.*—Nevada gold production decreased chiefly because of the decreased output of some of the larger gold producers of 1932 and because of the exhaustion of ore bodies at the Elkoro mine, at Jarbidge. In 1933 only three mines produced over 10,000 ounces each. The leading producer of gold in Nevada was the Nevada Consolidated Copper Co. at Ely, despite being, like most copper mines in the United States, on 20-percent capacity. The other two important producers were the Nevada Porphyry Gold Mines, Inc., at Round Mountain and the White Caps Gold Mining Co. at Tonopah.

*New Mexico.*—New Mexico's small increase came from the increased lead-silver-gold-copper concentrates from the Pecos zinc-lead mine at Tererro, from gold-silver concentrates from Mogollon, and from renewal of operations at Pinos Altos.

*Oregon.*—Oregon's small increase was from an increase in lode-gold operation. Placer operations, including both dredge boats and small-scale placers, produced 14,782.76 ounces, 76 percent of the State total yield, but a decrease compared with the placer output in 1932. The largest dredge boat in Oregon was shut down several times in 1933 by lack of water; two other boats did not begin until early in November.

*South Dakota.*—The South Dakota output of gold came almost entirely from the long-lived (1876 to date) and well-developed Homestake mine at Lead.

*Utah.*—Utah's gold production—109,129.55 ounces—decreased because there was a drop in the gold content for the year in ores mined at the Niagara and United States mines at Bingham which more than offset an increase from the copper ore of the Utah Copper Co., and because of a decrease of 13,194 ounces in the production of the Tintic district; some of these decreases were partly met by the output of the new cyanidation gold mill at Fairfield, reworking the old Mercur mill tailings. The source of gold in Utah in 1933 was as follows: Siliceous ores, 44 percent; copper ores, 33 percent; lead-zinc ores, 20 percent; and lead ores, 3 percent.

*Washington.*—The output of gold from Washington, principally from ore of smelting grade from the Republic district, fell from 5,082 ounces in 1932 to 4,563 in 1933. There was a notable pick-up in shipments from Republic to Trail, British Columbia, when the world price for gold became receivable, after August. The Boundary Red Mountain mine, in Whatcom County, hitherto a relatively large producer of gold, was idle in 1933.

*Wyoming.*—The gold yield from Wyoming, principally from a drag-line gasoline-powered washer placer operation in the Atlantic City district, increased from 257 to 2,200 ounces.

*Mine production of gold in the United States, by regions, 1932–33, and percent increase and decrease, in terms of recovered metals*

[Compiled by Chas. W. Henderson]

| State or Territory | 1932 (fine ounces) | 1933 (fine ounces) | Increase or decrease (fine ounces) | Percent of change | Value | | |
|---|---|---|---|---|---|---|---|
| | | | | | 1932 [1] | 1933 [1] | 1933 [2] |
| Western States and Alaska: | | | | | | | |
| Alaska | [3] 433,193.00 | [3] 457,274.00 | +24,081.00 | +5.6 | $8,954,894 | $9,452,692 | $11,687,923 |
| Arizona | 66,789.67 | [4] 79,250.00 | +12,460.33 | +18.7 | 1,380,665 | 1,638,243 | 2,025,630 |
| California | 569,166.99 | [4] 600,800.00 | +31,633.01 | +5.6 | 11,765,726 | 12,419,638 | 15,356,448 |
| Colorado | 317,927.95 | 242,827.70 | −75,100.25 | −23.6 | 6,572,154 | 5,019,694 | 6,206,676 |
| Idaho | 46,885.39 | [4] 63,228.00 | +16,342.61 | +34.9 | 969,207 | 1,307,039 | 1,616,108 |
| Montana | 40,602.01 | [4] 57,500.00 | +16,897.99 | +41.6 | 839,318 | 1,188,631 | 1,469,700 |
| Nevada | 129,719.83 | [4] 95,000.00 | −34,719.83 | −26.8 | 2,681,547 | 1,963,824 | 2,428,200 |
| New Mexico | 23,208.05 | 26,474.09 | +3,266.04 | +14.1 | 479,753 | 547,268 | 676,678 |
| Oregon | 19,861.21 | 20,239.66 | +378.45 | +1.9 | 410,568 | 418,391 | 517,326 |
| South Dakota | 480,337.58 | 512,403.77 | +32,066.19 | +6.7 | 9,929,459 | 10,592,326 | 13,097,040 |
| Texas | 8.66 | ---------- | −8.66 | ------ | 179 | ---------- | ---------- |
| Utah | 135,256.35 | 109,129.55 | −26,126.80 | −19.3 | 2,795,997 | 2,255,908 | 2,789,351 |
| Washington | 5,082.13 | 4,562.68 | −519.45 | −10.2 | 105,057 | 94,319 | 116,622 |
| Wyoming | 256.63 | 2,199.95 | +1,943.32 | +757.2 | 5,305 | 45,477 | 56,231 |
| | 2,268,295.45 | 2,270,889.40 | +2,593.95 | +1 | 46,889,829 | 46,943,450 | 58,043,933 |

[1] At statutory value of $20.67 plus.
[2] At average weighted value of $25.56.
[3] Refinery receipts reported by U.S. Bureau of the Mint.
[4] Subject to slight revision.

*Mine production of gold in the United States, by regions, 1932–33, and percent increase and decrease, in terms of recovered metals*—Continued

| State or Territory | 1932 (fine ounces) | 1933 (fine ounces) | Increase or decrease (fine ounces) | Percent of change | Value 1932 | Value 1933 | Value 1933 |
|---|---|---|---|---|---|---|---|
| Eastern States: | | | | | | | |
| Alabama | 68.84 | 3.97 | −64.87 | −94.2 | 1,423 | 82 | 101 |
| Georgia | 278.65 | 558.40 | +279.75 | +100.4 | 5,760 | 11,543 | 14,272 |
| Maryland | | 13.50 | +13.50 | | | 279 | 345 |
| North Carolina | 367.22 | 724.64 | +357.42 | +97.3 | 7,591 | 14,980 | 18,522 |
| Pennsylvania | 80.30 | 208.98 | +128.68 | +160.2 | 1,660 | 4,320 | 5,342 |
| South Carolina | 71.01 | 234.57 | +163.56 | +230.3 | 1,468 | 4,849 | 5,996 |
| Tennessee | 160.36 | 223.49 | +63.13 | +39.4 | 3,315 | 4,620 | 5,712 |
| Virginia | 30.81 | 32.22 | +1.41 | +4.6 | 637 | 666 | 824 |
| | 1,057.19 | 1,999.77 | +942.58 | +89.2 | 21,854 | 41,339 | 51,114 |
| Central States: Michigan | | 9.68 | +9.68 | | | 200 | 247 |
| Philippine Islands | 244,297.82 | [3] 279,534.00 | +35,236.18 | +14.4 | 5,050,084 | 5,778,481 | 7,144,889 |
| Puerto Rico | 106.44 | [3] 27.00 | −79.44 | −74.6 | 2,200 | 558 | 690 |
| | 244,404.26 | 279,561.00 | +35,156.74 | +14.4 | 5,052,284 | 5,779,039 | 7,145,579 |
| Grand total | 2,513,756.90 | 2,552,459.85 | +38,702.95 | +1.5 | 51,963,967 | 52,764,028 | [5] 65,240,873 |

[3] Refinery receipts reported by U.S. Bureau of the Mint.
[5] Indicating premium of $12,476,845.

*United States mine production of gold, 1792–1932, compared with Mint estimates.*—The Director of the Mint estimates the production of gold produced in the United States (including the Philippine Islands) from 1792 to 1932 as 226,325,740 ounces, valued at $20.67+ per ounce, or $4,678,568,300. Gold production in the Western States and Alaska from the beginning of production—1848 to 1932, inclusive, totals 227,152,943 ounces, valued at $4,695,668,076. The United States Bureau of Mines calculates the total production of gold for the Eastern States from 1799 to 1932 as 2,478,003 ounces, valued at $51,224,858. The mine production of continental United States and Alaska therefore totals 229,630,946 ounces, valued at $4,746,892,934. The difference can be accounted for in the difference between the Mint and Bureau figures for the first 5 years of California production.

*Gold and silver produced in the United States, 1792–1932*

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint]

| Period | Gold: Fine ounces | Gold: Value | Silver: Fine ounces | Silver: Value |
|---|---|---|---|---|
| 1792–1847 | 1,186,977 | $24,537,000 | 309,500 | $404,500 |
| 1848–72 | 58,279,781 | 1,204,750,000 | 118,568,200 | 157,749,900 |
| 1873–1932 | 166,858,982 | 3,449,281,300 | 3,103,318,677 | 2,362,404,089 |
| | 226,325,740 | 4,678,568,300 | 3,222,196,377 | 2,520,558,489 |

*Gold and silver produced in the Western States of the United States, and Alaska, in terms of recovered metals, 1848–1932*

[Compiled by Chas. W. Henderson]

| State | Period | Gold | | Silver (fine ounces) |
|---|---|---|---|---|
| | | Fine ounces | Value (at $20.67+) | |
| Arizona | 1860–1932 | 7, 798, 720 | $161, 213, 853 | 207, 562, 694 |
| California | 1848–1932 | 90, 176, 810 | 1, 864, 120, 113 | 85, 898, 101 |
| Colorado | 1858–1932 | 35, 162, 526 | 726, 873, 920 | 661, 988, 241 |
| Idaho | 1863–1932 | 6, 717, 303 | 138, 858, 969 | 340, 385, 909 |
| Montana | 1862–1932 | 15, 005, 138 | 310, 183, 743 | 633, 560, 627 |
| Nevada | 1859–1932 | 22, 368, 560 | 462, 399, 166 | 542, 495, 967 |
| New Mexico | 1848–1932 | 1, 843, 539 | 38, 109, 335 | 54, 197, 404 |
| Oregon | 1852–1932 | 5, 014, 193 | 103, 652, 568 | 4, 065, 287 |
| South Dakota | 1876–1932 | 14, 903, 611 | 308, 084, 980 | 8, 009, 821 |
| Texas | 1885–1932 | 4, 608 | 95, 252 | 22, 773, 945 |
| Utah | 1865–1932 | 6, 891, 179 | 142, 453, 322 | 592, 437, 273 |
| Washington | 1860–1932 | 1, 479, 687 | 30, 587, 837 | 9, 324, 502 |
| Wyoming | 1867–1932 | 60, 765 | 1, 256, 124 | 70, 531 |
| Total | | 207, 426, 639 | 4, 287, 889, 182 | 3, 162, 770, 302 |
| Alaska | 1880–1932 | 19, 726, 304 | 407, 778, 894 | 17, 333, 879 |
| Grand total | | 227, 152, 943 | 4, 695, 668, 076 | 3, 180, 104, 181 |

*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 |
| 1881–1890 | 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, 000 | 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 |
| 1932 | 24, 141, 483 | 499, 048, 746 | 164, 757, 002 | 46, 461, 475 | 1 to 6.82 |
| Total, 1493–1932 | 1, 108, 406, 886 | 22, 912, 805, 463 | 15, 335, 029, 104 | 14, 603, 482, 767 | 1 to 13.84 |
| 1933 [2] | 23, 962, 701 | 495, 353, 000 | 160, 000, 000 | 56, 000, 000 | 1 to 6.68 |
| Total, 1493–1933 [2] | 1, 132, 369, 587 | 23, 408, 158, 463 | 15, 495, 029, 104 | 14, 659, 482, 767 | 1 to 13.68 |

[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 1931–33, when London prices were not equivalent to gold and New York prices were used.
[2] Subject to revision.

## SILVER

*Newly mined silver receives 64.6465 cents per ounce by Presidential proclamation of December 21, 1933.*—The record low price of silver was 24⅞ cents on December 3, 1932. The average price of silver in New York in January 1933 was 25.40 cents; the price for London spot silver in January was 16.883 pence. The following table of silver prices for 1933, by months, is taken from Handy and Harman's Annual Review:[4]

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

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

On December 21, 1933, President Roosevelt issued a proclamation that gave 64.6465 cents per fine ounce to the producers of newly mined silver, as follows:

Under the clear authority granted to me by the last session of the Congress, I have today, by proclamation, proceeded to ratify the London agreement with regard to silver, which has already been put into effect by the Government of India, and which I understand other nations concerned are about to act on.

This proclamation, in accordance with the act of Congress, opens our mints to the coinage of standard silver dollars from silver hereafter produced in the United States or its possessions, subject to the depositors of such silver surrendering to the Government one half of it as seigniorage and to cover all usual charges and expenses. The dollars coined from half of such newly mined silver will be returned to the depositor. The half surrendered to the Government will be retained in the Treasury.

It will be remembered that at the London Conference 66 governments unanimously adopted the silver resolution proposed by our Government, providing in substance that these governments would refrain from the policy and practice of melting up and debasing silver coins; that they would replace low-valued paper money with silver coins; and that they would not enact legislation that would depreciate the value of silver in the world market. This resolution, however, was contingent upon an agreement between the governments of those countries producing large quantities of silver and the governments of those countries holding or using large quantities, looking to the elimination of an unnatural oversupply of silver on the markets of the world. This agreement, of course, was for the purpose of allowing demand and supply to govern the price of silver by the limitation and neutralization of this oversupply derived from the melting up of silver coins.

India had the power to dispose of, on the markets of the world, at any time, and at any price, hundreds of millions of ounces of silver. In fact, India had the power and capacity to dump silver derived from the melting up of Indian silver coins in an amount equal to the world's production from the mines for the period of 2 years. This power and the uncertainty attending its execution was destructive of the value and stability of silver throughout the world.

China agreed, during the period of 4 years commencing January 1, 1934, and ending January 1, 1938, not to permit the sale of any silver derived from the debasing or melting up of silver coins. India agreed to limit the sales of such silver to a maximum of 35,000,000 ounces annually during such period and Spain agreed not to sell in excess of 5,000,000 ounces of such silver annually during such period. After such sales, these governments are to be bound by the general resolution adopted at the London Conference to which I have heretofore referred.

As a condition of the agreement by China, India, and Spain, however, it was required that Australia, Canada, Mexico, Peru, and the United States should take silver from the production of their respective mines to the gross amount of 35,000,000 ounces annually for such period of 4 years. The United States, by reason of its large population and its large silver production, agreed to take from its mines annually at least 24,421,410 ounces of silver during such period.

[4] Handy & Harman, Eighteenth Annual Review of the Silver Market and the Gold Situation in the Arts and Industries; New York, 1934, 51 pp., 3 graphs.

The production of the United States for 1932 was approximately 24,000,000 ounces of silver.

## COINAGE OF SILVER

## BY THE PRESIDENT OF THE UNITED STATES OF AMERICA

## A PROCLAMATION

Whereas, by paragraph (2) of section 43, title III, of the act of Congress, approved May 12, 1933 (Public, No. 10), the President is authorized "By proclamation to fix the weight of the gold dollar in grains nine tenths fine and also to fix the weight of the silver dollar in grains nine tenths fine at a definite fixed ratio in relation to the gold dollar at such amounts as he finds necessary from his investigation to stabilize domestic prices or to protect the foreign commerce against the adverse effect of depreciated foreign currencies, and to provide for the unlimited coinage of such gold and silver at the ratio so fixed, * * *"; and

Whereas, from investigations made by me, I find it necessary, in aid of the stabilization of domestic prices and in accordance with the policy and program authorized by Congress, which are now being administered, and to protect our foreign commerce against the adverse effect of depreciated foreign currencies, that the price of silver be enhanced and stabilized; and

Whereas, a resolution presented by the delegation of the United States of America was unanimously adopted at the World Economic and Monetary Conference in London on July 20, 1933, by the representatives of 66 Governments, which in substance provided that said Governments will abandon the policy and practice of melting up or debasing silver coins; that low-valued silver currency be replaced with silver coins and that no legislation should be enacted that will depreciate the value of silver; and

Whereas, a separate and supplemental agreement was entered into, at the instance of the representatives of the United States, between China, India, and Spain, the holders and users of large quantities of silver on the one hand, and Australia, Canada, Mexico, Peru, and the United States on the other hand, as the chief producers of silver, wherein China agreed not to dispose of any silver derived from the melting up or debasement of silver coins, and India agreed not to dispose of over 35,000,000 ounces of silver per annum during a period of 4 years commencing January 1, 1934, and Spain agreed not to dispose of over 5,000,000 ounces of silver annually during said period, and both of said Governments agreed that at the end of said period of 4 years they would then subject themselves to the general resolution adopted at the London Conference, and in consideration of such limitation it was agreed that the Governments of the five producing countries would each absorb from the mines in their respective countries a certain amount of silver, the total amount to be absorbed by said producing countries being 35,000,000 ounces per annum during the 4 years commencing the 1st day of January 1934; that such silver so absorbed would be retained in each of said respective countries for said period of 4 years, to be used for coinage purposes or as reserves for currency, or to otherwise be retained and kept off the world market during such period of time, it being understood that of the 35,000,000 ounces the United States was to absorb annually at least 24,421,410 ounces of the silver produced in the United States during such period of time.

Now, therefore, finding it proper to cooperate with other Governments and necessary to assist in increasing and stabilizing domestic prices, to augment the purchasing power of peoples in silver-using countries, to protect our foreign commerce against the adverse effect of depreciated foreign currencies, and to carry out the understanding between the 66 Governments that adopted the resolution hereinbefore referred to; by virtue of the power in me vested by the act of Congress above cited, the other legislation designated for national recovery, and by virtue of all other authority in me vested;

I, Franklin D. Roosevelt, President of the United States of America, do proclaim and direct that each United States coinage mint shall receive for coinage into standard silver dollars any silver which such mint, subject to regulations prescribed hereunder by the Secretary of the Treasury, is satisfied has been mined, subsequently to the date of this proclamation, from natural deposits in the United States or any place subject to the jurisdiction thereof. The Director of the Mint, with the voluntary consent of the owner, shall deduct and retain of such silver so received 50 percent as seigniorage and for services performed by the Government of the United States relative to the coinage and delivery of silver dollars. The balance of such silver so received, that is, 50 percent thereof, shall be coined into standard silver dollars and the same, or an equal number of other standard silver dollars, shall be delivered to the owner or depositor of such silver. The 50 percent of such silver so deducted shall be retained as bullion by the Treasury and shall not be disposed of prior to the 31st day of December 1937, except for coining into United States coins.

The Secretary of the Treasury is authorized to prescribe regulations to carry out the purposes of this proclamation. Such regulations shall contain provisions substantially similar to the provisions contained in the regulations made pursuant to the act of Congress, approved April 23, 1918 (40 Statutes at Large, page 535), known as the Pittman Act, with such changes as he shall determine prescribing how silver mined, subsequently to the date of this proclamation from natural deposits in the United States or any place subject to the jurisdiction thereof, shall be identified.

This proclamation shall remain in force and effect until the 31st day of December 1937, unless repealed or modified by act of Congress or by subsequent proclamation.

The present ratio in weight and fineness of the silver dollar to the gold dollar shall, for the purposes of this proclamation, be maintained until changed by further order or proclamation.

Notice is hereby given that I reserve the right by virtue of the authority vested in me to revoke or modify this proclamation as the interest of the United States may seem to require.

In witness whereof I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the city of Washington this 21st day of December, in the year of our Lord nineteen hundred and thirty-three and of the independence of the United States of America the one hundred and fifty-eighth.

FRANKLIN D. ROOSEVELT.

*By the President:*
WILLIAM PHILLIPS,
*Acting Secretary of State.*

*Silver regulations.*—Silver regulations were prescribed under authority of paragraph (2), section 43, title III, of the act of Congress approved May 12, 1933 (Public, No. 10), and the President's proclamation of December 21, 1933, relating to the receipt and coinage of silver mined in the United States or any place subject to the jurisdiction thereof.

ARTICLE 1. *Silver which will be received.*—The United States coinage mints, under the conditions hereinafter specified and subject to the appropriate regulations governing the mints, will receive silver which any such mint is satisfied has been mined subsequent to December 21, 1933 from natural deposits in the United States or any place subject to the jurisdiction thereof. Such mints will also receive silver which forms a part of a mixture of domestic, secondary, and foreign silver provided such mints are satisfied that the aggregate amount of such mixture so received does not exceed the amount thereof which has been mined subsequent to December 21, 1933 from natural deposits in the United States or any place subject to the jurisdiction thereof.

*   *   *   *   *   *   *

ARTICLE 4. *Settlement for silver delivered.*—The Director of the Mint, pursuant to the voluntary consent of the depositor as required in the form of agreement to be executed in connection with affidavit TS–1, shall retain of such silver so delivered, 50 percent as seigniorage and for services performed by the Government of the United States, and the balance of such silver so received, that is, 50 percent thereof, shall be coined into standard silver dollars and the same, or an equal number of other standard silver dollars, shall be delivered to the owner or depositor of such silver. Any fractional part of $1 due hereunder shall be returned in any legal tender coin of the United States.

*   *   *   *   *   *   *

## UNITED STATES SILVER-MINING OPERATIONS

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

*Silver produced in the United States, by percentage of sources, as reported by mines, 1922–32, and total fine ounces* [1]

| Year | Placers | Dry and siliceous ore | Copper ore | Lead ore | Zinc ore | Copper-lead and copper-lead-zinc ores | Lead-zinc ore | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Fine ounces | Percent |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *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 | .16 | 14.63 | 32.07 | 20.48 | .02 | 9.35 | 23.29 | 29,856,628 | 100.00 |
| 1932 | .28 | 17.29 | 22.78 | 21.53 | .01 | 14.83 | 23.28 | 22,739,669 | 100.00 |

[1] Philippine Islands and Puerto Rico excluded.

*Alaska.*—Silver production in Alaska is mainly a byproduct. When operating, the Kennecott Copper Co. produced the bulk of the silver from Alaska. In 1933 the copper mines were idle; the Alaska Juneau mine produced 109,000 ounces.

*Arizona.*—Copper ores in Arizona yielded 87, 90, 89, and 89 percent, respectively, of the silver of Arizona in 1929, 1930, 1931, and 1932. As an index of silver production, copper production was respectively 415,314 tons in 1929, 288,095 tons in 1930, 200,672 tons in 1931, 91,944 tons in 1932, and 56,600 tons in 1933.

*California.*—Silver production in California has always been mainly a byproduct of the gold quartz mines, but some has also come from lead-silver and copper mines. The State also has made some silver production from nearly straight silver mines at Randsburg.

*Colorado.*—Colorado increased its silver output in 1933. The largest producing county was Eagle, with 1,484,143 ounces, principally from iron-copper-silver fluxing sulphide ores shipped from Gilman mainly to Utah smelters, where they were needed because of a lack of iron in Utah ores. The next largest county was San Juan, with 389,640 ounces, chiefly from lead-copper-gold-silver concentrates from the Shenandoah-Dives mill at Silverton.

*Idaho.*—Silver production in Idaho was 7,010,000 ounces compared with 6,716,968 ounces in 1932. In 1933 Idaho became the largest silver-producing State in the United States. The Coeur d'Alene district produced at least 6,750,000 ounces of silver. About 47 percent of the silver was recovered from the ore of the Sunshine mine, the largest producing silver mine in the United States. The Sunshine mine in 1933 increased its yield over that of 1932, with an output of twice the quantity of any other large silver producer in Idaho. Other large silver producers were the Bunker Hill & Sullivan at Kellogg, the Hecla at Burke, the Morning of the Federal Mining & Smelting Co. at Mullan, and the Crescent property adjacent to the Sunshine near Kellogg. The increased output of silver in 1933 was due chiefly to the increased production of lead-zinc-silver ore from the Morning mine.

*Montana.*—The output of silver in Montana increased in 1933 compared with that of 1932 because of the opening in 1933 of the Emma and Orphan Girl zinc-lead-silver mines at Butte. Copper ores from Butte yielded silver in 1933 in about the same quantity as in 1932. The Trout Mining Co. at Philipsburg contributed much silver in its lead-zinc-silver ore shipped to the custom lead-zinc milling plant at Anaconda.

*Nevada.*—Silver production in Nevada declined from 1,304,365 ounces in 1932 to 1,076,000 in 1933. The leading silver producers in 1933 were the Tonopah Mining Co. at Tonopah, Esmeralda County; Combined Metals Reduction Co. at Pioche, Lincoln County; Nevada Consolidated Copper Corporation at Ely, White Pine County; Bristol Silver Mines Co., Jack Rabbit district, Lincoln County; Gold Circle Consolidated Mines Co., Gold Circle, Elko County; and Treadwell Yukon Co., Ltd., at Tybo, Nye County.

*New Mexico.*—Mine production of recoverable silver in New Mexico was 1,181,580 ounces in 1933 compared with 1,142,351 ounces in 1932. San Miguel County produced 53 percent of the total in 1933, all from the lead-zinc-copper-silver-gold ore of the Pecos mine in the Willow Creek district; Grant County, 36 percent, chiefly from the Central district; Catron County, 11 percent, from the Mogollon district. Lead-zinc ore from Grant and San Miguel Counties yielded 84.32 percent of the total silver; dry and siliceous ores, chiefly from Catron County, 11.87 percent; copper-lead ore, from Grant County, 1.89 percent; copper ore, chiefly from Grant County, 1.58 percent; and lead ore, chiefly from Dona Ana and Grant Counties, 0.32 percent.

*Oregon.*—Silver production was nominal in Oregon for both 1932 and 1933.

*South Dakota.*—Silver in South Dakota is a byproduct of the Homestake gold mine.

*Texas.*—Texas produced only 160 ounces of silver in 1933. The State output has been 22,774,105 ounces from the beginning of production—1885 to 1933, inclusive. It also has reserves of silver ore at the Presidio mine at Shafter, which was reopened in January 1934 following the President's proclamation of December 21, 1933 granting 64.6465 cents to newly mined silver. The Hazel mine north of Van Horn has also produced silver.

*Utah.*—Utah, in a position to increase silver production because of large developed ore bodies but actually producing during the last 3 years largely to provide employment, yielded 5,669,197 ounces in 1933 compared with 6,962,097 ounces in 1932. The State dropped to second place as a silver producer, following Idaho. Lead-zinc ore yielded 57 percent of the total silver; lead ore, 20 percent; siliceous ore, 16 percent; copper ore, about 7 percent. The leading producers of silver in Utah in 1933, in order of output, were the Silver King Coalition, United States Smelting, Refining & Mining (including Lark), Tintic Standard, Eureka Standard, and Utah Copper companies. The building of a lead refinery at Midvale by the United States Smelting, Refining & Mining Co. was the largest new construction in Utah in 1933. The gold output from the company's Alaska operations are refined at this plant.

*Washington.*—The output of silver from Washington was 18,520 ounces, of which 75 percent came from the siliceous gold ore of the Republic district and 18 percent from the lead-zinc ore from the Josephine mine at Metaline Falls.

*Wyoming.*—Silver production in Wyoming is nominal.

*Mine production of silver in the United States, by regions, 1932–33, and percent increase and decrease in terms of recovered metals*

[Compiled by Chas. W. Henderson]

| State or Territory | 1932 (fine ounces) | 1933 (fine ounces) | Increase (+) or decrease (−) (fine ounces) | Percent of change |
|---|---|---|---|---|
| Western States and Alaska: | | | | |
| Alaska | [1] 256,673 | [1] 155,335 | −101,338 | −39.5 |
| Arizona | 2,082,823 | [2] 2,375,000 | +292,177 | +14.0 |
| California | 493,533 | [2] 385,000 | −108,533 | −22.0 |
| Colorado | 1,860,408 | 2,186,140 | +325,732 | +17.5 |
| Idaho | 6,716,968 | [2] 7,010,000 | +293,032 | +4.4 |
| Montana | 1,686,213 | [2] 2,650,000 | +963,787 | +57.2 |
| Nevada | 1,304,365 | [2] 1,076,000 | −228,365 | −17.5 |
| New Mexico | 1,142,351 | 1,181,580 | +39,229 | +3.4 |
| Oregon | 8,616 | 20,760 | +12,144 | +140.9 |
| South Dakota | 126,195 | 125,417 | −778 | −.6 |
| Texas | 1,422 | 160 | −1,262 | −88.7 |
| Utah | 6,962,097 | 5,669,197 | −1,292,900 | −18.6 |
| Washington | 17,412 | 18,520 | +1,108 | +6.4 |
| Wyoming | 195 | 260 | +65 | +33.3 |
| Total | 22,659,271 | 22,853,369 | +194,098 | +.9 |
| Eastern States: | | | | |
| Alabama | 10 | | −10 | |
| Georgia | 30 | 65 | +35 | +116.7 |
| North Carolina | 10,045 | 11,492 | +1,447 | +14.4 |
| Pennsylvania | 830 | 2,300 | +1,470 | +177.1 |
| South Carolina | 5 | 103 | +98 | +1,960.0 |
| Tennessee | 19,300 | 39,869 | +20,569 | +106.6 |
| Virginia | 8 | | −8 | |
| Total | 30,228 | 53,829 | +23,601 | +78.1 |
| Central States: | | | | |
| Illinois | 257 | 1,422 | +1,165 | +453.3 |
| Michigan | 71,408 | [1] 125,926 | +54,518 | +76.3 |
| Missouri | 1,128 | | −1,128 | |
| Total | 72,793 | 127,348 | +54,555 | +74.9 |
| Philippine Islands | 160,184 | [1] 181,371 | +21,187 | +13.2 |
| Puerto Rico | 12 | [1] 2 | −10 | −83.3 |
| Total | 160,196 | 181,373 | +21,177 | +13.2 |
| Grand total | 22,922,488 | 23,215,919 | +293,431 | +1.3 |

[1] Refinery receipts reported by U.S. Bureau of the Mint.
[2] Subject to slight revision.

The following tables on (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:

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

| Year | Ratio | Year | Ratio |
|---|---|---|---|
| 1687 | 14.94 | 1762 | 15.27 |
| 1688 | 14.94 | 1763 | 14.99 |
| 1689 | 15.02 | 1764 | 14.70 |
| 1690 | 15.02 | 1765 | 14.83 |
| 1691 | 14.98 | 1766 | 14.80 |
| 1692 | 14.92 | 1767 | 14.85 |
| 1693 | 14.83 | 1768 | 14.80 |
| 1694 | 14.87 | 1769 | 14.72 |
| 1695 | 15.02 | 1770 | 14.62 |
| 1696 | 15.00 | 1771 | 14.66 |
| 1697 | 15.20 | 1772 | 14.52 |
| 1698 | 15.07 | 1773 | 14.62 |
| 1699 | 14.94 | 1774 | 14.62 |
| 1700 | 14.81 | 1775 | 14.72 |
| 1701 | 15.07 | 1776 | 14.55 |
| 1702 | 15.52 | 1777 | 14.54 |
| 1703 | 15.17 | 1778 | 14.68 |
| 1704 | 15.22 | 1779 | 14.80 |
| 1705 | 15.11 | 1780 | 14.72 |
| 1706 | 15.27 | 1781 | 14.78 |
| 1707 | 15.44 | 1782 | 14.42 |
| 1708 | 15.41 | 1783 | 14.48 |
| 1709 | 15.31 | 1784 | 14.70 |
| 1710 | 15.22 | 1785 | 14.92 |
| 1711 | 15.29 | 1786 | 14.96 |
| 1712 | 15.31 | 1787 | 14.92 |
| 1713 | 15.24 | 1788 | 14.65 |
| 1714 | 15.13 | 1789 | 14.75 |
| 1715 | 15.11 | 1790 | 15.04 |
| 1716 | 15.09 | 1791 | 15.05 |
| 1717 | 15.13 | 1792 | 15.17 |
| 1718 | 15.11 | 1793 | 15.00 |
| 1719 | 15.09 | 1794 | 15.37 |
| 1720 | 15.04 | 1795 | 15.55 |
| 1721 | 15.05 | 1796 | 15.65 |
| 1722 | 15.17 | 1797 | 15.41 |
| 1723 | 15.20 | 1798 | 15.59 |
| 1724 | 15.11 | 1799 | 15.74 |
| 1725 | 15.11 | 1800 | 15.68 |
| 1726 | 15.15 | 1801 | 15.46 |
| 1727 | 15.24 | 1802 | 15.26 |
| 1728 | 15.11 | 1803 | 15.41 |
| 1729 | 14.92 | 1804 | 15.41 |
| 1730 | 14.81 | 1805 | 15.79 |
| 1731 | 14.94 | 1806 | 15.52 |
| 1732 | 15.09 | 1807 | 15.43 |
| 1733 | 15.18 | 1808 | 16.08 |
| 1734 | 15.39 | 1809 | 15.96 |
| 1735 | 15.41 | 1810 | 15.77 |
| 1736 | 15.18 | 1811 | 15.53 |
| 1737 | 15.02 | 1812 | 16.11 |
| 1738 | 14.91 | 1813 | 16.25 |
| 1739 | 14.91 | 1814 | 15.04 |
| 1740 | 14.94 | 1815 | 15.26 |
| 1741 | 14.92 | 1816 | 15.28 |
| 1742 | 14.85 | 1817 | 15.11 |
| 1743 | 14.85 | 1818 | 15.35 |
| 1744 | 14.87 | 1819 | 15.33 |
| 1745 | 14.98 | 1820 | 15.62 |
| 1746 | 15.13 | 1821 | 15.95 |
| 1747 | 15.26 | 1822 | 15.80 |
| 1748 | 15.11 | 1823 | 15.84 |
| 1749 | 14.80 | 1824 | 15.82 |
| 1750 | 14.55 | 1825 | 15.70 |
| 1751 | 14.39 | 1826 | 15.76 |
| 1752 | 14.50 | 1827 | 15.74 |
| 1753 | 14.54 | 1828 | 15.78 |
| 1754 | 14.48 | 1829 | 15.78 |
| 1755 | 14.68 | 1830 | 15.82 |
| 1756 | 14.94 | 1831 | 15.72 |
| 1757 | 14.87 | 1832 | 15.73 |
| 1758 | 14.85 | 1833 | 15.93 |
| 1759 | 14.15 | 1834 | 15.73 |
| 1760 | 14.14 | 1835 | 15.80 |
| 1761 | 14.54 | 1836 | 15.72 |

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

| Year | Ratio | Year | Ratio |
|---|---|---|---|
| 1837 | 15.83 | 1886 | 20.78 |
| 1838 | 15.85 | 1887 | 21.10 |
| 1839 | 15.62 | 1888 | 22.00 |
| 1840 | 15.62 | 1889 | 22.10 |
| 1841 | 15.70 | 1890 | 19.75 |
| 1842 | 15.87 | 1891 | 20.92 |
| 1843 | 15.93 | 1892 | 23.72 |
| 1844 | 15.85 | 1893 | 26.49 |
| 1845 | 15.92 | 1894 | 32.56 |
| 1846 | 15.90 | 1895 | 31.60 |
| 1847 | 15.80 | 1896 | 30.59 |
| 1848 | 15.85 | 1897 | 34.20 |
| 1849 | 15.78 | 1898 | 35.03 |
| 1850 | 15.70 | 1899 | 34.36 |
| 1851 | 15.46 | 1900 | 33.33 |
| 1852 | 15.59 | 1901 | 34.68 |
| 1853 | 15.33 | 1902 | 39.15 |
| 1854 | 15.33 | 1903 | 38.10 |
| 1855 | 15.38 | 1904 | 35.70 |
| 1856 | 15.38 | 1905 | 33.87 |
| 1857 | 15.27 | 1906 | 30.54 |
| 1858 | 15.38 | 1907 | 31.24 |
| 1859 | 15.19 | 1908 | 38.64 |
| 1860 | 15.29 | 1909 | 39.74 |
| 1861 | 15.50 | 1910 | 38.22 |
| 1862 | 15.35 | 1911 | 38.33 |
| 1863 | 15.37 | 1912 | 33.62 |
| 1864 | 15.37 | 1913 | 34.19 |
| 1865 | 15.44 | 1914 | 37.37 |
| 1866 | 15.43 | 1915 | 40.48 |
| 1867 | 15.57 | 1916 | 30.78 |
| 1868 | 15.59 | 1917 | 24.61 |
| 1869 | 15.60 | 1918 | 21.00 |
| 1870 | 15.57 | 1919 | 18.44 |
| 1871 | 15.57 | 1920 | 20.28 |
| 1872 | 15.63 | 1921 | 32.76 |
| 1873 | 15.93 | 1922 | 30.43 |
| 1874 | 16.16 | 1923 | 31.69 |
| 1875 | 16.64 | 1924 | 30.80 |
| 1876 | 17.75 | 1925 | 29.78 |
| 1877 | 17.20 | 1926 | 33.11 |
| 1878 | 17.92 | 1927 | 36.47 |
| 1879 | 18.39 | 1928 | 35.34 |
| 1880 | 18.05 | 1929 | 38.78 |
| 1881 | 18.25 | 1930 | 53.74 |
| 1882 | 18.20 | 1931 | 71.25 |
| 1883 | 18.64 | 1932 | 73.29 |
| 1884 | 18.61 | 1933 | [1] 59.06 |
| 1885 | 19.41 | | |

[1] Compared with $20.67+ for gold.

*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 | 1904 | $0. 62500 | $0. 53375 | $0. 57843 |
| 1875 | 1. 26125 | 1. 21000 | 1. 23883 | 1905 | . 66500 | . 55625 | . 61008 |
| 1876 | 1. 26000 | 1. 03500 | 1. 14950 | 1906 | . 72375 | . 63125 | . 67379 |
| 1877 | 1. 26000 | 1. 16000 | 1. 19408 | 1907 | . 71000 | . 52750 | . 65978 |
| 1878 | 1. 20750 | 1. 08500 | 1. 15429 | 1908 | . 58875 | . 48250 | . 53496 |
| 1879 | 1. 16750 | 1. 06500 | 1. 12088 | 1909 | . 54500 | . 50750 | . 52163 |
| 1880 | 1. 15000 | 1. 11250 | 1. 13931 | 1910 | . 57625 | . 50750 | . 54245 |
| 1881 | 1. 14500 | 1. 11000 | 1. 12823 | 1911 | . 57500 | . 52125 | . 54002 |
| 1882 | 1. 15000 | 1. 09000 | 1. 13855 | 1912 | . 65625 | . 55250 | . 62006 |
| 1883 | 1. 11750 | 1. 09500 | 1. 10874 | 1913 | . 65125 | . 58000 | . 61241 |
| 1884 | 1. 13250 | 1. 08000 | 1. 11161 | 1914 | . 60875 | . 49000 | . 56331 |
| 1885 | 1. 09500 | 1. 02750 | 1. 06428 | 1915 | . 58000 | . 47750 | . 51026 |
| 1886 | 1. 03500 | . 92500 | . 99880 | 1916 | . 79125 | . 57250 | . 67151 |
| 1887 | 1. 03500 | . 95000 | . 97899 | 1917 | 1. 16500 | . 73125 | . 84000 |
| 1888 | . 97750 | . 92000 | . 94300 | 1918 | 1. 01937 | . 88937 | . 98445 |
| 1889 | . 97250 | . 92500 | . 93634 | 1919 | 1. 38250 | 1. 01375 | 1. 12087 |
| 1890 | 1. 20500 | . 95750 | 1. 05329 | 1920 | 1. 37875 | . 60375 | 1. 01940 |
| 1891 | 1. 07500 | . 94750 | . 99033 | 1921 | . 73813 | . 53188 | . 63096 |
| 1892 | . 95250 | . 83000 | . 87552 | 1922 | . 74188 | . 62875 | . 67934 |
| 1893 | . 85000 | . 65000 | . 78219 | 1923 | . 69000 | . 62875 | . 65239 |
| 1894 | . 70000 | . 59500 | . 64043 | 1924 | . 72375 | . 63000 | . 67111 |
| 1895 | . 69000 | . 60000 | . 66268 | 1925 | . 73187 | . 66812 | . 69406 |
| 1896 | . 70250 | . 65625 | . 68195 | 1926 | . 68937 | . 51812 | . 62428 |
| 1897 | . 66125 | . 52750 | . 60774 | 1927 | . 60312 | . 54187 | . 56680 |
| 1898 | . 62250 | . 55125 | . 59064 | 1928 | . 63937 | . 56812 | . 58488 |
| 1899 | . 64750 | . 58625 | . 60507 | 1929 | . 57812 | . 46812 | . 53306 |
| 1900 | . 65750 | . 59750 | . 62065 | 1930 | . 47187 | . 31062 | . 38466 |
| 1901 | . 64500 | . 54750 | . 59703 | 1931 | . 37562 | . 26062 | . 29013 |
| 1902 | . 56875 | . 47375 | . 52815 | 1932 | . 31312 | . 24562 | . 28204 |
| 1903 | . 62375 | . 47500 | . 54208 | 1933 | . 45312 | . 24812 | . 34997 |

# COPPER

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

SUMMARY OUTLINE



In 1933 the copper industry recovered substantially from the depth of depression that was reached at the end of 1932, with a net result that the statistics of the 2 years are in some respects similar. World production, as shown by preliminary data, and domestic refinery production increased although domestic smelter production did not equal that of the previous year. Apparent domestic consumption, as measured by withdrawals of metal on domestic account, and exports increased, while imports and domestic stocks decreased. The yearly average price of copper delivered increased very slightly. Consumption abroad is reported to have increased, while stocks were materially reduced.

In the United States protracted negotiations for establishment of a copper code by the National Industrial Recovery Administration were an outstanding feature of the year. Many difficulties were encountered that prevented agreement among the many interests concerned, so that the code did not finally go into effect until April 26, 1934.

Features of the code are: (1) A 40-hour maximum working week, averaged over a 3-month period; (2) minimum wages, ranging from 30 cents to 47½ cents an hour, specified for 5 areal subdivisions of the United States; (3) allocation of 20,500 tons a month, with sales quotas specified for each primary producer, based upon their relative annual production capacities, the quotas being as follows:

| | Tons per annum | Monthly percentage sales quotas |
|---|---|---|
| Kennecott Copper Corporation | 366,500 | 1.67 |
| Anaconda Copper Mining Co. | 225,000 | 1.67 |
| Phelps Dodge Corporation | 168,000 | 1.67 |
| United Verde Copper Co. | 68,000 | 1.90 |
| Calumet & Hecla Consolidated Copper Co. | 50,000 | 2.20 |
| Miami Copper Co. | 36,000 | 2.30 |
| Magma Copper Co. | 25,000 | 2.50 |
| United Verde Extension Mining Co. | 24,000 | 2.50 |
| Consolidated Copper Mines Co. | 21,000 | 2.70 |
| Copper Range Co. | 17,500 | 3.00 |

In addition 9,500 tons a month will be allocated to secondary producers. The code includes no fixing of prices.

*Prices.*—Reports to the Bureau of Mines from copper-selling agencies in the United States indicate that 775,619,000 pounds of copper were delivered to domestic and foreign purchasers in 1933, at an average price (f.o.b. refinery) of 6.4 cents per pound. These deliveries are exclusive of copper produced and delivered outside of the United States. The average price for 1933 was 0.1 cent higher than that for 1932, the lowest on record, and was only 40 percent of the average price of 15.9 cents a pound for the entire production of the United States for the 88-year period, 1845–1932; it was only 38 percent of the average price of 16.7 cents for the 20-year period, 1913–32. 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.

*Average monthly prices at New York (refinery equivalent) per pound of electrolytic copper, 1929–33, in cents, as reported by the American Metal Market Co. and Engineering and Mining Journal*

| Month | American Metal Market Co. | | | | | Engineering and Mining Journal | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1929 | 1930 | 1931 | 1932 | 1933 | 1929 | 1930 | 1931 | 1932 | 1933 |
| January | 16.72 | 17.87 | 9.90 | 7.21 | 4.87 | 16.603 | 17.775 | 9.838 | 7.060 | 4.775 |
| February | 17.92 | 17.87 | 9.83 | 6.12 | 4.87 | 17.727 | 17.775 | 9.724 | 5.965 | 4.775 |
| March | 21.26 | 17.87 | 10.02 | 5.87 | 5.13 | 21.257 | 17.775 | 9.854 | 5.763 | 5.011 |
| April | 19.80 | 15.74 | 9.57 | 5.06 | 5.56 | 19.500 | 15.621 | 9.392 | 5.565 | 5.395 |
| May | 17.87 | 12.83 | 8.81 | 5.38 | 6.81 | 17.775 | 12.756 | 8.665 | 5.237 | 6.698 |
| June | 17.87 | 12.24 | 8.18 | 5.26 | 7.87 | 17.775 | 12.049 | 8.025 | 5.145 | 7.773 |
| July | 17.87 | 11.15 | 7.80 | 5.16 | 8.78 | 17.775 | 11.023 | 7.698 | 5.053 | 8.635 |
| August | 17.87 | 10.79 | 7.40 | 5.31 | 8.87 | 17.775 | 10.693 | 7.292 | 5.219 | 8.768 |
| September | 17.91 | 10.46 | 7.13 | 6.08 | 8.87 | 17.775 | 10.310 | 6.988 | 5.978 | 8.753 |
| October | 17.87 | 9.70 | 6.89 | 5.85 | 8.13 | 17.775 | 9.597 | 6.775 | 5.733 | 7.950 |
| November | 17.87 | 10.25 | 6.67 | 5.18 | 8.03 | 17.775 | 10.113 | 6.558 | 5.131 | 7.881 |
| December | 17.87 | 10.49 | 6.72 | 4.91 | 8.00 | 17.775 | 10.300 | 6.580 | 4.813 | 7.885 |
| Average | 18.23 | 13.11 | 8.24 | 5.67 | 7.15 | 18.107 | 12.982 | 8.116 | 5.555 | 7.025 |

The following table shows world production and the salient domestic statistics on copper for the 5-year period 1925–29 and for 1930, 1931, 1932, and 1933. Figure 3 shows similar details by years for the period 1910–33.

*World production and salient domestic statistics of copper, 1925–33*

[All tonnage figures in short tons]

| | Average 1925–29 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| World smelter production, new copper | 1,761,000 | 1,735,000 | 1,522,000 | 1,031,000 | [1] 1,091,000 |
| Percent of 1925–29 average | 100 | 99 | 86 | 59 | 62 |
| United States production: | | | | | |
| New copper— | | | | | |
| From domestic ores, as reported by— | | | | | |
| Mines | 885,826 | 705,074 | 528,875 | 238,111 | [2] 195,440 |
| Ore produced: | | | | | |
| Copper ore | 59,505,871 | [3] 47,381,509 | [3] 34,050,961 | (4) | (4) |
| Average yield of copper, percent | 1.44 | 1.43 | 1.50 | (4) | (4) |
| Copper-lead and copper-lead-zinc ores | 307,897 | 246,430 | 213,245 | (4) | (4) |
| Smelters | 892,730 | 697,195 | 521,356 | 272,005 | 225,000 |
| Value of copper produced | $263,484,400 | $181,271,000 | $94,887,000 | $34,273,000 | $28,800,000 |
| Percent of 1925–29 average | 100 | 69 | 36 | 13 | 11 |
| Refineries | 890,767 | 695,612 | 537,303 | 222,539 | 240,669 |
| Percent of 1925–29 average | 100 | 78 | 60 | 25 | 27 |
| Percent of world production represented | 50.6 | 40.0 | 35.4 | 21.6 | 22.1 |
| Classification of product, percent: | | | | | |
| Electrolytic | 89.8 | 88 | 88 | 84 | 88 |
| Lake | 9.8 | 10 | 10 | 12 | 12 |
| Casting | 0.4 | 2 | 2 | 4 | ---------- |
| From foreign ores, matte, etc., refinery reports | 317,287 | 382,918 | 213,418 | 117,895 | 130,120 |
| Percent of 1925–29 average | 100 | 120 | 67 | 37 | 41 |
| Total new refined, domestic and foreign | 1,208,054 | 1,078,530 | 750,721 | 340,434 | 370,789 |
| Percent of 1925–29 average | 100 | 89 | 62 | 28 | 31 |
| Percent of world production represented | 68.6 | 62 | 49 | 33 | 34 |
| Secondary copper recovered from old scrap only | 347,512 | 342,200 | 261,300 | 180,900 | 260,300 |
| Copper content of copper sulphate produced by refiners | 4,601 | 4,710 | 4,492 | 3,173 | 3,240 |
| Total production, new and old and domestic and foreign | 1,560,167 | 1,425,440 | 1,016,513 | 524,507 | 634,329 |
| Percent of 1925–29 average | 100 | 91 | 65 | 34 | 41 |
| Imports (unmanufactured) | 391,212 | 408,577 | 292,946 | 195,996 | 145,585 |
| Refined | 59,236 | 43,105 | 87,225 | 83,897 | 5,432 |
| Exports of metallic copper [5] | 522,616 | 376,557 | 278,787 | 147,678 | 151,913 |
| Refined (ingots, bars, rods, etc.) | 482,868 | 334,626 | 232,114 | 125,029 | 132,371 |
| Stocks at end of year | 307,200 | 532,500 | 636,300 | 691,000 | 600,500 |
| Refined copper | 86,100 | 307,500 | 462,300 | 502,000 | 406,500 |
| Blister and materials in solution | 221,100 | 225,000 | 174,000 | 189,000 | 194,000 |
| Withdrawals from total supply on domestic account: | | | | | |
| Total new copper | 778,123 | 632,509 | 451,032 | 259,602 | 339,350 |
| Percent of 1925–29 average | 100 | 81 | 58 | 33 | 44 |
| Total new and old copper | 1,288,700 | 1,099,500 | 798,000 | 508,000 | 677,500 |
| Price, average cents per pound | 14.7 | 13.0 | 9.1 | 6.3 | 6.4 |

[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 production has been adopted as the official production of this

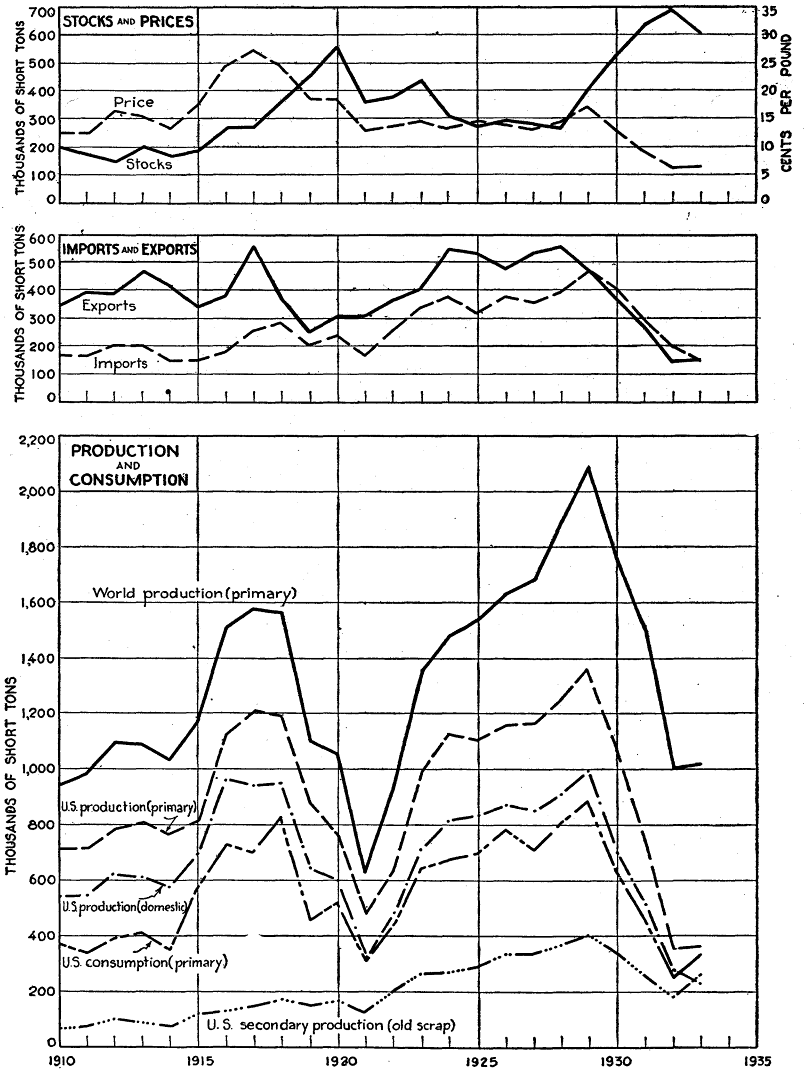


FIGURE 3.—Salient features of the copper industry, 1910–33.

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 copper chapter, Mineral Resources of the United States.

In 1933 production of 390,880,000 pounds was reported by the mines of the United States, 449,999,143 pounds from domestic ores by the smelters, and 481,338,031 pounds from domestic ores by the refineries.

*Copper produced from domestic ores, as reported by mines, smelters, and refineries, 1929–33, in pounds*

| Year | Mine | Smelter | Refinery |
|---|---|---|---|
| 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 | 476,221,076 | 544,009,948 | 445,077,874 |
| 1933 | [1] 390,880,000 | 449,999,143 | 481,338,031 |

[1] Subject to revision.

## PRIMARY COPPER

*Smelter production.*—The copper output of United States smelters from domestic ores in 1933 was 449,999,143 pounds, a decline of 94,010,805 pounds (17 percent) from the output in 1932. This production was 21 percent of world copper production, though it had averaged 51 percent during the period 1925–29. The origin of smelter production by States is shown below.

*Copper produced in the United States from domestic ores, 1929–33*

[Smelter output, in pounds fine]

| State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Alaska | 39,867,940 | 36,380,038 | 23,233,034 | 13,297,443 | 1,575,936 |
| Arizona | 829,206,475 | 570,897,080 | 400,310,634 | 201,136,276 | 122,697,035 |
| California | 33,084,232 | 26,262,447 | 8,344,901 | 5,514,045 | 632,049 |
| Colorado | 10,519,784 | 12,943,857 | 9,028,517 | 8,976,169 | 8,882,397 |
| Idaho | 6,267,487 | 2,713,681 | 1,626,541 | 662,957 | 2,183,284 |
| Michigan | 185,300,917 | 142,985,522 | 105,222,177 | 63,898,656 | 72,340,852 |
| Missouri | 1,880 | 2,198 | ---- | ---- | 181,703 |
| Montana | 299,894,853 | 198,795,883 | 173,910,101 | 97,918,141 | 94,262,651 |
| Nevada | 138,990,247 | 87,475,019 | 71,233,352 | 32,616,050 | 42,507,400 |
| New Mexico | 100,165,206 | 74,187,966 | 66,776,267 | 32,914,883 | 24,948,272 |
| North Carolina | (1) | (1) | (1) | (1) | (1) |
| Oregon | 739,151 | 229,753 | 9,332 | 36,890 | 9,301 |
| Pennsylvania | 3,581,393 | 3,061,174 | 843,956 | (1) | (1) |
| South Carolina | ---- | ---- | ---- | ---- | 408 |
| Tennessee | (1) | (1) | (1) | (1) | (1) |
| Texas | 393,740 | 165,731 | 514 | 8,588 | 2,137 |
| Utah | 325,965,289 | 205,769,698 | 161,023,199 | 76,402,502 | 65,655,914 |
| Vermont | 752,200 | (1) | ---- | ---- | ---- |
| Washington | 1,569,260 | 1,404,893 | 71,426 | 2,521 | 87,199 |
| Wyoming | 4,305 | 29,356 | 9,545 | 607 | 46 |
| Undistributed | 26,558,776 | 31,085,031 | 21,067,682 | 10,624,220 | 14,032,559 |
| | 2,002,863,135 | 1,394,389,327 | 1,042,711,178 | 544,009,948 | 449,999,143 |

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

The figures for smelter production in 1933 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 are 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 1933. 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 1933*

| Location | Company | Final copper product |
|---|---|---|
| Arizona: | | |
| Clemenceau | United Verde Extension Mining Co | Blister. |
| Douglas | Phelps Dodge Corporation | Anodes. |
| Hayden | American Smelting & Refining Co | Blister. |
| Superior | Magma Copper Co | Do. |
| Maryland: Baltimore | American Smelting & Refining Co | Electrolytic and casting. |
| Michigan: | | |
| Houghton | Copper Range Co. Smelting Department | Lake and blister. |
| Hubbell | Calumet & Hecla Consolidated Copper Co | Lake. |
| Montana: | | |
| Anaconda | Anaconda Copper Mining Co | Anodes. |
| 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. |
| Isabella | Ducktown Chemical & Iron Co | Do. |
| Texas: | | |
| El Paso | American Smelting & Refining Co | Do. |
| Do | Nichols Copper Co | Electrolytic. |
| Utah: | | |
| Garfield | do | Blister. |
| International | International Smelting Co | Do. |
| Washington: Tacoma | American Smelting & Refining Co | Blister, electrolytic, and casting. |

The precise quantity in pounds of copper produced by smelters in the United States and the value are shown by years for 1845–1930 in the copper chapter for 1930, Mineral Resources of the United States. The data are summarized for comparison with those of 1931, 1932, and 1933 in the following table:

*Copper produced (smelter output) in the United States, 1845–1933*

[Values rounded]

| Period | Quantity: Total (short tons) | Quantity: Average per year (short tons) | Total value |
|---|---|---|---|
| 1845–80 | 363, 996 | 10, 111 | $175, 490, 000 |
| 1881–1900 | 2, 994, 764 | 149, 738 | 796, 355, 000 |
| 1901–10 | 4, 281, 716 | 428, 172 | 1, 273, 911, 000 |
| 1911–20 | 7, 160, 559 | 716, 056 | 2, 850, 306, 000 |
| 1921–30 | 7, 423, 403 | 742, 340 | 2, 117, 235, 000 |
| 1931 | 521, 356 | 521, 356 | 94, 887, 000 |
| 1932 | 272, 005 | 272, 005 | 34, 273, 000 |
| 1933 | 225, 000 | 225, 000 | 28, 800, 000 |
| 1845–1933 | 23, 242, 799 | 261, 155 | 7, 371, 257, 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 copper chapter of 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 1933 was 390,880,000 pounds, a decline of 18 percent from that in 1932 and of 78 percent from the average for 1925–29.

*Production by States and districts.*—The following tables show mine and smelter production by States for 1932 and 1933 and mine production by districts 1929–33. In 1933 Arizona, Montana, Michigan, and Utah led in production with 79 percent of the smelter output. If the production of New Mexico and Nevada is added to the output of these States, 94 percent of the output of the country is represented. Among the copper-producing districts Bingham ranked first in 1933, Butte second, and Lake Superior third.

From 1845 through 1933 Arizona, Montana, Michigan, and Utah, in the order named, were the principal producers, contributing 84 percent of the total output. Butte, Lake Superior, Bingham, and Bisbee, in the order named, were the principal districts.

*Copper produced in the United States, according to smelter and mine returns, by States, 1932, 1933, and 1845–1933, in short tons*

| | 1932 | | 1933 | | | 1845–1933 | |
|---|---|---|---|---|---|---|---|
| | Smelter returns | Mine returns | Smelter returns | | Mine returns[1] | Smelter output | |
| | | | Percent of total | Quantity | | Total quantity | Percent of total |
| Alaska | 6,649 | 4,369 | 0.35 | 788 | [1] 13 | 616,041 | 2.65 |
| Arizona | 100,568 | 91,246 | 27.27 | 61,349 | [1] 56,600 | 7,605,006 | 32.72 |
| California | 2,757 | 709 | .14 | 316 | [1] 490 | 547,418 | 2.36 |
| Colorado | 4,488 | 3,699 | 1.97 | 4,441 | 4,834 | 189,592 | .82 |
| Idaho | 332 | 572 | .48 | 1,092 | [1] 795 | 73,343 | .31 |
| Michigan | 31,949 | 27,198 | 16.08 | 36,170 | 23,427 | 4,311,872 | 18.55 |
| Missouri | ---- | ---- | .04 | 91 | ---- | (3) | (3) |
| Montana | 48,959 | 42,424 | 20.95 | 47,131 | [1] 32,730 | 5,284,662 | 22.74 |
| Nevada | 16,308 | 15,744 | 9.45 | 21,254 | [1] 19,460 | 977,659 | 4.21 |
| New Mexico | 16,458 | 14,209 | 5.54 | 12,474 | 13,474 | 755,922 | 3.25 |
| North Carolina | (2) | (2) | (2) | (2) | (2) | (3) | (3) |
| Oregon | 18 | 16 | ---- | 5 | 6 | 10,333 | .04 |
| Pennsylvania | (2) | (2) | (2) | (2) | (2) | (3) | (3) |
| South Carolina | ---- | ---- | ---- | (5) | ---- | (3) | (3) |
| Tennessee | (2) | (2) | (2) | (2) | (2) | [4] 259,508 | [4] 1.12 |
| Texas | 4 | 4 | ---- | 1 | 1 | (3) | (3) |
| Utah | 38,201 | 32,482 | 14.59 | 32,828 | 36,792 | 2,429,078 | 10.45 |
| Washington | 1 | 3 | .02 | 44 | 3 | 14,252 | .06 |
| Wyoming | ---- | (5) | ---- | (5) | ---- | 15,860 | .07 |
| Undistributed | 5,313 | 5,436 | 3.12 | 7,016 | 6,813 | [6] 152,253 | [6] .65 |
| | 272,005 | 238,111 | 100.00 | 225,000 | [1] 195,440 | 23,242,799 | 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 1929–33 are confidential and are included under "Undistributed."
[5] Less than 1 ton.
[6] Includes Tennessee for 1929–33.

*Mine production of copper in the principal districts,[1] 1929–33, in terms of recovered copper, in short tons*

| District or region | State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| Butte | Montana | 148,158 | 97,736 | 92,181 | 42,300 | [2] 32,650 |
| Bingham | Utah | 155,946 | 87,535 | 73,853 | 31,234 | 35,818 |
| Lake Superior | Michigan | 93,201 | 84,691 | 59,030 | 27,198 | 23,427 |
| Bisbee (Warren) | Arizona | 93,065 | 63,950 | 47,664 | 23,702 | (3) |
| Yavapai County (mostly Jerome district). | do | 104,086 | 58,845 | 22,288 | 17,904 | (3) |
| Ely (Robinson) | Nevada | 65,378 | 52,693 | 35,667 | 15,442 | (3) |
| Globe-Miami | Arizona | 95,798 | 79,060 | 63,222 | 14,224 | (3) |
| Central (including Santa Rita) | New Mexico | 43,723 | 28,622 | 28,159 | 13,256 | 12,571 |
| Pioneer | Arizona | 19,558 | 16,193 | 14,052 | 11,026 | (3) |
| Ray (Mineral Creek) | do | 33,144 | 18,059 | 12,219 | 7,202 | (3) |
| Battle Mountain | Colorado | 1,570 | 2,925 | 3,324 | 2,810 | 4,082 |
| Plumas County | California | 12,465 | 9,765 | 6,227 | 522 | (3) |
| Willow Creek | New Mexico | 1,321 | 719 | 548 | 510 | 877 |
| Tintic | Utah | 1,583 | 1,431 | 784 | 473 | 428 |
| Park City | do | 1,262 | 839 | 409 | 451 | 366 |
| Lordsburg | New Mexico | 2,124 | 2,429 | 1,996 | 429 | 11 |
| Shasta County | California | 3,017 | 1,981 | 155 | 148 | (3) |
| Banner | Arizona | 2,520 | 3,775 | 1,303 | 124 | (3) |
| Bonanza | Colorado | 1,334 | 617 | 3 | --- | --- |
| Alder Creek | Idaho | 1,412 | 561 | --- | --- | (3) |
| Copper River [4] | Alaska | (5) | (5) | (5) | [6] 4,369 | (3) |
| Prince William Sound [4] | do | (5) | (5) | (5) | --- | --- |
| Ajo [4] | Arizona | 35,502 | 25,102 | (5) | (5) | (3) |
| Morenci-Metcalf [4] | do | 28,391 | 21,572 | (5) | 11,931 | (3) |
| Silver Bell [4] | do | 1,192 | 113 | (5) | --- | (3) |
| Battle Mountain [4] | Nevada | 1,216 | 653 | 70 | (5) | (3) |
| Jack Rabbit [4] | do | 1,319 | 998 | (5) | (5) | (3) |
| Yerington [4] | do | 1,635 | (5) | (5) | --- | (3) |
| Swain County [4] | North Carolina | (5) | (5) | (5) | (5) | (3) |
| Lebanon (Cornwall mine) [4] | Pennsylvania | 1,727 | 1,430 | (5) | (5) | (3) |
| Ducktown [4] | Tennessee | (5) | (5) | (5) | (5) | (3) |

[1] Districts producing 1,000 short tons or more in any year of the period, 1929–33.
[2] Subject to revision.
[3] Data not available.
[4] Not listed in order of output.
[5] Bureau of Mines not at liberty to publish figures.
[6] Includes a small quantity produced elsewhere in State.

*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 1931. The figures are derived from the mine reports in Mineral Resources. They disclose that ores which provided 78 percent of the copper produced from copper ores in the United States in 1931 were concentrated before smelting, while ores that were leached provided 6 percent of domestic production, the total for the two being 84 percent. Only 16 percent of the production was smelted directly.

Detailed figures for 1932 and 1933 are not yet available. 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 1931, with copper, gold, and silver content in terms of recovered metals*

| State | Ore, old tailings, etc., sold or treated (short tons) | Copper produced | | Gold produced (fine ounces) | Silver produced (fine ounces) | Value of gold and silver per ton of ore |
|---|---|---|---|---|---|---|
| | | Pounds | Percent | | | |
| Alaska | 89,818 | 22,614,000 | 12.59 | | 193,850 | $0.63 |
| Arizona | 13,606,755 | [1] 392,245,073 | 1.44 | 80,684.64 | [1] 2,889,868 | .18 |
| California | [2] 473,389 | [3] 12,724,578 | 1.34 | 13,607.47 | 322,148 | .79 |
| Colorado | 57,232 | 6,547,000 | 5.72 | 3,098.20 | 1,381,995 | 8.12 |
| Idaho | 548 | 41,588 | 3.79 | 439.07 | 1,421 | 17.31 |
| Michigan | 3,570,748 | 118,059,491 | 1.65 | | 1,437 | (4) |
| Montana | 1,878,757 | [5] 175,382,018 | 4.67 | 12,905.58 | 3,710,564 | .71 |
| Nevada | 2,936,899 | [6] 72,322,847 | 1.23 | 33,807.07 | 225,355 | .26 |
| New Mexico | 2,642,654 | 53,816,742 | 1.02 | 4,262.06 | 93,271 | .04 |
| North Carolina | 63,650 | (7) | (7) | (7) | (7) | (7) |
| Pennsylvania | [8] 2,451 | (7) | (7) | (7) | (7) | (7) |
| Tennessee | 510,838 | [7] 23,346,000 | [7] 2.29 | [7] 896.15 | [7] 63,900 | [7] .07 |
| Utah | 8,212,141 | [9] 141,826,992 | .86 | 65,018.65 | 679,503 | .19 |
| Washington | 5,063 | 198,698 | 1.96 | 25.60 | 10,322 | .70 |
| Wyoming | 18 | 9,000 | 25.00 | | 17 | .28 |
| Total and average | [10] 34,050,961 | 1,019,134,027 | 1.50 | 214,744.49 | 9,573,651 | 0.21 |

[1] Excludes 8,881,853 pounds of copper recovered from precipitates, but includes a small quantity of silver recovered from precipitates.
[2] Includes 41,053 tons of pyrites roasted for manufacture of sulphuric acid (residue leached) yielding 262,244 pounds of copper.
[3] Excludes 45,798 pounds of copper from mine water.
[4] Lump silver only produced in 1931.
[5] Excludes 9,092,564 pounds of copper from mine-water precipitates.
[6] Excludes 9,358 pounds of copper from "cyanide" precipitates.
[7] North Carolina and Pennsylvania included with Tennessee.
[8] Copper concentrates from pyritiferous magnetite ore.
[9] Excludes 4,634,511 pounds of copper from mine-water precipitates and 751,768 pounds from ore leached in place.
[10] Includes copper concentrates from pyritiferous magnetite ore from Pennsylvania.

*Copper ore, old tailings, etc., concentrated in the United States in 1931, with content in terms of recovered copper*

| State | Ore, old tailings, etc., concentrated (short tons) | Concentrates produced (short tons) | Copper produced (pounds) | Percent of copper from ore, etc. |
|---|---|---|---|---|
| Alaska | 83,012 | 17,049 | 14,144,558 | 8.52 |
| Arizona | 10,081,645 | [1] 530,006 | [1] 213,684,140 | 1.06 |
| California | 432,294 | 25,510 | 12,453,926 | 1.44 |
| Idaho | 325 | 33 | 12,075 | 1.86 |
| Michigan | 3,570,748 | 86,216 | 118,059,491 | 1.65 |
| Montana | 1,792,727 | 357,712 | 167,996,788 | 4.69 |
| Nevada | 2,899,575 | 120,723 | 68,785,770 | 1.19 |
| New Mexico | 2,620,180 | 85,915 | 52,581,000 | 1.00 |
| Pennsylvania | (2) | (3) | (3) | (3) |
| Tennessee | 423,587 | [3] 30,399 | [3] 11,013,680 | [4] 1.29 |
| Utah | 8,147,764 | 218,854 | 138,150,904 | .85 |
| Washington | 5,000 | 320 | 174,362 | 1.74 |
| Total and average | [2] 30,056,857 | 1,472,737 | 797,056,694 | 1.33 |

[1] Includes 19 tons of concentrates, containing 1,943 pounds of recoverable copper, from ore treated at gold and silver mills.
[2] There were 488,788 tons of pyritiferous magnetite ore, yielding 2,451 tons of copper concentrates, not included with copper ore.
[3] Pennsylvania included with Tennessee.
[4] Calculated by using copper ore from Tennessee and copper concentrates from Pennsylvania.

*Copper ore leached and smelted in the United States in 1931, 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 | | | | 6,806 | 8,469,442 | 62.22 |
| Arizona | 2,411,954 | 57,953,208 | 1.20 | 1,113,059 | 120,608,824 | 5.42 |
| California | [1] 29,335 | 262,244 | .45 | 42 | 8,408 | 10.01 |
| Colorado | | | | 57,232 | 6,547,000 | 5.72 |
| Idaho | | | | 223 | 29,513 | 6.62 |
| Montana | | | | 67,417 | 7,085,833 | 5.26 |
| Nevada | | | | 37,324 | 3,537,077 | 4.74 |
| New Mexico | | | | 22,474 | 1,235,742 | 2.75 |
| North Carolina | | | | (2) | (2) | (2) |
| Tennessee | | | | [2] 150,901 | [2] 12,332,320 | [2] 4.09 |
| Utah | (3) | (3) | (3) | 64,356 | 3,667,966 | 2.85 |
| Washington | | | | 63 | 24,336 | 19.31 |
| Wyoming | | | | 18 | 9,000 | 25.00 |
| Total and average | 2,441,289 | 58,215,452 | 1.19 | 1,519,915 | 163,555,461 | 5.38 |

[1] Residue from pyrites roasted for manufacture of sulphuric acid.
[2] North Carolina included with Tennessee.
[3] Ore leached in place yielded 751,768 pounds of copper; quantity of ore unknown.

*Copper-lead and copper-lead-zinc ores sold or treated in the United States in 1931, with content in terms of recovered copper*

| State | Copper-lead and copper-lead-zinc ores (short tons) | Copper produced (pounds) | Percent of copper |
|---|---|---|---|
| Arizona | 218 | 15,465 | 3.55 |
| California | 9,911 | 70,665 | .36 |
| Colorado | 144 | 9,000 | 3.13 |
| Idaho | 195,643 | 437,642 | .11 |
| Montana | 79 | 5,613 | 3.55 |
| Nevada | 3,824 | 139,373 | 1.82 |
| New Mexico | 3,347 | 233,208 | 3.48 |
| Utah | 79 | 7,841 | 4.96 |
| Total and average | 213,245 | 918,807 | .22 |

*Ores, old tailings, etc., classed as copper-bearing (copper, copper-lead, and copper-lead-zinc) sold or treated in the United States in 1931, with copper content, and copper produced from all sources, in terms of recovered copper*

| State | Copper from copper, copper-lead, and copper-lead-zinc ores, old tailing, etc. | | | Copper from all sources, including old slags, smelter cleanings, and precipitates (pounds) |
|---|---|---|---|---|
| | Ores, old tailings, etc., sold or treated (short tons) | Copper produced (pounds) | Percent of copper | |
| Alaska | 89,818 | 22,614,000 | 12.59 | 22,614,000 |
| Arizona [1] | 13,606,973 | 392,260,538 | 1.44 | 401,344,909 |
| California | 483,300 | 12,795,243 | 1.32 | 12,931,995 |
| Colorado [2] | 57,376 | 6,556,000 | 5.71 | 8,165,000 |
| Idaho | 196,191 | 479,230 | .12 | 1,144,915 |
| Michigan | 3,570,748 | 118,059,491 | 1.65 | 118,059,491 |
| Montana [1] | 1,878,836 | 175,387,631 | 4.67 | 184,555,735 |
| Nevada | 2,940,723 | 72,462,220 | 1.23 | 72,634,497 |
| New Mexico [3] | 2,646,001 | 54,049,950 | 1.02 | 61,503,100 |
| North Carolina | 63,650 | (4) | (4) | (4) |
| Oregon | | | | 1,700 |
| Pennsylvania | [5] 2,451 | (4) | (4) | (4) |
| Tennessee | 510,838 | [4] 23,346,000 | [4] 2.02 | [4] 23,346,000 |
| Utah [6] | 8,212,220 | 141,834,833 | .86 | 151,236,505 |
| Washington | 5,063 | 198,698 | 1.96 | 202,503 |
| Wyoming | 18 | 9,000 | 25.00 | 9,000 |
| Total and average | 34,264,206 | 1,020,052,834 | 1.49 | 1,057,749,350 |

[1] Considerable copper was recovered from mine-water precipitates.
[2] Much of the copper was derived in 1931 from ores classed as siliceous ores.
[3] Much of the copper was derived in 1931 from ores classed as siliceous ores and lead-zinc ores.
[4] North Carolina and Pennsylvania included with Tennessee.
[5] Copper concentrates from pyritiferous magnetite ore.
[6] Much of the copper was derived in 1931 from mine-water precipitates and from ores classed as lead-zinc ores.

*Copper ores produced in the United States, 1922–31, 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 |
| 1922 | 2,278,047 | 5.36 | 23,258,970 | 1.43 | 26,893,247 | 1.74 | 0.0049 | 0.386 | $0.49 |
| 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 |
| 1931 | 1,519,915 | 5.38 | [1] 30,056,857 | 1.33 | [1] 34,050,961 | 1.50 | .0063 | .281 | .21 |

[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 Alaskan mines of the Kennecott Copper Corporation were closed in October 1932 and remained idle during 1933. A clean-up of the concentrating plant resulted in the recovery of 550 tons of copper. The company acquired on June 12 all assets of the Nevada Consolidated Copper Co.

Mother Lode Coalition Mines Co., controlled by Kennecott, did not operate during the year, but a shipment of 295 tons of high-grade ore was made. This contained 191 tons of copper and 2,742 ounces of silver.

*Arizona.*—Phelps Dodge Corporation has not operated the New Cornelia branch at Ajo since April 1932 or the Morenci branch since July 1932, but mining at Bisbee in the Junction and Campbell divisions of the Copper Queen branch were continued. The following production from the company mines and from purchased ores treated at the Douglas reduction works in 1933 was reported: Copper, 38,796 tons; silver, 2,331,971 ounces; and gold, 43,882 ounces.

Both Inspiration Consolidated Copper Co. and Miami Copper Co. suspended operations in May 1932. Neither produced in 1933. Likewise no production was made by the Iron Cap Copper Co. and United Verde Copper Co.

Magma Copper Co. produced 152,866 tons of ore and treated this ore and 2,720 tons of other ore and concentrates. The yield of copper was 9,857 tons compared with 10,853 tons in 1932. In addition, 524,978 ounces of silver and 11,255 ounces of gold were produced.

United Verde Extension Mining Co. mined 185,833 tons of ore averaging 7.78 percent copper. Copper production was 16,606 tons compared with 17,876 tons in 1932.

*California.*—The Walker Mining Co. suspended operations in February 1932 and remained idle during 1933.

*Michigan.*—The copper mines of the Lake Superior district in 1933 produced 23,427 tons compared with 27,198 tons in 1932. This production was derived as follows: Calumet & Hecla Consolidated Copper Co., 16,599 tons of copper plus the copper content of 964 tons of oxide and Copper Range, 6,084 tons.

*Montana.*—The Anaconda Copper Mining Co. reports production in 1933 of 46,639 tons of copper, 2,391,635 ounces of silver, and 20,732 ounces of gold. In 1932 the production of copper was 48,787 tons.

*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 1933 their combined production was 2,940,455 tons of company ore, of which 189 tons were direct smelting ore. The average grade of company material milled was 1.29 percent copper, and the average recovery of concentrates was 86.85 percent of the total copper content. The total copper production from company ores was 33,570 tons, compared with 29,992 tons in 1932.

The Consolidated Copper Mines Corporation produced no copper in 1933.

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

*Tennessee.*—The copper producers of the Ducktown district do not publish details of their operations. The Tennessee Copper Co. continued to operate on a curtailed basis during 1933. The Ducktown Chemical & Iron Co. resumed smelting operations for only a brief period.

*Utah.*—The Utah Copper Co. mined 3,521,425 tons of ore, averaging 1.03 percent copper, compared with 3,169,411 tons in 1932. The net production of refined copper in 1933 was 34,731 tons, compared with 30,006 tons in 1932. The Arthur plant was idle throughout the year. The cost of copper production, exclusive of Federal taxes, was 6.455 cents per pound.

## REFINERY PRODUCTION

The refinery output of copper in the United States in 1933 was made by 10 plants; 8 of these employed the electrolytic method and 2 employed the furnace process on Lake Superior copper.

There are 5 large electrolytic refineries on the Atlantic seaboard, 3 lake refineries on the Great Lakes, and 4 refineries west of the Great Lakes—1 at Great Falls, Mont.; 1 at Tacoma, Wash.; 1 at El Paso, Tex.; and 1 at Clifton, Ariz. Of the above plants the lake refinery of the Quincy Mining Co. and the plant of the Phelps Dodge Corporation that produces furnace-refined copper at Clifton, Ariz., were idle in 1933. The electrolytic plant of the Nichols Copper Co. at El Paso, Tex., produced cathodes only in 1932 but in 1933 resumed the casting of cathodes into shapes.

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

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 some copper that was mined as much as 3 months earlier than the beginning of the calendar year.

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 66.

*Primary and secondary copper produced by regular refining plants in the United States and imported, 1929–33, in pounds*

| | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Primary: | | | | | |
| Domestic:[1] | | | | | |
| Electrolytic | 1,785,754,654 | 1,228,416,733 | 947,065,977 | [2]373,492,550 | [2]421,318,802 |
| Lake | 185,300,917 | 142,985,522 | 105,222,177 | [2]53,815,281 | [2]59,497,370 |
| Casting | 11,676,718 | 19,821,950 | 22,317,887 | 17,770,043 | 521,859 |
| | 1,982,732,289 | 1,391,224,205 | 1,074,606,041 | 445,077,874 | 481,338,031 |
| Foreign:[1] | | | | | |
| Electrolytic | 756,555,087 | 765,189,037 | 426,307,093 | 285,240,651 | 260,048,594 |
| Casting and best select | 825,000 | 645,936 | 529,199 | 549,209 | 191,927 |
| Refinery production, new copper | 2,740,112,376 | 2,157,059,178 | 1,501,442,333 | 680,867,734 | 741,578,552 |
| Imports refined copper | 134,014,792 | 86,210,331 | 174,449,893 | 167,793,988 | 10,863,358 |
| Total new refined copper made available | 2,874,127,168 | 2,243,269,509 | 1,675,892,226 | 848,661,722 | 752,441,910 |
| Secondary: | | | | | |
| Electrolytic | 331,858,103 | 279,423,370 | 156,099,339 | 120,397,873 | 170,878,078 |
| Casting | 2,300,000 | 1,106,114 | 28,914 | 56,654 | 160,214 |
| | 334,158,103 | 280,529,484 | 156,128,253 | 120,454,527 | 171,038,292 |
| Grand total | 3,208,285,271 | 2,523,798,993 | 1,832,020,479 | 969,116,249 | 923,480,202 |

[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 copper refineries in the United States in 1933 was 25,436,881 pounds having a copper content of 6,479,000 pounds, compared with 24,908,525 pounds, having a copper content of 6,345,000 pounds in 1932.

The production of copper sulphate by plants other than the regular primary refineries was 23,587,922 pounds, with a reported copper content of 6,085,000 pounds in 1933, compared with 25,805,774 pounds, with a reported copper content of 6,633,000 pounds in 1932.

## 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 1933 and imports and exports of scrap brass and copper, in short tons*

| | |
|---|---|
| Copper as metal | 193, 100 |
| Copper in alloys other than brass | 54, 000 |
| | 247, 100 |
| Copper from new scrap (not including brass) | 40, 000 |
| Copper from old scrap (not including brass) | 207, 100 |
| | 247, 100 |
| Brass scrap remelted: | |
| New clean scrap | 54, 000 |
| Old scrap | 76, 000 |
| | 130, 000 |
| Copper content of brass scrap (averaging about 70 percent copper): | |
| New clean scrap | 37, 800 |
| Old scrap | 53, 200 |
| | 91, 000 |
| Total copper produced from secondary sources (including copper content of brass scrap): | |
| From new scrap | 77, 800 |
| From old scrap | 260, 300 |
| | 338, 100 |
| Imports of scrap brass | 1, 085 |
| Imports of scrap copper | 130 |
| Exports of scrap brass | 15, 348 |
| Exports of scrap copper | 14, 219 |

*Refined copper from secondary sources produced in the United States, 1929–33, in pounds*

| | | | |
|---|---|---|---|
| 1929 | 1, 253, 100, 000 | 1932 | 496, 400, 000 |
| 1930 | 934, 400, 000 | 1933 | 676, 200, 000 |
| 1931 | 694, 000, 000 | | |

## STOCKS

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

*Stocks of copper in the United States, January 1, 1930–34, in pounds*

| Year | Refined copper | Blister and materials in process of refining | Year | Refined copper | Blister and materials in process of refining |
|---|---|---|---|---|---|
| 1930 | 306, 600, 000 | 500, 000, 000 | 1933 | 1, 004, 000, 000 | 378, 000, 000 |
| 1931 | 615, 000, 000 | 450, 000, 000 | 1934 | 813, 000, 000 | 388, 000, 000 |
| 1932 | 924, 600, 000 | 348, 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. Ninety-six percent, by weight, of the copper imported in 1933 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 made partly of copper, such as electrical machinery and other mechanisms. In 1933, however, a more normal relation recurred, exports being 20 percent greater than imports.

Considering refined copper only, imports amounted to only 4 percent of exports in 1933, which indicates strikingly the character of our foreign trade in copper, imports of refined having nearly ceased.

The imports of unmanufactured copper into the United States in 1933 amounted to 291,170,946 pounds, a decrease of 100,820,396 pounds (26 percent) from 1932 and a decrease of 70 percent from the record imports of 1929. The principal sources and the percentage of the total contributed by each in 1933 were as follows: Mexico 30 percent, Chile 19 percent, Peru 18 percent, Canada 12 percent, Africa 11 percent, Cuba 6 percent, and Yugoslavia 3 percent. The net decline of imports in 1933 resulted from a decline of 157 million pounds in imports of refined—76 million pounds from Canada, 80 million pounds from Chile, and 1 million pounds from Mexico—together with an increase of 56 million pounds in unrefined imports, chiefly blister from Chile, Mexico, and Africa.

*Copper (unmanufactured) imported into the United States, 1933, 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 |
|---|---|---|---|---|---|---|
| Africa: | | | | | | |
| British: | | | | | | |
| Union of South | | | | 3,000,450 | | |
| Mozambique | | | | 28,017,994 | | |
| Australia | 216,496 | 141,740 | 6,940 | | | |
| Canada | 1,208,574 | 11,165,887 | 1,532,151 | 19,961,695 | | 258,865 |
| Chile | 9,786,234 | 8,598,268 | 101,593 | 26,917,241 | 10,860,910 | |
| Cuba | 120,264 | 16,704,320 | | | | |
| France | 4,408 | | 176,146 | | | |
| Germany | | | 159,189 | | | |
| Mexico | 143,368 | 98,907 | | 87,675,601 | | |
| Peru | 450,232 | 45,182 | 62,838 | 52,800,175 | | |
| Spain | | | 161,283 | | | |
| United Kingdom | | | 177,212 | 8,043 | 2,448 | 250 |
| Venezuela | | | | | | |
| Yugoslavia | | | | 8,928,630 | | |
| Other | 521,730 | 1,078,617 | 66,125 | 9,160 | | 1,780 |
| | 12,451,306 | 37,832,921 | 2,443,477 | 227,318,989 | 10,863,358 | 260,895 |
| Total value | $795,277 | $2,043,975 | $142,396 | $13,774,453 | $613,720 | $16,091 |

*Copper (unmanufactured) imported into the United States, 1929–33, in pounds*

[General imports]

| | | | |
|---|---|---|---|
| 1929 | 974, 312, 201 | 1932 | 391, 991, 342 |
| 1930 | 817, 154, 236 | 1933 | 291, 170, 946 |
| 1931 | 585, 892, 098 | | |

Exports of copper of all classes in 1933 totaled 349,253,716 pounds, an increase of 21 million pounds (6 percent) over those in 1932 but a decrease of 69 percent from exports in 1928.

In 1933 the United States exported more copper to France than to any other country; Germany stood second in order of importance and Japan third. The exports (in millions of pounds) from the United States to the six leading importers of United States copper in 1933 show interesting changes from those in 1932 as follows:

| | 1932 | 1933 | Increase (+) or decrease (−), percent |
|---|---|---|---|
| France | 75 | 104 | +39 |
| Germany | 50 | 44 | −12 |
| Japan | 3 | 36 | +1,100 |
| Belgium | 18 | 33 | +83 |
| Italy | 49 | 30 | −39 |
| United Kingdom | 73 | 29 | −60 |

*Copper exported from the United States, 1933, in pounds*

| Country | Ore, concentrates, composition metal, and unrefined copper (copper content) | Refined | | Old and scrap | Pipes and tubes |
|---|---|---|---|---|---|
| | | Bars, ingots, or other forms | Rods | | |
| Belgium | 15, 198, 774 | 14, 481, 572 | 1, 615, 264 | 1, 786, 589 | |
| Canada | | 91, 930 | 158, 449 | 668 | 200, 871 |
| China | | 4, 070, 869 | | 2, 078 | 2, 820 |
| Denmark | | 2, 267, 366 | 336, 114 | | |
| France | 24, 671, 911 | 72, 855, 294 | 1, 591, 336 | 4, 608, 009 | 3, 335 |
| Germany | 47, 317 | 34, 762, 322 | 6 | 8, 927, 880 | |
| India (British) | | 352, 431 | 1, 344, 681 | 72, 586 | 4, 657 |
| Italy | | 30, 037, 514 | 56, 000 | 113, 005 | |
| Japan | | 28, 158, 249 | | 7, 399, 436 | 194 |
| Netherlands | 2, 276, 343 | 9, 140, 107 | 2, 579, 896 | 1, 297, 029 | 3, 862 |
| Norway | | 1, 001, 984 | 1, 709, 716 | | |
| Spain | | | | 2, 060, 461 | 1, 499 |
| Sweden | | 12, 195, 775 | 1, 167 | | |
| United Kingdom | 124, 497 | 26, 596, 672 | 13, 914 | 2, 006, 237 | 3, 436 |
| Union of Soviet Socialist Republics in Europe | | | | | 68 |
| Other | 3, 114, 084 | 13, 151, 421 | 6, 172, 537 | 163, 159 | 580, 910 |
| | 45, 427, 926 | 249, 163, 506 | 15, 579, 080 | 28, 437, 137 | 801, 652 |
| Total value | $3, 229, 785 | $16, 930, 654 | $1, 174, 037 | $1, 646, 583 | $133, 519 |

*Copper exported from the United States, 1933, in pounds*—Continued

| Country | Plates and sheets | Wire (except insulated) | Insulated wire and cable | Other copper manufactures |
|---|---|---|---|---|
| Belgium | | | 30,730 | (1) |
| Canada | 70,084 | 32,358 | 175,739 | |
| China | 1,333 | 1,078,504 | 258,547 | |
| Denmark | | | 5,573 | |
| France | 23,016 | | 29,407 | |
| Germany | 29,261 | | 7,795 | |
| India (British) | 174 | | 199,555 | |
| Italy | | | 14,229 | |
| Japan | 1,203 | 56,208 | 18,319 | |
| Netherlands | | 22,714 | 24,373 | |
| Norway | | 9,947 | 3,928 | |
| Spain | | 21,126 | 43,940 | |
| Sweden | | | 11,540 | |
| United Kingdom | 407,452 | | 7,794 | |
| Union of Soviet Socialist Republics in Europe | | | 16 | |
| Other | 600,718 | 1,350,048 | 5,308,784 | |
| | 1,133,241 | 2,570,905 | 6,140,269 | (1) |
| Total value | $178,574 | $247,397 | $1,098,478 | $278,229 |

[1] Figures for quantity not recorded.

*Copper [1] exported from the United States, 1929–33*

| Year | Pounds: Metallic [2] | Pounds: Total | Total value | Year | Pounds: Metallic [2] | Pounds: Total | Total value |
|---|---|---|---|---|---|---|---|
| 1929 | 992,895,119 | 998,474,549 | $181,684,409 | 1932 | 295,356,719 | 328,222,700 | $20,998,816 |
| 1930 | 753,114,927 | 753,294,022 | 104,316,175 | 1933 | 303,825,790 | 349,253,716 | 24,639,027 |
| 1931 | 557.574,235 | 557,873,744 | 54,230,992 | | | | |

[1] Exclusive of "Other copper manufactures," valued at $1,720,363 in 1929, $1,025,875 in 1930, $516,818 in 1931, $237,004 in 1932, and $278,229 in 1933; quantity not recorded.
[2] Exclusive of ore, concentrates, and composition metal. Exclusive also of unrefined copper, figures for which are not separable from those for ore and concentrates.

*Copper sulphate (blue vitriol) exported from the United States, 1929–33*

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

*Brass and bronze exported from the United States, 1932–33*

| | 1932 Pounds | 1932 Value | 1933 Pounds | 1933 Value |
|---|---|---|---|---|
| Ingots | 155,260 | $11,113 | 131,223 | $11,425 |
| Scrap and old | 30,145,251 | 1,255,490 | 30,695,384 | 1,367,759 |
| Bars and rods | 1,255,493 | 154,568 | 770,920 | 114,258 |
| Plates and sheets | 432,605 | 76,486 | 262,566 | 54,472 |
| Pipes and tubes | 1,545,498 | 228,135 | 855,325 | 151,487 |
| Pipe fittings and valves | 827,112 | 485,709 | 843,069 | 478,914 |
| Plumber's brass goods | 350,870 | 182,819 | 432,220 | 214,210 |
| Wire of brass or bronze | 232,563 | 50,564 | 240,004 | 50,449 |
| Brass wood screws | (1) | 21,273 | (1) | 13,948 |
| Hinges and butts of brass or bronze | (1) | 29,180 | (1) | 25,021 |
| Other hardware of brass or bronze | (1) | 167,762 | (1) | 148,816 |
| Other brass and bronze manufactures | (1) | 902,074 | (1) | 742,653 |
| | | 3,565,173 | | 3,373,412 |

[1] Weight not recorded.

*Unmanufactured brass exported from the United States, 1929–33*

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

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

## 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 1933 totaled 678,699,324 pounds, an increase of 159,496,556 pounds (31 percent) from 1932 and a decrease of 62 percent from the record year 1929.

*New refined copper withdrawn from total year's supply on domestic account, 1930–33, in pounds*

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

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

Adding the 676,200,000 pounds of secondary copper and copper in alloys produced during the year to the 678,699,324 pounds of new refined copper withdrawn on domestic account gives a total of about 1,354,899,324 pounds of new and old copper available for domestic consumption in 1933. 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 520,600,000 pounds. The total available for consumption by this calculation would be 1,199,299,324 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 1932 and 1933. 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 1932–33*

| Form | 1932 | | 1933 | |
|---|---|---|---|---|
| | Pounds | Percent | Pounds | Percent |
| Wire bars | 418,000,000 | 52.18 | 392,000,000 | 43.27 |
| Cathodes | 119,000,000 | 14.86 | 219,000,000 | 24.17 |
| Cakes | 98,000,000 | 12.23 | 160,000,000 | 17.66 |
| Ingots | 90,000,000 | 11.24 | 45,000,000 | 4.97 |
| Other forms | 76,000,000 | 9.49 | 90,000,000 | 9.93 |
| | 801,000,000 | 100.00 | 906,000,000 | 100.00 |

## WORLD PRODUCTION

In 1933 world production of copper was approximately 1,147,800 short tons, compared with 1,028,491 tons in 1932, an increase of 12 percent; but while the total for 1932 is based largely upon official reports of mine production by the various countries of the world that for 1933 is compiled chiefly from published company records and other reports and must be regarded as merely preliminary.

The Western Hemisphere contributed 638,686 tons (55.6 percent of the total) in 1933, compared with an average of 1,414,000 tons per year for 1925–29. Production in the Western Hemisphere had thus declined in 1933 to 45 percent of the 5-year average. The distribution of this tonnage in 1933 compared with that in 1932 follows:

*Copper production of Western Hemisphere by countries, 1932–33*

| Country | 1932 | 1933 | |
|---|---|---|---|
| | Short tons | Short tons | Percent of world total |
| United States [1] | 272,005 | 225,000 | 19.6 |
| Canada | 123,850 | 149,967 | 13.1 |
| Mexico | 38,716 | 43,901 | 3.8 |
| Cuba | 6,533 | 9,873 | .9 |
| Newfoundland | 2,373 | 500 | |
| Total North America | 443,477 | 429,241 | 37.4 |
| Chile [1] | 107,494 | 180,018 | 15.6 |
| Peru | 25,232 | 27,327 | 2.4 |
| Bolivia | 2,223 | 2,100 | .2 |
| Total South America | 134,949 | 209,445 | 18.2 |
| Total Western Hemisphere | 578,426 | 638,686 | 55.6 |

[1] Smelter production.

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

*Copper produced in the Western Hemisphere in 1933, by countries and mining groups*

| | Short tons | Percent of world total |
|---|---|---|
| United States: | | |
| Anaconda group (Montana) | 46,639 | 4.1 |
| Kennecott group: | | |
| Kennecott | 550 | |
| Mother Lode Coalition | 191 | |
| Nevada Consolidated | 33,570 | |
| Utah Copper | 34,731 | |
| | 69,042 | 6.0 |
| Phelps Dodge group | 38,796 | 3.4 |
| Arizona miscellaneous: | | |
| United Verde Extension | 16,606 | |
| Magma | 9,857 | |
| | 26,463 | 2.3 |
| Lake Superior: | | |
| Calumet and Hecla | 17,343 | |
| Copper Range | 6,084 | |
| | 23,427 | 2.0 |
| Sundry production: | | |
| Utah Delaware | 221 | |
| Colorado | 4,834 | |
| Idaho | 795 | |
| Utah (miscellaneous) | 1,840 | |
| Undistributed | 12,943 | |
| | 20,633 | 1.8 |
| Total United States | 225,000 | 19.6 |
| Canada: | | |
| Britannia | 3,995 | |
| Consolidated Mining & Smelting | 271 | |
| Canada—Continued. | | |
| Falconbridge | 2,104 | |
| Granby | 17,230 | |
| Hudson Bay | 20,472 | |
| Noranda | 32,504 | |
| Undistributed (includes International Nickel) | 73,391 | |
| Total Canada | 149,967 | 13.1 |
| Newfoundland (includes Buchans) | 500 | ---------- |
| Cuba (Matahambre) | 9,873 | .9 |
| Mexico: | | |
| Boleo | 9,447 | |
| Cananea (Anaconda) | 25,897 | |
| Undistributed | 8,557 | |
| Total Mexico | 43,901 | 3.8 |
| Total North America | 429,241 | 37.4 |
| Chile: | | |
| Andes (Anaconda) | 17,880 | |
| Braden (Kennecott) | 87,643 | |
| Chile Copper (Anaconda) | 61,523 | |
| Naltagua | 5,360 | |
| Undistributed | 7,612 | |
| | 180,018 | 15.6 |
| Peru: | | |
| Cerro de Pasco | 27,068 | |
| Undistributed | 259 | |
| | 27,327 | 2.4 |
| Bolivia | 2,100 | .2 |
| Total South America | 209,445 | 18.2 |
| Total Western Hemisphere | 638,686 | 55.6 |

The Eastern Hemisphere contributed 509,152 tons (44.4 percent of world production). The corresponding production in the Eastern Hemisphere for 1925–29 averaged 393,000 tons per year. The present production represents an increase of about 30 percent above the 5-year average. The distribution of this tonnage in 1933 compared with that in 1932 follows:

*Copper production of Eastern Hemisphere, 1932–33*

| Country | 1932 | 1933 | |
|---|---|---|---|
| | Short tons | Short tons | Percent of world total |
| Spain-Portugal | 40,786 | 40,508 | 3.5 |
| Union of Soviet Socialist Republics | 35,274 | 41,336 | 3.6 |
| Germany | 33,886 | 29,762 | 2.6 |
| Yugoslavia | 20,884 | 44,443 | 3.9 |
| Norway | 18,678 | 20,164 | 1.7 |
| Other Europe | 13,749 | 14,732 | 1.3 |
| Total Europe | 163,257 | 190,945 | 16.6 |
| Belgian Congo | 59,525 | 88,185 | 7.7 |
| Northern Rhodesia | 97,708 | 116,709 | 10.2 |
| Southwest Africa | 2,646 | | |
| Union of South Africa | 10,365 | 9,235 | .8 |
| Southern Rhodesia | 7 | | |
| Algeria | 7 | 20 | |
| Total Africa | 170,258 | 214,149 | 18.7 |
| Japan | 78,278 | 76,192 | 6.6 |
| British India | 12,566 | 9,771 | .9 |
| Other Asia | 9,289 | 2,037 | .2 |
| Total Asia | 100,133 | 88,000 | 7.7 |
| Australia | 16,417 | 16,058 | 1.4 |
| Total Eastern Hemisphere | 450,065 | 509,152 | 44.4 |

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 the Union of Soviet Socialist Republics (Russia) represents the result of intensive effort under the 5-year plan to develop six principal areas of copper mineralization, half of which are in the vicinity of the Urals. Few specific details are known of the progress made in this extensive program. Mansfeld produces nearly all of Germany's mine output, the balance being from several small sources. Bor provides practically the whole of Yugoslavia's output, and Sulitelma and Roros are the chief producers of Norway. All the production of Finland is derived from pyritic ore exported from Outokumpu, and copper produced in Sweden comes chiefly from Boliden mine. These sources account for about 93 percent of Europe's production.

*Africa.*—In Africa the entire production of Belgian Congo was made by Union Minière du Haut Katanga. The production of Northern Rhodesia is derived chiefly from Roan Antelope Copper Mines, Ltd., and Rhokana Corporation, Ltd., in nearly equal amounts, with a small tonnage from Mufulira which commenced producing in November 1933. Messina mine provides the production attributed to the Union of South Africa.

*Asia.*—The production of Japan proper is derived from five well-established sources, chief of which is Furukawa which produces about 20,000 tons. The others are Sumitomo, Nippon Sagyo, Mitsubishi, and Fujita. Of the production from India about equal amounts are derived from Bawdwin and from Indian Copper. Taiwan and Chosen usually contribute a few thousand tons.

*Australia.*—Mount Lyell provides most of Australian production.

*American control of production.*—Considering world production as a whole, it is notable that in 1933 less than a fifth of it was derived from the United States, although the domestic production from 1925 to 1929 averaged 49 percent of the world total. American enterprise has been responsible, however, for a large proportion of foreign production as well, as summarized in the following table.

*Copper production—proportion of domestic and foreign control, 1925–29, 1932, and 1933*

| | 1925–29 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Short tons | Percent of world total | Short tons | Percent of world total | Short tons | Percent of world total |
| United States: | | | | | | |
| Chief American groups: | | | | | | |
| Anaconda | 178,786 | 9.9 | 57,834 | 5.6 | 46,639 | 4.1 |
| Kennecott | 273,069 | 15.1 | 64,373 | 6.3 | 69,042 | 6.0 |
| Phelps Dodge | 141,390 | 7.8 | 41,544 | 4.0 | 38,796 | 3.4 |
| | 593,245 | 32.8 | 163,751 | 15.9 | 154,477 | 13.5 |
| Others | 299,485 | 16.6 | 108,254 | 10.5 | 70,523 | 6.1 |
| | 892,730 | 49.4 | 272,005 | 26.4 | 225,000 | 19.6 |
| Foreign: | | | | | | |
| Chief American groups: | | | | | | |
| Anaconda | 194,541 | 10.8 | 70,714 | 6.9 | 105,300 | 9.2 |
| Kennecott | 93,269 | 5.2 | 49,871 | 4.9 | 87,643 | 7.6 |
| Phelps Dodge | 20,068 | 1.1 | | | | |
| Cerro de Pasco | 45,929 | 2.5 | 22,910 | 2.2 | 27,068 | 2.4 |
| | 353,807 | 19.6 | 143,495 | 14.0 | 220,011 | 19.2 |
| Foreign ownership | 560,149 | 31.0 | 612,991 | 59.6 | 702,827 | 61.2 |
| | 913,956 | 50.6 | 756,486 | 73.6 | 922,838 | 80.4 |
| World total | 1,806,686 | 100.0 | 1,028,491 | 100.0 | 1,147,838 | 100.0 |

For the period 1925–29, 38.7 percent of foreign production, which constituted 19.6 percent of world production, was American owned. Together with domestic production 69.0 percent of world production was controlled in America, only 31.0 percent being foreign owned. American-controlled production had declined in 1932 to 40.4 percent of the world total and in 1933 was 38.8 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., together with 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 percent of world production). It included 593,245 tons of domestic copper (66 percent of domestic production), and 353,807 tons of foreign copper (39 percent of foreign production).

In 1933 the combined production of these four groups was only 374,488 tons (33 percent of the world total). Their combined domestic production was 154,477 tons (69 percent of the total domestic production). Their combined foreign production was 220,011 tons (24 percent of foreign production).

Of these large American companies, Anaconda in the 5-year period 1925–29 produced 20.7 percent of world production, Kennecott 20.3 percent, Phelps Dodge 8.9 percent, and Cerro de Pasco 2.5 percent. In 1933 they produced 13.3, 13.6, 3.4, and 2.4 percent, respectively, of world production.

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.

*World mine production of copper, 1929–33, in metric tons*

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

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada | 112, 545 | 137, 655 | 132, 586 | 112, 355 | 136, 048 |
| Cuba | 14, 982 | 15, 693 | 13, 507 | 5, 927 | 8, 957 |
| Mexico | 86, 554 | 73, 412 | 54, 212 | 35, 123 | 39, 826 |
| Newfoundland | 936 | 956 | 1, 459 | 2, 153 | (2) |
| United States | 904, 962 | 639, 629 | 479, 785 | 216, 010 | 177, 299 |
| | 1, 119, 979 | 867, 345 | 681, 549 | 371, 568 | (2) |
| South America: | | | | | |
| Bolivia [3] | 7, 188 | 3, 987 | 2, 049 | 2, 017 | (2) |
| Chile | 320, 630 | 220, 323 | 223, 284 | 228, 202 | (2) |
| Peru | 57, 019 | 50, 188 | 44, 753 | 22, 890 | (2) |
| Venezuela | ---------- | 96 | 746 | ---------- | (2) |
| | 384, 837 | 274, 594 | 270, 832 | 253, 109 | (2) |
| Europe: | | | | | |
| Austria | 2, 081 | 2, 216 | 1, 313 | 171 | (2) |
| Bulgaria [4] | 2, 000 | 2, 000 | 1, 000 | 500 | (2) |
| Czechoslovakia | 1, 359 | 1, 790 | 1, 252 | ---------- | (2) |
| Finland | 4, 565 | 4, 986 | 6, 396 | 6, 649 | (2) |
| France | 596 | 422 | 337 | [4] 300 | (2) |
| Germany | 28, 983 | 26, 972 | 29, 827 | 30, 741 | (2) |
| Great Britain | 69 | 49 | 67 | 62 | (2) |
| Greece | (5) | ---------- | ---------- | ---------- | (2) |
| Italy | 883 | 973 | 438 | 373 | (2) |
| Norway | 18, 890 | 17, 317 | 8, 708 | 16, 944 | (2) |
| Portugal [4] | 4, 000 | 4, 000 | 3, 000 | 2, 000 | (2) |
| Rumania [6] | 143 | 169 | (7) | 109 | (2) |
| Spain | 63, 700 | 58, 400 | 54, 000 | 35, 000 | (2) |
| Sweden | 1, 128 | 5, 523 | 1, 634 | 4, 309 | (2) |
| U.S.S.R. (Russia) | [7 8] 26, 000 | [8] 34, 100 | [8] 31, 100 | [8] 32, 000 | (2) |
| Yugoslavia | 15, 200 | 22, 700 | 28, 562 | 18, 946 | 35, 304 |
| | [8] 169, 597 | [8] 181, 617 | [8] 167, 634 | [8] 148, 104 | (2) |

1 In addition to the countries listed, copper is produced in Asiatic Turkey, but data of output are not available.
2 Data not available.
3 Copper content of exports.
4 Approximate production.
5 Less than half a ton.
6 Smelter product.
7 Year ended Sept. 30.
8 Small output from Russia in Asia included under Russia in Europe.

*World mine production of copper, 1929–33, in metric tons*—Continued

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Asia: | | | | | |
| China [9] | 3,469 | 1,203 | 157 | 16 | 36 |
| Cyprus | 5,900 | 5,200 | 3,900 | 3,300 | (2) |
| India, British | 7,200 | 11,800 | 11,600 | 11,400 | (2) |
| Japan: | | | | | |
| Japan proper [6] | 75,469 | 79,033 | 75,848 | 71,013 | 69,120 |
| Chosen [6] | 547 | 589 | 698 | 694 | (2) |
| Taiwan | 6,100 | 3,060 | 4,117 | 4,417 | (2) |
| Russia | (8) | (8) | (8) | (8) | (2) |
| | [8] 98,685 | [8] 100,885 | [8] 96,320 | [8] 90,840 | (2) |
| Africa: | | | | | |
| Algeria | 25 | 1 | | 6 | 18 |
| Belgian Congo [6] | [10] 136,992 | [10] 138,949 | [11] 120,000 | [11] 54,000 | [11] 80,000 |
| French Equatorial Africa | 186 | 600 | 80 | (2) | (2) |
| French West Africa | | 135 | 200 | (2) | (2) |
| Morocco, French | 75 | | | | (2) |
| Rhodesia: | | | | | |
| Northern | [6] 5,553 | 8,630 | 32,923 | 88,639 | (2) |
| Southern [6] | 362 | 1,334 | 538 | 6 | |
| South-West Africa [12] | 12,600 | 15,100 | 8,400 | 2,400 | (2) |
| Union of South Africa | [6] 9,309 | 8,627 | 10,206 | 9,403 | (2) |
| | 165,102 | 173,376 | 172,347 | 155,000 | (2) |
| Oceania: | | | | | |
| Australia | 13,018 | 13,192 | 13,749 | 14,893 | 14,568 |
| New Caledonia | | 50 | | | (2) |
| Papua [13] | | (5) | | | (2) |
| | 13,018 | 13,242 | 13,749 | 14,893 | (2) |
| | 1,951,000 | 1,611,000 | 1,402,000 | 1,033,000 | (2) |

2 Data not available.
5 Less than half a ton.
6 Smelter product.
8 Small output from Russia in Asia included under Russia in Europe.
9 Exports of ingots and slabs.
10 Includes copper smelted in Belgium from mattes and alloys produced in the Belgian Congo as follows: 1929, 1,453 tons; 1930, 2,545 tons.
11 Fine copper content of smelter output.
12 Year ended Mar. 31 of year following that stated.
13 Copper content of exports for year ended June 30 of year stated.

## *World smelter production of copper, 1929–33, in metric tons*

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

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada [2] | 72,661 | 101,554 | 110,588 | 95,710 | 118,109 |
| Mexico | 58,997 | 54,025 | 43,738 | [3] 34,000 | (4) |
| United States [5] | 998,789 | 729,611 | 537,175 | 278,997 | 227,223 |
| | 1,130,447 | 885,190 | 691,501 | 408,707 | (4) |
| South America: | | | | | |
| Chile | 303,188 | 208,011 | 215,696 | 97,517 | (4) |
| Peru | [2] 53,962 | [2] 47,287 | 44,395 | 22,531 | (4) |
| | 357,150 | 255,298 | 260,091 | 120,048 | (4) |
| Europe: | | | | | |
| Austria | 3,895 | 4,076 | 3,235 | 1,987 | (4) |
| Belgium [6] | 8,940 | 14,640 | 31,400 | 26,950 | (4) |
| Czechoslovakia | 1,694 | 1,521 | 1,215 | 936 | (4) |
| Finland | 235 | ---------- | ---------- | ---------- | (4) |
| France | 1,010 | 1,207 | [3] 1,000 | [3] 1,000 | (4) |
| Germany [7] | 53,600 | 59,200 | 55,500 | 50,900 | 49,500 |
| Great Britain [8] | 22,000 | 18,000 | 16,000 | 13,000 | (4) |
| Italy | 539 | 262 | 721 | 427 | 120 |
| Norway | 2,400 | 5,149 | 4,352 | 5,416 | (4) |
| Rumania [9] | 143 | 169 | (10) | 109 | (4) |
| U.S.S.R. (Russia) [3] | 25,000 | 26,000 | 29,000 | 35,000 | (4) |
| Spain | 28,455 | 22,996 | 25,734 | 15,555 | (4) |
| Sweden [11] | 4,748 | 5,523 | 2,854 | 3,138 | (4) |
| Yugoslavia | 20,675 | 24,463 | 24,351 | 30,159 | 40,318 |
| | 173,334 | 183,206 | 195,362 | 184,577 | (4) |
| Asia: | | | | | |
| China [12] | 3,469 | 1,203 | 157 | 16 | 36 |
| Chosen | 547 | 589 | 698 | 694 | (4) |
| India, British | 1,661 | 3,022 | 4,134 | 4,514 | (4) |
| Japan | 75,469 | 79,033 | 75,848 | 71,013 | 69,120 |
| | 81,146 | 83,847 | 80,837 | 76,237 | (4) |
| Africa: | | | | | |
| Belgian Congo | [13] 135,539 | [13] 136,404 | [2] 120,000 | [2] 54,000 | [2] 80,000 |
| Rhodesia: | | | | | |
| Northern | 5,553 | 6,370 | 9,070 | 68,977 | 105,877 |
| Southern | 362 | 1,334 | 538 | 6 | ---------- |
| Union of South Africa | 9,309 | 7,488 | 10,225 | 9,387 | 8,378 |
| | 150,763 | 151,596 | 139,833 | 132,370 | 194,255 |
| Oceania: Australia | 11,049 | 15,139 | 13,144 | 13,521 | (4) |
| | 1,904,000 | 1,574,000 | 1,381,000 | 935,000 | [14] 990,000 |

[1] In addition to the countries listed, copper is smelted in Turkey and Russia in Asia, but data of output are not available.
[2] Copper content of blister produced.
[3] Approximate production.
[4] Data not available.
[5] Smelter output from domestic and foreign ores, exclusive of scrap. The production from domestic ores only, exclusive of scrap, was as follows: 1929, 908,479 tons; 1930, 632,481 tons; 1931, 472,968 tons; 1932, 246,757 tons; 1933, 204,115 tons.
[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] Exclusive of material from scrap.
[12] Exports of ingots and slabs.
[13] 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.
[14] Approximate production, based on the output of the countries shown, which in 1932 contributed nearly 71 percent of the total world output.

# LEAD

By Elmer W. Pehrson and H. M. Meyer

SUMMARY OUTLINE



The lead industry of the United States made little progress in 1933. Although the New York price averaged 22 percent above 1932 and consumption was 10 percent higher, refinery production of primary lead declined 5 percent to the lowest level since 1896, and stocks increased 15 percent to a new high. A disturbing factor during the year was the large supply of secondary lead, production of which increased 13 percent compared with an increase of only 2 percent in the output of primary domestic lead. Primary producers, therefore, did not share in the increased market for lead to the same extent as secondary producers. Recovery of secondary lead in all forms was equivalent to 86 percent of the domestic primary output in 1933 compared with 42 percent during the 5-year period 1925–29. Production at the mines decreased 7 percent in 1933.

Figure 4 shows trends in the United States lead industry for 34 years.

During the first 3 months of 1933 domestic shipments were at the low level of 19,500 tons per month compared with over 60,000 tons in 1929. As production exceeded consumption, stocks mounted rapidly; yet in spite of this unsatisfactory statistical position the price held at 3 cents throughout January and February. Following the inauguration of the new administration on March 4 the price advanced on a short buying wave, but toward the end of March it again settled to 3 cents. However, as the Government's program for economic recovery was revealed, consumers began to stock up in anticipation of higher prices. This movement was stimulated further by the announcement of curtailment in production by a large producer and by the abandonment of the gold standard on April 20. In July domestic shipments exceeded 45,000 tons for the first time since October 1930. As production failed to keep pace with this increase stocks fell rapidly and prices soared, reaching a high of 4.50 cents which held from early in July to the middle of October.

In the latter part of the year the demand slackened, and by September shipments had declined to less than 30,000 tons. The higher price level had by this time stimulated production at the mines. Stocks again began to rise and at the end of the year amounted to 203,000 tons, 15 percent higher than at the beginning of the year. The quotation on December 30, 1933, was 4.15 cents; the average for the year was 3.87 cents.

Outside the United States improvement in the lead industry was more pronounced. Production increased 1 percent, and as consumption reached a higher level than in 1932 stocks decreased slightly. The London price averaged 2.21 cents per pound (United States exchange basis), an increase of 19 percent over 1932. No attempt was made to revive the International Association of Lead Producers during the year, but exchange of statistics was continued by voluntary cooperation of the various members.

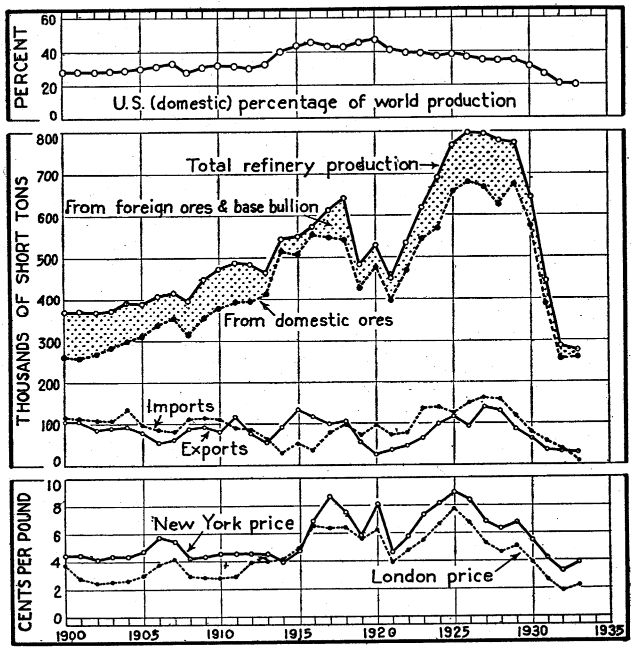


FIGURE 4.—Trends in the United States lead industry, 1900–33. Imports include general imports of lead in ore, base bullion, and refined; exports include refined lead and lead exported in manufactures with benefit of drawback.

The following table compares the lead industry of the United States during the past 4 years with the 5-year average for 1925–29.

*Salient statistics of the lead industry in the United States, 1925–33*

| | 1925–29 average | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Production of refined primary lead: | | | | | |
| From domestic ores........short tons.. | 660, 525 | 573, 740 | 390, 260 | 255, 337 | 259, 616 |
| From foreign ores and base bullion....................short tons.. | 123, 104 | 69, 293 | 52, 504 | 33, 024 | 13, 963 |
| | 783, 629 | 643, 033 | 442, 764 | 288, 361 | 273, 579 |
| Recovery of secondary lead: | | | | | |
| As pig lead.....................do.... | 126, 600 | 129, 000 | 128, 800 | 128, 000 | 131, 800 |
| In alloys.......................do.... | 153, 400 | 126, 800 | 105, 900 | 70, 300 | 92, 700 |
| | 280, 000 | 255, 800 | 234, 700 | 198, 300 | 224, 500 |
| Total production of pig lead (primary and secondary).................short tons.. | 910, 229 | 772, 033 | 571, 564 | 416, 361 | 405, 379 |
| Imports (general): | | | | | |
| Lead in base bullion.............do.... | 95, 747 | 38, 630 | 32, 320 | 13, 462 | 1, 587 |
| Lead in ore.....................do.... | 40, 096 | 39, 377 | 20, 888 | 21, 001 | 5, 958 |
| Exports of refined pig lead..........do.... | 98, 048 | 48, 307 | 21, 665 | 23, 516 | 22, 835 |
| Refined primary lead available for consumption...................short tons.. | 677, 322 | 582, 774 | 410, 606 | 257, 669 | 244, 299 |
| Estimated consumption of primary and secondary lead..............short tons.. | 900, 250 | 768, 600 | 567, 700 | 400, 000 | 439, 700 |
| Prices per pound of refined lead at New York: | | | | | |
| Highest monthly average.......cents.. | 10. 33 | 6. 25 | 4. 80 | 3. 75 | 4. 50 |
| Lowest monthly average.........do.... | 6. 02 | 5. 10 | 3. 79 | 2. 73 | 3. 00 |
| Average for year.................do.... | 7. 47 | 5. 52 | 4. 24 | 3. 18 | 3. 87 |
| Quotation at end of year.........do.... | 6. 25 | 5. 10 | 3. 75 | 3. 00 | 4. 15 |
| Mine production of recoverable lead short tons.. | 661, 799 | 558, 313 | 404, 622 | 292, 968 | [1] 273, 170 |
| Southeastern Missouri district percent of total.. | 30 | 35 | 39 | 40 | 31 |
| Utah............................do.... | 23 | 21 | 20 | 21 | 22 |
| Idaho...........................do.... | 21 | 24 | 25 | 25 | 27 |
| Joplin (Tri-State) region..........do.... | 13 | 7 | 5 | 6 | 9 |
| All other........................do.... | 13 | 13 | 11 | 8 | 11 |
| World smelter production of lead metric tons.. | 1, 678, 000 | 1, 696, 000 | 1, 386, 000 | 1, 159, 000 | 1, 160, 000 |
| United States.........percent of total.. | 38 | 33 | 27 | 22 | 21 |
| Mexico..........................do.... | 12 | 12 | 15 | 12 | 10 |
| Australia........................do.... | 10 | 10 | 11 | 16 | 19 |
| Canada..........................do.... | 7 | 8 | 9 | 10 | 10 |
| Spain...........................do.... | 9 | 7 | 8 | 9 | 7 |
| All other........................do.... | 24 | 30 | 30 | 31 | 33 |

[1] Subject to revision.

*Lead industry and NRA.*—The lead industry operated under the President's Reemployment Agreement during the latter half of 1933, pending preparation and approval of a final code of fair competition. The first draft of a basic code was submitted on August 3, and public hearings were held on December 22. After several revisions a final code was signed by the Administrator on May 24, 1934, which became effective on June 4.

The code provides for a code authority consisting of the executive committee of the Lead Industries Association, the secretary of the association, and the chairmen of the five divisions of the industry. The latter include mining, smelting and refining (including secondary metal), lead pigments, metallic lead products, and metallic foil products. Minimum wages and hours are specified for each division and provision is made for establishing standards for safety and health. No definite control of production or stabilization of the industry is set up, although provision is made that such proposals may be recommended. The code specifies trade-practice rules for the lead-pigments, metallic-lead-products, and metallic-foil-products divisions. There is no provision for price-fixing, but the trade practices specified for the lead pigments division provide for free exchange of price data and uniform bases for sale.

## DOMESTIC PRODUCTION

Refined pig lead produced in the United States is derived from three main sources—domestic ore, foreign ore and base bullion, and secondary materials. The following table shows the production from each of these sources from 1924 to 1933.

*Total pig lead produced in the United States, 1924–33, short tons*

| Year | From domestic ores and base bullion | From foreign ores and base bullion | From secondary materials | Total |
|---|---|---|---|---|
| 1924 | 566, 407 | 124, 086 | 90, 400 | 780, 893 |
| 1925 | 654, 921 | 112, 048 | 112, 420 | 879, 389 |
| 1926 | 680, 685 | 118, 256 | 125, 000 | 923, 941 |
| 1927 | 668, 320 | 128, 210 | 119, 000 | 915, 530 |
| 1928 | 626, 202 | 154, 869 | 138, 000 | 919, 071 |
| 1929 | 672, 498 | 102, 135 | 138, 500 | 913, 133 |
| 1930 | 573, 740 | 69, 293 | 129, 000 | 772, 033 |
| 1931 | 390, 260 | 52, 504 | 128, 800 | 571, 564 |
| 1932 | 255, 337 | 33, 024 | 128, 000 | 416, 361 |
| 1933 | 259, 616 | 13, 963 | 131, 800 | 405, 379 |

### PRIMARY LEAD

*Refinery production.*—Production of refined primary lead in 1933 declined 5 percent and was the lowest recorded since 1886. Production from foreign ores and base bullion declined 58 percent and was the lowest since 1886, the first year in which lead production from foreign raw materials was reported. Lead derived from domestic ores increased 2 percent in 1933.

*Refined primary lead produced in the United States, 1929–33*

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

[1] The lead content of antimonial lead is excluded (see p. 84).
[2] Desilverized soft lead is excluded.

*Source of primary lead.*—Of the total refined lead produced in 1933, 94.9 percent was derived from domestic ores, 2.8 percent from foreign ores, and 2.3 percent from foreign base bullion. Production from foreign ores declined 65 percent in 1933 owing to reduced tonnages from Newfoundland (included as "other foreign" in the following table), Europe (mostly Sweden), and South America. Smelting of Canadian ores was fairly well maintained in 1933; but Mexican ores, which in 1924 yielded over 33,000 tons of lead, have contributed only negligible amounts during the past 2 years. The production of refined lead from foreign base bullion declined 44 percent in 1933.

During the past 3 years virtually all foreign base bullion refined in the United States has come from Mexico. Details of the sources of lead derived from domestic ores are shown in the section on mine production.

*Refined primary lead produced in the United States, 1929–33, by sources, in short tons*

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

*Soft lead.*—Nonargentiferous lead ores of high purity, from which a soft lead can be produced without elaborate refining processes, are known as soft-lead ores. Most of the soft-lead ores produced in the United States are smelted into pig lead; but a substantial quantity is used each year in the manufacture of lead pigments, principally basic lead sulphate (white sublimed lead) and leaded zinc oxide. About one-fifth of the pig lead produced from soft-lead ores is desilverized and used largely in the manufacture of white lead where high purity is required. Undesilverized soft lead containing relatively high copper is extremely resistant to corrosion by acids and is known to the trade as chemical lead; it is used chiefly in the manufacture of cable, pipe, and sheets.

The following table gives the production of soft lead during the past 5 years:

*Soft lead produced in the United States from domestic ores, 1929–33, in short tons*

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

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

*Antimonial lead.*—Antimonial lead or hard lead is an important byproduct of the refining of base bullion, but the amount derived from this source is only a small part of the country's yearly production. The principal uses of 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 when the products have become worn out or obsolete. The smelting of such scrap yields 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.

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

*Antimonial lead produced at primary lead refineries, 1929–33*

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

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

## SECONDARY LEAD

Production of secondary lead has held up relatively much better than primary lead during the depression. In 1933 it amounted to 80 percent of the 5-year average 1925–29, whereas production of primary lead from domestic ores was only 39 percent. As a result of these divergent trends the output of secondary lead was equivalent to 86 percent of the domestic primary output in 1933 compared to 42 percent for the 5-year period.

Many of the lead-consuming industries, such as those making storage batteries and cable coverings and the building industry, provide a large return of secondary metal. It has been estimated that as much as 90 percent of the lead used in the manufacture of storage batteries is returned to the smelters. Although there has been a marked decline in the manufacture of new automobiles the total number of cars in operation has declined only about 10 percent, and the replacement of batteries in old cars has been largely responsible for the maintenance of the scrap supply for secondary smelting. Storage-battery scrap accounts for about half of the secondary lead production. Another factor of some importance in maintaining the supply of scrap has been the salvaging of materials in manufacturing plants that have failed during the depression.

The large proportion of secondary lead consumed during the last few years has added to the hardships of primary producers and the lead-mining communities. It should be borne in mind, however, that when consumption again expands the increase will be supplied largely by primary metal and that the ratio of secondary to primary production will probably return to the predepression average and for a few years may be below that average.

*Secondary lead recovered in the United States, 1929–33* [1]

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

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

## LEAD PIGMENTS

Lead pigments manufactured in 1933 contained 149,958 tons of lead from the sources shown in the following table. Of this total about 143,027 tons were derived from refined pig lead. White lead accounted for 42 percent; litharge, 40 percent; red lead, 14 percent; and sublimed lead and orange mineral, 4 percent. Sublimed lead and leaded zinc oxide are the principal pigments in which the lead content is derived from ores.

*Lead in pigments,[1] 1929–33, by sources, in short tons*

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

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

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

## MINE PRODUCTION

Mine production of recoverable lead in 1933 amounted to 273,170 tons, a decrease of 7 percent from 1932 and 59 percent below the average for 1925 to 1929. In the Western States and Alaska production increased 4 percent but that in the Central and Eastern States declined 19 and 30 percent, respectively.

Compared with the 5-year average (1925–29), production in 1933 was as follows: Western States, 43 percent; Central States, 38 percent; and Eastern States, about 76 percent. Missouri continued to rank first in production but recorded a large decrease (27 percent) due to curtailment of operations in the southeast district. Idaho, with a 3-percent increase, again ranked second, and Utah continued to rank third, although its output declined 7 percent in 1933. These 3 States accounted for 80 percent of the total production. Oklahoma ranked fourth and increased its output 70 percent.

The decline in lead production during the depression has been severe in all the principal producing States. Idaho more nearly maintained its production than any other important State, yet its 1933 output was only 53 percent of the predepression average. The output of Missouri was only 42 percent; Utah, 39 percent; Montana, 36 percent; Oklahoma, 31 percent; Kansas, 23 percent; and Colorado, 8 percent. These 7 States contributed 92 percent of the lead produced from 1925 to 1929.

*Mine production of recoverable lead in the United States, 1925–33, in short tons*

| State | 1925–29 average | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Western States and Alaska: | | | | | |
| Alaska | 982 | 1,365 | 1,661 | 1,261 | [1] 1,520 |
| Arizona | 9,743 | 4,246 | 982 | 1,182 | [1] 1,690 |
| California | 2,070 | 1,780 | 1,879 | 1,209 | [1] 375 |
| Colorado | 30,112 | 22,130 | 6,884 | 2,150 | 2,402 |
| Idaho | 141,610 | 134,058 | 99,365 | 72,118 | [1] 74,375 |
| Montana | 18,871 | 10,653 | 4,430 | 1,079 | [1] 6,700 |
| Nevada | 9,807 | 11,529 | 7,930 | 440 | [1] 2,320 |
| New Mexico | 6,730 | 10,378 | 11,269 | 10,114 | 11,043 |
| Oregon | 6 | 5 | 2 | 4 | 5 |
| South Dakota | 21 | | | 4 | 22 |
| Texas | 213 | 198 | | 17 | 3 |
| Utah | 149,509 | 115,495 | 79,212 | 62,776 | 58,688 |
| Washington | 1,323 | 576 | 1,386 | 921 | 840 |
| Wyoming | | | | 5 | |
| | 370,997 | 312,413 | 215,000 | 153,280 | [1] 159,980 |
| Central States: | | | | | |
| Arkansas | 38 | 53 | 78 | 4 | 10 |
| Illinois | 552 | 248 | 205 | 31 | 240 |
| Kansas | 26,121 | 12,910 | 7,082 | 6,490 | 6,089 |
| Kentucky | 135 | 101 | | | 176 |
| Missouri | 202,240 | 199,632 | 160,121 | 117,159 | 84,980 |
| Oklahoma | 58,306 | 23,052 | 13,210 | 10,634 | 18,038 |
| Wisconsin | 1,745 | 1,537 | 952 | 910 | 540 |
| | 289,137 | 237,533 | 181,648 | 135,228 | 110,073 |
| Eastern States: | | | | | |
| New York | | 8,367 (New York, Tennessee, Virginia) | 7,974 | 4,460 | 3,116 |
| Tennessee, Virginia | 4,096 | | | | |
| | 4,096 | 8,367 | 7,974 | 4,460 | 3,116 |
| | 664,230 | 558,313 | 404,622 | 292,968 | [1] 273,170 |

[1] Subject to revision.

*Mine production of recoverable lead in the principal lead-producing districts of the United States, 1929–33, in short tons*

| District | State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| Southeastern Missouri region | Missouri | 197,435 | 198,622 | 158,950 | 116,152 | 83,970 |
| Coeur d'Alene region | Idaho | 141,558 | 129,311 | 97,771 | 71,505 | [1] 74,000 |
| Bingham | Utah | 49,447 | 42,586 | 33,597 | 32,640 | 33,030 |
| Joplin region | Kansas, Missouri, Oklahoma. | 74,143 | 36,972 | 21,463 | 18,131 | 25,137 |
| Park City region | Utah | 42,570 | 30,875 | 17,368 | 12,653 | 11,557 |
| Willow Creek | New Mexico | 5,720 | 5,431 | 7,563 | 6,449 | 7,075 |
| Rush Valley | Utah | 11,751 | 10,157 | 8,773 | 7,222 | 6,916 |
| Tintic | do | 44,113 | 29,474 | 18,427 | 9,842 | 6,433 |
| Butte | Montana | 8,239 | 2,540 | | 1 | [1] 4,200 |
| Central | New Mexico | 3,766 | 3,936 | 3,420 | 3,521 | 3,408 |
| Eagle | Montana | | 1,287 | 3,489 | 741 | (2) |
| San Juan Mountains | Colorado | 17,386 | 11,722 | 908 | 792 | 906 |
| Metaline | Washington | 328 | 267 | 1,257 | 682 | 722 |
| Pend d'Oreille | Idaho | 863 | 956 | 1,020 | 576 | (2) |
| Upper Mississippi Valley | Iowa, Northern Illinois, Wisconsin. | 1,536 | 1,537 | 952 | 910 | 540 |
| Leadville | Colorado | 5,172 | 6,808 | 1,470 | 76 | 505 |
| Inyo County | California | 670 | 1,711 | 1,765 | 1,102 | (2) |
| Bisbee (Warren) | Arizona | 1,020 | 151 | 252 | 431 | (2) |
| Eagle County | Colorado | 198 | 2,821 | 3,816 | 221 | 8 |
| Cedar Plains | Montana | 1,177 | 120 | 25 | 2 | (2) |
| Dome | Idaho | 1,870 | 829 | | 1 | (2) |
| Tybo | Nevada | 1,991 | 3,622 | 4,083 | | (2) |
| San Francisco | Utah | 691 | 1,883 | 436 | | |
| Warm Springs | Idaho | 1,507 | 1,793 | 37 | | (2) |
| Barker | Montana | 6,137 | 4,578 | 21 | | (2) |
| Banner | Arizona | 2,938 | 929 | | | (2) |
| Austinville [3] | Virginia | (4) | (4) | (4) | (4) | (4) |
| Jack Rabbit [3] | Nevada | 2,430 | 1,464 | 240 | (4) | (2) |
| Oro Blanco [3] | Arizona | (4) | (4) | | | (2) |
| Pioche [3] | Nevada | 2,986 | 4,868 | 2,892 | (4) | (2) |
| St. Lawrence County [3] | New York | | (4) | (4) | (4) | (4) |

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

## STOCKS

Lead stocks, as reported by the American Bureau of Metal Statistics, are shown in the following table. Stocks of refined and antimonial lead include metal held by all primary refiners and most of the refiners of secondary material that produce common lead. Foreign lead refined in the United States and entered for domestic consumption is included. During the past 5 years stocks of refined pig lead have increased steadily. At the close of 1933 they were nearly five times the amount held at the close of 1929. Combined stocks of refined and antimonial lead on December 31, 1933, were equal to a 7-month supply at the average rate of consumption in 1933. If 50,000 tons are allowed as normal stock requirements, excess stocks at the end of 1933 were equivalent to 3 months of normal consumption. Stocks of base bullion have not varied much during the depression, but accumulations of ore have more than doubled.

*Lead stocks at end of year at smelters and refineries in the United States, 1929–33, in short tons*

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

According to trade estimates,[1] stocks outside the United States showed a small decline in 1933, dropping from 380,000 short tons on January 1 to 375,000 tons on December 31. World stocks, therefore, may be estimated to have increased from 556,000 to 578,000 tons during 1933. Normally, world stocks amount to approximately 200,000 tons.

## DOMESTIC CONSUMPTION

*New supply.*—The following table shows the refined primary lead available for consumption from 1929 to 1933. The computation does not take into account changes in producers' stocks, and as these have increased steadily during the past 5 years the quantities shown overstate actual consumption of new lead. Nevertheless, the supply available for consumption in 1933 was equivalent to only 35 percent of that in 1929.

*Refined primary pig lead available for consumption in the United States, 1929–33, in short tons*

| | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Supply: | | | | | |
| Stock in bonded warehouse Jan. 1 | 4,139 | 1,328 | (1) | (1) | (1) |
| Imports of pigs, bars, and old | 1,658 | 209 | 10 | 44 | 63 |
| Production | 774,633 | 643,033 | 442,764 | 288,361 | 273,579 |
| | 780,430 | 644,570 | 442,774 | 288,405 | 273,642 |
| Withdrawn: | | | | | |
| Exports— | | | | | |
| Pig lead | 73,251 | 48,307 | 21,665 | 23,516 | 22,835 |
| In manufactures, with benefit of drawback | 13,086 | 12,161 | 10,503 | 7,220 | 6,508 |
| Stock in bonded warehouse Dec. 31 | 1,328 | (1 2) | (1) | (1) | (1) |
| | 87,665 | 61,796 | 32,168 | 30,736 | 29,343 |
| Supply available for consumption | 692,765 | 582,774 | 410,606 | 257,669 | 244,299 |

1 Stocks of pigs, bars, etc., in bonded warehouse not separately recorded after April 1930 but included with base bullion. (See table on p. 92.)
2 For purpose of calculating quantity available for domestic consumption, stocks in warehouse are estimated to have remained unchanged from the beginning of the year.

1 Metal Bulletin, London, Jan. 30, 1934, p. 12.

*Consumption by uses.*—Owing to the large return of secondary lead from the lead-consuming industries the total consumption of pig lead greatly exceeds the supply of new lead available. The following table gives the American Bureau of Metal Statistics estimate of the total consumption of lead by industries during the past 5 years.

*Lead consumed in the United States,*[1] *1929–33, in short tons*

| Purpose | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| White lead | 119,700 | 83,900 | 77,500 | 54,500 | 59,100 |
| Red lead and litharge | 30,000 | 32,000 | 18,000 | 15,800 | 19,000 |
| Storage batteries | 210,000 | 163,000 | 157,000 | 138,000 | 147,000 |
| Cable covering | 220,000 | 208,000 | 117,000 | 55,000 | 31,000 |
| Building | 96,000 | 67,000 | 40,000 | 22,000 | 26,000 |
| Automobiles | 18,000 | 11,000 | 6,000 | 3,500 | 5,000 |
| Railway equipment | 5,700 | 5,200 | 1,000 | 300 | 200 |
| Shipbuilding | 300 | 500 | 400 | 200 | 100 |
| Ammunition | 41,100 | 33,300 | 29,700 | 23,300 | 32,300 |
| Terneplate | 4,200 | 2,700 | 2,200 | 1,400 | 2,500 |
| Foil | 39,800 | 26,000 | 20,000 | 14,000 | 22,500 |
| Bearing metal | 33,000 | 20,000 | 12,000 | 10,000 | 15,000 |
| Solder | 37,000 | 27,000 | 20,500 | 14,000 | 16,000 |
| Type metal | 18,000 | 16,000 | 14,400 | 10,800 | 11,000 |
| Calking | 31,500 | 21,000 | 15,000 | 10,000 | 12,000 |
| Castings | 18,000 | 12,000 | 7,000 | 5,000 | 5,000 |
| Other uses | 50,000 | 40,000 | 30,000 | 22,200 | 36,000 |
| | 972,300 | 768,600 | 567,700 | 400,000 | 439,700 |

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

The industrial use of lead in 1933 increased about 10 percent. As there was a decrease in the supply of new lead available, the rise in consumption was met by increased use of secondary lead. The storage-battery industry ranked first in lead consumption by a wide margin, showing an increase of 7 percent. The white-lead industry was the second largest consumer, using 8 percent more than in 1932. The use of lead for cable covering, which ranked first in 1929–30 and second in 1931–32, declined 44 percent in 1933 and dropped to fourth place. This was the fourth consecutive decline in this market for lead and reflects the low rate of investment in capital goods. Compared with 1929 lead consumption for the 5 major uses in 1933 was as follows: Storage batteries, 70 percent; white lead, 49 percent; ammunition, 79 percent; cable covering, 14 percent; and building, 27 percent. Lead used in foil increased 61 percent in 1933 and was equivalent to 57 percent of the 1929 tonnage.

There were few developments in the field of new uses in 1933. A new alloy containing less than 0.1 percent tellurium was put on the market; it is claimed to have much greater tensile strength and higher fatigue limit than ordinary lead and even greater resistance to corrosion by sulphuric acid. The architectural uses of lead are increasing slowly, and some progress has been made in the marketing of ornamental household objects.

## PRICES

The two major markets for lead in the United States are New York and St. Louis; a large part of the lead produced in the United States is sold at prices based on quotations in these markets. The New York quotations are influenced to some extent by the lower prices usually prevailing on the London market, so that the New York price seldom exceeds the St. Louis price by as much as the freight differential, 0.37 cent a pound.

The price of lead in 1933 made a substantial recovery from the extremely low level of 1932. The average New York quotation was 3.87 cents per pound, an increase of 22 percent over 1932. However, it was 9 percent below the average of 1931 and 43 percent below that for 1929. At the beginning of the year the quotation was 3 cents, the low for the year (the 1932 low was 2.65 cents). This level held until after March 4, when there was a sharp flurry upward following an increase in demand. This proved to be short-lived, however, and toward the end of March the quotation again settled to 3 cents. About this time one of the large producers announced a sharp reduction in production. This and the revelation of the Government's program for economic recovery stimulated a buying movement in anticipation of higher prices. Further impetus to the price movement was given by abandonment of the gold standard on April 20. On July 10 the high for the year, 4.50 cents, was reached and held until the middle of October. By this time the statistical position had again become unfavorable, and the price settled to 4.15 cents at the close of the year.

The London quotation for 1933 (United States exchange basis) averaged 2.21 cents per pound, 1.66 cents below the New York average. Owing to unsettled exchange conditions the differential between New York and London varied considerably—from 1.41 cents in February to 2.05 cents in August.

The following table shows the average monthly quotations at St. Louis, New York, and London during the past 3 years.

*Average monthly and yearly quoted prices of lead at St. Louis, New York, and London, 1931–33, in cents per pound* [1]

| Month | 1931 | | | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|---|---|---|
| | St. Louis | New York | London | St. Louis | New York | London | St. Louis | New York | London |
| January | 4.60 | 4.80 | 3.01 | 3.55 | 3.75 | 2.31 | 2.87½ | 3.00 | 1.57 |
| February | 4.33 | 4.54 | 2.92 | 3.51 | 3.72 | 2.25 | 2.87½ | 3.00 | 1.59 |
| March | 4.28 | 4.53 | 2.85 | 2.99 | 3.15 | 2.01 | 3.03 | 3.15 | 1.63 |
| April | 4.17 | 4.39 | 2.69 | 2.90 | 3.00 | 1.88 | 3.13 | 3.27 | 1.74 |
| May | 3.65 | 3.82 | 2.50 | 2.90 | 3.00 | 1.75 | 3.52 | 3.65 | 2.12 |
| June | 3.76 | 3.92 | 2.52 | 2.89 | 2.99 | 1.56 | 4.02 | 4.17 | 2.45 |
| July | 4.22 | 4.40 | 2.76 | 2.59 | 2.73 | 1.56 | 4.30 | 4.45 | 2.78 |
| August | 4.22 | 4.40 | 2.59 | 3.09 | 3.24 | 1.76 | 4.35 | 4.50 | 2.45 |
| September | 4.22 | 4.33 | 2.41 | 3.32 | 3.46 | 2.03 | 4.35 | 4.50 | 2.49 |
| October | 3.78 | 3.96 | 2.30 | 2.94 | 3.06 | 1.81 | 4.18 | 4.32 | 2.46 |
| November | 3.76 | 3.94 | 2.42 | 2.93 | 3.05 | 1.77 | 4.14 | 4.29 | 2.65 |
| December | 3.59 | 3.79 | 2.29 | 2.88 | 3.00 | 1.63 | 4.04 | 4.14 | 2.61 |
| Average | 4.05 | 4.24 | [2] 2.64 | 3.04 | 3.18 | [2] 1.86 | 3.74 | 3.87 | [2] 2.21 |

[1] St. Louis: Metal Statistics, 1934, p. 361. 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, 1934, p. 365. 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: 1931, £13.029; 1932, £11.913; 1933, £11.6708.

## FOREIGN TRADE

The foreign trade of the United States in lead consists largely of imports of ore and base bullion, which are smelted and/or refined in bond, and the export of this lead either as refined lead or in manufactured products. Since 1927, however, this trade has declined steadily. In 1933 only 7,608 tons of lead in ore and base bullion (including a small amount of refined lead) were imported, compared with 161,389 tons in 1927; exports of refined lead decreased from 125,267 to 22,835 tons. Lead exported in manufactures with benefit of drawback declined from 12,004 to 6,508 tons.

From 1914 to 1918, when foreign production was disturbed by the World War, exports exceeded imports. But with post-war readjustments the United States ceased to be an exporter, and from 1919 to 1932 imports exceeded exports. In 1933 there was a small export surplus due to liquidation of stocks of foreign lead held in bonded warehouses.

*Imports.*—General imports of lead in ore and matte declined 72 percent in 1933. Shipments from Newfoundland, which were half the 1932 total, ceased in 1933, while those from Sweden, Canada, and Chile declined 54, 34, and 71 percent, respectively. Imports of base bullion declined 88 percent owing to the drop in shipments from Mexico. Imports of refined lead were negligible. Total imports of lead decreased 78 percent compared with 1932 and 93 percent compared with 1929.

*Lead imported into the United States, 1929–33, 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 |
|---|---|---|---|---|
| 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 |
| 1933 | 5,958 | 1,587 | 63 | 7,608 |

[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, 1929–33, by sources, in short tons*

[General imports]

| Year | Canada | Mexico | South America | Europe | Other countries | Total |
|---|---|---|---|---|---|---|
| 1929 | 4,512 | 87,936 | 23,526 | 14 | 71 | 116,059 |
| 1930 | 17,268 | 36,721 | 22,472 | 113 | 1,642 | 78,216 |
| 1931 | 2,618 | 38,706 | 2,171 | | [1] 9,723 | 53,218 |
| 1932 | 2,459 | 13,545 | 2,811 | 5,053 | [2] 10,639 | 34,507 |
| 1933 | 1,629 | 2,155 | 1,479 | 2,292 | 53 | 7,608 |

[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, 1929–33, by countries, in short tons*

[General imports]

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

[1] Less than 1 ton.

*Lead imported into the United States, in base bullion, 1929–33, by countries, in short tons*

[General imports]

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

Imports for consumption increased in value in 1933 owing to the large increase in receipts of ore and matte as withdrawals from warehouse. Imports of base bullion for consumption decreased 88 percent in 1933.

*Lead remaining in warehouses in the United States, December 31, 1929–33, in short tons*

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

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

[1] Pigs, bars, and old included with base bullion; not recorded separately for 1930–33.

*Lead imported for consumption in the United States, 1929–33, by classes*

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

[1] Classification as follows: Jan. 1, 1929, to June 17, 1930, "Lead in ore and matte"; June 18, 1930, through 1933, "Lead in ores, flue dust, and mattes, n.s.p.f."
[2] Reclaimed scrap, etc. No imports of pigs, bars, etc., recorded for 1931.

*Miscellaneous products containing lead imported for consumption in the United States, 1929–33*

| Year | Babbitt metal, solder, white metal, and other combinations containing lead | | | Type metal and antimonial lead | | |
|---|---|---|---|---|---|---|
| | Gross weight (short tons) | Lead content (short tons) | Value | Gross weight (short tons) | Lead content (short tons) | Value |
| 1929 | 1,505 | 663 | $777,354 | 2,720 | 2,425 | $180,679 |
| 1930 | 1,399 | 530 | 593,103 | 328 | 275 | 32,934 |
| 1931 | 906 | 310 | 436,574 | ---------- | ---------- | ---------- |
| 1932 | 498 | 191 | 143,662 | 6 | 5 | 479 |
| 1933 | 2 | 2 | 1,741 | 371 | 70 | 39,212 |

*Exports.*—Exports of refined lead in 1933 were fairly well maintained, having declined only 3 percent; however, they amounted to only 69 percent of the 1929 total. Japan continued to be the principal buyer, taking 93 percent of the total. Foreign lead exported in manufactures with benefit of drawback amounted to 6,508 tons, a decrease of 10 percent from 1932 and 50 percent from 1929. Nearly half of this was contained in storage batteries exported. Other lead exports in 1933 included 174 tons of lead sheets, 100 tons of lead pipes, 207 tons of solder, and miscellaneous lead manufactures valued at $234,007.

*Refined lead exported from the United States, 1929–33*

| Year | Pigs, bars, and old | | Foreign lead exported in manufactures with benefit of drawback (short tons) |
|---|---|---|---|
| | Short tons | Value | |
| 1929 | 73,251 | $7,178,337 | 13,086 |
| 1930 | 48,307 | 3,904,213 | 12,161 |
| 1931 | 21,665 | 1,241,881 | 10,503 |
| 1932 | 23,516 | $1,069,697 | 7,220 |
| 1933 | 22,835 | 834,589 | 6,508 |

*Refined pig lead exported from the United States, 1929–33, by destinations, in short tons*

| Destination | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| COUNTRY | | | | | |
| Argentina | 599 | 934 | 226 | -------- | 113 |
| Brazil | 1,538 | 874 | 1,382 | 759 | 329 |
| Canada | 141 | 9 | 58 | 133 | 6 |
| France | 2,202 | 3,001 | 318 | 224 | -------- |
| Germany | 9,745 | 823 | 52 | 1,344 | 5 |
| Japan | 16,416 | 15,653 | 17,301 | 20,219 | 21,236 |
| Mexico | 83 | 40 | 171 | 13 | 5 |
| Netherlands | 1,522 | 22 | 13 | 112 | -------- |
| Philippine Islands | 111 | 543 | 400 | 475 | 360 |
| Sweden | 7,255 | 7,557 | 392 | -------- | -------- |
| United Kingdom | 23,732 | 9,157 | 3 | -------- | -------- |
| Uruguay | 448 | 364 | 145 | 84 | 140 |
| Other | 9,459 | 9,330 | 1,204 | 153 | 641 |
| | 73,251 | 48,307 | 21,665 | 23,516 | 22,835 |
| CONTINENT | | | | | |
| North America | 693 | 318 | 435 | 160 | 42 |
| South America | 3,852 | 2,442 | 1,903 | 863 | 735 |
| Europe | 50,649 | 27,899 | 795 | 1,793 | 5 |
| Asia | 18,055 | 17,289 | 18,524 | 20,700 | 22,053 |
| Africa and Oceania | 2 | 359 | 8 | -------- | -------- |
| | 73,251 | 48,307 | 21,665 | 23,516 | 22,835 |

## WORLD ASPECTS OF LEAD INDUSTRY

*International Association of Lead Producers.*—This organization was formed in September 1928, following a sharp recession in prices during the first part of that year. Membership included the principal producers of the British Empire, Mexico, Germany, Spain, France, Belgium, and Italy. Activities at first were confined to mere exchange of statistical data, but in August 1929 the Mexican and British interests united in a cooperative sales agreement in an endeavor to stabilize the market for lead. During 1930, as stocks mounted rapidly, there was agitation for curtailment of production. Nothing was accomplished until early in 1931 when, according to press reports, an agreement was reached to reduce production on May 1 to 15 percent below the 1930 level. This was increased to 20 percent effective July 1 and again reduced to 15 percent on November 1. It was also reported that agreement had been reached not to sell stocks except at a specified price considerably above the market at that time.

All these measures proved ineffective in reducing the constantly increasing gap between production and consumption. Stocks of lead outside the United States increased from 180,000 long tons at the end of 1929 to 290,000 tons at the close of 1931, and the London price of lead declined from over £22 per long ton in January 1929 to less than £12 in September 1931, when Great Britain abandoned the gold standard. The imposition of the British tariff on lead on March 1, 1932, ended the selling-pool arrangement, and on June 1, 1932, the association technically terminated. Several attempts to renew the agreement during the latter part of 1932 failed, and during 1933 no further effort was made in this direction. However, the statistical service formerly rendered by the association has continued without change from month to month through individual cooperation of the various producers.

*World production.*—World smelter production of lead in 1933 was maintained at about the same level as in 1932. Production in the United States decreased 4 percent, whereas that of the rest of the world increased 1 percent. The 10 leading producing countries and the percentage of the world total each contributed were as follows: United States, 20.9; Australia, 19.0; Mexico, 10.2; Germany, 10.1; Canada, 10.0; Spain, 7.5; India, 6.3; Belgium, 5.3; Italy, 2.1; and Union of Soviet Socialist Republics (Russia) 1.7. Increases in output were reported as follows: Germany, 23 percent; Australia, 16 percent; Union of Soviet Socialist Republics, 11 percent; Canada, 1 percent; and India, 1 percent. In addition to the United States, Italy showed a decrease of 23 percent; Spain, 18 percent; Mexico, 14 percent; and Belgium, 5 percent. The British Empire has achieved an outstanding position in lead production. From 1925 to 1929 it produced an average of about 370,000 metric tons a year or 22 percent of the total world output. In 1933 Empire production increased to 421,000 tons or 36 percent of the world total. This was an increase of 14 percent over the 5-year average, whereas world production decreased 31 percent.

*World production of lead, 1929–33, in metric tons* [1]

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

| Country [2] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Argentina | 9,020 | 8,882 | 7,609 | 3,481 | [3] 3,500 |
| Australia | 180,358 | 171,248 | 152,850 | 189,347 | 220,300 |
| Austria | 6,569 | 6,935 | 6,117 | 1,986 | 4,624 |
| Belgium | 82,850 | 85,370 | 70,850 | 64,160 | 60,960 |
| Canada | 138,095 | 138,105 | 126,301 | 114,820 | 115,469 |
| Chosen | 333 | 130 | 97 | 453 | [3] 500 |
| Czechoslovakia | 4,609 | 4,225 | 3,569 | 4,124 | [3] 4,000 |
| France | 20,358 | 20,170 | 19,100 | 12,000 | 7,711 |
| Germany [4] | 97,900 | 110,800 | 101,300 | 95,216 | 116,735 |
| Great Britain | 10,839 | 10,383 | 10,723 | 7,100 | [3] 10,000 |
| Greece | 5,361 | 7,329 | 6,797 | 6,482 | [3] 6,500 |
| Hungary | 109 | 70 | 52 | (5) | (5) |
| India (Burma) | 81,521 | 81,010 | 75,985 | 72,345 | 73,200 |
| Indo-China | 17 | 11 | 6 | 16 | (5) |
| Italy | 22,650 | 24,340 | 24,882 | 31,471 | 24,200 |
| Japan | 3,374 | 3,581 | 4,070 | [3] 4,000 | [3] 4,000 |
| Mexico | 239,952 | 242,537 | 210,427 | 137,099 | 118,460 |
| Northern Rhodesia | 1,661 | --- | --- | --- | 75 |
| Norway | [3] 300 | [3] 300 | 347 | 435 | [3] 500 |
| Peru | 19,448 | 14,979 | 252 | 327 | [3] 300 |
| Poland | 35,789 | 40,900 | 31,380 | 11,902 | 12,065 |
| Portugal | 96 | 89 | 108 | 109 | [3] 100 |
| Rumania | 565 | 984 | 1,314 | 1,938 | 2,000 |
| South West Africa [7] | 2,802 | 3,661 | 2,641 | 1,044 | 2,000 |
| Spain | 142,753 | 123,263 | 109,630 | 105,370 | 86,621 |
| Tunisia | 18,850 | 19,400 | 19,112 | 14,082 | 14,870 |
| Turkey | 7,324 | 4,664 | 2,767 | [3] 2,000 | [3] 2,000 |
| Union of Soviet Socialist Republics (Russia) | [6] 6,200 | 10,750 | 16,140 | 18,000 | [3] 20,000 |
| United States (refined) [8] | 636,997 | 551,645 | 374,224 | 251,365 | 242,483 |
| Yugoslavia | 9,471 | 10,049 | 7,929 | 8,321 | 6,337 |
| | 1,786,000 | 1,696,000 | 1,386,000 | 1,159,000 | 1,160,000 |

[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.

*World consumption.*—Estimates of world consumption in 1933 indicate a total of 1,178,000 metric tons, an increase of 10 percent over 1932. The increase in the United States (including secondary and antimonial lead) was 14 percent, compared with 8 percent elsewhere. The leading consumers and the percentage of the world total each took were: United States, 24.1; Great Britain, 23.3; France, 11.8; Germany, 11.7; Japan, 6.3; Russia, 3.1; Belgium, 3.0; and Italy, 2.8. These 8 countries accounted for 86 percent of the total. Europe took 65 percent of the total, North and South America 26 percent, Asia 8 percent, Australia 1 percent and Africa less than half of 1 percent. Besides the United States the five important lead-consuming countries showed increases as follows: Great Britain, 22 percent; Japan, 22 percent; France, 15 percent; Germany, 13 percent; and Belgium, 3 percent. Consumption in Russia and Italy declined 25 and 17 percent, respectively.

## REVIEW BY COUNTRIES

*Australia.*—Production of lead broke all previous records in 1933 owing to increased production at Mount Isa. The output of this property reached a peak of 5,215 long tons of silver-lead bullion in March, but this rate was not maintained for the rest of the year.

Production for the year totaled 45,150 tons. The plant was originally designed for a monthly capacity of 6,000 tons. As a prerequisite to obtaining concessions on taxes and freight rates from the Queensland Government, the domicile of the company was transferred from New South Wales to Queensland. Toward the end of the year operations were suspended owing to labor trouble, and the bullion was shipped to Great Britain for refining.

Notwithstanding the large increase in Mount Isa's production the Broken Hill district continued to supply the larger part of Australia's lead. A total of 1,202,600 tons of crude ore was raised, an increase of 105,000 tons over 1932. All four principal producers operated in 1933.

Exports of refined lead and bullion totaled 193,000 tons in 1933, an increase of 12 percent over 1932. Europe took 98 percent of the total, Great Britain being the principal market. Exports of lead ore increased from 4,685 to 29,792 tons.

*Belgium.*—Lead production in Belgium is derived from foreign ores and base bullion. In 1933, 62,572 metric tons of lead ore and 17,877 tons of metallic lead were imported. Newfoundland, Sweden, Great Britain, and Australia were the principal sources of ore, and Mexico contributed about two-thirds of the metallic lead. About 35,000 tons of refined pig lead were exported, France taking 75 percent of the total.

*Canada.*—Production of pig lead in Canada increased only 1 percent in 1933, but exports increased 33 percent, indicating a sharp decline in stocks. Of a total of 142,165 short tons shipped abroad, Great Britain took 61 percent and Japan 26 percent. Shipments to Great Britain and Japan increased 42 and 34 percent, respectively; 3,800 tons of lead in the form of ore were exported, over half of which came to the United States.

Mine production of lead amounted to 132,165 tons in 1933, of which British Columbia contributed 99 percent, Yukon 1 percent, and Ontario only a few tons. The Yukon production is in the form of high silver-lead concentrates which are shipped to the United States for smelting. The principal source of British Columbia lead is the Sullivan mine, of the Consolidated Mining & Smelting Co., Ltd. A total of 1,413,418 tons of lead-zinc ore was mined in 1933, a decrease of 2 percent from 1932. The lead content, however, was higher, so that a net increase in lead production was realized. Increased recoveries and lower production costs were accomplished in 1933. The company's smelter at Trail is the only lead smelter in Canada. The Base Metals Mining Corporation, Ltd., which had been idle since February 1931, reopened the Monarch mine in August. By the end of the year it had produced 5,773 tons of 79.1-percent lead concentrates, which were shipped to Europe for smelting.

*France.*—France ranks fourth in lead consumption and depends largely on foreign lead for its supply. In 1933 consumption amounted to 139,000 metric tons, whereas the domestic smelter output was only 7,700 tons. Imports were 131,633 tons in 1933, an increase of 20 percent over 1932. The 1933 total comprised 8,034 tons of argentiferous lead, 95 percent of which came from Greece, and 123,599 tons of refined lead from the following sources: Spain, 35 percent; Mexico, 28 percent; Belgium, 19 percent; Tunisia, 11 percent; and other countries, 7 percent. Imports of lead ore totaled 18,047 tons and exports, 11,849 tons.

The lead resources of France have never been adequate to supply French industry, but the mining industry, such as it was prior to 1929, has been seriously handicapped by the depression. At the close of 1933 it was stated that the number of active lead mines in the regions of LeGard and La Losere had declined from 114 in 1924 to 4, and only 4 of 9 smelters were in operation. For 2 years the Government had considered ways of subsidizing lead and zinc mining by means of customs duties, but at the close of 1933 no action had been taken.

*Germany.*—Consumption of lead in Germany in 1933 amounted to 138,200 metric tons, an increase of 13 percent over 1932, attributed mainly to a rise in building activity and to greater demand for storage batteries. This was met by increased activity at German mines and smelters rather than by larger imports of foreign pig lead. Thus the Government's policy of making Germany less dependent on foreign raw materials made some progress in the lead industry in 1933.

Aided by the subsidy, which was continued in 1933, German mines increased their lead output about 10 percent. Imports of foreign lead ores were 57 percent higher. As a result of these trends German smelters produced 23 percent more lead, and imports of pig lead declined 4 percent. Exports of pig lead rose from 23,096 to 26,956 tons. The principal sources of the 105,000 tons of lead ores imported in 1933 were: Newfoundland, 44 percent; Yugoslavia, 27 percent; and Great Britain, 22 percent. All showed large increases over 1932. Australia supplied 49 percent of the 48,685 tons of pig lead imported; Mexico, 16 percent; and the United States, 11 percent.

Professor Victor Tafel [2] of Breslau sums up the possibilities of production from German ore reserves as follows:

> The maximum annual output of lead from the Harz, Upper Silesian, Rhenish-Westphalian, Eifel, and Mansfeld districts was 47,500 metric tons. An increase of some 42,000 tons is conceivable, but even so only 66 percent of the reduced 1931 consumption would be covered. By including the Eastern Upper Silesian mines the percentage could be raised to 86.

*Great Britain.*—The revival of lead mining in Great Britain is of outstanding interest. This industry had suffered a steady decline since about 1870, when over 70,000 long tons of lead were produced. In 1930 production had fallen to below 10,000 tons. As a result of renewed activity at the Mill Close mine in Derbyshire and the Halkyn mines in Flintshire, production increased in 1932 to 40,633 tons of concentrates containing 81 percent lead, the highest output for over 30 years. Production in 1933 probably was 50,000 to 60,000 tons of concentrates. Most of this ore was shipped to the continent for smelting; at the close of the year, however, a new smelter was being constructed at the Mill Close mine, and the Halkyn mines were considering smelting their own ores in the near future.

Consumption of lead in Great Britain, which ranks second to the United States, increased 22 percent in 1933, owing to recovery in building activity and demand for storage batteries. The market was supplied largely by imported lead, of which 281,556 tons were received, an increase of 8 percent over 1932. Shipments from the British dominions increased 16 percent and accounted for 94 percent of the

[2] Metal Bulletin, London, Germany's Metal Supplies: Aug 1, 1933, p. 8.

total. Those from the United States, Mexico, and Spain decreased materially. Exports of lead in pigs, sheets, etc., dropped from 23,000 to 16,000 tons. A 10-percent tariff on non-British lead was in effect throughout the year.

*India.*—The Burma Corporation, Ltd., produced approximately 110,000 long tons of concentrates averaging 65 percent lead in 1933, from which 70,560 tons of refined lead were obtained. Exports of pig lead were 65,046 tons, of which 80 percent went to Great Britain and 15 percent to Japan.

*Italy.*—Lead consumption in Italy totaled 33,200 metric tons in 1933, a decrease of 17 percent from 1932. This was derived from a domestic production of 24,200 tons and imports amounting to 8,681 tons. In accordance with the Government's policy of making Italy less dependent on foreign raw materials a new lead smelter was put into operation during the year at San Gavino Monreale, Sardinia. This plant, with an annual capacity for producing 20,000 tons of refined lead, was designed to smelt Sardinian ores formerly exported to Tunisia for treatment. Lead mining continued under Government subsidy in 1933 but apparently at a much lower rate, as imports of ore increased from 15,404 to 17,819 tons.

*Japan.*—Lead consumption in Japan exceeded all previous records, amounting to 74,600 metric tons. As the domestic output was only about 4,000 tons, the demand was met largely by imports, which increased from 55,340 tons in 1932 to 66,598 in 1933. Canada supplied 48 percent of the total, United States 33 percent, and British India 16 percent.

*Mexico.*—Lead production in Mexico declined 14 percent in 1933 and was less than half of the output of 1930. The decrease was due to the low prices of lead and silver and the loss of markets in Great Britain resulting from the imposition of the tariff on non-British lead. Exports during the first half of 1933 were 30 percent below the corresponding period of 1932. As of June 1933 over 52,000 tons of refined lead remained in storage awaiting export.

*Newfoundland.*—The Buchans Mining Co. maintained capacity production during 1933. Production of lead concentrates totaled 49,455 short tons, of which 47,518 tons were shipped to Europe, Belgium taking 82 percent and Germany 18 percent. In addition, 152,188 tons of zinc concentrates and 1,564 tons of copper and lead-gold-iron concentrates were produced.

*Spain.*—Smelter production of lead in Spain in 1933 declined 18 percent to 86,621 metric tons. This was derived largely from domestic ores, production of which has declined steadily during the period of low prices. To avoid further unemployment by a threatened suspension of lead-mining activities, the Government created a fund of 5,000,000 pesetas to be used to extend credit to producers in the Linares-Carolina and Cartagena-Mazarron districts of southern Spain. Exports were well maintained in 1933 at 77,580 tons, compared with 78,902 tons in 1932.

*Tunisia.*—It was reported that Société Exploitations Miniéres en Tunisie intends to erect a lead smelter to treat its unsold lead ores.

*U.S.S.R. (Russia).*—In 1931 it was announced that under the first "five-year plan" lead production in 1933 was to be 116,000 metric tons. That the program fell far short of expectations is indicated by the fact that in 1933 production amounted to only 20,000 tons. Early in 1933 the second "five-year plan" was announced, calling for 147,000 tons of lead in 1934 and 360,000 tons in 1937.

As production has shown only slight increase, the sharp decline in imports from 42,000 tons in 1931 to 16,405 tons in 1933 indicates a 25 percent decrease in consumption. Great Britain supplied 48 percent of the 1933 imports and Spain 41 percent.

*Yugoslavia.*—Yugoslavia is becoming an important source of lead ores owing to the revival of mining in areas worked by the Romans centuries ago. In 1933 Trepca Mines, Ltd., treated 542,000 metric tons of ore averaging 9 percent lead, 9 percent zinc, and 3 ounces of silver per ton. This was an increase of 34 percent over the tonnage treated in 1932. Production of lead concentrates totaled 59,164 tons averaging 79 percent lead and 24 ounces of silver. A large part of the concentrates was shipped to German and Tunisian smelters.

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# ZINC[1]

By Elmer W. Pehrson

## SUMMARY OUTLINE



The domestic zinc industry exhibited considerable improvement in all of its major phases in 1933. Smelter production of primary slab zinc increased 48 percent compared with 1932, consumption of primary zinc increased 51 percent, stocks at primary smelters declined 14 percent, and the average price at St. Louis was 40 percent higher. In spite of these marked changes, however, the record for 1933 was far below predepression averages. Production was only 51 percent of the average from 1925 to 1929, consumption 59 percent, and price 60 percent; stocks were nearly two and one-half times as large as the 5-year average. Figure 5 shows trends in the United States zinc industry for 34 years.

During the first 3 months of 1933 shipments to consumers were at the low level of 15,000 tons per month. Production was increasing gradually, causing an increase in stocks which reached a high point at the end of April. This unsatisfactory statistical position and the unsettled economic condition of the country resulted in a steady decline in price to a low of 2.55 cents (St. Louis) about the middle of February. As the new administration's program for economic recovery was revealed consumers began to stock up in anticipation of higher prices. Deliveries rose to a peak for the year of over 45,000 tons in July, the highest recorded since October 1929. As production failed to keep pace with the increased demand stocks were reduced rapidly. Prices soared as a result of this and our departure from the gold standard on April 20. The high for the year was 5 cents during July and August.

By November deliveries had subsided to less than 27,000 tons, and as this was below the rate of production (which by this time had

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

reached about 33,000 tons) stocks increased at the end of November and again at the close of the year. Prices declined during the last 2 months of the year, but the closing quotation was considerably above that at the beginning of the year.

Outside the United States improvement in the zinc industry was less pronounced. Production abroad increased only 18 percent, compared with 48 percent in the United States; consumption increases

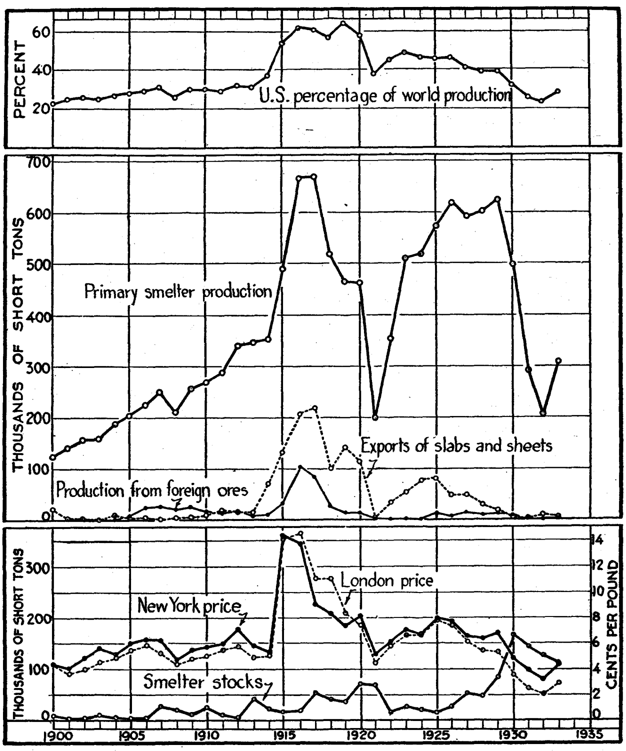


FIGURE 5.—Trends in the United States zinc industry, 1900–33. Imports of slab and sheet zinc are not shown, since they seldom exceed 500 tons annually.

were 15 and 51 percent, respectively. Although there was a substantial increase in consumption and a decline in stocks, the London price showed a relatively small increase, 16 percent, compared with 40 percent at St. Louis. The smaller increase in London was due partly to the exchange situation and partly to the hazardous existence of the International Zinc Cartel, which was technically dissolved at the end of January and subsequently renewed only for short periods.

A statistical summary follows, in which the zinc industry of the United States during the past 4 years is compared with the 5 predepression years, 1925–29.

*Salient statistics of the zinc industry in the United States, 1925–33*

| | 1925–29 average | 1930 | 1931 | 1932 | 1932 |
|---|---|---|---|---|---|
| Production of primary slab zinc: | | | | | |
| From domestic ores____short tons__ | 589, 648 | 489, 361 | 291, 996 | 207, 148 | 306, 010 |
| From foreign ores____do____ | 12, 734 | 8, 684 | | | 1, 172 |
| | 602, 382 | 498, 045 | 291, 996 | 207, 148 | 307, 182 |
| Electrolytic____percent of total__ | 21 | 26 | 28 | 11 | 29 |
| Distilled____do____ | 79 | 74 | 72 | 89 | 71 |
| Production of secondary slab zinc__short tons__ | 65, 380 | 49, 300 | 34, 800 | 20, 000 | 48, 100 |
| Stocks on hand at primary smelters Dec. 31 short tons__ | 45, 575 | 167, 293 | 143, 592 | 128, 192 | 110, 487 |
| Primary zinc available for consumption__do____ | 544, 016 | 408, 469 | 312, 592 | 213, 280 | 321, 789 |
| Price—prime western at St. Louis: | | | | | |
| Average for year____cents per pound__ | 6. 76 | 4. 56 | 3. 64 | 2. 88 | 4. 03 |
| Highest quotation____do____ | 8. 90 | 5. 45 | 4. 12½ | 3. 50 | 5. 00 |
| Lowest quotation____do____ | 5. 40 | 3. 95 | 3. 12½ | 2. 30 | 2. 55 |
| Price—yearly average at London____do____ | 6. 46 | 3. 60 | 2. 52 | 2. 12 | 2. 96 |
| Mine production of recoverable zinc short tons__ | 724, 720 | 595, 425 | 410, 318 | 285, 231 | [1] 384, 186 |
| Tri-State district (Joplin) percent of total__ | 49 | 36 | 29 | 34 | 36 |
| Western States____do____ | 30 | 33 | 30 | 25 | 29 |
| Other____do____ | 21 | 31 | 41 | 41 | 35 |
| World smelter production of zinc__short tons__ | 1, 435, 000 | 1, 537, 000 | 1, 099, 000 | 864, 000 | 1, 082, 000 |

[1] Subject to revision.

*The zinc industry and the NRA.*—During the last half of 1933 the zinc industry operated under the President's Reemployment Agreement pending preparation and approval of a final code of fair competition. The first draft of a basic code was submitted to the National Recovery Administration on July 28, 1933. It contained no provisions for production and price control. A public hearing on the code was held on December 8, 1933. The draft submitted at this time was greatly enlarged and modified to include production-control features and free exchange of price data between members, although no specific provisions were made for price fixing; the industry was grouped in nine divisions, including mining, prime western smelting, high-grade zinc, secondary zinc, rolled zinc, zinc alloy, zinc oxide, lithopone, and sulphuric acid, each of which was to be governed by a producers' committee. Minimum wages and hours of labor were specified for each division and in some cases for geographic sections thereof; moreover, unfair practices were outlined for each division. The American Zinc Institute, which represents about 98 percent of the volume of the industry, was designated as the agency to administer the code. At the public hearing some objections were raised to the wage rates and other labor provisions and to some of the provisions for production control and exchange of price data, and further changes were made in the draft. At present (May 1, 1934) the revised code is awaiting approval by the industry and final acceptance by the President.

## DOMESTIC PRODUCTION

*Production of primary and secondary slab zinc.*—Production of primary slab zinc in 1933 from domestic and foreign ores was 48 percent higher than in 1932 and was equivalent to 51 percent of the average output for the 5-year period 1925–29. For the first time since 1930 production of zinc from foreign ores was reported, but the amount was only 9 percent of the predepression 5-year average.

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

*Primary and secondary slab zinc produced in the United States, 1924–33*

| Year | Primary (short tons) | | | Secondary (short tons) | | | Total |
|---|---|---|---|---|---|---|---|
| | Domestic | Foreign [1] | Total | Redistilled | Remelted | Total | Short tons |
| 1924 | 515, 831 | 1, 508 | 517, 339 | 35, 486 | 23, 400 | 58, 886 | 576, 225 |
| 1925 | 555, 631 | 17, 315 | 572, 946 | 39, 181 | 22, 249 | 61, 430 | 634, 376 |
| 1926 | 611, 991 | 6, 431 | 618, 422 | 40, 799 | 23, 771 | 64, 570 | 682, 992 |
| 1927 | 576, 960 | 15, 556 | 592, 516 | 42, 784 | 22, 016 | 64, 800 | 657, 316 |
| 1928 | 591, 525 | 11, 056 | 602, 581 | 48, 666 | 22, 034 | 70, 700 | 673, 281 |
| 1929 | 612, 136 | 13, 311 | 625, 447 | 47, 348 | 18, 052 | 65, 400 | 690, 847 |
| 1930 | 489, 361 | 8, 684 | 498, 045 | [2] 34, 849 | 14, 451 | 49, 300 | 547, 345 |
| 1931 | 291, 996 | | 291, 996 | [2] 21, 625 | 13, 175 | 34, 800 | 326, 796 |
| 1932 | 207, 148 | | 207, 148 | 14, 718 | 5, 282 | 20, 000 | 227, 148 |
| 1933 | 306, 010 | 1, 172 | 307, 182 | 30, 087 | 18, 013 | 48, 100 | 355, 282 |

[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 nevertheless is deemed advisable to maintain a segregation of primary and secondary zinc; otherwise the long-time record of production might include metal that is constantly reworked.

*Distilled and electrolytic zinc.*—Electrolytic zinc accounted for the major part of the increase in primary zinc production in 1933, its output having increased 281 percent, while that of distilled zinc increased only 19 percent. Electrolytic zinc accounted for 29 percent of the total primary production in 1933 compared with 11 percent in 1932 and 21 percent for the 5-year period 1925–29. Production of redistilled secondary zinc increased 104 percent, most of the increase being in the output at primary smelters.

The sharp increase in the production of electrolytic zinc in 1933 is reflected in the increased production of high-grade zinc. Production of high-grade zinc increased 137 percent compared with 1932, whereas that of prime western increased only 52 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, 1929–33, in short tons*

APPORTIONED ACCORDING TO METHOD OF REDUCTION

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

APPORTIONED ACCORDING TO GRADE

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

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

*Production of primary slab zinc by States.*—Montana resumed first place in slab zinc production in 1933, a position held from 1928 to 1930; all its output is electrolytic zinc. Pennsylvania ranked second and replaced Illinois as the leading producer of distilled zinc. Illinois was the only State reporting a substantial decrease in 1933. Kansas which had a continuous record of production from 1877 to 1931, did not produce in 1932 and 1933.

*Primary slab zinc produced in the United States, by States, 1929–33, in short tons*

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

*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 1933, including unalloyed zinc, was 120,000 tons, an increase of 62 percent from 1932. The 1933 total was equivalent to 39 percent of the primary zinc production compared with 36 percent in 1932 and 28 percent during the 5-year period 1925-29. 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, 1929–33*

| Year | Made from zinc blende | | Made from sulphur | | Total | | |
|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Value per ton |
| 1929 | 627, 018 | $6, 038, 183 | 646. 980 | $6, 230, 417 | 1, 273, 998 | $12, 268, 600 | $9. 63 |
| 1930 | 536, 614 | 5, 167, 593 | 474, 092 | 4, 565, 506 | 1, 010, 706 | 9, 733, 099 | 9. 63 |
| 1931 | 426, 618 | 3, 745, 706 | [2] 381, 216 | 3, 347, 077 | 807, 834 | 7, 092, 783 | 8. 78 |
| 1932 | 341, 340 | 2, 594, 184 | 244, 644 | 1, 859, 294 | 585, 984 | 4, 453, 478 | 7. 60 |
| 1933 | 355, 027 | 2, 676, 904 | 242, 493 | 1, 828, 397 | 597, 520 | 4, 505, 301 | 7. 54 |

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

*Details of production of byproduct sulphuric acid at zinc-blende roasting plants in the United States, 1930–33*

| | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|
| Number of establishments | 21 | 21 | 20 | 18 |
| Blende used short tons | 565, 092 | 439, 243 | 340, 961 | 366, 979 |
| Sulphur used do | 125, 740 | [1] 100, 956 | 65, 510 | 64, 984 |
| Acid reported as 50°–60° B.: | | | | |
| Produced (expressed as 60° B.) do | 548, 660 | 390, 278 | 290, 237 | 346, 084 |
| Consumed at works (expressed as 60° B.) do | 28, 206 | 16, 375 | 13, 061 | 19, 742 |
| Sold (expressed as 60° B.) do | 518, 665 | 373, 254 | 274, 581 | 341, 670 |
| Value of acid sold: | | | | |
| Total | $4, 996, 275 | $3, 278, 509 | $2, 085, 791 | $2, 576, 018 |
| Average | $9. 63 | $8. 78 | $7. 60 | $7. 54 |
| Acid reported as 66° B. and stronger: | | | | |
| Produced (expressed as 66° B.) short tons | 385, 038 | 347, 964 | 246, 456 | 209, 530 |
| Consumed at works (expressed as 66° B.) do | 51, 314 | 46, 473 | 36, 698 | 24, 620 |
| Sold (expressed as 66° B.) do | 352, 886 | 294, 034 | 211, 370 | 188, 533 |
| Value of acid sold: | | | | |
| Total | $4, 867, 536 | $3, 884, 404 | $2, 525, 583 | $2, 169, 398 |
| Average | $13. 79 | $13. 21 | $11. 95 | $11. 51 |
| Total acid sold, equivalent in 60° B.: | | | | |
| Quantity short tons | 942, 128 | 726, 094 | 528, 225 | 567, 910 |
| Value | $9, 863, 811 | $7, 162, 913 | $4, 611, 374 | $4, 745, 416 |
| Total acid consumed at works (60° B.) short tons | 89, 783 | 72, 142 | 57, 099 | 49, 286 |

[1] Includes small quantity of pyrites.

*Rolled zinc.*—Production of rolled zinc increased 4 percent in 1933, a relatively small increase compared with increases in other products of the zinc industry. This, however, was due to the fact that production of rolled zinc had not dropped to the same extent during the depression as had that of other zinc products. Thus, rolled-zinc production in 1933 was approximately 70 percent of the 1929 output, whereas production of primary slab zinc was only 49 percent of the 1929 output. All gages of rolled zinc shared the 1933 increase. The average value per pound of rolled zinc increased 16 percent in 1933, whereas the quoted value of slab zinc increased 40 percent, so that the unit value added by rolling declined from 3.3 cents to 3.1 cents per pound.

The following are the percentages of various grades of zinc used in the manufacture of 41,261 tons of rolled zinc in 1933: Brass special, 56; prime western, 16; high-grade spelter, 15; intermediate, 10; and electrolytic, 3 percent.

*Production of rolled zinc and quantity available for consumption in the United States, 1932–33*

| | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Short tons | Value | | Short tons | Value | |
| | | Total | Average per pound | | Total | Average per pound |
| Sheet zinc not over 0.1 inch thick | 12, 291 | $1, 804, 000 | $0. 073 | 12, 810 | $2, 115, 000 | $0. 083 |
| Boiler plate and sheets over 0.1 inch thick | 454 | 58, 000 | . 064 | 469 | 72, 000 | . 077 |
| Strip and ribbon zinc [1] | 26, 986 | 3, 167, 000 | . 059 | 27, 982 | 3, 868, 000 | . 069 |
| Total zinc rolled | 39, 731 | 5, 029, 000 | . 063 | 41, 261 | 6, 055, 000 | . 073 |
| Imports | 39 | 4, 600 | | 46 | 6, 700 | |
| Exports | 3, 010 | 433, 000 | . 072 | 3, 189 | 468, 000 | . 073 |
| Available for consumption | 36, 760 | | | 38, 118 | | |
| Slab zinc (all grades) | | | . 030 | | | . 042 |
| Value added by rolling | | | . 033 | | | . 031 |

[1] Figures represent net production. In addition 8,066 tons in 1932 and 6,342 tons in 1933 were rerolled from scrap originating in fabricating plants operated in connection with zinc-rolling mills.

*Zinc dust.*—Commercial production of zinc dust in the United States began in 1910 and reached a maximum of about 11,500 tons in 1920. From 1922 to 1927 the annual production averaged about 8,000 tons. In 1933, 11,157 tons were produced—18 percent more than in 1932.

*Zinc dust [1] sold by producers in the United States, 1929–33*

| Year | Short tons | Value | | Year | Short tons | Value | |
|---|---|---|---|---|---|---|---|
| | | Total | Average per pound | | | Total | Average per pound |
| 1929 | 11, 050 | $1, 864, 672 | $0. 084 | 1932 | [2] 9, 440 | [2] $900, 796 | $0. 048 |
| 1930 | 9, 237 | 1, 205, 740 | . 065 | 1933 | 11, 157 | 1, 308, 594 | . 059 |
| 1931 | 10, 611 | 1, 148, 152 | . 054 | | | | |

[1] The zinc dust produced is principally "distilled." 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] Revised figures.

*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 on Lead and Zinc Pigments and Zinc Salts. In 1933 the total zinc content of all zinc pigments and salts produced in the

United States was 126,336 tons, 36 percent more than in 1932. Of the 1933 total, 57 percent was derived from ores, 26 percent from slab zinc, and 17 percent from secondary materials.

*Mine production.*—The following table shows the mine production of recoverable zinc in the United States, by States, from 1925 to 1933:

*Mine production of recoverable zinc in the United States, 1929–33, in short tons*

| State | 1925–29 average | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Western States: | | | | | |
| Arizona | 2,628 | 815 | | | [1] 6 |
| California | 3,999 | | 80 | | [1] 140 |
| Colorado | 32,868 | 36,259 | 16,187 | 109 | 1,285 |
| Idaho | 29,128 | 37,649 | 19,569 | 10,252 | [1] 21,090 |
| Montana | 72,519 | 26,421 | 6,747 | 2,197 | [1] 20,750 |
| Nevada | 5,570 | 14,584 | 10,431 | 127 | [1] 6,150 |
| New Mexico | 23,351 | 32,765 | 27,866 | 25,593 | 30,924 |
| Oregon | | 6 | | 6 | 6 |
| Utah | 44,385 | 44,495 | 37,291 | 29,666 | 29,745 |
| Washington | 575 | 352 | 4,974 | 2,245 | 3,369 |
| | 215,023 | 193,346 | 123,145 | 70,195 | [1] 113,465 |
| Central States: | | | | | |
| Arkansas | 71 | | | | 11 |
| Illinois | 1,174 | 9 | | | |
| Kansas | 114,323 | 74,304 | 39,051 | 26,277 | 40,947 |
| Kentucky | 644 | | | 46 | 228 |
| Missouri | 16,708 | 10,811 | 3,205 | 986 | 5,042 |
| Oklahoma | 226,969 | 136,153 | 78,132 | 63,437 | 91,065 |
| Wisconsin | 23,055 | 12,558 | 10,088 | 7,522 | 7,800 |
| | 382,944 | 233,835 | 130,476 | 98,268 | 145,093 |
| Eastern States: | | | | | |
| New Jersey | 93,839 | 97,626 | 94,285 | 81,460 | 75,125 |
| New York | 7,091 | 22,471 | 24,100 | 16,794 | 17,733 |
| Tennessee and Virginia [2] | 25,823 | 48,147 | 38,312 | 18,514 | 32,770 |
| | 126,753 | 168,244 | 156,697 | 116,768 | 125,628 |
| | 724,720 | 595,425 | 410,318 | 285,231 | [1] 384,186 |

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

Mine production of zinc increased 35 percent in 1933 but was still 47 percent below the yearly average from 1925 to 1929. Most of the 1933 increase was attributable to the Western and Central States areas, which made increases of 62 and 48 percent, respectively. Notwithstanding substantial increases in the production of New York, Tennessee, and Virginia the Eastern States as a whole did not share in the general increase to the same extent as the two areas previously mentioned, due to an 8-percent drop in the output of New Jersey. Yet the Eastern States output in 1933 nearly equaled the 5-year average from 1925 to 1929, whereas the Western States output was equivalent to only 53 percent of the predepression average and the Central States output to only 38 percent.

All of the zinc producing States except New Jersey recorded increases in 1933. Oklahoma resumed its position as the leading producer replacing New Jersey which ranked first in 1931 and 1932 and second in 1933; Kansas ranked third, New Mexico fourth, and Utah fifth. Among the larger producers, Montana recorded the largest percentage of increased production, its output in 1933 being nearly 10 times that in 1932; it was still 71 percent below the average from 1925 to 1929. Other large percentage increases were 106 percent in Idaho, 77 percent in Tennessee-Virginia, 56 percent in Kansas, 44 percent in Oklahoma, and 21 percent in New Mexico. The 1933 production of Nevada, New Mexico, Washington, New York, and Tennessee-Virginia exceeded the 5-year average from 1925 to 1929.

The table that follows shows the output of the principal zinc-producing districts of the United States during the past 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, 1929–33, in short tons*

| District | State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| Joplin region | Kansas, Missouri, Oklahoma. | 309,436 | 216,961 | 119,168 | 90,660 | 137,054 |
| New Jersey | New Jersey | 103,740 | 97,626 | 94,285 | 81,460 | 75,125 |
| Eastern Tennessee | Tennessee | 40,558 | 48,147 | 38,312 | 18,514 | 32,770 |
| Austinville | Virginia | | | | | |
| Coeur d'Alene region | Idaho | 43,046 | 33,145 | 18,934 | 10,251 | [1] 21,090 |
| Bingham | Utah | 21,794 | 22,362 | 26,608 | 21,746 | 20,648 |
| Willow Creek | New Mexico | 22,865 | 16,638 | 20,817 | 20,356 | 18,665 |
| St. Lawrence County | New York | 10,250 | 22,471 | 24,100 | 16,794 | 17,733 |
| Central | New Mexico | 11,224 | 15,319 | 7,050 | 5,121 | 11,220 |
| Summit Valley (Butte) | Montana | 50,550 | 13,984 | | | [1] 10,480 |
| Park City region | Utah | 27,965 | 19,543 | 9,436 | 7,863 | 8,296 |
| Upper Mississippi Valley. | Iowa, northern Illinois, Wisconsin. | 17,017 | 12,567 | 10,088 | 7,522 | 7,800 |
| Pioche | Nevada | 6,498 | 11,086 | 6,708 | (2) | (3) |
| Metaline Falls | Washington | 1,031 | 352 | 4,974 | 2,245 | 3,369 |
| Leadville | Colorado | 13,414 | 11,519 | 2,887 | 63 | 1,246 |
| San Juan Mountains | do | 14,403 | 10,434 | 41 | 4 | 9 |
| Battle Mountain | do | 420 | 14,272 | 13,259 | | |
| Southeastern Missouri region. | Missouri | 3,473 | 4,307 | 1,220 | 40 | |

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

## STOCKS

Stocks of zinc at primary reduction plants declined 14 percent in 1933. At the end of the year they were 34 percent below the recent high at the close of 1930 but about 2½ times as large as the average from 1925 to 1929. Stocks at secondary distilling plants decreased 26 percent, making a net drop of 14 percent in total stocks at primary and secondary plants. This was the third consecutive yearly decline since 1930. An analysis of the decrease in 1933 shows that stocks of the higher grades of zinc (grades A and B) fell 28 percent and the lower grades (C, D, and E) only 10 percent. At the beginning of 1933 there were on hand 30,085 tons of grades A and B and 101,477 tons of grades C, D, and E. At the close of the year the tonnages were 21,688 and 91,278, respectively.

*Stocks of zinc on hand at zinc-reduction plants in the United States at end of year, 1929–33, in short tons*

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

The decline in stocks of smelted zinc again was accompanied by a decrease in stocks of zinc ore in the Joplin district. At the beginning of 1933 about 43,000 tons of concentrates were on hand, with an estimated recoverable zinc content of 23,000 tons. By the end of the year this was reduced to less than 7,000 tons of concentrates, representing about 3,700 tons of metal.

Stocks of slab zinc outside of the United States, reported by the International Zinc Cartel, declined from 164,000 short tons at the beginning of 1933 to 148,000 tons at the close of the year. World stocks may therefore be estimated roughly at 296,000 tons on January 1, 1933, and 261,000 tons on December 31, 1933, a decrease of 12 percent.

## DOMESTIC CONSUMPTION

*New supply.*—The supply of new zinc available for consumption in 1933 increased 51 percent over 1932 but was still 44 percent below the record year 1928. Withdrawals of new copper on domestic account increased only 31 percent; and the supply of new lead available for consumption declined about 5 percent. Shipments of pig iron increased 68 percent. The relatively better showing of primary zinc compared with primary copper and lead may be ascribed to the fact that a smaller proportion of zinc than of copper and lead is consumed in the manufacture of capital goods, production of which has lagged behind consumers' goods. A very large proportion of zinc is used in galvanized wares, paint pigments, radio and flashlight batteries, fruit-jar covers, and other items which pass on to the consuming public rapidly. Moreover, the uses to which zinc is put are such that there is much less return of scrap than in the case of lead and copper.

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

*Primary slab zinc available for consumption in the United States, 1929–33, in short tons*

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

[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, 1929–33, in short tons*[1]

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

[1] Year Book, American Bureau of Metal Statistics, 1933.
[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. 107.)
[5] Includes slab zinc used for manufacture of French oxide, lithopone, atomized zinc dust, wire, zinc for wet batteries, slush castings, and for the desilverization of lead.

Industrial use of zinc increased 35 percent in 1933, and all phases of consumption shared the increase. Galvanizing, which accounted for 42 percent of the 1933 total, increased 36 percent. The American Zinc Institute reported that its program for increasing the use of higher-grade galvanized products was meeting with success, especially in the rural market. Increased automobile production was reflected in the 53-percent increase in the use of zinc in die castings. It is estimated that the average automobile contains 25 to 30 pounds of zinc in the form of die castings and rolled zinc. Consumption of slab zinc in rolled-zinc products increased only 4 percent in 1933, but this outlet for zinc did not decline to the same extent as others during the depression, owing to the unusual demand for fruit-jar covers in 1930 and 1931. Compared with 1929 the consumption of zinc in 1933 in the uses shown was as follows: Galvanizing, 51 percent; brass and castings, 51 percent; rolled zinc, 70 percent; die castings, 72 percent; other purposes, 52 percent; and all uses, 55 percent.

One of the principal uses included with "Other purposes" in the preceding table is French zinc oxide. In 1933 about 33,000 tons of zinc were so used, an increase of 65 percent over 1932.

## PRICES

The price of zinc in 1933 recovered substantially from the record low of 1932. The St. Louis quotation for prime western averaged 4.03 cents per pound, an increase of 40 percent over 1932 and 11 percent over 1931; however, it was 38 percent below the 1929 average. At the beginning of 1933 the quotation stood at 3.12½ cents, but the upward trend which had persisted during the latter half of 1932 was promptly reversed as a result of the unsettled economic condition of the country and unfavorable statistics showing increases in stocks. On February 17 the low for the year, 2.55 cents, was reached (the 1932 low was 2.30 cents). The quotation then fluctuated above and below 3 cents for about 2 months. After the United States went off the gold standard on April 20 the price rose rapidly and steadily until the high for the year, 5 cents, was reached during the latter part of July and the first part of August. Thereafter the trend was downward, as stocks mounted again during the latter part of the year. The closing quotation was 4.35 cents.

The following table presents a 5-year summary of zinc price data. It will be noted that in 1933 quotations averaged 4.40 cents in New York and 2.96 cents (United States exchange basis) in London, making a differential of 1.44 cents in favor of New York compared with 1.13 cents in 1932 and 1.47 cents in 1931. During 1933 the differential fluctuated between a low of 0.92 cent in February and a high of 1.89 cents in August, owing to the chaotic condition of foreign exchange.

*Prices of zinc and zinc concentrates, 1929–33*

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

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

In terms of price, zinc has staged a greater recovery than lead and copper. The average New York quotation for zinc in 1933 was 35 percent above 1932, whereas those for lead and copper increased only 22 and 26 percent, respectively. The fact that stocks of zinc had not increased to as large proportions as had lead and copper stocks doubtless was a contributing factor to the more favorable price situation of zinc. The price indexes in the preceding table indicate that the increase in nonferrous metal prices in 1933 was much more pronounced than that in the general price level.

The price of 60-percent zinc concentrates at Joplin averaged $26.88 per ton in 1933, an increase of 51 percent over 1932; it was still 37 percent below the 1929 average. According to the Joplin Globe, weekly average prices ranged from $16 to $35 per ton in 1933. The 1933 average was equivalent to 2.24 cents per pound of contained zinc. Since the St. Louis price of zinc averaged 4.03 cents, the difference of 1.79 cents per pound covers metallurgical losses, the cost of smelting and marketing, and such smelting profits as are realized. This was an increase of 29 percent over the smelters' margin in 1932 but was only 60 percent of the margin in 1929.

The following table shows the monthly fluctuations in quotations of common zinc at St. Louis and London and of 60-percent zinc concentrates at Joplin during 1932 and 1933. The New York quotation for slab zinc exceeds that at St. Louis by the freight differential—0.37 cent per pound.

*Average monthly quoted prices of common zinc (prompt delivery or spot) at St. Louis and London, and of 60-percent zinc concentrates at Joplin, 1932–33* [1]

| Month | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | 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 | 17.40 | 3.02 | 2.21 | 18.00 | 3.01 | 2.16 |
| February | 17.85 | 2.83 | 2.14 | 16.57 | 2.67 | 2.12 |
| March | 17.57 | 2.79 | 2.05 | 16.89 | 3.00 | 2.24 |
| April | 17.00 | 2.74 | 1.95 | 19.67 | 3.31 | 2.39 |
| May | 14.55 | 2.53 | 2.04 | 25.43 | 3.80 | 2.72 |
| June | 19.20 | 2.79 | 1.88 | 29.72 | 4.35 | 3.14 |
| July | 17.47 | 2.55 | 1.84 | 33.16 | 4.89 | 3.69 |
| August | 18.22 | 2.76 | 2.11 | 34.96 | 4.91 | 3.39 |
| September | 19.83 | 3.30 | 2.40 | 31.80 | 4.70 | 3.50 |
| October | 18.32 | 3.05 | 2.26 | 31.00 | 4.74 | 3.40 |
| November | 17.75 | 3.10 | 2.23 | 30.30 | 4.52 | 3.46 |
| December | 18.20 | 3.12 | 2.23 | 28.89 | 4.47 | 3.39 |
| Average for year | 17.83 | 2.88 | 2.12 | 26.88 | 4.03 | 2.96 |

[1] All quotations from Metal Statistics, 1934. 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, 1929–33, by grades, in cents per pound*

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

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

## 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, 1933, 12 active smelters were using 26,674 retorts, an increase of 29 percent over the 20,613 retorts in use at the end of 1932 at the same number of plants. Only 40 percent of the regular retorts in plants operating at the end of 1933 were in use. At the end of 1933, 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 1933.

*Primary zinc-smelting plants in the United States at end of 1933*

| Operating company (A=acid plant situated at the smelter) | Situation of plant | Regular horizontal retorts | Large vertical retorts |
|---|---|---|---|
| Athletic Mining & Smelting Co | Fort Smith, Ark | 3,328 | |
| Van Buren Zinc Co.[1] | Van Buren, Ark | 3,200 | |
| American Zinc Co. of Illinois (A) | East St. Louis, Ill | 5,760 | |
| Hegeler Zinc Co. (A) | Danville, Ill | 5,400 | |
| Illinois Zinc Co. (A) | Peru, Ill | 3,200 | |
| Matthiessen & Hegeler Zinc Co. (A) | La Salle, Ill | 6,420 | |
| Mineral Point Zinc Co. (A) [2] | Depue, Ill | 5,912 | 8 |
| Grasselli Chemical Co.[3] | Terre Haute, Ind | 4,200 | |
| American Steel & Wire Co.[3] | Cherryvale, Kans | 5,160 | |
| Blackwell Zinc Co., Inc | Blackwell, Okla | 9,600 | |
| Eagle-Picher Mining & Smelting Co | Henryetta, Okla | 4,800 | |
| National Zinc Co., Inc. (A) | Bartlesville, Okla | 4,256 | |
| 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) [2] | Langeloth, Pa | 4,864 | |
| New Jersey Zinc Co. (of Pennsylvania) (A) | Palmerton, Pa | 7,200 | 16 |
| American Smelting & Refining Co | Amarillo, Tex | 6,400 | |
| Grasselli Chemical Co.[4] | Meadowbrook, W.Va | 6,720 | 16 |
| United Zinc Smelting Corporation (A) | Moundsville, W.Va | 2,368 | |
| Total retorts | | 103,812 | 40 |
| Number of retorts in use at end of year | | 26,674 | (5) |
| Percent of total | | 25.7 | (5) |

[1] Idle since 1927.
[2] Horizontal-retort plant idle Dec. 31, 1933.
[3] Idle throughout 1933.
[4] Horizontal-retort plant idle throughout 1933.
[5] Data not available.

In addition to the primary zinc smelters listed in the foregoing table the Missouri Zinc Co., subsidiary of the Federated Metals Corporation, 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 1933. The Sandoval Zinc Co. has a plant at Sandoval, Ill., containing 896 regular horizontal retorts, which has operated exclusively on secondary materials for several years. Other secondary smelters which produced zinc in large graphite retorts in 1933 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 Evans-Wallower Zinc Co. plant at East St. Louis was idle throughout 1933. At the close of the year the Kellogg plant of the Sullivan Mining Co. and the Great Falls plant of the Anaconda Copper Mining Co. were operating at part capacity. In August 1933 Anaconda's two plants in Montana were producing at 80 percent of capacity, but owing to a shortage of zinc concentrates operations were curtailed to about 60 percent of capacity at the close of the year, the Anaconda plant having been shut down in November. On December 31, 1933 electrolytic-zinc production in the United States was about one-half 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 1929 to 1933 and a record of bonded-warehouse inventories.

*Zinc ore and old brass (fit only for remanufacture) imported into the United States, 1929–33*

[General imports]

| Year | Zinc content of zinc ore (short tons) | | | | Old brass | |
|---|---|---|---|---|---|---|
| | Canada | Mexico | Other countries | Total | Short tons | Value |
| 1929 | 848 | 13,563 | | 14,411 | 7,031 | $1,371,655 |
| 1930 | 13 | 25,644 | 182 | 25,839 | 3,573 | 535,761 |
| 1931 | (1) | 778 | 2 | 780 | 2,212 | 215,430 |
| 1932 | | 1,904 | | 1,904 | [2] 1,259 | [2] 63,642 |
| 1933 | 44 | 2,089 | (1) | 2,133 | 1,085 | 85,860 |

[1] Less than 1 ton.
[2] January–June 20, 1932. None recorded after June 20.

*Zinc remaining in warehouse in the United States, Dec. 31, 1929–33*

| Year | Ore and calamine | | Blocks, pigs, and old | | Zinc sheets | |
|---|---|---|---|---|---|---|
| | Zinc content (pounds) | Value | Pounds | Value | Pounds | Value |
| 1929 | 3,758,809 | $113,479 | | | | |
| 1930 | 27,185,311 | 784,670 | | | 43,334 | $2,081 |
| 1931 | 22,377,439 | 269,019 | 22,909 | $160 | 71,089 | 2,896 |
| 1932 | 10,211,618 | 240,338 | | | 43,339 | 2,071 |
| 1933 | 7,985,703 | 178,281 | 101,523 | 7,622 | | |

*Zinc imported for consumption in the United States, 1929-33*

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

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 1933, 2,133 tons of zinc in ore were imported, an increase over 1932 but equivalent to only 8 percent of the 1930 imports. Imports of slab zinc increased greatly in 1933 and were the largest since 1921. This zinc came largely from Mexico and Poland. Imports of old brass, which ceased after the imposition of the copper tariff in June 1932, were resumed in 1933. Canada supplied 83 percent of the total in 1933.

*Exports.*—The total value of the 1933 exports of zinc ore and domestic and foreign manufactures of zinc (not including galvanized products, alloys, and pigments) was approximately $825,000, a decrease of 9 percent from 1932 and 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, 1929-33*

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

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

Exports of slab zinc in 1933 declined 82 percent and were equivalent to less than 2 percent of the quantity exported in 1925. There were large decreases in shipments to Japan, British India, and the United Kingdom, those to the two latter countries having ceased entirely. Exports of sheet zinc increased 6 percent in 1933. The following table shows the exports of slab and sheet zinc by destinations during the past 4 years.

*Slab and sheet zinc exported from the United States, 1930–33, by destinations, in short tons*

| Destination | Slabs, blocks, or pigs | | | | Sheets, strips, etc. | | | |
|---|---|---|---|---|---|---|---|---|
| | 1930 | 1931 | 1932 | 1933 | 1930 | 1931 | 1932 | 1933 |
| Countries: | | | | | | | | |
| Canada | 846 | 7 | 15 | (1) | 1, 508 | 1, 087 | 1, 497 | 1, 417 |
| Chile | 1, 115 | 144 | 4 | 14 | 7 | 2 | 2 | 3 |
| France | | | | | 34 | 13 | 19 | 25 |
| Germany | 564 | 79 | 35 | 11 | 20 | 3 | | 2 |
| India (British) | | 112 | 1, 457 | | 4 | 1 | | (1) |
| Japan | | | 3, 371 | 758 | 194 | 232 | 197 | 220 |
| United Kingdom | 640 | 235 | 1, 428 | | 1, 193 | 957 | 1, 029 | 991 |
| Others | 1, 468 | 66 | 161 | 362 | 908 | 464 | 266 | 531 |
| | 4, 633 | 643 | 6, 471 | 1, 145 | 3, 868 | 2, 759 | 3, 010 | 3, 189 |
| Continents: | | | | | | | | |
| North America | 1, 077 | 23 | 16 | 4 | 1, 776 | 1, 197 | 1, 587 | 1, 562 |
| South America | 1, 186 | 145 | 5 | 43 | 314 | 195 | 89 | 254 |
| Europe | 2, 350 | 354 | 1, 611 | 335 | 1, 330 | 1, 021 | 1, 066 | 1, 087 |
| Asia | 20 | 121 | 4, 839 | 763 | 417 | 339 | 261 | 272 |
| Africa | | | | | 1 | 1 | 6 | 11 |
| Oceania | | | | | 30 | 6 | 1 | 3 |

[1] Less than 1 ton.

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 on Lead and Zinc Pigments and Zinc Salts.

## WORLD ASPECTS OF THE ZINC INDUSTRY

*International (European) Zinc Cartel.*—At the beginning of 1933 the cartel was functioning under a provisional agreement made on December 28, 1932, in which it was extended to the end of January 1933. The cartel included virtually all important zinc-smelting countries but the United States. The total producing capacity of the members had been established by agreement at Ostend in July 1930 at 1,125,000 metric tons of zinc per annum. On January 1, 1933, stocks reported by the cartel (including some nonmember stocks) amounted to 148,942 metric tons, of which 80,000 tons were frozen by agreement. Production was limited to 45 percent of capacity.

In January 1933 plans were made to extend the cartel beyond the end of the month. Demands were made for release of zinc-dust production from cartel control, release of frozen stocks, and increased production quotas. On January 18, a tentative agreement was made extending the cartel to the end of April. Zinc-dust production was released from cartel control, and 20 percent of the frozen stocks was released. Production over the specified quota (45 percent of Ostend basis) was permitted upon payment of fines. This agreement was not approved by some members who felt that stronger restrictions on production above quotas should be made. Technically the cartel was terminated at the end of January. News of the collapse caused a sharp drop in London zinc prices during the latter part of January.

Early in March, however, renewal of the cartel to the end of July was announced. The terms agreed upon tentatively in January were renewed, except that in the event stocks exceeded 155,000 tons members who had produced in excess of their quota were to cut production by a like amount below their quota. Attempts were made to secure an agreement covering 2 years, but this proved impossible because of the unsettled monetary conditions. However, in July a further extension to the end of October was announced. As stocks had shown a steady decline production quotas were increased to 50 percent. The embargo on the sales of stocks held by members was removed, and fines for overproduction were reduced.

In August the cartel was again threatened by members who were dissatisfied with the method of distributing the fines collected on overproduction. This difficulty was overcome early in October, and the continuance of the cartel to the end of the year was agreed upon. Meanwhile, production by members and outside producers had increased from 49,000 tons in January to 61,000 tons in October, which led to an increase in stocks in September and October. Some agitation for more drastic control of production followed, but in December the cartel agreement was renewed until July 1934 without change. Stocks at the end of the year were reported at 134,242 tons, a decrease of 14,700 tons for the year and of 70,000 tons since the cartel was first formed in August 1931.

*World production.*—World production of zinc (smelter basis) was 982,000 metric tons in 1933, an increase of 25 percent over 1932, but 32 percent below the record output of 1929. The increase in the United States was 48 percent and in the rest of the world 18 percent. The United States again ranked first in production, contributing 28 percent of the world total, compared with 24 percent in 1932 and 39 percent in 1929. Belgium contributed 14 percent of the total and recorded a 39-percent increase. Poland and Canada each produced about 8.5 percent of the world output; Poland suffered a 2-percent decline in tonnage, whereas Canada increased its output 7 percent. Among the remaining important producers, France, Germany, Great Britain, and Japan all showed major increases. Mexico's output was 8 percent below 1932, while Australia and Norway maintained production at about the 1932 level. There were no new producing countries in 1933, but Northern Rhodesia resumed production.

*World smelter production of zinc, 1929–33, in metric tons, by countries where smelted*

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

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Australia | 52,705 | 55,782 | 54,696 | 54,054 | [1] 55,000 |
| Belgium | 197,900 | 176,230 | 134,720 | 98,979 | 137,467 |
| Canada | 78,061 | 110,219 | 107,612 | 78,146 | 83,412 |
| Czechoslovakia | 10,675 | 13,472 | 7,947 | 6,031 | [1] 7,000 |
| France | 87,330 | 86,928 | 57,113 | 48,200 | 55,753 |
| Germany [2] | 102,000 | 97,300 | 45,300 | 41,979 | 50,867 |
| Great Britain [3] | 59,234 | 49,378 | 21,582 | 27,300 | [1] 41,000 |
| Indo-China | 3,808 | 3,857 | 2,900 | 2,280 | 3,100 |
| Italy | 15,804 | 19,264 | 16,913 | 17,984 | 23,197 |
| Japan | 22,098 | 24,669 | 25,407 | 25,000 | [1] 30,000 |
| Mexico | 15,099 | 29,431 | 35,619 | 30,349 | 28,000 |
| Netherlands | 25,712 | 23,255 | 19,323 | 15,624 | 18,478 |
| Northern Rhodesia | 12,316 | 18,194 | 7,038 | ---------- | 18,839 |
| Norway | 5,516 | 34,611 | 39,472 | 39,373 | [1] 39,000 |
| Poland | 169,029 | 174,362 | 130,756 | 84,953 | 83,599 |
| Spain | 11,825 | 10,697 | 10,094 | 9,505 | 8,535 |
| Sweden | 4,718 | 4,126 | ---------- | ---------- | ---------- |
| U.S.S.R. (Russia) | [4] 3,437 | [4] 4,650 | 11,400 | 14,000 | [1] 17,000 |
| United States | 567,393 | 451,816 | 264,893 | 187,921 | 277,606 |
| Yugoslavia | 6,291 | 5,514 | 4,504 | 2,157 | [1] 4,000 |
| | 1,451,000 | 1,394,000 | 997,000 | 784,000 | 982,000 |

[1] Approximate production.
[2] Exclusive of secondary material (Metallgesellschaft). The figures, published by the Stat. Reichsamt, which include secondary material, are as follows: 1929, 108,429 tons; 1930, 101,385 tons; 1931, 48,621 tons; 1932, 45,035 tons. Figures for 1933 not yet available.
[3] Some secondary material included.
[4] 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 (including primary and some secondary) in 1933 totaled about 1,020,000 metric tons, an increase of 26 percent over 1932. In spite of this large increase the rate of consumption in 1933 was still 23 percent below the 5-year average from 1925 to 1929. This estimate does not consider the change in stocks outside of the United States and Great Britain, and since there appears to have been a small decline in these stocks the figure given above probably understates actual consumption.

In consumption as well as production the increase was more pronounced in the United States than the rest of the world. Deliveries of primary zinc in the United States increased 51 percent in 1933, whereas consumption elsewhere increased only 15 percent. The United States continued to hold first place in zinc consumption in 1933, using 31 percent of the world total compared with 24 percent in 1932 and 39 percent during the 5 years from 1925 to 1929. Germany and Great Britain again ranked second and third and recorded increases of 1 and 7 percent, respectively, in the quantity of zinc consumed. France, Belgium, Japan, and Italy, the next largest consumers, made increases of 5, 53, 25, and 26 percent, respectively.

## REVIEW BY COUNTRIES

*Australia.*—Production was maintained at approximately full capacity throughout the year at the electrolytic plant at Risdon, Tasmania, the only zinc-reduction works in Australia. The reported output was 53,956 long tons, compared with 52,807 tons in 1932. As this output exceeded the quota allotted under the Zinc Cartel agreement, payment of penalties was necessitated.

At Broken Hill 1,202,600 tons of crude ore were raised, an increase of 105,000 tons over 1932. All of the four principal producers operated in 1933. The labor situation was eased early in the year by a 3-year wage agreement which provides a basic wage with bonuses varying with the price of lead.

Officials at Mt. Isa were considering the possibility of starting zinc production, but it was stated in December 1933 that such action would await further improvement in the price of the metal.

*Belgium.*—In Belgium production of slab zinc, which is derived almost entirely from imported ores, increased 39 percent in 1933. Exports, however, decreased from 64,045 metric tons in 1932 to 53,631 tons in 1933, Great Britain, Germany, and France taking smaller tonnages. Imports also decreased from 25,874 to 11,102 tons. Consumption, computed on a basis of production plus imports minus exports, amounted to approximately 95,000 tons, an increase of 53 percent over 1932. Nearly 46,000 tons of zinc sheets, wire, etc., were exported in 1933, which was equivalent to approximately half of the indicated consumption of slab zinc.

*Canada.*—Canadian zinc production (all electrolytic) amounted to 91,946 short tons in 1933, an increase of 7 percent over 1932. Seventy-five percent of the 1933 total was produced at Trail and 25 percent at Flin Flon. Production at Flin Flon increased 11 percent, whereas that at Trail increased only 5 percent. Exports of slab zinc were 86,726 tons, a slight decrease from 1932. Exports to Great Britain increased and amounted to 68 percent of the total shipments. Japan took 12,880 tons, 15 percent less than in 1932. Over 4,000 tons of zinc in the form of ore were exported chiefly to Europe in 1933, following no shipments in 1931 and 1932. This ore came largely from the Monarch mine at Field, British Columbia, and the Britannia mine on Howe Sound, British Columbia.

A very large part of the zinc production in British Columbia was derived from the Sullivan mine of the Consolidated Mining & Smelting Co. of Canada, Ltd. A total of 1,413,418 tons of lead-zinc ore was mined in 1933, a decrease of 2 percent from 1932. The zinc content of the ore was lower, but the recovery and grade of concentrates were cosiderably better than in 1932. Costs of production were again lowered in 1933. The company reported a profit of $1,056,000 after provision for depletion and depreciation compared with a deficit of $2,908,000 in 1932.

During 1933 the Hudson Bay Mining & Smelting Co., Ltd., the only zinc producer in Manitoba, mined and milled 1,604,869 tons of ore averaging 0.084 ounce of gold, 1.26 ounces of silver, 1.68 percent copper, and 3.9 percent zinc, from which, together with 610 tons of custom ore, 94,745 ounces of gold, 1,210,666 ounces of silver, 40,941,102 pounds of copper, and 46,305,736 pounds of zinc were produced and sold. Operating profit (before depreciation) was reported at about $2,700,000, compared with $1,400,000 in 1932.

*France.*—Production of zinc increased 16 percent in 1933. The smelting industry depends largely on foreign ores, of which 176,819 metric tons were imported in 1933 chiefly from Mexico, Spain, Newfoundland, and Sweden. Some ore is reexported after yielding its sulphur content for the manufacture of sulphuric acid. Exports in 1933 amounted to nearly 33,000 tons. About 45,000 tons of slab zinc were imported in 1933, Belgium supplying 50 percent and Norway 23 percent. Consumption increased from 95,500 tons in 1932 to about 100,800 tons in 1933. During the year there was some agitation for increased customs duties to provide a fund for subsidizing the lead and zinc mines of France and its colonies which have been hard hit by the depression. No official action was taken, however.

*Germany.*—Subsidies granted to the German zinc-mining industry in 1932 were continued in 1933. Although there was further agitation for a tariff to protect the domestic smelting industry, no official action was taken. That the policy of the Government, however, is to make Germany less dependent on foreign sources of zinc is indicated by the extension of credits to Giesche Erben for the construction of the 40,000-metric ton electrolytic zinc plant at Magdeburg, which will treat the ores now mined in German Upper Silesia and smelted in Poland. It will also provide a domestic supply of high-grade zinc which Germany now lacks.

Smelter production increased 21 percent in 1933, whereas consumption increased only 1 percent. Imports of slab zinc decreased only 1 percent, whereas exports increased 59 percent. Imports of zinc ore increased from 59,492 tons in 1932 to 79,068 in 1933; shipments from Newfoundland, Canada, and Mexico increased, while those from Greece and Russia decreased. Exports of zinc ore, consisting largely of shipments to Poland, increased from 95,150 to 101,459 tons.

*Great Britain.*—The smelter production of zinc in Great Britain in 1933 was estimated at 40,000 long tons, an increase of 51 percent over 1932. As consumption increased only 7 percent, there was a decrease in imports from 87,363 to 82,846 tons. Shipments from Australia and Belgium fell off considerably, but this decline was offset partly by increased tonnages from Canada and Germany. Exports of crude zinc amounted to about 6,000 tons in 1933. The smelting industry depends on foreign ores, of which 132,634 tons were imported in 1933, compared with 113,704 tons in 1932. These ores came principally from other parts of the British Empire, namely, Australia, Newfoundland, Canada, and British India.

The Imperial Smelting Corporation made further progress toward domination of the smelting industry by the acquisition of the Seaton Carew works of the Sulphide Corporation. This company, which is closely related to Australian and Indian mining interests, was the only zinc producer in Great Britain in 1933. The company has acquired rights for the manufacture of zinc by the vertical-retort process, and plants are being installed at Avonmouth and Seaton Carew.

The Zinc Manufacturing Co. continued to make zinc oxide at its Dartford plant, using the Coley process. It is understood that some progress has been made in reducing costs and that production of zinc is expected to begin soon.

*India.*—The Burma Corporation, Ltd., produced 61,432 long tons of zinc concentrates, averaging about 53.5 percent zinc in 1933 compared with 44,484 tons in 1932.

*Italy.*—Italy's production of zinc in 1933 increased 29 percent and was the highest on record. Consumption also increased, being 26 percent above 1932. Further progress was made toward realization of the Government's objective of making Italy independent of foreign zinc. Imports of slab zinc fell to 1,417 metric tons, as compared with over 10,000 tons in 1928. Imports of rolled zinc also decreased in 1933. Exports of zinc ore amounted to 31,597 tons; all but 1 ton went to Belgium.

*Mexico.*—Preliminary figures for 1933 indicate a mine production of 89,339 metric tons of zinc, an increase of about 56 percent over 1932. In spite of this large increase, the 1933 output was still 49 percent below the record output in 1929. Smelter production amounted to only 28,000 tons, a decrease of 8 percent from 1932. The greater part of the zinc ore produced in Mexico is shipped to Europe for treatment. There has been some agitation for increased smelting facilities in Mexico to aid employment and to make Mexican miners independent of European smelters. This may soon be realized in part, at least, as rumors indicate that a Mexican company has obtained a concession from the Government for a new zinc refinery and acid plant to be erected at Saltillo.

*Newfoundland.*—The Buchans Mining Co. maintained capacity production during 1933. Production of zinc concentrates totaled 152,188 short tons, of which 148,567 tons were shipped to Europe, Belgium taking 37 percent, Great Britain 35 percent, and France 28 percent. In addition, 49,455 tons of lead concentrate and 1,564 tons of copper and lead-gold-iron concentrates were produced.

*Poland.*—Smelter production declined 2 percent in 1933. The smelting industry is supported only partly by domestic ores. In 1933 about 113,000 metric tons of ore were imported, of which Germany supplied approximately 70 percent. About 80 percent of the zinc production of Poland is exported; shipments in 1933 amounted to 62,806 tons, of which Germany took 64 percent. As Germany plays such an important part in the Polish zinc industry, the completion of the German Madgeburg zinc plant will require some readjustment of the Polish industry.

*Rhodesia, Northern.*—The Rhodesia Broken Hill Co. resumed operations at its electrolytic zinc plant in January after having been idle since July 1931. Production for the year was 18,839 metric tons, which exceeded the previous record output of 18,194 tons in 1930. The company reported that its entire output up to the end of 1935 was sold.

*Spain.*—Preliminary estimates for 1933 indicate a decrease in zinc-mining activity. Production of zinc concentrates is estimated at 59,000 metric tons, compared with 83,000 tons in 1932. A large part of the ore is produced at the Reocin mine in the Province of Santander. This ore is exported mainly to Norway, where it is reduced to metal by the electrolytic process. Exports of ore totaled nearly 75,000 tons in 1933. Some ores, derived as byproducts of lead mining in the southern Provinces, are smelted in the south of Spain. Smelter production declined from 9,505 tons in 1932 to 8,535 tons in 1933.

*Yugoslavia.*—Trepca Mines, Ltd., treated 542,000 metric tons of ore averaging about 9 percent zinc, 9 percent lead, and 3 ounces of silver per ton. This was an increase of 34 percent over the tonnage treated in 1932. About 84,500 tons of 50-percent zinc concentrates were produced compared with 63,200 tons in 1932. This company is one of the few producers which operated profitably during the depression. Other areas which were worked extensively by the Romans were being actively explored in 1933.

# LEAD AND ZINC PIGMENTS AND ZINC SALTS

By Elmer W. Pehrson and H. M. Meyer

## SUMMARY OUTLINE



Sales of lead and zinc pigments in 1933 totaled $45,000,000, an increase of 17 percent over 1932. As per-ton values received by producers were slightly lower, the rise in value was due entirely to the increase in quantity production resulting from the greater volume of business in the paint, automobile, rubber, textile, and ceramic industries, in which lead and zinc pigments are chiefly used. Dollar volume of paint sales increased 4 percent, rubber-tire production 14 percent, automobile production 43 percent, and automobile-storage-battery production 12 percent.

*Salient statistics of the lead and zinc pigments industry of the United States, 1925–33*

| | 1925–29 (Average) | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Production (sales) of principal pigments: | | | | | |
| White lead (dry and in oil) short tons | 154,483 | 102,140 | 97,368 | 66,674 | 72,982 |
| Litharge do | 84,845 | 72,578 | 63,890 | 58,096 | 61,193 |
| Red lead do | 41,362 | 32,941 | 25,853 | 18,880 | 21,988 |
| Zinc oxide do | 154,208 | 119,142 | 95,700 | 72,250 | 98,542 |
| Leaded zinc oxide do | 26,609 | 17,279 | 18,577 | 14,305 | 22,868 |
| Lithopone do | 177,745 | 164,065 | 151,850 | 121,667 | 140,831 |
| Value of products: | | | | | |
| All lead pigments | $60,092,000 | $36,386,000 | $29,128,000 | $19,133,000 | $20,819,000 |
| All zinc pigments | 41,314,000 | 32,867,000 | 27,139,000 | 19,430,000 | 24,143,000 |
| Total | 101,406,000 | 69,253,000 | 56,267,000 | 38,563,000 | 44,962,000 |
| Value per ton received by producers: | | | | | |
| White lead (dry) | 178 | 140 | 124 | 117 | 112 |
| Litharge | 176 | 134 | 109 | 89 | 101 |
| Red lead | 193 | 154 | 129 | 111 | 120 |
| Zinc oxide | 133 | 125 | 125 | 110 | 105 |
| Leaded zinc oxide | 124 | 120 | 115 | 91 | 88 |
| Lithopone | 98 | 97 | 86 | 84 | 83 |
| Foreign trade: | | | | | |
| Lead pigments: | | | | | |
| Value of exports | 1,346,000 | 1,514,000 | 947,000 | 365,000 | 327,000 |
| Value of imports | 30,000 | 17,000 | 14,000 | 6,000 | 2,000 |
| Zinc pigments: | | | | | |
| Value of exports | 2,150,000 | 1,827,000 | 1,058,000 | 466,000 | 230,000 |
| Value of imports | 931,000 | 785,000 | 635,000 | 521,000 | 563,000 |
| Export balance | 2,535,000 | 2,539,000 | 1,356,000 | 304,000 | [1] 8,000 |

[1] Import balance.

The greater part of the 1933 increase was supplied by zinc pigments which advanced 26 percent in quantity and 24 percent in total value; production of lead pigments increased only 9 percent in both quantity and value. All zinc pigments shared in the increase; leaded zinc oxide advanced 60 percent in quantity, zinc oxide 36 percent, and lithopone 16 percent. Unit values of these three pigments decreased 3, 5, and 1 percent, respectively. Of the lead pigments, basic lead sulphate recorded the largest production increase, which amounted to 27 percent. The output of red lead increased 16 percent, orange mineral 9 percent, white lead 9 percent, and litharge 5 percent. Unit values of all lead pigments except white lead were higher in 1933 than in 1932, but the average was half a percent below that in 1932.

Production of zinc sulphate and zinc chloride in 1933 increased 34 and 37 percent, respectively, above 1932.

Foreign trade in lead and zinc pigments was again affected adversely by recessions in exports of white lead to the United Kingdom and zinc pigments to Canada and by increased imports of lithopone. As a result of these changes imports exceeded exports by $8,000, the first import surplus in many years. The extent to which foreign trade has declined is indicated by the fact that in 1933 exports of lead and zinc pigments were valued at only $557,000, compared with an average of $3,496,000 during the 5-year period 1925–29. In the 5 predepression years there was an average export surplus of $2,535,000. This decline was due primarily to the development of domestic production facilities by the principal customers, United Kingdom and Canada, and to the general low level of industrial activity throughout the world. The British preferential tariff also contributed to the decline in United States exports to the British areas in 1933.

The foregoing table contrasts the salient statistics of the lead- and zinc-pigment industry during the past 4 years with the 5-year average 1925–29, and figure 6 shows production and price trends during the past 19 years.

*The industry and NRA.*—The manufacture of lead and zinc pigments will be governed by the Code of Fair Competition for the Lead Industry and the Code of Fair Competition for the Zinc Industry, respectively, and the manufacture of lead and zinc salts comes under the Code of Fair Competition for the Chemical Manufacturing Industries established on February 10, 1934.

The lead code which became effective on June 4, 1934, provides for administration by the Lead Industries Association and establishes a lead pigments division within the industry. Minimum wages and hours of labor are specified, as well as trade practices for marketing lead pigments. The latter include provisions for free exchange of price data and set up uniform bases for sale of pigments. The code contains no production-control features, but provision is made for action along this line at a later date.

The Zinc Code had not yet been ratified on June 5, 1934. The latest draft available establishes the American Zinc Institute as the administrating agency. Divisions for zinc oxide and lithopone are provided, each of which is governed by a producers' committee. Minimum wages and hours of employment are specified for each division, as well as unfair trade practices and uniform bases of selling. The code contains no provision for control of pigment production, but free exchange of price lists is mandatory. Zinc-sulphide pigment is included in the lithopone division.

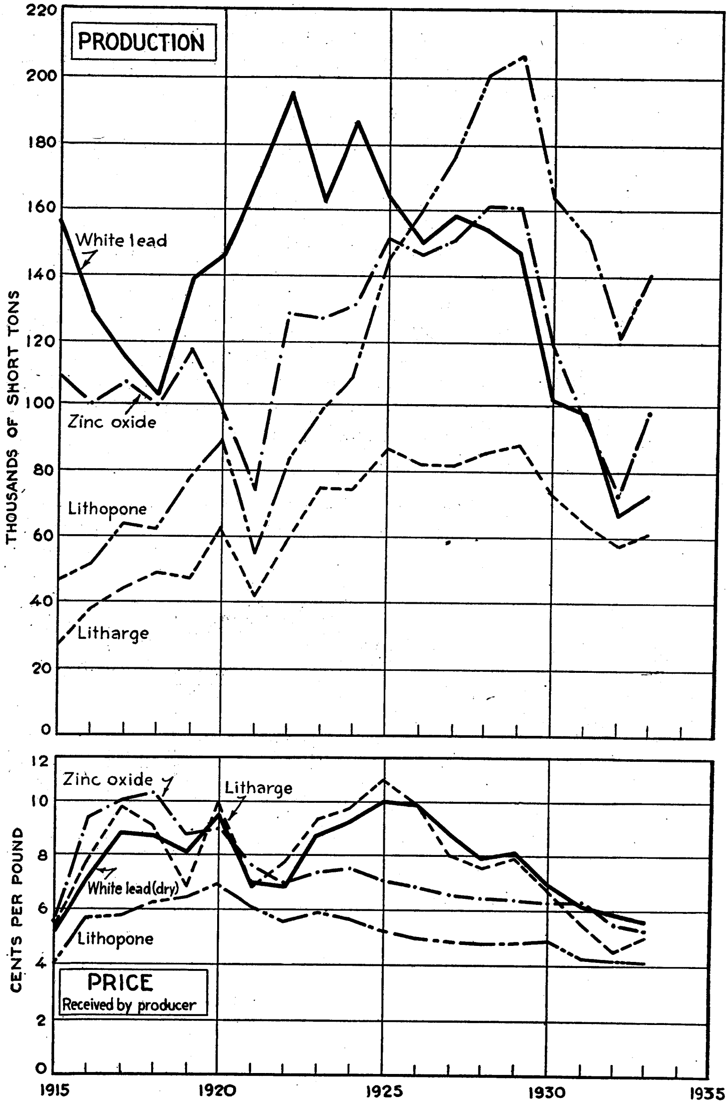


FIGURE 6.—Production and price trends of the principal lead and zinc pigments, 1915–33.

## 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 $44,962,000 in 1933, compared with

$38,563,000 in 1932. The total value of all lead pigments sold was $20,819,000 and that of all zinc pigments sold $24,143,000. Sales of lead pigments increased 9 percent in total value and quantity, whereas sales of zinc pigments increased 24 percent in total value and 26 percent in quantity. The average value per ton of lead pigments sold in 1933, as reported by producers, dropped 0.6 percent, whereas the average New York quotation for pig lead increased 22 percent in 1933 compared with 1932. Zinc pigments were 1.3 percent less in value per ton, compared with a 40-percent increase in the St. Louis quotation for slab zinc.

*Lead pigments.*—All lead pigments shared in the tonnage increase in 1933. Production of white lead was 9 percent above 1932 but 63 percent below the peak of 1922. Production of litharge increased only 5 percent and was 30 percent under the record output of 1929. Basic lead sulphate showed the largest percentage increase (27) in 1933 but was still less than half the 1928 output. Production of red lead and orange mineral increased 16 and 9 percent, respectively. Unit values of all the lead pigments except white lead were higher in 1933 than in 1932 by percentages ranging from 8 for red lead to 13 for litharge. The per-ton value of dry white lead declined 4 percent and that of white lead in oil 9 percent.

*Lead pigments sold by domestic manufacturers in the United States, 1932–33*

| Pigment | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | 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 | 5,708 | $534,369 | $94 | 7,320 | $736,404 | $101 |
| Blue | 549 | 34,125 | 62 | 625 | 65,525 | 105 |
| Red lead | 18,880 | 2,101,860 | 111 | 21,988 | 2,637,640 | 120 |
| Orange mineral | 212 | 37,691 | 178 | 231 | 45,928 | 199 |
| Litharge | 58,096 | 5,155,555 | 89 | 61,193 | 6,197,124 | 101 |
| White lead: | | | | | | |
| Dry | 19,946 | 2,329,876 | 117 | 24,628 | 2,763,630 | 112 |
| In oil [1] | 46,728 | 8,939,422 | 191 | 48,354 | 8,372,689 | 173 |

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

*Lead pigments sold by domestic manufacturers in the United States, 1924–33, in short tons*

| Year | White lead | | Basic lead sulphate or sublimed lead | | Red lead | Orange mineral | Litharge |
|---|---|---|---|---|---|---|---|
| | Dry | In oil | White | Blue | | | |
| 1924 | 42,622 | 144,872 | 14,572 | 1,088 | 36,813 | 331 | 74,724 |
| 1925 | 43,426 | 120,479 | 14,996 | 1,090 | 41,669 | 840 | 86,546 |
| 1926 | 37,968 | 111,845 | 12,271 | 1,236 | 42,550 | 813 | 82,540 |
| 1927 | 38,669 | 119,026 | 13,482 | 1,061 | 39,073 | 709 | 81,655 |
| 1928 | 42,049 | 111,923 | 16,002 | 1,234 | 40,497 | 459 | 85,570 |
| 1929 | 42,159 | 104,872 | 15,580 | 1,234 | 43,021 | 678 | 87,916 |
| 1930 | 32,548 | 69,592 | 10,308 | 1,219 | 32,941 | 356 | 72,578 |
| 1931 | 30,922 | 66,446 | 8,790 | 896 | 25,853 | 282 | 63,890 |
| 1932 | 19,946 | 46,728 | 5,708 | 549 | 18,880 | 212 | 58,096 |
| 1933 | 24,628 | 48,354 | 7,320 | 625 | 21,988 | 231 | 61,193 |

*Zinc pigments and salts.*—The following percentage increases in production were recorded in 1933: Zinc oxide 36, leaded zinc oxide 60, lithopone 16, zinc chloride 37, and zinc sulphate 34. Zinc oxide and lithopone production in 1933 were 36 and 21 percent, respectively, below the 5-year average for 1925–29. Values per ton realized by producers of zinc pigments were lower in 1933 than in 1932, but values of the zinc salts were higher.

*Production and value of zinc pigments and salts sold by domestic manufacturers in the United States, 1932–33*

| Pigment or salt | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Short tons | Value (at plant, exclusive of container) | | Short tons | Value (at plant, exclusive of container) | |
| | | Total | Average | | Total | Average |
| Zinc oxide [1] | 72,250 | $7,956,697 | $110 | 98,542 | $10,379,937 | $105 |
| Leaded zinc oxide [1] | 14,305 | 1,296,076 | 91 | 22,868 | 2,011,761 | 88 |
| Lithopone | 121,667 | 10,176,856 | 84 | 140,831 | 11,751,500 | 83 |
| Zinc chloride, 50° B | 23,524 | 1,033,255 | 44 | 32,187 | 1,459,745 | 45 |
| Zinc sulphate | 4,252 | 138,476 | 33 | 5,698 | 221,780 | 39 |

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

*Zinc pigments and salts sold by domestic manufacturers in the United States, 1924–33, in short tons*

| Year | Zinc oxide | Leaded zinc oxide | Lithopone | Zinc chloride (50° B.) | Zinc sulphate |
|---|---|---|---|---|---|
| 1924 | 131,470 | 26,729 | 109,469 | 51,054 | 4,674 |
| 1925 | 151,354 | 31,750 | 145,019 | 45,619 | 5,593 |
| 1926 | 146,923 | 23,859 | 159,931 | 47,296 | 6,612 |
| 1927 | 151,246 | 26,064 | 176,994 | 40,141 | 6,418 |
| 1928 | 160,904 | 24,223 | 200,468 | 45,669 | 4,733 |
| 1929 | 160,611 | 27,149 | 206,315 | 43,189 | 7,454 |
| 1930 | 119,142 | 17,279 | 164,065 | 29,043 | 6,249 |
| 1931 | 95,700 | 18,577 | 151,850 | 34,885 | 5,290 |
| 1932 | 72,250 | 14,305 | 121,667 | 23,524 | 4,252 |
| 1933 | 98,542 | 22,868 | 140,831 | 32,187 | 5,698 |

## CONSUMPTION BY INDUSTRIES

*White lead.*—By far the principal use of white lead is in the manufacture of paint, which accounted for 94 percent of the total consumption in 1933. The tonnage used in 1933 was 8 percent above that in 1932 and 50 percent below that in 1929. Consumption of white lead in the ceramic industry decreased 8 percent in 1933.

*Distribution of white lead (dry and in oil) sales, 1930–33, by industries*

| Industry | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total |
| Paint | 91,563 | 89.6 | 91,832 | 94.3 | 63,399 | 95.1 | 68,368 | 93.7 |
| Ceramics | 3,366 | 3.3 | 2,848 | 2.9 | 1,761 | 2.6 | 1,617 | 2.2 |
| Other | 7,211 | 7.1 | 2,688 | 2.8 | 1,514 | 2.3 | 2,997 | 4.1 |
| | 102,140 | 100.0 | 97,368 | 100.0 | 66,674 | 100.0 | 72,982 | 100.0 |

*Basic lead sulphate.*—Consumption of basic lead sulphate in paint manufacture in 1933 was 24 percent above that in 1932 and 47 percent below that in 1929. The use of this pigment in storage batteries has slumped 96 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, 1930–33, by industries*

| Industry | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total |
| Paints | 9, 573 | 83. 0 | 8, 311 | 85. 8 | 5, 689 | 90. 9 | 7, 072 | 89. 0 |
| Storage batteries | 1, 104 | 9. 6 | 697 | 7. 2 | 195 | 3. 1 | 99 | 1. 3 |
| Rubber | 394 | 3. 4 | 173 | 1. 8 | 77 | 1. 2 | 161 | 2. 0 |
| Other | 456 | 4. 0 | 505 | 5. 2 | 296 | 4. 8 | 613 | 7. 7 |
| | 11, 527 | 100. 0 | 9, 686 | 100. 0 | 6, 257 | 100. 0 | 7, 945 | 100. 0 |

*Litharge.*—Notwithstanding a substantial increase in the production of storage batteries in 1933, sales of litharge to this industry decreased 7 percent. A large part of this decrease is believed to be due to increased use of black oxides, although exact information is not available, the development being in the nature of a trade secret. Sales to the insecticide industry also fell off slightly, but large increases were reported in shipments to the oil-refining, ceramic, chrome-pigment, and rubber industries.

*Distribution of litharge sales, 1930–33, by industries*

| Industry | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total |
| Storage batteries | 33, 173 | 45. 7 | 31, 605 | 49. 5 | 29, 365 | 50. 5 | 27, 327 | 44. 6 |
| Insecticides | 6, 000 | 8. 3 | 7, 508 | 11. 8 | 11, 735 | 20. 2 | 11, 126 | 18. 2 |
| Oil refining | 12, 028 | 16. 6 | 7, 351 | 11. 5 | 4, 793 | 8. 3 | 6, 070 | 9. 9 |
| Ceramics | 4, 089 | 5. 6 | 4, 124 | 6. 5 | 2, 963 | 5. 1 | 5, 438 | 8. 9 |
| Chrome pigments | 3, 286 | 4. 5 | 3, 582 | 5. 6 | 2, 591 | 4. 5 | 3, 973 | 6. 5 |
| Rubber | 4, 736 | 6. 5 | 3, 032 | 4. 7 | 1, 921 | 3. 3 | 2, 875 | 4. 7 |
| Varnish | 698 | 1. 0 | 641 | 1. 0 | 1, 360 | 2. 3 | 610 | 1. 0 |
| Linoleum | 388 | . 5 | 208 | . 3 | 169 | . 3 | 106 | . 2 |
| Other | 8, 180 | 11. 3 | 5, 839 | 9. 1 | 3, 199 | 5. 5 | 3, 668 | 6. 0 |
| | 72, 578 | 100. 0 | 63, 890 | 100. 0 | 58, 096 | 100. 0 | 61, 193 | 100. 0 |

*Red lead.*—The use of red lead in the manufacture of storage batteries in 1933 increased 22 percent but was still 50 percent below that in 1929. The decline compared with 1929 was due partly to the decrease in battery manufacture and partly to the fact that the quantity of red lead used per battery has fallen off considerably. Red lead is used widely as a protective paint for iron and steel; this outlet increased 12 percent in 1933.

*Distribution of red lead sales, 1930–33, by industries*

| Industry | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total |
| Storage batteries | 18,998 | 57.7 | 13,700 | 53.0 | 10,655 | 56.4 | 12,949 | 58.9 |
| Paints | 10,906 | 33.1 | 9,256 | 35.8 | 6,389 | 33.8 | 7,182 | 32.7 |
| Ceramics | 835 | 2.5 | 811 | 3.1 | 467 | 2.5 | 715 | 3.2 |
| Other | 2,202 | 6.7 | 2,086 | 8.1 | 1,369 | 7.3 | 1,142 | 5.2 |
| | 32,941 | 100.0 | 25,853 | 100.0 | 18,880 | 100.0 | 21,988 | 100.0 |

*Orange mineral.*—Sales of orange mineral increased 9 percent in 1933 due to increased use in paint manufacture, which is included under "Other" in the following table:

*Distribution of orange mineral sales, 1930–33, by industries*

| Industry | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total | Short tons | Percent of total |
| Ink manufacture | 88 | 24.7 | 119 | 42.2 | 58 | 27.4 | 18 | 7.8 |
| Color pigments | 188 | 52.8 | 114 | 40.4 | 108 | 50.9 | 96 | 41.6 |
| Other | 80 | 22.5 | 49 | 17.4 | 46 | 21.7 | 117 | 50.6 |
| | 356 | 100.0 | 282 | 100.0 | 212 | 100.0 | 231 | 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.

Total sales of zinc oxide increased 36 percent in 1933 and of leaded zinc oxide 60 percent. Virtually all of the leaded zinc oxide is used in the manufacture of paint. Zinc oxide is used in the manufacture of rubber, paint, floor coverings, textiles, ceramics, and pharmaceuticals. In 1929 it is estimated that over 40 percent of the zinc oxide sold was used in rubber and about 30 percent of the combined sales of zinc oxide and leaded zinc oxide in paint. Depew [1] has described the role of zinc oxide in rubber manufacture.

*Lithopone.*—Sales of lithopone to all of its major uses increased in 1933. The paint industry took 14 percent more, floor coverings and textiles 5 percent more, and rubber 28 percent more. The increasing popularity of the high-strength lithopones is indicated by a 38-percent increase in sales compared with a 15-percent increase in sales of ordinary grades. The use of titanated lithopone is also increasing. In 1933 producers reported the use of 5,500 tons of lithopone in the manufacture of this product compared with 4,300 tons in 1932. Lithopone production capacity was reported at 233,320 tons per year in 1933 compared with 221,720 tons in 1932.

[1] Depew, Harlan A., Zinc Oxide in Rubber: Ind. and Eng. Chem. vol. 25, 1933, pp. 370–374 and 532–538

*Distribution of lithopone sales, 1929–33, by industries*

| Industry | 1929 (short tons) | 1930 (short tons) | 1931 (short tons) | 1932 (short tons) | 1933 | |
|---|---|---|---|---|---|---|
| | | | | | Short tons | Percent of total |
| Paints, etc. | 150,804 | 126,076 | 119,446 | 93,465 | 106,995 | 76.0 |
| Floor coverings and textiles | 37,506 | 23,656 | 20,780 | 17,601 | 18,472 | 13.1 |
| Rubber | 7,176 | 5,997 | 5,833 | 3,955 | 5,078 | 3.6 |
| Other | 10,829 | 8,336 | 5,791 | 6,646 | 10,286 | 7.3 |
| | 206,315 | 164,065 | 151,850 | 121,667 | 140,831 | 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 increased 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, 3,800 tons in 1932, and about 2,500 tons in 1933. Meanwhile the consumption of creosote increased from 51,000,000 gallons to a peak of 226,000,000 gallons in 1929; it has since declined to 106,000,000 gallons in 1932. Compared with 1928, consumption of zinc chloride in 1932 had declined 67 percent and that of creosote 53 percent. The treatment of railway crossties consumes most of the zinc chloride used in this field, and the low level of consumption in recent years has been due to curtailment of maintenance expenditures by the railroads during the depression. Other important uses for zinc chloride include dry batteries, soldering flux, vulcanized fiber, and oil refining. The latter probably increased considerably in 1933, as trade reports indicate an expansion of refining capacity using the zinc chloride process.

*Zinc sulphate.*—Sales of zinc sulphate increased 34 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 compared with only 509 tons in 1931 and 408 tons in 1932.

## 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 1933 95.4 percent of the lead in lead pigments was derived from pig lead, 4.6 percent from ore, and less than one-tenth percent from secondary material. For zinc pigments and salts the proportions were 56.7 percent from ore, 26.0 percent from slab zinc, and 17.3 percent from secondary materials.

*Metal content of lead pigments and zinc pigments and salts produced by domestic manufacturers, 1932–33, by sources, in short tons*

| Source | 1932 | | 1933 | |
|---|---|---|---|---|
| | Lead in pigments [1] | Zinc in pigments and salts | Lead in pigments [1] | Zinc in pigments and salts |
| Domestic ore | 4,932 | 54,932 | 6,875 | 71,622 |
| Metal | 127,318 | 19,853 | 143,027 | 32,916 |
| Secondary material [2] | 262 | 17,860 | 56 | 21,798 |
| | 132,512 | 92,645 | 149,958 | 126,336 |

[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. There was a large increase in the quantity of zinc drosses used in the manufacture of zinc oxide in 1933.

*Lead content of lead and zinc pigments produced by domestic manufacturers, 1932–33, by sources, in short tons*

| Pigment | 1932 | | | | 1933 | | | |
|---|---|---|---|---|---|---|---|---|
| | 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 | | 53,784 | | 53,784 | | 60,469 | | 60,469 |
| Red lead | | 17,569 | | 17,569 | | 20,060 | | 20,060 |
| Litharge | | 52,877 | | 52,877 | | 56,469 | | 56,469 |
| Orange mineral | | 147 | | 147 | | 136 | | 136 |
| Basic lead sulphate | 1,733 | 2,941 | 262 | 4,936 | 1,908 | 5,893 | | 7,801 |
| Leaded zinc oxide | 3,199 | | | 3,199 | 4,967 | | 56 | 5,023 |
| Zinc oxide | | | | | | | | |
| | 4,932 | 127,318 | 262 | 132,512 | 6,875 | 143,027 | 56 | 149,958 |

*Zinc content of zinc pigments and salts produced by domestic manufacturers, 1932–33, by sources, in short tons*

| Pigment or salt | 1932 | | | | 1933 | | | |
|---|---|---|---|---|---|---|---|---|
| | 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 | 33,295 | 19,771 | 325 | 53,391 | 42,110 | 32,784 | 2,848 | 77,742 |
| Leaded zinc oxide | 7,556 | 24 | | 7,580 | 10,913 | 31 | 118 | 11,062 |
| Lithopone | [1] 13,574 | | 11,910 | [1] 25,484 | [1] 17,749 | | 11,288 | [1] 29,037 |
| Zinc chloride | | 53 | 5,104 | 5,157 | | 101 | 6,680 | 6,781 |
| Zinc sulphate | 507 | 5 | 521 | 1,033 | 850 | | 864 | 1,714 |
| | 54,932 | 19,853 | 17,860 | 92,645 | 71,622 | 32,916 | 21,798 | 126,336 |

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

## PRODUCERS AND PLANTS

The following companies reported having sold or used lead and zinc pigments and zinc salts of their own production in 1933:

White lead:
- Anaconda Lead Products Co. (electrolytic process) — East Chicago, Ind.
- Carter White Lead Co — West Pullman, Chicago, Ill.
- The Eagle-Picher Lead Co — Cincinnati, Ohio.
- Euston Lead Co — Scranton, Pa.
- W. P. Fuller & Co — South San Francisco, Calif.
- John T. Lewis & Bros. Co — Philadelphia, Pa.
- National Lead Co — Chicago, Ill.
- Do — St. Louis, Mo.
- Do — Perth Amboy, N.J.
- Do — Brooklyn, N.Y.
- Do — Port Richmond, N.Y.
- National Lead Co. of California — Melrose, Calif.
- Sherwin-Williams Co — Chicago, Ill.

Basic lead sulphate, or sublimed lead:
- The Eagle-Picher Lead Co — Joplin, Mo.
- Eagle-Picher Mining & Smelting Co — Galena, Kans.
- St. Louis Smelting & Refining Works of National Lead Co — Collinsville, Ill.

Red lead, orange mineral, and litharge:
- Andrews Lead Co — Long Island City, N.Y.
- The Eagle-Picher Lead Co — East St. Louis, Ill.
- Do — Joplin, Mo.
- Do — Newark, N.J.
- Evans Lead Co — Charleston, W.Va.
- W. P. Fuller & Co — South San Francisco, Calif.

| | |
|---|---|
| Red lead, orange mineral, and litharge—Continued. | |
| Grasselli Chemical Co | East Chicago, Ind. |
| Hammond Lead Products, Inc | Hammond, Ind. |
| Morris P. Kirk & Son | Los Angeles, Calif. |
| John T. Lewis & Bros. Co | Philadelphia, Pa. |
| Metals Refining Co | Hammond, Ind. |
| National Lead Co | Chicago, Ill. |
| Do | St. Louis, Mo. |
| Do | Brooklyn, N.Y. |
| National Lead Co. of California | Melrose, Calif. |
| Sherwin-Williams Co | Chicago, Ill. |
| Zinc oxide and leaded zinc oxide: | |
| American Zinc Co. of Illinois | Hillsboro, Ill. |
| American Zinc Oxide Co | Columbus, Ohio. |
| The Eagle-Picher Lead Co | Hillsboro, Ill. |
| Empire Zinc Co | Canon City, Colo. |
| Grasselli Chemical Co | East Chicago, Ind. |
| International Lead Refining Co. (French process) | Do. |
| Do | Akron, Ohio. |
| Lowenthal Metals Corporation | Chicago, Ill. |
| New Jersey Zinc Co. (of Pennsylvania) | Palmerton, Pa. |
| Do. (French process) | Freemansburg, Pa. |
| Ozark Smelting & Mining Co | Coffeyville, Kans. |
| Röhm & Haas Co., Inc | Bristol, Pa. |
| St. Joseph Lead Co | Josephtown, Pa. |
| Lithopone: | |
| Chemical & Pigment Co., Inc | Oakland, Calif. |
| Do | Collinsville, Ill. |
| Do | St. Helena, Md. |
| The Eagle-Picher Lead Co | Argo, Ill. |
| Krebs Pigment & Color Corporation | Newport, Del. |
| Do | Newark, N.J. |
| Mineral Point Zinc Co | Depue, Ill. |
| New Jersey Zinc Co. (of Pennsylvania) | Palmerton, Pa. |
| Ozark Smelting & Mining Co | Coffeyville, Kans. |
| Sherwin-Williams Co | Chicago, Ill. |
| United Color & Pigment Co | Newark, N.J. |
| Zinc salts: | |
| American Smelting & Refining Co | Selby, Calif. |
| Do | Durango, Colo. |
| Do | Omaha, Nebr. |
| Do | Perth Amboy, N.J. |
| Charles Cooper & Co | Newark, N.J. |
| General Chemical Co | Chicago, Ill. |
| Grasselli Chemical Co | East Chicago, Ind. |
| Do | Cleveland, Ohio. |
| Do | Weirton, W.Va. |
| Great Western Electro-Chemical Co | Pittsburg, Calif. |
| Harshaw Chemical Co | Cleveland, Ohio. |
| Merrimac Chemical Co | Everett, Mass. |
| Ozark Smelting & Mining Co | Coffeyville, Kans. |
| Röhm & Haas Co | Philadelphia, Pa. |

## PRICES

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

*Range of quotations on lead pigments and zinc pigments and salts at New York, 1931–33, in cents per pound*

| Product | 1931 | 1932 [1] | 1933 [1] |
|---|---|---|---|
| Basic lead sulphate, or sublimed lead, dry, casks | 6.00- 6.75 | 5.50- 6.00 | 5.50- 6.00 |
| White lead, or basic lead carbonate: | | | |
| Dry, casks | 6.50- 7.25 | 6.00- 6.50 | 6.00- 6.50 |
| In oil, carload lots | 9.33-10.30 | (2) | (2) |
| Litharge, American, commercial, powdered, casks | 5.75- 7.75 | [3] 5.25- 6.00 | [3] 5.50- 7.00 |
| Red lead, dry, casks | 6.75- 8.75 | 6.25- 7.00 | 6.50- 8.00 |
| Orange mineral, American, casks | 9.50-10.75 | 8.75-10.75 | 9.00-11.75 |
| Lead acetate, brown, broken, barrels [1] | 10.00-10.50 | 9.00-10.50 | 8.50-10.50 |
| Lead arsenate, powdered, drums [1] | 10.00-16.00 | 9.50-14.00 | 9.00-13.50 |
| Zinc oxide: | | | |
| American process, lead-free, bags, car lots | 6.50 | [4] 5.75- 6.50 | [4] 5.75 |
| American process, leaded, barrels, car lots | 6.50 | [4] 5.75- 6.50 | [4] 5.75 |
| French process, red seal, bags, car lots | 9.38 | [4] 8.63- 9.75 | [4] 8.63 |
| French process, green seal, bags, car lots | 10.38 | [4] 9.63-10.38 | [4] 9.63 |
| French process, white seal, barrels, car lots | 11.63 | [4] 10.88-11.63 | [4] 10.88 |
| Lithopone, American, bags, car lots | 4.50 | [4] 4.50 | [4] 4.50 |
| Zinc sulphide, 500-pound barrels | 13.00-16.50 | 13.00-13.50 | 13.00-13.50 |
| Zinc chloride: | | | |
| Solution,[5] tanks | 2.25- 3.00 | 3.00 | 2.00- 3.00 |
| Fused | 5.00- 5.75 | 5.00- 5.75 | 4.25- 5.75 |
| Zinc sulphate, crystals, barrels [1] | 3.00- 3.50 | 3.00- 3.50 | 2.75- 3.75 |

[1] Compiled from weekly reports.
[2] Figures not available.
[3] Does not specify "American" in 1932 and 1933.
[4] Beginning with June 4, 1932, through December 30, 1933, recorded as 2-ton lots.
[5] At works.

The only changes in the quotations for white lead and basic lead sulphate in 1933 were increases of one-half cent a pound on the 1st of June. At the beginning of 1934 the basis of the quotations was changed to 20-ton lots with a one-fourth cent increase in price for smaller lots. Quotations for the lead oxides fluctuated with the price of lead and were 1¼ cents per pound higher at the close of the year than at the beginning. Prices of red lead were 1 cent higher than litharge throughout the year.

Quotations for American and French process zinc oxides and lithopone were maintained throughout the year. During the last week of the year it was announced that, effective January 1, 1934, the basis of the quotations was changed from 2- to 20-ton carload lots. The new price schedules included an advance of one-tenth cent per pound for American-process, 35-percent leaded zinc oxide, a reduction of one-fourth cent for French-process zinc oxide, and no change for lithopone and other American-process oxides.

## FOREIGN TRADE

Imports of lead and zinc pigments and salts increased 8 percent in 1933 and exports declined, so that the substantial export surplus realized in previous years virtually disappeared. The exact status of the export surplus in 1933 is not ascertainable as data on one item are missing. Excluding this item from the totals in 1932 and 1933, an import surplus of $38,000 for 1933 is indicated, compared with an export surplus of $336,000 in 1932. In 1929 the export surplus was in excess of $3,000,000.

The following table shows the value of the various pigments and salts imported and exported for 1932–33:

*Value of foreign trade of the United States in lead and zinc pigments and salts, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Imports | Exports | Imports | Exports |
| Lead pigments: | | | | |
| White lead | $5,073 | $174,403 | $460 | $120,433 |
| Red lead | 734 | [1] 58,150 | 109 | 63,638 |
| Litharge | | 132,942 | | 142,890 |
| Orange mineral | 530 | (1) | 1,566 | (1) |
| Total | 6,337 | 365,495 | 2,135 | 326,961 |
| Zinc pigments: | | | | |
| Zinc oxide | 241,963 | 196,149 | 247,241 | 122,101 |
| Lithopone | 271,678 | 270,195 | 313,341 | 107,923 |
| Zinc sulphide | 7,186 | | 2,483 | |
| Total | 520,827 | 466,344 | 563,065 | 230,024 |
| Lead and zinc salts: | | | | |
| Lead arsenate | | 96,199 | 58 | 44,808 |
| All lead compounds [2] | 46,528 | | 37,177 | |
| Zinc chloride | 15,456 | | 34,677 | |
| Zinc sulphate | 3,097 | | 2,732 | |
| All zinc compounds [2] | | 46,215 | | (3) |
| Total | 65,081 | 142,414 | 74,644 | [4] 44,808 |
| Grand total | 592,245 | 974,253 | 639,844 | [4] 601,793 |

[1] Red lead includes orange mineral.
[2] Excluding pigments. Salts not classified separately.
[3] Figures not available.
[4] Exclusive of the value of "all zinc compounds", figures for which are not available for 1933.

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

*Lead pigments and salts imported for consumption in the United States, 1929–33, in short tons*

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

[1] Less than 1 ton.

The principal exports are white lead, litharge, red lead, and lead arsenate. Exports of white lead, litharge, and red lead amounted to less than 3 percent of the domestic production of each of these pigments in 1933. Shipments of white lead to foreign countries decreased 38 percent owing to a 90-percent decline in purchases by the United Kingdom, formerly our principal customer. Exports of red lead and litharge increased 6 percent; shipments to Canada were 13 percent less in 1933 than in 1932 but still amounted to 52 percent of the total.

*Lead pigments and salts exported from the United States, 1929–33, in short tons*

| Year | White lead | Red lead [1] | Litharge | Lead arsenate | Other lead compounds | Total value |
|---|---|---|---|---|---|---|
| 1929 | 5,908 | 2,890 | (2) | 782 | ---------- | $1,616,937 |
| 1930 | 6,546 | 4,128 | (2) | 1,135 | ---------- | 1,777,169 |
| 1931 | 5,008 | 3,087 | (2) | 894 | ---------- | 1,123,369 |
| 1932 | 1,681 | 493 | 1,493 | 595 | ---------- | 461,694 |
| 1933 | 1,048 | 570 | 1,538 | 299 | ---------- | 371,769 |

[1] Includes litharge from 1929 to 1931 and an unknown quantity of orange mineral, 1929 to 1933.
[2] Included with red lead.

*White lead and red lead, orange mineral, and litharge exported from the United States, by destinations, 1930–33, in short tons*

| Destination | White lead | | | | Red lead, orange mineral, and litharge | | | |
|---|---|---|---|---|---|---|---|---|
| | 1930 | 1931 | 1932 | 1933 | 1930 | 1931 | 1932 | 1933 |
| Countries: | | | | | | | | |
| Argentina | 434 | 67 | 31 | 60 | 96 | 103 | 63 | 109 |
| Canada | 66 | 81 | 23 | 75 | 1,604 | 1,935 | 1,268 | 1,104 |
| Netherlands | 257 | 361 | 387 | 377 | 58 | 37 | 4 | -------- |
| Netherland West Indies | 3 | 1 | 3 | 2 | 901 | (1) | 3 | 58 |
| Panama | 101 | 1 | 201 | 26 | 79 | 76 | 2 | 68 |
| Philippine Islands | 380 | 112 | 145 | 138 | 144 | 86 | 105 | 164 |
| United Kingdom | 4,750 | 4,235 | 743 | 73 | 442 | 233 | 26 | 17 |
| Others | 555 | 150 | 148 | 296 | 804 | 617 | 515 | 588 |
| Total | 6,546 | 5,008 | 1,681 | 1,047 | 4,128 | 3,087 | 1,986 | 2,108 |
| Continents: | | | | | | | | |
| North America | 388 | 152 | 326 | 223 | 2,814 | 2,117 | 1,379 | 1,404 |
| South America | 575 | 83 | 75 | 150 | 199 | 223 | 218 | 210 |
| Europe | 5,075 | 4,619 | 1,131 | 479 | 701 | 490 | 197 | 213 |
| Asia | 484 | 123 | 148 | 141 | 300 | 217 | 170 | 201 |
| Africa | 8 | 30 | (1) | 53 | 7 | 40 | 21 | 80 |
| Oceania | 16 | 1 | 1 | 1 | 107 | (1) | 1 | (1) |

[1] Less than 1 ton.

*Zinc pigments and salts.*—The value of zinc pigments and salts imported again exceeded that exported as a result of increases in receipts of lithopone and zinc chloride and decreases in exports of zinc oxide and lithopone. Lithopone is the most important zinc import of this group; imports increased 8 percent in quantity in 1933, Netherlands supplying 91 percent of the total, Belgium 7 percent, and Germany 2 percent. Imports of zinc oxide decreased 5 percent; the principal sources were United Kingdom 52 percent, Belgium 16 percent, France 16 percent, Canada 9 percent, and Germany 6 percent. Germany supplied 83 percent of the zinc chloride imported.

*Zinc pigments and salts imported for consumption in the United States, 1929–33, in short tons*

| Year | Zinc oxide | | Litho-pone | Zinc sulphide | Zinc chloride | Zinc sulphate | Total value |
|---|---|---|---|---|---|---|---|
| | Dry | In oil | | | | | |
| 1929 | 1, 267 | 110 | 8, 409 | 315 | 638 | 909 | $1, 122, 490 |
| 1930 | 1, 056 | 79 | 7, 018 | 80 | 351 | 519 | 831, 284 |
| 1931 | 1, 352 | 105 | 5, 674 | 67 | 278 | 208 | 662, 706 |
| 1932 | 2, 515 | 157 | 4, 724 | 33 | 251 | 131 | 539, 380 |
| 1933 | 2, 359 | 182 | 5, 096 | 11 | 556 | 84 | 600, 474 |

Exports of zinc oxide and lithopone decreased 43 percent and 63 percent, respectively, in 1933, and the total export value of these two commodities declined 51 percent. Almost all of this decline was due to the drop in shipments to Canada, which, however, continued to be the principal consumer.

*Zinc pigments and salts exported from the United States, 1929–33, in short tons*

| Year | Zinc oxide | Litho-pone | Zinc salts | Total value | Year | Zinc oxide | Litho-pone | Zinc salts | Total value |
|---|---|---|---|---|---|---|---|---|---|
| 1929 | 17, 638 | 4, 556 | 1, 711 | $2, 919, 140 | 1932 | 1, 261 | 3, 212 | 299 | $512, 559 |
| 1930 | 10, 753 | 3, 665 | 1, 558 | 1, 956, 085 | 1933 | 722 | 1, 186 | (1) | [2] 230, 024 |
| 1931 | 5, 131 | 3, 821 | 1, 011 | 1, 146, 395 | | | | | |

[1] Zinc salts not separately recorded. [2] Exclusive of value of zinc salts.

*Zinc oxide and lithopone exported from the United States, by destinations, 1930–33, in short tons*

| Destination | Zinc oxide | | | | Lithopone | | | |
|---|---|---|---|---|---|---|---|---|
| | 1930 | 1931 | 1932 | 1933 | 1930 | 1931 | 1932 | 1933 |
| Countries: | | | | | | | | |
| Argentina | 68 | 171 | 79 | 16 | 3 | 12 | 19 | 12 |
| Canada | 4, 547 | 2, 818 | 740 | 286 | 3, 217 | 3, 318 | 2, 883 | 881 |
| Cuba | 91 | 58 | 23 | 22 | 187 | 100 | 82 | 41 |
| France | 428 | 1 | 4 | 5 | 2 | ------- | (1) | ------- |
| United Kingdom | 4, 719 | 1, 523 | 97 | 36 | 82 | 232 | 89 | 132 |
| Others | 900 | 560 | 318 | 357 | 174 | 159 | 139 | 120 |
| Total | 10, 753 | 5, 131 | 1, 261 | 722 | 3, 665 | 3, 821 | 3, 212 | 1, 186 |
| Continents: | | | | | | | | |
| North America | 4, 812 | 2, 998 | 904 | 437 | 3, 458 | 3, 466 | 2, 983 | 975 |
| South America | 105 | 217 | 94 | 39 | 26 | 33 | 44 | 54 |
| Europe | 5, 378 | 1, 713 | 116 | 72 | 85 | 236 | 95 | 133 |
| Asia | 176 | 93 | 61 | 80 | 40 | 26 | 1 | 3 |
| Africa | 14 | 8 | 5 | 3 | ------- | ------- | 1 | 1 |
| Oceania | 268 | 102 | 81 | 91 | 56 | 60 | 88 | 20 |

[1] Less than 1 ton.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA, IDAHO, AND MONTANA

**(MINE REPORT)**

By C. N. Gerry, T. H. Miller, and Paul Luff

SUMMARY OUTLINE



*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of $20.671835 from January 1 to August 9 to all producers; (2) that of (*a*) $20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export by some producers, to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, September 8 to November 1); and (4) the period of the Reconstruction Finance Corporation arbitrarily fixed, gradually rising price (generally above the world price), from October 25 to December 31, 1933. For further details see the general article on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

In the tables of production of Arizona, Idaho, and Montana, 1929–33, gold production in 1933 is shown with two values, (1) the legal coinage value ($20.67+ per ounce) and (2) the average weighted price ($25.56 per ounce).

*Calculation of value of other metals.*—The silver prices are 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, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

## ARIZONA

The output of gold, silver, copper, lead, and zinc from Arizona ores and gravels in 1933, in terms of recovered and estimated recoverable metals, was 79,250 fine ounces of gold, 2,375,000 fine ounces of silver, 113,200,000 pounds of copper, 3,375,000 pounds of lead, and 11,500 pounds of zinc. These figures compare with a production in 1932 of 66,789.67 ounces of gold, 2,082,823 ounces of silver, 182,491,825 pounds of copper, 2,364,300 pounds of lead, and no zinc. The figures for 1929 were 202,318.14 ounces of gold, 7,543,283 ounces of silver, 830,628,411 pounds of copper, 16,054,122 pounds of lead, and 2,458,580 pounds of zinc.

*Mine production of gold in Arizona, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 202,318.14 | $4,182,287 | 1932 | 66,789.67 | $1,380,665 |
| 1930 | 169,390.38 | 3,501,610 | 1933 [2] | 79,250.00 | [3] 1,638,243<br>[4] 2,025,630 |
| 1931 | 126,185.94 | 2,608,495 | | | |

[1] 1929–32: At legal value ($20.67+ per ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] Subject to revision.
[3] At legal coinage value ($20.67+ per ounce).
[4] At average weighted price ($25.56 per ounce).

*Mine production of gold, silver, copper, lead, and zinc in Arizona, 1929–33, in terms of recovered metals*

| Year | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| 1929 | 25,860,772 | 202,318.14 | 7,543,283 | 830,628,411 | 16,054,122 | 2,458,580 | $155,567,133 |
| 1930 | 19,802,919 | 169,390.38 | 5,540,732 | 576,190,607 | 8,491,623 | 1,630,506 | 81,042,416 |
| 1931 | 13,690,610 | 126,185.94 | 3,245,311 | 401,344,909 | 1,964,112 | | 40,144,694 |
| 1932 | 4,414,579 | 66,789.67 | 2,082,823 | 182,491,825 | 2,364,300 | | 13,535,935 |
| 1933 [1] | 992,500 | 79,250.00 | 2,375,000 | 113,200,000 | 3,375,000 | 11,500 | [2] 9,839,651 |

[1] Subject to revision.
[2] Value of gold calculated at legal coinage value of $20.671835 per fine ounce.

*Gold.*—The production of gold in Arizona increased from 66,789.67 ounces valued at $1,380,665 in 1932 to 79,250 ounces valued at $1,638,243 in 1933 (calculated at the legal coinage value of $20.671835 per fine ounce). Nearly 60 percent of the gold produced in Arizona in 1933 was recovered from copper ore from the Copper Queen branch of the Phelps Dodge Corporation, the United Verde Extension mine at Jerome, and the Magma property at Superior; most of the remainder was recovered from siliceous gold ore from mines in Pinal, Mohave, and Maricopa Counties. Other gold recovered was from placer operations in Lynx Creek, Big Bug, Copper Basin, and Weaver districts, Yavapai County; Plomosa district, Yuma County; Greaterville district, Pima County; San Francisco River district, Greenlee County; and Lost Basin district, Mohave County.

The largest producers of gold in Arizona in 1933 were the Copper Queen branch of the Phelps Dodge Corporation at Bisbee, United Verde Extension mine at Jerome, Magma mine and Lake Superior & Arizona lease at Superior, Big Jim mine at Oatman, Arizona Gold

Mines (reorganized in December as Gold Standard Mines Corporation, Roadside and Arabian mines) in the Katherine section of Mohave County, Vulture mine and Vulture tailings dump near Wickenburg, Tombstone Development Co. at Tombstone, Golden Belt mine near Cleator, Cyclopic mine northeast of Chloride, and Calari Dredging Co. near Prescott.

The New Cornelia at Ajo, Tom Reed at Oatman, and Katherine mines west of Kingman, large producers of gold in 1932, were idle in 1933.

Gold production in 1933 included development and treatment of gold ore in the Arabian and Roadside mines by the Arizona Gold Mines; the ore was treated in the Katherine cyanidation mill northwest of Kingman. At the old Vulture mine in the Vulture Mountains, Maricopa County, lessees produced considerable gold by treating oxidized ore from the upper levels of the mine by amalgamation and concentration, and a large quantity of gold was recovered by treating the old tailings dump by cyanidation. New gold also was produced from placer gravel on Lynx Creek by the Calari Dredging Co. The only production of importance in the Oatman area was that of the Big Jim mine, operated by lessees who used the Telluride mill throughout the year. (A Bureau of Mines information circular describing this mine and the milling methods used is in course of publication.) In the last quarter of the year the recovery of gold from placer gravel was undertaken at the King Tut property in Lost Basin district 50 miles north of Chloride. A plant equipped to recover gold by scraper, tractor, and dry tables was erected and operated late in the year. Several new concentration mills were constructed at properties in Yavapai County, which also treated gold ore at the close of the year.

*Silver.*—The silver output of Arizona increased from 2,082,823 ounces in 1932 to about 2,375,000 ounces in 1933, the total value from $587,356 to $831,250, and the average price from 28.2 to 35 cents an ounce. The copper-smelting plants at Douglas, Clemenceau, and Superior continued to receive company ore and custom material, and receipts at the Douglas smelter increased substantially. In 1933 about half the silver produced in Arizona came from copper ore from the Copper Queen branch at Bisbee and much of the remainder from copper ore from the Magma and United Verde Extension mines. Lead ore and siliceous ore containing silver were shipped to the plant at El Paso, Tex. A large quantity of silver also was produced from mines in the Tombstone district, Cochise County.

*Copper.*—The copper output of Arizona decreased from 182,491,825 pounds in 1932 to about 113,200,000 pounds in 1933, or 38 percent, and the value decreased from $11,496,985 to about $7,244,800. Nearly 74 percent of the total value of the mine output of the five metals in 1933 was that of copper. The copper smelters at Douglas, Clemenceau, and Superior continued operation, although the Magma plant at Superior was idle the latter half of the year.

The output of copper in Arizona in 1933 was less than in any year in the last 3 decades. Nearly all the large producers of copper in Arizona were idle in 1933. Some of them, such as the Morenci branch and the New Cornelia branch of the Phelps Dodge Corporation and the Miami and Inspiration mines near Miami, operated part of 1932 but were idle during 1933. The United Verde mine at

Jerome and smelter at Clarkdale have been idle since May 20, 1931. The Ray Mines division of the Nevada Consolidated Copper Co. produced only in the first 3 months of the year.

The largest copper producers in Arizona in 1933 were the Copper Queen branch of the Phelps Dodge Corporation, the United Verde Extension mine at Jerome, the Magma mine at Superior, and the Ray Mines division of the Nevada Consolidated Copper Co.

*Lead.*—Lead production in Arizona increased from 2,364,300 pounds in 1932 to 3,375,000 in 1933, the total value from $70,929 to $124,875, and the average price from 3 to 3.7 cents a pound. No lead ore was smelted in Arizona in 1933, and many of the large producers of lead remained idle. All silver-lead ore mined in the State was shipped to El Paso, Tex., for smelting. The Tombstone Extension mine at Tombstone was the leading producer of lead in Arizona in 1933; its ore also contained appreciable quantities of gold and silver. The 79 mine near Hayden Junction in Gila County (a large producer of lead in 1922–23 and 1928–30) ranked second, and the Tombstone Development Co. at Tombstone was third.

*Zinc.*—Most of the zinc and lead-zinc mines in Arizona remained idle in 1933; however, a car of ore containing lead and zinc was shipped to Midvale, Utah, for milling.

*Ore output.*—In 1933 mines and dumps in Arizona produced about 992,500 tons of ore, old tailings, etc., a decrease of 3,422,079 tons from the output of 1932. This unusually large decrease is the result of the idleness of many of the former large copper producers and the greatly reduced output of those remaining in operation. In 1932 more than 98 percent of the total ore, old tailings, etc., produced in Arizona was copper material. The bulk of the ore produced in 1933 was copper ore. Old tailings containing gold from the Vulture dump near Wickenburg and siliceous gold ore from the Big Jim mine at Oatman were treated by cyanidation. Several thousand tons of first-class lead ore were shipped to the smelter at El Paso, Tex., from the Tombstone Extension and Tombstone Development properties at Tombstone, the Copper Queen branch of the Phelps Dodge Corporation at Bisbee, and the dump of the 79 Lead-Copper Co., near Hayden Junction in Gila County.

*Review of districts and operations.*—The principal producing mining districts in Arizona have been the copper-producing districts—the Warren (Bisbee) in Cochise County, Verde (Jerome) in Yavapai County, Globe in Gila County, Pioneer (Superior) in Pinal County, Ajo in Pima County, Mineral Creek (Ray) in Pinal County, and Copper Mountain (Morenci) in Greenlee County. The former large copper producers in the Globe, Ajo, and Copper Mountain districts were idle in 1933, as was the United Verde mine at Jerome; the Ray Mines in the Mineral Creek district were operated only the first 3 months of the year; and the Magma mine in the Pioneer district was closed on June 26. The only large copper producers to operate throughout the year were the Phelps Dodge Corporation at Bisbee and the United Verde Extension Mining Co. at Jerome.

## IDAHO

The output of gold, silver, copper, lead, and zinc from Idaho ores and gravels in 1933, in terms of recovered and estimated recoverable metals, was 63,228 fine ounces of gold, 7,010,000 fine ounces of silver, 1,589,000 pounds of copper, 148,750,000 pounds of lead, and 42,185,000 pounds of zinc. These figures compare with 46,885.39 ounces of gold, 6,716,968 ounces of silver, 1,143,381 pounds of copper, 144,235,067 pounds of lead, and 20,504,234 pounds of zinc in 1932.

The three factors affecting production in 1933 were the increase in gold output from new and old properties, particularly from dredging operations near Warren, Idaho County; the large silver production from the Sunshine mine (the largest producing silver mine in the United States) near Kellogg; and the increased output of silver, lead, and zinc from the Morning mine of the Federal Mining & Smelting Co. The large production of silver from the Sunshine mine and the output from other large producers gave Idaho first place in silver production in the United States, a position held by Utah from 1920 to 1932.

*Mine production of gold in Idaho, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 20, 247. 11 | $418, 545 | 1932 | 46, 885. 39 | $969, 207 |
| 1930 | 21, 445. 07 | 443, 309 | 1933 [2] | 63, 228. 00 | [3] 1, 307, 039<br>[4] 1, 616, 108 |
| 1931 | 18, 361. 36 | 379, 563 | | | |

[1] 1929–32: At legal value ($20.67+ per fine ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] Subject to revision.
[3] At legal coinage value ($20.67+ per ounce).
[4] At average weighted price ($25.56 per ounce).

*Mine production of gold, silver, copper, lead, and zinc in Idaho, 1929–33, in terms of recovered metals*

| Year | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| 1929 | 2, 174, 125 | 20, 247. 11 | 9, 414, 403 | 5, 131, 438 | 297, 389, 488 | 91, 350, 807 | $31, 104, 246 |
| 1930 | 1, 944, 900 | 21, 445. 07 | 9, 420, 639 | 3, 111, 555 | 268, 115, 963 | 75, 298, 172 | 21, 494, 867 |
| 1931 | 1, 299, 927 | 18, 361. 36 | 7, 220, 923 | 1, 144, 915 | 198, 729, 228 | 39, 137, 212 | 11, 418, 013 |
| 1932 | 1, 032, 853 | 46, 885. 39 | 6, 716, 968 | 1, 143, 381 | 144, 235, 067 | 20, 504, 234 | 7, 877, 604 |
| 1933 [1] | 1, 137, 500 | 63, 228. 00 | 7, 010, 000 | 1, 589, 000 | 148, 750, 000 | 42, 185, 000 | [2] 11, 137, 755 |

[1] Subject to revision.
[2] Value of gold calculated at legal coinage value of $20.671835 per fine ounce.

*Gold.*—The mine output of gold in 1933 was about 63,228 ounces compared with 46,885.39 ounces in 1932, an increase of 35 percent. The value of the output in 1933, at the legal coinage value of $20.671835 per fine ounce, was $1,307,039.

Eight gold properties in Idaho, including both lode and placer mines, produced 50,144 ounces, nearly 84 percent of the States' gold output. Four dredges—2 at Warren, 1 at Pierce, and 1 in Owyhee County—produced 16,285 ounces of gold, or nearly double the output in 1932, due chiefly to the large production of the new dredge of the Warren Creek Dredging Co. at Warren. The Idaho Gold Dredging Co., also at Warren, which produced a large quantity of gold in 1932, increased its output in 1933. The production of gold from lode mines also increased substantially, due chiefly to the increased output of gold from the Yellow Pine property at Stibnite and the Gnome mine at Orogrande. The Boise-Rochester property of the St. Joseph Lead Co. at Atlanta was the largest producer of gold in Idaho in 1933, but its output was less than in 1932. Next in order of output were the Yellow Pine Co. at Stibnite, Valley County; the Idaho Gold Dredging Co., and the Warren Creek Dredging Co., both at Warren, Idaho County; the Gnome Gold Mining Co. at Orogrande, Idaho County; the Lone Pine mine, Ten Mile District, Idaho County; the Golden Hand, Inc., Ramey Ridge District, Idaho County; and the Gold Dredging, Inc., at Pierce, Clearwater County.

*Silver.*—The output of silver increased from 6,716,968 ounces in 1932 to about 7,010,000 in 1933 and the value from $1,894,185 to about $2,453,500. The average price of silver was 28.2 cents in 1932 and 35 cents in 1933. The increased production of more than 293,000 ounces was due chiefly to the increased production of lead-zinc ore from the Morning mine at Mullan. Notable increases in the output of silver were made at the Sunshine mine near Kellogg, the Frisco mine near Mace, the Gold Hunter mine near Mullan, and the Atlanta property of the St. Joseph Lead Co.

Operations at the Sunshine mine, which resulted in an increase in its production of silver (twice that of any other large silver producer of Idaho) was an outstanding feature of the industry in the State. In the Coeur d'Alene region, which produced at least 6,750,000 ounces of silver, about 47 percent of the silver was recovered from the ore of the Sunshine (Yankee Boy) mine; only four other mines in the Coeur d'Alene region produced more than 250,000 ounces each. Smaller important producers of silver were the Page, Frisco, Golconda, and Gold Hunter mines. Much silver was produced from gold ore by the St. Joseph Lead Co. and the Yellow Pine Co. The largest producers of silver in 1933 were the Sunshine Mining Co. east of Kellogg, the Bunker Hill & Sullivan mine at Kellogg, the Hecla mine at Burke, the Morning mine of the Federal Mining & Smelting Co. at Mullan, and the Crescent property adjacent to the Sunshine mine near Kellogg. In the latter half of the year several mines near Wallace increased their output of lead-zince ore because of the increase in metal prices.

*Copper.*—The output of copper increased from 1,143,381 pounds in 1932 to about 1,589,000 in 1933 and the value from $72,033 to $101,696. About half the copper produced in Idaho in 1933 came from copper-lead ore rich in silver from the Sunshine (Yankee Boy) property and the Crescent mine, both on Big Creek east of Kellogg. The remainder came chiefly from lead ore and lead-zinc ore from the Bunker Hill, Hecla, and Morning mines.

*Lead.*—The output of lead increased from 144,235,067 pounds in 1932 to about 148,750,000 in 1933 and the value from $4,327,052 to about $5,503,750, owing to the increase in the average price of lead from 3 cents a pound in 1932 to 3.7 cents in 1933. The increase was due chiefly to the larger output of lead-zinc ore from the Morning mine of the Federal Mining & Smelting Co. Idaho maintained its position as the second largest producer of lead in the United States, Missouri ranking first. The Bunker & Sullivan mine was by far the largest producer of lead in 1933, although the output was about 10,000,000 pounds less than in 1932. The Hecla mine at Burke was second; its output was about 1,000,000 pounds less than in 1932. The Morning mine ranked third; its production of lead in 1933 was nearly double that in 1932, and this large increase more than offset curtailed activity by other large lead producers. In 1933 these three mines produced about 90 percent of the total lead output of the State. Other large lead producers were the Page, Golconda, Frisco, Gold Hunter, Star, and Blackhawk mines.

*Zinc.*—The zinc produced from mines in Idaho increased from 20,504,234 pounds in 1932 to about 42,185,000 in 1933 and the value from $615,127 to about $1,771,770. The average price of zinc increased from 3 cents a pound in 1932 to 4.2 cents in 1933, and the large zinc mines increased their output as the price increased. The production of zinc in 1933 from the two chief producers of zinc in Idaho, the Morning and Bunker Hill & Sullivan mines, was more than double that in 1932. There were also large increases in the output of zinc from the Frisco and Golconda mines. Nearly 63 percent of the zinc output was recovered by roasting and leaching at the Great Falls (Montana) electrolytic plant, and the remainder was recovered at the Silver King (Idaho) plant of the Sullivan Mining Co.

The Morning mine exceeded all others in zinc production and produced more than half the zinc of the State. Next in order were the Bunker Hill & Sullivan, Frisco, Golconda, and Star mines. The Sidney mine on Pine Creek, a large producer of silver, lead, and zinc from 1925 to 1932, was idle in 1933.

*Ore output.*—About 1,137,500 tons of ore, old tailings, etc., were produced in Idaho in 1933, an increase of about 104,600 tons over 1932. The gain was due chiefly to the increase in the output of lead-zinc ore from the Morning and Frisco mines. About 88 percent of the ore was produced from mines in the Coeur d'Alene region; most of the remainder came from two mines at Atlanta and Stibnite. About one-half of the ore was lead ore, and the remainder was chiefly lead-zinc ore and copper-lead ore.

*Coeur d'Alene region.*—The Coeur d'Alene region in Shoshone County is the chief producing district in Idaho. In 1932, 21 lode mines and 15 placers produced 97 percent of the State's output of silver, 99 percent of the output of copper, 99 percent of the output of lead, and nearly all the zinc. The region, however, produces very little gold. Most of the gold in Idaho in 1932 was produced from lode mines in the Middle Boise (Atlanta) district in Elmore County and the Yellow Pine district in Valley County and from placer areas worked by dredges in the Warren district in Idaho County. In 1933 the Coeur d'Alene region produced about 1,032,000 tons of ore yielding, in terms of recovered metals, 1,420 ounces of gold, 6,767,000 ounces of silver, 1,500,000 pounds of copper, 148,000,000 pounds of lead, and 42,185,000 pounds of zinc, compared with an output in 1932 of 912,664 tons of ore yielding 394.45 ounces of gold, 6,547,674 ounces of silver, 1,129,952 pounds of copper, 143,010,500 pounds of lead, and 20,502,267 pounds of zinc.

## MONTANA

The output of gold, silver, copper, lead, and zinc from Montana ores and gravels in 1933, in terms of recovered and estimated recoverable metals, was 57,500.00 fine ounces of gold, 2,650,000 ounces of silver, 65,460,000 pounds of copper, 13,400,000 pounds of lead, and 41,500,000 pounds of zinc. These figures compare with a production in 1932 of 40,602.01 ounces of gold, 1,686,213 ounces of silver, 84,847,349 pounds of copper, 2,157,766 pounds of lead, and 4,393,034 pounds of zinc.

*Mine production of gold in Montana, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 54,758.03 | $1,131,949 | 1932 | 40,602.01 | $839,318 |
| 1930 | 43,489.17 | 899,001 | 1933 [2] | 57,500.00 | [3] 1,188,631<br>[4] 1,469,700 |
| 1931 | 40,112.16 | 829,192 | | | |

[1] 1929–32: At legal value ($20.67+ per ounce); in 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] Subject to revision.
[3] At legal coinage value ($20.67+ per ounce).
[4] At average weighted price ($25.56 per ounce).

*Mine production of gold, silver, copper, lead, and zinc in Montana, 1929–33, in terms of recovered metals*

| Year | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| 1929 | 4,723,445 | 54,578.03 | 12,716,977 | 297,725,973 | 39,213,707 | 136,351,734 | $71,779,547 |
| 1930 | 2,686,669 | 43,489.17 | 7,052,889 | 196,187,523 | 21,306,044 | 52,841,108 | 32,720,416 |
| 1931 | 2,085,683 | 40,112.16 | 3,829,837 | 184,555,735 | 8,860,186 | 13,494,986 | 19,575,053 |
| 1932 | 765,014 | 40,602.01 | 1,686,213 | 84,847,349 | 2,157,766 | 4,393,034 | 6,856,737 |
| 1933 [1] | 861,600 | 57,500.00 | 2,650,000 | 65,460,000 | 13,400,000 | 41,500,000 | [2] 8,544,371 |

[1] Subject to revision.
[2] Value of gold calculated at legal coinage value of $20.671835 per fine ounce.

*Gold.*—The value of the gold output increased from $839,318 in 1932 to about $1,188,631 in 1933 (calculated at the legal coinage value of $20.671835 per fine ounce). The change in the value of gold, which became receivable at about $30.64 in September and rose to $34.06 an ounce in December, resulted in the operation of numerous placers and many low-grade gold mines and old tailings dumps. During the last quarter of the year several new producers were added to the list.

The largest gold producers in the State in 1933 were the Jardine, August, Liberty Montana, Boss Tweed-Clipper, Story dredge, Anaconda, Gold Coin, and Southern Cross mines. Considerable gold also was produced from the Gould, Midas, Golden Sunlight, L. B., Holdfast, Ermont, and Brumlummon mines; the Jib tailing dump; and new placer operations on Prickly Pear Creek 1½ miles south of East Helena in Jefferson County. The old Jib mine and tailing dumps near Basin, Jefferson County, were taken over by Roy E. Miller, Inc., and during the last half of the year about 48,000 tons of old tailings containing gold, silver, and lead were treated in the reconditioned flotation mill on the property. Besides the old tailings milled several cars of crude gold ore were shipped to a smelter. A new 75-ton cyanide mill was constructed at the August mine in Phillips County, where considerable gold ore was treated during the last quarter of the year. Before the mill was completed several cars of high-grade gold ore were shipped to a smelter.

The Story Gold Dredging Co., which early in 1933 had replaced its drag-line and sluicing machinery with a dredge at its creek and bench gravel area on Norwegian Creek in Madison County, produced a large quantity of gold from January 28 to September 9. The Boss Tweed-Clipper group near Pony, Madison County, was operated nearly all year by the Pacific Gold Mining Co. The property is equipped with a 125-ton flotation mill, and rich gold concentrates were marketed. The Jardine Mining Co. operated its mine and mill at Jardine, Park County, the entire year and became the largest producer of gold in Montana. The old Gould mine in the Stemple district, Lewis and Clark County, was operated by the Standard Silver Lead Co., and considerable gold was recovered in a 35-ton flotation mill.

A new source of gold in Montana in 1933 was the placer production from claims on Prickly Pear Creek 1½ miles south of East Helena in Jefferson County. The claims were operated late in the year; the gold was recovered by a drag-line excavator with a floating washer.

The Ohio-Keating Gold Mining Corporation at Radersburg, Broadwater County, which produced $66,000 in gold in 1932, was idle in 1933, and the output of gold from the Liberty Montana property near Jefferson Island, Madison County, was only about half that in 1932. There was also a large decrease in the output of gold from the I. B. property at Bannack, Beaverhead County. The property was closed from April to September, when operations were resumed by the Thompson Milling Co.

*Silver.*—The output of silver increased from 1,686,213 ounces in 1932 to about 2,650,000 in 1933 and the value from $475,512 to $927,500. The Anaconda Copper Mining Co. was again the leading producer of silver in Montana. The production of silver from copper ores was about the same as in 1932, but there was a large increase in silver recovered from lead-zinc ore from the Orphan Girl and Emma properties at Butte. The Trout Mining Co. at Philipsburg produced a large quantity of silver from lead-zinc ore shipped to the custom lead-zinc milling plant at Anaconda, and a large quantity of silver was produced from siliceous-silver ore from a property in the Vipond district, Beaverhead County.

*Copper.*—The copper output, in terms of recoverable metal, decreased from 84,847,349 pounds in 1932 to about 65,460,000 in 1933 and the value from $5,345,383 to $4,189,440. As usual, the Anaconda Copper Mining Co. produced nearly all the State's copper from its mines at Butte, and the decreased output was due entirely to further curtailment in production at these properties. Montana dropped to third place as a producer of copper, ranking below Arizona and Utah.

*Lead.*—The production of recoverable lead increased from 2,157,766 pounds valued at $64,733 in 1932 to about 13,400,000 pounds valued at $495,800 in 1933. The large increase was due to the operation of the Orphan Girl and Emma mines by the Anaconda Copper Mining Co., which resulted in the first production of lead and zinc from mines at Butte since 1930, and to the increase in the output of lead from the Jack Waite property in Sanders County. The largest producers of lead in Montana in 1933 were, in order of importance, the Emma mine and the Orphan Girl and Jack Waite properties. The lead smelter at East Helena resumed operation in January and continued throughout the year at reduced capacity. The receipts in 1933 consisted chiefly of lead concentrates from the Coeur d'Alene region in Idaho and concentrates, crude ore, and the electrolytic zinc-plant residues from Montana; the 1933 receipts were more than double those in 1932.

*Zinc.*—The output of recoverable zinc increased from 4,393,034 pounds in 1932 to about 41,500,000 in 1933 and the value from $131,791 to about $1,743,000. This large increase was due chiefly to operation of two lead-zinc producers at Butte—the Orphan Girl and Emma mines. Both properties were operated by the Anaconda Copper Mining Co., and about 135,000 tons of lead-zinc ore were treated in the flotation concentrator at Anaconda. The largest producers of zinc in Montana in 1933, in order of importance, were the Orphan Girl mine and the Emma mine at Butte and the plant treating the old slag dump at the lead smelter at East Helena. The production of zinc from the "slag" plant in 1933 was more than double that in 1932. The production of zinc from the Trout group at Philipsburg was large. The custom flotation plant for the treatment of lead-zinc ore at Anaconda, owned by the Anaconda Copper Mining Co., started operating in June. The electrolytic zinc plant at Great Falls was operated the entire year, and the electrolytic zinc plant at Anaconda was active a short time in the fall.

*Ore output.*—The output of ore, old tailings, etc., increased from 765,014 tons in 1932 to about 861,600 in 1933. There was a decrease of about 176,000 tons in copper-bearing materials, but large increases in lead-zinc ore and siliceous gold ore and old tailings more than offset the loss. About 57 percent of the total material was classified as copper ore, 16 percent as lead-zinc ore, and most of the remainder as siliceous ore, old tailings, and slag.

*Butte (Summit Valley) district.*—In 1933 the output of copper from mines in the Butte district decreased more than 19,000,000 pounds, or nearly 23 percent from that in 1932, and the production of gold was slightly less; however, the production of silver, lead, and zinc increased considerably. The chief features of the mining industry in Montana in 1933 were the reopening and operation of the Emma and Orphan Girl mines at Butte by the Anaconda Copper Mining Co. These mines produced 134,000 tons of lead-zinc ore. The production of the Butte district in 1933, in terms of recovered metals, was about 3,000 ounces of gold, 2,360,000 ounces of silver, 65,300,000 pounds of copper, 8,400,000 pounds of lead, and 20,963,000 pounds of zinc, compared with 3,188 ounces of gold, 1,560,174 ounces of silver, 84,600,413 pounds of copper, and 2,600 pounds of lead in 1932.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA

(MINE REPORT)

By F. W. Horton and H. M. Gaylord [1]

SUMMARY OUTLINE



The total value of the gold, silver, copper, lead, and zinc produced in California in 1933, in terms of recovered metals and with gold computed at $20.671835 per fine ounce, is estimated at $12,656,669, an increase of $589,919 or 4.9 percent over that in 1932. The higher prices for gold during the latter part of the year stimulated gold mining; and the value of the gold output, which was the largest since 1925, constituted 98 percent of the value of the total production. Conversely, continued low prices for copper and lead caused large decreases in both the quantity and value of their output and a 22-percent decline in the quantity of silver recovered, as the greater part of the silver output of the State normally is derived from refining of the base metals. The quantities of copper and lead produced were 31 and 69 percent less, respectively, than in 1932. There was a small production of zinc in 1933, but none in the preceding year.

The value of the gold, silver, copper, lead, and zinc produced in 1933 brought the total value of these five metals produced in the State since 1848 to $2,157,627,604.

*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of $20.671835, from January 1 to August 9 to all producers; (2) that of (*a*) $20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export by some producers, to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, September 8 to November 1); and (4) the period of the Reconstruction Finance Corporation arbitrarily fixed, gradually rising price (generally above the world price), October 25 to December 31, 1933. For greater details see the general article on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

Below is a table of mine gold production in California, 1929–33, in terms of recovered metal; two values (1) the legal coinage value ($20.67+ per ounce) and (2) the average weighted price ($25.56 per ounce) are given for 1933.

[1] The assistance of Opal Y. Sharman, of the Bureau of Mines, is acknowledged.

*Mine production of gold in California, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 412,479.25 | $8,526,703 | 1932 | 569,166.99 | $11,765,726 |
| 1930 | 457,199.98 | 9,451,162 | 1933 [2] | 600,800.00 | [3] 12,419,638<br>[4] 15,356,448 |
| 1931 | 523,135.09 | 10,814,162 | | | |

[1] 1929–32: At legal value ($20.67+ per ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] Subject to revision.
[3] Gold figured at legal coinage value ($20.671835 per ounce).
[4] Gold figured at average weighted price ($25.56 per ounce).

*Mine production of gold, silver, copper, lead, and zinc in California, 1929–33, in terms of recovered metals*

| Year | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|
| | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| 1929 | 412,479.25 | 1,176,895 | 33,218,994 | 1,429,489 | | $15,090,589 |
| 1930 | 457,199.98 | 1,622,803 | 27,285,272 | 3,559,564 | | 13,801,004 |
| 1931 | 523,135.09 | 867,818 | 12,931,995 | 3,757,256 | 159,865 | 12,387,734 |
| 1932 | 569,166.99 | 493,533 | 1,417,876 | 2,417,416 | | 12,066,750 |
| 1933 [1] | 600,800.00 | 385,000 | 976,400 | 751,400 | 285,444 | [2] 12,656,669 |

[1] Subject to revision.
[2] Gold figured at legal coinage value ($20.671835 per fine ounce).

*Calculation of value of metal production.*—The value of metal production hereinafter reported has been calculated at the figures given in the following table. 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. Gold values do not appear in the table but are computed hereinafter at $20.671835 per fine ounce.

*Prices of silver, copper, lead, and zinc, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Gold.*—In 1933 California made an estimated output of 600,800 fine ounces of gold compared with 569,167 ounces in 1932, an increase of 31,633 ounces (5.6 percent) and maintained its position as the leading gold-producing State, exceeding both South Dakota and Alaska in output. Approximately three-fifths of the production was from lode mines and two-fifths from placers. Thirty-nine lode and placer properties in the State produced over 1,000 fine ounces of gold each. Of these 21 produced from 1,000 to 5,000 ounces, 8 from 5,000 to 10,000 ounces, 3 from 10,000 to 20,000 ounces, 5 from 20,000 to 50,000 ounces, and 2 more than 50,000 ounces. These 39 properties produced 511,281 fine ounces and accounted for 85 percent of the total production.

The following 20 mines or companies, virtually all of which were old, established producers, yielded 301,411 fine ounces of lode gold, or slightly more than half of the total gold output of the State: Empire Star Mines Co., Ltd., Idaho Maryland Mines Co., Great Northern Gold Mines, Inc. (Hoge), and Golden Center Mine, all in Nevada County; Argonaut Mining Co., Ltd., Kennedy Mining & Milling Co., Central Eureka Mining Co., and Pioneer Lucky Strike Gold Mining Co., all in Amador County; The Mountain Copper Co., Ltd., Shasta County; Original Sixteen to One Mine, Inc., Sierra County; Middle Fork Gold Mining Co. (Sliger), Montezuma-Apex Mining Co., and Beebe Gold Mining Co., Eldorado County; Yellow Aster and King Solomon, Kern County; Carson Hill and Royal, Calaveras County; King Solomon Mines Co., Siskiyou County; and Pacific Mining Co. (Pine Tree and Josephine) and Diltz, Mariposa County. On account of the appreciation in the price of gold much marginal ore was transformed into payable or reserves which in many instances were further increased by active development work.

The production of gold by dredging was 199,364.31 fine ounces—approximately one-third of the gold output of the State and 10,523.42 ounces more than the dredge output in 1932. The Natomas Co. with 6 dredges and the Capital Dredging Co. with 3 dredges in the Folsom district, Sacramento County, and the Yuba Consolidated Gold Fields with 3 dredges at Hammonton, Yuba County, and 1 in Merced County were the largest operators and made a combined output of over three-fourths of the total dredge production. The 13 dredges of these companies handled 41,917,000 cubic yards of gravel, an average of 3,224,400 cubic yards apiece. Each of the following companies operated a single dredge: The Lancha Plana Gold Dredging Co. at Camanche, Amador County; Shasta Butte Gold Dredging Co., Oroville, Butte County; Allen Placer, Burson, Calaveras County; Canyon Creek Dredging Co., Georgetown, Eldorado County; Snelling Gold Dredging Co., Snelling, Merced County; Gold Hill Dredging Co. in the Willow Hill district, 2 miles southeast of Folsom, Sacramento County; Crow Creek dredge at Cottonwood, Shasta County; Cal Oro Dredging Co. on Greenhorn Creek, Yreka, Siskiyou County; La Grange Gold Dredging Co., La Grange, Stanislaus County; Gold Bar Dredging Co. and Trinity Dredging Co., both at Lewiston, Trinity County.

The 14 companies named operated a total of 24 dredges which handled 55,296,890 cubic yards of gravel and made an average recovery of 0.0036 ounce of fine gold per cubic yard.

The Natomas Co. had a most successful year. Its dredges recovered 69,425 ounces of fine gold from 18,290,841 cubic yards of ground with a gross return of $0.0981 per cubic yard. The quantity of gravel washed increased 1,999,143 yards and the gross yield $0.0185 per yard over 1932. Costs per yard were reduced about 3 percent to $0.0459 per yard. A new dredging area estimated to contain about 52,000,000 cubic yards of profitable ground was developed in prospecting, and the company authorized the construction of a 16-cubic-foot dredge, designed to dig 40 feet below the water line, to bring this area into production.

The Yuba Consolidated Gold Fields began construction of a new dredge west of Hammonton, which will have a large capacity and will be capable of digging to a greater depth than any of the company's other dredges. Part of the equipment for the new dredge was obtained by dismantling one that had worked out its ground on the north side of the Yuba River. This corporation reported acquisition of one new dredging property and the possibility of further extending its operations on the Yuba River. The Lancha Plana Gold Dredging Co. handled about 3,000 cubic yards of gravel a day at its properties on the Mokelumne River 17 miles westerly from San Andreas. Twleve men were employed. The Gold Hill Dredging Co. started mining April 1, with a dredge moved from near Dayton, Nev. The Gold Bar Dredging Co. rebuilt its dredge damaged by fire and recommenced mining in June.

The large increase in the price of gold, if maintained, will notably extend the areas that may be mined profitably and thus add many years to the life of the gold-dredging industry in the State.

The output of drift placers was relatively unimportant compared with the total gold output of the State. The five largest producing mines, in order of output, were the Calaveras Central at Angels Camp, Calaveras County; Gray Wing Extension at Folsom, Sacramento County; Vallecito-Western 3 miles east of Angels Camp, Calaveras County, operated by the Tonopah Belmont Development Co.; Cohen-Gooday on the West Branch of Feather River in Butte County, operated by the Genii Consolidated Mines Co., Ltd.; and the New Era at Oroville, Butte County. These five mines produced a total of 7,829 fine ounces of gold.

The production of gold from hydraulic operations in California is surrounded by so many restrictions as to tailings disposal that it constituted less than 1 percent of the State's total output in 1933. Trinity, Siskiyou, and Sierra Counties, in the order named, were the leading producers of placer gold by hydraulicking and yielded over half the output. The Redding Creek placers 7 miles from Douglas City, Buckeye Placer Mines, Inc., Carrville, Red Hill mine on the Trinity River 3½ miles from Junction City, Osborne Hill mine 1 mile southwest of Helena, all in Trinity County; and the Depot Hill mine, 5 miles northeast of Camptonville, Sierra County, were the five largest producers by hydraulicking and yielded a total of 2,037 fine ounces of gold.

One hundred and seven bullion dealers in California, including banks merchants, and private refiners licensed by the State mineralogist of California under the Ore Buyers License Act, commonly known as the "High-Grade Bill", sold approximately 42,600 fine ounces of gold (7 percent of the estimated total State production) to the San Francisco Mint and other refiners. The major part of this gold was derived from small-scale placer operations and some from pocket hunting. Most of the placer gold purchased by licensed bullion buyers came from the Consumnes River in Eldorado and Amador Counties; the Feather River and its tributaries and Big Butte Creek in Butte and Plumas Counties; Mokelumne River in Amador and Calaveras Counties; Big Canyon and Webber Creeks in Eldorado County; the Yuba River and Deer Creek in Nevada County; North, South, and Middle Forks of the American River and Buckeye, Blue Canyon, and Indian Creeks in Placer County; Black Hawk, Nelson, Rush, Sloat, Spanish, and Squirrel Creeks in Plumas County; Klamath and Salmon Rivers and their tributaries in Siskiyou County; the Sacramento River and its tributaries, Beegum, Clear, and Cottonwood

Creeks, and French Gulch in Shasta County; Trinity River and its tributaries in Trinity County; and Stanislaus and Tuolumne Rivers and Bull and Woods Creeks in Tuolumne County. Some of the gold purchased was recovered from beach sands in Santa Cruz, Monterey, and Humboldt Counties, and small quantities were derived from San Gabriel and San Francisquito Canyons in Los Angeles County. Bullion buyers in Fresno, Humboldt, Kern, and San Bernardino Counties reported minor purchases.

*Silver.*—The production of silver in California was almost entirely a byproduct of gold mining, although silver ore and lead-silver ore have been mined in Inyo, Mono, Napa, and San Bernardino Counties. The output of silver in 1933 was approximately 385,000 fine ounces valued at $134,750, a decrease of 108,533 fine ounces (22 percent) compared with 1932. The average price was 35 cents a fine ounce compared with 28.2 cents in 1932. Nevada County, with over 162,000 fine ounces of silver derived from gold ores mined in the Grass Valley-Nevada City district, ranked first in output. San Bernardino County, the leading silver-producing county in 1932, ranked second in 1933 with an output of approximately 86,800 ounces. The Cerro Gordo and Santa Rosa properties in Inyo County contributed largely to the silver output of the State. Shasta and Amador Counties each produced about 20,000 ounces from gold ore. Gold-dredging operations in the State yielded 12,579 ounces of silver.

*Copper.*—The production of copper in California in 1933 was approximately 976,400 pounds valued at $62,490 compared with 1,417,876 pounds valued at $89,326 in 1932. The average price of copper was 6.4 cents a pound compared with 6.3 cents in 1932. Although Plumas, Shasta, and Trinity Counties have been consistent producers of copper, Shasta County was the only one reporting a production from a copper deposit in 1933, and this was derived from ore mined and concentrated in 1930 by the Mountain Copper Co., Ltd. This company, long recognized as a copper producer, turned to gold mining in 1931 and has since devoted itself to mining the gold-bearing gossan capping its copper deposit at Iron Mountain and treating it in a 500-ton cyanidation plant. In addition to the copper concentrates mentioned, the residues from pyrite sold to manufacturers of sulphuric acid were treated by the company in its leaching plant at Martinez, Contra Costa County. The copper from these residues and cement copper recovered from the water from the Iron Mountain mines constituted a large part of the total copper yield of the State.

*Lead.*—The mine production of lead in California in 1933 was approximately 751,400 pounds valued at $27,802, a decrease of 1,666,016 pounds (about 69 percent) in quantity and $44,720 in value compared with 1932. The average price of the metal in 1933 was 3.7 cents a pound compared with 3 cents in 1932. Lead ores were mined chiefly in Inyo and San Bernardino Counties. The largest producers were the Carbonate, Cerro Gordo, and Santa Rosa mines in the Cerro Gordo district, Inyo County. The American Smelting & Refining Co. took over the Estelle and Cerro Gordo mines in 1929 and operated them as a unit, but the company abandoned the properties early in 1933. Some lead ore from the Black Hawk and Buckeye districts, San Bernardino County, was sold to Utah smelters and to the Selby smelter.

*Zinc.*—The mine production of zinc in California in 1933 was approximately 285,400 pounds valued at $11,987. No output was recorded in 1932. The small production was derived principally from zinc carbonate ore from the Estelle mine, Inyo County, and from zinc concentrate recovered from copper-lead-zinc ore mined and milled by the Spanish Mining Co., Nevada County, in 1931.

*Review of principal mines and mills.*—The continued increase in the price of gold during the last half of 1933, which amounted to 65 percent at the close of the year, drew attention to the reopening of many mines that had long been closed because of unprofitable operation. Many of these old properties were in process of rehabilitation before the close of the year, but few had reached the production stage. Development of some of the better-known, low-grade deposits was also undertaken, and plants for the treatment of mine dumps and tailings were built and placed in operation. The outstanding technical development in the gold-mining industry of California in 1933 was the continued trend toward adoption of flotation for concentrating sulphide ore. The low cost and high recoveries effected by flotation are steadily increasing the percentage of auriferous concentrates produced by this method, and most of the large producers are using the process either in the treatment of primary ore or old tailings.

Empire Star Mines Co., Ltd., in Nevada County was the only company in the State whose output exceeded 100,000 fine ounces of gold. Its Grass Valley mines produced 201,566 tons of ore, which yielded an average of 0.380 ounce of gold per ton, corresponding to a mill extraction of 96.32 percent. Active development work at these mines, consisting of 21,994 feet of underground development and 1,180 feet of diamond drilling, resulted in the discovery of an important ore body on the 8,600-foot level of the North Star, which it is predicted will materially increase the life of the mine. Ore reserves in the Grass Valley properties as of December 31, 1933, were reported at approximately 257,000 tons having an average gold content of 0.359 ounce a ton. The Murchie mine east of Nevada City produced 79,768 tons of ore containing an average of 0.415 ounce of gold and 1.48 ounces of silver a ton. This ore was concentrated by flotation in the Murchie mill and yielded 1,635.7 tons of concentrates, which were treated by cyanidation at the Empire plant. The recovery by flotation was 93.68 percent of the gold. Mine development consisted of 9,326 feet of underground work. During 1933 the Empire Star Mines Co., Ltd., purchased the Sultana group of 27 claims, comprising about 188 acres contiguous to the Empire mine on the south, and made an arrangement for the joint operation of the Zeibright mine about 25 miles east of Grass Valley.

The Idaho Maryland Mines Co. was the second largest producer of lode gold in the State and carried forward a program of active development at the Idaho Maryland and Brunswick mines. A gross yield of $866,245.97 in gold and silver, with gold figured at $20.67+ an ounce, was obtained from 68,233 tons of ore. The Idaho Maryland mine is developed by a 3-compartment inclined shaft with main haulage levels at depths of 1,000 and 2,000 feet. During 1933 two electric compressors with a total capacity of 3,750 cubic feet were installed in a new hoist house, and retimbering the shaft and main haulage levels was continued. Underground development work consisted of 6,483 feet of drifts and crosscuts and 1,007 feet of raises and winzes, and 2 new air shovels and 2 electric locomotives were placed in operation. The ore is crushed by stamps in 2 plants, 1 having a capacity of 70 tons a day and the other of twice as much. After amalgamation the ore is concentrated on tables and vanners and by flotation, and the concentrates are shipped to smelters. Plans were completed for a 25-ton cyanide plant to treat the concentrates and for a 300-ton ball-mill flotation plant for the treatment of ore and of old mill tailings which have been impounded since 1926. The company leased the Brunswick and Morehouse mines from Idaho Maryland Consolidated Mines, Inc., and unwatered the Brunswick property. A new headframe, ore bins, hoist, and compressor building, and transformer house were erected, and a 6-cell flotation machine was installed in the Brunswick mill. An average of over 200 men was employed.

The Argonaut Mining Co., Ltd., continued active mining and development at its property one-half mile southeast of Martell, Amador County. The Argonaut mine is the deepest in California, with workings more than a mile beneath the surface. Over 6,000 feet of development work was completed during the year, and lateral exploration disclosed new ore bodies, which it is said will add materially to the life of the mine. The property is equipped with a 60-stamp mill which operated continuously throughout the year. After amalgamation the ore is concentrated on 36 Frue vanners, and the concentrates are cyanided at the plant of the Amador Metals Reduction Co., which worked the tailings from the mine. About 200 men were employed.

The Mountain Copper Co., Ltd., treated about 225,000 tons of gossan from the Iron Mountain Mine, Shasta County, in a 500-ton cyanidation plant to recover gold and silver. The company did not mine or concentrate any sulphide ore in 1933 because of the low price of copper.

The Kennedy Mining & Milling Co. deepened the inclined shaft at its Kennedy mine in the Mother Lode district, Amador County, to the 5,250-foot level. The mine also has a 4,650-foot vertical shaft and is further developed by several miles of drifts, crosscuts, and raises. The mill is equipped with 100 stamps, of which an average of 40 were operated during the year. After amalgamation the ore is concentrated by gravity methods and by flotation, and the concentrates are shipped to a smelter. During 1933 an increased tonnage of old impounded tailings was treated by flotation. Lead and zinc sulphides in the concentrates yielded a small return.

The Central Eureka Mining Co. concentrated its mining activities on the lower levels of the Old Eureka mine 1 mile north of Martell in the Sutter Creek district, Amador County. During the year ended April 1, 1934, the company milled 47,194 tons of ore, which yielded 14,793 ounces of mill bullion and 685.5 tons of concentrates. Bullion receipts for the year averaged $23.472 an ounce, and the total value of bullion and concentrates was $406,713. Most of the ore was mined between the 2,000- and 2,300-foot levels. Development during the year consisted of 2,916 feet of drifts, crosscuts, and raises. The ore is treated in a 40-stamp mill which operated steadily throughout the year. The pulp from the amalgamating plates was concentrated on 16 Frue vanners, and the concentrates were shipped to the Amador Metals Reduction Co., at Jackson, for cyanidation. Approximately 100 men were employed. The mill tailings are impounded and, together with the old mine dumps, will be treated by the Central Tailings Co., which spent about $100,000 in equipping a plant for this purpose.

The Original Sixteen to One mine in the Alleghany district, Sierra County, was operated steadily throughout the year. The mine is developed by two inclined shafts, 1,300 and 2,100 feet deep, with a 750-foot winze below the 2,100-foot level, and drifts at various levels with connecting raises. Low-grade ore is ground in a 100-ton ball mill and passed over riffles, and the riffle concentrate is amalgamated in Berden pans. High-grade ore after grinding goes directly to the amalgamating pans. Sulphides in the form of high-grade tailings from the amalgamating pans are shipped to a smelter.

The Great Northern Gold Mines, Inc., owner of the Hoge mine 4 miles northwest of Nevada City, operated its 100-ton flotation mill throughout the year. A Gates crusher, rolls, and a ball mill in closed circuit with a Dorr classifier reduce the ore to 80-mesh, after which it is concentrated in a rougher-cleaner flotation circuit. The concentrates are settled, filtered, and shipped to a smelter. The mine is developed by a 600-foot inclined shaft and a winze 600 feet in depth.

The Middle Fork Gold Mine Co. operated the Sliger mine continuously during the year. The mine is in Eldorado County about 9 miles from Auburn up the Middle Fork of the American River. It is developed by an inclined shaft which was deepened 100 feet during the year. The ore was treated in a 60-ton flotation plant, and the concentrates were shipped to the Selby smelter.

The Golden Center mine at Grass Valley, Nevada County, is developed by an inclined shaft 1,300 feet deep and over 2½ miles of drifts and crosscuts. Development work in 1933 consisted of 1,521 feet of drifts, 933 feet of crosscuts, and 287 feet of winzes. The 20-stamp mill on the property was operated throughout the year with only 15 days lost time. The ore is first amalgamated, then concentrated in 6 flotation cells which have a capacity of 125 tons. The concentrates are shipped to a smelter and contain enough galena to bring a slight return for lead. A 600-horsepower diesel engine and direct-connected generator were installed, and commencing September 1 this unit supplied almost two-thirds of the power consumption.

The Montezuma-Apex Mining Co. started development of the Montezuma mine 7 miles south of Eldorado, Eldorado County, in January and completed construction of a 120-ton mill early in April. The mine is opened to a vertical depth of 1,200 feet and has 4,430 feet of drifts. During 1933 development work consisted of 290 feet of raises, 2,039 feet of drifts, and 341 feet of shaft. The ore is reduced to minus 2-inch size by a Blake-type crusher, then ground in a ball mill to 65-mesh. Free gold in the discharge from the ball mill is caught in a hydraulic trap before the pulp goes to a classifier. The overflow from the classifier goes to flotation cells, and the coarse discharge is returned to the ball mill. Concentrates were shipped to smelters at Garfield, Utah, and Selby, Calif.

The Pioneer Lucky Strike Gold Mining Co. operated the Pioneer mine at Pine Grove, Amador County, 340 days out of the year and did 1,250 feet of development work. Aside from a production in 1932 the mine has been idle since the late eighties. It is opened by a 340-foot tunnel and by a shaft 194 feet deep and has over 1,000 feet of drifts. The ore containing pyrite, pyrrhotite, chalcopyrite, arsenopyrite, and galena is treated by flotation. A jaw crusher breaks the ore to three-fourths to 1-inch size and discharges it to a 4- by 4-foot Marcy mill of the overflow type. The mill discharge goes to a Dorr classifier, the overflow from which is treated in a 4-foot K & K flotation unit producing finished concentrates. The sands from the classifier are returned to the ball mill. The tailings from the 4-foot flotation unit discharge to a 6-foot matless cell, the tailings from which flow to a 6-foot K & K unit. The tailings from this last unit go to waste, and the rougher concentrates, together with those from the matless cell, are returned to the 4-foot unit for cleaning. During the year a 700-cubic foot, motor-driven compressor was installed, and the power supply for the mill was changed from Diesel-engine drive to electricity. A headframe and an electric hoist were installed and 1½ miles of 17,000-volt power line constructed. The mill operated 353 days. The concentrates were shipped to the Selby smelter.

The Yellow Aster Mining & Milling Co. operated its mine at Randsburg, Kern County, from January 1 to October 14, when it was optioned to the Anglo-American Mining Corporation. This corporation spent the remainder of the year in repairing the 50-stamp mill at the property and adding flotation and cyanidation units to increase the mill capacity to 250 tons a day. The underground workings of the Yellow Aster extend 320 feet below the bottom of a glory hole which is about 400 feet deep, 1,000 feet long, and 600 feet wide. The ore so far treated is oxidized, and its gold content has been recovered entirely by amalgamation. However, the discovery of sulphides in a 40-foot winze from the lowest level indicates a possible change in the character of the ore at this depth. The Randsburg Aster Gold Co. had an operating lease on the tailings dump of the Yellow Aster mine in 1933 and treated a small tonnage of tailings by cyanidation.

The Beebe mine at Georgetown, Eldorado County, was operated continuously in 1933, but milling operations were hindered by numerous shut-downs for repairs and changes. The mine is developed by a 300-foot vertical shaft with levels at depths of 130 and 250 feet. During the year 2,465 feet of underground development were done. Recoveries are effected in a 400-ton flotation mill and a 20-ton cyanide plant. The ore is ground to 80-mesh in a Hardinge Hadsell Mill and concentrated by Kraut flotation machines. The concentrates are ground to 400-mesh before they are cyanided. In November the Hadsell mill originally installed was replaced by a new cradle-mounted Hardinge Hadsell unit. During the year the cyanide plant was changed from batch operation by decantation to a continuous counterflow plant. All ore from the Woodside-Eureka and Alpine Mines was treated in the Beebe mill.

The King Solomon Mines Co. operated its property 7 miles from Black Bear, Siskiyou County, most of the year. The surface ore is so soft that it requires no blasting and is mined with a power shovel. From the mine bin the ore is delivered over 2,500-foot aerial cable tramway operated by gravity to a 200-ton mill on Matthews Creek, where it is ground in Hardinge mills and the gold recovered by amalgamation and flotation. A 250-horsepower Diesel engine and an electric generator were installed to furnish power for the mill.

The Pacific Mines Co., operating the Pine Tree and Josephine mines in Bear Valley near Bagby, Mariposa County, erected a 100-ton flotation mill and placed it in operation during the year. The ore is crushed to 2-inch size and ground in a ball mill to 60-mesh. The discharge from the ball mill is classified, the coarse material being returned for regrinding; the fines go to the flotation units. A recovery of 219 tons of concentrates, containing 3,111 ounces of gold,was made from 18,840 tons of ore.

The King Solomon mine 3 miles from Randsburg, Kern County, was operated throughout the year, and about 1,200 feet of underground development was done. The number of stamps was increased from 5 to 15, and a 50-ton ball mill was purchased to give additional milling capacity. The ore is oxidized, and the gold is recovered by amalgamation. A production of 2,473 ounces of gold and 679 ounces of silver was made from 2,595 tons of ore.

The Carson Hill mine at Melones, Calaveras County, was reopened and the crushing and cyanide plant rehabilitated and enlarged. Milling operations started on September 4, and a capacity of 20,000 tons per month was reached early in 1934. Underground mining was supplemented by steam-shovel operations on low-grade surface ore, a method of mining novel to the Mother Lode. Bullion shipments aggregating approximately $300,000 were made by April 1, 1934, at which time additional equipment was being installed to increase milling capacity to 1,000 tons per day.

Construction of a huge dredge, no. 17, for Yuba Consolidated Gold Fields was begun by the Yuba Manufacturing Co. When equipped it will weigh approximately 3,500 tons. The hull, which has been launched at Hammonton, is 233 feet 9 inches long, 68 feet wide, and 11 feet 6 inches deep. The bucket ladder will be 200 feet long, weigh 300 tons, and be able to dig 110 feet below the water line. A novel feature is an idler attached to the underside of the ladder to support the slack in the bucket line. The tailings stacker will be 250 feet long, the longest ever installed on a gold dredge, and will carry a 44-inch conveyor belt. The dredge is designed to handle 350,000 cubic yards of gravel a month. It will be electrically equipped throughout and will develop 1,300 horsepower.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO

(MINE REPORT)

By Chas. W. Henderson

SUMMARY OUTLINE



The total output of gold, silver, copper, lead, and zinc from Colorado ores and gravels in 1933, in terms of recovered and estimated recoverable metals, was 242,827.70 fine ounces of gold, 2,186,140 fine onces of silver, 9,667,000 pounds of copper, 4,803,000 pounds of lead, and 2,569,000 pounds of zinc. This output compares with a production in 1932 of 317,927.95 ounces of gold, 1,860,408 ounces of silver, 7,398,000 pounds of copper, 4,299,000 pounds of lead, and 218,000 pounds of zinc. There were 614 lode mines and 286 placers producing in 1933 and 478 lode mines and 335 placers in 1932, an increase of 136 lode mines but a decrease of 49 placers.

The total recorded output from Colorado ores and gravels from 1858 to 1933, inclusive, all in terms of recovered metals, has been 35,405,354 ounces of gold, 664,174,381 ounces of silver, 330,470,430 pounds of copper, 4,616,442,583 pounds of lead, and 2,232,912,985 pounds of zinc.

*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of $20.671835, from January 1 to August 9 to all producers; (2) that of (*a*) $20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export by some producers, to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, from September 8 to November 1); and (4) the period of the Reconstruction Finance

Corporation arbitrarily fixed, gradually rising price (generally above the world price), from October 25 to December 31, 1933. For further details see chapter of this volume on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

Following is a table on mine production of gold in Colorado, 1929–33, in terms of recovered metal; two values are given for 1933—(1) at legal coinage value ($20.67+ per ounce) and (2) at average weighted price ($25.56 per ounce).

*Mine production of gold in Colorado, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 213,689.69 | $4,417,358 | 1932 | 318,927.95 | $6,572,154 |
| 1930 | 218,539.82 | 4,517,619 | 1933 | 242,827.70 | [2] 5,019,694<br>[3] 6,206,676 |
| 1931 | 233,299.75 | 4,822,734 | | | |

[1] 1929–32: At legal value ($20.67+ per ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] At legal coinage value ($20.67+ per ounce).
[3] At average weighted price ($25.56 per ounce).

*Calculation of value of metal production.*—The value of metal production hereinafter reported 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, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Mine production of gold, silver, copper, lead, and zinc in Colorado, 1929–33, in terms of recovered metals*

| Year | Mines producing | | | Ore sold or treated (short tons) | Gold (lode and placer) | | Silver (lode and placer) | |
|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | Total | | Fine ounces | Value | Fine ounces | Value |
| 1929 | 290 | 13 | 303 | 1,172,193 | 213,689.69 | $4,417,358 | 4,397,377 | $2,343,802 |
| 1930 | 313 | 21 | 334 | 1,335,731 | 218,539.82 | 4,517,619 | 4,382,852 | 1,687,398 |
| 1931 | 340 | 195 | 535 | 1,036,562 | 233,299.75 | 4,822,734 | 2,195,914 | 636,815 |
| 1932 | 478 | 335 | 813 | 935,895 | 317,927.95 | 6,572,154 | 1,860,408 | 524,635 |
| 1933 | 614 | 286 | 900 | 845,495 | 242,827.70 | 5,019,694 | 2,186,140 | 765,149 |

| Year | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| 1929 | 8,905,074 | $1,567,293 | 48,889,906 | $3,080,064 | 58,861,000 | $3,884,826 | $15,293,343 |
| 1930 | 10,514,000 | 1,366,820 | 44,260,000 | 2,213,000 | 72,518,000 | 3,480,864 | 13,265,701 |
| 1931 | 8,165,000 | 743,015 | 13,768,000 | 509,416 | 32,373,000 | 1,230,174 | 7,942,154 |
| 1932 | 7,398,000 | 466,074 | 4,299,000 | 128,970 | 218,000 | 6,540 | 7,698,373 |
| 1933 | 9,667,000 | 618,688 | 4,803,000 | 177,711 | 2,569,000 | 107,898 | 6,689,140 |

*Gold and silver produced at placer mines in Colorado, 1929–33, in fine ounces, in terms of recovered metals*

| Year | Sluicing and hydraulic | | Dredging | | Total | |
|---|---|---|---|---|---|---|
| | Gold | Silver | Gold | Silver | Gold | Silver |
| 1929 | 355.72 | 60 | 1,862.27 | 488 | 2,217.99 | 548 |
| 1930 | 358.90 | 57 | 6,328.61 | 1,600 | 6,687.51 | 1,657 |
| 1931 | 777.32 | 121 | 266.90 | 69 | 1,044.22 | 190 |
| 1932 | 1,376.79 | 283 | 1,122.02 | 288 | 2,498.81 | 571 |
| 1933 | 2,511.55 | 549 | 2,813.96 | 711 | 5,325.51 | 1,260 |

*Gold.*—The production of gold in Colorado in 1933, in terms of recovered metal, was 242,827.70 fine ounces, a decrease from 1932 of 75,100.25 ounces. In 1933 the Cripple Creek district contributed 109,868.38 ounces (45.25 percent of the State total). Park County yielded 60,146.33 ounces (24.77 percent); San Juan, 23,473.87 ounces (9.67 percent); Lake, 10,727.20 ounces (4.42 percent); and Ouray, 9,255.25 ounces (3.81 percent). The largest increases in quantity were 4,453.16 ounces in Lake County, 1,908.20 ounces in Summit, 1,425.13 ounces in Eagle, and 536.96 ounces in Boulder. The largest decreases were 65,603.37 ounces in Park County, 11,726.97 ounces in Gilpin, 4,894.10 ounces in San Juan, and 3,223.03 in Ouray.

The yield of placer gold was 5,325.51 fine ounces, an increase of 2,826.70 ounces over 1932. Summit County produced 57 percent of the total placer gold, principally from the operation of two dredges—one by the Continental Dredging Co. and the other by the Tiger Placers Co., both of which ran only part of the year. The other counties producing placer gold in 1933 were Adams, Arapahoe, Boulder, Chaffee, Clear Creek, Costilla, Delta, Denver, Douglas, Eagle, Elbert, Fremont, Garfield, Gilpin, Gunnison, Jackson, Jefferson, Lake, La Plata, Moffat, Montezuma, Montrose, Ouray, Park, Pitkin, Rio Grande, Routt, San Juan, San Miguel, and Teller.

*Silver.*—The production of silver in Colorado in 1933, in terms of recovered metal, was 2,186,140 fine ounces, valued at $765,149, an increase of 325,732 ounces in quantity and $240,514 in value from 1932, after a decrease in 1932 of 335,506 ounces in quantity and $112,180 in value from 1931. In 1933 Eagle County produced 67.89 percent of the State total, San Juan 17.82 percent, Pitkin 3.15 percent, Ouray 2.44 percent, Park 1.85 percent, and Lake 1.65 percent. The largest increases were 373,324 ounces in Eagle County, 22,867 ounces in Pitkin, and 19,223 ounces in Lake. The largest decreases were 101,553 ounces in San Juan County and 22,694 in Park.

*Copper.*—The production of recoverable copper in Colorado in 1933 was 9,667,000 pounds, valued at $618,688, an increase of 2,269,000 pounds in quantity and $152,614 in value from 1932. Eagle County produced 84.44 percent of the total copper output, San Juan 12.25 percent, and Ouray 1.67 percent; the combined output of the other counties producing copper was 1.64 percent of the State total in 1933. Production in Eagle County increased 2,543,000 pounds in quantity and $168,372 in value from 1932. The largest decrease was 384,000 pounds in quantity and $23,008 in value in San Juan County.

*Lead.*—The production of recoverable lead in Colorado in 1933, reckoned as lead in lead bullion and in leaded zinc oxide, was 4,803,000 pounds, valued at $177,711, an increase of 504,000 pounds in quantity and $48,741 in value from 1932. Park, San Juan, and Lake Counties, each of which produced more than 1,000,000 pounds, were the most important producing counties in 1933. Clear Creek and San Miguel Counties made increases in both quantity and value of output. Gunnison County, which produced no lead in 1932, yielded 163,000 pounds in 1933. Lead ore yielded 559,758 pounds of lead, lead-zinc ore 759,700 pounds, and dry and siliceous ore 3,417,425 pounds; a small output came from copper and copper-lead ores.

*Zinc.*—The zinc-bearing ores marketed from Colorado in 1933 contained 2,569,000 pounds of recoverable zinc, valued at $107,898, an increase of 2,351,000 pounds in quantity and $101,358 in value from 1932. Lake County led in zinc production in 1933 with 2,492,000 pounds (97 percent of the State total) compared with 126,000 pounds (57.8 percent) in 1932. Gunnison County, yielding 60,000 pounds, and San Miguel, yielding 17,000 pounds, were the only other counties in the State from which zinc was recovered from ores mined in 1933.

## MINE PRODUCTION BY COUNTIES

*Mine production of gold, silver, copper, lead, and zinc in Colorado in 1933, by counties, in terms of recovered metals*

| County | Mines producing | | | Gold (lode and placer) | | Silver (lode and placer) | |
|---|---|---|---|---|---|---|---|
| | Lode | Placer | Total | Fine ounces | Value | Fine ounces | Value |
| Adams | | 2 | 2 | 4.69 | $97 | | |
| Arapahoe | | 1 | 1 | 1.84 | 38 | | |
| Boulder | 185 | 4 | 189 | 4,402.51 | 91,008 | 11,926 | $4,174 |
| Chaffee | 9 | 14 | 23 | 369.10 | 7,630 | 1,872 | 655 |
| Clear Creek | 70 | 8 | 78 | 5,512.77 | 113,959 | 28,206 | 9,872 |
| Costilla | | 2 | 2 | 16.45 | 340 | 2 | 1 |
| Custer | 1 | | 1 | 2.61 | 54 | | |
| Delta | 1 | 1 | 2 | 4.35 | 90 | 100 | 35 |
| Denver | | 8 | 8 | 19.59 | 405 | 6 | 2 |
| Dolores | 3 | | 3 | 39.52 | 817 | 4,820 | 1,687 |
| Douglas | | 6 | 6 | 23.90 | 494 | | |
| Eagle | 9 | 3 | 12 | 4,326.76 | 89,442 | 1,484,143 | 519,450 |
| Elbert | | 1 | 1 | 10.79 | 223 | | |
| Fremont | | 2 | 2 | 11.95 | 247 | 2 | 1 |
| Garfield | | 1 | 1 | 1.55 | 32 | | |
| Gilpin | 69 | 50 | 119 | 4,152.27 | 85,835 | 8,366 | 2,928 |
| Gunnison | 21 | 9 | 30 | 319.76 | 6,610 | 7,135 | 2,497 |
| Jackson | | 2 | 2 | 4.84 | 100 | | |
| Jefferson | | 6 | 6 | 353.67 | 7,311 | 51 | 18 |
| Lake | 31 | 14 | 45 | 10,727.20 | 221,751 | 35,989 | 12,596 |
| La Plata | 12 | 1 | 13 | 1,954.64 | 40,406 | 14,760 | 5,166 |
| Moffat | 1 | 9 | 10 | 23.85 | 493 | 3 | 1 |
| Montezuma | 1 | 1 | 2 | 171.83 | 3,552 | 129 | 45 |
| Montrose | | 36 | 36 | 199.35 | 4,121 | 63 | 22 |
| Ouray | 9 | 4 | 13 | 9,255.25 | 191,323 | 53,323 | 18,663 |
| Park | 31 | 19 | 50 | 60,146.33 | 1,243,335 | 40,526 | 14,184 |
| Pitkin | 2 | 1 | 3 | 7.84 | 162 | 68,860 | 24,101 |
| Rio Grande | 2 | 1 | 3 | 188.81 | 3,903 | 28 | 10 |
| Routt | | 2 | 2 | 8.37 | 173 | 3 | 1 |
| Saguache | 5 | | 5 | 28.15 | 582 | 1,500 | 525 |
| San Juan | 12 | 5 | 17 | 23,473.87 | 485,248 | 389,642 | 136,375 |
| San Miguel | 22 | 11 | 33 | 3,685.69 | 76,190 | 23,560 | 8,246 |
| Summit | 14 | 55 | 69 | 3,509.22 | 72,542 | 3,420 | 1,197 |
| Teller | 104 | 7 | 111 | 109,868.38 | 2,271,181 | 7,705 | 2,697 |
| | 614 | 286 | 900 | 242,827.70 | 5,019,694 | 2,186,140 | 765,149 |
| Total, 1932 | 478 | 335 | 813 | 317,927.95 | 6,572,154 | 1,860,408 | 524,635 |

*Mine production of gold, silver, copper, lead, and zinc in Colorado in 1933, by counties, in terms of recovered metals*—Continued

| County | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| Adams | | | | | | | $97 |
| Arapahoe | | | | | | | 38 |
| Boulder | 4,000 | $256 | 26,000 | $962 | | | 96,400 |
| Chaffee | 300 | 19 | 16,000 | 592 | | | 8,896 |
| Clear Creek | 11,000 | 704 | 141,000 | 5,217 | | | 129,752 |
| Costilla | | | | | | | 341 |
| Custer | | | | | | | 54 |
| Delta | | | 400 | 15 | | | 140 |
| Denver | | | | | | | 407 |
| Dolores | 800 | 51 | 6,000 | 222 | | | 2,777 |
| Douglas | | | | | | | 494 |
| Eagle | 8,163,000 | 522,432 | 15,000 | 555 | | | 1,131,879 |
| Elbert | | | | | | | 223 |
| Fremont | | | | | | | 248 |
| Garfield | | | | | | | 32 |
| Gilpin | 12,500 | 800 | 84,000 | 3,108 | | | 92,671 |
| Gunnison | 1,300 | 83 | 163,000 | 6,031 | 60,000 | $2,520 | 17,741 |
| Jackson | | | | | | | 100 |
| Jefferson | | | | | | | 7,329 |
| Lake | 15,000 | 960 | 1,010,000 | 37,370 | 2,492,000 | 104,664 | 377,341 |
| La Plata | 200 | 13 | 9,700 | 359 | | | 45,944 |
| Moffat | 400 | 26 | | | | | 520 |
| Montezuma | | | | | | | 3,597 |
| Montrose | | | | | | | 4,143 |
| Ouray | 161,500 | 10,336 | 280,400 | 10,375 | | | 230,697 |
| Park | 82,000 | 5,248 | 1,319,300 | 48,814 | | | 1,311,581 |
| Pitkin | | | 178,000 | 6,586 | | | 30,849 |
| Rio Grande | | | 200 | 7 | | | 3,920 |
| Routt | | | | | | | 174 |
| Saguache | 3,000 | 192 | 68,000 | 2,516 | | | 3,815 |
| San Juan | 1,184,000 | 75,776 | 1,198,400 | 44,341 | | | 741,740 |
| San Miguel | 28,000 | 1,792 | 248,300 | 9,187 | 17,000 | 714 | 96,129 |
| Summit | | | 39,300 | 1,454 | | | 75,193 |
| Teller | | | | | | | 2,273,878 |
| | 9,667,000 | 618,688 | 4,803,000 | 177,711 | 2,569,000 | 107,898 | 6,689,140 |
| Total, 1932 | 7,398,000 | 466,074 | 4,299,000 | 128,970 | 218,000 | 6,540 | 7,698,373 |

*Gold and silver produced at lode mines in Colorado in 1933, by counties, in terms of recovered metals*

| County | Ore sold or treated | Gold | Silver |
|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* |
| Boulder | 7,984 | 4,322.79 | 11,920 |
| Chaffee | 363 | 293.78 | 1,860 |
| Clear Creek | 14,449 | 5,462.99 | 28,200 |
| Custer | 3 | 2.61 | |
| Delta | 1 | .19 | 100 |
| Dolores | 41 | 39.52 | 4,820 |
| Eagle | 91,258 | 4,308.23 | 1,484,140 |
| Gilpin | 48,471 | 3,567.08 | 8,220 |
| Gunnison | 736 | 256.34 | 7,120 |
| Lake | 18,356 | 10,420.99 | 35,920 |
| La Plata | 7,801 | 1,951.45 | 14,760 |
| Moffat | 2 | | 3 |
| Montezuma | 21 | 169.65 | 129 |
| Ouray | 16,125 | 9,243.45 | 53,320 |
| Park | 62,643 | 59,899.81 | 40,480 |
| Pitkin | 3,677 | .97 | 68,860 |
| Rio Grande | 27 | 186.39 | 28 |
| Saguache | 131 | 28.15 | 1,500 |
| San Juan | 199,612 | 23,462.36 | 389,640 |
| San Miguel | 23,613 | 3,596.44 | 23,520 |
| Summit | 711 | 473.64 | 2,640 |
| Teller | 349,470 | 109,815.36 | 7,700 |
| | 845,495 | 237,502.19 | 2,184,880 |
| Total, 1932 | 935,895 | 315,429.14 | 1,859,837 |

*Gold and silver produced at placer mines in Colorado in 1933, by counties, in fine ounces*

| County | Sluicing and hydraulic | | Dredging | | Total | |
|---|---|---|---|---|---|---|
| | Gold | Silver | Gold | Silver | Gold | Silver |
| Adams | 4.69 | | | | 4.69 | |
| Arapahoe | 1.84 | | | | 1.84 | |
| Boulder | 79.72 | 6 | | | 79.72 | 6 |
| Chaffee | 75.32 | 12 | | | 75.32 | 12 |
| Clear Creek | 49.78 | 6 | | | 49.78 | 6 |
| Costilla | 16.45 | 2 | | | 16.45 | 2 |
| Delta | 4.16 | | | | 4.16 | |
| Denver | 19.59 | 6 | | | 19.59 | 6 |
| Douglas | 23.90 | | | | 23.90 | |
| Eagle | 18.53 | 3 | | | 18.53 | 3 |
| Elbert | 10.79 | | | | 10.79 | |
| Fremont | 11.95 | 2 | | | 11.95 | 2 |
| Garfield | 1.55 | | | | 1.55 | |
| Gilpin | 585.19 | 146 | | | 585.19 | 146 |
| Gunnison | 63.42 | 15 | | | 63.42 | 15 |
| Jackson | 4.84 | | | | 4.84 | |
| Jefferson | 353.67 | 51 | | | 353.67 | 51 |
| Lake | 306.21 | 69 | | | 306.21 | 69 |
| La Plata | 3.19 | | | | 3.19 | |
| Moffat | 23.85 | | | | 23.85 | |
| Montezuma | 2.18 | | | | 2.18 | |
| Montrose | 199.35 | 63 | | | 199.35 | 63 |
| Ouray | 11.80 | 3 | | | 11.80 | 3 |
| Park | 246.52 | 46 | | | 246.52 | 46 |
| Pitkin | 6.87 | | | | 6.87 | |
| Rio Grande | 2.42 | | | | 2.42 | |
| Routt | 8.37 | 3 | | | 8.37 | 3 |
| San Juan | 11.51 | 2 | | | 11.51 | 2 |
| San Miguel | 89.25 | 40 | | | 89.25 | 40 |
| Summit | 221.62 | 69 | 2,813.96 | 711 | 3,035.58 | 780 |
| Teller | 53.02 | 5 | | | 53.02 | 5 |
| | 2,511.55 | 549 | 2,813.96 | 711 | 5,325.51 | 1,260 |
| Total, 1932 | 1,376.79 | 283 | 1,122.02 | 288 | 2,498.81 | 571 |

## MINING INDUSTRY

In 1933 the total ore, old tailings, etc., sold or treated in Colorado was 845,495 tons compared with 935,895 tons in 1932. The quantity of low-grade gold ore treated in Gilpin County was 231,944 tons less in 1933 than in 1932, but this large decrease was partly offset by increases in the quantity of material treated at new or remodeled mills in Boulder, Clear Creek, La Plata, Park, and San Miguel Counties; by increased shipments of mine and dump sulphotelluride gold ores from the Cripple Creek district to the Golden Cycle mill at Colorado Springs; and by increased shipments of ore to smelters from Eagle, Gunnison, and Lake Counties. Operating details in these and other counties and districts of the State are given in the following review by counties and districts.

## ORE CLASSIFICATION

*Ore sold or treated in Colorado in 1933, with content in terms of recovered metals*

| Source | Ore | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold ore | 538,162 | 205,312.25 | 190,443 | 293,030 | 2,058,875 | 16,000 |
| Dry gold and silver ore | 199,134 | 23,710.70 | 396,733 | 1,181,208 | 1,160,350 | |
| Dry silver ore | 4,604 | 6.28 | 70,803 | 1,330 | 198,200 | |
| | 741,900 | 229,029.23 | 657,979 | 1,475,568 | 3,417,425 | 16,000 |
| Copper ore | 91,133 | 3,862.60 | 1,482,975 | 8,177,020 | 18,917 | |
| Copper-lead ore | 66 | 1.10 | 984 | 2,900 | 47,200 | |
| Lead ore | 2,604 | 4,608.44 | 40,969 | 10,672 | 559,758 | 1,000 |
| Lead-zinc ore | 9,792 | .82 | 1,973 | 840 | 759,700 | 2,552,000 |
| | 103,595 | 8,472.96 | 1,526,901 | 8,191,432 | 1,385,575 | 2,553,000 |
| Total, lode mines | 845,495 | 237,502.19 | 2,184,880 | 9,667,000 | 4,803,000 | 2,569,000 |
| Total, placers | | 5,325.51 | 1,260 | | | |
| | 845,495 | 242,827.70 | 2,186,140 | 9,667,000 | 4,803,000 | 2,569,000 |
| Total, 1932 | 935,895 | 317,927.95 | 1,860,408 | 7,398,000 | 4,299,000 | 218,000 |

## METALLURGIC INDUSTRY

Custom reduction plants operating in Colorado in 1933 were the lead bullion-leady copper matte smelter at Leadville, the Golden Cycle roast-amalgamation-cyanidation-flotation mill at Colorado Springs, the Chain O'Mines amalgamation-gravity concentration-selective flotation mill at Central City, the St. Joe flotation mill in Left Hand Canyon (Boulder County), the sampling plant at Boulder, the Watrous flotation mill at Silver Plume (Clear Creek County), the Clear Creek-Gilpin Ore Co. sampler at Idaho Springs (opened December 14), and the Smuggler-Union mill at Pandora (San Miguel County). Zinc-lead sulphide ore from Lake County was shipped to Coffeyville, Kans.; iron-copper-silver ore from Eagle County and small lots of gold ore from the San Juan region went to Utah smelters for reduction; and zinc-lead-silver ore from Gunnison and San Miguel Counties went to the selective flotation mill at Midvale, Utah.

Details of treatment of the total ore produced in the State in 1933 are shown in the following tables.

*Mine production of metals in Colorado in 1933, by methods of recovery, in terms of recovered metals*

| Method of recovery | Material treated | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Ore amalgamated | 407,650 | 48,527.84 | 7,674 | | | |
| Concentrates, sands, and slimes cyanided | 360,743 | 92,173.84 | 25,261 | | | |
| Concentrates smelted | 19,580 | 74,777.22 | 586,042 | 1,456,240 | 3,341,343 | 77,000 |
| Ore smelted | 112,539 | 22,023.29 | 1,565,903 | 8,210,760 | 1,461,657 | 2,492,000 |
| Placer | | 5,325.51 | 1,260 | | | |
| | | 242,827.70 | 2,186,140 | 9,667,000 | 4,803,000 | 2,569,000 |
| Total, 1932 | | 317,927.95 | 1,860,408 | 7,398,000 | 4,299,000 | 218,000 |

*Ore treated by amalgamation, concentrates, sands, and slimes treated by cyanidation, and gold and silver contained in bullion and precipitates in Colorado in 1933*

| Process | Material treated | Gold in bullion | Silver in bullion | Quicksilver purchased | Sodium cyanide used |
|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* |
| Amalgamation | 407,650 | 48,527.84 | 7,674 | 3,086 | |
| Cyanidation | [1] 360,743 | 92,173.84 | 25,261 | | [2] 327,680 |

[1] Includes 298,142 tons of sands and slimes from ore and concentrates known to have been first amalgamated and 62,601 tons of estimated tailings from ore first floated and other sands and slimes from iron concentrates first amalgamated.
[2] Reduced to equivalent of 96- to 98-percent strength. Actually 655,360 pounds of cyanamid of approximately 48- to 49-percent strength.

*Mine production of metals from gold and silver mills in Colorado in 1933, by counties, in terms of recovered metals*

| County | Ore treated | Recovered in bullion | | Concentrates and recovered metal | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Gold | Silver | Concentrates produced | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Boulder | 5,167 | 3,262.76 | 9,090 | 33 | 631.03 | 635 | 2,200 | 19,000 | |
| Chaffee | 281 | 196.48 | 1,014 | | | | | | |
| Clear Creek | 9,568 | 2,301.83 | 5,514 | 299 | 1,472.61 | 8,665 | 2,300 | 48,561 | |
| Custer | 3 | 2.61 | | | | | | | |
| Dolores | | 9.54 | 23 | | | | | | |
| Eagle | 39 | 39.13 | 163 | | | | | | |
| Gilpin | 47,909 | 2,321.75 | 1,725 | 867 | 905.33 | 4,335 | 8,200 | 47,300 | |
| Gunnison | 327 | 87.73 | 807 | 2 | 37.80 | 39 | 100 | 1,100 | |
| Lake | 289 | 346.88 | 377 | | | | | | |
| La Plata | 174 | 252.90 | 683 | 3 | 57.24 | 69 | 200 | 1,700 | |
| Montezuma | 17 | 47.27 | 73 | | | | | | |
| Ouray | 14,970 | 5,461.10 | 1,731 | 1,564 | 2,220.30 | 44,049 | 160,100 | 264,200 | |
| Park | 7,174 | 14,340.30 | 2,694 | 490 | 9,230.11 | 9,436 | 28,200 | 278,000 | |
| Rio Grande | 26 | 181.59 | | | | | | | |
| Saguache | 2 | .40 | | | | | | | |
| San Juan | 2 | 172.83 | 34 | | | | | | |
| San Miguel | 23,183 | 1,707.48 | 1,123 | 1,158 | 1,492.80 | 20,190 | 22,100 | 216,200 | |
| Summit | 377 | 153.74 | 184 | 142 | 80.80 | 261 | | | |
| Teller | 349,470 | 109,815.36 | 7,700 | | | | | | |
| | 458,978 | 140,701.68 | 32,935 | 4,558 | 16,128.02 | 87,679 | 223,400 | 876,061 | |
| Total, 1932 | 653,317 | 177,841.99 | 44,401 | 5,968 | 18,595.18 | 72,376 | 175,100 | 782,500 | 84,000 |

*Mine production of metals from concentrating mills in Colorado in 1933, by counties, in terms of recovered metals*

| County | Ore treated | Concentrates and recovered metal | | | | | |
|---|---|---|---|---|---|---|---|
| | | Concentrates produced | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Boulder | 2,794 | 130 | 412.70 | 2,195 | 1,800 | 7,000 | |
| Clear Creek | 4,448 | 394 | 780.31 | 3,834 | 4,500 | 46,500 | |
| Gilpin | 325 | 69 | 61.80 | 235 | | 6,832 | |
| Gunnison | 157 | 118 | .82 | 1,973 | 840 | 63,000 | 60,000 |
| La Plata | 7,457 | 147 | 980.81 | 10,475 | | 7,650 | |
| Ouray | 700 | 34 | 3.70 | 6,887 | 400 | 15,000 | |
| Park | 54,690 | 4,802 | 33,272.90 | 21,215 | 38,000 | 955,000 | |
| Pitkin | 3,600 | 232 | .57 | 62,048 | | 169,400 | |
| San Juan | 199,549 | 9,056 | 23,103.31 | 388,613 | 1,183,000 | 1,171,300 | |
| San Miguel | 258 | 40 | 32.28 | 888 | 4,300 | 23,600 | 17,000 |
| | 273,978 | 15,022 | 58,649.20 | 498,363 | 1,232,840 | 2,465,282 | 77,000 |
| Total, 1932 | 205,875 | 10,716 | 29,997.39 | 557,670 | 1,566,500 | 1,503,250 | 8,000 |

*Gross metal content of concentrates produced from ores mined in Colorado in 1933, by classes of concentrates*

| Class of concentrates | Concentrates produced (dry weight) | Gross metal content | | | | |
|---|---|---|---|---|---|---|
| | | Gold | Silver | Copper (wet assay) | Lead (wet assay) | Zinc |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold | 1,618 | 2,965.32 | 17,754 | 14,069 | 98,432 | 133,443 |
| Copper | 335 | 311.37 | 4,640 | 26,802 | 12,401 | 12,401 |
| Copper-lead | 11,157 | 35,494.30 | 443,023 | 1,716,379 | 1,933,467 | 1,839,440 |
| Lead | 6,391 | 36,002.56 | 120,592 | 58,875 | 1,657,978 | 600,806 |
| Zinc | 79 | 3.70 | 162 | 2,421 | 3,010 | 85,476 |
| | 19,580 | 74,777.25 | 586,171 | 1,818,546 | 3,705,288 | 2,671,566 |
| Total, 1932 | 16,684 | 48,620.48 | 632,403 | 2,183,276 | 2,538,481 | 2,403,689 |

*Mine production of metals from Colorado concentrates in 1933, in terms of recovered metals*

BY COUNTIES

| | Concentrates | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Boulder | 163 | 1,043.73 | 2,830 | 4,000 | 26,000 | |
| Clear Creek | 693 | 2,252.92 | 12,499 | 6,800 | 95,061 | |
| Gilpin | 936 | 967.13 | 4,570 | 8,200 | 54,132 | |
| Gunnison | 120 | 38.62 | 2,012 | 940 | 64,100 | 60,000 |
| La Plata | 150 | 1,038.05 | 10,544 | 200 | 9,350 | |
| Ouray | 1,598 | 2,224.00 | 50,936 | 160,500 | 279,200 | |
| Park | 5,292 | 42,503.01 | 30,651 | 66,200 | 1,233,000 | |
| Pitkin | 232 | .57 | 62,048 | | 169,400 | |
| San Juan | 9,056 | 23,103.31 | 388,613 | 1,183,000 | 1,171,300 | |
| San Miguel | 1,198 | 1,525.08 | 21,078 | 26,400 | 239,800 | 17,000 |
| Summit | 142 | 80.80 | 261 | | | |
| | 19,580 | 74,777.22 | 586,042 | 1,456,240 | 3,341,343 | 77,000 |
| Total, 1932 | 16,684 | 48,592.57 | 630,046 | 1,741,600 | 2,285,750 | 92,000 |

BY CLASSES OF CONCENTRATES

| | Concentrates | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Dry gold | 1,618 | 2,965.32 | 17,754 | 11,600 | 87,800 | |
| Copper | 335 | 311.37 | 4,640 | 22,100 | 11,000 | |
| Copper-lead | 11,157 | 35,494.30 | 442,894 | 1,373,800 | 1,741,461 | |
| Lead | 6,391 | 36,002.53 | 120,592 | 46,441 | 1,498,237 | 1,000 |
| Zinc | 79 | 3.70 | 162 | 2,299 | 2,845 | 76,000 |
| | 19,580 | 74,777.22 | 586,042 | 1,456,240 | 3,341,343 | 77,000 |

*Gross metal content of Colorado crude ore shipped to smelters in 1933, by classes of ore*

| Class of ore | Ore | | Gross metal content | | | | |
|---|---|---|---|---|---|---|---|
| | | | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Percent* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold | 8,529 | 7.58 | 13,119.94 | 34,224 | 22,297 | 143,980 | 3,552 |
| Dry gold and silver | 313 | .28 | 441.60 | 5,204 | 2,897 | 439 | 3,280 |
| Dry silver | 303 | .27 | 1.90 | 1,738 | 1,165 | 15,442 | |
| Copper | 91,133 | 80.98 | 3,862.60 | 1,482,976 | 8,518,545 | 32,071 | 1,819,460 |
| Copper-lead | 66 | .06 | 1.10 | 984 | 3,449 | 52,792 | |
| Lead | 2,560 | 2.27 | 4,596.29 | 40,790 | 13,234 | 619,369 | 5,931 |
| Lead-zinc | 9,635 | 8.56 | | | | 995,327 | 3,114,108 |
| | 112,539 | 100.00 | 22,023.43 | 1,565,916 | 8,561,587 | 1,859,420 | 4,946,331 |
| Total, 1932 | 76,703 | 100.00 | 88,994.60 | 1,185,390 | 6,219,978 | 2,564,251 | 2,427,788 |

*Mine production of metals from Colorado crude ore shipped to smelters in 1933, in terms of recovered metals*

BY COUNTIES

| | Ore | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Boulder | 23 | 16.30 | | | | |
| Chaffee | 82 | 97.30 | 846 | 300 | 16,000 | |
| Clear Creek | 433 | 908.24 | 10,187 | 4,200 | 45,939 | |
| Delta | 1 | .19 | 100 | | 400 | |
| Dolores | 41 | 29.98 | 4,797 | 800 | 6,000 | |
| Eagle | 91,219 | 4,269.10 | 1,483,977 | 8,163,000 | 15,000 | |
| Gilpin | 237 | 278.20 | 1,925 | 4,300 | 29,868 | |
| Gunnison | 252 | 129.99 | 4,301 | 360 | 98,900 | |
| Lake | 18,067 | 10,074.11 | 35,543 | 15,000 | 1,010,000 | 2,492,000 |
| La Plata | 170 | 660.50 | 3,533 | | 350 | |
| Moffat | 2 | | 3 | 400 | | |
| Montezuma | 4 | 122.38 | 56 | | | |
| Ouray | 455 | 1,558.35 | 653 | 1,000 | 1,200 | |
| Park | 779 | 3,056.50 | 7,135 | 15,800 | 86,300 | |
| Pitkin | 77 | .40 | 6,812 | | 8,600 | |
| Rio Grande | 1 | 4.80 | 28 | | 200 | |
| Saguache | 129 | 27.75 | 1,500 | 3,000 | 68,000 | |
| San Juan | 61 | 186.22 | 993 | 1,000 | 27,100 | |
| San Miguel | 172 | 363.88 | 1,319 | 1,600 | 8,500 | |
| Summit | 334 | 239.10 | 2,195 | | 39,300 | |
| | 112,539 | 22,023.29 | 1,565,903 | 8,210,760 | 1,461,657 | 2,492,000 |
| Total, 1932 | 76,703 | 88,994.58 | 1,185,390 | 5,656,400 | 2,013,250 | 126,000 |

BY CLASSES OF ORE

| | Ore | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Dry gold | 8,529 | 13,119.94 | 34,223 | 17,530 | 129,464 | |
| Dry gold and silver | 313 | 441.60 | 5,204 | 2,008 | 350 | |
| Dry silver | 303 | 1.90 | 1,738 | 930 | 13,800 | |
| Copper | 91,133 | 3,862.60 | 1,482,975 | 8,177,020 | 18,917 | |
| Copper-lead | 66 | 1.10 | 984 | 2,900 | 47,200 | |
| Lead | 2,560 | 4,596.15 | 40,779 | 10,372 | 555,226 | |
| Total to copper and lead plants | 102,904 | 22,023.29 | 1,565,903 | 8,210,760 | 764,957 | |
| Lead-zinc | 9,635 | | | | 696,700 | 2,492,000 |
| | 112,539 | 22,023.29 | 1,565,903 | 8,210,760 | 1,461,657 | 2,492,00 |

## REVIEW BY COUNTIES AND DISTRICTS

*Mine production of gold, silver, copper, lead, and zinc in Colorado in 1933, by counties and districts, in terms of recovered metals*

| County and district | Number of mines producing | | Ore sold or treated | Gold | | | Silver | | | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | Lode | Placer | Total | Lode | Placer | Total | | | | |
| | | | *Short tons* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| Adams County | ----- | 2 | ----- | ----- | 4.69 | 4.69 | ----- | ----- | ----- | ----- | ----- | ----- | $97 |
| Arapahoe County | ----- | 1 | ----- | ----- | 1.84 | 1.84 | ----- | ----- | ----- | ----- | ----- | ----- | 38 |
| Boulder County | 185 | 4 | 7,984 | 4,322.79 | 79.72 | 4,402.51 | 11,920 | 6 | 11,926 | 4,000 | 26,000 | ----- | 96,400 |
| Chaffee County: | | | | | | | | | | | | | |
| Arkansas River | ----- | 4 | ----- | ----- | 7.84 | 7.84 | ----- | ----- | ----- | ----- | ----- | ----- | 162 |
| Chalk Creek | 4 | ----- | 254 | 187.69 | ----- | 187.69 | 1,860 | ----- | 1,860 | 300 | 16,000 | ----- | 5,142 |
| Free Gold | 1 | ----- | 3 | .53 | ----- | .53 | ----- | ----- | ----- | ----- | ----- | ----- | 11 |
| Granite [1] | 1 | 10 | 51 | 93.58 | 67.48 | 161.06 | ----- | 12 | 12 | ----- | ----- | ----- | 3,334 |
| Riverside | 1 | ----- | 16 | 7.37 | ----- | 7.37 | ----- | ----- | ----- | ----- | ----- | ----- | 152 |
| Trout Creek | 2 | ----- | 39 | 4.61 | ----- | 4.61 | ----- | ----- | ----- | ----- | ----- | ----- | 95 |
| Clear Creek County: | | | | | | | | | | | | | |
| Alice | 4 | ----- | 134 | 53.48 | ----- | 53.48 | 13 | ----- | 13 | ----- | ----- | ----- | 1,111 |
| Argentine | 1 | ----- | 31 | 28.80 | ----- | 28.80 | 284 | ----- | 284 | 1,000 | 2,700 | ----- | 858 |
| Empire | 8 | ----- | 797 | 345.68 | ----- | 345.68 | 118 | ----- | 118 | ----- | ----- | ----- | 7,187 |
| Geneva Creek | 1 | ----- | 6 | 1.30 | ----- | 1.30 | 185 | ----- | 185 | 400 | 317 | ----- | 130 |
| Griffith | 8 | ----- | 1,231 | 492.55 | ----- | 492.55 | 3,035 | ----- | 3,035 | ----- | 21,767 | ----- | 12,049 |
| Idaho Springs | 42 | 8 | 12,138 | 4,432.24 | 49.78 | 4,482.02 | 23,823 | 6 | 23,829 | 9,550 | 103,632 | ----- | 105,437 |
| Montana | 3 | ----- | 19 | 3.60 | ----- | 3.60 | 400 | ----- | 400 | ----- | 3,584 | ----- | 347 |
| Trail Creek | 3 | ----- | 93 | 105.34 | ----- | 105.34 | 342 | ----- | 342 | 50 | 9,000 | ----- | 2,633 |
| Costilla County: Grayback | ----- | 2 | ----- | ----- | 16.45 | 16.45 | ----- | 2 | 2 | ----- | ----- | ----- | 341 |
| Custer County: Rosita Hills | 1 | ----- | 3 | 2.61 | ----- | 2.61 | ----- | ----- | ----- | ----- | ----- | ----- | 54 |
| Delta County | 1 | 1 | 1 | .19 | 4.16 | 4.35 | 100 | ----- | 100 | ----- | 400 | ----- | 140 |
| Denver County | ----- | 8 | ----- | ----- | 19.59 | 19.59 | ----- | 6 | 6 | ----- | ----- | ----- | 407 |
| Dolores County: Pioneer | 3 | ----- | 41 | 39.52 | ----- | 39.52 | 4,820 | ----- | 4,820 | 800 | 6,000 | ----- | 2,777 |
| Douglas County | ----- | 6 | ----- | ----- | 23.90 | 23.90 | ----- | ----- | ----- | ----- | ----- | ----- | 494 |
| Eagle County: | | | | | | | | | | | | | |
| Burns | ----- | 1 | ----- | ----- | 12.95 | 12.95 | ----- | 2 | 2 | ----- | ----- | ----- | 269 |
| Gypsum | ----- | 1 | ----- | ----- | 3.86 | 3.86 | ----- | 1 | 1 | ----- | ----- | ----- | 80 |
| Red Cliff | 9 | 1 | 91,258 | 4,308.23 | 1.72 | 4,309.95 | 1,484,140 | ----- | 1,484,140 | 8,163,000 | 15,000 | ----- | 1,131,530 |
| Elbert County | ----- | 1 | ----- | ----- | 10.79 | 10.79 | ----- | ----- | ----- | ----- | ----- | ----- | 223 |
| Fremont County: Arkansas River | ----- | 2 | ----- | ----- | 11.95 | 11.95 | ----- | 2 | 2 | ----- | ----- | ----- | 248 |
| Garfield County | ----- | 1 | ----- | ----- | 1.55 | 1.55 | ----- | ----- | ----- | ----- | ----- | ----- | 32 |

[1] The Granite district lies in both Chaffee and Lake Counties.

*Mine production of gold, silver, copper, lead, and zinc in Colorado in 1933, by counties and districts, in terms of recovered metals*—Continued

| County and district | Number of mines producing | | Ore sold or treated | Gold | | | Silver | | | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | Lode | Placer | Total | Lode | Placer | Total | | | | |
| | | | *Short tons* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| Gilpin County: | | | | | | | | | | | | | |
| Southern | 53 | 40 | 47,437 | 3,282.43 | 529.66 | 3,812.09 | 7,869 | 143 | 8,012 | 12,500 | 84,000 | | $85,515 |
| Northern | 16 | 10 | 1,034 | 284.65 | 55.53 | 340.18 | 351 | 3 | 354 | | | | 7,156 |
| Gunnison County: | | | | | | | | | | | | | |
| Cochetopa | 2 | | 58 | 25.35 | | 25.35 | 1 | | 1 | | | | 524 |
| Domingo | 3 | | 24 | 14.30 | | 14.30 | 171 | | 171 | | 100 | | 360 |
| Elk Mountain | 2 | 2 | 1 | .24 | 2.03 | 2.27 | 116 | 2 | 118 | | | | 89 |
| Gold Brick | 7 | | 328 | 203.02 | | 203.02 | 845 | | 845 | 460 | 6,600 | | 4,766 |
| Rock Creek | 2 | | 14 | 3.46 | | 3.46 | 1,078 | | 1,078 | | 300 | | 459 |
| Taylor Park | | 7 | | | 61.39 | 61.39 | | 13 | 13 | | | | 1,273 |
| Tin Cup | 3 | | 9 | 6.81 | | 6.81 | 332 | | 332 | | | | 257 |
| Tomichi | 2 | | 302 | 3.16 | | 3.16 | 4,577 | | 4,577 | 840 | 156,000 | 60,000 | 10,013 |
| Jackson County | | 2 | | | 4.84 | 4.84 | | | | | | | 100 |
| Jefferson County | | 6 | | | 353.67 | 353.67 | | 51 | 51 | | | | 7,329 |
| Lake County: | | | | | | | | | | | | | |
| California (Leadville) | 27 | 10 | 18,298 | 10,344.70 | 153.13 | 10,497.83 | 35,507 | 24 | 35,531 | 15,000 | 1,009,700 | 2,492,000 | 372,427 |
| Granite [1] | 2 | 3 | 47 | 61.99 | 11.94 | 73.93 | 66 | 2 | 68 | | | | 1,552 |
| St. Kevin | 1 | | 7 | 9.60 | | 9.60 | 336 | | 336 | | 300 | | 328 |
| Twin Lakes | 1 | 1 | 4 | 4.70 | 141.14 | 145.84 | 11 | 43 | 54 | | | | 3,034 |
| La Plata County: California | 12 | 1 | 7,801 | 1,951.45 | 3.19 | 1,954.64 | 14,760 | | 14,760 | 200 | 9,700 | | 45,944 |
| Moffat County: | | | | | | | | | | | | | |
| Douglas Mountain | 1 | | 2 | | | | 3 | | 3 | 400 | | | 27 |
| Fourmile (Timberlake) | | 7 | | | 18.98 | 18.98 | | | | | | | 393 |
| Lay | | 1 | | | 2.45 | 2.45 | | | | | | | 50 |
| Round Bottom | | 1 | | | 2.42 | 2.42 | | | | | | | 50 |
| Montezuma County | 1 | 1 | 21 | 169.65 | 2.18 | 171.83 | 129 | | 129 | | | | 3,597 |
| Montrose County: | | | | | | | | | | | | | |
| Naturita | | 34 | | | 197.08 | 197.08 | | 62 | 62 | | | | 4,096 |
| Uncompahgre River | | 2 | | | 2.27 | 2.27 | | 1 | 1 | | | | 47 |
| Ouray County: | | | | | | | | | | | | | |
| Sneffels | 5 | 2 | 15,135 | 8,044.94 | 4.64 | 8,049.58 | 46,035 | 2 | 46,037 | 160,100 | 265,100 | | 202,568 |
| Uncompahgre | 4 | 2 | 990 | 1,198.51 | 7.16 | 1,205.67 | 7,285 | 1 | 7,286 | 1,400 | 15,300 | | 28,129 |
| Park County: | | | | | | | | | | | | | |
| Alma Placers | | 4 | | | 83.71 | 83.71 | | 19 | 19 | | | | 1,738 |
| Beaver Creek | | 2 | | | 5.04 | 5.04 | | | | | | | 104 |
| Buckskin | 5 | | 116 | 78.77 | | 78.77 | 220 | | 220 | 1,000 | 1,800 | | 1,836 |
| Consolidated Montgomery | 5 | | 1,560 | 428.22 | | 428.22 | 1,551 | | 1,551 | 100 | 900 | | 9,434 |
| Fairplay | | 7 | | | 118.91 | 118.91 | | 21 | 21 | | | | 2,465 |
| Hall Valley | 1 | | 129 | 17.85 | | 17.85 | 3,580 | | 3,580 | 11,500 | 2,600 | | 2,454 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Horseshoe | 1 | -------- | 1 | -------- | -------- | -------- | 9 | -------- | 9 | -------- | 1,000 | -------- | 40 |
| Mosquito | 19 | -------- | 60,837 | 59,374.97 | -------- | 59,374.97 | 35,120 | -------- | 35,120 | 69,400 | 1,313,000 | -------- | 1,292,705 |
| Tarryall | -------- | 6 | -------- | -------- | 38.86 | 38.86 | -------- | 6 | 6 | -------- | -------- | -------- | 805 |
| Pitkin County: Roaring Fork | 2 | 1 | 3,677 | .97 | 6.87 | 7.84 | 68,860 | -------- | 68,860 | -------- | 178,000 | -------- | 30,849 |
| Rio Grande County: Summitville | 2 | 1 | 27 | 186.39 | 2.42 | 188.81 | 28 | -------- | 28 | -------- | 200 | -------- | 3,920 |
| Routt County: Hahns Peak | -------- | 2 | -------- | -------- | 8.37 | 8.37 | -------- | 3 | 3 | -------- | -------- | -------- | 174 |
| Saguache County: | | | | | | | | | | | | | |
| Kerber Creek | 4 | -------- | 105 | 3.09 | -------- | 3.09 | 1,490 | -------- | 1,490 | 3,000 | 68,000 | -------- | 3,293 |
| Vulcan | 1 | -------- | 26 | 25.06 | -------- | 25.06 | 10 | -------- | 10 | -------- | -------- | -------- | 522 |
| San Juan County: | | | | | | | | | | | | | |
| Animas | 10 | 5 | 199,611 | 23,442.70 | 11.51 | 23,454.21 | 389,630 | 2 | 389,632 | 1,184,000 | 1,198,400 | -------- | 741,331 |
| Eureka | 2 | -------- | 1 | 19.66 | -------- | 19.66 | 10 | -------- | 10 | -------- | -------- | -------- | 409 |
| San Miguel County: | | | | | | | | | | | | | |
| Iron Springs | 8 | -------- | 400 | 218.57 | -------- | 218.57 | 548 | -------- | 548 | 300 | 4,300 | 1,000 | 4,930 |
| Lower San Miguel | -------- | 8 | -------- | -------- | 60.69 | 60.69 | -------- | 18 | 18 | -------- | -------- | -------- | 1,261 |
| Mount Wilson | 1 | -------- | 5 | 16.80 | -------- | 16.80 | 3 | -------- | 3 | -------- | -------- | -------- | 348 |
| Upper San Miguel | 13 | 3 | 23,208 | 3,361.07 | 28.56 | 3,389.63 | 22,969 | 22 | 22,991 | 27,700 | 244,000 | 16,000 | 89,590 |
| Summit County: | | | | | | | | | | | | | |
| Breckenridge | 7 | 54 | 540 | 382.05 | 3,033.86 | 3,415.91 | 1,395 | 780 | 2,175 | -------- | 26,300 | -------- | 72,347 |
| Montezuma | 2 | -------- | 12 | 1.70 | -------- | 1.70 | 938 | -------- | 938 | -------- | 5,000 | -------- | 548 |
| Ten Mile | 5 | 1 | 159 | 89.89 | 1.72 | 91.61 | 307 | -------- | 307 | -------- | 8,000 | -------- | 2,298 |
| Teller County: Cripple Creek | 104 | 7 | 349,470 | 109,815.36 | 53.02 | 109,868.38 | 7,700 | 5 | 7,705 | -------- | -------- | -------- | 2,273,878 |
| Total Colorado | 614 | 286 | 845,495 | 237,502.19 | 5,325.51 | 242,827.70 | 2,184,880 | 1,260 | 2,186,140 | 9,667,000 | 4,803,000 | 2,569,000 | 6,689,140 |

[1] The Granite district lies in both Chaffee and Lake Counties.

## ADAMS COUNTY

No gold was recovered in 1933 by the Brannan, Carlson, and Gordon gravel plants on Clear Creek, which from 1922 to 1932, inclusive, recovered 1,116.54 fine ounces of gold and 165 ounces of silver from sluice boxes placed below waste flumes; but two small lots of placer gold reported to have been recovered on the Pompino and Russell ranches in Adams County were sold to the Denver Mint.

## ARAPAHOE COUNTY

A small placer on the Old Curtis ranch in Arapahoe County in 1933 yielded 2 crude ounces of bullion, 0.945 fine in gold and 0.019 fine in silver.

## BOULDER COUNTY

In 1933 Boulder County had more mines listed as producers than any other county in the State, but the majority produced only small lots of ore, ranging from less than ½ ton to 25 tons, which were shipped direct to the Golden Cycle mill at Colorado Springs or to the Boulder Ore Sampling Works, the latter idle until June 1 when operation by the St. Joe Mining & Milling Co. began. During the last 4 months of the year the St. Joe Mining & Milling Co. also operated the St. Joe flotation mill on Left Hand Creek near Gold Hill on ores purchased and ores from company mines, including the Cold Spring group. The mill was reconditioned in 1933, and complete sampling equipment was installed. It has a rated capacity of 60 tons per 24 hours. Gold concentrates from the mill, containing some copper and lead, were shipped to the Leadville smelter, and other shipments of gold concentrates were made to the Golden Cycle mill at Colorado Springs. The company also shipped crude ore and concentrates purchased at the sampler at Boulder to the Golden Cycle mill.

The Black Swan flotation mill between Salina and Crisman was operated part of the year on ores from the Tambourine mine. At the Slide mines the Slide Mines, Inc., constructed a new mill building in 1933 and early in 1934 completed the installation of both gravity- and flotation-concentration equipment, including a Hadsel Mill. Remodeling of several old mills, including the Black Cloud at Salina, was begun late in 1933, but none of these operated during the year. Mines producing 1 car or more of ore included the Big Horn, Boulder County Tunnel, Dime, Fairfax, Fortune, Grand Republic group, Gray Eagle, Herold group, Hereafter, Horsfal, Ingram, John Jay, KeKeOnga, Keystone, Klondyke, Larson, Logan-Croesus group, Mack, Milan, Mogul, Monitor, Myrtle (dump), Poorman, Potosi-Caribou (mill), Richmond, St. Joe Mining & Milling Co. property, Silver Harp, Slide, Sunshine, Sure Shot, Tambourine, Wano, White Raven, and Wood Mountain group.

Placer gold was recovered by sluicing at the Beaver Creek, Crews, and one other placer and by a special machine consisting of a steam shovel, bucket elevator, portable screen with tailings stacker, and sluice boxes at the Colby placer.

## CHAFFEE COUNTY

*Arkansas River district* (*Nathrop, Buena Vista*).—Four lots of placer gold recovered by small-scale operations on the Arkansas River were sold to the Denver Mint in 1933.

*Chalk Creek district* (*Romley, St. Elmo*).—A lessee operating small sections of the Mary Murphy mine above the fourth level extracted lead-silver-gold ore which was shipped to the Leadville smelter and gold-silver ore which was sold to the Golden Cycle mill. Experimental work was done in the 100-ton concentrating mill on the property of the Philip Carey Mining & Milling Co., and clean-up operations resulted in shipment of gold ore to the Leadville smelter and of a small lot of gold concentrates to the Golden Cycle mill. Small shipments of smelting ore were made to the Leadville smelter from two other mines in the district in 1933.

*Free Gold district* (*1 mile north of Buena Vista*).—The Connie L mine was the only producer of ore in the Free Gold district in 1933; the ore was sold to the Golden Cycle mill at Colorado Springs.

*Granite district.*—In 1933 shipments of gold ore were made from one lode mine in the Granite district to the Golden Cycle mill. Placer gold was recovered by sluicing at the Cache Creek, Davis-Rooney, Franklin, Lost Canon, Old Channel, Pay Day, and three other placers and by drift mining at the Mariposa placer.

*Riverside district.*—Gold ore was shipped from the Big Chief mine in the Riverside district to the Golden Cycle mill in 1933.

*Trout Creek district.*—At the Forgotten mine 35 tons of dump ore ground in a Huntington mill and amalgamated yielded amalgamation bullion, and a small lot of gold ore was shipped to the Leadville smelter from the Eastman group.

## CLEAR CREEK COUNTY

*Alice district* (*Yankee, Lincoln*).—In 1933 the Reynolds stamp mill was used to treat small tonnages of ore from the Lalla, Ottawa, and Reynolds mines; the amalgamation bullion produced was shipped to the Denver Mint. Three tons of concentrates made from the Ottawa ore were shipped to the Leadville smelter. The output from the San Juan mine was 85 tons of gold ore, which was treated at the mine in a 5-ton stamp mill equipped with amalgamation plates and concentration tables; the concentrates were shipped to the Golden Cycle mill at Colorado Springs.

*Argentine district.*—The only production from mines in the Argentine district in 1933 was 31 tons of gold-silver ore shipped to the Leadville smelter by the Santiago Mines Co.

*Empire district.*—At the Golden Eagle mine 500 tons of gold ore were treated in a small stamp mill and yielded amalgamation bullion. Ore from this mine was also shipped to the Golden Cycle mill at Colorado Springs. Shipments of gold ore were made from the Conqueror mine to the Leadville smelter and to the Golden Cycle mill. Other producing mines in the district were the Badger, Forgotten, Gold Dirt-Empress Tunnel-Sprankel group, Mint, Pittsburg, and Twin Lode.

*Geneva Creek* (*Collier Mountain*) *district.*—Six tons of copper-silver-gold ore were shipped from the Silver Queen mine in the Geneva Creek district to the Leadville smelter in 1933.

*Griffith district* (*Georgetown-Silver Plume*).—The principal producer of metals in the Griffith district in 1933 was the Pulaski mine, from which ore was trucked 1½ miles to the Watrous concentration-flotation mill for treatment. The mill was operated at a daily average of 30 tons for approximately 100 days during the year. The lead-gold-silver concentrates produced were shipped to the Leadville smelter. In addition, a small output was made from the Big Chief, Centennial, Commonwealth Tunnel, Eva D, Phoenix, Verdun, and one other mine in the district in 1933.

*Idaho Springs district.*—In 1933 the output of metals from the Idaho Springs district came chiefly from operations of the Lincoln, Mattie, and North American group of mines. During the year the mill at the Lincoln mine was remodeled by the Alma-Lincoln Mining Co., and milling of ores from the lower level of the Lincoln mine was begun on October 18 at full capacity of 50 tons per 24 hours and continued throughout the year, making gold-silver-lead-copper-[zinc] concentrates which were sold to the Leadville smelter.

Gold bullion and lead-gold-silver-[zinc] concentrates were produced at the Mattie amalgamation-concentration mill; also some crude ore was shipped direct from the mine to the Leadville smelter. At the North American group of mines the Engineers Mining Co., lessee on the properties connected with the Central (Big Five) adit, reopened the Belman, Edgar, and Fulton mines. Ores from the Belman and Fulton were treated in the washing plant built during the year near the entrance of the Central adit, and the pulp from the washer was sent to the Argo mill (leased and operated by the Galli Milling Co.). The products—amalgamation bullion and gold-silver-lead-copper concentrates—were shipped to the Denver Mint and the Leadville smelter, respectively. Other producers of 1 car or more of ore were the Barber-Elliot, Bismark, Shafter, Summit, West Gold, and Wheatland. Some placer gold was recovered from the bars of Clear Creek by small-scale methods.

*Montana district* (*Lawson, Dumont*).—Producing properties in the Montana district in 1933 were the Hiawatha, Jo Reynolds, and Princess of India group.

*Trail Creek district.*—One car of ore was shipped from the Freeland dump in 1933, and a small output was made from the New Era and Poorman mines.

## COSTILLA COUNTY

*Grayback district.*—Hydraulic operations at the Trinchera ranch and sluicing at the Midnight claim in the Grayback district yielded the output of gold from Costilla County in 1933.

## CUSTER COUNTY

*Rosita Hills district.*—The only production of metals in Custer County in 1933 came from a sample lot of gold ore shipped from the Hector mine in the Rosita Hills district to the Golden Cycle mill.

## DELTA COUNTY

One ton of lead-silver ore was shipped from Hotchkiss to the Leadville smelter in 1933. Placer gold was recovered at the Ruby Wear claim on the Gunnison River.

## DENVER COUNTY

Only a few people were engaged in panning and rocking within the bounds of the city and county of Denver in 1933. Some were thus engaged during the year on the Platte River and some of its tributaries, between its junction with Cherry Creek (in the heart of the city of Denver) and Englewood, Arapahoe County, and east and south on Cherry Creek in Denver, Arapahoe, Douglas, and Elbert Counties. Those who recovered any gold in these counties naturally gravitated to Denver to sell it to assayers, jewelers, dental-supply concerns, and the Denver Mint. The aggregate of the production of placer gold in Arapahoe, Denver, Douglas, and Elbert Counties is correct, but the separation as to counties naturally is partly estimated. The estimate for Denver County in 1933 is 19.59 fine ounces of gold and 6 ounces of silver.

## DOLORES COUNTY

*Pioneer district (Rico).*—The only shipments of ore from Rico in 1933 were 41 tons of lead-silver-gold-copper-zinc ore by the Rico Enterprise Mining Co. to the International Smelting Co., Tooele, Utah, and a lot of less than one-half ton of gold ore from one other property to the Golden Cycle mill at Colorado Springs. One lot of amalgamation bullion reported to have come from the Covina mine was sold to the Denver Mint.

## DOUGLAS COUNTY

Douglas County is credited with the production of 23.90 fine ounces of placer gold in 1933, principally from placers on Little Dry Creek.

## EAGLE COUNTY

*Burns district.*—The Clipper placer, on the Colorado River about 1 mile above Burns, was worked by a hydraulic pump and sluices in 1933 and yielded placer bullion which, when melted at the Denver Mint, weighed 15.52 ounces and averaged 0.834 fine in gold and 0.155 fine in silver.

*Gypsum district.*—An operator in the Gypsum district made a shipment of placer bullion to the Denver Mint in 1933.

*Red Cliff (Battle Mountain) district.*—The 600-ton flotation mill of the Empire Zinc Co. (New Jersey Zinc Co.) at Gilman was not operated in 1933. Crude iron-silver-copper ore from the Eagle mine was shipped to the Leadville (Colo.) smelter and to the Garfield (Utah) smelter. Among other producing lode mines were the Alligator, Champion, Groundhog, Poorman, Potvin group (Copper King and Pine Martin), Star of the West, and Tiptop. A small lot of placer gold was recovered at the Jack Flats placer.

## ELBERT COUNTY

The gold produced in Elbert County in 1933 came from a placer operation on the Crail ranch.

## EL PASO COUNTY

The Golden Cycle mill [1] at Colorado Springs, El Paso County, has treated for many years all the ores from the Cripple Creek district, Teller County. These ores are gold-[silver]-sulphotelluride ores—pyrite and tellurides, mainly calaverite, with siliceous gangue. In recent years much of the material has been dump ores containing as low as 0.1125 ounce gold (occasionally even lower) per ton. When built in 1907 the mill was a 1,200-ton roast-amalgamation-cyanidation mill. In 1927 a supplementary mill, comprising crushers, a ball mill, and a Dorr classifier, was installed to treat in an all-sliming cyanidation circuit, without preliminary roasting, gold pyrite ores and concentrates, siliceous silver ores, and miscellaneous ores from other parts of Colorado and from New Mexico. In 1929 crushers, ball mills, and Fahrenwald flotation machines were installed to treat any ores offered, including zincky ores. This addition to the plant began operating in November 1929, and zincky ores were purchased until November 1930. Very little straight silver ore has been treated since the Creede district closed in 1930. In 1933 the flotation plant was operated chiefly in treating low-grade sulphotelluride ores from Cripple Creek, but it also floated out graphitic or carbonaceous gangue material with the lead and copper from ore from the American and London mines of the Mosquito district, Park County, thus making high-grade gold-[silver-lead-copper] concentrates and eliminating carbon and copper—both cyanicides; the other product was iron concentrates, which were roasted and cyanided. The lead-copper concentrates receive preliminary cyanide treatment prior to shipment to the smelter. Crude ore and concentrates from other counties were also treated by flotation. The bulk of the ore received was from the Cripple Creek district and, with all the concentrates produced from the Cripple Creek ores, went through the regular process of roasting, amalgamation, and cyanidation. The tailings from all operations were cyanided.

## FREMONT COUNTY

*Arkansas River district.*—At the Jay Hill placer group near Howard on the Arkansas River equipment consisting of a drag line, pumps, gasoline engines, hopper, and shaking riffle pans was used to recover placer gold in 1933. An operator using a cradle and sluice boxes on the Florence dump and in the Arkansas River one-half mile east of Florence produced the remainder of the gold sold from Fremont County during the year.

## GARFIELD COUNTY

One lot of placer bullion shipped from Newcastle, Garfield County, to the Denver Mint in 1933 weighed 1.98 crude ounces and was 0.795¼ fine in gold and 0.199 fine in silver.

## GILPIN COUNTY

*Southern districts (Black Hawk, Central City, Nevadaville, Russell Gulch).*—The largest production of metals in Gilpin County in 1933 came from the area known as "The Patch" at Nevadaville, mined

[1] Harner, L. S., Milling Methods and Costs at the Golden Cycle Mill, Colorado Springs, Colo.: Inf. Circ. 6739, Bureau of Mines, 1933, 18 pp.

by shrinkage stoping and glory holing. The ore is transported by aerial tram and trucks to the mill within the limits of Central City. The mine and amalgamation-gravity concentration-selective flotation mill were operated 69 days at a daily rate of 407 tons by the Chain O'Mines, Inc., from January to October, when all properties were leased to the Chain Syndicate which operated the property for 60 days at a daily rate of approximately 290 tons during the remainder of the year. The products of the mill were amalgamation bullion, shipped direct to the Denver Mint, and copper-[zinc]-lead-silver-gold concentrates, shipped to the Leadville smelter. Other mines producing 1 carload or more of ore were the Delmonico, Gettysburg, Homestake, Independence, Morning Star, Pay Me, Perrin, Pittsburg, Russell, Saratoga, and West Notaway.

The Eugene Mines, Inc., which was sluicing and drift mining on North Clear Creek at Black Hawk, was the principal producer of placer gold in the southern districts.

Individuals by panning and sluicing old tailings and stream gravel recovered small amounts of gold bullion which were sold chiefly to merchants at Central City.

*Northern districts.*—The Perigo 30-ton amalgamation-concentration mill in Gamble Gulch was operated only a few days in 1933. A lessee on the Baker lode of the Perigo group mined ore which yielded 20.82 fine ounces of gold, and a clean-up of the mill netted 29.84 fine ounces. Some production was made from the Lone Star, Mackey, Newport, Providence, We Got 'Em, and other lode mines.

Special placer equipment consisting of a drag-line power shovel, hopper, revolving screen, sluice boxes, and stacker belt, with gasoline engines as power, was installed at the Pactolus placer along South Boulder Creek by the Prommel Mining Co., and testing and sampling operations of the gravel yielded bullion which, after being melted at the Denver Mint, weighed 6.78 ounces and had a fineness of 0.883 in gold and 0.098 in silver. Other placers in the district were worked by sluicing and included the Bergstrom, Fontleroy, Fuller, Harvey, Perigo, and Security.

## GUNNISON COUNTY

*Cochetopa (Parlin) district.*—Producing mines in the Cochetopa district in 1933 were the Lucky Strike and Maple Leaf. Gold ore from the Lucky Strike was shipped to the Midvale (Utah) smelter and to the Golden Cycle mill at Colorado Springs. The output from the Maple Leaf was in the form of amalgamation bullion resulting from 3 months' operation of the 25-ton mill (ball mill and plates) on the property.

*Domingo (Goose Creek, White Earth) district (Madera, Powderhorn, Spencer, Vulcan).*—Small lots of dry gold ore from the Dollar and Old Lott mines were shipped to the Leadville smelter in 1933, and 1 ton of lead ore from another property was shipped to the Midvale (Utah) smelter.

*Elk Mountain district.*—In 1933 a test shipment of silver ore from the Maxine lode was made to the Leadville smelter, and a lot of less than one-half ton (also silver ore) was shipped from the Silver Spruce mine to the Golden Cycle mill. A small production of placer gold was made from the Hayden-McCleod placer.

*Gold Brick district (Ohio).*—Producing mines in the Gold Brick district in 1933 were the Carter, Dodson, King Solomon, Lulu, Raymond group, Sunset, and Victory. The Carter mine and mill were operated during the last 11 days of December only; the mill is equipped for amalgamation and concentration, but 5 tons of concentrates produced were not shipped during the year. Lessees on the Raymond group shipped gold-silver-lead ore to the Midvale (Utah) smelter and to the Golden Cycle mill at Colorado Springs.

*Rock Creek district.*—Silver ore was shipped from the Black Queen mine to the Leadville smelter, and 1 ton of gold ore from another property in the district was shipped to the Midvale (Utah) smelter in 1933.

*Taylor Park district.*—Hydraulicking at one property and sluicing at miscellaneous small placers yielded the output of gold and silver from the Taylor Park district in 1933.

*Tin Cup district.*—The output of metals from the Tin Cup district in 1933 came from the Enterprise, Sevicy, and Wahl mines, each of which shipped small lots of gold or gold-silver ore to the Golden Cycle mill.

*Tomichi district.*—Lead-zinc ore from the Morning Star mine and lead ore from the Eureka were shipped to the Midvale (Utah) smelter from the Tomichi district in 1933.

## JACKSON COUNTY

Two small lots of placer gold, reported to have been mined in Jackson County, were sold to the Denver Mint in 1933.

## JEFFERSON COUNTY

In 1933 the Humphreys Gold Corporation installed special placer equipment, consisting of two drag-line excavators, a trommel screening and sluicing plant, mill jig, Wilfley table, and arrastre, using gasoline engines for power, on Clear Creek 10 miles above Golden and operated about 100 days during the summer. Small sluicing and panning operations on Clear Creek 2 miles west of Arvada and near Golden also yielded placer bullion.

## LAKE COUNTY

### LEADVILLE DISTRICT

The Leadville district in 1933 produced 18,298 tons of ore yielding' in terms of recovered metals, 10,344.70 fine ounces of gold, 35,507 fine ounces of silver, 15,000 pounds of copper, 1,009,700 pounds of lead, and 2,492,000 pounds of zinc compared with 4,339 tons of ore yielding 6,181.55 ounces of gold, 16,738 ounces of silver, 6,000 pounds of copper, 152,000 pounds of lead, and 126,000 pounds of zinc in 1932.

The A.V. lead bullion-leady copper matte smelter of the American Smelting & Refining Co. operated as a lead-bullion plant with subsidiary leady-copper matte during January, February, and one third of March; it was idle during April but ran one third of May, the whole of June and July, a few days in August, all of September and October, 12 days in November, and from December 11 to the end of the year. The copper furnace installed in 1932 was not operated in 1933.

The Ibex Mining Co. was the largest producer of gold, silver, and copper in the district in 1933. The bulk of the lead and all of the zinc output came from shipments of lead-zinc ore to the pigment plant at Coffeyville, Kans., by the Rock Hill Mines Co., and from shipments by the Colorado Zinc-Lead Co. of middlings collected in mill ponds from former operation of the Colorado Zinc-Lead Co. mill. Other properties producing more than 1 carload each included the Adelaide, American smelter dump, Elva Elma, Lilian, Valley, New Monarch, New Vinnie, President, Tribune, and Venir. Active placers included the Arnold, Hector, Ideal, Jenny June, Robinson, Thomas Starr, and Wells & Moyer.

### OTHER DISTRICTS

*Granite district.*—The Belle of Granite and Hattie Jane were the only producing lode mines in the Granite district in 1933. A small quantity of gold was produced by individual placers on the Arkansas River north of Granite.

*St. Kevin district.*—One lot of gold-silver ore was shipped from the St. Kevin district to the Leadville smelter in 1933.

*Tenmile (Climax, Fremont Pass) district.*—In 1933 the Climax Molybdenum Co. mill at Climax on Fremont Pass, which started the year at 15,000 tons a month and continued at an increasing rate, reaching 100,000 tons a month in December, treated 692,985 tons of molybdenum ore yielding molybdenum sulphide concentrates containing 5,028,695 pounds of elemental molybdenum.

*Molybdenum production at the Climax mill in Colorado, 1924–33*

| | Elemental molybdenum (pounds) | | Elemental molybdenum (pounds) |
|---|---|---|---|
| 1924 (idle first 7 months; operated last 5 months) [2] | 156, 935 | 1929 | 3, 529, 295 |
| 1925 | 821, 757 | 1930 | 3, 083, 000 |
| 1926 | 1, 057, 367 | 1931 | 2, 644, 399 |
| 1927 | 1, 858, 228 | 1932 | 1, 913, 395 |
| 1928 | 2, 957, 845 | 1933 | 5, 028, 695 |

*Twin Lakes district.*—Four tons of gold ore were shipped from a mine in the Twin Lakes district to the Leadville smelter in 1933. At the Derry Ranch placers the Mount Elbert Gold Dredging Co. recovered placer gold by power shovel, washing screen, and sluices.

## LA PLATA COUNTY

The American Smelting & Refining Co. lead bullion-leady copper matte smelter at Durango, which was closed November 30, 1930, remained idle in 1933.

*California (or La Plata) district (Hesperus, La Plata).*—The May Day Milling Co. operated its 50-ton flotation mill, built at the May Day mine in 1932, at an average daily rate of 35 tons for 200 days during 1933. Gold-silver concentrates from the mill and crude ore from the mine were sold to the Leadville smelter. The La Plata

[1] Idle from April 1919 to Aug. 1, 1924.

200-ton flotation mill was operated very intermittently and at limited capacity on ore from the Gold King group. Other producing mines in the district in 1933 were the Bessie G, Last Chance, Little Animas, Lost Lode, May Rose, Monarch, Mountain Lily, Oro Fino, Tip Top, and Valley View Consolidated Mining Co. property.

### MOFFAT COUNTY

*Douglas Mountain district.*—Two tons of copper ore were shipped from the Garfield-Bromide group in secs. 9 and 16, T. 7 N., R. 101 W. of the sixth principal meridian, to the Garfield (Utah) copper plant in 1933.

*Fourmile (or Timberlake) district.*—Six placer mines on Timberlake Gulch and Fourmile Creek several miles south of Baggs, Wyo., and one placer near Great Divide (presumably on the Timberlake watershed) were worked by sluices and yielded placer gold in 1933.

*Lay district.*—The Grant placer, 2 miles north of Jackrabbit Springs, was the only producer in the Lay district in 1933.

*Round Bottom district.*—A small amount of gold was recovered by sluicing at the Hoover placer, 12 miles southwest of Craig, in 1933.

### MONTEZUMA COUNTY

The Red Arrow was the only producing lode mine in Montezuma County in 1933. The mine was discovered on June 3, 1933, on the west side of Gold Run Draw about 500 feet northwest of the junction with the East Mancos River, in sec. 11, T. 36 N., R. 12 W. When the discovery became generally known later in the year it attracted much attention because of the large number of gold nuggets found near the surface. Shipments of high-grade gold ore were made to the Golden Cycle mill and the Midvale (Utah) smelter in 1933. For a general description of the mine and local geology the reader is referred to a press notice, "The Red Arrow Gold Discovery in the La Plata Mountains, Colorado", released by the United States Geological Survey, February 28, 1934. A small lot of placer bullion mined in the county weighed 2.44 ounces after being melted at the Denver Mint and had a fineness of 0.904½ in gold and 0.086½ in silver.

### MONTROSE COUNTY

*Naturita district.*—Many small placers, worked mostly by sluices on stream and bench gravel on the San Miguel River below Naturita, yielded all the gold and silver produced in the Naturita district in 1933.

*Uncompahgre River district.*—Operation of two small placers on the Uncompahgre River resulted in the recovery of a little gold in 1933.

### OURAY COUNTY

*Sneffels district.*—The King Lease continued operation on the upper workings of the Camp Bird mine in 1933 and operated both the mine and the 75-ton amalgamation and flotation mill 365 days. The products consisted of amalgamation bullion and of concentrates which were classed as lead-copper with the principal value in gold but which also carried nearly 20 times as much silver as gold and a considerable quantity of zinc; the zinc naturally was not saved at the

Leadville smelter. Other producing lode mines in the district were the Atlas (mill clean-up), Governor, Revenue Tunnel, and Trust Ruby.

*Uncompahgre district* (*Ouray*).—Shipments of gold ore were made from the Schofield and Wanakah mines in the Uncompahgre district to the Leadville smelter in 1933, and a small production was made from other mines in the district.

## PARK COUNTY

*Alma Placers district.*—Sluicing operations on the Platte River east of Alma yielded small lots of placer gold in 1933.

*Beaver Creek district.*—A small production of placer gold was made in 1933 from two placers on Beaver Creek.

*Buckskin district* (*Alma*).—Small lots of smelting ore were shipped to the Leadville smelter from the Loveland Mountain group, Summit Mining Co. property, and Wyandotte mine in 1933. Gold ore from the Excelsior, Loveland Mountain group, and Wyandotte was shipped to the Golden Cycle mill at Colorado Springs. Three lots of amalgamation bullion from the Alma Gold Corporation property were sold to the Denver Mint.

*Consolidated Montgomery district* (*Alma.*)—The Magnolia 30-ton gravity- and flotation-concentration mill was operated about half the month of June, all of September, and the first 10 days of October, treating 1,500 tons of ore from the Magnolia mine; the resulting gold-silver concentrates were sold to the Golden Cycle mill. Other producing properties in the Magnolia district, all of which shipped small lots of smelting ore to the Leadville smelter, were the Chicago lode, Kansas, North Star Mining Co., and Pacific mine. Toward the end of the year the Alma Syndicate remodeled the mill at its Weber group, built a tramway from its Morning Star group, and milled several hundred tons of gold ore; the concentrates were not shipped until 1934.

*Fairplay district.*—Small panning and sluicing operations by individuals, principally on the Beaver Creek, Fairplay, and Snowstorm placers, yielded the gold and silver produced in the Fairplay district in 1933.

*Hall Valley district* (*Webster*).—Gold-silver ore was shipped to the Golden Cycle mill and copper-gold-silver-lead ore to the Garfield (Utah) smelter from the Missouri mine in 1933.

*Horseshoe district.*—One ton of lead ore from the Happy Boy mine was sold to the Leadville smelter in 1933.

*Mosquito district* (*Alma*).—The Mosquito district ranked second in the State in output of gold in 1933, after holding first place in 1932. The decrease in 1933 was due almost entirely to the decreased output of the American mine, which had yielded an extraordinary production of gold the preceding year. Shipments of crude ore from this mine to the Golden Cycle mill were discontinued July 1, and a new 100-ton flotation mill for the treatment of low-grade crude ore and dump material was built. Production from the mill was begun in September and continued for the remainder of the year, producing gold-silver-lead-copper concentrates which were sold to the Leadville smelter. The London Gold Mines Co., operating the London and London Extension mines, was the largest producer of gold, silver, copper, and lead in Park County in 1933. The company shipped high-grade gold ore containing silver, copper, and lead to the Golden Cycle mill and lead concentrates with the principal value in gold to the Leadville smelter. The concentrates were made at the 125-ton flotation mill on the property. The "North London" mine, operated by the Fairplay Gold Mines, Inc., was an important producer of gold in 1933. The ore is transported about three-fourths mile by aerial tram from the mine to the "North London" 80-ton flotation mill for treatment, and concentrates made are shipped to the Leadville smelter. Other producers of more than 1 car of ore each were the London-Butte, Orphan Boy, and West London.

*Tarryall district.*—Hydraulicking at the Fortune placer and sluicing operations at the Park Gulch, Illinois, and three other placers yielded the gold and silver sold from the Tarryall district in 1933.

## PITKIN COUNTY

*Roaring Fork district (Aspen).*—Except for 6 tons of lead ore mined at the Carrie lease the lode-mine output of the Roaring Fork district in 1933 consisted of silver-lead ore from the Midnight mine, mostly milled at the Midnight 50-ton flotation mill which was operated continuously throughout the year. The resulting lead-silver concentrates and also crude smelting ore were shipped to the Leadville smelter. A zinc unit was added to the equipment of the mill during the year, and 30 tons of concentrates assaying 40 percent zinc were produced but not sold in 1933. A small quantity of gold, 0.952 fine, presumably placer and perhaps from the Independence district near Aspen, was deposited at the Denver Mint by a miner from Aspen.

## RIO GRANDE COUNTY

*Summitville district.*—In 1933 the production from Rio Grande County came chiefly from shipments of gold ore from the Little Annie mine by the Summitville Mines Corporation to the Golden Cycle mill at Colorado Springs. The only other lode producer was the Marian Mining Co., which shipped 1 ton of lead-gold-silver ore to the Leadville smelter. One small lot of placer gold was shipped from Del Norte to the Denver Mint.

## ROUTT COUNTY

*Hahns Peak district.*—No production was made from lode mines in Routt County in 1933. Small placer operations in the Hahns Peak district yielded a little gold, most of which was sold at a drug store in Steamboat Springs.

## SAGUACHE COUNTY

*Kerber Creek district (Bonanza).*—Two shipments of lead ore were made in October 1933 from the Columbine mine to the Leadville smelter. Lead-copper-silver ore was shipped from the Rawley mines to the smelter, and a small production was made from two other properties.

*Vulcan district.*—Twenty-six tons of gold ore were shipped from the Continental mine in the Vulcan district to the Midvale (Utah) smelter in 1933.

### SAN JUAN COUNTY

*Animas district.*—The Shenandoah-Dives mine continued as the chief producer of metals in San Juan County in 1933. Its output was 198,549 tons of gold-silver ore yielding 9,020 tons of gold-silver-copper-lead-[zinc] concentrates, sold to the Leadville smelter; the ore was milled at the company 550-ton combined flotation- and gravity-concentration mill. The zinc in the concentrates seldom reached the penalty point. Among other producers from lode mines in the Animas district were the Delano Extension, El Banco Mines Co., Iowa Tiger, Royal Charter, San Juan Queen, and White Quail mines. Panning and sluicing operations in the district yielded a small output of placer gold.

*Eureka district (Eureka, Silverton).*—The only production from the Eureka district in 1933 came from two small lots of gold ore shipped to the Golden Cycle mill at Colorado Springs.

### SAN MIGUEL COUNTY

*Iron Springs district (Ophir).*—The Boot Jack mine was the principal producer of metals in the Iron Springs district in 1933. The ore was milled at a 6-stamp mill equipped with two amalgamating plates and a concentrating table. The amalgamation bullion was shipped to the Denver Mint, and the concentrates were sent to the Leadville smelter. Other producers in the district (all small) included the Carribeau, Crown Point, Hattie, Silver Tip, and Wealth of Ophir.

*Lower San Miguel district (Sawpit, Vanadium).*—The output from the Lower San Miguel district in 1933 all came from small placer mines along the San Miguel River and its tributaries.

*Mount Wilson district.*—Amalgamation bullion was recovered from ore in the Silver Pick mine and shipped to the Denver Mint in 1933.

*Upper San Miguel district.*—The Smuggler-Union mine was the principal producer of metals in the Upper San Miguel district in 1933. The 250-ton flotation mill, which had been under construction before September 15 by the Telluride Holding Corporation in the concrete mill building at Pandora built in 1920 by the now defunct Smuggler-Union Mining Co., was operated during the remainder of the year. The Gold Run Mining & Milling Co., operating its 500-ton mill built in 1933 for the treatment of an accumulation of tailings from old mills in the Upper San Miguel Basin, was the next largest producer in the district. Among the other producing lode mines were the Alta, Black Bear, Golden Eagle, La Junta, Laura, Liberty Bell, Lucky Strike, and Nellie. A small quantity of placer gold was recovered by individuals sluicing stream gravel and tailings below Telluride.

### SUMMIT COUNTY

*Breckenridge district.*—The output of gold in Summit County in 1933 came principally from the operation of two dredges—one by the Continental Dredging Co. about 1½ miles north of Breckenridge in Blue River Valley and the other by the Tiger Placers Co., operating through the town of Breckenridge. The dredge of the Continental Dredging Co. is electrically driven and is equipped with 96 buckets, each with a capacity of 8½ cubic feet. It was operated from June 1 to August 1 and from September 4 to December 31. The Tiger

Placers Co. dredge is reported to have a capacity of 5,000 cubic yards a day and to be equipped with 85 buckets, each with a capacity of 9½ cubic feet. It was remodeled during the year and placed in operation on September 1. Placers worked by other methods, mostly sluicing, included the Beaver Head, Bemrose-Bostwick, Denver, Gold Run, Jerusalem, Louis D. Emile, Nigger, and Old Solid. Miscellaneous small lots of smelting ore were shipped from lode mines in the district to the Leadville smelter.

*Montezuma district.*—Production from the Montezuma district in 1933 was limited to a small lot of lead-silver ore from the Silver King mine and 8 tons of lead-gold-silver ore from another property to the Leadville smelter.

*Ten Mile district (Frisco, Kokomo, Robinson).*—Small shipments of smelting ore were made from the Boston, Excelsior, and two other properties in the Ten Mile district in 1933, and 1 shipment of gold ore was made from the Gold Ledge mine to the Golden Cycle mill. One placer in the district yielded a little gold.

## TELLER COUNTY

Mine and dump siliceous sulphotelluride gold ores from the Cripple Creek district in 1933 aggregated in calculated recovered metals 109,815.36 fine ounces of gold and 7,700 fine ounces of silver compared with 109,346.95 ounces of gold and 7,656 ounces of silver in 1932. In these calculations account is taken of mill slags, clean-ups, and stolen specimen gold. Such accounting has been made in all previous reports of this series in Mineral Resources and Minerals Yearbook. Recovery of 53.02 fine ounces of gold and 5 fine ounces of silver was made by placer methods in the district in 1933.

In 1933 the Golden Cycle mill at Colorado Springs (operations described under El Paso County) continued to hold the exclusive market for Cripple Creek ores. The treatment rates for the Cripple Creek district and for miscellaneous ores from other districts, effective September 1, 1933, follow. These rates were continued into 1934.

*Cripple Creek treatment rates, Golden Cycle mill effective Sept. 1, 1933 (in effect during 1934)*

| | |
|---|---|
| Ore up to and including $4 gold per ton | $1.95 plus $0.60 freight. |
| Over $4 and including $5 gold per ton | $1.95 plus $0.75 freight. |
| Over $5 and including $8 gold per ton | $2.50 plus $1 freight. |
| Over $8 and including $10 gold per ton | $4.40 (includes freight). |
| Over $10 and including $15 gold per ton | $5.70 (includes freight). |
| Over $15 and including $20 gold per ton | $7.00 (includes freight). |
| Over $20 and including $25 gold per ton | $7.35 (includes freight). |
| Over $25 and including $30 gold per ton | $7.90 (includes freight). |
| Over $30 and including $40 gold per ton | $8.50 (includes freight). |
| Over $40 and including $100 gold per ton | $9.60 (includes freight). |
| Over $100 gold per ton | $6.50 plus $3.10 freight. |

Freight rates on ores of value over $100 per ton is $3.10 plus 1 percent of value in excess of $100 unless consignment be released to value not to exceed $100 per ton.

An added charge of $5 will be made for sampling all lots of ore containing less than 10 tons, dry weight, and an extra charge of $2.50 per lot made for each lot, when more than one lot shipped in a car.

An added charge of 10 cents per ton made if ore is sacked. An added charge of 10 cents per ton will be made if ore is received frozen.

An added charge of 5 cents per ton will be made for each 1 percent moisture in excess of 10 percent.

## BASIS OF PAYMENTS

Gold-bearing materials received at the Golden Cycle mill, Colorado City, Colo., until further notice, will be settled for on the basis of world gold prices, according to Treasury regulations. To obtain the world price, gold must be recovered from actual deposits in the United States or any places subject to its jurisdiction and be eligible under President Roosevelt's Executive order of August 29, 1933.

Settlement will be made in the following manner until further notice:

1. Provisional advance payment will be made according to the terms of the schedule under which material is shipped, which, in respect to the gold content, is predicated on the present mill price for gold of $20.00 per troy ounce.
2. Final settlement will be made according to the terms of schedule under which the material is shipped, with the exception that an additional payment will be made for the gold content based upon the amount by which the realized price for gold shall exceed the mint price of $20.67 per troy ounce as follows:

   First 5 ounces gold per dry ton contained in product pay 90 percent of said excess price. Second 5 ounces of gold per dry ton contained in product pay 92½ percent of said excess price. All gold contained in product in excess of 10 ounces per dry ton pay 95 percent of said excess price.

In the event that in any calendar month the "realized price" shall be less than the "mill price" the price paid in respect to such gold content shall be the "realized price" less 8 percent.

The term "realized price" referred to above shall be the net average price per ounce realized by the buyer upon all sales of gold originating in mines of the United States made by it in this country or abroad during the calendar month of delivery of seller's product. The said net average price shall mean the gross average price less cost of delivery to place of sale from buyer's refinery, including cost of insurance, selling expenses paid to others, and such other direct expenses as packing costs, cables, etc.

The term "mill price" referred to above shall be understood to refer to the provisional advance payment of $20.00 per troy ounce.

The term "mint price" referred to above shall be understood to refer to the present mint price of $20.67 per troy ounce, and not to any other or different mint price at which gold may hereafter be purchased by the mint.

*Treatment rates for miscellaneous ores and concentrates at the Golden Cycle mill, Colorado Springs, Sept. 1, 1933*

| | |
|---|---|
| Ore up to and including $8 [calculated value] per ton | $2.50 |
| Over $8 and including $10 [calculated value] per ton | $3.00 |
| Over $10 and including $15 [calculated value] per ton | $4.00 |
| Over $15 and including $20 [calculated value] per ton | $4.50 |
| Over $20 and including $40 [calculated value] per ton | $5.50 |
| Over $40 [calculated value] per ton | $6.00 |

An added charge of $5 will be made for sampling all lots of ore containing less than 10 tons, dry weight, and an extra charge of $2.50 per lot made for each lot when more than one lot in a car.

An added charge of 10 cents per ton made if ore is sacked. An added charge of 10 cents per ton will be made if ore is received frozen.

An added charge of 5 cents per ton will be made for each 1 percent moisture in excess of 10 percent. Minimum deduction of 1 percent.

The above rates are exclusive of freight rates.

Freight charges must either be guaranteed or prepaid by shipper.

Ore containing nonsulphide copper in excess of 0.2 percent will not be accepted for treatment at this plant.

## TRUCK SHIPMENTS AND SHIPMENTS LESS THAN 10 TONS

When umpiring is done, shipper must pay umpire expense.

Further: When values are less than 3.00 ounces gold per ton of ore, provisional advance payment will be made at $19.50 per ounce.

BASIS OF PAYMENTS

Miscellaneous ores:

Gold: No payment for gold when under 0.02 ounce per ton; $19.50 per ounce when 0.02 ounce per ton up to and including 0.50 ounce per ton; $20.00 per ounce when settlement value exceeds 0.50 ounce per ton.

Silver: No payment for silver when under 1.0 ounce per ton. Market quotation date immediately preceding date of settlement, excluding fraction of cents, unless ore exceeds 100 ounces silver per ton, in which event 2½ cents per ounce additional will be charged for ounces in excess of 100 ounces.

Silver contents:

Pay 50 percent on ore containing 1 ounce and including 5 ounces.
Pay 65 percent on ore over 5 ounces and including 10 ounces.
Pay 75 percent on ore over 10 ounces and including 20 ounces.
Pay 85 percent on ore over 20 ounces and including 50 ounces.
Pay 90 percent on ore over 50 ounces and including 100 ounces.
Pay 95 percent on ore over 100 ounces.

Sulphide lead: No payment when sulphide lead content is under 3.0 percent.

Wet assay less 1.0 percent; pay for 80 percent of remainder at New York quotation less 2½ cents per pound. Market quotation date immediately preceding date of settlement used as basis of payment.

No payment for nonsulphide lead content.

Sulphide copper: Wet assay less 1.0 percent; pay for 80 percent of remainder at New York quotation less 9 cents per pound. When copper quoted over 15 cents per pound, deduct 25 percent of excess. Market quotation date immediately preceding date of settlement used as basis of payment.

No payment for nonsulphide copper content.

Concentrates: Payment for gold and silver values only.

Gold: $19.00 per ounce when settlement value is 2.0 ounces or under; $19.50 per ounce when settlement value exceeds 2.0 ounces.

Silver: Subject to payment as above. No payment or penalties made other than as specified above.

All new shippers should send a 5-pound sample of ore, charges prepaid, for testing before billing shipments.

To insure prompt settlements, shippers should authorize settlements on mill assays, or compare assays promptly by telephone, telegraph, or letter to mill office, giving mill lot numbers. In the absence of such information within a reasonable length of time, settlements will be made on mill assays.

Rates subject to change at the option of mill manager.

WHEREAS, by reason of the existing uncertainty in respect to the gold standard as a basis for the currency of this country and the currencies of other countries, and the possibility of changes in the monetary policy of the Government of the United States and of other governments in relation to gold, gold may cease to be purchased freely for treasury or central bank purposes, or may be purchased in smaller quantities and at different prices, with the result that the market price of gold may cease to be determined in accordance with the price established by governmental purchases, and may be greater or less than the said mint price heretofore fixed in the United States, and may be a fluctuating price; and

WHEREAS, at the present time, in consequence of the Executive order of the President dated August 29, 1933, the market price of gold recovered from natural deposits in the United States or any place subject to the jurisdiction thereof will, so long as such Executive order remains in effect, vary from time to time:

The price specified in the foregoing provisions of "basis of payments" is hereinafter called the "schedule price." The term "mint price" as used herein shall be understood to refer to the present mint price of $20.67 per ounce, and not to any other or different price at which gold may hereafter be purchased at the mint.

From and after the date hereof, payment in respect to the gold content of the seller's product shall be determined with reference to the relation between the mint price and a sum equivalent to the net average price per ounce realized by the buyer upon all sales of gold originating in mines of the United States made by it in this country or abroad during the month of delivery of seller's product. The said net average price shall mean the gross average price, less cost of delivery to place of sale from buyer's refinery, including cost of insurance, selling expenses paid to others, and such other direct expenses as packing costs and cables.

The sum equivalent to the said net average price is hereinafter called the "realized price."

Whenever in any calendar month the realized price shall be equal to said mint price (i.e., not less than \$20.67 and not more than \$20.68 per ounce), the price paid in respect to said gold content shall be the schedule price.

Whenever in any calendar month the realized price shall exceed the mint price, the amount paid in respect to such gold content shall be the sum of the mint price plus an additional payment based on the excess price as follows:

First 5 ounces gold per dry ton contained in product pay 90 percent of said excess price. Second 5 ounces gold per dry ton contained in product pay 92½ percent of said excess price. All gold contained in product in excess of 10 ounces per dry ton pay 95 percent of said excess price.

Whenever in any calendar month the realized price shall be less than the schedule price, the price paid in respect to said gold content shall be the realized price less 8 percent.

Settlement on the basis of the realized price as above provided shall be made as soon as practicable after the 15th and 30th of each month. Provisional advance payment will be made on the date following agreement upon assays of the schedule price so long and during such periods as the Treasury of the United States shall regularly purchase gold as tendered in the manner heretofore followed and to pay therefor the fixed price of \$20.67 per ounce. If and so long as the Treasury of the United States shall discontinue or decline regularly to purchase gold as aforesaid and to pay therefor the said fixed price of \$20.67 per ounce, or shall purchase gold at some other or different price, provisional advance payment will be made in such an amount as the mill shall determine. Adjustment of over or under payments provisionally made in advance will be made at the time of settlement on the basis of realized price by payment of the difference by the buyer or seller as the case may be.

## MINES REVIEW

Production from mines and dumps in the Cripple Creek district revived considerably during the last 4 months of 1933, resulting in increased shipments to the Golden Cycle mill. Among the large producers were mines of the United Gold Mines Co., an operating and holding company for property scattered throughout the district. The following tables are taken from the company's annual report, dated February 15, 1934.

*Total production of property—United Gold Mines Co.*

| | Net tons | Gross value |
|---|---|---|
| Ore mined before consolidation | 26,310 | \$456,806.19 |
| Production under operations of the United Gold Mines Co. | 1,083,591 | 12,160,120.95 |
| Total to Dec. 31, 1933 | 1,109,901 | 12,616,927.14 |

*Production of the United Gold Mines Co.—Company ore in 1933*

| Mine | Net tons | Gross value | Company ore cash receipts | Average gross value per ton | Number of cars shipped |
|---|---|---|---|---|---|
| Vindicator | 4,035 | \$11,787.75 | \$2,419 98 | \$2.921 | 133 |
| Rose Nicol | 5,388 | 75,265.72 | 49,117.95 | 13.969 | 150 |
| | 9,423 | 87,053.47 | 51,537.93 | 8.124 | 283 |

*Production of the United Gold Mines Co.—Lessee ore in 1933*

| Group | Net tons | Gross value | Royalties received | Tax | Lessees' receipts | Average gross value per ton | Number of cars |
|---|---|---|---|---|---|---|---|
| Deadwood group: | | | | | | | |
| Miscellaneous lessee | 7, 785 | $49, 164. 60 | $4, 082. 40 | $482. 22 | $19, 613. 51 | $6. 315 | 245 |
| Findlay | 2, 966 | 11, 626. 68 | 430. 80 | 113. 42 | 3, 393. 28 | 3. 919 | 104 |
| Shurtloff | 222 | 2, 207. 88 | 111. 74 | 22. 06 | 983. 67 | 9. 948 | 9 |
| Vindicator | 28, 294 | 184, 996. 76 | 37, 119. 41 | 1, 802. 80 | 54, 455. 86 | 6. 538 | 860 |
| Theresa | 8, 697 | 74, 574. 54 | 17, 442. 27 | 741. 99 | 22, 927. 33 | 8. 575 | [1] 285 |
| Rose Nicol | 5, 527 | 57, 878. 51 | 13, 822. 46 | 578. 76 | 20, 012. 21 | 10. 472 | 179 |
| Londonderry | 1, 330 | 6, 660. 71 | 166. 44 | 46. 63 | 1, 635. 69 | 5. 008 | 47 |
| Isabella | 96 | 453. 30 | 8. 79 | | 129. 55 | 4. 736 | 4 |
| Solomon | 1, 087 | 9, 862. 41 | 721. 00 | 97. 01 | 4, 123. 97 | 9. 074 | 35 |
| Hardwood | 617 | 3, 246. 90 | 166. 65 | 30. 46 | 938. 96 | 5. 264 | 19 |
| W.P.H. | 1, 803 | 12, 757. 53 | 655. 16 | 125. 04 | 5, 205. 67 | 7. 726 | 54 |
| Bonanza | 110 | 1, 691. 18 | 171. 78 | 16. 92 | 806. 85 | 15. 351 | 4 |
| | 58, 534 | 415, 121. 00 | 74, 898. 90 | 4, 057. 31 | 134, 226. 55 | 7. 092 | 1, 845 |

[1] And 8 sacks.

The annual report of the Cresson Consolidated Gold Mining & Milling Co. for the 12 months ended December 31, 1933 (dated Feb. 15, 1934) says:

During the 12 months 63,136 dry tons of ore were shipped on company account of a gross value of $516,192.17, averaging $8.15 per ton; the returns, less transportation and treatment of $223,472.26, were $292,719.91, giving the ore a net value of $4.63 per ton. The company received as additional income the sum of $5,324.52 interest on bank deposits, and $161,395.25 net royalty on 29,816 tons lessee ore, making a total of $459,439.68, with total expenses of $296,757.62, resulting in a net gain from operations of $162,682.06.

*Development*

| | Feet | Feet |
|---|---|---|
| Drifts and crosscuts: | | |
| Company | 5, 447 | |
| Lessees | 2, 572 | |
| | | 8, 019 |
| Raises and winzes: | | |
| Company | 1, 192 | |
| Lessees | 2, 074 | |
| | | 3, 266 |
| Total | | 11, 285 |

This is 2,300 feet more than reported in 1932.

The total cost per ton on ore shipped was 47 cents less than 1932, notwithstanding an increase in taxes from 6 to 19 cents per ton.

The mine and surface equipment has been kept up in good condition.

The mine has more ore development than at last annual report. The raised price of gold has been of much benefit on the low-grade ore of the Cresson.

*Production of the Cresson Consolidated Gold Mining & Milling Co., Colorado, 1903 to December 31, 1933*

| Period | Dry short tons | Gross value | Freight and treatment | Net value |
|---|---|---|---|---|
| 1903 to Dec. 31, 1932 | 2, 029, 346 | $34, 352, 047. 65 | $10, 448, 460. 53 | $23, 903, 587. 12 |
| 1933: | | | | |
| Company ore | 63, 136 | 516, 192. 17 | 223, 472. 26 | 292, 719. 91 |
| Lessee ore | 29, 816 | 463, 544. 13 | 154, 981. 36 | 308, 562. 77 |
| 1903 to Dec. 31, 1933 | 2, 122, 298 | 35, 331, 783. 95 | 10, 826, 914. 15 | 24, 504, 869. 80 |

*Production of the Cresson Consolidated Gold Mining & Milling Co., Colorado, 1903 to December 31, 1933*—Continued

| Period | Royalties received by company | Amount paid lessees | Average gross value per ton | Average net value per ton | Dividends |
|---|---|---|---|---|---|
| 1903 to Dec. 31, 1932 | | | $16.92 | $11.78 | $12,405,672.50 |
| 1933: | | | | | |
| Company ore | | | 8.15 | 4.63 | 48,800.00 |
| Lessee ore | $161,354.63 | $147,208.14 | 15.54 | 10.40 | |
| 1903 to Dec. 31, 1933 | | | 16.65 | 11.54 | 12,454,472.50 |

The Granite Gold Mining Co. operated its mines to October 6, 1933, when the property was sold to the Colorado International Mining Corporation which continued production throughout the year. Other important producers were the Atlas Gold Mines Co. (Midget-Bonanza King), Acacia Gold Mining Co. (Morning Star and North and South Burns), Buckeye Mines & Milling Co., Commonwealth Gold, Inc., Dr. Jack Pot Mining Co., Economic mill dump, Elkton Co. group, Empire Lee Mining Co., Forest Queen, Free Coinage Gold Mining Co., Hildreth Frost properties, International Gold Producers, Inc. (Logan), Jerry Johnson Gold Mining Co., LeClair Consolidated Mines Co. (Mary McKinney), Mexican Gold & Silver Mining Co. (Gold Pinnacle), New Gold Dollar Mining Co., New El Paso Mines, Inc., Portland Gold Mining Co., Queen Gold Mining Co., Raven Apex, School Section 16, Smith Moffat Mines Co., Stratton-Cripple Creek Mining & Development Co., and Strong Mining Co.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN AND CENTRAL STATES

**(MINE REPORT)**

By J. P. Dunlop and H. M. Meyer

## SUMMARY OUTLINE



Mines in the Eastern and Central States yielded metals in 1933 valued as follows: Gold, $41,539; silver, $63,412; copper, $3,870,684; lead, $8,375,986; and zinc, $24,702,464. There were increases in both quantity and value of gold, silver, and zinc.

The value of metal production herein reported has been calculated at the figures given in the table on page 192. 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.

At $20.671835 per fine ounce the value of the gold produced in 1933 is $41,539. Using the average premium received from August to December 31 would add approximately $9,800 to the value of the gold, allocated chiefly as follows: Georgia, $2,730; North Carolina, $3,540; Pennsylvania, $1,020; South Carolina, $1,150; Tennessee, $1,100; and Virginia, $160. For details regarding premium on newly mined gold see chapter of this volume on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

*Salient statistics of mine production of gold, silver, copper, lead, and zinc in the Eastern and Central States in 1933, 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 |
|---|---|---|---|---|---|---|---|
| Eastern States: | *Short tons* | | *Fine ounces* | *Pounds* | *Short tons* | *Short tons* | |
| Alabama | | $82 | | | | | $82 |
| Georgia | 529 | 11,543 | 65 | | | | 11,566 |
| Maryland | | 279 | | | | | 279 |
| New Jersey | 471,607 | | | | | 75,125 | [1] 8,272,400 |
| New York | 180,670 | | | | (2) | 17,733 | [3] 1,489,572 |
| North Carolina | 24,653 | 14,980 | 11,492 | (4) | | | [5] 19,002 |
| Pennsylvania | 347,290 | 4,320 | 2,300 | (4) | | | [5] 5,125 |
| South Carolina | 510 | 4,849 | 103 | | | | 4,885 |
| Tennessee | 986,233 | 4,620 | 39,869 | [4] 13,626,320 | [2] 3,116 | [6] 32,770 | [7] 3,873,922 |
| Virginia | 247,530 | 666 | | | (2) | (6) | [8] 666 |
| | 2,259,022 | 41,339 | 53,829 | 13,626,320 | 3,116 | 125,628 | 13,677,499 |
| Total, 1932 | 1,998,849 | 21,854 | 30,228 | 10,872,200 | 4,460 | 116,768 | 11,095,057 |
| Central States: | | | | | | | |
| Arkansas | (9) | | | | 10 | 11 | 1,664 |
| Illinois | (9) | | 1,422 | | 240 | | 18,258 |
| Kansas | 1,229,000 | | | | 6,089 | 40,947 | 3,890,134 |
| Kentucky | (9) | | | | 176 | 228 | 32,176 |
| Michigan | [10] 697,158 | 200 | [11] 125,926 | 46,853,130 | | | 3,042,874 |
| Missouri | 2,660,800 | | | | 84,980 | 5,042 | 6,712,048 |
| Oklahoma | 3,622,100 | | | | 18,038 | 91,065 | 8,984,272 |
| Wisconsin | 256,400 | | | | 540 | 7,800 | 695,160 |
| | [10] 8,465,458 | 200 | 127,348 | 46,853,130 | 110,073 | 145,093 | 23,376,586 |
| Total, 1932 | 7,577,875 | | 72,793 | 54,396,108 | 135,228 | 98,268 | 17,457,242 |

[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.
[10] Excludes 200 tons of old tailings from Michigan cyanided for the recovery of gold and silver.
[11] According to Bureau of the Mint.

*Prices of silver, copper, lead, and zinc, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Gold and silver.*—The output of gold in the Eastern States was valued at $41,339 in 1933, or $19,485 more than in 1932. Placer mines yielded 663.37 fine ounces of gold in 1933, compared with 226.88 ounces in 1932. Gold derived from siliceous ores increased from 459.04 fine ounces in 1932 to 712.41 ounces in 1933. Gold derived from the refining of copper bullion increased from 371.27 fine ounces in 1932 to 623.99 ounces in 1933. The number of placer mines operated nearly doubled. Yields of gold were reported in 1933 by 22 lode-gold mines and 37 placers. There was considerable prospecting in the Appalachian States in 1933, but few of the new properties made any appreciable production, as most of the work was experimental. There was considerable inquiry into prospects near Rapidan, Va., and in the old Coker Creek district in Tennessee which may result in a much larger output of gold from these States. In 1933, 2,869 tons of siliceous ore was treated at mills in Georgia, North Carolina, South Carolina, and Virginia. The value of the estimated output of gold in the Southern Appalachian States from 1799 to 1933 inclusive, is recorded as $51,280,217.

Michigan was the only one of the Central States to produce gold in 1933. The small yield of $200 in gold was from the treatment of tailings from an old mine at Ishpeming which has been idle for many years.

Of the silver (53,829 ounces) produced in the Eastern States in 1933 all except 77 ounces from placer bullion and 183 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. The increase of the copper output in the Eastern States in 1933 was accompanied by an increase of 23,601 ounces in silver over the 1932 output.

Production of silver in the Central States in 1933 was 127,348 ounces. The Illinois output was from galena concentrates recovered in milling fluorspar and that of Michigan was from copper ore and siliceous gold and silver tailings. No silver was recovered in 1933 from any zinc or lead concentrates shipped from Missouri.

*Copper.*—The mine production of copper in the Eastern States was 13,626,320 pounds, valued at $872,084, an increase of 2,754,120 pounds over that in 1932; each of the producing States showed an increase. The output from these States cannot be stated separately. It 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 $0.07 per ton in gold and silver. The copper concentrates from magnetite ore contained about 26 percent copper and $2.37 to the ton in gold and silver.

All the copper produced in 1933 in the Central States was from mines in Michigan; no copper ore or residues from lead ore containing copper were shipped from southeastern Missouri. The output of refined copper in Michigan was 46,853,130 pounds in 1933 compared with 54,396,108 pounds in 1932. The average recovery of copper per ton of rock treated increased from 47.6 pounds in 1932 to 67.2 pounds in 1933.

*Lead.*—All the production of lead from mines in the Eastern States was from lead-zinc ores from the Austinville mine in Virginia, the Balmat mine in New York, and the Embree mine in Tennessee. Galena concentrates shipped amounted to about 5,100 tons, which yielded 3,116 tons of lead.

The lead recovered from mine shipments of lead ore and concentrates in the Central States decreased from 135,228 tons in 1932 to 110,073 tons in 1933. The decrease was mainly due to much smaller shipments from mines in southeastern Missouri. Missouri shipments yielded 84,980 tons of lead, of which 83,970 tons were from mines in southeastern Missouri. Production of lead in Oklahoma as measured by recovered metal increased from 10,634 tons in 1932 to 18,038 in

1933. Shipments of lead concentrates from Kansas mines yielded 6,089 tons of lead in 1933, compared with 6,490 in 1932. Wisconsin lead-zinc mines produced ore yielding 910 tons of lead in 1932 and 540 in 1933. Lead concentrates from Illinois mines yielded 240 tons of lead; lead concentrates from Kentucky, 176 tons; and lead concentrates from Arkansas, 10 tons. Mines in the Tri-State region shipped 32,947 tons of lead concentrates containing 25,137 tons of recoverable lead. This region produced 18,131 tons of recoverable lead in 1932.

*Zinc.*—The recoverable zinc in ore and concentrates shipped from mines in the Eastern States was 125,628 tons, valued at $12,514,652, in 1933, compared with 116,768 tons, valued at $10,112,130, in 1932. Mines in New Jersey yielded 75,125 tons, as metal or in oxide, valued at $8,272,400.

[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 17,733 tons of zinc was 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 32,770 tons, of which part was from concentrates made and stocked at mines in 1932. All zinc concentrates shipped were sphalerite except 2,240 tons of zinc carbonate from Tennessee.

Shipments of zinc concentrates from mines in the Central States had a recovered zinc content of 145,093 tons in 1933 compared with 98,268 tons in 1932. Mines in the Tri-State or Joplin region shipped ore and concentrates yielding 137,054 tons of zinc in 1933 compared with 90,660 tons in 1932. A considerable part of the shipments in both 1932 and 1933 was from stocks at mines; stocks were very small at the end of 1933. Mines in Oklahoma contributed 66.4 percent and mines in Kansas 29.9 percent of the zinc from the Tri-State region in 1933. The zinc recovered from mines in Wisconsin increased from 7,522 tons in 1932 to 7,800 in 1933 and that from mines in Missouri from 986 tons in 1932 to 5,042 in 1933. No Illinois mines shipped any zinc in 1933, and shipments from Arkansas contained 11 tons of recoverable zinc. Mines in Kentucky shipped zinc carbonate ore and lead-zinc ore containing 228 tons of recoverable zinc.

## MINE PRODUCTION IN THE EASTERN STATES

*Alabama.*—The value of the gold produced in Alabama from 1830 to 1933, inclusive, is recorded as $769,311. There was no revival of gold mining in 1933, and the only output reported was $82 from the W. F. Pasley mine near Alexander City, Tallapoosa County.

*Georgia.*—The value of the gold produced in Georgia from 1830 to 1933, inclusive, is recorded as $17,870,982. In 1933, 22 placer mines and 7 lode mines yielded $11,543 in gold and 65 ounces of silver. The production in 1932 was $5,760 in gold and 30 ounces of silver. Placer mines yielded $8,125 in gold in 1933, including about $4,400 from placers near Dahlonega and Auraria in Lumpkin County and $2,400 from mines in White County, the remainder was produced by small mines operating in Cherokee, Dawson, Douglas, Paulding, and Hall Counties. Gold produced from siliceous ore amounted to $3,418, mainly from McDuffie and Lumpkin Counties. The largest producing placers were the Etowah Corporation, Topabri Co., Inc., T. J. Stevenson, and the Dixie Gravel Co. The lode gold-producing properties in 1933 were the Hammond in Dawson County, the Brown and the Miller in Hall County, the Chestatee and the Capps in Lumpkin County, the Hamilton in McDuffie County, and the Russell in White County. The Hammond mine near Dawsonville, which is equipped with a 5-stamp mill, was opened in 1933 and treated ore said to assay $4 to $12 a ton. The Brown mine near Flowery Branch operated a small 5-stamp mill for about 6 weeks in 1933, and the Miller mine near Gainesville was operated for a few weeks but was idle at the end of the year. The numerous properties controlled by Dr. Craig R. Arnold at Dahlonega were operated spasmodically by various lessees; A. T. Leavitt operated the Capps mine and 10-stamp mill and sank a shaft at the Lockhart mine. The Barlow mine, owned by Arnold, is under lease to the Slyvanite Gold Mines, Ltd., which has diamond-drilled five holes. There are many inquiries for leases in the Dahlonega district, and the output of gold should increase in 1934. The Hamilton mine and 10-stamp mill near Thomson was operated by W. H. Fluker in 1933 on ore hoisted during development. The mine is opened by 3 shallow shafts, of which 2 were sunk in 1933.

*Maryland.*—The estimated total gold production of Maryland has been $71,684. No gold was produced in 1933, but bullion containing $279 in gold from operations several years ago near Great Falls was sold in 1933.

*New Jersey* (see also note on p. 194).—The production of zinc ore in New Jersey in 1933 was 471,607 tons containing 75,125 tons 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 milled in New York in 1933 was 59,831 tons, and the quantity of lead-zinc ore 120,839 tons; the concentrates shipped yielded 17,733 tons of zinc. The mines were not operated at capacity in 1932 or 1933. The old Edwards mine yields sulphide zinc ore and is equipped with a 500-ton all-flotation plant. The Balmat mine near Sylvan Lake produces lead-zinc ore which gives a recovery of about 1 ton of galena concentrates to 9 tons of sphalerite concentrates at its 800-ton all-flotation plant.

*North Carolina.*—The value of the gold produced in North Carolina from 1799 to 1933, inclusive, is recorded as $23,713,258. The yield of gold in 1933 was $14,980 and that of silver 11,492 ounces. Nine placer mines yielded $4,220 in gold and ten lode mines $10,760. The Fontana copper mine was the largest producer of gold in the State, but its ore runs less than 25 cents a ton in gold.

Placer gold was recovered in Alleghany, Cabarrus, Franklin, Montgomery, Nash, Randolph, Rutherford, and Stanly Counties. The two largest producing placers were the Herrin in Cabarrus County near Stanfield and the Black Ankle at Seagrove in Randolph County.

All the lode-gold mines were comparatively small producers, and only 1,820 tons of gold ore were milled in 1933. The producing lode-gold mines were the Hearne and Sibley in Cabarrus County, operated by W. L. Cotton; the Crayton, also in Cabarrus County; the Pegram-Wadsworth and the Capps Hill in Mecklenburg County; the Iola and the Rich Cog in Montgomery County; the Cline and the 1,000-Acre Tract in Rutherford County; and the Whitley in Stanly County. At the old Iola mine near Candor in Montgomery County a small quantity of ore was milled at a 10-stamp mill. The Dana B. Burns 5-stamp mill near Asheville, was operated on ore from the Cline and other properties by E. B. Ward and R. E. Whittaker. Several lessees on the 1,000-Acre Tract near Union Mills in Rutherford County milled about 50 tons of ore at the Thompson 10-stamp mill. A number of old mines including the Gold Hill, Union, and Whitney at Gold Hill in Rowan County were purchased by the Gold Hill-Whitney Mines Syndicate and are to be developed in 1934. The Pegram-Wadsworth Land Co. sank six shallow shafts on a 200-acre tract in Charlotte and mined some ore to determine the average values. Some of this ore was milled at an old stamp mill but did not yield the gold content indicated by the assays, so work was suspended pending further development of the property. The Whitley mine near Albemarle was operated by E. L. Blackmar; more ore was milled at this property in 1933 than at any other gold mine in North Carolina. The largest producing gold placers were the Nugget mine near Stanfield, operated by M. E. Herrin; the Portis near Essex, operated by W. L. Long; and the Black Ankle near Seagrove, equipped with a log washer, operated about 3 months in 1933. 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 0.66 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 reduced rate in 1933, and only 2,158 tons of copper concentrates were shipped. The ore mined is pyritiferous magnetite, and the tailings from the iron concentrates go to the flotation plant. The copper concentrates, which contained about 26 percent copper and $2.37 to the ton in gold and silver, were shipped to the Nichols Copper Co.

*South Carolina.*—From 1829 to 1933, inclusive, mines in South Carolina yielded $5,189,602 in gold. The output in 1933 was $4,849, of which $4,177 came from lode-gold mines. The most productive placer was the Brewer near Jefferson in Chesterfield County, operated by E. M. Croxton, smaller yields were reported by C. D. Colby and R. E. Burg. The old Haile mine in Lancaster County near Kershaw was the largest lode-gold producer. The Notts mine and 10-stamp mill in Union County near Glenn Springs were operated by J. P. Cannon for a few days. The Young mine at Troy, with its 5-stamp mill, was operated by the Pioneer Mining Co., and the Carolina Mines, Inc., in York County shipped a small quantity of ore to smelters.

*Tennessee.*—Mines in Tennessee produced $365,641 in gold from 1831 to 1933, inclusive. Almost the entire output since 1906 has been from copper ore.

A small quantity of gold was marketed in 1933 by W. M. Fulton from prospecting in the Coker Creek district in Monroe County. Small quantities of gold, not sold in 1933, were recovered by other prospectors. Some shallow pits were sunk, and experimental methods of recovery from clay and gravel were tried. Gold assays from 20 cents to $2 a ton were reported, and further development is expected in 1934.

There were increases in the quantity of gold, silver, copper, and zinc in 1933 from mines in Tennessee. The output of gold increased from $3,315 in 1932 to $4,620 in 1933 and that of silver from 19,300 to 39,869 ounces. Tennessee produces little lead, and the output in 1933 was 134 tons less than in 1932. The total lead recovered from mines in Virginia, New York, and Tennessee in 1933 was 3,116 tons, and the total zinc recovered from mines in Tennessee and Virginia (for which separate figures may not be given) was 32,770 tons. The output of copper from mines in North Carolina, Pennsylvania, and Tennessee was 13,626,320 pounds, an increase of 2,754,120 pounds.

The Tennessee Copper Co. ran its flotation plant and smelter on ore from the Polk County and Burra-Burra mines in Tennessee and on sulphide ore from the Fontana mine in North Carolina; the company mines were operated 225 days, the 900-ton flotation plant was operated 160 days, and the smelter was operated full time on reduced daily tonnage. The Ducktown Chemical & Iron Co. operated its Isabella mine for a short period only and its smelter but 1 month to clean up copper concentrates made in 1932 and 1933. The Mascot mine and mill of the American Zinc Co. of Tennessee were operated at a slightly higher rate in 1933 than in 1932; very little development work was done at the mine. The Universal Exploration Co. kept its 800-ton all-flotation plant running, but not at full capacity, on zinc sulphide ore. The blende concentrates shipped had an average zinc content of 64.97 percent. Universal also mined and milled some zinc carbonate ore. The Embree Iron Co. in Washington County shipped high-grade zinc carbonate and galena concentrates direct to smelters.

*Virginia.*—The value of gold produced by Virginia mines from 1828 to 1933, inclusive, is recorded as $3,299,739, of which only about $10,500 was produced during the last 23 years. In 1933 Virginia produced $666 in gold. The Moss mine near Tabscott, Goochland County, was operated by J. C. Williams. The mine has two shafts, one 150 and one 102 feet deep, and is equipped with a small stamp mill. Development was continued by Leo Faust on the Waller mine. The Moss and the Waller mines are in the James River area about 40 miles from Richmond. The Rapidan Gold Corporation of Fredericksburg operated a placer prospect near the confluence of Wilderness and Rapidan Rivers in Orange County. A small quantity of gold was recovered by sluicing, and a 125-foot shaft was sunk to reach a lode vein believed to contain good values in gold.

Shipments of zinc concentrates from Virginia increased in 1933, and some galena concentrates were shipped. The Bureau of Mines is not at liberty to publish the lead and zinc output of the State as the Austinville mine of the Bertha Mineral Co. is the only producer of lead-zinc ore in Virginia.

## MINE PRODUCTION IN THE CENTRAL STATES

*Quantity and tenor of ores.*—The only fair basis for comparing the relative magnitude of mining operations in different States is 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 low 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 the metal content of the crude ore raised cannot be calculated. In Arkansas very little ore has been mined for several years, and the average tenor calculated from the output of ore during these years would not 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, 1931–33, by States*

| State | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | 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 | 1, 913, 200 | 3. 04 | 750, 500 | 3. 92 | 1, 229, 000 | 3. 25 |
| Michigan | 3, 570, 748 | 1. 65 | 1, 142, 775 | 2. 38 | 697, 158 | 3. 36 |
| Missouri | 5, 240, 400 | 3. 17 | 3, 786, 600 | 3. 19 | 2, 660, 800 | 3. 48 |
| Oklahoma | 3, 828, 900 | 3. 06 | 1, 587, 700 | 3. 70 | 3, 622, 100 | 3. 02 |
| Wisconsin | 318, 700 | 3. 99 | 310, 300 | 3. 28 | 256, 400 | 3. 82 |
| | 14, 871, 948 | | 7, 577, 875 | | 8, 465, 458 | |

[1] The percentages represent the metal content of the ore insofar as it is recovered in the concentrates. In Michigan the metal so recovered is copper; in the other Central States the metals are lead and zinc combined, the relative proportions of which are shown in the table on p. 192 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. Subsequent records year by year are found in Mineral Resources and Minerals Yearbook.

*Mine production of lead and zinc in the Central States in 1933, by regions*

| Region | Lead [1] | | Zinc [2] | | Total value |
|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | |
| Concentrates: | | | | | |
| Joplin | 32, 947 | $1, 457, 185 | 259, 580 | $6, 786, 056 | $8, 243, 241 |
| Southeastern Missouri | 116, 226 | 4, 081, 486 | | | 4, 081, 486 |
| Upper Mississippi Valley [3] | 760 | 31, 056 | 25, 786 | 331, 242 | 362, 298 |
| Kentucky-southern Illinois | 597 | 20, 408 | 754 | 8, 753 | 29, 161 |
| Northern Arkansas | 13 | 500 | 36 | 448 | 948 |
| | 150, 543 | 5, 590, 635 | 286, 156 | 7, 126, 499 | 12, 717, 134 |
| Total, 1932 | 187, 886 | 5, 768, 554 | 198, 055 | 3, 277, 940 | 9, 046, 494 |
| Metal: | | | | | |
| Joplin | 25, 137 | 1, 860, 138 | 137, 054 | 11, 512, 536 | 13, 372, 674 |
| Southeastern Missouri | 83, 970 | 6, 213, 780 | | | 6, 213, 780 |
| Upper Mississippi Valley [3] | 540 | 39, 960 | 7, 800 | 655, 200 | 695, 160 |
| Kentucky-southern Illinois | 416 | 30, 784 | 228 | 19, 152 | 49, 936 |
| Northern Arkansas | 10 | 740 | 11 | 924 | 1, 664 |
| | 110, 073 | 8, 145, 402 | 145, 093 | 12, 187, 812 | 20, 333, 214 |
| Total, 1932 | 135, 228 | 8, 113, 680 | 98, 268 | 5, 896, 080 | 14, 009, 760 |

[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.

## REVIEW BY STATES

*Arkansas.*—Only 36 tons of zinc concentrates were shipped from mines in Arkansas in 1933. The two shippers were the Red Fox Mining Co., of Bergman, and G. L. Huffman, of St. Joe. About 13 tons of galena was shipped from the Brewer land near Ponca, Newton County. No work was reported by any of the old mines near Zinc or Rush Creek.

*Illinois.*—None of the zinc or lead mines in northern Illinois were operated in 1933, and the shipments from fluorspar mines in southern Illinois were 384 tons of galena concentrates having an average lead content of 63.8 percent. The recoveries from these shipments were 240 tons of lead and 1,422 ounces of silver compared with 31 tons of lead and 257 ounces of silver in 1932. The Hillside Fluor Spar Mines and the Franklin Fluorspar Co. were the largest shippers in 1933.

*Kansas.*—The output of zinc concentrates in Kansas in 1933 was larger than in 1932; the shipments included a considerable quantity of zinc concentrates milled in 1932. The recovered lead in concentrates shipped decreased from 6,490 tons in 1932 to 6,089 tons in 1933, and the recovered zinc increased from 26,277 to 40,947 tons.

The total quantity of zinc and lead-zinc ore and old tailings milled in Kansas in 1933 was 1,229,000 tons (750,500 tons in 1932), and the total shipments were 7,752 tons of galena concentrates, 80 tons of lead carbonate, and 77,246 tons of sphalerite concentrates. The galena concentrates had an average lead content of 79.6 percent and the sphalerite concentrates an average zinc content of 60.3 percent. The following average prices were received by sellers of concentrates: Galena concentrates, $45.68 a ton, and sphalerite concentrates, $26.94 a ton. The 725,400 tons of crude ore milled yielded, by weight, 0.83 percent in galena concentrates assaying 79.6 percent lead and, by weight, 6.67 percent in sphalerite concentrates averaging 60.4 percent zinc. The 503,600 tons of old tailings treated yielded only 18 tons of galena concentrates but contained 1.56 percent in sphalerite concentrates with an average of 58.3 percent zinc.

The total concentrates made by flotation in 1933 were 17,050 tons of sphalerite and 500 tons of galena.

Of the total shipments of sphalerite (77,246 tons) one mine in the Crestline area contributed about 400 tons; the remaining shipments were from mines near Baxter Springs and Blue Mound. The latter area also contributed 7,482 tons of galena concentrates. The mines at Galena shipped 120 tons of galena and 80 tons of lead carbonate, and those at Crestline 150 tons of galena.

In the Galena camp most of the lead concentrates were produced by small lessees of the Eagle-Picher Mining & Smelting Co., and the only producing mine at Crestline was the Crutchfield, operated by the Pershing Mining Co.

*Mine shipments of lead and zinc in Kansas, 1932–33*

| Year | Lead concentrates [1] | | Zinc concentrates | | Metal content [2] | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lead | | Zinc | |
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 1932 | 8,379 | $327,344 | 49,487 | $889,066 | 6,490 | $389,400 | 26,277 | $1,576,620 |
| 1933 | 7,832 | 356,523 | 77,246 | 2,077,251 | 6,089 | 450,586 | 40,947 | 3,439,548 |

[1] Includes 79 tons of lead carbonate, containing 56 percent lead, from Galena in 1932, and 80 tons of lead carbonate, containing 47 percent lead, in 1933.
[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, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Crude ore | Old tailings | Crude ore | Old tailings |
| Total ore and old tailings milled...short tons | 507,100 | 243,400 | 725,400 | 503,600 |
| Total concentrates shipped: | | | | |
| Galena...do | 8,375 | 4 | [1] 7,734 | 18 |
| Sphalerite...do | 44,168 | 5,319 | 69,412 | 7,834 |
| Ratio of concentrates to ore, etc.: | | | | |
| Lead...percent | 0.91 | ------ | 0.83 | ------ |
| Zinc...do | 7.03 | 2.01 | 6.67 | 1.56 |
| Metal content of ore, etc.: | | | | |
| Lead...do | .72 | ------ | .66 | ------ |
| Zinc...do | 4.24 | 1.17 | 4.03 | .91 |
| Average lead content of galena concentrates...do | 79.3 | 75.0 | 79.6 | 77.7 |
| Average zinc content of sphalerite concentrates...do | 60.4 | 59.5 | 60.4 | 58.3 |
| Average value per ton: | | | | |
| Galena concentrates | $39.21 | $16.50 | $45.69 | $41.72 |
| Sphalerite concentrates | 18.11 | 16.73 | 26.66 | 28.93 |

[1] Also 80 tons of lead carbonate.

The mines near Baxter Springs shipped 962 tons of galena and 9,326 tons of sphalerite concentrates. Very little drilling or development was done in this area, but several old mines were reopened. The principal shippers in 1933 were the Rupe Milling Co. (Peru tailings), Lucky O.K. Mining Co., Baxter Chat Co. (Lucky O.K. tailings), Barnsdall Zinc Co., Iron Mountain Lead & Zinc Co., Lowther & Co. (Peru mine), St. Louis Smelting & Refining Co., and Vinegar Hill Zinc Co. The last two properties were not operated in 1933, and the concentrates shipped were taken from stocks at the mines.

The mines in the Blue Mound area, which in 1932 shipped 6,304 tons of galena and 43,337 tons of sphalerite, did not increase their production greatly, but the shipments, which included galena and sphalerite concentrates from ore milled in 1931 and 1932, totaled 6,520 tons of galena concentrate and 67,520 tons of sphalerite concentrate in 1933. The larger shippers in this area were the Jay Hawk Mining Co. (tailings), Tri-State Zinc, Inc. (tailings), Black Eagle Mining Co. (ore and tailings), Eagle-Picher Mining & Smelting Co. (Bendelari mine), Mid Continent Lead & Zinc Corporation, Vinegar Hill Zinc Co. (Barr mine), Redskin Mining Co., Kansas Exploration Co., Interstate Zinc & Lead Co., Roberts & White (Foley mine), Cortez King Brand

Mining Co. (tailings), Federal Mining & Smelting Co. (Jarrett mine), and the Commerce Mining & Royalty Co. (Wilbur and Webber mines).

All the mines in the Waco district (in Kansas) were idle in 1933, and no shipments were made.

*Kentucky.*—In 1933 Kentucky mines shipped 203 tons of galena and some lead-zinc ore. The lead-zinc ore shipped had a zinc content of 33 percent and a lead content of 8 percent. In addition, 209 tons of zinc carbonate were shipped. The recoverable content of all the ore and concentrates shipped was 176 tons of lead and 228 tons of zinc. The shippers in 1933 were Avery H. Reed, Roberts & Frazer, Eagle Fluor Spar Co., Inc., and Lafayette Fluorspar Co.

*Michigan.*—Copper was mined in Michigan in 1933 by only two companies, the Calumet & Hecla Consolidated Copper Co. and the Copper Range Co. Mineral from the Mohawk mine, produced earlier, was treated at the smelter of the Copper Range Co. The mine output for the State was 697,158 tons of rock, from which 68,999,174 pounds of mineral containing 46,853,130 pounds of recoverable copper were obtained. Production in 1932 totaled 1,142,775 tons of rock, 79,753,030 pounds of mineral, and 54,396,108 pounds of refined copper. Continuing the advances of recent years, the yield of copper from ores in 1933 was 67.2 pounds to the ton (3.36 percent), considerably above the high average of 47.6 pounds (2.38 percent) recorded for 1932. At the Calumet & Hecla mining was confined to the old backs and shaft pillars in the upper part of the conglomerate lode. At the Champion mine of the Copper Range Co. the average recovery of copper from rock was increased entirely by careful hand-sorting, in the stope, of rock that contained copper from rock that did not contain copper. Despite increased labor costs during the year at both properties and largely as a result of the higher recoveries mentioned, the average cost of producing copper at Calumet & Hecla was reduced from 10.64 cents a pound in 1932 to 6.75 in 1933, and the average cost of producing copper at the Champion mine was reduced from 8.646 to 7.51 cents a pound.

In 1933 the Ishpeming Gold Mining Co. cyanided 200 tons of old tailings from the old Ropes mine at Ishpeming and recovered 9.67 ounces of gold and 14 ounces of silver.

*Mine production of gold, silver, and copper in Michigan, 1929–33* [1]

| Year | Gold (fine ounces) | Silver (fine ounces) | Copper | | | Concentrate ("mineral") | | Ore ("rock") (short tons) |
|---|---|---|---|---|---|---|---|---|
| | | | Pounds | Yield: Pounds per ton of ore ("rock") | Yield: Percent | Pounds | Yield (percent copper) | |
| 1929 | | 20,795 | [2] 186,402,218 | [2] 24.5 | [2] 1.23 | [3] 286,583,602 | [3] 65.0 | [4] 7,598,180 |
| 1930 | | 7,820 | [2] 169,381,413 | [2] 25.4 | [2] 1.27 | [3] 258,005,986 | [3] 65.7 | [4] 6,659,036 |
| 1931 | | 1,437 | 118,059,491 | 33.1 | 1.65 | 172,431,815 | 68.5 | 3,570,748 |
| 1932 | | 71,408 | 54,396,108 | 47.6 | 2.38 | 79,753,030 | 68.2 | 1,142,775 |
| 1933 | 9.67 | [5] 125,926 | 46,853,130 | 67.2 | 3.36 | 68,999,174 | 67.9 | [6] 697,158 |

[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] According to Bureau of the Mint.
[6] Excludes 200 tons of old tailings cyanided for recovery of gold and silver.

*Value of silver and copper produced in Michigan mines, 1929–33*

| Year | Silver | Copper | | Total | Year | Silver | Copper | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | Per ton of ore ("rock") | | | | Total | Per ton of ore ("rock") | |
| 1929 | $11,084 | $32,806,790 | $4.32 | $32,817,874 | 1932 | $20,137 | $3,426,955 | $3.00 | $3,447,092 |
| 1930 | 3,011 | 22,019,584 | 3.31 | 22,022,595 | 1933 | [1] 44,074 | 2,998,600 | 4.30 | 3,042,674 |
| 1931 | 417 | 10,743,414 | 3.01 | 10,743,831 | | | | | |

[1] According to Bureau of the Mint.

Mining operations by the Calumet & Hecla Consolidated Copper Co. were confined to the old backs and shaft pillars in the upper part of the conglomerate lode. Output amounted to 33,197,106 pounds of copper at an average cost sold (not including depreciation and depletion) of 6.75 cents a pound and 1,928,893 pounds of oxide at an average cost sold of 5.23 cents a pound. The average selling price was 6.82 cents a pound for copper and 6.09 cents for oxide. The reclamation plants at Lake Linden and Hubbell were idle again, as in 1931 and 1932. At the Calumet mill 493,218 tons of rock were stamped in 1933. The Ahmeek mill was idle. The smelter received 26,345 tons of new concentrates during the year. Concentrates from stock brought the total tonnage treated at the smelter to 31,541 tons, from which 43,817,803 pounds of refined copper were produced.

In 1933, as in 1932, output at the Champion mine of the Copper Range Co. was maintained at 1,000,000 pounds of recoverable copper a month, all from the south end of the mine. The average cost of production was 7.51 cents a pound compared with 8.646 cents in 1932. The decrease in cost of production in the face of higher wage rates was possible largely because of careful hand-sorting, in the stope, of copper-bearing rock from barren rock. The yield was increased from 40.8 pounds in the first quarter to 67.91 pounds in the last three quarters of the year. The rock mined was of about the same quality as that mined in recent years. The Champion mill treated 203,940 tons of rock averaging 59.66 pounds of copper to the ton compared with 291,265 tons averaging 41.847 pounds in 1932. The plant of the Michigan Smelting Co., now operated under the name of Copper Range Co. Smelting Department, treated 9,700 tons of Copper Range mineral and 10,000 tons of Mohawk mineral. Smelting of Mohawk mineral was completed in July, and thereafter the plant was operated intermittently.

*Copper produced by the Champion mine of the Copper Range Co., 1929–33*

| Year | Rock stamped | Copper produced | Yield per ton | Cost per pound [1] | Price received |
|---|---|---|---|---|---|
| | *Short tons* | *Pounds* | *Pounds* | *Cents* | *Cents* |
| 1929 | 446,804 | 20,660,701 | 46.24 | 11.76 | 17.94 |
| 1930 | (2) | 19,999,564 | 44.57 | 11.60 | 11.43 |
| 1931 | [3] 404,830 | [3] 17,721,270 | [3] 43.77 | [3] 9.754 | [3] 8.2 |
| 1932 | 291,265 | 12,188,578 | 41.847 | 8.646 | 6.0 |
| 1933 | 203,940 | 12,167,130 | 59.66 | 7.51 | 7.46 |

[1] Excludes depreciation and depletion.
[2] Figures not given.
[3] Includes Baltic mine.

Mining operations at the Mohawk mine were discontinued on September 12, 1932. The Copper Range Co. reported that in 1933 it purchased for $25,000 all the lands and remaining buildings owned by the Mohawk Mining Co. in Keweenaw and Houghton Counties.

*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, 1932–33*

| Year | Lead concentrates | | | | Zinc concentrates | | | | Metal content [1] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Galena | | Carbonate | | Sphalerite | | Silicate | | Lead | | Zinc | |
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 1932 | 849 | $25, 837 | 646 | $14, 491 | 1, 538 | $25, 180 | 404 | $4, 248 | 1, 007 | $60, 420 | 946 | $56, 760 |
| 1933 | 1, 170 | 44, 337 | 307 | 9, 750 | 8, 798 | 245, 064 | 1, 325 | 19, 887 | 1, 010 | 74, 740 | 5, 042 | 423, 528 |

[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, 1930–33*

| | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|
| Total ore ... short tons | 328, 800 | 104, 800 | 46, 400 | 170, 800 |
| Total concentrates in ore: | | | | |
| Lead ... percent | 0. 40 | 1. 63 | 3. 61 | 0. 81 |
| Zinc ... do | 3. 89 | 3. 76 | 4. 69 | 4. 51 |
| Metal content of ore: | | | | |
| Lead ... do | . 31 | 1. 15 | 2. 48 | . 60 |
| Zinc ... do | 2. 25 | 2. 15 | 2. 60 | 2. 51 |
| Average lead content of galena concentrates ... do | 76. 0 | 74. 6 | 75. 6 | 72. 3 |
| Average lead content of lead carbonate concentrates ... do | 60. 0 | 59. 1 | 59. 6 | 60. 6 |
| Average zinc content of sphalerite concentrates ... do | 60. 0 | 58. 6 | 59. 5 | 59. 8 |
| Average zinc content of silicates and carbonates ... do | 40. 1 | 39. 0 | 39. 8 | 39. 4 |
| Average value per ton: | | | | |
| Galena concentrates | $59. 39 | $41. 21 | $30. 43 | $37. 89 |
| Lead carbonate concentrates | 53. 42 | 31. 78 | 22. 43 | 31. 76 |
| Sphalerite concentrates | 33. 55 | 22. 05 | 16. 37 | 27. 85 |
| Zinc silicates and carbonates | 24. 00 | 12. 63 | 10. 51 | 15. 01 |

*Tenor of lead ore and concentrates in southeastern Missouri disseminated-lead district, 1930–33*

| | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|
| Total lead ore ... short tons | 6, 681, 300 | 5, 135, 600 | 3, 740, 200 | 2, 490, 000 |
| Galena concentrates in ore ... percent | 4. 15 | 4. 36 | 4. 36 | 4. 67 |
| Zinc content of ore ... do | . 13 | . 04 | . 01 | ---------- |
| Average lead content of galena concentrates ... do | 73. 0 | 72. 4 | 72. 7 | 73. 7 |
| Average value per ton of galena concentrates | $59. 60 | $43. 93 | $30. 01 | $35. 12 |
| Average zinc content of sphalerite concentrates ... percent | 58. 2 | 57. 6 | 57. 15 | ---------- |
| Average value per ton of sphalerite concentrates | $18. 80 | $17. 86 | $16. 25 | ---------- |

*Mine shipments of lead and zinc concentrates in southeastern and central Missouri, 1907–33*

| Year | Lead concentrates (galena) | | Zinc concentrates | | | |
|---|---|---|---|---|---|---|
| | | | Sphalerite | | Carbonate and silicate | |
| | Short tons | Value | Short tons | Value | Short tons | Value |
| 1907–29 | 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 | | |
| 1933 | 116,226 | 4,081,486 | | | | |

The value of the lead and zinc shipped from Missouri mines was $6,712,048 in 1933 compared with $7,089,018 in silver, lead, and zinc in 1932. No silver was recovered from lead or copper ores in 1933 and only 1,128 ounces in 1932, as no copper ore was shipped in 1932 and no copper ore or zinc concentrates were shipped in 1933 from southeastern Missouri. The quantity of recovered lead declined from 117,159 tons in 1932 to 84,980 tons in 1933, and the recovered zinc increased from 986 tons in 1932 to 5,042 tons in 1933.

Shipments of lead concentrates (of which only 307 tons were lead carbonate) were 117,703 tons compared with 164,484 tons in 1932. Of the total in 1933, 116,226 tons were shipped from mines in southeastern Missouri and averaged 73.7 percent lead; the recovered lead content was 83,970 tons in 1933 compared with 116,152 tons in 1932.

Shipments of lead concentrates from mines in southwestern Missouri comprised 1,170 tons of galena and 307 tons of lead carbonate. In 1933, as in 1932, the quoted price for galena concentrates was that paid for small lots, and sellers of carload lots and larger lots were paid $2 to $4 above the quoted price.

The total value of concentrates sold is based on actual receipts by the sellers and not on quoted prices. Quoted prices of galena in the Tri-State region in 1933 ranged from $32.50 in February to $52.50 in June, July, and August, and the production ranged from about 1,300 tons in April to 3,750 in September. The base prices quoted for sphalerite ranged from $16 a ton in February to $35 in July and August, and the monthly production ranged from about 10,500 tons in April to about 25,500 in September.

All of the zinc concentrates shipped from Missouri mines in 1933 were from properties in southwestern Missouri. The total quantity of blende concentrates shipped (which included several thousand tons from stocks at mines) in 1933 was 8,798 tons, an increase of 7,180 tons. The blende concentrates had an average zinc content of 59.8 percent and brought an average price of $27.85 a ton.

The shipments of zinc silicate in 1933 were 1,325 tons (921 tons more than in 1932) and averaged about 39.4 percent in zinc content. All the zinc silicate was purchased at a flat price, as there were no quoted prices in 1933 and there was a demand from only one smelter.

The flotation concentrates made in Missouri in 1933 were 550 tons of sphalerite and 44,747 tons of galena.

The quantity of crude ore and old tailings treated in Missouri in 1933 was 2,660,800 tons. The total amount received for all classes of lead and zinc concentrates sold in 1933 was $4,400,524, an average of $1.65 per ton of crude ore and old tailings treated (34 cents more than in 1932).

There was no special demand for high-grade, lead-free zinc concentrates, and most operators endeavored to keep their milled sphalerite at about 60 percent zinc content. Some zinc concentrates were shipped under contract and not sold to smelters. These concentrates were valued at the current weekly base price of sphalerite on the date of shipment.

*Southwestern Missouri.*—More mills were operated in southwestern Missouri in 1933 than in 1932, but nearly all operated intermittently. The largest shipper of blende concentrates, the Kansas Exploration Corporation, did no milling in 1933 but cleaned out all stocks at mines. Various lessees at Waco, including the Playter Mining Co., were the next largest shippers of blende concentrates. The Missouri Mining Co. built a 600-ton tailing plant at Chitwood which was operated during November and December. A 250-ton mill was erected at Diamond by the American Zinc, Lead & Smelting Co. which was treating ore in December 1933. Other shippers of zinc concentrates were the Connico Mining Co. at Fidelity, the Webb City Mining Co. at Carl Junction, and the Mary Jane Mining Co. at Joplin. The Locklyn Mining Co. at Stotts City produced some concentrates before its concentrating plant was burned. The plant has been rebuilt, and another shaft has been sunk.

Some old mines near Springfield were reopened, and a small quantity of high-grade blende and galena was sold.

The zinc silicate shipped in 1933 was mainly from small mines at Granby, Joplin, Aurora, and Wentworth, and small shipments were made from mines at Ozark and Westplains. All the galena and lead carbonate sold were small lots from Joplin, Granby, Oronogo, and Webb City. The 66 Mine Corporation opened a mine at Carthage, and a 200-ton mill was under construction in December. The old Movokan mine near Joplin was acquired by the Triple P. Mining Co.; the mine was unwatered and the mill repaired preparatory to treating ore and old tailings. Land owners and lease holders in the Webb City-Oronogo district have applied for a $450,000 loan from the PWA to unwater a large part of the camp, which has been idle many years, and to construct a modern, 500-ton, steel concentrating plant, to serve as a custom mill for all mines operated under the project.

*Southeastern Missouri.*—The lead ore (2,490,000 tons) mined in the disseminated-lead district in southeastern Missouri yielded 4.67 percent in galena concentrates averaging 73.7 percent lead. As the operators mine and smelt their lead concentrates the assigned value of $35.12 a ton is more or less arbitrary. Of the 215 tons of galena produced by operators of shallow diggings most was purchased and shipped by T. F. Blount of Potosi. The Annapolis mine in Iron County was 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 about 17,000 tons, milled about 2,400,000 tons of crude ore. They were operated at the following percentages of their capacity in 1933: April 1 to May 26, 25; May 27 to August 26, 33.3; August 27 to September 30, 37; and October 1 to December 31, 50. The St. Louis Smelting & Refining Co., a subsidiary of the National Lead Co., operated its 3,500-ton plant only in January and February and then discontinued all mining and milling.

*Oklahoma.*—Many mills in Oklahoma were idle in the early part of 1933. The increase in the base price of sphalerite from $16 a ton to more than $30 resulted in a large number of mills being started. The large operators, however, voluntarily restricted output, when stocks threatened to accumulate, by closing for certain periods each month. About 65 mills were operated during 1933, but virtually none was in successive daily operation. Stocks of sphalerite were reduced to the normal 2 weeks' supply, and most of such stocks were held by a few operators who declined to sell even at $35 a ton. About 2,600 tons of the galena and 68,500 tons of the sphalerite were flotation products.

*Mine shipments of lead and zinc in Oklahoma in 1933, by districts*

| District | Lead concentrates (galena) | | Zinc concentrates (sphalerite) [2] | | Metal content [1] | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lead | | Zinc | |
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| Miami | 23,338 | $1,033,575 | 172,095 | $4,441,772 | 17,809 | $1,317,866 | 91,025 | $7,646,100 |
| Peoria | 300 | 13,000 | [2] 116 | 2,082 | 229 | 16,946 | 40 | 3,360 |
| | 23,638 | 1,046,575 | 172,211 | 4,443,854 | 18,038 | 1,334,812 | 91,065 | 7,649,460 |
| Total, 1932 | 13,649 | 468,891 | 118,276 | 2,177,934 | 10,634 | 638,040 | 63,437 | 3,806,220 |

[1] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

[2] Output from Peoria in 1933 is zinc silicate containing 40 percent zinc.

*Tenor of lead and zinc ore, old tailings, and slimes milled and concentrates produced in Oklahoma, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Crude ore | Old tailings and slimes | Crude ore | Old tailings and slimes |
| Total ore, etc., milled ........ short tons | 1,262,200 | 325,500 | 2,188,200 | 1,433,900 |
| Total concentrates shipped: | | | | |
| Galena ........ do | 13,437 | 212 | 23,193 | 445 |
| Sphalerite ........ do | 108,332 | 9,944 | [1] 148,541 | 23,554 |
| Ratio of concentrates to ore, etc.: | | | | |
| Lead ........ percent | 0.79 | 0.05 | 0.92 | 0.03 |
| Zinc ........ do | 6.01 | 2.28 | 6.02 | 1.53 |
| Metal content of ore, etc.: | | | | |
| Lead ........ do | .63 | .04 | .72 | .02 |
| Zinc ........ do | 3.66 | 1.37 | 3.63 | .97 |
| Average lead content of galena concentrates ........ do | 79.6 | 73.1 | 78.1 | 63.8 |
| Average zinc content of sphalerite concentrates ........ do | 61.0 | 60.3 | 60.3 | 58.9 |
| Average value per ton: | | | | |
| Galena concentrates | $34.47 | $26.75 | $44.60 | $27.39 |
| Sphalerite concentrates | 18.50 | 17.48 | 25.64 | 26.85 |

[1] Also 116 tons of zinc silicate.

*Mine production of lead and zinc concentrates in Oklahoma, 1891–1933, by districts*

| District | Lead concentrates (mainly galena) | | Zinc concentrates | | | |
|---|---|---|---|---|---|---|
| | | | Sphalerite | | Zinc silicate and carbonate | |
| | Short tons | Value | Short tons | Value | Short tons | Value |
| Davis | | | 558 | $27, 399 | 899 | $24, 592 |
| Miami [1] | 1, 086, 100 | $93, 681, 009 | 5, 922, 066 | 240, 337, 607 | 164 | 2, 692 |
| Peoria | 2, 554 | 123, 763 | 220 | 8, 289 | 3, 060 | 78, 869 |
| | 1, 088, 654 | 93, 804, 772 | 5, 922, 844 | 240, 373, 295 | 4, 123 | 106, 153 |

[1] Including Quapaw and Sunnyside.

At the old camp of Peoria, G. G. McConkey shipped galena and zinc silicate and then sold his holdings to the Log Cabin Mining Co. The new owners built a 150-ton mill which was operated late in December 1933. A number of leases were operated at Commerce, and 532 tons of galena and 1,737 tons of sphalerite were shipped. The largest shippers were the Lost Trail Mining Co. and the Crabapple Mining Co. The Quapaw-Sunnyside area had numerous small operators. Among the shippers of concentrates were the Atlas Milling Co. (tailings), Mission Mining Co., Hicks Mining Co., White-McKay Mining Co., Prairie Chicken Mining Co., and East Side Mining Co. The shipments of galena and sphalerite from the Douthat area were mainly those of the Admiralty Zinc Co., Ramage Mining Co., Meyer Milling Co. (tailings), and Skelton Lead & Zinc Co. A mill was built by the Lawyers Lead & Zinc Co., but it was not operated until 1934. The largest shippers from the Hockerville area were the Canadian Mining & Milling Co., Roberts & White (Farmington mine), Massell Mining Co., Blue Bonnet Mining Co., Lucky Ox Mining Co., and C. Y. Semple (Brewster tailings).

Near Picher and Cardin the larger shippers in 1933 were the Eagle-Picher Mining & Smelting Co., Davis Mining Co., Tri-State Zinc Co. (tailings), Cardin Milling Co. (tailings), Hutt Mining Co. (tailings), Peru-Laclede Syndicate (tailings), Interstate Zinc & Lead Co., W. H. Aul & Co. (tailings), Evans Wallower Lead Co., Commerce Mining & Royalty Co. (2 mills), Rialto Mining Corporation, Velie Mines Corporation, Century Zinc Co. (Barnsdall mine), Pioneer Lead & Zinc Co. (tailings), and F. & B. Milling Co. (tailings).

Among the mines operated by sublessees which shipped crude ore to the large Central mill of the Eagle-Picher Mining & Smelting Co. were the Blue Diamond, Davis 1 and 2, Crystal, Waxahachie, Kitty, Golden Hawk, Mudd, Foch, Tri-State, Robob, and Underwriters 1 and 2.

*Wisconsin.*—Very little prospecting was done in Wisconsin in 1933, and no new mines were opened. The National Zinc Separating Co. at Cuba City, which was merged with the Vinegar Hill Zinc Co., was the only roasting plant operated in Wisconsin in 1933. Virtually all the raw zinc concentrates were treated at this plant before shipment to smelters. The Vinegar Hill Zinc Co., which was the largest producer, worked the Badger, Crawford, and Trewartha mines. The Badger mine was worked out and abandoned in 1933. The Lucky Five

Mining Co. operated its mine and mill during the last 3 months of 1933 only. The Badger Zinc Mining Co. all-flotation plant was idle the entire year.

*Mine production of lead and zinc in Wisconsin, 1932–33*

| Year | Lead concentrates | | Zinc concentrates (sphalerite) | | Metal content [1] | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lead | | Zinc | |
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 1932 | 1,312 | $38,493 | 28,133 | $178,326 | 910 | $54,600 | 7,522 | $451,320 |
| 1933 | 760 | 31,056 | 25,786 | 331,242 | 540 | 39,960 | 7,800 | 655,200 |

[1] In calculating the metal content of the ores from assays allowance has been made for roasting and smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

*Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1930–33*

| | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|
| Total ore ... short tons | 486,400 | 318,700 | 310,300 | 256,400 |
| Total concentrates in ore: | | | | |
| Lead ... percent | 0.44 | 0.41 | 0.42 | 0.30 |
| Zinc ... do | 10.6 | 10.7 | 9.07 | 10.01 |
| Metal content of ore: | | | | |
| Lead ... do | .32 | .30 | .30 | .22 |
| Zinc ... do | 3.34 | 3.69 | 2.98 | 3.60 |
| Average lead content of galena concentrates ... do | 73.5 | 74.3 | 70.7 | 72.5 |
| Average zinc content of sphalerite concentrates ... do | 31.6 | 34.3 | 32.9 | 35.7 |
| Average zinc content of zinc carbonate concentrates ... do | 43.0 | ----- | ----- | ----- |
| Average value per ton: | | | | |
| Galena concentrates | $60.91 | $45.35 | $29.34 | $40.86 |
| Sphalerite concentrates | 13.00 | 9.28 | 6.34 | 12.85 |
| Zinc carbonate concentrates | 27.77 | ----- | ----- | ----- |

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA

**(MINE REPORT)**

By F. W. Horton and H. M. Gaylord

SUMMARY OUTLINE



The value of the gold, silver, copper, lead, and zinc from mines in Nevada in 1933 is estimated at $5,519,754, with gold calculated at $20.671835 a fine ounce. This is an increase of $452,583 or 8.9 percent over the total value of the metals marketed in 1932 and is accounted for by increases in the production and value of copper, lead, and zinc. The increases in the last two metals were not due entirely to greater mining activity, as a considerable quantity of lead and zinc concentrates from ore mined in 1930 and 1931 was shipped in 1933, which accounted largely for the gain in their recorded production. The quantities of gold and silver produced decreased, but the value of the silver output increased $8,769 due to a higher average price of the metal in 1933 (35 cents an ounce compared with 28.2 cents in 1932).

Copper was the leading metal in terms of marketed value and yielded 45.13 percent of the total value of the five metals. Gold ranked second and yielded 35.58 percent of the total value, followed by zinc (9.36 percent), silver (6.82 percent), and lead (3.12 percent). The low price of silver and of the base metals, together with large stocks of the latter, made it difficult for Nevada operators to continue mining, and 1932 and 1933 registered low marks for the total value of metals produced in the State. In 1933 the value of the production was only about one-sixth that in 1929. Several properties were closed throughout the year, but with the improvement in the price of metals during the latter part of the year some operators were preparing to reopen their mines. A noticeable increase in gold-mining operations followed the rise in gold prices, particularly in the Comstock district where there was much activity among old-time silver-gold producers. Mills at Silver City were busy on custom ore and both the Comstock and Silver City districts, active mining camps of former days, took on new life.

*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of $20.671835 from January 1 to August 9 to all producers; (2) that of (*a*) $20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export by some producers, to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, September 8 to November 1); and (4) the period of the Reconstruction Finance Corporation arbitrarily fixed, gradually rising price (generally above the world price), October 25 to December 31, 1933. For greater details see the general article on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

Below is a table of mine gold production in Nevada, 1929–33, in terms of recovered metal; two values (1) the legal coinage value ($20.67+ per ounce) and (2) the average weighted price ($25.56 per ounce) are given for 1933.

*Mine production of gold in Nevada, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 163,711.22 | $3,384,211 | 1932 | 129,719.83 | $2,681,547 |
| 1930 | 149,064.47 | 3,081,436 | 1933 [2] | 95,000.00 | [3] 1,963,824<br>[4] 2,428,200 |
| 1931 | 142,293.76 | 2,941,473 | | | |

[1] 1929–32: At legal value ($20.67+ per ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] Subject to revision.
[3] Gold figured at legal coinage value ($20.671835 per ounce).
[4] Gold figured at average weighted price ($25.56 per ounce).

*Mine production of gold, silver, copper, lead, and zinc in Nevada, 1929–33, in terms of recovered metals*

| Year | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|
| | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| 1929 | 163,711.22 | 4,923,526 | 140,138,809 | 19,692,568 | 16,920,083 | $33,030,237 |
| 1930 | 149,064.47 | 4,219,832 | 109,203,512 | 23,058,381 | 29,168,117 | 21,455,517 |
| 1931 | 142,293.76 | 2,562,071 | 72,634,497 | 15,860,634 | 20,861,438 | 11,673,787 |
| 1932 | 129,719.83 | 1,304,365 | 31,487,606 | 880,986 | 254,795 | 5,067,171 |
| 1933 [1] | 95,000.00 | 1,076,000 | 38,920,000 | 4,648,000 | 12,297,000 | [2] 5,519,754 |

[1] Subject to revision.
[2] Gold figured at legal coinage value ($20.671835 per fine ounce).

*Calculation of value of metal production.*—The value of metal production hereinafter reported has been calculated at the figures given in the following table. 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. Gold values do not appear in the table but are computed hereinafter at $20.671835 per fine ounce.

*Prices of silver, copper, lead, and zinc, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Gold.*—In 1933 Nevada made an estimated output of 95,000 fine ounces of gold compared with 129,720 ounces in 1932, a decrease of 26.8 percent. The Nevada Porphyry Gold Mines, Inc., at Round Mountain, the Nevada Consolidated Copper Corporation, at Ely, and the White Caps Gold Mining Co., at Tonopah, were the only three companies in the State that produced more than 10,000 ounces of gold each in 1933. These three companies yielded about 37 percent of the total gold output. Other leading gold producers with outputs between 1,000 and 10,000 ounces were: Black Mammoth Consolidated Mining Co. (Mary mine), Silver Peak district, Esmeralda County; Tonopah Mining Co., Tonopah district, Esmeralda and Nye Counties; Bradshaw, Inc. (Goldfield Consolidated tailings dump), Goldfield district, Esmeralda County; Copper Canyon Mining Co., Battle Mountain district, Lander County; Consolidated Coppermines Corporation, Robinson district, White Pine County; Miners Gold Mining Co., Gold Circle district, Elko County; Goldfield Deep Mines Co., Goldfield district, Esmeralda County; Arizona Comstock Corporation, Comstock district, Storey County; and the Tonopah Divide Mining Co., Divide district, Esmeralda County. These 11 companies produced 30.75 percent of the gold output of the State and together with the 3 leading producers yielded 68 percent of the total gold. The Elkoro Mines Co., at Jarbidge, one of the leading gold producers in 1932, did not operate in 1933. Noteworthy placer mining was carried on in the Lynn district, Eureka County; Battle Mountain district, Lander County; Manhattan and Round Mountain districts, Nye County; and Placerites district, Pershing County. With the closing of the Carson City Mint July 1, 1933, gold producers were obliged to send their output elsewhere, and much of the production during the last half of the year went to the San Francisco Mint.

*Silver.*—Silver production from mines in Nevada declined from 1,304,365 fine ounces in 1932 to 1,076,000 in 1933, a decrease of 17.5 percent, but the value of the output increased slightly from $367,831 to $376,600. The leading silver producers were the Tonopah Mining Co., Combined Metals Reduction Co., Nevada Consolidated Copper Corporation, Bristol Silver Mines Co., Gold Circle Consolidated Mines Co., and Treadwell Yukon Co., Ltd. The silver in stored lead and zinc concentrates from ore mined at Tybo in previous years and shipped by the last-named company placed it among the chief silver producers in 1933. These 6 companies produced between 70 and 75 percent of the total silver output of the State. Mining of straight silver ore was nearly nil, and almost the entire yield was derived from gold-silver, copper, lead, and zinc ores. The prominent silver-producing districts in the past have been Tonopah (Esmeralda and Nye Counties), Tybo (Nye County), Pioche (Lincoln County), Jarbidge (Elko

County), Robinson (White Pine County), Jack Rabbit (Lincoln County), Cherry Creek (White Pine County), and Gold Circle (Elko County).

*Copper.*—The copper produced from mines in Nevada in 1933, in terms of recoverable metal, was 38,920,000 pounds valued at $2,490,880 compared with 31,487,606 pounds valued at $1,983,719 in 1932, an increase of 7,432,394 pounds or 23.6 percent in quantity and of $507,161 or 25.6 percent in value. The Nevada Consolidated Copper Corporation was again the leading producer of copper, although its operations were somewhat intermittent during the early part of the year and repairs temporarily stopped all smelter operations during the latter part of the year. The company afforded a market for low-grade siliceous ore and purchased about the same tonnages from shippers at Kimberly, Cherry Creek, and Ely as in 1932. The Copper Canyon Mining Co. made regular shipments to the Garfield and Tooele smelters, and the Bristol Silver Mines Co. shipped copper-lead ore to Tooele during the last half of the year. These three companies were the leading copper producers of the State. The remainder of the copper output came from ores mined primarily for their gold and other metal content. The Consolidated Coppermines Corporation operated its mines 8 months of the year and shipped gold-bearing ore to the International smelter at Tooele.

*Lead.*—The production of recoverable lead in Nevada increased from 880,986 pounds in 1932 to 4,648,000 in 1933, a gain of 3,767,014 pounds (428 percent). In June the Treadwell Yukon Co., Ltd., began shipping the lead-zinc concentrates it had held in storage for over a year to the Amarillo smelter in Texas. The output of lead from this source, together with the lead contained in ore produced by the Combined Metals Reduction Co., made up the larger part of the total lead output. The Bristol Silver Mines Co., the next largest producer of lead, shipped copper-lead ore mined by lessees on its property in the Jack Rabbit district, of Lincoln County. Ore shipped from the Pilot Mountains district, Mineral County, and the White Pine district, White Pine County, to the Midvale smelter, Utah, yielded considerable lead. Lessees on the Richmond Eureka Mining Co. property in the Eureka district, Eureka County, also shipped lead-bearing ore, and some was shipped from Clark County. The companies mentioned produced virtually the entire output.

*Zinc.*—The output of recoverable zinc from Nevada ores in 1933 was 12,297,000 pounds valued at $516,474, an increase of 12,042,205 pounds in quantity and $508,830 in value compared with 1932. All of the zinc marketed came from lead-zinc ore mined at Pioche by the Combined Metals Reduction Co. and from lead-zinc concentrates shipped by the Treadwell Yukon Co., Ltd. The Combined Metals Reduction Co. treated ore at its flotation plant near Stockton, Utah, and shipped the zinc concentrate to the Anaconda Mining Co. electrolytic zinc plant in Montana. The Treadwell Yukon Co. shipped its concentrates to the Amarillo plant of the American Smelting & Refining Co. in Texas. The Yellow Pine Mining Co., at Goodsprings, Clark County, shipped carbonate lead-zinc ore to the Ozark Smelting & Refining Co. plant at Coffeyville, Kans. A new plant manufacturing zinc oxide at Richmond, Calif., treated zinc carbonate ore shipped from the Muncy Creek mine and the property of the Ely Gold Mining Co.

## REVIEW BY COUNTIES AND DISTRICTS

*Churchill County.*—Production of gold and silver in Churchill County was small in 1933. A shipment of gold-silver ore was made from a property in the Fairview district, 42 miles east of Fallon, and a small lot of ore from the Rainbow mine in the Jessup district was treated at the Olinghouse mill. A small quantity of placer gold was dry-washed in the Ione district.

*Clark County.*—The value of all metals produced in Clark County in 1933 decreased from that in 1932. Seven mines, each with an output between 50 and 400 ounces of gold, yielded nearly 90 percent of the total gold produced. Placer miners along the Colorado River east of Nelson and Searchlight contributed 100 to 150 ounces to the gold output. Mining in the Eldorado Canyon district was active. A mill was installed at the Eldorado Boulder, a flotation plant at the Eldorado Merger, and a new mill was planned at the Techatticup mine for the treatment of tailings by flotation. The Eldorado Rand Co. operated its 10-stamp amalgamation and cyanidation mill the entire year and was the largest producer of gold in the county and district. The ore from this property contains pyrite, chalcopyrite, tetrahedrite, sphalerite, galena, quartz, and calcite.

A new body of free-milling ore was opened at the Nippeno mine near Crescent. The Duplex mine in the Searchlight district was the second largest gold producer in the county. Its mill was dismantled and the ore was treated either in a custom amalgamation mill at Searchlight or shipped to a smelter. The Good Hope and St. Louis mines were operated and the bullion recovered was shipped to the Selby smelter, Calif. Ore and old tailings from the Golden Chariot mine, owned by the Campbell Estate, was treated by amalgamation and cyanidation. The mine was operated continuously but the mill only periodically. Small lots of ore shipped mostly to the Midvale smelter and ore from the shaft of the old Pompeii mine made up the balance of the gold yield of the county. The output of lead and zinc was derived from the Yellow Pine Mining Co. property under development by the U.S. Smelting, Mining & Refining Co., which discovered a new ore body.

*Douglas County.*—There was little mining in Douglas County. The production of gold did not exceed 50 ounces and came largely from the Gardnerville district. In the vicinity of Minden in the Mt. Siegel district a little placer mining was reported.

*Elko County.*—Gold and silver were the chief metals produced in Elko County in 1933, but the output was below that of 1932. The county is one of the five leading ones in gold output. Ore yielding gold, silver, and copper was shipped from the Charleston district to Utah smelters, and two cars of lead ore were shipped from the Delano district. Gold Circle was the principal producing district in the county. The Buena Gold Mines, Inc., the Miners Gold Mining Co., and the Gold Circle Consolidated Mines Co. were the leading gold producers. The Buena Co. (Esmeralda and Cook groups) operated from April 1 to December 24 and treated nearly 700 tons of gold ore in its 10-ton ball mill. This company leased the Sleeping Beauty mine, which has produced some high-grade gold ore. The Miners Gold Mining Co. treated its ore in the Gold Circle cyanide plant. This company and the Gold Circle Consolidated Mines Co. were the two largest producers in the district. The latter company started unwatering the Elko Prince mine and opened up new ore shoots on the 100-foot level. The Bluster mine was the largest of several small producers in the Jarbidge district. The tailings dump of the old Legitimate group of claims was cyanided and virtually worked out. The Elkoro Mines Co. closed its property April 1, as the ore body was exhausted; no ore was shipped in 1933. In the Mountain City district the International Smelting Co. continued development of the Rio Tinto property, which was begun in June 1931, but shipped no ore. One lot of zinc ore from the Muncy Creek mine in the Mud Springs district was shipped to the zinc oxide plant of the Metals Recovery Co. at Richmond, Calif. The Bruneau Consolidated Gold Mines Co. in the Rowland district did 200 feet of development work and treated 300 tons of gold ore by amalgamation. Small shipments of lead ore from the Tecoma district were made to Utah smelters. Some placer mining was done in the Tuscarora district.

*Esmeralda County.*—This county was one of the five leading gold-producing counties in the State in 1933, and with increasing gold and silver prices there was much activity. The mill of the Tonopah Mining Co., at Millers, was rebuilt by the General Metals Recovery Corporation, and plans were effected to work the old tailings accumulated over a period of 26 years. In the Desert district Gilbert Bros. operated the Mammoth and Last Hope mines and treated ore in a 30-ton amalgamation plant. The Gilbert Mammoth Gold Mines Co. shipped 100 tons of gold ore to the Garfield smelter. The property of the Tonopah Divide Mining Co. was the largest producer of gold in the Divide district, but the production was from lessees who shipped their ore to Garfield for treatment. The ore contained a much higher gold content than in 1932, although a smaller tonnage was mined. During the latter part of the year the Diamondfield Daisy Gold Mining Co. shipped gold ore to the Midvale smelter. The Gold Zone Mining Co. and the Brougher Divide Mining Co. each shipped a car of ore to Utah smelters. Although the production of the Goldfield district was less than in 1932, new developments presaged an increase in its output.

The decreased gold output was due to completion of the cyanidation of the Goldfield Consolidated tailings dump by Bradshaw, Inc. This company was reorganized and under the name of Bradshaw Syndicate, Inc., leased a dump of lower-grade tailings, estimated to contain 1,250,000 tons, about 1,800 feet north of the old plant which it began remodeling in preparation for production early in 1934. High-grade gold ore was mined from the old workings of the Florence claims of the Goldfield Deep Mines Co. and shipped to the smelter by lessees. The Imperial mine in the Railroad Springs district was under development, and construction of a cyanide mill was begun. The Mary mine in the Silver Peak district continued to be the largest producer in the district, and increased ore shipments with a larger yield in gold and silver were made from the mine by the Lucky Boy Divide Mining Co. In Tule Canyon, southern Esmeralda County, the Los Angeles Rock & Gravel Corporation prospected stream gravel 10 miles from Lida and the same distance from Gold Point, with a small yield of gold bullion. The Tonopah Extension Mines, Inc., shipped about 350 tons of gold-silver ore from its Esmeralda property.

*Eureka County.*—The two leading producing districts in the county were Eureka and Lynn, the former producing from lode mines and the latter from placers. Lessees operated the property of the Richmond Eureka Mining Co. and shipped 130 tons of lead ore to the Midvale plant of U.S. Smelting, Mining & Refining Co., owner of the property. In the Lynn district the Bull Dog placer, 21 miles north of Carlin, was worked from March through December and yielded nearly 100 ounces of gold. The Arrowhead and Spotted Horse placer claims in Sheep Canyon, belonging to the Nelson Bros., were worked by dry-wash methods and produced nearly 150 ounces of gold 0.933 fine. Small lots of placer gold were reported shipped from other claims in the district. Lead-silver ore was shipped from the Consolidated Silver Cortez property during the latter part of the year.

*Humboldt County.*—The production of metals in Humboldt County came mostly from small producers. Most of the gold ore mined was treated by amalgamation. A 10-stamp mill was built at the Daveytown mine, although only 5 stamps were operated. The ore at this property occurs in small lenses, and approximately 1,000 tons were treated in 1933. A lessee shipped high-grade gold ore from the Buckskin National property in the National district. The 50-ton flotation mill on the property was not operated. The Basque Mining & Milling Co. shut down its Big Four mines in the Sherman district after treating 400 tons of ore in its amalgamation-concentration mill. In the Winnemucca district the Nevada Consolidated Mines Co. did 600 feet of drifting at its property, which is developed by 6,800 feet of underground workings, and treated 100 tons of ore averaging $27 a ton in gold and silver. On account of the low price of silver its activities were confined principally to development work. Fifteen tons of lead ore were shipped from the Gold Summit and Panic claims and yielded 40 ounces of gold, 160 ounces of silver, and 2,160 pounds of lead. The claims were worked from July to October. Outputs of placer gold were reported from the Gold Run, Leonard Creek, Sawtooth, and Winnemucca districts.

*Lander County.*—The value of metal production in Lander County, one of the five chief gold-producing counties in 1933, was largely from gold and silver, and the principal activity was in the Battle Mountain district. The leading producer was the Copper Canyon Mining Co., operating both lode and placer properties. Shipments of ore were made to copper smelters from the Copper Canyon mine, and increases in tonnage and in the gold and copper content of the ore were reported. Indications for continued production of gold ore from the district in 1934 were promising. Single cars of ore shipped from Betty O'Neal, Buffalo Valley, Hilltop, Humbug, and other properties made up the total output of the county from lode mines. Lessees worked the Copper Canyon placer property by hand rockers and small placer machines and shipped gold 0.870 fine to the San Francisco Mint; the yield increased slightly over that in 1932. The Dahl and Christensen placer in the same district was actively worked by the Grand Hills Mining Co. of Oklahoma City, Okla., and was the largest producer of placer gold. Old tailings and bench gravels were worked with a steam shovel having a daily capacity of 2,400 cubic yards. Placer gold also was recovered from the Bullion district.

*Lincoln County.*—Gold, silver, copper, lead, and zinc were produced in Lincoln County in 1933, the largest output being derived from the Pioche district. Here the Combined Metals Reduction Co. operated its property from August 1 to December 31 and shipped ore from its

Amalgamated Shaft No. 1 to its flotation plant at Stockton, Utah. The ore is a high-grade, lead-zinc-silver ore, and with improvment in the prices of these metals the company renewed mining activities after a shut-down in 1931. The Prince Consolidated Mining Co. shipped from the Comet mine ore which averaged 0.03 ounce of gold and 25 ounces of silver to the ton and 30 percent lead. Development work was actively carried on, and the Union Pacific Railroad considered rebuilding the Prince Spur to provide transportation for the ores from the Prince mines and the Caselton shaft of the Combined Metals Reduction Co. In the Caliente district, gold ore was shipped from the Advance group, and 500 feet of development work were done. The Easter mine in this district was also under development, and a car of ore averaging 0.95 ounce of gold and 3.9 ounces of silver to the ton was shipped to a smelter. In the Ferguson district the Jumbo claim of the Delamar Exploration Co. was operated by a lessee who shipped 2 lots of ore to Utah smelters, averaging 3.5 and 4.2 ounces of gold and 4.19 and 10.22 ounces of silver to the ton. Mining at the property was carried on 9 months of the year, and considerable surface equipment was installed. Ore averaging 0.88 ounce of gold and 14.2 ounces of silver to the ton was shipped from the Magnolia mine of the Delamar Co. The Caliente Cyaniding Co. treated the Delamar tailings dump by the decantation method of cyaniding. Small lots of lead ore were shipped from the Groom district. During the latter part of the year the Bristol Silver Mines Co. began shipping silver-lead-copper ore to the smelter from its property in the Jack Rabbit district, which is developed by a 1,200-foot inclined shaft.

*Lyon County.*—In Lyon County production came mostly from the Silver City district where there are many small mines, and much custom ore is treated at the Donovan and Trimble mills. Producing mines were the Emma Nevada, Gordon, Keyes, Milwaukee, and Montezuma, none of which, with the exception of the Milwaukee, produced more than 75 ounces of gold. The Western Empire Gold Mines, Inc., developed the Keyes, Milwaukee, and Mount Bullion mines and milled the ore in the plant of the Recovery Milling Co. at Silver City; the concentrates and bullion were shipped to California for treatment. The 10-ton flotation pilot mill on the Pony Meadows and Stone Cabin groups treated 200 tons of gold ore from the property, and the machinery for a 200-ton flotation plant was purchased but not installed in 1933. A small crew operated the Washington claim in the Talapoosa district and shipped 3 cars of ore containing $20 a ton in gold and silver to Salt Lake smelters. Lode and placer mining were carried on in the Yerington district, and small outputs of gold, less than 15 ounces each, were reported by individuals. A lessee on the Mason Valley mine, belonging to the Eastern Iron & Metal Co., shipped 3 cars of copper ore to the Garfield smelter.

*Mineral County.*—All mining districts of Mineral County produced gold, silver, copper, or lead in 1933, but except for the Pilot Mountains, Pine Grove, Regent, and Silver Star districts only small operations were reported. Lessees shipped a car of gold ore from the Olympic mine, Bell district. In the Pine Grove district the Interstate Mining & Development Co. in May discovered a new vein running parallel to the Rockland, with narrow cross fractures of high-grade ore. Amalgamation and concentration equipment was to be installed on the property for operation in May 1934. Several gold producers in the Pilot Mountains district shipped small lots of ore to smelters. The principal lead and silver production of the district came from 54 tons of ore shipped by Flagg & Whiting from a property 26 miles southwest of Mina. One lot of ore from the Storm Cloud mine contained 307.395 ounces of gold and 225.15 ounces of silver to the ton. Two other lots ran 10.73 and 12.205 ounces of gold and 9.9 and 21.75 ounces of silver to the ton. A car of ore averaging 0.965 ounce of gold and 33.55 ounces of silver to the ton was shipped from the Nevada Rand mine in the Rand district. In the Regent (Rawhide) district gold and silver were produced from both lode and placer mines; all ore was shipped to a smelter. The Owl dump was worked with a dry washer and yielded the largest output of gold in the district. The Rosenberg placer produced over $600 in gold by dry washing. In the Silver Star district the Sunset mine of the Sunnyside group was the largest producer of gold. The Mina Gold Mines Co. shipped precipitates from the Douglass mine.

*Nye County.*—Manhattan, Round Mountain, and Tonopah were the chief producing districts in Nye County, which was one of the five leading gold-producing counties in the State in 1933. Although gold was the chief product, some lead ore was shipped from the Bullion district. The White Caps Gold Mining Co., Nevada Porphyry Gold Mines, Inc., Tonopah Mining Co., and Tonopah Extension Mines, Inc., were the largest producers in the county. At Manhattan the White Caps mine was operated by lessees during the entire year and made a larger gold output than in 1932. The ore was shipped to the Garfield smelter. The Chaffin Lease operated a 100-ton cyanide plant on White Caps tailings. A lessee cyanided 2,400 tons of tailings from the War Eagle mill during the latter part of the year. About 800 tons of gold ore were shipped from the Jumbo mine, which was worked by the glory-hole method. The Kane 10-stamp custom mill treated gold ore from several properties in the district, principally the Amalgamated, Consolidated, Crescent, Mayflower, Nelly Gray, Stray Dog, and Verden. At Round Mountain the Gold Hill Development Co. treated 6,200 tons of ore in its 100-ton cyanide plant and shipped the precipitates to a California smelter. The property was closed in March.

The Sunnyside and Fairview mines of the Nevada Porphyry Gold Mines, Inc., were operated profitably in 1933. The company's placer property yielded a large output of gold. Small lots of placer gold from dry washing were produced in the district. At the Monte Cristo mine 300 tons of ore were treated by amalgamation in the 5-ton ball-mill plant. In the Tonopah district the property of the Tonopah Belmont Development Co. was idle. The Thirty-First Annual Report of the company states that steps were being taken to determine whether the tailings from the mill at Tonopah, consisting of over a million tons, could be re-treated at a profit, which seemed possible on account of the increased metal prices. Lessees operated the Tonopah Extension mine and shipped a small tonnage of ore and mill clean-up material to the Garfield and Selby smelters. At the property of the Tonopah Mining Co. the number of leasers increased considerably due to the rise in the price of gold and silver. Production and shipments to the smelters were 4,444 dry tons of ore containing 3,796 ounces of gold and 334,523 ounces of silver. In addition, 132 tons of material were recovered from mill clean-up, containing 584 ounces of gold and 50,290 ounces of silver. During the year a lease was granted to the General Metals Recovery Corporation for treating the mill tailings at Millers. This operation, however, continued for only about 2 months due to inadequate plant facilities. Plans were under way to alter and reconstruct the plant, which it was hoped would make the operation successful. The Tybo property of the Treadwell Yukon Co., Ltd., was closed throughout the year, but the company expected to reopen it early in 1934. Stored zinc concentrates were shipped to the Amarillo smelter in Texas.

*Pershing County.*—The chief production in Pershing County in 1933 was gold and silver from lode and placer mining in the Rochester, Rosebud, Scossa, and Seven Troughs districts. A shipment of lead ore was made from the Aldrich district, and a little lead was recovered from gold ores in the Sierra district. Small lots of gold ore were shipped from the Box Canyon, Imlay, and Lovelock districts, and much placer mining was carried on in the Placerites district. Limerick Canyon yielded considerable placer gold by dry washing. In the Scossa district the Dawes Gold Mines, Inc., shipped 140 tons of gold ore and did much development work on the Scossa property. The Nevada State Gold Mines Co., controlling the Seven Troughs mine, reported approximately 500 tons of ore mined and shipped by lessees. The Rogers mill treated custom ore in addition to the 225 tons mined by the Rogers Bros. at the Reagen No. 2 claim of the Nevada State Gold Mines Co.

*Storey County.*—Although the famous Comstock district is in Storey County, it was not one of the five leading gold-producing counties in 1933, and since 1928 the value of its gold output has not exceeded $100,000. However, considerable activity was reported in the county during 1933. The Donovan amalgamation and cyanidation plant and the Trimble amalgamation mill were in regular operation. The Arizona Comstock Corporation operated the Middle Mines group, consisting of the Hale and Norcross, Chollar, Savage, and Potosi mines, and treated ore in its flotation plant, averaging about 115 tons a day for at least 10 months of the year, according to a letter from the mining editor of the Nevada State Journal dated January 15, 1934. Material from the Mexican mill site at Virginia City was salvaged and yielded considerable gold and silver. In the Comstock Keystone, a new prospect, 1,100 feet of development work were done, and approximately 2,100 tons of ore therefrom were amalgamated in the Donovan and Trimble mills.

Production was reported from the Overman and New York mines of the Consolidated Chollar Gould & Savage Mining Co., which did 2,559 feet of new work and rehabilitated 1,400 feet of old workings. Development work only was carried on until August 6, after which the mine and 50-ton flotation mill were operated until the end of the year. The ore was broken in a Blake-type crusher to minus 1½-inch, ground in a Hardinge mill to minus 48-mesh, and treated by flotation in a 6-cell Kraut unit; the concentrates were dried and shipped to a smelter. The Overland group was operated by the Comstock Silver Mining Co. until August 30, when it was taken over by the Nevada Securities Co. The property was equipped with a 30-ton amalgamation-concentration mill and a 50-ton flotation plant which treated ore and old tailings.

*Washoe County.*—The production of Washoe County consisted of small amounts of gold ore which, except for production at the Springfield Nevada and Texas mines, yielded individually less than 100 fine ounces. All ore mined in the county was treated at the Springfield mill at Olinghouse. The Grubstake, Keystone, and Sunbeam mines each produced 40 to 50 tons of ore.

*White Pine County.*—Of the five leading gold-producing counties in Nevada, White Pine usually ranks first, second, or third. It is also the chief copper-producing county, and the activity of the Nevada Consolidated Copper Co. has in the past virtually determined the gold and copper output of the county. In June all the assets of this company were acquired by the Kennecott Copper Corporation, and operations were continued at much restricted capacity by a new company, the Nevada Consolidated Copper Corporation, wholly owned by the Kennecott Copper Corporation. At the Nevada division of the new company a moderate program of smelting-plant improvements involving rearrangement and centralization was begun in the latter part of the year, and some mining with power shovels was carried on by the company on the Ora and Emma Nevada claims of the Consolidated Coppermines Corporation.

No copper ores were mined by the Consolidated Coppermines Corporation in 1933. The Eleventh Annual Report of the company states:

> Leasing operations, conducted during the year in the recently acquired Lane City territory, in the territory south of Nevada Consolidated's pit, and in the recently acquired territory west of Kimberly, yielded 2,439.877 ounces of gold, 16,097.67 ounces of silver, and 64,516 pounds of lead. The majority of the ores produced from these leasing operations were sent to the smelter at McGill, but some of the higher-grade gold ores and all of the lead-silver ores were shipped to the smelters in Salt Lake Valley. * * * The Emma Nevada and Morris-Brooks mines have been kept unwatered, and necessary repair work has been done to keep them in good condition so that renewed production of ore can be attained on short notice and with minimum expense.

Lead ore was shipped to a Salt Lake smelter from the Carbonate Lead mine in the Duck Creek district, and zinc carbonate ore was shipped from the Muncy Creek mine in the Aurum district to a zinc oxide plant at Richmond, Calif. The Egan mine in the Cherry Creek district was operated and the ore treated in the McGill smelter of the Nevada Consolidated Copper Corporation. Due to the intermittent operations of this smelter the Ely Gold Mining Co. was closed down from March to September.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO

(MINE REPORT)

By CHAS. W. HENDERSON

SUMMARY OUTLINE



The total production of gold, silver, copper, lead, and zinc from New Mexico ores and gravels in 1933, in terms of recovered and estimated recoverable metals, was 26,474.09 fine ounces of gold, 1,181,580 fine ounces of silver, 26,947,000 pounds of copper, 22,086,000 pounds of lead, and 61,848,000 pounds of zinc. This output compares with a production in 1932 of 23,208.05 fine ounces of gold, 1,142,351 fine ounces of silver, 28,419,000 pounds of copper, 20,227,000 pounds of lead, and 51,186,000 pounds of zinc and shows increases of 3,266.04 ounces in gold, 39,229 ounces in silver, 1,859,000 pounds in lead, and 10,662,000 pounds in zinc and a decrease of 1,472,000 pounds in copper. There were 92 lode mines and 302 placers producing in 1933, an increase of 5 lode mines but a decrease of 76 placers from 1932.

The total recorded production of gold, silver, copper, lead, and zinc (in terms of recovered metals) in New Mexico from 1848 to 1933, inclusive, has been 1,870,013 fine ounces of gold, 55,378,984 fine ounces of silver, 1,516,500,473 pounds of copper, 392,122,385 pounds of lead, and 790,138,394 pounds of zinc.

*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of $20.671835, from January 1 to August 9 to all producers; (2) that of (*a*) $20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export by some producers, to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, from September 8 to November 1); and (4) the period of the Reconstruction Finance Corporation arbitrarily fixed, gradually rising price (generally above the world price), from October 25 to December 31, 1933. For further details see chapter of this volume on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

Following is a table on mine production of gold in New Mexico, 1929–33, in terms of recovered metal; two values are given for 1933—(1) at legal coinage value ($20.67+ per ounce) and (2) at average weighted price ($25.56 per ounce).

*Mine production of gold in New Mexico, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 35, 176. 46 | $727, 162 | 1932 | 23, 208. 05 | $479, 753 |
| 1930 | 32, 370. 42 | 669, 156 | 1933 | 26, 474. 09 | [2] 547, 268<br>[3] 676, 678 |
| 1931 | 31, 161. 24 | 644, 160 | | | |

[1] 1929-32: At legal value ($20.67+ per ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] At legal coinage value ($20.67+ per ounce).
[3] At average weighted price ($25.56 per ounce).

*Calculation of value of metal production.*—The value of metal production hereinafter reported 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, 1929–33*

| 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* |
| 1929 | $0. 533 | $0. 176 | $0. 063 | $0. 066 | 1932 | $0. 282 | $0. 063 | $0. 030 | $0. 030 |
| 1930 | . 385 | . 130 | . 050 | . 048 | 1933 | . 350 | . 064 | . 037 | . 042 |
| 1931 | . 290 | . 091 | . 037 | . 038 | | | | | |

*Mine production of gold, silver, copper, lead, and zinc in New Mexico, 1929–33, in terms of recovered metals*

| Year | Mines producing | | | Ore (short tons) | Gold (lode and placer) | | Silver (lode and placer) | |
|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | Total | | Fine ounces | Value | Fine ounces | Value |
| 1929 | 113 | 8 | 121 | 4, 506, 807 | 35, 176. 46 | $727, 162 | 1, 121, 546 | $597, 784 |
| 1930 | 88 | 5 | 93 | 2, 971, 441 | 32, 370. 42 | 669, 156 | 1, 107, 335 | 426, 324 |
| 1931 | 59 | 109 | 168 | 3, 003, 941 | 31, 161. 24 | 644, 160 | 1, 041, 859 | 302, 139 |
| 1932 | 87 | 378 | 465 | 1, 464, 718 | 23, 208. 05 | 479, 753 | 1, 142, 351 | 322, 143 |
| 1933 | 92 | 302 | 394 | 1, 475, 839 | 26, 474. 09 | 547, 268 | 1, 181, 580 | 413, 553 |

| Year | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| 1929 | 97, 717, 262 | $17, 198, 238 | 22, 260, 811 | $1, 402, 431 | 68, 910, 000 | $4, 548, 060 | $24, 473, 675 |
| 1930 | 65, 150, 000 | 8, 469, 500 | 20, 756, 900 | 1, 037, 845 | 65, 529, 000 | 3, 145, 392 | 13, 748, 217 |
| 1931 | 61, 503, 100 | 5, 596, 782 | 22, 537, 000 | 833, 869 | 55, 732, 000 | 2, 117, 816 | 9, 494, 766 |
| 1932 | 28, 419, 000 | 1, 790, 397 | 20, 227, 000 | 606, 810 | 51, 186, 000 | 1, 535, 580 | 4, 734, 683 |
| 1933 | 26, 947, 000 | 1, 724, 608 | 22, 086, 000 | 817, 182 | 61, 848, 000 | 2, 597, 616 | 6, 100, 227 |

*Gold and silver produced at placer mines in New Mexico, 1929–33*

| Year | Gold | | Silver | | Total value | Year | Gold | | Silver | | Total value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fine ounces | Value | Fine ounces | Value | | | Fine ounces | Value | Fine ounces | Value | |
| 1929 | 79.82 | $1,650 | 4 | $2 | $1,652 | 1932 | 1,270.28 | $26,259 | 181 | $51 | $26,310 |
| 1930 | 63.66 | 1,316 | 18 | 7 | 1,323 | 1933 | 1,399.15 | 28,923 | 160 | 56 | 28,979 |
| 1931 | 406.59 | 8,405 | 59 | 17 | 8,422 | | | | | | |

*Gold.*—The mine production of recoverable gold in New Mexico was 26,474.09 fine ounces in 1933, compared with 23,208.05 fine ounces in 1932. San Miguel County produced 73.37 percent of the total in 1933, Catron 10.02 percent, and Grant 6.77 percent. Lead-zinc ore yielded 73.37 percent of the total gold, dry and siliceous ore 16.97 percent, and copper ore 4.24 percent. Placer mines yielded 5.28 percent.

*Silver.*—The mine production of recoverable silver in New Mexico amounted to 1,181,580 fine ounces, valued at $413,553, in 1933, compared with 1,142,351 fine ounces, valued at $322,143, in 1932. San Miguel County produced 52.64 percent of the total in 1933, all from the lead-zinc ore of the Pecos mine in the Willow Creek district; Grant County 35.51 percent, chiefly from the Central district; and Catron County 10.67 percent, all from the Mogollon district. Lead-zinc ore from Grant and San Miguel Counties yielded 84.32 percent of the total silver; dry and siliceous ore, chiefly from Catron County, 11.87 percent; copper-lead ore, from Grant County, 1.89 percent; copper ore, chiefly from Grant County, 1.58 percent; and lead ore, chiefly from Dona Ana and Grant Counties, 0.32 percent.

*Copper.*—The mine production of recoverable copper in New Mexico amounted to 26,947,000 pounds, valued at $1,724,608, in 1933, compared with 28,419,000 pounds, valued at $1,790,397, in 1932. Grant County produced 93.37 percent of the total in 1933, chiefly from operation of the Santa Rita mines in the Central district. San Miguel County, second in order of output, yielded 6.51 percent, all from the lead-zinc ore of the Pecos mine. Copper ore yielded 82.36 percent and lead-zinc ore 17.17 percent of the total copper.

*Lead.*—The mine production of recoverable lead in New Mexico amounted to 22,086,000 pounds, valued at $817,182, in 1933, compared with 20,227,000 pounds, valued at $606,810, in 1932. The chief lead-producing districts were the Willow Creek, San Miguel County; Central, Grant County; and Magdalena, Socorro County. Lead-zinc ore yielded 95 percent, copper-lead ore 3.40 percent, and lead ore 1.34 percent of the total lead.

*Zinc.*—The mine production of recoverable zinc in New Mexico amounted to 61,848,000 pounds, valued at $2,597,616, in 1933, compared with 51,186,000 pounds, valued at $1,535,580, in 1932. The zinc-producing districts in 1933 were the Willow Creek in San Miguel County, the Central in Grant County, the Magdalena in Socorro County, and the Pinos Altos in Grant County. Zinc concentrates produced in 1933 amounted to 65,740 tons, containing, as shipped, 3,225.58 ounces of gold, 201,131 ounces of silver, 1,249,586 pounds of copper, 1,795,610 pounds of lead, and 72,091,528 pounds of zinc. The average zinc content was therefore 54.83 percent.

## MINE PRODUCTION BY COUNTIES

*Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1933, by counties, in terms of recovered metals*

| County | Mines producing | | | Ore (short tons) | Gold (lode and placer) | | Silver (lode and placer) | |
|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | Total | | Fine ounces | Value | Fine ounces | Value |
| Catron | 2 | | 2 | 32,914 | 2,651.77 | $54,817 | 126,020 | $44,107 |
| Colfax | 3 | 12 | 15 | 2,422 | 347.14 | 7,176 | 83 | 29 |
| Dona Ana | 3 | | 3 | 305 | 9.48 | 196 | 2,060 | 721 |
| Grant | 28 | 50 | 78 | 1,240,896 | 1,792.00 | 37,044 | 419,580 | 146,853 |
| Hidalgo | 8 | | 8 | 266 | 111.12 | 2,297 | 1,849 | 647 |
| Lincoln | 8 | 72 | 80 | 567 | 703.47 | 14,542 | 289 | 101 |
| Luna | 1 | | 1 | 28 | .29 | 6 | 143 | 50 |
| Otero | 1 | 59 | 60 | 3 | 197.42 | 4,081 | 20 | 7 |
| Rio Arriba | 2 | | 2 | 6 | 11.95 | 247 | 5 | 2 |
| Sandoval | 1 | | 1 | 465 | 158.33 | 3,273 | 7,940 | 2,779 |
| San Miguel | 1 | | 1 | 191,905 | 19,424.69 | 401,544 | 621,977 | 217,692 |
| Santa Fe | 7 | 71 | 78 | 168 | 333.98 | 6,904 | 49 | 17 |
| Sierra | 20 | 37 | 57 | 272 | 716.53 | 14,812 | 1,291 | 452 |
| Socorro | 4 | | 4 | 5,529 | 6.92 | 143 | 120 | 42 |
| Taos | 2 | 1 | 3 | 37 | 8.71 | 180 | 137 | 48 |
| Torrance | 1 | | 1 | 56 | .29 | 6 | 17 | 6 |
| | 92 | 302 | 394 | 1,475,839 | 26,474.09 | 547,268 | 1,181,580 | 413,553 |
| Total, 1932 | 87 | 378 | 465 | 1,464,718 | 23,208.05 | 479,753 | 1,142,351 | 322,143 |

| County | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| Catron | 3,000 | $192 | 400 | $15 | | | $99,131 |
| Colfax | | | | | | | 7,205 |
| Dona Ana | 3,000 | 192 | 80,000 | 2,960 | | | 4,069 |
| Grant | 25,160,000 | 1,610,240 | 6,873,000 | 254,301 | 22,507,000 | $945,294 | 2,993,732 |
| Hidalgo | 21,000 | 1,344 | 24,000 | 888 | | | 5,176 |
| Lincoln | 1,000 | 64 | 14,000 | 518 | | | 15,225 |
| Luna | | | 20,000 | 740 | | | 796 |
| Otero | | | | | | | 4,088 |
| Rio Arriba | | | | | | | 249 |
| Sandoval | | | | | | | 6,052 |
| San Miguel | 1,753,000 | 112,192 | 14,149,000 | 523,513 | 37,329,000 | 1,567,818 | 2,822,759 |
| Santa Fe | 1,000 | 64 | | | | | 6,985 |
| Sierra | 3,000 | 192 | 600 | 22 | | | 15,478 |
| Socorro | | | 925,000 | 34,225 | 2,012,000 | 84,504 | 118,914 |
| Taos | | | | | | | 228 |
| Torrance | 2,000 | 128 | | | | | 140 |
| | 26,947,000 | 1,724,608 | 22,086,000 | 817,182 | 61,848,000 | 2,597,616 | 6,100,227 |
| Total, 1932 | 28,419,000 | 1,790,397 | 20,227,000 | 606,810 | 51,186,000 | 1,535,580 | 4,734,683 |

## MINING INDUSTRY

Steady operation of the Pecos mine and mill, San Miguel County, accounted for most of the increase in production of both gold and silver in New Mexico in 1933 and more than offset a reduction in the output from Grant County. The Combination mill of the Black Hawk Consolidated Mines Co. at Hanover (treating ores from company mines and from the Ground Hog and San Jose mines of the Asarco Mining Co.) also contributed to the output of silver. The placer production of gold from the State increased slightly due to greater activity by individual mines in Lincoln and Otero Counties. The Pewabic mine of the Peru Mining Co. at Hanover (mill at Deming) and the Kelly group of the Empire Zinc Co. in the Magdalena district, Socorro County, were the chief sources of increase in output of zinc; the other producers averaged close to their 1932 production. Chino Mines of the Nevada Consolidated Copper Co. produced 82 percent of the State output of copper; most of the remainder came from lead-copper concentrates from the Combination and Pecos mills.

Details of the foregoing and other operations will be found under the following review by counties and districts.

### ORE CLASSIFICATION

*Ore sold or treated in New Mexico in 1933, with content in terms of recovered metals*

| Source | Ore | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold ore | 5,212 | 1,670.70 | 4,907 | 25,215 | 55,491 | 67,000 |
| Dry gold and silver ore | 33,388 | 2,818.06 | 134,408 | 3,000 | 511 | |
| Dry silver ore | 50 | 4.00 | 987 | 640 | 185 | |
| | 38,650 | 4,492.76 | 140,302 | 28,855 | 56,187 | 67,000 |
| Copper ore | 1,100,707 | 1,121.71 | 18,657 | 22,193,206 | 1,622 | |
| Copper-lead ore | 1,419 | 11.00 | 22,370 | 91,886 | 751,065 | |
| Lead ore | 877 | 24.78 | 3,809 | 5,163 | 295,354 | |
| Lead-zinc ore | 255,946 | 19,424.69 | 996,282 | 4,627,890 | 20,981,772 | 48,298,000 |
| Zinc ore | 78,240 | | | | | 13,483,000 |
| | 1,437,189 | 20,582.18 | 1,041,118 | 26,918,145 | 22,029,813 | 61,781,000 |
| Total, lode mines | 1,475,839 | 25,074.94 | 1,181,420 | 26,947,000 | 22,086,000 | 61,848,000 |
| Total, placers | | 1,399.15 | 160 | | | |
| | 1,475,839 | 26,474.09 | 1,181,580 | 26,947,000 | 22,086,000 | 61,848,000 |
| Total, 1932 | 1,464,718 | 23,208.05 | 1,142,351 | 28,419,000 | 20,227,000 | 51,186,000 |

## METALLURGIC INDUSTRY

All markets for New Mexico ore and concentrates are outside the State. In 1933 lead ores and concentrates were sold to the American Smelting & Refining Co. lead plant at El Paso, Tex., and copper ore and concentrates were sold to the American Smelting & Refining Co. copper plant at El Paso, Tex. Zinc concentrates were shipped to the American Smelting & Refining Co. natural-gas retort plant at Amarillo, Tex.; to the Illinois Zinc Co. retort plant at Peru, Ill.; to the American Zinc Co. of Illinois, East St. Louis, Ill.; to the American Metal Co. producer-gas retort plant at Langeloth, Pa.; and to the American Metal Co. natural-gas retort plant at Blackwell, Okla. Zinc-lead sulphide ore was shipped to the Ozark Smelting & Mining Co. zinc-lead pigment plant at Coffeyville, Kans. Small lots of gold ore were sold to the Golden Cycle mill at Colorado Springs, Colo.

All important mills in New Mexico used the selective flotation method in 1933; the following table gives the names of the flotation mills active and the location, county, rated capacity, type of ore treated, and type of concentrate produced.

*Flotation mills in New Mexico active in 1933*

| Name of company or mill | Location of mill | County | Rated capacity (short tons per 24 hours) | Type of ore treated | Type of concentrate produced |
|---|---|---|---|---|---|
| Chino Mines | Hurley | Grant | [1] 15,000 | Copper-gold-silver | Copper-gold-silver. |
| Combination (Black Hawk). | Hanover | do | [2] 250 | Zinc-lead-copper-silver. | Zinc, lead-silver, copper-silver. |
| Gillette | Pinos Altos | do | 50 | Gold-silver-copper-lead, zinc. | Gold-silver-copper-lead, zinc. |
| Little Fanney | Mogollon | Catron | 50 to 70 | Gold and silver | Gold and silver. |
| Molybdenum Corporation of America. | Red River and Sulphur Creek. | Taos | 40 | Molybdenum | Molybdenum. |
| Pecos (American Metal Co.). | Alamitos Canyon. | San Miguel | [3] 600 | Zinc-lead-copper-gold-silver. | Zinc, lead-copper-gold-silver. |
| Peru Mining Co | Wemple | Luna | [4] 300 | Zinc | Zinc. |

[1] 6,253 tons for 171 days.
[2] 225 tons for 260 days.
[3] 526 tons for 365 days.
[4] 235 tons for 333 days.

*Mine production of metals in New Mexico in 1933, by methods of recovery, in terms of recovered metals*

| Method of recovery | Material treated | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Ore amalgamated | 2,943 | 597.28 | 154 | | | |
| Ore cyanided | 67 | 67.81 | 150 | | | |
| Concentrates smelted | [1] 130,016 | 23,287.96 | 1,140,281 | 26,802,677 | 20,115,900 | 59,836,000 |
| Ore smelted | 9,919 | 1,121.89 | 40,835 | 144,323 | 1,970,100 | 2,012,000 |
| Placer | | 1,399.15 | 160 | | | |
| | | 26,474.09 | 1,181,580 | 26,947,000 | 22,086,000 | 61,848,000 |
| Total, 1932 | | 23,208.05 | 1,142,351 | 28,419,000 | 20,227,000 | 51,186,000 |

[1] From 1,462,910 tons of ore treated at concentrating mills and 2,420 tons of ore first amalgamated.

*Gross metal content of New Mexico concentrates produced in 1933, by classes of concentrates*

| Class of concentrates | Concentrates produced (dry weight) | Gross metal content: Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold | 46 | 126.00 | 40 | 299 | | |
| Dry gold and silver | 383 | 2,632.57 | 125,043 | 3,230 | 729 | |
| Copper | 31,956 | 1,016.60 | 16,573 | 22,878,836 | | |
| Copper-lead | 31,891 | 17,412.84 | 897,947 | 5,015,404 | 22,723,583 | 7,506,998 |
| Zinc | 65,740 | 3,225.58 | 201,131 | 1,249,586 | 1,795,610 | 72,091,528 |
| | 130,016 | 24,413.59 | 1,240,734 | 29,147,355 | 24,519,922 | 79,598,526 |
| Total, 1932 | 120,867 | 21,104.03 | 1,220,859 | 30,861,199 | 23,342,308 | 68,290,881 |

*Mine production of metals from New Mexico concentrates in 1933, by counties, in terms of recovered metals*

| County | Ore treated at concentrating mills | Concentrates and recovered metal | | | | | |
|---|---|---|---|---|---|---|---|
| | | Concentrates produced | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Catron | 32,885 | 383 | 2,632.57 | 125,043 | 3,000 | 400 | |
| Colfax | | [1] 46 | 123.60 | 38 | | | |
| Grant | 1,238,120 | 69,011 | 1,104.70 | 393,221 | 25,046,677 | 5,966,500 | 22,507,000 |
| San Miguel | 191,905 | 60,576 | 19,424.69 | 621,977 | 1,753,000 | 14,149,000 | 37,329,000 |
| Socorro | | (1) | 2.40 | 2 | | | |
| | 1,462,910 | 130,016 | 23,287.96 | 1,140,281 | 26,802,677 | 20,115,900 | 59,836,000 |
| Total, 1932 | 1,438,676 | 120,867 | 18,557.21 | 1,051,965 | 27,367,900 | 19,178,700 | 50,953,000 |

[1] From ore treated at gold and silver mills equipped for amalgamation and concentration, as follows: Colfax County, 2,416 tons; Socorro County, 4 tons.

*Gross metal content of New Mexico crude ore shipped to smelters in 1933, by classes of ore*

| Class of ore | Ore | Gross metal content | | | | |
|---|---|---|---|---|---|---|
| | | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold | 1,252 | 791.56 | 2,220 | 21,315 | 12,210 | |
| Dry gold and silver | 503 | 185.49 | 9,365 | 246 | 438 | |
| Dry silver | 50 | 4.00 | 987 | 674 | 386 | |
| Copper | 317 | 105.13 | 2,084 | 27,825 | 2,890 | |
| Copper-lead | 1,419 | 11.00 | 22,370 | 116,615 | 856,883 | |
| Lead | 877 | 24.80 | 3,811 | 8,486 | 324,930 | |
| Lead-zinc | 5,501 | | | | 1,307,660 | 2,515,540 |
| | 9,919 | 1,121.98 | 40,837 | 175,161 | 2,505,397 | 2,515,540 |
| Total, 1932 | 24,887 | 2,825.94 | 90,307 | 1,159,945 | 1,238,166 | 290,720 |

*Mine production of metals from New Mexico crude ore shipped to smelters in 1933, by counties, in terms of recovered metals*

| County | Ore | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Catron | 29 | 19.20 | 977 | | | |
| Dona Ana | 305 | 9.48 | 2,060 | 3,000 | 80,000 | |
| Grant | 2,764 | 419.08 | 26,289 | 113,323 | 906,500 | |
| Hidalgo | 266 | 111.12 | 1,849 | 21,000 | 24,000 | |
| Lincoln | 191 | 169.39 | 173 | 1,000 | 14,000 | |
| Luna | 28 | .29 | 143 | | 20,000 | |
| Otero | 3 | 2.61 | | | | |
| Sandoval | 465 | 158.33 | 7,940 | | | |
| Santa Fe | 40 | 21.50 | 20 | 1,000 | | |
| Sierra | 247 | 209.68 | 1,250 | 3,000 | 600 | |
| Socorro | 5,525 | .92 | 117 | | 925,000 | 2,012,000 |
| Torrance | 56 | .29 | 17 | 2,000 | | |
| | 9,919 | 1,121.89 | 40,835 | 144,323 | 1,970,100 | 2,012,000 |
| Total, 1932 | 24,887 | 2,824.89 | 89,604 | 1,051,100 | 1,048,300 | 233,000 |

## REVIEW BY COUNTIES AND DISTRICTS

*Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1933, by counties and districts, in terms of recovered metals*

| County and district | Mines producing | | Ore sold or treated | Gold | | | Silver | | | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | Lode | Placer | Total | Lode | Placer | Total | | | | |
| | | | *Short tons* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| Catron County: Mogollon | 2 | | 32,914 | 2,651.77 | | 2,651.77 | 126,020 | | 126,020 | 3,000 | 400 | | $99,131 |
| Colfax County: Mount Baldy | 3 | 12 | 2,422 | 291.80 | 55.34 | 347.14 | 74 | 9 | 83 | | | | 7,205 |
| Dona Ana County: Organ | 3 | | 305 | 9.48 | | 9.48 | 2,060 | | 2,060 | 3,000 | 80,000 | | 4,069 |
| Grant County: | | | | | | | | | | | | | |
| Burro Mountain | 1 | | | 1.11 | | 1.11 | | | | | | | 23 |
| Central | 15 | | 1,239,379 | 1,193.12 | | 1,193.12 | 414,711 | | 414,711 | 25,142,000 | 6,816,000 | 22,440,000 | 2,973,573 |
| Gold Hill | 2 | | 40 | 19.25 | | 19.25 | 17 | | 17 | | | | 404 |
| Pinos Altos | 8 | 49 | 1,462 | 326.87 | 223.59 | 550.46 | 4,697 | 58 | 4,755 | 18,000 | 57,000 | 67,000 | 19,118 |
| Steeple Rock | 1 | | 5 | 1.50 | | 1.50 | 94 | | 94 | | | | 64 |
| White Signal | 1 | 1 | 10 | 11.42 | 15.14 | 26.56 | 1 | 2 | 3 | | | | 550 |
| Hidalgo County: | | | | | | | | | | | | | |
| Eureka | 3 | | 10 | 5.71 | | 5.71 | 29 | | 29 | | 5,000 | | 313 |
| Lordsburg | 5 | | 256 | 105.41 | | 105.41 | 1,820 | | 1,820 | 21,000 | 19,000 | | 4,863 |
| Lincoln County: | | | | | | | | | | | | | |
| Gallinas Mountains | 1 | | 42 | .39 | | .39 | 123 | | 123 | 1,000 | 14,000 | | 633 |
| Jicarilla | 2 | 68 | 130 | 82.62 | 236.02 | 318.64 | 26 | 24 | 50 | | | | 6,604 |
| Nogal | 2 | 4 | 196 | 240.04 | 14.27 | 254.31 | 88 | 2 | 90 | | | | 5,289 |
| White Oaks | 3 | | 199 | 130.13 | | 130.13 | 26 | | 26 | | | | 2,699 |
| Luna County: Cooks Peak | 1 | | 28 | .29 | | .29 | 143 | | 143 | | 20,000 | | 796 |
| Otero County: | | | | | | | | | | | | | |
| Orogrande | | 59 | | | 194.81 | 194.81 | | 20 | 20 | | | | 4,034 |
| Sacramento | 1 | | 3 | 2.61 | | 2.61 | | | | | | | 54 |
| Rio Arriba County: Headstone | 2 | | 6 | 11.95 | | 11.95 | 5 | | 5 | | | | 249 |
| Sandoval County: Cochiti | 1 | | 465 | 158.33 | | 158.33 | 7,940 | | 7,940 | | | | 6,052 |
| San Miguel County: Willow Creek | 1 | | 191,905 | 19,424.69 | | 19,424.69 | 621,977 | | 621,977 | 1,753,000 | 14,149,000 | 37,329,000 | 2,822,759 |
| Santa Fe County: | | | | | | | | | | | | | |
| Los Cerrillos | 1 | 26 | 40 | 28.30 | 31.15 | 59.45 | 7 | 3 | 10 | | | | 1,232 |
| San Pedro | 6 | 45 | 128 | 125.05 | 149.48 | 274.53 | 28 | 11 | 39 | 1,000 | | | 5,753 |
| Sierra County: | | | | | | | | | | | | | |
| Las Animas (Hillsboro) | 20 | 23 | 272 | 239.02 | 221.32 | 460.34 | 1,260 | 17 | 1,277 | 3,000 | 600 | | 10,177 |
| Pittsburg | | 14 | | | 256.19 | 256.19 | | 14 | 14 | | | | 5,301 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Socorro County: | | | | | | | | | | | | | |
| Magdalena | 3 | | 5,525 | .92 | | .92 | 117 | | 117 | | 925,000 | 2,012,000 | 118,789 |
| Silver Hills | 1 | | 4 | 6.00 | | 6.00 | 3 | | 3 | | | | 125 |
| Taos County: | | | | | | | | | | | | | |
| Red River | 2 | | 37 | 6.87 | | 6.87 | 137 | | 137 | | | | 190 |
| Rio Grande River | | 1 | | | 1.84 | 1.84 | | | | | | | 38 |
| Torrance County: Scholle | 1 | | 56 | .29 | | .29 | 17 | | 17 | 2,000 | | | 140 |
| Total New Mexico | 92 | 302 | 1,475,839 | 25,074.94 | 1,399.15 | 26,474.09 | 1,181,420 | 160 | 1,181,580 | 26,947,000 | 22,086,000 | 61,848,000 | 6,100,227 |

## CATRON COUNTY

*Mogollon district.*—The Andrew Jackson Consolidated, Champion, and Little Fanney mines, operated as one group, produced most of the ore mined in Catron County in 1933. The Wright Leasing Co., which from October 15, 1931, has been operating the Lehigh Metals Co. Little Fanney mill (remodeled in 1931 from cyanidation to flotation) turned over the management in January 1933 to the Black Hawk Consolidated Mines Co., which continued operation throughout 1933. The Last Chance was the only other mine from which shipments were made.

## COLFAX COUNTY

*Mount Baldy district (Baldy, Elizabethtown, Therma).*—Producing lode mines in Colfax County in 1933 were the Aztec (dump material), Montezuma, and Rio, all of which made shipments to the Golden Cycle mill at Colorado Springs, Colo.; the Aztec mill also made recoveries in the form of amalgam bullion and concentrates. Placer gold was recovered by sluicing on Willow Creek and in Mills Gulch, by sluicing and hydraulic operations on South Ponil Creek, and by a drag-line and screening-plant installation on Ute Creek.

## DONA ANA COUNTY

*Organ district.*—Production from Dona Ana County in 1933 was confined to two small lots of silver ore and 296 tons of lead ore shipped from the Organ district to the El Paso smelter.

## GRANT COUNTY

*Burro Mountain district (Tyrone).*—In 1933 one lot of ore was shipped from the Shamrock group to the El Paso smelter. A 5-ton ball mill with amalgamation plates was installed at this property in November 1933 and the owner reported that the first gold retort was shipped to the San Francisco Mint on January 5, 1934.

*Central district (Bayard, Fierro, Georgetown, Hanover, Santa Rita).*—The Black Hawk Consolidated Mines Co. 250-ton concentrator 1 mile south of Hanover operated in 1933 as a custom mill for the treatment of zinc-lead-copper-silver sulphide ore from the Ground Hog and San Jose properties of the Asarco Mining Co., near Cobre, and also treated company ore of somewhat similar type. The mill feed averaged 7.55 ounces of silver, 3.67 percent copper (wet assay), 6.84 percent lead (wet assay), and 13.28 percent zinc. The mill was operated 260 days in 1933 at a daily average of 225 tons. The Black Hawk Consolidated Mines Co. also shipped lead-silver ore from its Lucky Bill mine to the El Paso smelter. One lessee worked intermittently during the year at the property of the Hanover-Bessemer Iron & Copper Co. and shipped gold ore to the El Paso smelter. The Nevada Consolidated Copper Co., Chino Mines division, operated its flotation mill at Hurley for 171 days (15 days per month) at an average daily rate of 6,253 tons; the mill consists of 7 units, with a total capacity of 15,000 tons in 24 hours. The ore is mined from open pits at Santa Rita by electric shovels.

The Peru Mining Co. operated its 300-ton Peru mill (at Deming) at a daily rate of 235 tons for 11 months during 1933 on lead-free zinc sulphide ore from its Pewabic mine at Hanover. Small shipments of smelting ore were made from other properties in the district.

*Gold Hill district.*—Several tons of gold ore were shipped to the El Paso smelter from two properties in the Gold Hill district in 1933.

*Pinos Altos district.*—The principal producer of ore in the Pinos Altos district in 1933 was the Consolidated Gold Mines, Inc., which operated the remodeled Gillette gravity concentration-flotation mill on ore from a group of consolidated old properties in the district, shipping copper-lead concentrates to the El Paso smelter and zinc concentrates to the Amarillo (Texas) plant. Shipments of smelting ore, principally gold-silver ore containing some copper and lead, were made from the Copper Bell, Mammoth, Grand View, and other mines. Small panning and sluicing operations yielded the placer gold produced in the district in 1933.

*Steeple Rock district.*—One lot of gold-silver ore was shipped from the Norman King mine to the El Paso smelter in 1933.

*White Signal district.*—Ten tons of ore from the Copperhead mine, crushed and amalgamated in a home-made mill, yielded 11.42 fine ounces of gold. The Sunset Gold Fields, Inc., in 1933 recovered several ounces of gold from tests of a placer deposit 23 miles northeast of Lordsburg in Gold Gulch, Burro Mountains, in secs. 21, 22, 27, and 28, T. 20 S., R. 16 W. of the New Mexico principal meridian, and in late 1933 and early 1934 installed placer equipment including four Ainlay bowls having a reported capacity of 60 cubic yards per hour. Operation was begun on March 5, 1934.

## HIDALGO COUNTY

*Eureka district (Hachita).*—One small lot of gold ore and two small lots of lead ore were shipped from Hachita, presumably from the Hidalgo County side of the Eureka district, in 1933.

*Lordsburg district (including Pyramid and Virginia or Shakespeare districts).*—Production from the Lordsburg district in 1933 came chiefly from the Bonney mine, which shipped siliceous copper-silver-gold ore crude to the El Paso smelter.

## LINCOLN COUNTY

*Gallinas Mountains or Red Cloud district.*—One property in the Gallinas Mountains district produced lead ore (containing some copper), which was shipped to the El Paso smelter in 1933.

*Jicarilla district.*—In 1933 the output from lode mines in the Jicarilla district came from 80 tons of gold ore amalgamated at a 10-ton plant (later moved out of the district) at the Lucky Strike mine during November and from 50 tons of gold ore from another property shipped to the El Paso smelter. Sluicing, panning, and drift mining yielded placer gold, most of which was purchased by merchants at Ancho and Carrizozo.

*Nogal district.*—Producing lode mines in the Nogal district in 1933 were the Helen Rae and Parsons. Some gold was recovered by placer miners working on a small scale.

*White Oaks district.*—Gold ore was shipped from the Smuggler mine to the El Paso smelter, and gold was recovered by amalgamation from 100 tons of ore milled at a 15-ton amalgamation mill on the property of the Little Mack Mining Co. A small quantity of gold bullion was recovered from a property in Baxter Gulch.

### LUNA COUNTY

*Cooks Peak district.*—Test shipments of lead-silver-gold ore were made to the El Paso smelter from the Faywood mine in the Cooks Peak district in 1933 as a sampling check in investigations toward determining the advisability of installing a mill. The owner reported that the ore contained wulfenite (lead molybdate) and vanadium minerals, in addition to lead carbonates and lead sulphide.

*Deming.*—The Peru selective flotation mill (total capacity, 300 tons per day) at Wemple, near Deming, was operated 11 months at an average rate of 235 tons per day on lead-free zinc sulphide ore from the Peru Mining Co. Pewabic mine at Hanover, Grant County.

### OTERO COUNTY

*Orogrande district.*—Production from the Orogrande district in 1933 was all from placer mines worked by sluicing, hand rockers, and pans and was nearly all sold in amounts ranging from 1 to 53 pennyweights to merchants at Orogrande.

*Sacramento district.*—A small lot of gold ore was shipped from the Sacramento district to the El Paso smelter.

### RIO ARRIBA COUNTY

*Headstone district.*—Two small lots of gold ore were shipped from the Headstone district to the Golden Cycle mill at Colorado Springs, Colo., in 1933.

### SANDOVAL COUNTY

*Cochiti (Bland) district.*—A lessee operating as one group the Crown Point, Iron King, Laura S, Lone Star, and Washington claims in the Cochiti district shipped gold-silver ore to the El Paso smelter in 1933.

### SAN MIGUEL COUNTY

*Willow Creek district (Terrero).*—The Pecos mine of the American Metal Co. on Willow Creek, the only producing mine in San Miguel County in 1933, in its seventh year of production was operated continuously, except for minor shut-downs for repairs, at a daily average of 526 tons. The mill is in Alamitos Canyon, 6 miles by road from Glorieta station and 4 miles by railroad spur from Fox station on the Atchison, Topeka & Santa Fe Railway; it is connected with the mine by a 12-mile aerial tram.

The actual heads of ore into the mill in 1933 averaged 0.130 ounce gold and 4.38 ounces silver per ton, 0.82 percent copper (wet assay), 5.11 percent lead (wet assay), and 13.78 percent zinc. The yield from 191,905 dry tons treated in 1933 was 41,110 tons of zinc concentrates—averaging 0.078 ounce gold and 4.01 ounces silver per ton, 1.11 percent copper (wet assay), 1.64 percent lead (wet assay), 54.70 percent zinc, and 7.43 percent iron—and 19,466 tons of lead-copper concentrates—averaging 0.89 ounce gold and 26.78 ounces silver per ton, 3.72 percent copper (wet assay), 40.38 percent lead (wet assay), 12.39 percent zinc, and 10.68 percent iron.

### SANTA FE COUNTY

*Los Cerrillos district.*—The Benton was the only producing lode mine in the Los Cerrillos district in 1933. Individuals working small placers in the district recovered placer gold which was sold through merchants at Cerrillos.

*San Pedro or New Placers (Golden, San Pedro) district.*—At the Santa Fe mine lessees recovered bullion from 30 tons of gold ore treated in a Huntington mill. From other properties in the district 40 tons of gold ore were shipped to the El Paso smelter, and bullion recovered by amalgamation was shipped to the Denver Mint. Placer mines in the district were worked by dry washers and sluices and yielded gold bullion which was marketed through jewelers and mercantile establishments or sent direct to the Denver Mint.

### SIERRA COUNTY

*Las Animas (Hillsboro) district.*—In 1933 many small lots of ore were shipped from the Hillsboro district. Except for one lot of lead ore weighing less than one-half ton, all the ore was classed as gold or silver ore. The Snake-Opportunity was the largest producer; other producing mines yielded ore in quantities ranging from less than one-half ton to 17 tons. Gold bullion was produced at placer mines by the use of sluices, dry washers, and various makes of mechanical concentrators.

*Pittsburg district.*—All the metal production in the Pittsburg district in 1933 came from placer operations, chiefly from the Shandon placer which was operated by dry washers until October, when equipment consisting of a drag line and Ainlay bowls was installed.

### SOCORRO COUNTY

*Magdalena district (Kelly, Magdalena).*—The Magdalena district, which was idle in 1931 and had only a limited production in 1932, made a substantial output in 1933. All but 24 tons of the ore shipped from the district was classed as lead-zinc ore.

*Silver Hills district.*—Production from the Silver Hills district resulted from short test runs of a 25-ton flotation mill built in 1933 at the Open Cut Mines, 21 miles south of Magdalena in the north fork of South Canyon.

### TAOS COUNTY

*Red River district.*—Gold ore was sold to the Golden Cycle mill at Colorado Springs, Colo, from the Black Copper and Memphis mines in the Red River district in 1933. The Molybdenum Corporation of America continued one shift a day, 6 days a week, to mill molybdenum ore from the Phyllis group at its 40-ton (per 24 hours) flotation mill at the junction of Sulphur Creek and Red River above Questa.

*Rio Grande River district.*—A small lot of placer gold recovered in the Rio Grande River, presumably in Taos County, was sold to the Denver Mint in 1933.

### TORRANCE COUNTY

*Scholle district.*—Only 56 tons of copper ore were shipped from the Scholle district in 1933. Sporadically in the past, whenever copper prices were high, this district has shipped copper ore to the El Paso smelter from several shallow ore bodies in the "Red Beds."

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN OREGON

**(MINE REPORT)**

By F. W. Horton and H. M. Gaylord [1]

SUMMARY OUTLINE



The output of gold, silver, copper, lead, and zinc from Oregon ores and gravels in 1933, in terms of recovered metals, was 20,239.66 fine ounces of gold, 20,760 fine ounces of silver, 11,453 pounds of copper, 9,379 pounds of lead, and 12,290 pounds of zinc. This output compares with a production in 1932 of 19,861.21 ounces of gold, 8,616 ounces of silver, 32,199 pounds of copper, 7,917 pounds of lead, and 12,061 pounds of zinc. The value of the gold, calculated at $20.671835 a fine ounce, represented 98 percent of the total value of all the metals produced in 1933. There were 111 lode mines and prospects and 292 placers producing in 1933 compared with 99 lode mines and prospects and 169 placers in 1932.

The quantity of ore, including old smelter cleanings, milled and shipped was 11,557 tons or more than twice that in 1932; its average yield per ton was 0.472 ounce of gold and 1.609 ounces of silver. As evidenced by the tonnage treated all the lode operations were small. Only 7 lode mines in the State produced over 100 ounces of gold each, and only 1 yielded over 1,000 ounces.

Jackson County, with a metal production valued at $158,716 (including gold calculated at $20.671835 an ounce) was the largest contributor to the total value of metals; the value of its output was 37.1 percent of the State total. Baker and Josephine Counties were the next largest producers, with 23.2 and 21.3 percent of the total, respectively.

*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of $20.671835, from January 1 to August 9 to all producers; (2) that of (*a*) $20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export

[1] The assistance of Opal Y. Sharman, of the Bureau of Mines, is acknowledged.

by some producers, to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, from September 8 to November 1); and (4) the period of the Reconstruction Finance Corporation arbitrarily fixed, gradually rising price (generally above the world price), from October 25 to December 31, 1933. For further details see chapter of this volume on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

Following is a table on mine production of gold in Oregon, 1929–33, in terms of recovered metal; two values are given for 1933—(1) at legal coinage value ($20.67+ per ounce) and (2) at average weighted price ($25.56 per ounce).

*Mine production of gold in Oregon, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 17,092.00 | $353,323 | 1932 | 19,861.21 | $410,568 |
| 1930 | 14,401.34 | 297,702 | 1933 | 20,239.66 | [2] 418,391<br>[3] 517,326 |
| 1931 | 15,350.10 | 317,315 | | | |

[1] 1929–32: At legal value ($20.67+ per ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] At legal coinage value ($20.67+ per ounce).
[3] At average weighted price ($25.56 per ounce).

*Calculation of value of metal production.*—The value of metal production hereinafter reported 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, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Mine production of gold, silver, copper, lead, and zinc in Oregon, 1929–33, in terms of recovered metals*

| Year | Mines producing | | Ore, old tailings, etc. (short tons) | Gold | | Silver | |
|---|---|---|---|---|---|---|---|
| | Lode | Placer | | Fine ounces | Value | Fine ounces | Value |
| 1929 | 45 | 111 | 10,509 | 17,092.00 | $353,323 | 30,009 | $15,995 |
| 1930 | 47 | 143 | 8,994 | 14,401.34 | 297,702 | 9,000 | 3,465 |
| 1931 | 57 | 139 | 7,092 | 15,350.10 | 317,315 | 7,254 | 2,104 |
| 1932 | 99 | 169 | 5,195 | 19,861.21 | 410,568 | 8,616 | 2,430 |
| 1933 | 111 | 292 | 11,557 | 20,239.66 | 418,391 | 20,760 | 7,266 |

*Mine production of gold, silver, copper, lead, and zinc in Oregon, 1929–33, in terms of recovered metals*—Continued

| Year | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| 1929 | 655,746 | $115,411 | 20,180 | $1,271 | | | $486,000 |
| 1930 | 176,300 | 22,919 | 9,113 | 456 | 12,528 | $601 | 325,143 |
| 1931 | 1,700 | 155 | 3,497 | 129 | | | 319,703 |
| 1932 | 32,199 | 2,029 | 7,917 | 238 | 12,061 | 362 | 415,627 |
| 1933 | 11,453 | 733 | 9,379 | 347 | 12,290 | 516 | 427,253 |

*Gold.*—The production of gold in Oregon in 1933 was 20,239.66 fine ounces, an increase of only 378.45 ounces (less than 2 percent) compared with 1932. The yield from lode mines increased 1,797.59 ounces, but this gain was nearly balanced by a decrease of 1,419.14 ounces in placer production. The lode mines furnished 27 percent of the total gold in 1933, compared with only 18 percent in 1932.

Baker County was by far the largest producer of lode gold, supplying over half the total, owing to shipment of concentrates held in storage at the Sumpter smelter and high-grade ore from the Columbia and Taber property; the other chief lode gold-producing counties were Josephine, Jackson, Grant, and Douglas, in the order named. Dry gold ore and old smelter cleanings treated amounted to 11,293 tons and yielded 5,397.21 ounces of gold or nearly 99 percent of the total lode gold. Of the total lode gold recovered 2,389.88 ounces (43.8 percent) was from amalgamation; 1,965.46 ounces (36 percent) from smelting ore and old smelter cleanings; 905.48 ounces (16.6 percent) from smelting flotation concentrates; and 196.08 ounces (3.6 percent) from smelting table concentrates.

Placer mines in Oregon in 1933 yielded 14,782.76 fine ounces of gold—73 percent of the total gold output of the State. The number of placer workings, most of them (except the dredges) small and operated but a short time, was 292 in 1933 and 169 in 1932. Jackson County was the largest producer of placer gold in 1933 and furnished 6,940.88 ounces (47 percent) of the State placer total; Josephine, Baker, and Grant Counties ranked next, with 24.4, 10.3, and 9.8 percent, respectively. The total gold produced by dredges was 4,736 ounces compared with 7,781 ounces in 1932, a decrease of 39 percent. This falling off in dredge output was due to the fact that the largest producer was forced to shut down several times during the year, owing to lack of water, and that two other dredges did not begin producing until early in November. Only 14 placers in the State produced over 100 ounces of fine gold each.

*Itinerant placer miners.*—The quantity of gold purchased in small lots from itinerant miners and shipped to United States mints and assay offices by banks, storekeepers, private refineries, and other dealers was an important part of the total output of the State in 1933. Much of this gold can be allocated to particular mines and localities, but it is impossible to determine the exact source of many of the small amounts recovered by "snipers" which aggregated approximately 3,500 fine ounces or over 17 percent of the gold output of the State in 1933. Of this 3,500 ounces, 600 ounces were purchased in Baker, Grant, and Malheur Counties; more than 2,500 ounces in Douglas, Jackson, and Josephine Counties, the most important placer-gold regions in the State; 220 ounces in Coos, Curry, and Lane Counties; and 170 ounces could not be allocated to any county or mining district, as no data on source were obtainable. These amounts do not represent all the gold purchased by the banks, storekeepers, and other dealers, but only that part of it which was sent to United States mints and assay offices without any particular identification as to source. To trace the individual small lots back to the producing localities is difficult, but much cooperation was received from the bullion buyers. In Jackson and Josephine Counties the streams and tributaries of the Applegate, Illinois, and Rogue Rivers were important sources of these small amounts of placer gold, and lots as low as 0.02 ounce of gold were accepted by the buyers. Streams frequently mentioned in reports from bullion buyers were Althouse, Briggs, Centennial, Democrat, Evans, Foots, Galice, Grave, Green, Jump-off Joe, Louse, Sardine, Six Mile, Sucker, Whiskey, Williams, and Wolf. In eastern Oregon definite localities were not given so generally, but "sniping" was reported on the Oregon side of Snake River, principally in the Connor Creek district, and small amounts of gold were taken from Chicken, Clarks, Cow, Dixie, Pine, and Willow Creeks in southern Baker County.

*Silver.*—The output of silver in Oregon was 20,760 fine ounces in 1933 compared with 8,616 ounces in 1932, an increase of 141 percent. Baker County contributed 17,031 ounces (82 percent) of the total. This large increase in total yield was due to the shipment, from the Bay Horse mine, of silver ore which had been in storage at the old Sumpter smelter. The second largest producer was Jackson County, with an output of 1,952 ounces (9.4 percent) of the State total. Of the total silver, 11,525 ounces (55.5 percent) came from dry gold ore and old smelter cleanings; 6,929 ounces (33.4 percent) from dry silver ore; and small amounts (93 and 47 ounces) from lead-zinc and lead ores, respectively. The rest (2,166 ounces or 10.4 percent) was recovered from placer bullion.

*Copper.*—No copper ore was mined in Oregon in 1933, and the 11,453 pounds of recoverable copper produced were derived wholly from other ores, as follows: 6,316 pounds from gold ore, 4,735 pounds from dry silver ore, and 402 pounds from lead-zinc ore. The copper output was valued at $733, and Baker County supplied 79 percent of the total.

*Lead.*—The recoverable lead production of Oregon in 1933 was only 9,379 pounds, of which 4,925 pounds were derived from lead-zinc ore produced in Marion County, 4,216 pounds from dry gold ore from Baker, Jackson, and Josephine Counties, and 238 pounds from lead ore mined in Jackson County. The total production was valued at only $347.

*Zinc.*—The recoverable zinc produced from Oregon ore in 1933 totaled 12,290 pounds valued at $516 and was derived from lead-zinc ore mined in Marion County.

## MINE PRODUCTION BY COUNTIES

*Mine production of gold, silver, copper, lead, and zinc in Oregon in 1933, by counties, in terms of recovered metals*

| County | Gold | | | | | | Silver (lode and placer) | |
|---|---|---|---|---|---|---|---|---|
| | Lode | | Placer | | Total | | | |
| | Fine ounces | Value | Fine ounces | Value | Fine ounces | Value | Fine ounces | Value |
| Baker | 2,948.40 | $60,949 | 1,519.36 | $31,408 | 4,467.76 | $92,357 | 17,031 | $5,961 |
| Coos | | | 140.19 | 2,898 | 140.19 | 2,898 | 17 | 6 |
| Crook | 13.28 | 275 | | | 13.28 | 275 | 6 | 2 |
| Curry | 53.86 | 1,113 | 342.88 | 7,088 | 396.74 | 8,201 | 51 | 18 |
| Douglas | 355.51 | 7,349 | 322.43 | 6,665 | 677.94 | 14,014 | 377 | 132 |
| Grant | 442.07 | 9,138 | 1,446.98 | 29,912 | 1,889.05 | 39,050 | 352 | 123 |
| Harney | 39.64 | 819 | 7.58 | 157 | 47.22 | 976 | 7 | 2 |
| Jackson | 702.33 | 14,518 | 6,940.88 | 143,481 | 7,643.21 | 157,999 | 1,952 | 683 |
| Josephine | 793.01 | 16,393 | 3,602.78 | 74,476 | 4,395.79 | 90,869 | 650 | 228 |
| Klamath, Lane, Marion, and Union | 91.75 | 1,897 | 56.31 | 1,164 | 148.06 | 3,061 | 256 | 90 |
| Lincoln | | | 42.82 | 885 | 42.82 | 885 | 5 | 2 |
| Linn | 12.33 | 255 | 7.12 | 147 | 19.45 | 402 | 7 | 2 |
| Malheur | 4.72 | 98 | 183.83 | 3,800 | 188.55 | 3,898 | 29 | 10 |
| Undistributed [1] | | | 169.60 | 3,506 | 169.60 | 3,506 | 20 | 7 |
| | 5,456.90 | 112,804 | 14,782.76 | 305,587 | 20,239.66 | 418,391 | 20,760 | 7,266 |
| Total, 1932 | 3,659.31 | 75,645 | 16,201.90 | 334,923 | 19,861.21 | 410,568 | 8,616 | 2,430 |

| County | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| Baker | 9,071 | $581 | 2,480 | $92 | | | $98,991 |
| Coos | | | | | | | 2,904 |
| Crook | | | | | | | 277 |
| Curry | | | | | | | 8,219 |
| Douglas | 431 | 28 | | | | | 14,174 |
| Grant | 100 | 6 | | | | | 39,179 |
| Harney | | | | | | | 978 |
| Jackson | | | 926 | 34 | | | 158,716 |
| Josephine | 100 | 6 | 1,048 | 39 | | | 91,142 |
| Klamath, Lane, Marion, and Union | 1,751 | 112 | 4,925 | 182 | 12,290 | $516 | 3,961 |
| Lincoln | | | | | | | 887 |
| Linn | | | | | | | 404 |
| Malheur | | | | | | | 3,908 |
| Undistributed [1] | | | | | | | 3,513 |
| | 11,453 | 733 | 9,379 | 347 | 12,290 | 516 | 427,253 |
| Total, 1932 | 32,199 | 2,029 | 7,917 | 238 | 12,061 | 362 | 415,627 |

[1] Purchases (by bullion buyers) that cannot be distributed by sources.

*Ore and old smelter cleanings sold or treated and lode mines producing in Oregon, 1932–33, by counties*

| County | Ore and old smelter cleanings (short tons) | | Lode mines producing | |
|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 |
| Baker | 767 | 5,842 | 20 | 28 |
| Crook | | 34 | | 1 |
| Curry | 3 | 7 | 2 | 3 |
| Douglas | 1,685 | 1,242 | 9 | 6 |
| Grant | 429 | 887 | 14 | 16 |
| Harney | | 55 | | 2 |
| Jackson | 1,352 | 2,581 | 30 | 30 |
| Josephine | 454 | 708 | 16 | 18 |
| Lane | 392 | 180 | 4 | 4 |
| Marion | 45 | | 1 | |
| Linn | | 12 | | 1 |
| Malheur | 28 | 9 | 2 | 2 |
| Wheeler | 40 | | 1 | |
| | 5,195 | 11,557 | 99 | 111 |

## MINING INDUSTRY

The stimulating effect of the higher price of gold during the latter part of 1933 was not reflected in a notably larger gold output, because considerable time is required to prepare for increasing the yield from operating properties and even longer to bring prospects or old mines to the producing stage. However, there were unusual activity in the leasing and sale of both placer and lode properties during the fall and winter and an increased demand for mining equipment, which presage an increased future production. At the close of the year several old mines were being rehabilitated, but none of these had come into any large-scale production. Lode mining for metals other than gold was not active, and the production of base metals came largely from gold ores or from shipment or treatment of base ores mined in 1932.

### ORE CLASSIFICATION

*Ore and old smelter cleanings sold or treated in Oregon in 1933, with content in terms of recovered metals*

| Source | Ore and old smelter cleanings | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold ore | [1] 11, 293 | 5, 397. 21 | 11, 525 | 6, 316 | 4, 216 | |
| Dry silver ore | 215 | 11. 20 | 6, 929 | 4, 735 | | |
| Lead ore | 2 | 47. 80 | 47 | | 238 | |
| Lead-zinc ore | 47 | . 69 | 93 | 402 | 4, 925 | 12, 290 |
| Total, lode mines | 11, 557 | 5, 456. 90 | 18, 594 | 11, 453 | 9, 379 | 12, 290 |
| Total, placers | | 14, 782. 76 | 2, 166 | | | |
| | 11, 557 | 20, 239. 66 | 20, 760 | 11, 453 | 9, 379 | 12, 290 |
| Total, 1932 | 5, 195 | 19, 861. 21 | 8, 616 | 32, 199 | 7, 917 | 12, 061 |

[1] Includes 18 tons of old smelter cleanings smelted.

*Value of metals from ore and old smelter cleanings sold or treated in Oregon in 1933, by classes of ore*

| Class | Ore and old smelter cleanings (short tons) | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|
| Dry gold ore | [1] 11, 293 | $111, 570 | $4, 034 | $404 | $156 | | $116, 164 |
| Dry silver ore | 215 | 232 | 2, 425 | 303 | | | 2, 960 |
| Lead ore | 2 | 988 | 16 | | 9 | | 1, 013 |
| Lead-zinc ore | 47 | 14 | 33 | 26 | 182 | $516 | 771 |
| | 11, 557 | 112, 804 | 6, 508 | 733 | 347 | 516 | 120, 908 |
| Total, 1932 | 5, 195 | 75, 645 | 1, 797 | 2, 029 | 238 | 362 | 80, 071 |

[1] Includes 18 tons of old smelter cleanings smelted.

*Ore and old smelter cleanings sold or treated in Oregon in 1933, by counties, with content in terms of recovered metals*

DRY GOLD ORE

| County | Ore and old smelter cleanings | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Baker | [1] 5,627 | 2,937.20 | 9,784 | 4,336 | 2,480 | |
| Crook | 34 | 13.28 | 6 | | | |
| Curry | 7 | 53.86 | 8 | | | |
| Douglas | 1,242 | 355.51 | 331 | 431 | | |
| Grant | 887 | 442.07 | 137 | 100 | | |
| Harney | 55 | 39.64 | 7 | | | |
| Jackson | 2,579 | 654.53 | 905 | | 688 | |
| Josephine | 708 | 793.01 | 188 | 100 | 1,048 | |
| Lane and Marion | 133 | 91.06 | 152 | 1,349 | | |
| Linn | 12 | 12.33 | 4 | | | |
| Malheur | 9 | 4.72 | 3 | | | |
| | 11,293 | 5,397.21 | 11,525 | 6,316 | 4,216 | |
| Total, 1932 | 4,973 | 3,621.47 | 4,098 | 886 | 3,069 | |

DRY SILVER ORE

| County | Ore and old smelter cleanings | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Baker | 215 | 11.20 | 6,929 | 4,735 | | |
| | 215 | 11.20 | 6,929 | 4,735 | | |
| Total, 1932 | (2) | | | | | |

LEAD ORE

| County | Ore and old smelter cleanings | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Jackson | 2 | 47.80 | 47 | | 238 | |
| | 2 | 47.80 | 47 | | 238 | |
| Total, 1932 | 1 | 2.51 | 14 | | 195 | |

LEAD-ZINC ORE

| County | Ore and old smelter cleanings | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Marion | 47 | 0.69 | 93 | 402 | 4,925 | 12,290 |
| | 47 | .69 | 93 | 402 | 4,925 | 12,290 |
| Total, 1932 | 45 | .33 | 89 | 365 | 4,653 | 12,061 |

[1] Includes 18 tons of old smelter cleanings smelted.
[2] None produced in 1932.

## METALLURGIC INDUSTRY

Ore from Oregon mines, including a few tons of old smelter cleanings, treated or shipped in 1933 amounted to 11,557 tons, of which 5,097 tons were amalgamated, 4,597 tons concentrated, and 1,863 tons sent direct to smelters; no material was reported treated by cyanidation. Ore from three mines was treated by flotation and yielded 134 tons of concentrates averaging in recovered metals 6.76 ounces of gold and 22.59 ounces of silver to the ton of concentrates, 1.55 percent copper, 1.84 percent lead, and 4.59 percent zinc, and the 1,845 tons of ore shipped direct to smelters yielded 1.06 ounces of gold and 7.57 ounces of silver to the ton and less than 1 percent copper and lead; the ore and concentrates were smelted at Tacoma, Wash.; Murray, Garfield, and Midvale, Utah; and Selby, Calif.

*Mine production of metals in Oregon in 1933, by methods of recovery*

| Method of recovery | Material treated | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Ore amalgamated | 5,097 | 2,389.88 | 525 | | | |
| Ore and old smelter cleanings smelted | 1,863 | 1,965.46 | 14,031 | 6,184 | 238 | |
| Concentrates smelted: | | | | | | |
| Flotation | 134 | 905.48 | 3,027 | 4,159 | 4,925 | 12,290 |
| Table | 74 | 196.08 | 1,011 | 1,110 | 4,216 | |
| Total, lode mines | | 5,456.90 | 18,594 | 11,453 | 9,379 | 12,290 |
| Total, placers | | 14,782.76 | 2,166 | | | |
| | | 20,239.66 | 20,760 | 11,453 | 9,379 | 12,290 |
| Total, 1932 | | 19,861.21 | 8,616 | 32,199 | 7,917 | 12,061 |

*Mine production of metals from gold and silver (amalgamation) mills in Oregon in 1933, by counties, in terms of recovered metals*

| County | Ore treated | Recovered in bullion | | Concentrates and recovered metal | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Gold | Silver | Concentrates produced | Gold | Silver | Copper | Lead |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* |
| Baker | 748 | 552.10 | 142 | 11 | 39.00 | 195 | 1,010 | 2,480 |
| Crook | 34 | 13.28 | 6 | | | | | |
| Curry | 6 | 52.76 | 8 | | | | | |
| Douglas | 35 | 111.13 | 8 | | | | | |
| Grant | 874 | 393.17 | 92 | 7 | 20.90 | 16 | | |
| Harney | 55 | 39.64 | 7 | | | | | |
| Jackson | 2,577 | 568.46 | 139 | 48 | 64.07 | 757 | | 688 |
| Josephine | 659 | 600.27 | 97 | 7 | 53.40 | 23 | 100 | 1,048 |
| Lane and Marion | 88 | 42.02 | 19 | 1 | 18.71 | 20 | | |
| Linn | 12 | 12.33 | 4 | | | | | |
| Malheur | 9 | 4.72 | 3 | | | | | |
| | 5,097 | 2,389.88 | 525 | 74 | 196.08 | 1,011 | 1,110 | 4,216 |
| Total, 1932 | 3,275 | 2,324.10 | 1,267 | 10 | 47.50 | 97 | | |

*Mine production of metals from concentrating mills in Oregon in 1933, by counties, in terms of recovered metals*

| County | Ore treated | Concentrates and recovered metal | | | | | |
|---|---|---|---|---|---|---|---|
| | | Concentrates produced | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Baker, Douglas, and Marion | 4,597 | 134 | 905.48 | 3,027 | 4,159 | 4,925 | 12,290 |
| | 4,597 | 134 | 905.48 | 3,027 | 4,159 | 4,925 | 12,290 |
| Total, 1932 | 1,445 | 65 | 342.91 | 1,020 | 1,015 | 5,031 | 12,061 |

*Gross metal content of Oregon concentrates produced in 1933, by classes of concentrates*

| Class of concentrates | Concentrates produced (dry weight) | Gross metal content | | | | |
|---|---|---|---|---|---|---|
| | | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold | 177 | 1,058.37 | 3,733 | 3,880 | 1,147 | ---------- |
| Copper-lead | 11 | 39.00 | 195 | 1,031 | 4,133 | ---------- |
| Lead | 7 | 4.14 | 105 | 491 | 6,103 | ---------- |
| Zinc | 13 | .05 | 5 | 163 | 168 | 13,809 |
| | 208 | 1,101.56 | 4,038 | 5,565 | 11,551 | 13,809 |
| Total, 1932 | 75 | 390.41 | 1,117 | 1,168 | 5,299 | 13,675 |

*Mine production of metals from Oregon concentrates in 1933, in terms of recovered metals*

BY COUNTIES

| | Concentrates | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Baker | 99 | 747.19 | 2,859 | 4,336 | 2,480 | ---------- |
| Douglas | 29 | 196.60 | 270 | 431 | ---------- | ---------- |
| Grant | 7 | 20.90 | 16 | ---------- | ---------- | ---------- |
| Jackson | 48 | 64.07 | 757 | ---------- | 688 | ---------- |
| Josephine | 7 | 53.40 | 23 | 100 | 1,048 | ---------- |
| Lane and Marion | 18 | 19.40 | 113 | 402 | 4,925 | 12,290 |
| | 208 | 1,101.56 | 4,038 | 5,269 | 9,141 | 12,290 |
| Total, 1932 | 75 | 390.41 | 1,117 | 1,015 | 5,031 | 12,061 |

BY CLASSES OF CONCENTRATES

| | Concentrates | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Dry gold | 177 | 1,058.37 | 3,733 | 3,757 | 688 | ---------- |
| Copper-lead | 11 | 39.00 | 195 | 1,010 | 2,480 | ---------- |
| Lead | 7 | 4.14 | 105 | 347 | 5,813 | ---------- |
| Zinc | 13 | .05 | 5 | 155 | 160 | 12,290 |
| | 208 | 1,101.56 | 4,038 | 5,269 | 9,141 | 12,290 |

*Gross metal content of Oregon crude ore shipped to smelters in 1933, by classes of ore*

| Class of ore | Ore (dry weight) | Gross metal content | | | |
|---|---|---|---|---|---|
| | | Gold | Silver | Copper | Lead |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* |
| Dry gold | 1,628 | 1,891.87 | 6,995 | 1,504 | ---------- |
| Dry silver | 215 | 11.20 | 6,929 | 4,881 | ---------- |
| Lead | 2 | 47.80 | 47 | ---------- | 397 |
| | 1,845 | 1,950.87 | 13,971 | 6,385 | 397 |
| Total, 1932 | 475 | 944.80 | 3,987 | 32,226 | 3,157 |

*Mine production of metals from Oregon crude ore shipped to smelters in 1933, in terms of recovered metals*

BY COUNTIES

| | Ore | Gold | Silver | Copper | Lead |
|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* |
| Baker | 1,726 | 1,634.52 | 13,652 | 4,735 | ---------- |
| Curry | 1 | 1.10 | ---------- | ---------- | ---------- |
| Douglas | 7 | 47.78 | 53 | ---------- | ---------- |
| Grant | 13 | 28.00 | 29 | 100 | ---------- |
| Jackson | 4 | 69.80 | 56 | ---------- | 238 |
| Josephine | 49 | 139.34 | 68 | ---------- | ---------- |
| Lane | 45 | 30.33 | 113 | 1,349 | ---------- |
| | 1,845 | 1,950.87 | 13,971 | 6,184 | 238 |
| Total, 1932 | 475 | 944.80 | 3,987 | 31,184 | 2,886 |

BY CLASSES OF ORE

| | Ore | Gold | Silver | Copper | Lead |
|---|---|---|---|---|---|
| Dry gold | 1,628 | 1,891.87 | 6,995 | 1,449 | ---------- |
| Dry silver | 215 | 11.20 | 6,929 | 4,735 | ---------- |
| Lead | 2 | 47.80 | 47 | ---------- | 238 |
| | 1,845 | 1,950.87 | 13,971 | 6,184 | 238 |

## REVIEW BY COUNTIES AND DISTRICTS

*Mine production of gold, silver, copper, lead, and zinc in Oregon in 1933, by counties and districts, in terms of recovered metals* [1]

| County and district [1] | Mines producing | | Ore and old smelter cleanings | Gold | | | Silver (lode and placer) [2] | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | Lode | Placer | Total | | | | | |
| | | | *Short tons* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| Baker County: | | | | | | | | | | | |
| Baker | 5 | 6 | 241 | 123.65 | 320.18 | 443.83 | 287 | 1,010 | 2,480 | | $9,432 |
| Bridgeport | | 6 | | | 104.90 | 104.90 | 21 | | | | 2,175 |
| Connor Creek | | 5 | | | 74.82 | 74.82 | 13 | | | | 1,552 |
| Cornucopia | 1 | 3 | 3,350 | 708.19 | 16.80 | 724.99 | 2,667 | 3,326 | | | 16,133 |
| Cow Creek | | 1 | | | 5.01 | 5.01 | | | | | 104 |
| Eagle Creek | 2 | | 55 | 46.47 | | 46.47 | 11 | | | | 965 |
| Greenhorn [3] | 5 | 7 | 115 | 143.48 | 175.41 | 318.89 | 79 | | | | 6,620 |
| Mormon Basin [4] | 5 | 10 | 185 | 86.46 | 373.92 | 460.38 | 83 | | | | 9,546 |
| Pine Creek | | 5 | | | 175.87 | 175.87 | 35 | | | | 3,648 |
| Sparta | | 1 | | | 4.58 | 4.58 | 1 | | | | 95 |
| Sumpter | 3 | 5 | 1,744 | 1,649.11 | 240.43 | 1,889.54 | 13,784 | 4,735 | | | 44,187 |
| Weatherby | 3 | 4 | 66 | 111.34 | 17.74 | 129.08 | 32 | | | | 2,679 |
| Coos County: | | | | | | | | | | | |
| Johnson Creek | | 3 | | | 30.40 | 30.40 | 5 | | | | 630 |
| Randolph | | 4 | | | 104.04 | 104.04 | 12 | | | | 2,155 |
| Crook County: Ochoco | 1 | | 34 | 13.28 | | 13.28 | 6 | | | | 277 |
| Curry County: | | | | | | | | | | | |
| Agness | | 2 | | | 3.86 | 3.86 | | | | | 80 |
| Elk River | | 1 | | | 2.14 | 2.14 | | | | | 44 |
| Gold Beach | | 5 | | | 113.36 | 113.36 | 13 | | | | 2,348 |
| Sixes | | 5 | | | 158.04 | 158.04 | 25 | | | | 3,276 |
| Douglas County: | | | | | | | | | | | |
| Coffee Creek | | 3 | | | 15.13 | 15.13 | 3 | | | | 314 |
| Cow Creek | | 7 | | | 144.32 | 144.32 | 18 | | | | 2,989 |
| Green Mountain | 1 | 6 | 5 | 3.11 | 131.71 | 134.82 | 23 | | | | 2,795 |
| Riddle | 2 | 2 | 31 | 117.12 | 6.61 | 123.73 | 9 | | | | 2,561 |
| Grant County: | | | | | | | | | | | |
| Canyon | 3 | 7 | 251 | 64.56 | 1,212.54 | 1,277.10 | 184 | | | | 26,464 |
| Greenhorn [3] | 4 | | 295 | 192.59 | | 192.59 | 53 | | | | 4,000 |
| Quartzburg | 7 | 4 | 269 | 128.55 | 17.87 | 146.42 | 69 | 100 | | | 3,057 |
| Harney County: Harney | 1 | 3 | 5 | 1.48 | 7.58 | 9.06 | 2 | | | | 188 |

[1] Only those districts shown separately for which Bureau of Mines is at liberty to publish figures; other producing districts listed in footnote 5 and their output included under "Undistributed."

[2] Of the 20,760 ounces of silver produced, 18,594 ounces were from lode mines and 2,166 ounces from placers.

[3] Greenhorn district lies in both Baker and Grant Counties.

[4] Mormon Basin district lies in both Baker and Malheur Counties.

*Mine production of gold, silver, copper, lead, and zinc in Oregon in 1933, by counties and districts, in terms of recovered metals*—Contd.

| County and district | Mines producing | | Ore and old smelter cleanings | Gold | | | Silver (lode and placer) | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | Lode | Placer | Total | | | | | |
| | | | *Short tons* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| Jackson County: | | | | | | | | | | | |
| Ashland | 3 | 2 | 1,291 | 213.71 | 42.17 | 255.88 | 738 | | 688 | | $5,573 |
| Gold Hill | 14 | 27 | 556 | 235.50 | 4,562.74 | 4,798.24 | 685 | | | | 99,428 |
| Jacksonville | 8 | 40 | 722 | 180.96 | 1,410.89 | 1,591.85 | 336 | | | | 33,024 |
| Upper Applegate | 3 | 24 | 7 | 14.60 | 925.08 | 939.68 | 145 | | | | 19,476 |
| Josephine County: | | | | | | | | | | | |
| Althouse | 1 | 3 | 5 | 5.16 | 63.17 | 68.33 | 12 | | | | 1,417 |
| Galice | 6 | 6 | 132 | 188.72 | 377.19 | 565.91 | 70 | | | | 11,723 |
| Grants Pass | 4 | 17 | 73 | 41.41 | 998.97 | 1,040.38 | 182 | 100 | | | 21,577 |
| Lower Applegate | | 3 | | | 134.16 | 134.16 | 13 | | | | 2,778 |
| Waldo | 3 | 6 | 386 | 377.15 | 601.69 | 978.84 | 111 | | | | 20,273 |
| Lincoln County: | | | | | | | | | | | |
| Collins Creek | | 1 | | | 32.76 | 32.76 | 5 | | | | 679 |
| Seal Rock | | 2 | | | 10.06 | 10.06 | | | | | 208 |
| Linn County: Quartzville | 1 | 1 | 12 | 12.33 | 7.12 | 19.45 | 7 | | | | 404 |
| Malheur County: | | | | | | | | | | | |
| Malheur | 2 | 2 | 9 | 4.72 | 13.58 | 18.30 | 5 | | | | 380 |
| Mormon Basin [4] | | 8 | | | 170.25 | 170.25 | 24 | | | | 3,528 |
| Undistributed [5] | 23 | 45 | 1,718 | 793.25 | 1,975.67 | 2,768.92 | 992 | 2,182 | 6,211 | 12,290 | 58,471 |
| Total Oregon | 111 | 292 | 11,557 | 5,456.90 | 14,782.76 | 20,239.66 | 20,760 | 11,453 | 9,379 | 12,290 | 427,253 |

[4] Mormon Basin district lies in both Baker and Malheur Counties.

[5] Includes following districts: Bull Run, Rock Creek, and Virtue, Baker County; Powers, Coos County; Chetco, Mule Creek, and Port Orford, Curry County; North and South Myrtle Creek, Nugget, and Olalla, Douglas County; Granite and Susanville, Grant County; Pueblo, Harney County; Applegate and Elk Creek, Jackson County; Greenback, Illinois River, and Kerby, Josephine County; Klamath River, Klamath County; Bohemia and Roosevelt Beach, Lane County; North Santiam, Marion County; Camp Carson, Union County; and purchases (by bullion buyers) that cannot be distributed by sources.

## EASTERN OREGON

*Baker County.*—Baker County supplied 54 percent of the lode gold, 10.28 percent of the placer gold, 82 percent of the total silver, 79.2 percent of the copper, and 26.4 percent of the lead produced in the State in 1933.

During the summer the Cornucopia Gold Mines, Inc., at Cornucopia, completed the installation of a 75-ton flotation plant and a mile of flume to supply water to its hydroelectric plant, which furnished power for its mining and milling operations. The new mill treated ore transported from the Last Chance vein through the Clark tunnel, which is about a mile long and cuts the vein at the 1,600-foot level. Concentrates were hauled to the railroad at Robinette and shipped to the Tacoma smelter. On December 1 a 6,000-foot low-level tunnel to intersect the Union Companion vein 400 feet below the shaft bottom was begun. It is expected that this tunnel will cut the Whitman vein about 2,500 feet and the Last Chance vein about 4,000 feet from the portal.

In the Sumpter district the Columbia and Taber Fraction made the largest gold output of any lode mine in the State and next to the largest of silver. The ore, from old workings, was shipped to the Tacoma smelter and averaged over 1 ounce of gold and 4 ounces of silver to the ton. The Imperial-Eagle Mining Co., in the Cable Cove district 11 miles northwest of Sumpter, engaged in development work during the summer and late in the year shipped a 50-ton car of ore to the smelter at Midvale, Utah. Prospect work on the Ivy May and Star veins furnished part of this ore, and the rest was from the Imperial vein. The mill, which has a capacity of 100 to 125 tons a day, was under repair; ore bins were erected, and arrangements were made for handling shipping ore in bulk rather than in sacks as heretofore. The ore is hauled to the railroad at Sumpter by teams or trucks. As a result of the advance in price of gold the old smelter at Sumpter was cleaned up, and low-grade ore, concentrates, and flue dust were shipped to the Tacoma smelter. The old Rainbow mine in the Mormon Basin district was rehabilitated and made ready for production early in 1934. New machinery was installed, and much general development work was done at the property. In the Bull Run district the Record Mining Co. completed 1,072 feet of drifting and crosscutting on its Whited property 5½ miles south of Unity in preparation for production early in 1934. The Bull Run mine 5 miles southwest of Unity has a 30-ton mill and made a small production during 1933. Among the lode mines in Baker County not already mentioned the principal producers were the Gold Bug, Baker district; Sanger Development, Eagle Creek district; Parkersville group and Red Bird, Greenhorn district; Independence, Mormon Basin district; Hallock group, Virtue district; and Gleason and Gold Cluster group, Weatherby district.

The Washington Gulch placer 7 miles southwest of Baker operated only 3 weeks, due to shortage of water. About 5,400 cubic yards of gravel were loaded by power shovel into three 5-ton trucks, which carried the material to the sluice, and approximately 100 ounces of gold were recovered. The Robinson placer, also in the Baker district, was worked by drag line with a washing plant on skids and yielded a small production. The Smith & Harms Mining Co., the largest producer of placer gold in the Bridgeport district, operated its Nugget Association claims for 2 months in the fall; about 8,000 cubic yards of gravel were hoisted and conveyed to the sluice by a 4-yard bucket and trolley line. In the Greenhorn district the Winterville placers, 9 miles northwest of Whitney, hydraulicked with two giants from May 20 to August 7 and produced about 120 ounces of gold from 20,000 cubic yards of material handled principally in development work. In November the Howard Investment Co. began operating its dredge on Clarks Creek in the Mormon Basin district on a full-time schedule and made the largest production of placer gold in Baker County. The Rye Valley placers in the same district were hydraulicked and yielded considerable gold. In the Pine Creek district the Elliott drift mine and the Nugget placer, both on Pine Creek, were the largest producers. The latter property was purchased by the Humphreys Mines, Inc., of Denver, Colo., which also drilled ground on the George Elliott ranch to determine whether it was suitable for dredging. The Harris placer in the Sumpter district was worked by a drag line with a floating washing plant to yield virtually the entire output of placer gold in the district. At the Buck Gulch placer near Sumpter an 8½-ounce nugget was found in the spring clean-up. Much of the placer gold produced in Baker County was sold to banks and bullion buyers.

*Crook County.*—The Red Bird mine at Prineville, with an output of 13 ounces of gold, was the only producer of lode gold in Crook County in 1933. No placer operations were reported.

*Grant County.*—The Rabbit mine in the Greenhorn district ran its 5-stamp mill most of the summer and was the largest producer of lode gold in Grant County in 1933. Next in order of production were the Cougar Ridge mine, Quartzburg district; Ruby Creek mine, Granite district; Jinks mine, Greenhorn district; Carrie Nation group, Canyon district; and Equity group, Quartzburg district. At the Cougar Ridge mine 200 tons of ore were milled and yielded approximately 65 ounces of gold of which about 80 percent was recovered by amalgamation. Due to water shortage the mill averaged only about two 8-hour shifts a week beginning in August. The ore, crushed to 40-mesh, was amalgamated and the discharge from the plates concentrated on tables. The Jinks mine and Carrie Nation group each produced a small tonnage of high-grade ore. A 5-ton mill was installed at the Equity group for amalgamating and concentrating the ore, which contains considerable sulphides. The new plant ran 32 days before the close of the year.

The Empire Gold Dredging & Mining Co. was the largest producer of placer gold in Grant County in 1933. Its dredge in the Canyon district handled 388,000 cubic yards of gravel during the year. Early in November the Timms Gold Dredging Co. started its dredge on the Middle Fork of John Day River in the Susanville district. About 100,000 cubic yards of gravel were handled during the remainder of the year to yield the second largest output of placer gold in the county. The dredge, which is of the Yuba type, has a capacity of 2,000 cubic yards a day and is powered by electricity derived from the operation of a 300-horsepower Diesel engine. At the Marysville placers in the Canyon district 11,340 cubic yards of gravel were hydraulicked between May 1 and July 8 and yielded the third largest output of placer gold in the county. Grant County contributed 9.8

percent of the placer gold and 8.1 percent of the lode gold produced in the State in 1933.

*Harney County.*—The only appreciable metal production in Harney County in 1933 was derived from the Ashdown mine, which yielded a small output of lode gold.

*Malheur County.*—Condor Gold Mines, Inc., prospected the Sunday Hill mine in the Mormon Basin district and installed a power shovel for mining the large, low-grade deposit by opencut methods. A dozen or more small placer operations in Malheur County yielded a total of 184 ounces of fine gold in 1933.

### WESTERN OREGON

*Coos County.*—Placers near Powers and in the Johnson Creek district and beach sand deposits at Bandon and Bullards yielded 140 fine ounces of gold in 1933. No lode gold was produced in Coos County.

*Curry County.*—A placer washing plant was erected in 1933 on the Hughes beach property about 1½ miles south of Cape Blanco. A gasoline shovel loaded the sand into trucks, which delivered it to hoisting equipment discharging to a 150-ton bin, which in turn fed a shaking screen. The oversize dropped onto a conveyor belt, which stacked it at a distance. The undersize was run over amalgamating plates and through sluices to recover the gold and associated platinum metals. Washing was begun October 23, and about 2,500 cubic yards of sand yielding 88 ounces of fine gold were handled before the end of the year. A total of 255 fine ounces of gold was derived in 1933 from 20 or more smaller placer operations in the Agness, Chetco, Elk River, Gold Beach, Mule Creek, Port Orford, and Sixes districts. About half of these operations treated beach sands. Only 2.3 percent of the placer gold output of the State came from Curry County; the lode gold output totaled 53.86 ounces.

*Douglas County.*—Only 6.5 percent of the lode gold and 2.2 percent of the placer gold output of the State in 1933 were produced in Douglas County. The Chieftain mine in the Nugget district, with an output of approximately 200 fine ounces, was the principal producer of lode gold in the county; its sulphide ore was treated in a 15-ton all-flotation plant equipped with a jaw crusher, ball mill, drag classifier, and Fahrenwald flotation units. The Huckleberry mine in the Riddle district, with an output exceeding 100 fine ounces, was the second largest producer of lode gold in the county; high-grade ore was treated in a ¼-ton test mill. Placer activities were confined to numerous small sluicing and hydraulic operations, only two of which reported production exceeding 20 ounces. The Cow Creek and Green Mountain districts yielded over 85 percent of the county output of placer gold in 1933.

*Jackson County.*—Jackson County was the leading producer of placer gold in the State in 1933, yielding 47 percent of the total output. Of the county total, the Gold Hill district produced 65.8 percent, the Jacksonville district 20.3 percent, the Upper Applegate district 13.3 percent, and the Ashland district 0.6 percent. The largest producers in the Gold Hill district in 1933 were the Rogue River Gold Co., which ran its dredge on Foots Creek whenever enough water was available (equivalent to 7 months out of the year); the Skeels & Graham Co., which operated its gasoline shovel and screening plant on Sardine Creek during the late winter; the Huston placer mine on Lane Creek, where ground-sluicing operations were carried on until June 1; the Lance hydraulic mine on Foots Creek; and the M. S. Johnson hydraulic operation. In the Jacksonville district much of the placer output was derived from drift mining and sluicing operations along Jackson Creek, which individually yielded 2 to 120 ounces. The largest production by hydraulicking was from the James Davies mine. In the Upper Applegate district the Sterling mine and the Pacific Placer (Old Layton) were the principal producers.

Jackson County produced 12.9 percent of the total output of lode gold in the State in 1933. The Gold Hill, Ashland, and Jacksonville districts were the principal producers; the Shorty Hope, Ashland, American Boy, Gold Wedge, and Bull of the Woods mines led in individual output. A 5-stamp mill with concentrating table was installed at the Shorty Hope mine. The Opp mine at Jacksonville was under development by Pacific States Mines, Inc., and much of the machinery for a 100-ton amalgamation-flotation plant was installed. A 50-ton unit of the mill was placed in operation on a 1-shift basis late in the year. The Jacksonville Gold Mining Co. started development at the old Town mine at Jacksonville and installed a 35-ton Straub unit, which will treat company and custom ore. At the Ashland mine 200 feet of the old shaft, 350 feet of tunnel, and 1,050 feet of levels were reclaimed and 450 feet of new development completed. Additions were made to the mill to provide for cyaniding the concentrates.

*Josephine County.*—Approximately 25 percent of the placer gold and 15 percent of the lode gold mined in the State in 1933 came from Josephine County. The Grants Pass, Greenback, Waldo, and Illinois River districts, in the order given, were the principal producers of placer gold and collectively supplied 2,882 fine ounces or 80 percent of the county total; the remainder came from the Galice, Lower Applegate, and Althouse districts. The leading producers were the Llano De Oro mine, Waldo district; Ruble mine, Greenback district; Oscar Creek mine, Lower Applegate district; Columbia, Greenback district; Dean and Dean mine, Galice district; and Forest Queen mine, Grants Pass district. At the Oscar Creek mine gravel dug with a 1-yard Diesel shovel was transported over a mile to the sluice in 5-ton trucks. The principal producing lode mines were the Rainbow, Waldo district; Greenback, Greenback district; Black Bear and Log Cabin, Illinois River district; and Oriole and Gold Bond, Galice district. At the Greenback mine a mill was under construction, and at the Oriole a lower tunnel was being driven under contract to connect with the No. 3 tunnel and thus provide 188 feet of backs.

*Lane County.*—The Bartels Mining Co. produced a little gold from its Evening Star and Lead Crystal claims in the Bohemia district. Sluicing operations in the same district and at Roosevelt Beach yielded 13 fine ounces of gold in 1933.

*Lincoln County.*—Sluicing operations on beach sand at the mouth of Collins Creek, a mile south of Seal Rock, yielded 32.76 ounces of fine gold in 1933. Other beach sand operations at Seal Rock yielded 10.06 ounces of gold.

*Linn County.*—A small production of gold from the Tillicum mine, which is equipped with a 2-stamp mill, and a few ounces of placer gold from sluicing operations on the Santiam River constituted the entire output of Linn County in 1933.

*Marion County.*—A small shipment of lead-zinc-copper concentrate was made to the Midvale smelter in 1933 from the Ruth mine in the North Santiam district. Production of gold in Marion County was negligible.

# GOLD, SILVER, COPPER, AND LEAD IN SOUTH DAKOTA

**(MINE REPORT)**

By Chas. W. Henderson

## SUMMARY OUTLINE



Metal-mining history in South Dakota began with the discovery of placer gold in 1875 in the gravels of French Creek near the present site of Custer. To date metal mining has been confined to the three southwestern counties—Custer, Lawrence, and Pennington—in what is known as the Black Hills. In 1933 the metal mines of the State produced 512,403.77 fine ounces of gold and 125,417 fine ounces of silver, compared with an output in 1932 of 480,337.58 ounces of gold, 126,195 ounces of silver, and 7,000 pounds of lead. The gold output in 1933 was the largest in any year on record and came chiefly from the Homestake mine at Lead, Lawrence County, which has been producing almost continuously since 1876. The quantity of gold recovered at placer mines in 1933 was 1,269.75 ounces, compared with 1,095.16 ounces in 1932. The total production of gold, silver, copper, and lead (in terms of recovered metals) in South Dakota from the beginning of production in 1875 to the end of 1933 has been 15,416,015 fine ounces of gold, 8,135,238 fine ounces of silver, 195,691 pounds of copper, and 568,313 pounds of lead.

*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of $20.671835, from January 1 to August 9 to all producers; (2) that of (*a*) $20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export by some producers,[1] to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, from September 8 to November 1); and (4) the period of the Reconstruction Finance Corporation arbitrarily fixed, gradually rising price (generally above the world price), from October 25 to December 31, 1933. For further details see chapter of this volume on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

Following is a table on mine production of gold in South Dakota, 1929–33, in terms of recovered metal; two values are given for 1933—

[1] The Homestake Mining Co. of South Dakota was one of the United States gold producers that shipped abroad in the period Aug. 9 to 29.

(1) at legal coinage value ($20.67+ per ounce) and (2) at average weighted price ($25.56 per ounce).

*Mine production of gold in South Dakota, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 316,836.85 | $6,549,599 | 1932 | 480,337.58 | $9,929,459 |
| 1930 | 407,221.14 | 8,418,008 | 1933 | 512,403.77 | [2] 10,592,326<br>[3] 13,097,040 |
| 1931 | 432,075.39 | 8,931,791 | | | |

[1] 1929–32: At legal value ($20.67+per ounce); 1933: At both legal coinage value ($20.67+per ounce) and average weighted price ($25.56 per ounce).
[2] At legal coinage value ($20.67+per ounce).
[3] At average weighted price ($25.56 per ounce).

*Calculation of value of metal production.*—The value of metal production hereinafter reported 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, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Mine production of gold, silver, and lead in South Dakota, 1929–33, in terms of recovered metals* [1]

| Year | Mines producing | | | Ore (short tons) | Gold (lode and placer) | | Silver (lode and placer) | | Lead | | Total value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | Total | | Fine ounces | Value | Fine ounces | Value | Pounds | Value | |
| 1929 | 2 | | 2 | 1,463,159 | 316,836.85 | $6,549,599 | 85,182 | $45,402 | | | $6,595,001 |
| 1930 | 2 | 8 | 10 | 1,365,156 | 407,221.14 | 8,418,008 | 105,236 | 40,516 | | | 8,458,524 |
| 1931 | 6 | 83 | 89 | 1,404,153 | 432,075.39 | 8,931,791 | 113,562 | 32,933 | | | 8,964,724 |
| 1932 | 8 | 217 | 225 | 1,409,893 | 480,337.58 | 9,929,459 | 126,195 | 35,587 | 7,000 | $210 | 9,965,256 |
| 1933 | 4 | 215 | 219 | 1,432,555 | 512,403.77 | 10,592,326 | 125,417 | 43,896 | | | 10,636,222 |

[1] For total production of gold and silver in South Dakota, by years, see Henderson, Chas. W., Mineral Resources, 1913, pt. I, p. 42; Mineral Resources, 1922, pt. I, p. 194; and subsequent volumes of same series.

*Gold and silver produced at placer mines in South Dakota, 1929–33* [1]

| Year | Gold | | Silver | | Total value |
|---|---|---|---|---|---|
| | Fine ounces | Value | Fine ounces | Value | |
| 1930 | 47.41 | $980 | 5 | $2 | $982 |
| 1931 | 96.17 | 1,988 | | | 1,988 |
| 1932 | 1,095.16 | 22,639 | 85 | 24 | 22,663 |
| 1933 | 1,269.75 | 26,248 | 97 | 34 | 26,282 |

[1] No production in 1929

## MINING AND METALLURGIC INDUSTRY

All the ores mined in South Dakota during 1933 were classed as dry gold ores and were treated by amalgamation and cyanidation or by amalgamation only. Operations at the Homestake mine (the largest producer of gold in the United States) are described under the following review by counties; the three other lode mines yielded a total of 166.02 fine ounces of gold and 21 fine ounces of silver in 1933. The number of placer operations decreased from 217 in 1932 to 215 in 1933, but the output of placer gold increased owing to the wider use of machinery in handling the gravels.

### METALLURGIC RECOVERY

*Gold and silver bullion produced at mills in South Dakota by amalgamation, 1929–33*

| Year | Ore treated | Gold in bullion | Silver in bullion | Quicksilver used |
|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* |
| 1929 | 1,437,935 | 210,869.03 | 51,676 | 9,225 |
| 1930 | 1,364,456 | 270,448.01 | 65,265 | 12,021 |
| 1931 | 1,404,106 | 288,155.99 | 67,857 | 15,305 |
| 1932 | 1,402,275 | 310,637.81 | 72,639 | 7,633 |
| 1933 | 1,432,555 | 328,449.02 | 71,985 | 29,410 |

*Gold and silver bullion produced at mills in South Dakota by cyanidation, 1929–33*

| Year | Material treated | | | Gold in bullion product | Silver in bullion product | Sodium cyanide used [1] |
|---|---|---|---|---|---|---|
| | Crude ore | Sands and slimes | Total | | | |
| | *Short tons* | *Short tons* | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* |
| 1929 | 25,224 | 1,358,870 | 1,384,094 | 105,967.82 | 33,506 | 353,859 |
| 1930 | 700 | 1,348,144 | 1,348,844 | 136,725.72 | 39,966 | 382,110 |
| 1931 | 47 | 1,400,191 | 1,400,238 | 143,823.23 | 45,705 | 375,535 |
| 1932 | | 1,396,330 | 1,396,330 | 168,561.00 | 50,166 | 437,773 |
| 1933 | | 1,430,738 | 1,430,738 | 182,685.00 | 53,335 | [2] 447,172 |

[1] In terms of 96- to 98-percent strength.
[2] Actually 890,665 pounds of cyanamid (49-percent strength) and 1,839 pounds of sodium cyanide (96- to 98-percent strength); cyanamid reduced to equivalent of 96- to 98-percent strength to conform with earlier use of figures for high-strength NaCN and KCN.

## REVIEW BY COUNTIES

### CUSTER COUNTY

*Mine production of gold and silver in Custer County, S.Dak., 1929–33, in terms of recovered metals* [1]

| Year | Mines producing (all placer) | Gold (all placer) | | Silver (all placer) | Total value |
|---|---|---|---|---|---|
| | | *Fine ounces* | | *Fine ounces* | |
| 1930 | 4 | 6.34 | $131 | | $131 |
| 1931 | 41 | 45.57 | 942 | | 942 |
| 1932 | 80 | 697.81 | 14,425 | 50 | 14,439 |
| 1933 | 52 | 893.63 | 18,473 | 57 | 18,493 |

[1] No production in 1929.

All the production from Custer County in 1933 was from placer mines.

Four placer operations on French Creek west of Custer and one on Lightning Creek, all of which used power shovels or drag lines and specially constructed washing plants or centrifugal separators, recovered 93 percent of the total county output of both gold and silver in 1933; the remainder was produced by individual miners sluicing on Spring and Battle Creeks, who sold most of the gold to banks at Hermosa and Custer.

## LAWRENCE COUNTY

*Mine production of gold, silver, and lead in Lawrence County, S.Dak., 1929–33, in terms of recovered metals*

| Year | Mines producing | | Ore | Gold (lode and placer) | | Silver (lode and placer) | Lead | Total value |
|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | |
| | | | *Short tons* | *Fine ounces* | | *Fine ounces* | *Pounds* | |
| 1929 | 1 | | 1, 437, 935 | 314, 011. 03 | $6, 491, 184 | 84, 987 | | $6, 536, 482 |
| 1930 | 1 | 4 | 1, 364, 456 | 406, 879. 08 | 8, 410, 937 | 105, 184 | | 8, 451, 433 |
| 1931 | 2 | 22 | 1, 403, 964 | 431, 916. 77 | 8, 928, 512 | 113, 507 | | 8, 961, 429 |
| 1932 | 3 | 17 | 1, 409, 211 | 479, 300. 90 | 9, 908, 029 | 126, 103 | 7, 000 | 9, 943, 800 |
| 1933 | 3 | 21 | 1, 432, 285 | 511, 289. 36 | 10, 569, 289 | 125, 340 | | 10, 613, 158 |

*Homestake mine.*—The Homestake mine and mills were operated continuously in 1933. A new operating shaft called the "Ross", with an ultimate depth of 5,000 feet, was begun during the year and progress has been rapid; part of the shaft was excavated by raising. In March 1934 all levels above the 3,200.were connected with the new shaft, and it is expected that cages can be operated from the 2,700 level by July 1. A new cyanide sand plant (called cyanide sand plant No. 3) was built in 1933 and was expected to be put into operation January 10, 1934; the capacity of the new plant is 1,000 tons in 24 hours. In 1933 the company operated 6 mills: Amicus, 240 stamps and 15 tube mills, daily average 1,309 tons; Pocahontas, 160 stamps, 670 tons; South, 120 stamps, 8 rod mills, and 4 tube mills, 1,960 tons; cyanide sand plant No. 1, 1,744 tons; cyanide sand plant No. 2, 377 tons; and slime plant, 1,601 tons. Ore from the Homestake mine to the company mills, treated by amalgamation followed by cyanidation of sands and slimes, totaled 1,432,195 tons in 1933, an increase of 30,602 tons over 1932, and revenue (including the premium on gold) from the sale of gold-silver bullion bars and a small quantity of assay laboratory slag was $12,900,317—$2,988,459 more than in 1932. Dividends paid in 1933 were $3,767,400. From 1876 to 1933, inclusive, this mine has yielded bullion and concentrates which brought a cash return of $266,294,806 after freight, express, insurance, mint, and smelter charges are deducted; the company has paid $66,420,682 in dividends.

The annual report of the general manager of the Homestake Mining Co. for year ended December 31, 1933, says:

Operations at the mine were carried on throughout the year without interruption. The increase in number of employees necessitated by the shorter work week and the increase in the wage scale materially increased operating costs.

Following is a condensed report of the mine engineer.

There are 469,063 tons of ore broken down and remaining in the stopes.

There are 15,098,453 tons of ore blocked out and remaining in the mine.

Sinking of the Ellison Shaft from the 2,600-foot level to the 3,200-foot level was completed except for a 20-foot bulkhead just below the 2,600-foot level.

Excellent progress was made on the Ross Shaft. The pilot raise was completed from the surface to the 3,050-foot level. Stripping to full size was completed for a total of 1,314 feet and steel shaft sets installed in a total of 1,250 feet.

Construction of the Ross Shaft surface plant will be completed in 1934.

Cyanide Plant No. 3 was practically completed. The grinding and classifying equipment have been tested and the plant will be placed in full operation about January 10, 1934.

*Ore milled, receipts, and dividends, Homestake mine, 1929–33* [1]

| Year | Ore milled | Receipts for bullion product | | Dividends |
|---|---|---|---|---|
| | | Total | Per ton | |
| | *Short tons* | | | |
| 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 | 1,401,593 | 9,911,858.40 | 7.0719 | 2,662,296 |
| 1933 | 1,432,195 | 12,900,316.78 | 9.0074 | 3,767,400 |

[1] From 1876 to 1933, inclusive, this mine yielded bullion and concentrates which brought $266,294,806 and paid $66,420,682 in dividends.

*Other mines.*—A total of 139.90 fine ounces of gold and 21 fine ounces of silver was produced from two other lode mines in the county in 1933. Small-scale placer mining in Blacktail and Deadwood Gulches and Two Bit and Whitewood Creeks in the eastern part of the county and on the East Fork of Beaver Creek in the western part yielded 95.51 fine ounces of gold. Operations of the Bear Creek Mining Co. on Iron Creek, using its specially constructed equipment for the recovery of placer gold, resulted in the production of gold bullion which was sold to the Denver Mint.

## PENNINGTON COUNTY

*Mine production of gold and silver in Pennington County, S.Dak., 1929–33, in terms of recovered metals*

| Year | Mines producing | | Ore | Gold (lode and placer) | | Silver (lode and placer) | Total value |
|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | |
| | | | *Short tons* | *Fine oz.* | | *Fine oz.* | |
| 1929 | 1 | | 25,224 | 2,825.82 | $58,415 | 195 | $58,519 |
| 1930 | 1 | | 700 | 335.72 | 6,940 | 52 | 6,960 |
| 1931 | 4 | 20 | 189 | 113.05 | 2,337 | 55 | 2,353 |
| 1932 | 5 | 120 | 682 | 338.87 | 7,005 | 42 | 7,017 |
| 1933 | 1 | 142 | 270 | 220.78 | 4,564 | 20 | 4,571 |

Production was made from one lode mine (the Western Bell) in Pennington County in 1933. Placer miners panning, sluicing, and drift mining on Castle, Rapid, Slate, and Spring Creeks recovered gold in small quantities, which they sold for amounts ranging from 13 cents to $30 to jewelers and merchants at Hill City, Keystone, Mystic, and Rapid City.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN TEXAS

(MINE REPORT)

By Chas. W. Henderson

## SUMMARY OUTLINE



In the year 1933 metal mines in Texas produced (in terms of recovered metals) 160 fine ounces of silver, 2,000 pounds of copper, and 6,000 pounds of lead from small shipments of ore from Culberson, Hudspeth, and Presidio Counties to the El Paso smelter. Details are given in the tables that follow.

The total production of gold, silver, copper, lead, and zinc in Texas (in terms of recovered metals) from the beginning of production in 1885 to the end of 1933, according to Henderson,[1] has been 4,608 fine ounces of gold, 22,774,105 fine ounces of silver, 1,309,960 pounds of copper, 3,781,126 pounds of lead, and 1,488,474 pounds of zinc.

*Mine production of gold, silver, copper, and lead in Texas, 1929–33, in terms of recovered metals* [1]

| Year | Ore (short tons) | Gold | | Silver | | Copper | | Lead | | Total value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Fine ounces | Value | Fine ounces | Value | Pounds | Value | Pounds | Value | |
| 1929 | 63,872 | 1,278.99 | $26,439 | 1,020,516 | $543,935 | 341,000 | $60,016 | 849,683 | $53,530 | $683,920 |
| 1930 | 31,147 | 176.47 | 3,648 | 389,239 | 149,857 | 143,100 | 18,603 | 396,820 | 19,841 | 191,949 |
| 1932 | 185 | 8.66 | 179 | 1,422 | 401 | 7,000 | 441 | 34,000 | 1,020 | 2,041 |
| 1933 | 63 | ---------- | ---------- | 160 | 56 | 2,000 | 128 | 6,000 | 222 | 406 |

[1] No production in 1931.

The value of metal production herein reported 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.

[1] For production from 1885 to 1927 and prices used in calculating values see Henderson, Chas. W., Mineral Resources, 1927, pt. I, pp. 477–478. *See also* Henderson, Chas. W., Mineral Resources, 1914, pt. I, p. 236.

*Prices of silver, copper, lead, and zinc, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Mine production of silver, copper, and lead in Texas in 1933, by counties and by classes of ore, in terms of recovered metals*

| County | Mines producing | Ore [1] | | Silver | | Copper | | Lead | | Total value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Class | Short tons | Fine ounces | Value | Pounds | Value | Pounds | Value | |
| Culberson | 1 | Copper | 2 | 12 | $4 | 200 | $13 | | | $17 |
| Hudspeth | 1 | do | 43 | 51 | 18 | 1,800 | 115 | | | 133 |
| Presidio | 1 | Lead | 18 | 97 | 34 | | | 6,000 | $222 | 256 |
| | 3 | | 63 | 160 | 56 | 2,000 | 128 | 6,000 | 222 | 406 |

[1] All sold crude to smelter.

## REVIEW BY COUNTIES

*Brewster, Culberson, and Hudspeth Counties.*—The chapters on Texas in Mineral Resources, 1929 and 1930, part I, give details of development in these three counties.

*El Paso County.*—The copper-smelting works and lead plant of the American Smelting & Refining Co. are at El Paso. At the end of 1933 the copper works consisted of 2 reverberators, with a total annual capacity of 600,000 tons of ore, and 3 converters; the lead plant was equipped with 3 furnaces having a total annual capacity of 200,000 tons. The lead plant treats lead ore and concentrates from Arizona, New Mexico, and Texas and lead ore in bond from Mexico. The copper plant was built originally in 1910 to handle copper concentrates from Chino Mines at Santa Rita, N.Mex.; it also receives copper ore and concentrates from Arizona. Natural gas for fuel was introduced in these plants in 1930.[2] Both plants were operated very intermittently in 1933.

The Nichols electrolytic copper refinery, also at El Paso, was completed and set in operation in 1930 to treat copper anodes produced at the Arizona smelters of the Phelps Dodge Corporation and the Calumet and Arizona Mining Co. The yearly capacity is 100,000 tons of anodes.[3] The plant was not operated at full capacity during 1933.

*Presidio County.*—From 1885 to 1930, inclusive, the Presidio mine at Shafter, Tex., has produced (in terms of recovered metal) 20,282,186 ounces of silver. The property was closed June 30, 1930, owing to the declining price of silver, but the mine contains reserves of silver ore. It was reopened early in 1934.

[2] Marble, E. R., Natural-Gas Firing at El Paso Smelting Works: Min. and Met., October 1930, pp. 466–7.

[3] Robie, E. H., A Trip Through the New Nichols Copper Refinery at El Paso, Tex.: Eng. and Min. Jour., vol. 129, January 1930, pp. 5–10; Furnace and Casting Equipment of the New Nichols Refinery: Eng. and Min. Jour., vol. 129, January 1930, pp. 73–6.

Corwin, F. R., and Harloff, C. S., El Paso Refinery of the Nichols Copper Co.: Min. and Met., October 1930, pp. 459–65.

*Production of silver from the Presidio mine,[1] 1885–1930* [2]

| Period | Mill heads treated (short tons) | Silver content of mill heads (ounces) | | Recovery of silver | |
|---|---|---|---|---|---|
| | | Per ton | Total | Percent | Ounces |
| 1885–1912 | 450,000 | 25.84 | 11,628,000 | 81.68 | 9,497,750 |
| 1913–26 | 720,000 | 12.00 | 8,640,000 | 83.66 | 7,228,224 |
| 1927 | 48,190 | 22.87 | 1,102,105 | [3] 91.41 | [3] 1,004,384 |
| 1928 | 57,475 | 23.17 | 1,331,696 | 91.04 | 1,212,340 |
| 1929 | 54,644 | 19.74 | 1,078,673 | 90.30 | 974,049 |
| Total, 1885–1929 | 1,330,309 | 17.88 | 23,780,474 | | 19,916,747 |
| 1930 | 24,985 | (?) | (?) | (?) | 365,439 |
| Total, 1885–1930 | 1,355,294 | (?) | (?) | (?) | 20,282,186 |

[1] Howbert, Van Dyne, and Gray, F. E., Milling Methods and Costs at Presidio Mine of the American Metal Co. of Texas: Am. Inst. Min. and Met. Eng. Tech. Pub. 368, 1930; Howbert, Van Dyne, and Bosustow, Robert, Mining Methods and Costs at Presidio Mine of the American Metal Co. of Texas: Am. Inst. Min. and Met. Eng. Tech. Pub. 334, 1930.

[2] No production in 1931, 1932, and 1933.

[3] Using the company's 1927 report of 1,004,384 ounces of silver recovered gives 91.13 percent recovery; using 91.41 percent (Howbert and Gray, work cited, p. 6) as recovery gives 1,007,434 ounces of silver recovered.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH

(MINE REPORT)

By C. N. Gerry and T. H. Miller [1]

## SUMMARY OUTLINE



The output of gold, silver, copper, lead, and zinc from Utah mines in 1933, in terms of recovered metals, was 109,129.55 fine ounces of gold, 5,669,197 fine ounces of silver, 73,583,130 pounds of copper, 117,376,556 pounds of lead, and 59,489,193 pounds of zinc. This output compares with a production in 1932 of 135,256.35 ounces of gold, 6,962,097 ounces of silver, 64,964,111 pounds of copper, 125,552,966 pounds of lead, and 59,331,888 pounds of zinc. There were 121 lode mines and 21 placers producing in 1933 compared with 86 lode mines and 19 placers in 1932.

Since 1864 the output of the five metals in Utah has been as follows: Gold, 7,000,309 fine ounces; silver, 598,106,470 fine ounces; copper, 4,855,654,109 pounds; lead, 7,196,590,720 pounds; and zinc 984,274,157 pounds. The total value of this output has been \$1,814,314,105 [2] of which \$144,709,230 [2] represents the value of gold.

*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of \$20.671835, from January 1 to August 9 to all producers; (2) that of (*a*) \$20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export by some producers, to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, from September 8 to November 1); and (4) the period of the Reconstruction Finance Corporation arbitrarily fixed, gradually rising price (generally above the world price), from October 25 to December 31, 1933. For further details see

[1] Assisted by Paul Luff and Jeannette Froiseth.
[2] Value of gold calculated at \$20.671835 an ounce.

chapter of this volume on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

Following is a table on mine production of gold in Utah, 1929–33, in terms of recovered metal; two values are given for 1933—(1) at legal coinage value ($20.67+ per ounce) and (2) at average weighted price ($25.56 per ounce).

*Mine production of gold in Utah, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 240,419.63 | $4,969,915 | 1932 | 135,256.35 | $2,795,997 |
| 1930 | 208,455.03 | 4,309,148 | 1933 | 109,129.55 | [2] 2,255,908<br>[3] 2,789,351 |
| 1931 | 198,740.12 | 4,108,323 | | | |

[1] 1929–32: At legal value ($20.67+ per ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] At legal coinage value ($20.67+ per ounce).
[3] At average weighted price ($25.56 per ounce).

*Calculation of value of metal production.*—The value of metal production hereinafter reported 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, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Mine production of gold, silver, copper, lead, and zinc in Utah, 1929–33, in terms of recovered metals*

| Year | Mines producing | | Ore, old tailings, etc. (short tons) | Gold | | Silver | |
|---|---|---|---|---|---|---|---|
| | Lode | Placer | | Fine ounces | Value | Fine ounces | Value |
| 1929 | 127 | 3 | 19,831,975 | 240,419.63 | $4,969,915 | 17,592,396 | $9,376,747 |
| 1930 | 103 | | 11,041,841 | 208,455.03 | 4,309,148 | 13,129,421 | 5,054,827 |
| 1931 | 96 | 9 | 8,954,617 | 198,740.12 | 4,108,323 | 8,290,966 | 2,404,380 |
| 1932 | 86 | 19 | 3,768,542 | 135,256.35 | 2,795,997 | 6,962,097 | 1,963,311 |
| 1933 | 121 | 21 | 4,116,935 | 109,129.55 | 2,255,908 | 5,669,197 | 1,984,219 |

| Year | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| 1929 | 318,282,523 | $56,017,724 | 298,754,429 | $18,821,529 | 103,019,485 | $6,799,286 | $95,985,201 |
| 1930 | 180,526,423 | 23,468,435 | 230,989,780 | 11,549,489 | 88,990,938 | 4,271,565 | 48,653,464 |
| 1931 | 151,236,505 | 13,762,522 | 158,423,453 | 5,861,668 | 74,581,072 | 2,834,081 | 28,970,974 |
| 1932 | 64,964,111 | 4,092,739 | 125,552,966 | 3,766,589 | 59,331,888 | 1,779,957 | 14,398,593 |
| 1933 | 73,583,130 | 4,709,320 | 117,376,556 | 4,342,933 | 59,489,193 | 2,498,546 | 15,790,926 |

*Gold.*—The quantity of gold produced in Utah in 1933 decreased 19 percent from that in 1932. Gold recovered from lead-zinc ore decreased 15,414 ounces and from siliceous gold ore 13,280 ounces, but gold recovered from copper ore increased 4,461 ounces. Siliceous gold ore and old tailings yielded 43.67 percent of the total gold, copper ore 32.56 percent, lead-zinc ore 19.46 percent, and lead ore and old slag 3.21 percent. Large decreases in gold output were reported by the Eureka Standard, Niagara, United States, and Live Yankee mines; increases came from the Utah Copper, Mammoth, and Manning properties. The leading producers of gold in Utah in 1933 were the Utah Copper, Eureka Standard, United States, Mammoth, and Utah-Delaware mines. These five properties (each with a production of more than 3,000 ounces) yielded 82 percent of the State total gold output. Other large producers were the Live Yankee, Silver King, Utah Metal & Tunnel, Niagara, Manning, and Bingham Metals. Placer mines in Utah yielded 142.51 fine ounces of gold in 1933.

*Silver.*—The output of silver in Utah declined from 6,962,097 fine ounces in 1932 to 5,669,197 ounces in 1933, and the State dropped to second place as a silver producer, following Idaho. More than 57 percent of the total silver produced in Utah in 1933 was recovered from lead-zinc ore, but there was a decrease of 519,643 ounces from this source compared with 1932; more than 20 percent from lead ore and old slag, a decrease of 791,331 ounces; nearly 16 percent from siliceous ore and old tailings, a decline of only about 10,000 ounces; and nearly all the remainder from copper ore. Large decreases in silver output were reported by the Tintic Standard, Park City Consolidated, Niagara, and Silver King Coalition mines; increases were reported at the Lark, Utah Copper, Plutus, West Calumet, and United States properties. The leading producers of silver in Utah in 1933 were the Silver King Coalition, United States (including Lark), Tintic Standard, Eureka Standard, and Utah Copper companies. These six properties produced 88 percent of the State total silver output.

*Copper.*—The output of recoverable copper in Utah in 1933 increased more than 13 percent over that in 1932 as the result of increased production at the Utah Copper mine at Bingham. Nearly 95 percent of the total copper produced in Utah in 1933 came from copper ore and mine-water precipitates and nearly all the remainder from lead-zinc ore and siliceous gold ore. About 89 percent of the total copper came from copper ore milled; the remainder came largely from copper precipitates and crude siliceous gold ore smelted and from lead-zinc ore milled. The Utah Copper Co. produced about 94 percent of the total copper. Other producers of more than 400,000 pounds each were the United States, Silver King Coalition, Lark, and Utah-Delaware properties.

*Lead.*—The output of recoverable lead from mines in Utah in 1933 declined 8,176,410 pounds (6.51 percent) from that in 1932. There was a decrease of 13,010,484 pounds in lead from lead ore and old slag, but a gain of 5,256,748 pounds in lead from lead-zinc ore. The output of lead from the Bingham district increased 778,442 pounds in 1933 as the result of the large increase at the Lark mine; the increase at the Lark mine was partly offset by the decreases at the Niagara and United States mines. The large decrease in output of lead from the Tintic Standard mine in the Tintic district accounted for nearly all the decrease in the State total. Smaller decreases were reported by the Silver King Coalition, Bluestone Lime & Quartzite, and Park Utah Consolidated companies. Of the total lead produced 76 percent came from lead-zinc ore milled and 22.51 percent from crude lead ore smelted. The leading lead producers in Utah in 1933 were the United States, Silver King Coalition, Lark, Bluestone Lime & Quartzite, and Tintic Standard properties. These five mines (each producing more than 11,600,000 pounds of lead) yielded over 94 percent of the State total lead output. Other large producers were the Niagara, West Calumet, Eureka Standard, and Chief Consolidated properties.

*Zinc.*—The output of recoverable zinc in Utah in 1933 increased slightly over that in 1932. Zinc produced from the Bingham district decreased 2,196,176 pounds, but this was more than offset by gains at the Silver King Coalition at Park City and at other mines in the State. The decrease in zinc from the Bingham district resulted from the unusually large decline in output from the Niagara mine, but the latter was nearly offset by the increase from the Lark property. Virtually all the zinc produced in the State in 1933 came from lead-zinc ore milled, but a little zinc was recovered from lead-zinc ore and zinc ore smelted. The United States mine at Bingham was the largest producer of zinc in Utah in 1933, followed by the Silver King Coalition mine at Park City and the Lark and Niagara mines at Bingham. Other large producers of zinc were the West Calumet, Chief Consolidated, and Cardiff mines.

## MINE PRODUCTION BY COUNTIES

*Mine production of gold, silver, copper, lead, and zinc in Utah in 1933, by counties, in terms of recovered metals*

| County | Gold | | Silver | |
|---|---|---|---|---|
| | Fine ounces | Value | Fine ounces | Value |
| Beaver | 2.66 | $55 | 254 | $89 |
| Box Elder | 68.64 | 1,419 | 143 | 50 |
| Garfield | 24.38 | 504 | 15 | 5 |
| Grand | 33.28 | 688 | 3 | 1 |
| Iron | 160.56 | 3,319 | 608 | 213 |
| Juab | 7,579.64 | 156,685 | 193,079 | 67,578 |
| Millard | 161.91 | 3,347 | 421 | 147 |
| Morgan | | | 18 | 6 |
| Piute | 321.65 | 6,649 | 1,326 | 464 |
| Salt Lake | 62,106.92 | 1,283,864 | 2,008,490 | 702,972 |
| San Juan | 51.42 | 1,063 | 3 | 1 |
| Sevier | 56.65 | 1,171 | 315 | 110 |
| Summit | 2,329.69 | 48,159 | 1,678,278 | 587,397 |
| Tooele | 5,286.52 | 109,282 | 247,057 | 86,470 |
| Uintah | 26.61 | 550 | 3 | 1 |
| Utah | 30,907.51 | 638,915 | 1,538,936 | 538,628 |
| Wasatch | .24 | 5 | 208 | 73 |
| Washington | 11.27 | 233 | 40 | 14 |
| | 109,129.55 | 2,255,908 | 5,669,197 | 1,984,219 |
| Total, 1932 | 135,256.35 | 2,795,997 | 6,962,097 | 1,963,311 |

*Mine production of gold, silver, copper, lead, and zinc in Utah in 1933, by counties, in terms of recovered metals*—Continued

| County | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| Beaver | 23 | $1 | 3,536 | $131 | | | $276 |
| Box Elder | 137 | 9 | 8,547 | 316 | | | 1,794 |
| Garfield | 1,044 | 67 | | | | | 576 |
| Grand | | | | | | | 689 |
| Iron | | | | | | | 3,532 |
| Juab | 319,149 | 20,426 | 785,708 | 29,071 | 346,522 | $14,554 | 288,314 |
| Millard | 2,345 | 150 | | | | | 3,644 |
| Morgan | | | 6,992 | 259 | | | 265 |
| Piute | 685 | 44 | 5,189 | 192 | | | 7,349 |
| Salt Lake | 71,660,883 | 4,586,296 | 66,695,562 | 2,467,736 | 41,650,859 | 1,749,336 | 10,790,204 |
| San Juan | | | | | | | 1,064 |
| Sevier | | | | | | | 1,281 |
| Summit | 731,060 | 46,788 | 23,111,546 | 855,127 | 16,592,736 | 696,895 | 2,234,366 |
| Tooele | 98,367 | 6,295 | 14,472,264 | 535,474 | 899,076 | 37,761 | 775,282 |
| Uintah | | | | | | | 551 |
| Utah | 762,209 | 48,781 | 12,285,660 | 454,569 | | | 1,680,893 |
| Wasatch | | | 1,552 | 58 | | | 136 |
| Washington | 7,228 | 463 | | | | | 710 |
| | 73,583,130 | 4,709,320 | 117,376,556 | 4,342,933 | 59,489,193 | 2,498,546 | 15,790,926 |
| Total, 1932 | 64,964,111 | 4,092,739 | 125,552,966 | 3,766,589 | 59,331,888 | 1,779,957 | 14,398,593 |

*Ore, old tailings, etc., sold or treated and lode mines producing in Utah, 1932–33, by counties*

| County | Ore, old tailings, etc. (short tons) | | Lode mines producing | | County | Ore, old tailings, etc. (short tons) | | Lode mines producing | |
|---|---|---|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | | 1932 | 1933 | 1932 | 1933 |
| Beaver | 17 | 12 | 2 | 3 | Salt Lake | 3,465,666 | 3,841,627 | 25 | 30 |
| Box Elder | 1,146 | 265 | 5 | 8 | Sevier | 273 | 182 | 1 | 1 |
| Garfield | | 11 | | 1 | Summit | 97,540 | 101,543 | 1 | 1 |
| Grand | 1 | | 1 | | Tooele | 29,508 | 62,955 | 15 | 29 |
| Iron | 38 | 536 | 1 | 4 | Utah | 115,556 | 77,068 | 7 | 9 |
| Juab | 32,044 | 31,648 | 15 | 20 | Wasatch | 25,831 | 4 | 3 | 1 |
| Millard | 23 | 303 | 3 | 1 | Washington | 100 | 14 | 1 | 2 |
| Morgan | | 6 | | 2 | | | | | |
| Piute | 799 | 761 | 6 | 9 | | 3,768,542 | 4,116,935 | 86 | 121 |

## MINING INDUSTRY

The total value of the mine output in Utah in 1933 was $1,392,333 more than that in 1932 but was far less than the average ($58,827,661) for the decade 1924–33. The general improvement in metal prices resulted in the reopening of several properties closed during 1931 or 1932, including the Chief Consolidated, Plutus, and other mines in the Tintic district, and of mines in other districts. The sharp increase in the sales price of gold stimulated activity in all parts of the State, including lode mines in gold districts such as Stateline, Detroit, Park Valley, Camp Floyd (Mercur), and Clifton (Gold Hill), and districts in Piute County. There was also increased activity at placer mines in the districts in Grand, San Juan, and Uintah Counties. The improvement in price of silver at the close of the year resulted in immediate reopening of the Park City Consolidated property at Park City and the Utah-Apex mine at Bingham.

One of the major developments during 1933 was the work of the American Smelting & Refining Co. at the Boston Consolidated section of the Utah Copper Co. and at the Utah Metal & Tunnel properties at Bingham. The extensive development program begun at these properties is discussed under Salt Lake County. The American Smelting & Refining Co. also purchased the Grand Central mine, one of the large gold properties of the Tintic district.

## ORE CLASSIFICATION

*Ore, old tailings, etc., sold or treated in Utah in 1933, with content in terms of recovered metals*

| Source | Mines producing | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|---|
| | | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold ore | 49 | [1] 139,473 | 47,658.11 | 485,315 | 1,475,651 | 630,504 | |
| Dry gold and silver ore | 9 | 2,687 | 535.64 | 40,122 | 30,397 | 41,071 | |
| Dry silver ore | 10 | [2] 7,847 | 527.53 | 376,858 | 88,269 | 426,754 | |
| Copper ore | 15 | [3] 3,524,073 | 35,527.84 | 353,154 | [4] 69,672,596 | 26,663 | |
| Lead ore | 53 | [5] 62,319 | 3,500.00 | 1,159,767 | 268,778 | 26,784,446 | |
| Zinc ore | 1 | 47 | | | | 1,220 | 34,430 |
| Lead-zinc ore | 13 | 380,489 | 21,237.92 | 3,253,966 | 2,047,439 | 89,465,898 | 59,454,763 |
| Total, lode mines | [6] 121 | 4,116,935 | 108,987.04 | 5,669,182 | [4] 73,583,130 | 117,376,556 | 59,489,193 |
| Total, placers | 21 | | 142.51 | 15 | | | |
| | 142 | 4,116,935 | 109,129.55 | 5,669,197 | [4] 73,583,130 | 117,376,556 | 59,489,193 |
| Total, 1932 | 105 | 3,768,542 | 135,256.35 | 6,962,097 | [7] 64,964,111 | 125,552,966 | 59,331,888 |

[1] Includes 1 ton of old slag sold to a smelter and 24,709 tons of old tailings treated by cyanidation.
[2] Includes 73 tons of old smelter cleanings sold to a smelter.
[3] Includes 14 tons of old mill cleanings sold to a smelter.
[4] Includes 4,107,381 pounds of copper saved from precipitates.
[5] Includes 6,683 tons of old slag sold to a smelter.
[6] A mine producing more than one class of ore is counted but once in arriving at total for all classes.
[7] Includes 4,490,379 pounds of copper saved from precipitates.

*Value of metals from ore, old tailings, etc., sold or treated in Utah in 1933, by classes of ore*

| Class | Ore, old tailings, etc. (short tons) | Gold | Silver | Copper | Lead | Zinc | Total |
|---|---|---|---|---|---|---|---|
| Dry gold ore | 139,473 | $985,180 | $169,860 | $94,442 | $23,329 | | $1,272,811 |
| Dry gold and silver ore | 2,687 | 11,073 | 14,043 | 1,945 | 1,520 | | 28,581 |
| Dry silver ore | 7,847 | 10,905 | 131,900 | 5,649 | 15,790 | | 164,244 |
| Copper ore | 3,524,073 | 734,426 | 123,604 | [1] 4,459,046 | 987 | | 5,318,063 |
| Lead ore | 62,319 | 72,351 | 405,919 | 17,202 | 991,024 | | 1,486,496 |
| Zinc ore | 47 | | | | 45 | $1,446 | 1,491 |
| Lead-zinc ore | 380,489 | 439,027 | 1,138,888 | 131,036 | 3,310,238 | 2,497,100 | 7,516,289 |
| | 4,116,935 | 2,252,962 | 1,984,214 | [1] 4,709,320 | 4,342,933 | 2,498,546 | 15,787,975 |
| Total, 1932 | 3,768,542 | 2,792,854 | 1,963,307 | [2] 4,092,739 | 3,766,589 | 1,779,957 | 14,395,446 |

[1] Includes value of 4,107,381 pounds of copper saved from precipitates.
[2] Includes value of 4,490,379 pounds of copper saved from precipitates.

*Gold ore.*—Forty-nine properties produced 139,473 tons of siliceous gold material (including 24,709 tons of old tailings and 1 ton of old slag) in 1933, compared with 45 properties producing 99,623 tons in 1932. Most of the increase was due to re-treatment by cyanidation of old Mercur tailings by the Manning Gold Mining Co. The Eureka Standard mine was the largest producer of gold ore in Utah in 1933, followed by the Mammoth, Utah-Delaware, and Utah Metal & Tunnel. These three properties and the Manning produced 86 percent of the total gold ore, old tailings, etc. About 80 percent of the total siliceous gold material was shipped crude to smelters; the remainder was chiefly old tailings re-treated by cyanidation.

*Gold and silver ore.*—Nine properties produced 2,687 tons of siliceous gold and silver ore in 1933, compared with eight properties producing 1,967 tons in 1932. All the output was smelted, and nearly 80 percent of it came from the Mammoth dump and the Centennial and Park Bingham mines.

*Silver ore.*—Ten properties produced 7,847 tons of siliceous silver material (including 73 tons of smelter clean-up) in 1933, compared with nine properties producing 10,394 tons in 1932. All the material was of smelting grade, and nearly all of it came from the Tintic district, chiefly from the Tintic Standard, Plutus, and Chief Consolidated mines.

*Copper ore.*—The output of copper ore, etc., in 1933 increased 10 percent over that in 1932 due to increased rate of production at the Utah Copper property at Bingham. Although copper ore, etc., was produced at 15 properties, virtually all of it was mined by the Utah Copper Co. and was of concentrating grade.

*Lead ore.*—The output of lead material from 53 properties totaled 62,319 tons (including 6,683 tons of old slag) in 1933, compared with 36 properties producing 88,780 tons of lead ore in 1932. Almost all the decrease was due to further curtailment in output of lead ore at the Tintic Standard mine. The Bluestone Lime & Quartzite property at Bauer and the Tintic Standard mine at Dividend produced nearly 76 percent of the total lead ore, etc. Nearly all the lead material was crude ore smelted; only 999 tons were treated at concentration plants.

*Zinc ore.*—Zinc ore was produced in Utah in 1933 for the first time since 1929. The output consisted of two cars of oxidized ore from the Queen of the Hills mine in the Ophir district, Tooele County.

*Lead-zinc ore.*—The output of lead-zinc ore increased from 371,093 tons in 1932 to 380,489 tons in 1933 and comprised more than 9 percent of the total ore, old tailings, etc., produced in Utah. About 71 percent of the total lead-zinc ore came from three mines in the West Mountain district operated by the United States Smelting, Refining & Mining Co., and nearly all the remainder came from the Silver King Coalition mine at Park City. About 98 percent of the total lead-zinc ore was treated at two flotation plants at Midvale and Park City; several hundred tons of oxidized ore from a property in Big Cottonwood Canyon were shipped to an eastern zinc plant. The United States mine at Bingham was by far the largest producer of lead-zinc ore in Utah in 1933, followed by the Silver King Coalition, Lark, and Niagara properties. The West Calumet mine at Bauer in the Rush Valley district, Tooele County, produced several thousand tons of lead-zinc ore.

*Ore, old tailings, etc., sold or treated in Utah in 1933, by counties, with content in terms of recovered metals*

DRY GOLD ORE

| County | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Beaver | 1 | 1.06 | | | | |
| Box Elder | 240 | 67.62 | 65 | 37 | 787 | |
| Iron | 536 | 160.56 | 608 | | | |
| Juab | 22,867 | 6,509.57 | 65,730 | 216,811 | 24,624 | |
| Millard | 303 | 149.43 | 418 | 2,345 | | |
| Piute | 673 | 311.68 | 521 | 54 | | |
| Salt Lake | [1] 35,590 | 6,883.75 | 66,270 | 663,697 | 107,503 | |
| Sevier | 182 | 56.65 | 315 | | | |
| Tooele | [2] 29,586 | 3,930.16 | 7,507 | 14,711 | 61,541 | |
| Utah | 49,492 | 29,576.36 | 343,870 | 577,996 | 436,049 | |
| Washington | 3 | 11.27 | 11 | | | |
| | 139,473 | 47,658.11 | 485,315 | 1,475,651 | 630,504 | |
| Total, 1932 | 99,623 | 60,938.52 | 535,405 | 1,346,556 | 840,355 | |

DRY GOLD AND SILVER ORE

| County | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Beaver | 2 | 1.45 | 141 | | | |
| Juab | 1,862 | 339.14 | 27,468 | 27,029 | 18,816 | |
| Salt Lake | 782 | 185.00 | 11,901 | 3,257 | 20,283 | |
| Utah | 41 | 10.05 | 612 | 111 | 1,972 | |
| | 2,687 | 535.64 | 40,122 | 30,397 | 41,071 | |
| Total, 1932 | 1,967 | 588.48 | 29,086 | 32,588 | 33,739 | |

DRY SILVER ORE

| County | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Juab | [3] 2,808 | 146.99 | 64,729 | 33,331 | 111,074 | |
| Piute | 34 | .97 | 639 | 543 | 2,124 | |
| Salt Lake | 55 | 7.00 | 783 | | 146 | |
| Tooele | 28 | 2.04 | 1,398 | 6 | 968 | |
| Utah | 4,922 | 370.53 | 309,309 | 54,389 | 312,442 | |
| | 7,847 | 527.53 | 376,858 | 88,269 | 426,754 | |
| Total, 1932 | 10,394 | 640.60 | 347,997 | 84,111 | 479,879 | |

COPPER ORE

| County | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Garfield | 11 | 14.08 | 15 | 1,044 | | |
| Juab | 471 | 181.54 | 757 | 31,341 | 397 | |
| Salt Lake | [4] 3,523,577 | 35,331.22 | 352,343 | [5] 69,632,517 | 26,266 | |
| Tooele | 3 | 1.00 | 10 | 466 | | |
| Washington | 11 | | 29 | 7,228 | | |
| | 3,524,073 | 35,527.84 | 353,154 | [5] 69,672,596 | 26,663 | |
| Total, 1932 | 3,196,677 | 31,066.35 | 324,693 | [6] 61,290,507 | 192,768 | |

LEAD ORE

| County | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Beaver | 9 | 0.15 | 113 | 23 | 3,536 | |
| Box Elder | 25 | 1.02 | 78 | 100 | 7,760 | |
| Juab | 1,514 | 359.00 | 23,647 | 7,234 | 404,370 | |
| Morgan | 6 | | 18 | | 6,992 | |
| Piute | 54 | 9.00 | 166 | 88 | 3,065 | |
| Salt Lake | [7] 10,167 | 985.26 | 48,096 | 56,794 | 1,419,208 | |
| Tooele | 27,927 | 1,194.76 | 202,296 | 74,826 | 13,402,766 | |
| Utah | 22,613 | 950.57 | 885,145 | 129,713 | 11,535,197 | |
| Wasatch | 4 | .24 | 208 | | 1,552 | |
| | 62,319 | 3,500.00 | 1,159,767 | 268,778 | 26,784,446 | |
| Total, 1932 | 88,780 | 5,217.55 | 1,951,098 | 314,396 | 39,794,930 | |

[1] Includes 1 ton of old slag sold to a smelter.
[2] Includes 24,709 tons of old tailings treated by cyanidation.
[3] Includes 73 tons of old smelter cleanings sold to a smelter.
[4] Includes 14 tons of old mill cleanings sold to a smelter.
[5] Includes 4,107,381 pounds of copper saved from precipitates.
[6] Includes 4,490,379 pounds of copper saved from precipitates.
[7] Includes 6,683 tons of old slag sold to a smelter.

*Ore, old tailings, etc., sold or treated in Utah in 1933, by counties, with content in terms of recovered metals*—Continued

ZINC ORE

| County | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Tooele | 47 | | | | 1,220 | 34,430 |
| | 47 | | | | 1,220 | 34,430 |
| Total, 1932 | (8) | | | | | |

LEAD-ZINC ORE

| County | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Juab | 2,126 | 43.40 | 10,748 | 3,403 | 226,427 | 346,522 |
| Salt Lake | 271,456 | 18,706.27 | 1,529,094 | 1,304,618 | 65,122,156 | 41,650,859 |
| Summit | 101,543 | 2,329.69 | 1,678,278 | 731,060 | 23,111,546 | 16,592,736 |
| Tooele | 5,364 | 158.56 | 35,846 | 8,358 | 1,005,769 | 864,646 |
| | 380,489 | 21,237.92 | 3,253,966 | 2,047,439 | 89,465,898 | 59,454,763 |
| Total, 1932 | 371,093 | 36,652.29 | 3,773,609 | 1,895,019 | 84,209,150 | 59,331,888 |

[8] None produced in 1932.

*Zinc products (as marketed from Utah mines and mills) sold to smelters and electrolytic plants in 1933*

| Classification | County | Quantity (dry weight) | Gross zinc | Average assay of ore and concentrates | Recovered zinc |
|---|---|---|---|---|---|
| | | *Short tons* | *Pounds* | *Percent* | *Pounds* |
| Oxidized zinc ore | Tooele | 47 | 38,150 | 40.59 | 34,430 |
| Oxidized lead-zinc ore | Salt Lake | 755 | 380,612 | 25.21 | 323,520 |
| Zinc concentrates | Juab, Salt Lake, Summit, and Tooele. | 58,009 | 65,669,611 | 56.60 | 59,131,243 |
| | | 58,811 | 66,088,373 | 56.19 | 59,489,193 |
| Total, 1932 | | 58,463 | 66,111,812 | 56.54 | 59,331,888 |

## METALLURGIC INDUSTRY

Of the total ore, old tailings, etc., produced in Utah in 1933, 94.79 percent was ore (chiefly copper ore) treated at concentration plants, 0.65 percent was ore and old tailings treated by cyanidation, and 4.53 percent was crude ore, old slag, and cleanings shipped to smelters. There were 18 milling plants operating in Utah in 1933—7 gold and silver mills (1 amalgamation, 1 cyanidation, and 5 combined amalgamation and concentration), 6 straight gravity concentration plants (3 treating gold ore and 3 treating lead ore), and 5 straight flotation plants (1 copper, 1 lead, and 3 lead-zinc); in addition, 2 mine-water precipitation plants were operated. As indicated in the following tables, nearly all the ore concentrated was treated by straight flotation.

The Magna mill of the Utah Copper Co., the Midvale mill of the United States Smelting, Refining & Mining Co., and the mill of the Silver King Coalition Mines Co. at Park City were operated regularly during 1933. Operations were resumed in August at the Bauer plant of the Combined Metals Reduction Co. The Arthur plant of the Utah Copper Co., the mills (both sulphide and oxide) of the International Smelting Co. at Tooele, the Chief Consolidated mill at Eureka, and the Judge mill of the Park Utah Consolidated Mines Co. at Park City were idle during 1933.

A new 500-ton cyanide plant was constructed near Fairfield by the Manning Gold Mining Co. and is reviewed under Tooele County; old plants were reconditioned; and flotation sections of part of the Magna mill of the Utah Copper Co. were remodeled. Of major importance to the metallurgic industry of Utah was the construction of a lead refinery at Midvale by the United States Smelting, Refining & Mining Co.; it is noted under Salt Lake County.

The following tables summarize the ore-concentration data for Utah in 1933.

*Mine production of metals from gold and silver mills in Utah in 1933, by counties, in terms of recovered metals*

| County | Ore and old tailings treated (dry weight) | | Recovered in bullion | | | | Concentrates and recovered metal | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Amalgamation | | Cyanidation | | | | | |
| | Ore | Old tailings | Gold | Silver | Gold | Silver | Concentrates produced | Gold | Silver | Lead |
| | *Short tons* | *Short tons* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* |
| Beaver | 1 | | 1.06 | | | | | | | |
| Box Elder | 98 | | 30.14 | 5 | | | 1 | 2.39 | 2 | 78 |
| Iron | 350 | | 54.55 | 36 | | | 5 | 21.00 | 23 | |
| Juab | 500 | | 17.09 | 15 | | | 10 | 22.77 | 22 | |
| Piute | 604 | | 26.53 | 11 | | | 5 | 85.91 | 293 | |
| Sevier | 120 | | 2.63 | 1 | | | 1 | 2.48 | 23 | |
| Tooele | 1,921 | 24,709 | | | 1,769.70 | 20 | | | | |
| Washington | 3 | | 11.27 | 11 | | | | | | |
| | 3,597 | 24,709 | 143.27 | 79 | 1,769.70 | 20 | 22 | 134.55 | 363 | 78 |
| Total, 1932 | 900 | | 124.96 | 24 | | | 65 | 105.57 | 11 | 1,947 |

*Utah ore concentrated in 1933, by classes of ore, methods of concentration, and classes of concentrates*

| Class of ore concentrated | Method of concentration | Ore concentrated | Gross content of mill feed | | | | |
|---|---|---|---|---|---|---|---|
| | | | Gold | Silver | Copper | Lead | Zinc |
| | | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Copper sulphide | Flotation | 3,521,425 | 47,925.20 | 363,519 | 72,765,813 | | |
| Lead-zinc sulphide | do | [1] 379,734 | 25,355.95 | 3,464,463 | 2,857,585 | 98,010,807 | 85,947,173 |
| | | [1] 3,901,159 | 73,281.15 | 3,827,982 | 75,623,398 | 98,010,807 | 85,947,173 |
| Siliceous gold | Gravity | 105 | 24.60 | 38 | | 800 | |
| Lead sulphide | do | [1] 999 | 23.75 | 4,268 | 2,293 | 186,220 | |
| | | [1] 1,104 | 48.35 | 4,306 | 2,293 | 187,020 | |
| | | 3,902,263 | 73,329.50 | 3,832,288 | 75,625,691 | 98,197,827 | 85,947,173 |

| Class of ore concentrated | Method of concentration | Concentrates produced | | Gross content of concentrates | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Class | Quantity | Gold | Silver | Copper | Lead | Zinc |
| | | | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Copper sulphide | Flotation | Copper sulphide | 99,458 | 34,856.00 | 312,333 | 67,322,930 | | |
| Lead-zinc sulphide | do | Lead sulphide | [2] 77,109 | 12,744.25 | 2,963,746 | 1,750,974 | 89,313,508 | |
| | | Zinc sulphide | 58,009 | 1,653.75 | 203,437 | 612,298 | 2,660,316 | 65,669,611 |
| | | Siliceous | 59,691 | 6,839.92 | 86,783 | 220,487 | 2,071,897 | |
| | | | [2] 194,809 | 21,237.92 | 3,253,966 | 2,583,759 | 94,045,721 | 65,669,611 |
| | | | [2] 294,267 | 56,093.92 | 3,566,299 | 69,906,689 | 94,045,721 | 65,669,611 |
| Siliceous gold | Gravity | Siliceous | 11 | 19.94 | 30 | | 644 | |
| Lead sulphide | do | Lead sulphide | [2] 243 | 17.55 | 3,493 | 1,590 | 161,579 | |
| | | | [2] 254 | 37.49 | 3,523 | 1,590 | 162,223 | |
| | | | [3] 294,521 | 56,131.41 | 3,569,822 | 69,908,279 | 94,207,944 | 65,669,611 |

[1] 400 tons of ore treated by straight flotation included under gravity.
[2] 100 tons of concentrates from ore treated by straight flotation included under gravity.
[3] Figures do not include 22 tons of siliceous concentrates from ore first treated by amalgamation containing 134.55 ounces of gold, 363 ounces of silver, and 81 pounds (78 pounds recovered) of lead.

*Mine production of metals from concentrating mills in Utah in 1933, by counties, in terms of recovered metals*

| County | Ore and old tailings treated | | Concentrates and recovered metal | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ore | Old tailings | Concentrates produced | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Short tons* | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Box Elder | 105 | ---------- | 11 | 19.94 | 30 | ---------- | 591 | ---------- |
| Juab | 2,126 | ---------- | 1,016 | 43.40 | 10,748 | 3,403 | 226,427 | 346,522 |
| Piute | 54 | ---------- | 18 | 9.00 | 166 | 88 | 3,065 | ---------- |
| Salt Lake | 3,792,171 | ---------- | 258,127 | 53,563.93 | 1,841,722 | 66,607,968 | 64,913,933 | 41,327,339 |
| Summit | 101,543 | ---------- | 33,367 | 2,329.69 | 1,678,278 | 731,060 | 23,111,546 | 16,592,736 |
| Tooele | 5,864 | ---------- | 1,882 | 163.95 | 36,778 | 8,746 | 1,071,506 | 864,646 |
| Utah | 400 | ---------- | 100 | 1.50 | 2,100 | 800 | 80,000 | ---------- |
| | 3,902,263 | ---------- | 294,521 | 56,131.41 | 3,569,822 | 67,352,065 | 89,407,068 | 59,131,243 |
| Total, 1932 | 3,561,075 | 50 | 280,917 | 62,724.72 | 4,369,479 | 57,556,792 | 89,801,232 | 59,331,888 |

*Gross metal content of Utah concentrates produced in 1933, by classes of concentrates*

| Class of concentrates | Concentrates produced (dry weight) | Gross metal content | | | | |
|---|---|---|---|---|---|---|
| | | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry and siliceous | 59,724 | 6,994.41 | 87,176 | 220,487 | 2,072,622 | ---------- |
| Copper | 99,458 | 34,856.00 | 812,333 | 67,322,930 | ---------- | ---------- |
| Lead | 77,352 | 12,761.80 | 2,967,239 | 1,752,564 | 89,475,087 | ---------- |
| Zinc | 58,009 | 1,653.75 | 203,437 | 612,298 | 2,660,316 | 65,669,611 |
| | 294,543 | 56,265.96 | 3,570,185 | 69,908,279 | 94,208,025 | 65,669,611 |
| Total, 1932 | 280,982 | 62,830.29 | 4,369,490 | 60,063,384 | 93,928,664 | 66,111,812 |

*Mine production of metals from Utah concentrates in 1933, in terms of recovered metals*

BY COUNTIES

| | Concentrates | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Box Elder | 12 | 22.33 | 32 | ---------- | 669 | ---------- |
| Iron | 5 | 21.00 | 23 | ---------- | ---------- | ---------- |
| Juab | 1,026 | 66.17 | 10,770 | 3,403 | 226,427 | 346,522 |
| Piute | 23 | 94.91 | 459 | 88 | 3,065 | ---------- |
| Salt Lake | 258,127 | 53,563.93 | 1,841,722 | 66,607,968 | 64,913,933 | 41,327,339 |
| Sevier | 1 | 2.48 | 23 | ---------- | ---------- | ---------- |
| Summit | 33,367 | 2,329.69 | 1,678,278 | 731,060 | 23,111,546 | 16,592,736 |
| Tooele | 1,882 | 163.95 | 36,778 | 8,746 | 1,071,506 | 864,646 |
| Utah | 100 | 1.50 | 2,100 | 800 | 80,000 | ---------- |
| | 294,543 | 56,265.96 | 3,570,185 | 67,352,065 | 89,407,146 | 59,131,243 |
| Total, 1932 | 280,982 | 62,830.29 | 4,369,490 | 57,556,792 | 89,803,179 | 59,331,888 |

BY CLASSES OF CONCENTRATES

| | | | | | | |
|---|---|---|---|---|---|---|
| Dry and siliceous | 59,724 | 6,994.41 | 87,176 | 209,463 | 1,243,862 | ---------- |
| Copper | 99,458 | 34,856.00 | 312,333 | 65,303,242 | ---------- | ---------- |
| Lead | 77,352 | 12,761.80 | 2,967,239 | 1,265,123 | 85,654,644 | ---------- |
| Zinc | 58,009 | 1,653.75 | 203,437 | 574,237 | 2,508,640 | 59,131,243 |

The quantity of crude siliceous gold ore shipped to smelters in 1933 increased, but this gain was more than offset by further declines in the quantity of first-class lead ore and copper ore. Crude lead-zinc ore shipped to smelters in 1933 totaled 755 tons; none was shipped in 1932.

*Gross metal content of Utah crude ore shipped to smelters in 1933, by classes of ore*

| Class of ore | Ore (dry weight) | Gross metal content | | | | |
|---|---|---|---|---|---|---|
| | | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry and siliceous | 121,522 | 46,631.14 | 900,489 | 1,645,729 | 1,959,875 | |
| Copper | 2,634 | 576.91 | 40,795 | 265,585 | 48,477 | |
| Lead | 54,637 | 3,462.86 | 1,151,960 | 305,615 | 27,536,569 | |
| Zinc | 47 | | | | 1,500 | 38,150 |
| Lead-zinc | 755 | | | | 283,948 | 380,612 |
| | 179,595 | 50,670.91 | 2,093,244 | 2,216,929 | 29,830,369 | 418,762 |
| Total, 1932 | 206,472 | 71,889.98 | 2,591,267 | 3,080,887 | 38,300,256 | |

*Mine production of metals from Utah crude ore shipped to smelters in 1933, in terms of recovered metals*

BY COUNTIES

| | Ore | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Beaver | 11 | 1.60 | 254 | 23 | 3,536 | |
| Box Elder | 62 | 16.17 | 106 | 137 | 7,878 | |
| Garfield | 11 | 14.08 | 15 | 1,044 | | |
| Iron | 186 | 85.01 | 549 | | | |
| Juab | 28,949 | 7,489.80 | 180,999 | 315,116 | 555,901 | |
| Millard | 303 | 149.43 | 418 | 2,345 | | |
| Morgan | 6 | | 18 | | 6,992 | |
| Piute | 103 | 200.21 | 856 | 597 | 2,124 | |
| Salt Lake | 42,758 | 8,403.95 | 162,406 | 925,125 | 1,576,152 | 323,520 |
| Sevier | 62 | 51.54 | 291 | | | |
| Tooele | 30,461 | 3,352.87 | 210,259 | 89,621 | 13,400,758 | 34,430 |
| Utah | 76,668 | 30,906.01 | 1,536,836 | 761,409 | 12,205,660 | |
| Wasatch | 4 | .24 | 208 | | 1,552 | |
| Washington | 11 | | 29 | 7,228 | | |
| | 179,595 | 50,670.91 | 2,093,244 | 2,102,645 | 27,760,553 | 357,950 |
| Total, 1932 | 206,472 | 71,889.98 | 2,591,267 | 2,916,268 | 35,749,087 | |

BY CLASSES OF ORE

| | Ore | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Dry and siliceous | 121,522 | 46,631.14 | 900,489 | 1,593,687 | 1,094,280 | |
| Copper | 2,634 | 576.91 | 40,795 | 257,422 | 26,663 | |
| Lead | 54,637 | 3,462.86 | 1,151,960 | 251,536 | 26,425,429 | |
| Zinc | 47 | | | | 1,220 | 34,430 |
| Lead-zinc | 755 | | | | 212,961 | 323,520 |

The miscellaneous material produced in Utah in 1933 consisted chiefly of old tailings re-treated by cyanidation, old lead slag shipped to a smelter, and copper precipitates smelted.

## REVIEW BY COUNTIES AND DISTRICTS

*Mine production of gold, silver, copper, lead, and zinc in Utah in 1933, by counties and districts, in terms of recovered metals*

| County and district | Mines producing | | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| | | | *Short tons* | | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| Beaver County: | | | | | | | | | |
| Fortuna | 1 | | (1) | (1) | | | | | (1) |
| Lincoln | 1 | | 9 | $3 | 113 | 23 | 3,536 | | $175 |
| Newton | 1 | | 2 | 30 | 141 | | | | 79 |
| Box Elder County: | | | | | | | | | |
| Lucin | 1 | | 25 | 21 | 78 | 100 | 7,760 | | 342 |
| Park Valley | 7 | | 240 | 1,398 | 65 | 37 | 787 | | 1,452 |
| Garfield County: Imperial | 1 | 3 | 11 | 504 | 15 | 1,044 | | | 576 |
| Grand County: | | | | | | | | | |
| Colorado River | | 3 | | 330 | 3 | | | | 331 |
| La Sal | | 2 | | 229 | | | | | 229 |
| Miners Basin | | 2 | | 129 | | | | | 129 |
| Iron County: Stateline | 4 | | 536 | 3,319 | 608 | | | | 3,532 |
| Juab County: | | | | | | | | | |
| Detroit [2] | 2 | | 463 | 3,741 | 677 | 30,647 | | | 5,940 |
| Mount Nebo | 1 | | (1) | (1) | (1) | (1) | (1) | | (1) |
| Spring Creek | 1 | | 500 | 824 | 37 | | | | 837 |
| Tintic [3] | 15 | | 30,551 | 151,188 | 191,700 | 287,865 | 767,172 | 346,522 | 279,645 |
| West Tintic | 1 | | 128 | 930 | 657 | 621 | 17,590 | | 1,851 |
| Millard County: | | | | | | | | | |
| Detroit [2] | 1 | | 303 | 3,089 | 418 | 2,345 | | | 3,385 |
| Sawtooth | | 3 | | 258 | 3 | | | | 259 |
| Morgan County: Argenta | 2 | | 6 | | 18 | | 6,992 | | 265 |
| Piute County: | | | | | | | | | |
| Gold Mountain [4] | 2 | | 625 | 2,252 | 324 | | | | 2,365 |
| Mount Baldy | 1 | | 32 | 420 | 99 | | | | 455 |
| Ohio | 6 | | 104 | 3,977 | 903 | 685 | 5,189 | | 4,529 |
| Salt Lake County: | | | | | | | | | |
| Big Cottonwood | 6 | | 1,040 | 415 | 6,006 | 2,995 | 340,079 | 323,520 | 28,879 |
| Little Cottonwood | 3 | | 394 | 1,629 | 5,035 | 5,857 | 90,572 | 30,936 | 8,416 |
| Smelter | 2 | | 6,684 | 738 | 4,333 | 15,858 | 205,477 | | 10,873 |
| West Mountain (Bingham) | 19 | 3 | 3,833,509 | 1,281,082 | 1,993,116 | 71,636,173 | 66,059,434 | 41,296,403 | 10,742,036 |
| San Juan County: Blanding | | 2 | | 1,063 | 3 | | | | 1,064 |
| Sevier County: Gold Mountain [4] | 1 | | 182 | 1,171 | 315 | | | | 1,281 |
| Summit County: Uintah | 1 | | 101,543 | 48,159 | 1,678,278 | 731,060 | 23,111,546 | 16,592,736 | 2,234,366 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Tooele County: | | | | | | | | | |
| Camp Floyd | 4 | ---------- | 27,064 | 39,621 | 75 | ---------- | ---------- | ---------- | 39,647 |
| Clifton | 10 | ---------- | 3,249 | 41,819 | 10,199 | 14,714 | 243,959 | ---------- | 55,357 |
| Crater Island | 1 | ---------- | (1) | (1) | (1) | (1) | ---------- | ---------- | (1) |
| Free Coinage | 1 | ---------- | 24 | 3 | 140 | ---------- | 24,630 | ---------- | 963 |
| Lakeside | 1 | ---------- | 495 | 83 | 564 | 724 | 193,887 | ---------- | 7,500 |
| North Tintic | 1 | ---------- | (1) | ---------- | (1) | ---------- | (1) | ---------- | (1) |
| Ophir | 3 | ---------- | 886 | 229 | 11,816 | 29,098 | 173,590 | 64,169 | 15,345 |
| Rush Valley | 7 | ---------- | 31,188 | 27,464 | 224,179 | 52,906 | 13,832,938 | 834,907 | 656,198 |
| Silver Islet | 1 | ---------- | (1) | (1) | (1) | (1) | (1) | ---------- | (1) |
| Uintah County: Green River | ---------- | 3 | ---------- | 550 | 3 | ---------- | ---------- | ---------- | 551 |
| Utah County: | | | | | | | | | |
| Alpine | 1 | ---------- | (1) | (1) | (1) | ---------- | (1) | ---------- | (1) |
| American Fork | 3 | ---------- | 7,169 | 51,624 | 22,509 | 195,024 | 185,117 | ---------- | 78,832 |
| Tintic [3] | 5 | ---------- | 69,894 | 587,290 | 1,516,419 | 567,185 | 12,098,772 | ---------- | 1,601,992 |
| Wasatch County: Snake Creek | 1 | ---------- | 4 | 5 | 208 | ---------- | 1,552 | ---------- | 136 |
| Washington County: | | | | | | | | | |
| Bull Valley | 1 | ---------- | (1) | (1) | (1) | ---------- | ---------- | ---------- | (1) |
| Tutsagubet | 1 | ---------- | 11 | ---------- | 29 | 7,228 | ---------- | ---------- | 473 |
| Undistributed [5] | ---------- | ---------- | 64 | 321 | 111 | 941 | 5,977 | ---------- | 641 |
| Total Utah | 121 | 21 | 4,116,935 | 2,255,908 | 5,669,197 | 73,583,130 | 117,376,556 | 59,489,193 | 15,790,926 |

[1] Included under "Undistributed."
[2] Detroit district lies in both Juab and Millard Counties.
[3] Tintic district lies in both Juab and Utah Counties.
[4] Gold Mountain district lies in both Piute and Sevier Counties.
[5] Includes items entered as "(1)" above.

## BEAVER COUNTY

Shipments from Beaver County in 1933 consisted of a test lot of gold ore from the Fortuna group, a little lead ore from the Burnt Hollow claim, and a test lot of gold-silver ore from the Sheep Rock property. The chief activity in the county was the sinking of the new Drum shaft of the King David Mining Co. Work was begun in January, and the new shaft was sunk to the 770-foot level; crosscuts were started on the 750-foot level.

## BOX ELDER COUNTY

A lessee operated the Tecoma mine in the Lucin district in 1933 and shipped 1 car of oxidized lead ore to a smelter. The remainder of the county output consisted of siliceous gold ore from seven properties in the Park Valley district, including the Century, Susannah, Raft River, and Western Gold mines.

## GARFIELD COUNTY

The Bromide Gold Mining Co., a new company operating the Bromide property 90 miles southwest of Green River, made test shipments of gold-copper ore to smelters near Salt Lake City in 1933. Three placers, also in the Imperial district, were productive, including the Big Bend and Eagle City claims.

## GRAND COUNTY

Placer gold was produced in 1933 from the Colorado River, La Sal, and Miners Basin districts.

## IRON COUNTY

The Big Dipper Mining Corporation, operating the Gold Coin property in the Stateline district north of Modena, treated several hundred tons of gold ore in 1933 in a 25-ton experimental mill using chiefly amalgamation and concentration. Other producers in the district were the Jenny property of the Superior Gold Mining Co. and two prospects; the former was reported late in the year to be building a 50-ton flotation plant.

## JUAB COUNTY

*Detroit district.*—The Ibex property of the Ibex Gold Mining Co. in Juab County produced several hundred tons of sulphide copper ore in 1933 containing considerable gold. The property was taken over by the Engineers Exploration & Mining Co., which also acquired the Copper Head property in the Detroit district in Millard County.

*Spring Creek district.*—The Queen of Sheba Mining Co. worked its property southeast of Ibapah in 1933, built a small amalgamation and concentration mill, and treated about 500 tons of low-grade gold ore.

*Tintic district.*—As indicated in the following table, the output from mines in the Tintic district, including both Juab and Utah Counties, was considerably less in 1933 than in 1932. The mines in both sections of the Tintic district are reviewed here.

*Mine production of gold, silver, copper, lead, and zinc in Tintic district, Juab and Utah Counties, Utah, 1932–33, and total, 1869–1933, in terms of recovered metals*

| | Mines producing | Ore, old tailings, etc. | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|
| 1933 | | *Short tons* | | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| Juab County | 15 | 30,551 | $151,188 | 191,700 | 287,865 | 767,172 | 346,522 | $279,645 |
| Utah County | 5 | 69,894 | 587,290 | 1,516,419 | 567,185 | 12,098,772 | | 1,601,992 |
| | 20 | 100,445 | 738,478 | 1,708,119 | 855,050 | 12,865,944 | 346,522 | 1,881,637 |
| Total, 1932 | 15 | [1] 125,195 | 1,011,223 | 2,371,974 | 946,949 | 19,684,217 | 112,464 | 2,333,678 |
| Total, 1869–1933 | | (2) | 45,323,295 | 229,563,935 | 219,782,223 | 1,672,028,499 | 32,237,928 | 340,305,876 |

[1] Includes 38 tons of assay-office cleanings sold to a smelter.
[2] Figures not available.
NOTE.—Total dividends, 1869–1933, $55,431,790.

*Mine production of gold, silver, copper, lead, and zinc in Tintic district, Juab and Utah Counties, Utah, in 1933, by classes of ore, in terms of recovered metals*

| Class of ore | Mines producing | Ore | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|---|
| | | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry and siliceous | 15 | 74,866 | 34,418.98 | 793,701 | 715,887 | 896,727 | |
| Copper | 1 | 8 | .57 | 80 | 694 | 397 | |
| Lead | 11 | 23,445 | 1,260.92 | 903,590 | 135,066 | 11,742,393 | |
| Lead-zinc | 2 | 2,126 | 43.40 | 10,748 | 3,403 | 226,427 | 346,522 |
| | [1] 20 | 100,445 | 35,723.87 | 1,708,119 | 855,050 | 12,865,944 | 346,522 |

[1] A mine producing more than one class of ore is counted but once in arriving at total for all classes.

There were 15 producing mines and old dumps in the Juab County section of the Tintic district in 1933—the Empire, Alaska, Bullion Beck, Centennial, Iron Blossom, Dragon, Chief, Mammoth, Mammoth dump, Plutus, Swansea, Treasure Hill, Tintic West, Victoria, and North Lily Knight (old smelter dump) properties.

The Mammoth mine, operated by the Mammoth Mining Co., was by far the largest producer in the western section of the Tintic district in 1933, and its output increased over that in 1932. Approximately 22,000 tons of ore were produced, nearly all of it gold ore shipped to smelters. Several hundred tons of siliceous gold and silver material were also shipped by lessees from old Mammoth dumps.

All the mines of the Chief Consolidated Mining Co. were closed in February 1932, but the improvement in metal prices allowed the reopening of the Plutus and Chief No. 1 properties in June 1933 on a leasing basis. Production from these mines was about the same as in 1932; decreases in gold and copper were reported, but the output of lead and zinc increased. According to the annual report of the Chief Consolidated Mining Co. the output from all properties totaled 5,816 tons of ore of all classes, 261 ounces of gold, 89,213 ounces of silver, 22,200 pounds of copper, 574,903 pounds of lead, and 510,590 pounds of zinc. The Grand Central property, a large producer of gold and formerly owned by the Chief Consolidated Mining Co., was sold in 1933 to the American Smelting & Refining Co. The property was idle in 1933.

The Tintic properties (Centennial, Bullion Beck, and Victoria), controlled by the United States Smelting, Refining & Mining Co., were all productive in 1933. Their output was about the same as in 1932; it comprised siliceous gold and silver ore from the Centennial and Victoria mines and lead ore from the Victoria and Bullion Beck mines. The Eagle & Blue Bell property was idle.

The remainder of the district (Juab County) output consisted of siliceous ore from the Alaska, Empire, Dragon, Treasure Hill, and North Lily Knight (old dump) properties; lead ore from the Swansea and Tintic West mines; a little lead-zinc ore from the Alaska mine; and a small lot of copper ore from the Iron Blossom mine.

In the eastern section of the Tintic district (Utah County) the Eureka Lilly, Eureka Standard, Success, Tintic Standard, and Utah Consolidated properties were operated in 1933. The output was less than in 1932 due to decreased output of gold at the Eureka Standard mine and further curtailment in output of lead ore at the Tintic Standard mine.

According to the printed annual report of the Tintic Standard Mining Co., the Tintic Standard mine produced 26,856 tons of ore containing 1,290.34 ounces of gold, 1,188,861 ounces of silver, 207,411 pounds of copper, and 12,374,625 pounds of lead, a considerable decrease from the 1932 output. The consolidated net income in 1933 was $383,439, and four quarterly dividends of 5 cents a share were paid, a total of $230,663 for the year. The company has paid $14,747,883 in dividends since 1917. Development in 1933 consisted of 1,281 feet of drifting and 249 feet of raising.

The Eureka Standard Consolidated Mining Co. (64.45 percent owned by Tintic Standard Mining Co.) continued regular operations during 1933, and its output of ore (42,693 tons) was more than in 1932 (36,478 tons); however, the gold content was considerably less, resulting in a decrease in output of gold. Production in 1933 was 27,042.97 ounces of gold, 325,679 ounces of silver, 395,712 pounds of copper, and 770,223 pounds of lead. Net operating profit was $84,300, and dividends (paid in part from surplus) were $179,951. Development consisted of 4,706 feet of drifting, 560 feet of raising, and 110 feet of shaft sinking.

The remainder of the district (Utah County) output consisted of 68 tons of siliceous gold and silver ore and 21 tons of oxidized lead ore from the Colorado Consolidated (Success) mine, a car of lead ore from the Utah Consolidated property, and 173 tons of siliceous gold ore and 48 tons of oxidized lead ore from the Eureka Lilly property.

*West Tintic district.*—Several cars of oxidized lead ore containing gold and silver from the Old Scotia mine were shipped to a smelter.

## MILLARD COUNTY

*Detroit district.*—The Engineers Exploration & Mining Co. acquired the Copper Head property 30 miles northwest of Delta and announced an extensive development program. The output from the mine in 1933 was gold ore of smelting grade produced by lessees.

*Sawtooth district.*—The output of the Sawtooth district in 1933 was placer gold, chiefly from the Amasy property 50 miles west of Delta. Other placer areas in the county, particularly near the House Range, were being explored during the year.

### MORGAN COUNTY

*Argenta district.*—Lessees operated the Dan Heiners group of the Morgan Chief Mining Co. and the Lucky Boy property of the Morgan Argenta Mining Co. and shipped test lots of rich lead ore in 1933.

### PIUTE COUNTY

*Gold Mountain district.*—The Annie Laurie Consolidated Gold Mines Co. operated its property in 1933; several hundred tons of gold ore were treated by amalgamation and concentration, and 1 car of siliceous gold ore was shipped to a smelter.

*Mount Baldy district.*—Lessees shipped 1 car of gold ore from the property of the Deer Trail Mining Co. near Marysvale in 1933.

*Ohio district.*—The output of the Ohio district in 1933 included high-grade gold ore from the Wedge mine, a little lead ore from the Cascade property (treated in a small jig plant), and 1 car of siliceous silver ore from the property of the Bullion Canyon Gold Mining & Milling Co.

### SALT LAKE COUNTY

*Big and Little Cottonwood districts.*—Production from mines in Big and Little Cottonwood districts has been combined in the following table:

*Mine production of gold, silver, copper, lead, and zinc in Big Cottonwood and Little Cottonwood districts, Utah, 1932–33, and total, 1867–1933, in terms of recovered metals*

| Year | Mines producing | Ore | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons* | | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| 1932 | 10 | 488 | $963 | 9,337 | 4,710 | 217,924 | 1,446 | $10,474 |
| 1933 | 9 | 1,434 | 2,044 | 11,041 | 8,852 | 430,651 | 354,456 | 37,295 |
| Total, 1867–1933 | | 608,948 | 574,386 | 16,477,384 | 15,854,701 | 232,601,263 | 1,140,123 | 33,393,190 |

The property of the Cardiff Mining & Milling Co. was the largest producer in the Big Cottonwood district in 1933; oxidized lead ore was shipped to Murray for smelting, and several hundred tons of oxidized lead-zinc ore were shipped to Coffeyville, Kans., for smelting. Lead sulphide ore from the Maxfield mine was treated in a 15-ton gravity concentration plant; oxidized lead ore of smelting grade was shipped from the Prince of Wales and Democrat mines; and siliceous gold ore was marketed from the Golden Porphyry and Silver King properties.

In the Little Cottonwood district in 1933 the Mineral Veins Coalition Mines Co. resumed operations at the Columbus, Flagstaff, etc., group and shipped lead-zinc ore to a custom mill at Midvale and oxidized lead ore to the smelter at Murray. Oxidized lead ore and a small lot of copper ore were produced from the Columbus Rexall property, and small lots of rich gold ore were shipped from the Dipper (Clementine) group.

*Bingham or West Mountain district.*—The mine production of the West Mountain district is given in the following tables:

*Mine production of gold, silver, copper, lead, and zinc in Bingham or West Mountain district, Utah, 1932–33, and total, 1865–1933, in terms of recovered metals*

| Year | Mines producing | Ore, etc. | Gold | Silver | Copper [1] | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons* | | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| 1932 | 17 | 3,465,178 | [2] $1,450,356 | 1,973,814 | [3] 62,468,976 | 65,280,992 | 43,492,579 | $9,205,725 |
| 1933 | 22 | [4] 3,833,509 | [2] 1,281,082 | [2] 1,993,116 | [5] 71,636,173 | 66,059,434 | 41,296,403 | 10,742,036 |
| Total, 1865–1933 | | ([6]) | [2] 62,902,632 | [2] 89,850,761 | 4,452,152,772 | 2,246,839,091 | 466,763,295 | 989,231,588 |

[1] Includes copper saved from precipitates.
[2] Includes placer production.
[3] Includes 4,490,379 pounds of copper saved from precipitates.
[4] Includes 14 tons of old mill cleanings sold to a smelter.
[5] Includes 4,107,381 pounds of copper saved from precipitates.
[6] Figures not available.

NOTE.—Total dividends, 1865–1933, $242,889,503 (exclusive of dividends paid by United States Smelting, Refining & Mining Co.).

*Mine production of gold, silver, copper, lead, and zinc in Bingham or West Mountain district, Utah, in 1933, by classes of ore, in terms of recovered metals*

| Class of ore | Mines producing | Ore and old cleanings | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|---|
| | | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry and siliceous | 11 | 36,385 | 7,014.55 | 78,828 | 666,777 | 127,236 | |
| Copper | 11 | [1] 3,523,571 | 35,331.22 | 352,276 | [2] 69,631,456 | 26,155 | |
| Lead | 9 | 2,965 | 913.00 | 33,707 | 34,664 | 1,028,280 | |
| Lead-zinc | 7 | 270,588 | 18,705.15 | 1,528,302 | 1,303,276 | 64,877,763 | 41,296,403 |
| | [3] 22 | [1] 3,833,509 | [4] 61,963.92 | [5] 1,993,113 | 71,636,173 | 66,059,434 | 41,296,403 |

[1] Includes 14 tons of old mill cleanings sold to a smelter.
[2] Includes 4,107,381 pounds of copper saved from precipitates.
[3] A mine producing more than one class of ore is counted but once in arriving at total for all classes.
[4] Also 8.42 ounces of gold valued at $174 produced from placers.
[5] Also 3 ounces of silver valued at $1 produced from placers.

The Utah Copper Co. continued periodic operations at the large opencut copper mine at Bingham. The output of copper ore in 1933 was 11 percent above that in 1932 but far below the average for recent past years and amounted to about 20 percent of capacity. The company produced 3,521,425 dry tons of copper ore at a total mining cost of 41.06 cents a ton. The ore was treated by flotation in the Magna mill (the Arthur plant remaining idle) at a cost of 50.31 cents a ton; the ore contained 1.03 percent copper, and the mill recovery was 92.83 percent. In addition to copper ore the company produced 2,381 tons of siliceous gold ore from underground operations at the Sulphide mine and shipped from the central plant at Copperton copper precipitates yielding 3,970,277 net pounds of copper. Total cost of producing 1 pound of net copper, calculated in the usual manner, was 6.455 cents in 1933 compared with 8.48 cents in 1932. After payment of all charges and inventory adjustments net operating income to surplus was $928,276; no dividends were paid in 1933. Total net production of refined copper from all sources was 69,462,298 pounds, an increase of 15.75 percent over 1932. Early in 1933 the company leased its Sulphide mine to the American Smelting & Refining Co. This lease also involved part of the property of the Utah Metal & Tunnel Co.

The United States Smelting, Refining & Mining Co. continued operations at the United States, Lark, and Niagara properties in 1933. The output of lead-zinc ore from the Niagara mine in 1933 decreased decidedly from 1932, but the loss was more than offset by increased output from the Lark unit. The output of lead-zinc ore from the United States mine also increased. Production of gold in 1933 from the combined properties was decidedly less than in 1932, but production of silver, copper, lead, and zinc varied only slightly from the output in 1932. Nearly all the ore (99 percent) from the three properties was lead-zinc ore of milling grade treated at the 1,000-ton flotation plant at Midvale; the remainder was mostly lead ore and copper ore of smelting grade. At the United States mine the company did 16,262 feet of drifting, 3,087 feet of raising, and 255 feet of sinking; development at the Lark unit, consisted of 19,929 feet of drifting and 2,582 feet of raising and at the Niagara mine 1,380 feet of drifting and 300 feet of raising.

The consolidated net profit from all operations (including properties in Alaska and Mexico as well as in Utah and other States) was $5,169,875. Dividends on regular and preferred stock amounted to $4,281,643. During 1933 the company built a new lead refinery at its lead-smelting plant at Midvale. The work was the largest new construction reported by any company in Utah during the year. The plant employs the Parkes process and has an annual capacity of 72,000 tons of refined lead. The gold output from the operations in Alaska is also being refined at this plant.

Lessees continued to work the Highland Boy & Yampa property of the Utah-Delaware Mining Co. in 1933 and shipped nearly 20,000 tons of ore to smelters. Nearly all the ore was siliceous gold ore containing silver, copper, and lead. The output was considerably less than in 1932. The property was operated the entire year, and about 2,800 feet of development was done.

The property of the Utah Metal & Tunnel Co. was actively worked in 1933. All the output was produced above the 1,000-foot level by a lessee who shipped about 12,000 tons of ore (nearly all siliceous gold ore) to local smelters. The chief interest in the property in 1933 centered in the long-term lease on the lower levels of the mine granted to the American Smelting & Refining Co. The leasing company started sinking an 1,800-foot shaft from the Armstrong Tunnel level, and drifts and crosscuts will be extended into the surrounding country as the successive limestone beds are opened; at the end of the year the new shaft was down more than 600 feet.

The Bingham Metals Co. continued working its New England property adjoining the Utah Metal & Tunnel ground. Nearly 3,000 tons of ore were shipped during 1933, including lead-zinc ore to the Combined Metals mill at Bauer and siliceous gold ore, lead ore, and copper ore to local smelters.

Other producers in the West Mountain district in 1933 were the Ohio Copper Co. (copper precipitates), the Park Bingham group of the Combined Metals Reduction Co. (siliceous ore and lead ore), the Montana-Bingham Consolidated property (siliceous ore, lead ore, and copper precipitates), and the Osceola-Lucky Boy, Bingham-Premier, Gold & Silver, and Buffalo properties (all siliceous ore). Copper precipitates were also shipped from various small operations, and a little placer gold was marketed.

### SAN JUAN COUNTY

*Blanding district.*—The Blanding Gold Mining Co. operated a small sluicing plant in Doozit Canyon during the early spring of 1933 while water was available from Johnson Creek and sold about 50 ounces of placer gold. Considerable exploration and development work was also reported by the McGowan Syndicate and other operators in the new placer area near Blanding.

### SEVIER COUNTY

*Gold Mountain district.*—The Sevier-Miller group of the Annie Laurie Consolidated Gold Mines Co. was operated by a lessee who treated gold ore by amalgamation and concentration and shipped crude gold ore to a smelter.

### SUMMIT AND WASATCH COUNTIES

#### PARK CITY REGION

*Mine production of gold, silver, copper, lead, and zinc in Park City region, Summit and Wasatch Counties, Utah, 1932–33, and total, 1870–1933, in terms of recovered metals*

| Year | Mines producing | Ore | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons* | | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| 1932 | 4 | 123, 371 | $55, 576 | 2, 330, 544 | 901, 333 | 25, 305, 855 | 15, 725, 399 | $2, 000, 511 |
| 1933 | 2 | 101, 547 | 48, 164 | 1, 678, 486 | 731, 060 | 23, 113, 098 | 16, 592, 736 | 2, 234, 502 |
| Total, 1870–1933 | | (1) | 8, 257, 132 | 205, 534, 785 | 56, 513, 087 | 2, 041, 726, 938 | 383, 495, 851 | 294, 659, 806 |

1 Figures not available.

NOTE.—Total dividends, 1870–1933, $64,643,862.

*Mine production of gold, silver, copper, lead, and zinc in Park City region, Summit and Wasatch Counties, Utah, in 1933, by classes of ore, in terms of recovered metals*

| Class of ore | Mines producing | Ore | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|---|
| | | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Lead | 1 | 4 | 0. 24 | 208 | | 1, 552 | |
| Lead-zinc | 1 | 101, 543 | 2, 329. 69 | 1, 678, 278 | 731, 060 | 23, 111, 546 | 16, 592, 736 |
| | 2 | 101, 547 | 2, 329. 93 | 1, 678, 486 | 731, 060 | 23, 113, 098 | 16, 592, 736 |

The Silver King Coalition Mines Co. was the only producer in Summit County in 1933. According to the annual report of the company, regular operations were maintained during the year and 25,257 feet of development was done. The mine produced 101,543 tons of lead-zinc ore which was treated in the company flotation plant and yielded 18,507 tons of lead concentrates and 14,860 tons of zinc concentrates. In addition to current production the company marketed 4,220 tons of zinc concentrates from stock pile (produced in 1932). The net profit after deducting all charges, including depreciation, was $433,686; dividends of $366,140 were paid in 1933. Total production (gross content of both lead and zinc concentrates, including zinc concentrates from stock pile) amounted to 2,370.12 ounces of gold, 1,715,251 ounces of silver, 938,414 pounds of copper, 24,467,200 pounds of lead, and 23,775,910 pounds of zinc.

Regular development was continued in 1933 at the Silver King Western property operating through the Spiro tunnel, but no shipments of ore were made. Total development to date includes 4,120 feet of tunnel work, 203 feet of raises, and 173 feet of crosscuts. The American Flag group was acquired during the year by the Park City Development Co., and the equipment and 1,100-foot shaft were repaired for resumption of operations.

A test lot of lead ore from the St. Louis & Vassar property in the Snake Creek district was the only production from mines in Wasatch County in 1933.

The Park Utah Consolidated Mines Co. reported no production from its properties in Summit and Wasatch Counties in 1933. The Park City Consolidated Mines Co. was idle in 1933, but the marked improvement in price of silver resulted in reopening of the mine the last week of December, and preparations were made to resume shipments of ore in January 1934.

The New Park Mining Co., controlling the Park Galena, Mayflower, and Star of Utah groups, resumed development during 1933.

## TOOELE COUNTY

*Camp Floyd (Mercur) district.*—The Manning Gold Mining Co. was organized early in 1933 to treat the 500,000-ton tailings dump north of Fairfield. The company erected a 500-ton cyanide plant which began operating in October and re-treated nearly 25,000 tons of old tailings before the end of the year. The new plant was the largest milling-plant construction undertaken in Utah during 1933 and is the only regularly operated cyanide plant in the State. The tailings re-treated were those left from mill operations in Manning Canyon prior to 1900, before the Consolidated Mercur mill at Mercur was built.

The remainder of the district production in 1933 consisted of siliceous gold ore from the Consolidated Mercur, La Cigale, and Sacramento mines. The increased price of gold resulted in considerable exploration and development in the district, which had been virtually abandoned for many years.

*Clifton (Gold Hill) district.*—The largest producer of gold in the Clifton district in 1933 was the Rube (Palmer) mine operated by the Gold Hill Mines, Inc. The company shipped more than 1,100 tons of gold ore during the first half of the year, but the reserves of commercial ore were depleted and the property was idle the remainder of the year. The Aurum Gold Mining Co. shipped about 1,200 tons of gold ore from the Cane Springs property, did 350 feet of development, and installed new mining machinery.

The remainder of the district output in 1933 consisted of siliceous ore from the Alvarado, Gold Spar, and Midas properties; lead ore from the Garrison, Success, Pocahontas, and Tom Tom groups; and a little copper ore from the Lucy L. and Pole Star claims.

*Free Coinage district.*—A lessee shipped 1 car of oxidized lead ore of smelting grade in 1933 from the Humdinger group of the Lead Ore Mining Co.

*Lakeside district.*—Nearly 500 tons of lead ore were shipped in 1933 from the Monarch property 17 miles north of Delle on the Western Pacific Railroad.

*Ophir district.*—The property of the Ophir Hill Consolidated Mining Co. (under lease and option to the International Smelting Co.) was operated in 1933 by lessees who shipped several cars of lead-zinc ore to the Combined Metals mill at Bauer and several hundred tons of lead ore to the smelter at Tooele. Several lots of silver ore were shipped from the Chloride Point property, and 2 cars of oxidized zinc ore from the Queen of the Hills group were shipped to an eastern zinc smelter.

*Rush Valley district.*—The Bluestone Lime & Quartzite Mining Co. continued regular operations at its Cyclone-Tip Top group in 1933, shipped about 25,200 tons of first-class lead ore to the smelter near Tooele, and was the largest producer of lead ore in the State; however, production of all metals was less than in 1932. Lessees continued operations at the Honerine-Galena King property of the Combined Metals Reduction Co., treated several hundred tons of lead ore in the jig plant, and shipped first-class lead ore to the smelter near Tooele. The Combined Metals Reduction Co. started operations at the West Calumet group August 16 and treated nearly 5,200 tons of lead-zinc ore in the flotation plant at Bauer before the end of the year. The Combined Metals mill which had been idle since December 1931 was reopened on a 1-unit basis in August 1933; receipts were chiefly lead-zinc ore from Pioche, Nev. The remainder of the district output in 1933 consisted of lead ore from the Utah Ophir Mines Co., Gisborn-Muirbrook Mines, Inc., and two prospects.

### UINTAH COUNTY

*Green River district.*—The Utah Mining & Metal Corporation and the Rio Verde Mining & Metal Corporation operated placer claims 20 miles south of Vernal on the Green River at Horseshoe Bend; gold bullion was sold at the Denver Mint.

### UTAH COUNTY

Production of metals in Utah County was valued at $1,680,893 in 1933 compared with $2,285,608 in 1932 and was chiefly from mines in the eastern section of the Tintic district.

*American Fork district.*—The American Smelting & Refining Co. suspended shipments of gold-copper ore from the Live Yankee mine early in the summer of 1933. The property was leased shortly afterward, and shipments were resumed by the lessee. More than 6,600 tons of siliceous gold ore containing silver and copper were shipped to Garfield for smelting. Production of gold in 1933 was only about one third that in 1932.

The American Fork Gold Mining Co. operated the Pacific mine from June until November. Sulphide lead ore was treated in a small flotation plant, and first-class lead ore was shipped for smelting.

*Mine production of gold, silver, copper, lead, and zinc in American Fork district, Utah, 1932–33, and total, 1870–1933, in terms of recovered metals*

| Year | Mines producing | Ore | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons* | | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| 1932 | 2 | 21,617 | $147,710 | 58,826 | 545,380 | 263,120 | | $206,551 |
| 1933 | 3 | 7,169 | 51,624 | 22,509 | 195,024 | 185,117 | | 78,832 |
| Total, 1870–1933 | | 134,024 | 817,722 | 2,149,098 | 2,017,347 | 32,429,773 | 313,926 | 5,061,448 |

*Tintic district.*—The mines in the Utah County section of the Tintic district are reviewed under Juab County.

## WASHINGTON COUNTY

The output from mines in Washington County in 1933 consisted of a small lot of gold ore from a prospect in the Bull Valley (Gold Strike) district treated by amalgamation and a small shipment of oxidized copper ore from the Dixie (Apex) property near St. George.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN WASHINGTON

(MINE REPORT)

By C. N. Gerry and T. H. Miller [1]

## SUMMARY OUTLINE



The output of gold, silver, copper, lead, and zinc from Washington ores and gravels in 1933, in terms of recovered metals, was 4,562.68 fine ounces of gold, 18,520 fine ounces of silver, 5,781 pounds of copper, 1,680,430 pounds of lead, and 6,738,169 pounds of zinc. This output compares with a production in 1932 of 5,082.13 ounces of gold, 17,412 ounces of silver, 5,524 pounds of copper, 1,842,267 pounds of lead, and 4,489,334 pounds of zinc. There were 37 lode mines and 70 placers producing in 1933 compared with 40 lode mines and 55 placers in 1932.

Since 1860 Washington has yielded an output of the five metals as follows: Gold, 1,484,249 fine ounces; silver, 9,343,022 fine ounces; copper, 27,068,896 pounds; lead, 69,503,729 pounds; and zinc, 36,856,532 pounds. The total value has amounted to $48,776,001 [2] of which $30,682,156 [2] (63 percent) represents the value of gold.

*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of $20.671835, from January 1 to August 9 to all producers; (2) that of (*a*) $20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export by some producers, to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, from September 8 to November 1); and (4) the period of the Reconstruction Finance Corporation arbitrarily fixed, gradually rising price (generally above the world price), from October 25 to December 31, 1933. For further details

[1] The assistance of Paul Luff and LaRu Shepherd is acknowledged.
[2] Value of gold calculated at $20.671835 an ounce.

see chapter of this volume on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

Following is a table on mine production of gold in Washington, 1929–33, in terms of recovered metal; two values are given for 1933—(1) at legal coinage value ($20.67+ per ounce) and (2) at average weighted price ($25.56 per ounce).

*Mine production of gold in Washington, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 3,719.94 | $76,898 | 1932 | 5,082.13 | $105,057 |
| 1930 | 4,244.81 | 87,748 | 1933 | 4,562.68 | [2] 94,319<br>[3] 116,622 |
| 1931 | 2,904.19 | 60,035 | | | |

[1] 1929-32: At legal value ($20.67+ per ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] At legal coinage value ($20.67+ per ounce).
[3] At average weighted price ($25.56 per ounce).

*Calculation of value of metal production.*—The value of metal production hereinafter reported 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, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Mine production of gold, silver, copper, lead, and zinc in Washington, 1929–33, in terms of recovered metals*

| Year | Mines producing | | Ore, old tailings, etc. (short tons) | Gold | | Silver | |
|---|---|---|---|---|---|---|---|
| | Lode | Placer | | Fine ounces | Value | Fine ounces | Value |
| 1929 | 29 | 4 | 93,527 | 3,719.94 | $76,898 | 47,182 | $25,148 |
| 1930 | 24 | 14 | 45,456 | 4,244.81 | 87,748 | 32,816 | 12,634 |
| 1931 | 24 | 21 | 92,049 | 2,904.19 | 60,035 | 22,410 | 6,499 |
| 1932 | 40 | 55 | 42,272 | 5,082.13 | 105,057 | 17,412 | 4,910 |
| 1933 | 37 | 70 | 53,984 | 4,562.68 | 94,319 | 18,520 | 6,482 |

| Year | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| 1929 | 1,400,489 | $246,486 | 1,015,190 | $63,956 | 2,117,344 | $139,745 | $552,233 |
| 1930 | 1,206,438 | 156,837 | 1,152,585 | 57,629 | 703,782 | 33,782 | 348,630 |
| 1931 | 202,503 | 18,428 | 2,771,116 | 102,531 | 9,947,495 | 378,005 | 565,498 |
| 1932 | 5,524 | 348 | 1,842,267 | 55,268 | 4,489,334 | 134,680 | 300,263 |
| 1933 | 5,781 | 370 | 1,680,430 | 62,176 | 6,738,169 | 283,003 | 446,350 |

*Gold and silver produced at placer mines in Washington, 1929–33, in fine ounces*

| Year | Gold | Silver | Year | Gold | Silver |
|---|---|---|---|---|---|
| 1929 | 295.76 | 98 | 1932 | 386.95 | 75 |
| 1930 | 190.90 | 43 | 1933 | 990.96 | 166 |
| 1931 | 153.06 | 12 | | | |

*Gold.*—The production of gold in Washington decreased from 5,082.13 ounces in 1932 to 4,562.68 ounces in 1933. Production from placer mines increased from 386.95 to 990.96 ounces and that from lode mines near Republic in Ferry County increased 755 ounces, but the large decrease in production of gold from Whatcom County, caused by the idleness of the Boundary Red Mountain mine, more than offset these gains. The Old Gold mine at Republic greatly increased its output of siliceous gold ore in 1933 and was the largest producer of gold in Washington, followed by the Mountain Lion and Knob Hill mines, also at Republic. Nearly 66 percent of the total gold produced in 1933 came from siliceous gold ore of smelting grade from mines in the Republic district, Ferry County; most of the remainder came from placers.

*Silver.*—The output of silver from mines in Washington increased from 17,412 ounces in 1932 to 18,520 ounces in 1933. About 70 percent of the total in 1933 came from siliceous gold ore from mines in the Republic district and nearly 18 percent from lead-zinc ore from the Josephine mine at Metaline Falls. The Mountain Lion mine at Republic was the largest silver producer in the State in 1933, followed by the Knob Hill property, also at Republic, and the Josephine mine at Metaline Falls.

*Copper.*—The production of recoverable copper in Washington has been insignificant since the closing of the Index property in 1931. No copper ore was produced in Washington in 1933, and nearly all the copper produced came from lead-zinc ore.

*Lead.*—The output of recoverable lead from mines in Washington decreased slightly in 1933, due chiefly to lessened output of first-class lead ore from mines in the Northport district, Stevens County, as there was a slight increase in production of lead from lead-zinc ore. Nearly 86 percent of the total lead produced in Washington in 1933 was recovered from lead-zinc ore from the Josephine mine of the Pend Oreille Mines & Metals Co. near Metaline Falls, Pend Oreille County; nearly all the remainder came from lead ore of smelting grade from the Electric Point and Gladstone Mountain mines in the Northport district, Stevens County.

*Zinc.*—The output of recoverable zinc in Washington in 1933 increased 50 percent over that in 1932 but was considerably below the record of 9,947,495 pounds in 1931. The entire production in 1933 came from the Josephine property of the Pend Oreille Mines & Metals Co. near Metaline Falls, where 48,479 dry tons of lead-zinc ore were treated by flotation.

# MINE PRODUCTION BY COUNTIES

*Mine production of gold, silver, copper, lead, and zinc in Washington in 1933, by counties, in terms of recovered metals*

| County | Gold (lode and placer) | | Silver (lode and placer) | |
|---|---|---|---|---|
| | Fine ounces | Value | Fine ounces | Value |
| Asotin | 81.75 | $1,690 | 14 | $5 |
| Benton | 9.29 | 192 | | |
| Chelan | 93.32 | 1,929 | 26 | 9 |
| Clallam | 55.63 | 1,150 | 9 | 3 |
| Douglas | 4.26 | 88 | | |
| Ferry | 3,090.87 | 63,894 | 13,020 | 4,557 |
| Garfield | 2.27 | 47 | | |
| Grant | 4.31 | 89 | | |
| King | 2.32 | 48 | | |
| Kittitas | 297.70 | 6,154 | 151 | 53 |
| Lincoln | 179.47 | 3,710 | 20 | 7 |
| Okanogan | 329.92 | 6,820 | 894 | 313 |
| Pend Oreille | 18.62 | 385 | 3,263 | 1,142 |
| Snohomish | 73.14 | 1,512 | 14 | 5 |
| Stevens | 154.99 | 3,204 | 1,069 | 374 |
| Whatcom | 112.91 | 2,334 | 23 | 8 |
| Whitman | 37.83 | 782 | 11 | 4 |
| Yakima | 14.08 | 291 | 6 | 2 |
| | 4,562.68 | 94,319 | 18,520 | 6,482 |
| Total, 1932 | 5,082.13 | 105,057 | 17,412 | 4,910 |

| County | Copper | | Lead | | Zinc | | Total value |
|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | |
| Asotin | | | | | | | $1,695 |
| Benton | | | | | | | 192 |
| Chelan | | | | | | | 1,938 |
| Clallam | | | | | | | 1,153 |
| Douglas | | | | | | | 88 |
| Ferry | 16 | $1 | 160 | $6 | | | 68,458 |
| Garfield | | | | | | | 47 |
| Grant | | | | | | | 89 |
| King | | | | | | | 48 |
| Kittitas | | | | | | | 6,207 |
| Lincoln | | | | | | | 3,717 |
| Okanogan | 32 | 2 | 974 | 36 | | | 7,171 |
| Pend Oreille | 5,062 | 324 | 1,443,783 | 53,420 | 6,738,169 | $283,003 | 338,274 |
| Snohomish | | | | | | | 1,517 |
| Stevens | 217 | 14 | 235,513 | 8,714 | | | 12,306 |
| Whatcom | 454 | 29 | | | | | 2,371 |
| Whitman | | | | | | | 786 |
| Yakima | | | | | | | 293 |
| | 5,781 | 370 | 1,680,430 | 62,176 | 6,738,169 | 283,003 | 446,350 |
| Total, 1932 | 5,524 | 348 | 1,842,267 | 55,268 | 4,489,334 | 134,680 | 300,263 |

*Ore and old mill cleanings sold or treated and lode mines producing in Washington, 1932–33, by counties*

| County | Ore and old mill cleanings (short tons) | | Lode mines producing | | County | Ore and old mill cleanings (short tons) | | Lode mines producing | |
|---|---|---|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | | 1932 | 1933 | 1932 | 1933 |
| Chelan | 171 | 110 | 7 | 4 | Pend Oreille | 33,443 | 48,479 | 2 | 1 |
| Ferry | 4,418 | 4,719 | 9 | 10 | Stevens | 762 | 263 | 8 | 6 |
| King | 22 | | 1 | | Whatcom | 3,067 | 104 | 4 | 2 |
| Kittitas | 56 | 40 | 6 | 5 | | | | | |
| Okanogan | 333 | 269 | 3 | 9 | | 42,272 | 53,984 | 40 | 37 |

## MINING INDUSTRY

The most important feature of the mining industry of Washington in 1933 was the resumption of mining and milling of lead-zinc ore at the Josephine property of the Pend Oreille Mines & Metals Co. near Metaline Falls, Pend Oreille County. As a result, the total value of metal production in Pend Oreille County increased $161,132, or more than the total increase ($146,087) in the State. There was an increase in output of siliceous gold ore from the Republic district, but this gain was more than offset by the large decrease in Whatcom County caused by the idleness of the Boundary Red Mountain mine. There was marked increase in placer-mining activity in nearly all the producing areas of the State, especially on the Columbia and Snake Rivers and in the Northport, Meyers Creek, Similkameen, Ozette, and Sultan districts; the total placer-gold output was 990.96 fine ounces in 1933 compared with 386.95 ounces in 1932.

### ORE CLASSIFICATION

*Ore and old mill cleanings sold or treated in Washington in 1933, with content in terms of recovered metals*

| Source | Mines producing | Ore and old mill cleanings | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|---|
| | | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry gold ore | 30 | [1] 5,261 | 3,561.99 | 13,890 | 626 | 263 | |
| Dry silver ore | 2 | 14 | 2.80 | 618 | | 485 | |
| Lead ore | 5 | 230 | 6.93 | 586 | 93 | 235,899 | |
| Lead-zinc ore | 1 | 48,479 | | 3,260 | 5,062 | 1,443,783 | 6,738,169 |
| Total, lode mines | [2] 37 | 53,984 | 3,571.72 | 18,354 | 5,781 | 1,680,430 | 6,738,169 |
| Total, placers | 70 | | 990.96 | 166 | | | |
| | 107 | 53,984 | 4,562.68 | 18,520 | 5,781 | 1,680,430 | 6,738,169 |
| Total, 1932 | 95 | 42,272 | 5,082.13 | 17,412 | 5,524 | 1,842,267 | 4,489,334 |

[1] Includes 4 tons of old mill cleanings sold to a smelter.
[2] A mine producing more than one class of ore is counted but once in arriving at total for all classes.

*Value of metals from ore and old mill cleanings sold or treated in Washington in 1933, by classes of ore*

| Class | Ore and old mill cleanings (short tons) | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|
| Dry gold ore | [1] 5,261 | $73,633 | $4,862 | $40 | $10 | | $78,545 |
| Dry silver ore | 14 | 58 | 216 | | 18 | | 292 |
| Lead ore | 230 | 143 | 205 | 6 | 8,728 | | 9,082 |
| Lead-zinc ore | 48,479 | | 1,141 | 324 | 53,420 | $283,003 | 337,888 |
| | 53,984 | 73,834 | 6,424 | 370 | 62,176 | 283,003 | 425,807 |
| Total, 1932 | 42,272 | 97,058 | 4,889 | 348 | 55,268 | 134,680 | 292,243 |

[1] Includes 4 tons of old mill cleanings sold to a smelter.

*Dry and siliceous ore.*—The output of dry and siliceous ore and old mill cleanings, nearly all gold ore, decreased 3,221 tons from 1932 due to the closing of the Boundary Red Mountain mine in Whatcom County. Most (4,716 tons) of the material produced in 1933 was gold ore of smelting grade from mines in the Republic district.

No gold and silver ore was produced in Washington in 1933, and only 14 tons of silver ore was produced.

*Copper ore.*—No copper ore has been produced in Washington since the closing of the Sunset copper mine near Index in 1931.

*Lead ore.*—All the lead ore produced in Washington in 1933 was of smelting grade, and nearly all (224 tons) of it came from the Electric Point and Gladstone Mountain mines near Northport.

*Lead-zinc ore.*—Nearly 90 percent of the total ore produced in Washington in 1933 was lead-zinc ore; the metals recovered from it accounted for 76 percent of the total value of the State metal output. All the lead-zinc ore produced in 1933 came from the Josephine mine of the Pend Oreille Mines & Metals Co. and was treated by flotation.

*Ore and old mill cleanings sold or treated in Washington in 1933, by counties, with content in terms of recovered metals*

| County | Ore and old mill cleanings | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| DRY GOLD ORE | | | | | | |
| Chelan | 110 | 37.35 | 17 | | | |
| Ferry | 4,718 | 3,011.00 | 12,980 | | | |
| Kittitas | 40 | 262.43 | 140 | | | |
| Okanogan | 256 | 136.61 | 707 | 32 | 263 | |
| Stevens | 33 | 12.09 | 23 | 140 | | |
| Whatcom | [1] 104 | 102.51 | 23 | 454 | | |
| | 5,261 | 3,561.99 | 13,890 | 626 | 263 | |
| Total, 1932 | 8,491 | 4,695.18 | 14,467 | 2,128 | 2,534 | |
| DRY SILVER ORE | | | | | | |
| Okanogan | 11 | 0.24 | 109 | | 485 | |
| Stevens | 3 | 2.56 | 509 | | | |
| | 14 | 2.80 | 618 | | 485 | |
| Total, 1932 | 5 | | 30 | | | |
| LEAD ORE | | | | | | |
| Ferry | 1 | 6.29 | 34 | 16 | 160 | |
| Okanogan | 2 | .49 | 41 | | 226 | |
| Stevens | 227 | .15 | 511 | 77 | 235,513 | |
| | 230 | 6.93 | 586 | 93 | 235,899 | |
| Total, 1932 | 353 | | 251 | 36 | 490,020 | |
| LEAD-ZINC ORE | | | | | | |
| Pend Oreille | 48,479 | | 3,260 | 5,062 | 1,443,783 | 6,738,169 |
| | 48,479 | | 3,260 | 5,062 | 1,443,783 | 6,738,169 |
| Total, 1932 | 33,423 | | 2,589 | 3,360 | 1,349,713 | 4,489,334 |

[1] Includes 4 tons of old mill cleanings sold to a smelter.

*Zinc products produced or marketed from Washington mines and mills in 1933*

| Classification | County | Quantity (dry weight) | Gross zinc | Average assay of concentrates | Recovered zinc |
|---|---|---|---|---|---|
| | | *Short tons* | *Pounds* | *Percent* | *Pounds* |
| Zinc concentrates | Pend Oreille | 6,086 | 7,486,855 | 61.51 | 6,738,169 |
| | | 6,086 | 7,486,855 | 61.51 | 6,738,169 |
| Total, 1932 | | 4,047 | 4,988,150 | 61.63 | 4,489,334 |

## METALLURGIC INDUSTRY

The 300-ton flotation plant of the Pend Oreille Mines & Metals Co. at the Josephine property near Metaline Falls was operated regularly on lead-zinc ore the latter half of 1933. A small plant in the Palmer Mountain district, Okanogan County, treated gold ore from two properties by amalgamation and gravity concentration, and three small amalgamation plants in Chelan and Kittitas Counties operated for short periods. The amalgamation mill of the Boundary Red Mountain mine was idle.

About 90 percent of the total ore produced in Washington in 1933 was treated by flotation; nearly all the remainder was crude ore shipped to smelters.

*Gross metal content of Washington concentrates produced in 1933, by classes of concentrates*

| Class of concentrates | Concentrates produced (dry weight) | Gross metal content | | | | |
|---|---|---|---|---|---|---|
| | | Gold | Silver | Copper | Lead | Zinc |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Dry and siliceous | 10 | 18.53 | 34 | 21 | 208 | |
| Lead | 1,076 | | 2,660 | 1,880 | 1,466,967 | |
| Zinc | 6,086 | | 600 | 4,567 | 44,368 | 7,486,855 |
| | 7,172 | 18.53 | 3,294 | 6,468 | 1,511,543 | 7,486,855 |
| Total, 1932 | 5,027 | 26.35 | 2,616 | 4,958 | 1,410,744 | 4,988,150 |

*Mine production of metals from Washington concentrates in 1933, in terms of recovered metals*

BY COUNTIES

| | Concentrates | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* |
| Okanogan | 10 | 18.53 | 34 | 20 | 125 | |
| Pend Oreille | 7,162 | | 3,260 | 5,062 | 1,443,783 | 6,738,169 |
| | 7,172 | 18.53 | 3,294 | 5,082 | 1,443,908 | 6,738,169 |
| Total, 1932 | 5,027 | 26.35 | 2,616 | 3,375 | 1,350,013 | 4,489,334 |

BY CLASSES OF CONCENTRATES

| | Concentrates | Gold | Silver | Copper | Lead | Zinc |
|---|---|---|---|---|---|---|
| Dry and siliceous | 10 | 18.53 | 34 | 20 | 125 | |
| Lead | 1,076 | | 2,660 | 1,410 | 1,408,289 | |
| Zinc | 6,086 | | 600 | 3,652 | 35,494 | 6,738,169 |

Most of the crude ore of smelting grade was siliceous gold ore from mines at Republic, shipped chiefly to the smelter at Trail, British Columbia, and lead ore from mines near Northport, shipped to Bradley, Idaho, and East Helena, Mont.

*Gross metal content of Washington crude ore shipped to smelters in 1933, by classes of ore*

| Class of ore | Quantity (dry weight) | Gross metal content | | | |
|---|---|---|---|---|---|
| | | Gold | Silver | Copper | Lead |
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* |
| Dry and siliceous | 5,034 | 3,239.36 | 14,301 | 665 | 829 |
| Lead | 230 | 6.93 | 586 | 127 | 246,555 |
| | 5,264 | 3,246.29 | 14,887 | 792 | 247,384 |
| Total, 1932 | 5,484 | 2,779.09 | 14,302 | 2,327 | 512,237 |

*Mine production of metals from Washington crude ore shipped to smelters in 1933, in terms of recovered metals*

BY COUNTIES

| | Ore | Gold | Silver | Copper | Lead |
|---|---|---|---|---|---|
| | *Short tons* | *Fine ounces* | *Fine ounces* | *Pounds* | *Pounds* |
| Ferry | 4,719 | 3,017.29 | 13,014 | 16 | 160 |
| Kittitas | 5 | 2.27 | | | |
| Okanogan | 177 | 115.17 | 820 | 12 | 849 |
| Stevens | 263 | 14.80 | 1,043 | 217 | 235,513 |
| Whatcom | 100 | 96.76 | 10 | 454 | |
| | 5,264 | 3,246.29 | 14,887 | 699 | 236,522 |
| Total, 1932 | 5,484 | 2,779.09 | 14,302 | 2,149 | 491,087 |

BY CLASSES OF ORE

| | | | | | |
|---|---|---|---|---|---|
| Dry and siliceous | 5,034 | 3,239.36 | 14,301 | 606 | 623 |
| Lead | 230 | 6.93 | 586 | 93 | 235,899 |

## REVIEW BY COUNTIES AND DISTRICTS

*Mine production of gold, silver, copper, lead, and zinc in Washington in 1933, by counties and districts, in terms of recovered metals*

| County and district | Mines producing | | Ore and old mill cleanings | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| | | | *Short tons* | | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| Asotin County: Snake River | | 6 | | $1,690 | 14 | | | | $1,695 |
| Benton County: | | | | | | | | | |
| Columbia River | | 1 | | 44 | | | | | 44 |
| Yakima River | | 1 | | 148 | | | | | 148 |
| Chelan County: | | | | | | | | | |
| Blewett | 2 | 4 | 2 | 673 | 3 | | | | 674 |
| Columbia River | | 1 | | 215 | 3 | | | | 216 |
| Entiat | 2 | | 108 | 648 | 17 | | | | 654 |
| Wenatchee River | | 1 | | 393 | 3 | | | | 394 |
| Clallam County: Ozette | | 4 | | 1,150 | 9 | | | | 1,153 |
| Douglas County: Columbia River | | 2 | | 88 | | | | | 88 |
| Ferry County: | | | | | | | | | |
| Belcher | 1 | | 2 | 55 | 9 | | | | 58 |
| Columbia River | | 5 | | 1,419 | 6 | | | | 1,421 |
| Curlew | | 1 | | 38 | | | | | 38 |
| Keller | 1 | | 1 | 130 | 34 | 16 | 160 | | 149 |
| Republic | 8 | 2 | 4,716 | 62,252 | 12,971 | | | | 66,792 |
| Garfield County: Snake River | | 1 | | 47 | | | | | 47 |

*Mine production of gold, silver, copper, lead, and zinc in Washington in 1933, by counties and districts, in terms of recovered metals*—Continued

| County and district | Mines producing | | Ore and old mill cleanings | Gold | Silver | Copper | Lead | Zinc | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| | | | *Short tons* | | *Fine ounces* | *Pounds* | *Pounds* | *Pounds* | |
| Grant County: Columbia River | | 1 | | $89 | | | | | $89 |
| King County: Tolt River | | 1 | | 48 | | | | | 48 |
| Kittitas County: | | | | | | | | | |
| Fish Lake | 1 | | 5 | 47 | | | | | 47 |
| Swauk | 4 | 4 | 35 | 6,107 | 151 | | | | 6,160 |
| Lincoln County: Columbia River | | 3 | | 3,710 | 20 | | | | 3,717 |
| Okanogan County: | | | | | | | | | |
| Cascade | 3 | | 103 | 1,424 | 94 | | | | 1,457 |
| Columbia River | | 2 | | 689 | 6 | | | | 691 |
| Conconully | 1 | | 11 | 5 | 109 | | 485 | | 61 |
| Meyers Creek | 1 | 4 | 50 | 2,677 | 37 | | | | 2,690 |
| Palmer Mountain | 3 | | 103 | 798 | 634 | 32 | 489 | | 1,040 |
| Similkameen | | 4 | | 1,208 | 14 | | | | 1,213 |
| Squaw Creek | 1 | | 2 | 19 | | | | | 19 |
| Pend Oreille County: Metaline | 1 | 3 | 48,479 | 385 | 3,263 | 5,062 | 1,443,783 | 6,738,169 | 338,274 |
| Snohomish County: | | | | | | | | | |
| Skykomish River | | 2 | | 530 | 3 | | | | 531 |
| Sultan River | | 3 | | 982 | 11 | | | | 986 |
| Stevens County: | | | | | | | | | |
| Big Sheep Creek | | 1 | | 58 | | | | | 58 |
| Columbia River | | 5 | | 711 | 6 | | | | 713 |
| Kettle Falls | 1 | | 3 | 53 | 509 | | | | 231 |
| Northport | 3 | 1 | 227 | 2,132 | 531 | 77 | 235,513 | | 11,037 |
| Orient | 2 | | 33 | 250 | 23 | 140 | | | 267 |
| Whatcom County: Slate Creek | 2 | 2 | 104 | 2,334 | 23 | 454 | | | 2,371 |
| Whitman County: Snake River | | 4 | | 782 | 11 | | | | 786 |
| Yakima County: Summit | | 1 | | 291 | 6 | | | | 293 |
| Total Washington | 37 | 70 | 53,984 | 94,319 | 18,520 | 5,781 | 1,680,430 | 6,738,169 | 446,350 |

## ASOTIN COUNTY

The production in Asotin County in 1933 was all placer gold and a little silver from bars along the Snake River.

## BENTON COUNTY

Small lots of placer gold were marketed in 1933 from operations on the Columbia River near Allard and the Yakima River near Kennewick.

## CHELAN COUNTY

Placer gold and a little silver were recovered in 1933 by various operators on the Columbia and Wenatchee Rivers.

*Blewett and Peshastin district.*—Most of the output of the district in 1933 was placer gold from claims on Peshastin Creek; a little gold ore from two claims near Blewett was treated by amalgamation.

*Entiat district.*—Siliceous gold ore from the Rex and Sunshine properties near Entiat was treated in 1933 by amalgamation.

## CLALLAM COUNTY

The production in Clallam County in 1933 was all placer gold and silver recovered from beach sands, chiefly near Ozette.

### DOUGLAS COUNTY

A little placer gold was recovered in 1933 from bars on the Columbia River.

### FERRY COUNTY

*Columbia River district.*—Placer bullion was marketed in 1933 from five properties on the Columbia River, including the Rogers Bar, Wilmott Bar, Davis, and White Stone locations.

*Republic district.*—Eight lode mines and two placers in the Republic district produced 4,716 tons of ore, 3,011.44 ounces of gold, and 12,971 ounces of silver in 1933. The entire output from lode mines was siliceous gold ore of smelting grade, and nearly all of it was shipped to Trail, British Columbia, for smelting. The Old Gold mine was the largest producer in Washington, followed by the Mountain Lion and Knob Hill properties; other producing lode mines were the Surprise, Last Chance, El Caliph, Ben Hur, and Blaine-Republic. From 1896 to the end of 1933 the district produced 717,600 tons of ore and old tailings, $8,805,191 in gold, 2,608,465 ounces of silver, and 236 pounds of lead, valued in all at $10,434,115.

### GARFIELD, GRANT, AND KING COUNTIES

The entire production from Garfield, Grant, and King Counties in 1933 was placer gold; it came from the Snake River, Garfield County; Columbia River, Grant County; and Tolt River, King County.

### KITTITAS COUNTY

*Swauk district.*—Siliceous gold ore from four properties in the Swauk district, including the Mountain Daisy, Sunrise, and Golden Eagle mines, was treated in 1933 by amalgamation; most of the output was gold from the Mountain Daisy property. Placer gold was produced at four properties also, including the Golden Rule and Swauk placers; the dredge of the Swauk Mining & Dredging Co. was idle.

### LINCOLN COUNTY

The Clark Diggings—placer claims on the Columbia River 15 miles north of Wilbur—were operated in 1933 from March 12 until December 16, and $4,657 was received for the placer bullion marketed. Placer gold was also produced from two other claims near Wilbur.

### OKANOGAN COUNTY

*Cascade district.*—Siliceous gold ore of smelting grade from the Golden Axe and Bodie properties was shipped in 1933 to Trail, British Columbia.

*Columbia River district.*—Placer gold was marketed in 1933 from two operations on the Columbia River near Kartar and Pateros.

*Meyers Creek and Mary Ann Creek district.*—The Ottia May, Don Mooney, and various small placers in the district yielded bullion valued at $2,090; most of the output came from the Ottia May placer. The Poland China lode mine was also operated in 1933; siliceous gold ore was treated by amalgamation and concentration, and first-class gold ore was shipped to smelters.

*Palmer Mountain district.*—Siliceous gold ore from the Hiawatha mine was treated in 1933 by amalgamation and concentration, gold ore and lead ore from the Premier mine were shipped to a smelter, and gold ore from the Triune (Crescent) property was concentrated; the concentrates and some crude ore were shipped for smelting.

*Similkameen district.*—The production (all placer) of the Similkameen district in 1933 was $1,208 in gold and 14 ounces of silver. Most of the output came from the Vancouver property near Oroville, operated by the Vancouver Mines, Inc., which handled approximately 1,000 cubic yards of material by a drag-line dredge.

## PEND OREILLE COUNTY

*Metaline district (Metaline Falls).*—The entire output of the Metaline district, except a little placer bullion from operations on the Pend Oreille River, was lead-zinc ore from the Josephine mine of the Pend Oreille Mines & Metals Co. Operations were resumed at the mine and 300-ton flotation plant (both idle since May 1, 1932) on June 1, 1933, and 48,479 dry tons of ore was mined and milled by the end of the year. The mine was the only producer of zinc in Washington in 1933 and was by far the largest producer of lead. The ore yielded 6,086 dry tons of zinc concentrates, averaging 61.51 percent zinc, and 1,076 dry tons of lead concentrates.

## SNOHOMISH COUNTY

The entire output from Snohomish County in 1933 was placer bullion from operations on the Skykomish and Sultan Rivers. The Skykomish Placer Mines, Inc., was organized to take over a large area of placer ground on the Skykomish River at Goldbar and was reported to be actively developing the ground for operations.

## STEVENS COUNTY

*Columbia River district.*—Placer operations in 1933 at various places on the Columbia River in Stevens County produced $711 in gold and 6 ounces of silver.

*Northport district.*—Lessees operated the Electric Point, Gladstone Mountain, and United Treasure lode mines in the Northport district in 1933 and shipped 227 tons of high-grade lead ore to the smelters at Bradley, Idaho, and East Helena, Mont. The output of ore was less than in 1932. Nearly all the gold produced in the district in 1933 came from a placer on Nigger Creek.

*Orient district.*—One car of gold ore from the Father Lode and a test lot of similar ore from the White Bear property were shipped to smelters.

## WHATCOM COUNTY

*Mount Baker district (Sumas).*—The Boundary Red Mountain mine in Whatcom County near Sardis, British Columbia, was idle in 1933. Except in 1919, 1920, and 1926 the mine has been a large producer of gold since 1914.

*Slate Creek district.*—The Azurite Gold Mining Co. treated gold ore in a 30-ton Mace furnace and shipped the resulting copper matte (15 tons) to Tacoma in 1933 for smelting. A little placer gold was also marketed from the district.

### WHITMAN COUNTY

*Snake River (Riparia) district.*—Placer operators at various places on the Snake River, chiefly at Riparia, produced $782 in gold and 11 ounces of silver in 1933.

### YAKIMA COUNTY

*Summit district.*—Lessees operated placer claims of the Gold Hill Consolidated Mining Co. and sold about 20 ounces of bullion in 1933 to the San Francisco Mint.

# GOLD, SILVER, COPPER, AND LEAD IN WYOMING

(MINE REPORT)

By Chas. W. Henderson

SUMMARY OUTLINE



The total output of the metal mines in Wyoming in 1933 (not including iron mines), in terms of recoverable metals, was 2,199.95 fine ounces of gold and 260 fine ounces of silver compared with 256.63 ounces of gold, 195 ounces of silver, 397 pounds of copper, and 9,800 pounds of lead in 1932. The E. T. Fisher Co., operating a special sluicing installation in Rock Creek east of Atlantic City, Fremont County, produced 80 percent of the total gold and 74 percent of the total silver in 1933; there were 19 other producing placer operations in the State in 1933. The number of producing lode mines decreased from 10 in 1932 to 4 in 1933, but the output of lode gold increased from 177.44 ounces in 1932 to 366.73 ounces in 1933. All the ore was classified as dry gold ore, and the gold and silver were recovered in the form of amalgam bullion, except 118.94 ounces of gold and 17 ounces of silver contained in 39 tons of dry gold concentrates shipped from a mill near Atlantic City to a smelter at Midvale, Utah.

The total recorded production of gold, silver, copper, and lead (in terms of recovered metals) in Wyoming from 1867 to 1933, inclusive, has been 62,965 fine ounces of gold, 70,791 fine ounces of silver, 32,633,559 pounds (revised figures) of copper, and 9,800 pounds of lead.

*Premium on newly mined gold.*—There were four epochs of gold prices for newly mined gold in the United States in 1933: (1) The period of the legal coinage value of $20.671835, from January 1 to August 9 to all producers; (2) that of (*a*) $20.671835 to the majority of producers and (*b*) the fluctuating world price as secured by export by some producers, to August 29; (3) the period of fluctuating world price as secured through the agency of the Federal Reserve banks, to October 25 (period of actual bank sales, from September 8 to November 1); and (4) the period of the Reconstruction Finance Corporation arbitrarily fixed, gradually rising price (generally above the world price), from October 25 to December 31, 1933. For further details see chapter of this volume on Gold and Silver (pp. 25 to 52), by Chas. W. Henderson.

Following is a table on mine production of gold in Wyoming, 1929–33, in terms of recovered metal; two values are given for 1933—(1) at legal coinage value ($20.67+ per ounce) and (2) at average weighted price ($25.56 per ounce).

*Mine production of gold in Wyoming, 1929–33, in terms of recovered metal*

| Year | Fine ounces | Value [1] | Year | Fine ounces | Value [1] |
|---|---|---|---|---|---|
| 1929 | 48.13 | $995 | 1932 | 256.63 | $5,305 |
| 1930 | 443.02 | 9,158 | 1933 | 2,199.95 | [2] 45,477 |
| 1931 | 56.36 | 1,165 | | | [3] 56,231 |

[1] 1929–32: At legal value ($20.67+ per ounce); 1933: At both legal coinage value ($20.67+ per ounce) and average weighted price ($25.56 per ounce).
[2] At legal coinage value ($20.67+ per ounce).
[3] At average weighted price ($25.56 per ounce).

*Calculation of value of metal production.*—The value of metal production hereinafter reported 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, 1929–33*

| 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* |
| 1929 | $0.533 | $0.176 | $0.063 | $0.066 | 1932 | $0.282 | $0.063 | $0.030 | $0.030 |
| 1930 | .385 | .130 | .050 | .048 | 1933 | .350 | .064 | .037 | .042 |
| 1931 | .290 | .091 | .037 | .038 | | | | | |

*Mine production of gold, silver, copper, and lead in Wyoming, 1929–33, in terms of recovered metals*

| Year | Ore (short tons) | Gold (lode and placer) | | Silver (lode and placer) | | Copper | | Lead | | Total value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Fine ounces | Value | Fine ounces | Value | Pounds | Value | Pounds | Value | |
| 1929 | 143 | 48.13 | $995 | 26 | $14 | 4,301 | $757 | | | $1,766 |
| 1930 | 1,285 | 443.02 | 9,158 | 122 | 47 | 11,600 | 1,508 | | | 10,713 |
| 1931 | 23 | 56.36 | 1,165 | 17 | 5 | 9,000 | 819 | | | 1,989 |
| 1932 | 640 | 256.63 | 5,305 | 195 | 55 | 397 | 25 | 9,800 | $294 | 5,679 |
| 1933 | 1,071 | 2,199.95 | 45,477 | 260 | 91 | | | | | 45,568 |

*Mine production of gold and silver in Wyoming in 1933, by counties, in terms of recovered metals* [1]

| County | Mines producing | | Ore sold or treated | Gold | | | Silver | | | Total value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | Lode | Placer | Total | Lode | Placer | Total | |
| | | | *Short tons* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | *Fine ounces* | |
| Albany | 2 | | 5 | 4.02 | | 4.02 | | | | $83 |
| Big Horn | | 1 | | | 1.79 | 1.79 | | | | 37 |
| Carbon | | 1 | | | 6.24 | 6.24 | | | | 129 |
| Fremont | 2 | 13 | 1,066 | 362.71 | 1,785.86 | 2,148.57 | 60 | 195 | 255 | 44,504 |
| Park | | 3 | | | 26.56 | 26.56 | | 2 | 2 | 550 |
| Sheridan | | 1 | | | 2.13 | 2.13 | | 2 | 2 | 45 |
| Teton | | 1 | | | 10.64 | 10.64 | | 1 | 1 | 220 |
| | 4 | 20 | 1,071 | 366.73 | 1,833.22 | 2,199.95 | 60 | 200 | 260 | 45,568 |

[1] No copper, lead, or zinc produced in Wyoming in 1933.

## REVIEW BY COUNTIES AND DISTRICTS

### ALBANY COUNTY

*Centennial and La Plata districts.*—A small shipment of gold concentrates was made in 1933 to the Golden Cycle mill at Colorado Springs, Colo., by lessees who made a test run of the 35-ton concentrating mill at the Utopia group of claims 1 mile west of Centennial.

*Douglas Creek district (Holmes, Keystone).*—One ton of gold ore, extracted by lessees while doing development work and extending one of the adits on the Gold Crater group of claims in the Douglas Creek district, was sold to the Boulder Ore Sampling Works, at Boulder, Colo.

### BIG HORN COUNTY

A miner working in the Big Horn Mountains north of Kane recovered the placer gold credited to Big Horn County in 1933.

### CARBON COUNTY

No production was made from lode mines in Carbon County in 1933, but a sluicing operation at the Working Boy placer in Strawberry Gulch near Savery Creek yielded 6.24 fine ounces of placer gold.

### FREMONT COUNTY

*Atlantic City district.*—The Atlantic City district produced 98 percent of the total output of both gold and silver from Wyoming mines in 1933. Placer mines, principally the E. T. Fisher Co. operation on Rock Creek, yielded 83 percent of the district total. The Fisher apparatus is a sluicing machine mounted on a movable track and fed with gravel by a 1½-cubic yard drag-line shovel; the shovel, pump, and machine were operated by gasoline engines. Twelve other placers worked by rockers and sluices yielded a total of 31.19 ounces of gold and 2 ounces of silver. Producing lode mines were the McGrath or "1914"-Sullivan property, from which were shipped the products of its mill—gold-silver bullion to the Denver Mint and concentrates to the Midvale (Utah) smelter—and the Duncan, from which gold-silver bullion was shipped to the Denver Mint.

### PARK COUNTY

Panning, rocking, and sluicing operations on Clark Fork and tributaries near Clark, south of the Montana-Wyoming boundary line, resulted in recovery of the placer bullion sold from Park County in 1933.

### SHERIDAN COUNTY

Four men working the Rocky Fall placer claim about 3 miles from the head of Little Big Horn River in 1932 recovered 3.99 crude ounces of placer bullion, with a fineness of 0.539 in gold and 0.442 in silver. The product was not sold until 1933 and is therefore credited as production for 1933.

### TETON COUNTY

A small, special placer installation at the Inspiration claim on the Snake River 5 miles from Moran yielded placer gold which was marketed through a merchant at Moran.

# SECONDARY METALS

By J. P. Dunlop [1]

## SUMMARY OUTLINE



The total value of certain nonferrous metals, for which the quantity recovered from secondary sources is reported to the Bureau of Mines, was $101,268,800 in 1933, $36,246,000 more than in 1932; the total quantity increased 176,600 short tons. The increase in total value was due partly to higher average prices for the metals, other than nickel and aluminum; but the recovery of each secondary metal also increased.

*Secondary metals of certain classes recovered in the United States, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| Copper, including that in alloys other than brass | 187,700 | $23,650,200 | 247,100 | $31,628,800 |
| Brass scrap re-treated | 86,400 | 8,916,500 | 130,000 | 14,378,000 |
| Lead as metal | 128,000 | 11,898,000 | 131,800 | 16,613,000 |
| Lead in alloys | 70,300 | | 92,700 | |
| Zinc as metal | 20,000 | 1,578,000 | 48,100 | 4,678,800 |
| Zinc in alloys other than brass | 6,300 | | 7,600 | |
| Tin as metal | 4,650 | 6,248,100 | 7,250 | 16,508,700 |
| Tin in alloys and chemical compounds | 10,100 | | 14,850 | |
| Aluminum as metal | 12,200 | 10,992,000 | 14,500 | 15,343,000 |
| Aluminum in alloys | 11,800 | | 19,000 | |
| Antimony as metal and in alloys | 6,450 | 725,000 | 7,400 | 963,500 |
| Nickel as metal | 200 | 1,015,000 | 300 | 1,155,000 |
| Nickel in nonferrous alloys and salts | 1,250 | | 1,350 | |
| | 545,350 | 65,022,800 | 721,950 | 101,268,800 |

*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,

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

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.

An editorial in Metal Industry points out that secondary metals are an ever-increasing factor in the metal market.[2]

## 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 16,380,604 fine ounces of silver and 975,471 fine ounces of gold from waste or discarded material in 1933. There was a decrease of about 99,000 ounces in gold.

Jewelry and dental waste furnish the largest quantity of secondary gold,[3] and silverware and photographic waste furnish the largest quantity of secondary silver. The consumption of silver in the photographic industry in the United States is estimated at 6,000,000 fine ounces in 1933 compared with 5,182,400 ounces in 1932. It is stated that about a million feet of old film yields 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 publications shows that an enormous quantity of such ferrous material is salvaged and reused.

To ascertain the approximate quantities of waste material marketed which are not included in the classes for which figures are available at any responsible source, the National Association of Waste Material Dealers, Inc., has distributed a questionnaire asking dealers to give the tonnage of all classes of waste material handled in 1932 and in the first 6 months of 1933.

Rural collections of scrap metals remained comparatively small, though they were larger than in 1932. The main increase in secondary metals marketed occurred in the latter half of 1933, when industrial urban centers had a spurt of activity. The tendency to eliminate small secondary metal plants and to concentrate the industry in larger units continued in 1933. Many large smelters of primary ore, bullion, and concentrates are increasingly competitive purchasers of scrap metals and drosses. A paper prepared for the American Institute of Mining and Metallurgical Engineers by W. A. Scheuch, works mana-

[2] Metal Industry, Scrap Versus New Metal: September 1933, pp. 312–313.
[3] Hoke, C. M., The Buying and Selling of Old Gold: Metal Industry, February 1933, pp. 55–59.

ger of the Nassau Smelting & Refining Co., Tottenville, N.Y., includes the following statements:

> Reports on process developments have not been released by the large domestic smelters and refiners, who are not only investigating secondary materials as a source of raw material but also are basing their future plant operations on the use of a definite proportion of such material. The laboratory investigations on nonferrous alloys from secondary sources have been brought to a stage where it can be stated that the alloys so produced are commercially of a quality equal to the same alloys produced by direct alloying of the constituent metals themselves.

The proportion of secondary to primary metals may rise very sharply in times of low consumption, especially of copper and lead. It is probable that secondary metals are destined to form a larger proportion of the metals used in industry and that the influence of this secondary production will have a growing significance to mine operators. This has been shown to some extent in the difficulty of adopting a code for the copper industry that would regulate the volume of secondary copper marketed.

An editorial in Metal Industry[4] states that one factor in this problem was discussed in the report of President Hoover's Research Committee on Social Trends in the chapter on Utilization of Natural Wealth. The authors state that the stock of secondary material modifies the demand for primary metal and adds to the bargaining power of the larger consumers, who are also the largest producers of scrap, thus helping to stabilize prices.

The year 1933 opened very inauspiciously for those engaged in metal industries; prices were at the lowest ebb and consumption was at a minimum during the first quarter of the year. Both prices and consumption advanced too rapidly at the end of the second quarter, and both receded rapidly. Thereafter conditions improved and the market was more stable, so that on the whole 1933 was fairly prosperous for many dealers and smelters. Wide fluctuation in metal prices created opportunities for speculation. Waves of buying occasionally occurred, and some secondary metals were temporarily scarce. The price of heavy copper scrap ranged from 3.75 cents to 7.5 cents a pound in 1933; No. 1 composition scrap from 2.25 cents to 6 cents a pound; old scrap zinc from 1.125 cents to 3.185 cents a pound; cast aluminum scrap from 4 cents to 7.75 cents a pound; and heavy lead scrap from 2.25 cents to 4 cents a pound. The average weekly quotations for many scrap metals and alloys can be found in the Waste Trade Journal, the Waste Trade Review, and Metal Industry.

*Secondary copper and brass.*—The copper produced by smelters of secondary material in 1933 includes 107,600 tons of pig copper (part of which was electrolytically refined), 54,000 tons of copper in alloys other than brass, and 91,000 tons of copper in remelted brass; these figures indicate increases over 1932 of 27,300 tons in pig copper, 6,800 tons in copper in alloys other than brass, and 30,500 tons in copper contained in brass. Regular copper smelters produced about 25,000 tons more secondary copper in 1933 than in 1932.

The total value of secondary copper as metal and in brass and other alloys computed at 6.4 cents a pound—the average price in 1933 of all merchantable grades of new metal—was $43,276,800, about $12,006,100 more than in 1932.

[4] Metal Industry, Scrap Versus New Metal: September 1933, pp. 312–313.

Imports of brass scrap decreased 174 tons and those of scrap copper 1,081 tons. There was a very small increase in brass scrap exported and a decrease of 2,960 tons in the quantity of scrap copper exported.

*Secondary copper recovered in the United States, 1932–33, and imports and exports of brass and copper scrap, in short tons*

| | 1932 | 1933 |
|---|---|---|
| Copper as metal | [1] 140,500 | [1] 193,100 |
| Copper in alloys other than brass | 47,200 | 54,000 |
| | 187,700 | 247,100 |
| Copper from new scrap (not including brass) | 35,000 | 40,000 |
| Copper from old scrap (not including brass) | 152,700 | 207,100 |
| | 187,700 | 247,100 |
| Brass scrap remelted: | | |
| New clean scrap | 46,000 | 54,000 |
| Old scrap | 40,400 | 76,000 |
| | 86,400 | 130,000 |
| Copper content of brass scrap (averaging 70 percent copper): | | |
| New scrap | 32,200 | 37,800 |
| Old scrap | 28,280 | 53,200 |
| | 60,480 | 91,000 |

| | 1932 | 1933 |
|---|---|---|
| Total secondary copper (including copper content of brass scrap): | | |
| From new scrap | 67,200 | 77,800 |
| From old scrap | 180,980 | 260,300 |
| | 248,180 | 338,100 |
| As metal | 140,500 | 193,100 |
| In brass and other alloys | 107,680 | 145,000 |
| | 248,180 | 338,100 |
| Brass scrap imported | 1,259 | 1,085 |
| Scrap copper imported | 1,211 | 130 |
| Brass scrap exported | 15,073 | 15,348 |
| Scrap copper exported | 17,179 | 14,219 |

[1] Of these totals secondary copper reported by smelters and refiners that treat mainly primary metal comprised 60,227 tons in 1932 and 85,519 tons in 1933.

The terms "new brass scrap" and "new copper scrap", as applied in the preceding table, refer to the scrap that is accumulated in fabricating products; "old scrap" is the metal that was made into products and after service has been discarded and returned to be remelted or refined for further use. Few junkmen, dealers, or smelters keep any statistics of "old scrap" and "new scrap." Most of the new scrap is clippings, grindings, and defective articles made in the ordinary operations in fabricating goods, some of which is reused at the plant and the remainder sold. All foundries (many of which purchase scrap metals) are advised in the Bureau of Mines questionnaire to exclude all scrap made and used in their own plants and to give data solely on purchased scrap. Those that purchase only "new scrap" of certain grades and assay can give correct data; the others usually can make no distinction between "new" and "old" scrap. Secondary smelters usually cannot give exact figures but occasionally can estimate the proportion of "new" scrap metal treated. The figures given in the preceding table are the best obtainable.

Another less familiar definition of "new scrap" is as follows: New scrap metal is that part of the sales or shipments of primary metals (improperly and erroneously termed "consumption") which does not go into products but which is almost inevitably returned by fabricators of metallic articles to plague the sellers of "primary metals." This definition may be obnoxious to some, as it conveys the insinuation that sometimes "consumption" is overestimated.

Railroads probably disposed of more scrap metals in 1933 than in 1932, but the quantity was much less than in 1928 and 1929. Reports for 1933 show that railroads reused at their shops and foundries the following quantities of scrap metals: 1,600 tons of brass; 1,570 tons of copper; 12,138 tons of copper in alloys other than brass; 1,000 tons of tin in babbitt, solder, and bronze; and 3,500 tons of lead in various alloys. In general there do not appear to be any large accumulations of scrap copper and brass at most fabricating plants or dealers' yards, though it is reported that there are extensive stocks at yards of the utility, electric, and automobile companies.

*Secondary lead.*—The output of secondary lead in 1933 equaled 82 percent of the total production of refined primary lead in the United States, compared with 69 percent in 1932. Much recovered lead is derived from old batteries, pipe, sheet, and lead-covered cable; other sources are solder, babbitt, and shot. Very little was heard of rebuilt batteries in 1933, and it is probable that fewer old batteries were repaired and sold instead of being shipped to smelters. The American Bureau of Metal Statistics estimates that 11,200,000 automobile batteries were made in 1933 or 1,200,000 more than in 1932 but about 4,800,000 less than in 1929. The total lead (as oxide or metal) and antimony content of automobile batteries is figured as 147,000 tons compared with 138,000 tons in 1932.

Secondary lead recovered by smelters whose product is mainly primary metal increased 8,021 tons in 1933. The output of pig lead by secondary smelters decreased 4,221 tons, and lead in scrap alloys increased 24,750 tons.

*Secondary lead recovered in the United States, 1932–33, in short tons*

| | 1932 | 1933 |
|---|---|---|
| Secondary lead recovered by smelters that treat mainly ore | 33, 611 | 41, 632 |
| Secondary lead recovered by smelters that treat only scrap and drosses | 94, 389 | 90, 168 |
| | 128, 000 | 131, 800 |
| Secondary lead recovered in remelted alloys: | | |
| Estimated secondary lead content of antimonial lead produced at regular lead smelters | 13, 486 | 11, 136 |
| Lead content of drosses and scrap alloys treated at secondary smelters | 56, 814 | 81, 564 |
| | 70, 300 | 92, 700 |
| Total secondary lead recovered | 198, 300 | 224, 500 |

*Refined primary lead produced in the United States, 1932–33, in short tons*

| | 1932 | 1933 |
|---|---|---|
| From domestic ore | 255, 337 | 259, 616 |
| From foreign ore and base bullion | 33, 024 | 13, 963 |

The collection of old discarded batteries was good in urban areas but only fair in rural areas. The active demand from smelters stimulated collection and shipment where car lots could be gathered. Probably not more than 65 to 70 percent of discarded batteries were returned from rural areas, but the collections from large cities and from areas near smelting plants was probably 75 to 85 percent. In 1930 and 1931 discarded automobile batteries were normally returned as scrap after about 22 months' use. In 1933 this use seems to have extended to about 30 months. It is estimated that about 111,000 to 120,000 tons of old battery plates and oxide were available in 1933. The average lead and antimony content of each automobile battery, which had declined to 24.6 pounds in 1931 and 1932, increased to 25.1 pounds in 1933 owing to the increased installation of radio equipment in automobiles.

A number of secondary smelters treating old batteries and other lead alloys now recover most of the lead as good-grade pig lead. The residues and drosses containing antimony are then used in making hard lead containing various percentages of antimony.

The changing conditions in the buying and marketing of secondary lead and the rivalry of secondary and primary smelters in the purchase of scrap lead and lead alloys are aptly described in an article by Tzach.[5] The lead mines felt the competition of secondary lead very keenly in 1933 because the quantity of scrap lead re-treated is very important when the consumption for the United States is at such a low ebb.[6]

*Secondary zinc.*—Secondary zinc recovered as pig metal and in alloys (including brass) increased 40,300 tons in 1933, largely in redistilled and remelted zinc from drosses which were more plentiful in 1933 than in 1932, though still much below the quantity available some years ago. The quantity of remelted brass increased from the abnormally small quantity treated in 1932, and the zinc content of brass was 10,900 tons greater in 1933 than in 1932. The total recovery of secondary zinc (including that in brass) equaled 28.7 percent of the total output of primary slab zinc in the United States (307,182 tons) in 1933.

*Secondary zinc [1] recovered in the United States, 1932–33, and products made from zinc dross, skimmings, and ashes, in short tons*

| | 1932 | 1933 |
|---|---|---|
| Secondary zinc recovered by redistillation | 14,718 | 30,087 |
| Secondary zinc recovered by sweating, remelting, etc | 5,282 | 18,013 |
| Total zinc recovered unalloyed | 20,000 | 48,100 |
| Zinc recovered in alloys other than brass | 6,300 | 7,600 |
| Zinc recovered in brass (estimated) | 21,600 | 32,500 |
| Zinc dust made from zinc dross | [2] 9,440 | 11,157 |
| Zinc dross used for zinc dust (estimated) | [2] 11,000 | 13,000 |
| Zinc concentrates and ore exported | ------ | } 809 |
| Zinc dross exported | 178 | } |
| Lithopone made from zinc skimmings and ashes | 58,225 | 56,521 |
| Secondary zinc content of lithopone | 11,910 | 11,288 |
| Zinc chloride made from zinc skimmings, ashes, etc | 23,193 | 30,370 |
| Zinc content of zinc chloride made from zinc skimmings, etc | 5,104 | 6,680 |
| Zinc content of zinc sulphate made from zinc skimmings, ashes, etc | 521 | 864 |

[1] Figures do not include scrap and dross used for lithopone, oxide, zinc dust, or chloride. The use for some of these, especially for zinc chloride, is large.
[2] Revised figures.

Zinc recovered by redistillation increased from 14,718 tons in 1932 to 30,087 tons in 1933. Of the 1933 total, 14,230 tons (an increase of 12,634 tons) were recovered at primary smelters from zinc drosses and 15,857 tons (an increase of 2,735 tons) at 5 plants employed large graphite retorts instead of small clay retorts, such as are used by smelters that treat zinc concentrates or mixed concentrates and

[5] Tzach, Samuel, Scrap and the Lead Market: Eng. and Min. Jour., September 1933, pp. 371–373.
[6] Cornell, I. H., Looking Back at the 1933 Lead Market: Nat. Waste Review, February 1934, pp. 13–14.

drosses. Two smelters using clay retorts treated only drosses and residues in 1933 and one smelter equipped with graphite retorts was idle in 1933.

The five active zinc smelters using large graphite retorts in 1933 were:

Federated Metals Corporation, Trenton, N.J.
General Smelting Co., Philadelphia, Pa.
Nassau Smelting & Refining Co., Tottenville, N.Y.
Superior Zinc Corporation, Bristol, Pa.
Wheeling Steel Corporation, Wheeling, W.Va.

Of the total output of 138,151 tons of lithopone in 1933, 56,521 tons containing 11,288 tons of zinc were made from zinc skimmings and ashes.

The quantity of zinc chloride made in 1933 was 30,822 tons, of which 30,370 tons containing 6,680 tons of zinc were from zinc residues.

The American Bureau of Medal Statistics estimates that 148,000 tons of zinc (39,000 tons more than in 1932) was used in 1933 in zincking (galvanizing) sheets, forms, tubes, wire, and other materials.

*Secondary tin.*—Secondary tin recovered amounted to 22,100 short tons valued at $16,508,700 in 1933 compared with 14,750 tons valued at $6,248,100 in 1932. The total value assigned is based on the yearly average price (37.35 cents a pound in 1933 and 21.18 cents in 1932) given by the American Metal Market for 99 percent metal, prompt delivery at New York. The total recovered increased 7,350 tons, 4,750 tons being in tin in alloys. Recovery of tin from scruff and drosses increased from about 3,400 tons in 1932 to 4,600 tons in 1933.

Secondary tin recovered in 1933 was equivalent to about 31 percent of the tin imported into the United States as pig metal in 1933.

According to the American Iron and Steel Institute the quantity of tin plate and terneplate made in 1933 was 1,769,098 long tons (736,591 tons more than in 1932). It is estimated that 28,900 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, 1932–33*

| | 1932 | 1933 |
|---|---|---|
| Tin recovered as pig tin ........ short tons | 4,650 | 7,250 |
| Tin recovered in alloys and chemical compounds ........ do | 10,100 | 14,850 |
| | 14,750 | 22,100 |
| Clean tin-plate scrap treated at detinning plants ........ long tons | 132,894 | 155,844 |
| Metallic tin recovered at detinning plants ........ pounds | 1,406,675 | 1,876,642 |
| Tin content of tin tetrachloride, tin bichloride, tin crystals, and tin oxide made at detinning plants ........ pounds | 3,536,107 | 4,015,259 |
| Total tin recovered at detinning plants ........ do | 4,942,782 | 5,891,901 |
| Tin tetrachloride, tin bichloride, tin crystals, and tin oxide made at detinning plants ........ pounds | 7,540,318 | 8,640,013 |
| Average quantity of tin recovered per long ton of clean tin-plate scrap ........ do | 37.2 | 37.8 |

*Tin (metal) and tin concentrates (tin content) imported into the United States, 1932–33, in short tons*

| | 1932 | 1933 |
|---|---|---|
| Tin imported as metal | 38,998 | 71,364 |
| Tin concentrates (tin content) imported | 19 | 27 |

The quantity of tin-plate clippings treated at detinning plants increased about 22,950 long tons in 1933, and the average cost of such clippings delivered at plants increased from $5.60 a long ton in 1932 to $6.83 a ton in 1933. These clippings were treated at plants of the Vulcan Detinning Co. at Sewaren, N.J., Neville Island, Pa., and Streator, Ill.; by the Johnston & Jennings Co. of Cleveland, Ohio; and at the plants of the Metal & Thermit Co., at South San Francisco, Calif., East Chicago, Ind., and Chrome, N.J.

Tin-plate clippings imported in 1932 totaled 6,094 long tons, but the imports for 1933 are not available and probably were less than in 1932, for it is reported that some tin-plate clippings normally shipped to the United States from Canada were diverted to Japan in 1933.

The exports of iron and steel scrap (including clean tin-plate clippings) in 1933 were 773,406 long tons, about half of which were shipped during the last 4 months. The purchase of tin-plate clippings for shipment to Japan was especially large in this period. Evidently this fact is responsible for a bill recently introduced in the House of Representatives prohibiting the export of all scrap material containing tin from which the tin can be recovered by detinning or other reclamation process except on a permit from the Secretary of War in each case for specified quantities.

The tin reported recovered in alloys and compounds in 1933 included the tin content of products made from clean tin-plate scrap. Most of the tin recovered at the plants listed was in tin bichloride, tin crystals, tin tetrachloride, and tin oxide.

The total recovery of tin as metal or in compounds from clean tin-plate scrap in 1933 was 2,946 short tons, whereas it is estimated that makers of tin plate and terneplate consumed more than 32,000 short tons of tin.

Apparently no old tin-coated containers were used in 1933 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 recovery of secondary aluminum, including that in alloys, totaled 33,500 short tons valued at $15,343,000 compared with 24,000 tons valued at $10,992,000 in 1932. The value in both 1932 and 1933 is computed at 22.9 cents a pound, the average yearly quotation for 98- to 99-percent ingot aluminum.

The value of primary aluminum produced in the United States declined from $20,453,000 in 1932 to $16,174,000 in 1933, owing to a decrease of about 19 percent in output.

*Secondary aluminum recovered in the United States, 1932–33, in short tons*

| | 1932 | 1933 |
|---|---|---|
| Secondary aluminum recovered unalloyed | 12,200 | 14,500 |
| Aluminum recovered in alloys (mainly No. 12) | 11,800 | 19,000 |
| | 24,000 | 33,500 |

*Primary aluminum produced in the United States and imported and exported, 1932–33, in pounds*

| | 1932 | 1933 |
|---|---|---|
| Primary aluminum produced in the United States | 104,885,000 | 85,126,000 |
| Aluminum (crude and semicrude) imported for consumption | 8,184,713 | 15,270,459 |
| Aluminum (crude and semicrude) exported | 4,436,690 | 5,707,661 |

A large number of alloys containing aluminum contribute to the secondary aluminum recovered, but No. 12 (a mixture of about 92 percent aluminum and 8 percent copper) constitutes the largest supply of material for remelting and refining. Other alloys are numerous but are used in smaller quantities. Many automobile aluminum crankcases are sold to foundries and do not reach the secondary smelters. Foundries operated at a reduced rate. It is stated that the automobiles made during 1931 and 1932 did not yield as much scrap aluminum as in former years and that alloy aluminum scrap was rather scarce late in 1933, when factories increased their output after a long period of low rate of operations.

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 [7] by Anderson is interesting to smelters and users of secondary aluminum.

The market for mixed cast-aluminum alloys was generally weak early in 1933 but rather active in the fall. Prices for scrap cast aluminum ranged from 4 cents a pound in February to as high as 7.75 cents in July.

*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, most of which was recovered in alloys, increased 14.7 percent from 1932 to 1933. The average price for ordinary brands of antimony, as stated by the American Metal Market, was 6.51 cents a pound in 1933, compared with 5.62 cents in 1932. Smelters that ordinarily use primary ores, concentrates, or metal reported 1,720 tons of antimony as contained in 17,805 tons of antimonial lead. The recovery of secondary antimony by secondary smelters increased 1,567 tons in 1933.

[7] Anderson, R. J., Secondary Aluminum: The Sherwood Press, Inc., Cleveland, Ohio, 1931, 563 pp.

Imports of antimony in ore, as metal, or in oxide were 1,736 tons larger in 1933 than in 1932 but 4,621 tons less than in 1931.

*Secondary antimony recovered in and antimony imported into and exported from the United States, 1932–33, in short tons*

| | 1932 | 1933 |
|---|---|---|
| Secondary antimony in antimonial lead scrap smelted at regular smelters | 1,410 | 793 |
| Secondary antimony recovered at secondary smelters | 5,040 | 6,607 |
| | 6,450 | 7,400 |
| Antimony imported in ore, as metal, or as oxide or salts | 3,742 | 5,478 |
| Foreign antimony exported | 123 | 98 |

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. Part of the batteries are smelted on toll charged by the custom smelters. This toll had a considerable range in 1933, but on the whole it was less than in former years.

*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, again expanded in 1933.

The secondary nickel reported as recovered in 1933 came mainly from scrap-nickel anodes, nickel silver, copper-nickel alloys, and Monel metal. Nickel is also used in white gold, and in aluminum and zinc alloys for die castings. In 1932, 1,030 tons of nickel and alloys containing nickel were purchased and exported to Europe for smelting. No comparable figures are available for 1933, but the export demand was active and the number of buyers and exporters of such scrap increased so that the quantity exported in all probability exceeded the exports in 1932. The quantity of nickel produced as a byproduct from the electrolytic refining of copper was 69 tons less in 1933 than in 1932.

*Secondary nickel recovered in the United States, 1932–33, in short tons*

| | 1932 | 1933 |
|---|---|---|
| Nickel recovered as metal | 200 | 300 |
| Nickel recovered in nonferrous alloys and salts | 1,250 | 1,350 |
| | 1,450 | 1,650 |

*Primary nickel produced in the United States and imported and exported, 1932–33, in short tons*

| | 1932 | 1933 |
|---|---|---|
| Nickel produced as a byproduct from the electrolytic refining of copper at domestic refineries | 195 | 126 |
| Nickel imported for consumption in the United States as nickel or in nickel ores and matte, oxide, and alloys | 10,815 | 26,430 |
| Nickel, Monel metal, and other alloys exported | 1,030 | 755 |

Analyses of various nickel alloys were published in Mineral Resources for 1915.[8] Considerable information as to the uses of nickel, Monel metal, and other nickel alloys is given in Inco and in special pamphlets on nickel and its various alloys, publications of the International Nickel Co. This company purchases nickel scrap and Monel scrap.

## CLASSIFICATION OF OLD METALS

The classification of old metals drawn up by the metals division of the National Association of Waste Material Dealers, Inc., Times Building, New York, N.Y., and changed from time to time as desirable, is the standard of both dealers and manufacturers in the United States. The latest classification (Circular M), effective March 16, 1932, follows.

### Standard Classification for Old Metals, Effective from March 16, 1932

1. *Delivery.*—(*a*) Delivery of more or less of the specified quantity up to 1¼ percent is permissible.

(*b*) If the term "about" is used, it is understood that 5 percent more or less of the quantity may be delivered.

(*c*) Should the seller fail to make deliveries as specified in the contract, the purchaser has the option of canceling all of the uncompleted deliveries or holding he seller for whatever damages the purchaser may sustain through failure to deliver, and if unable to agree on the amount of damages an arbitration committee of the National Association of Waste Material Dealers, Inc., appointed for this purpose, to determine the amount of such damages.

(*d*) In the event that buyer should claim the goods delivered on a contract are not up to the proper standard, and the seller claims that they are a proper delivery, the dispute shall be referred to an arbitration committee of the National Association of Waste Material Dealers, Inc., to be appointed for that purpose.

(*e*) A carload, unless otherwise designated, shall consist of the weight governing the minimum carload weight at the lowest carload rate of freight in the territory in which the seller is located. If destination of material requires a greater carload minimum weight, buyer must so specify.

(*f*) A ton shall be understood to be 2,000 pounds unless otherwise specified. On material purchased for direct foreign shipment a ton shall be understood to be a gross ton of 2,240 pounds unless otherwise specified.

(*g*) If, through embargo, a delivery cannot be made at the time specified, the contract shall remain valid and shall be completed immediately on the lifting of the embargo, and terms of said contract shall not be changed.

(*g*–1) When shipments for export for which space has been engaged have been delivered or tendered to a steamship for forwarding and through inadequacy of cargo space the steamship cannot accept the shipment, or where steamer is delayed in sailing beyond its scheduled time, shipment on the next steamer from the port of shipment shall be deemed a compliance with the contract as to time of shipment.

(*h*) In case of a difference in weight and the seller is not willing to accept buyer's weights, a sworn public weigher shall be employed, and the party most in error must pay the costs of handling and reweighing.

(*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.

[8] Hess, Frank L., Nickel: Mineral Resources of the United States, 1915, pt. I, pp. 763–765.

3. *No. 2 copper wire.*—To consist of miscellaneous clean copper wire which may contain a percentage of tinned wire and soldered ends but to be free of hair wire and burnt wire which is brittle; the tinned wire not to be over 15 percent of the total weight.

4. *No. 1 heavy copper.*—This shall consist of untinned copper not less than 1/16 inch thick, and may include trolley wire, heavy field wire, heavy armature wire, that is not tangled, and also new untinned and cleaned copper clippings and punchings, and copper segments that are clean.

5. *Mixed heavy copper.*—May consist of tinned and untinned copper, consisting of copper clippings, clean copper pipe and tubing, copper wire free of hair wire and burnt and brittle wire, free from nickel-plated material.

6. *Light copper.*—May consist of the bottoms of kettles and boilers, bathtub linings, hair wire, burnt copper wire which is brittle, roofing copper and similar copper, free from radiators, brass, lead and solder connections, readily removable iron, old electrotype shells, and free of excessive paint, tar, and scale.

7. *Composition or red brass.*—May consist of red scrap brass, valves, machinery bearings and other parts of machinery, including miscellaneous castings made of copper, tin, zinc and/or lead, no piece to measure more than 12 inches over any one part or to weigh over 60 pounds, to be free of railroad boxes and other similarly excessively leaded material, cocks and faucets, gates, pot pieces, ingots, and burned brass, aluminum composition, manganese, and iron.

8. *Railroad bearing.*—Shall consist of railroad boxes or car journal bearings, must be old standard used scrap, free of yellow boxes, also iron-backed boxes, and must be free of babbitt, also free of excessive grease and dirt.

9. *Cocks and faucets.*—To be mixed red and yellow brass, free of gas cocks and beer faucets, and to contain a minimum of 35 percent red.

10. *Heavy yellow brass.*—May consist of heavy brass castings, rolled brass, rod brass ends, chandelier brass, tubing, not to contain over 15 percent of tinned and/or nickel-plated material; no piece to measure more than 12 inches over any one part and must be in pieces not too large for crucibles. Must be free of manganese mixture, condenser tubes, iron, dirt, and excessive corroded tubing. Must be free of aluminum brass containing over 0.20 percent aluminum.

11. *Yellow brass castings.*—Shall consist of brass castings in crucible shape, that is, no piece to measure more than 12 inches over any one part; must be free of manganese mixtures, tinned and nickel-plated material, and must be free of visible aluminum brass.

12. *Light brass.*—May consist of miscellaneous brass, tinned or nickel plated that is too light for heavy brass, to be free of gun shells containing paper, ashes or iron, loaded lamp bases, clock works, and automobile gaskets. Free of visible iron unless otherwise specified.

13. *Old rolled brass.*—May consist exclusively of old pieces of sheet brass and pipe free from solder, tinned and nickel-plated material, iron, paint, and corrosion, ship sheathing, rod brass, condenser tubes, and Muntz metal material.

14. *New brass clippings.*—Shall consist of the cuttings of new sheet brass to be absolutely clean and free from any foreign substances and not to contain more than 10 percent of clean brass punchings to be not smaller than 1/4 inch in diameter.

15. *Brass pipe.*—Shall consist of brass pipe, free of nickel-plated, tinned, soldered, or pipes with cast brass connections. To be sound, clean pipes free of sediment and condenser tubes.

16. *No. 1 red composition turnings.*—To be free of railroad car box turnings and similarly excessively leaded material, aluminum, manganese, and yellow brass turnings; not to contain over 2 percent free iron; to be free of grindings and foreign material, especially babbitt. Turnings not according to this specification to be sold subject to sample.

17. *No. 1 yellow rod brass turnings.*—Shall consist of strictly rod turnings, free of aluminum, manganese, composition, Tobin and Muntz metal turnings; not to contain over 3 percent free iron, oil, or other moisture; to be free of grindings and babbitts; to contain not more than 0.30 percent tin and not more than 0.15 percent combined iron.

18. *No. 1 yellow brass turnings.*—Shall consist of yellow brass turnings, free of aluminum, manganese, and composition turnings; not to contain over 3 percent of free iron, oil, or other moisture; to be free of grindings and babbitts. To avoid dispute, to be sold subject to sample.

19. *Auto radiators (unsweated).*—All radiators to be subject to deduction of actual iron. The tonnage 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 airplane sheet.

33. *Scrap aluminum castings.*—Shall consist of clean, heavy automobile castings, containing not more than 12 percent industrial mixed castings, and to be free from die cast aluminum, pattern metal, and hat blocks. All of above material also to be free from iron, babbitt, brass, and any other foreign substance. Oil and grease must not exceed 2 percent.

34. *Aluminum borings.*—To avoid dispute, should be sold subject to sample.

35. *Aluminum foil.*—Shall consist of pure aluminum foil, free from paper and any foreign ingredients.

36. *Babbitt metal.*—Shall contain bearing metal of all kinds. Shall not contain scrap hard metal, Allen metal (which is copper and lead alloy) die cast, ornamental metal, casket metal, zinc boxes, or type metal.

37. *Packages.*—Shall be good strong packages suitable for shipment and each package shall be plainly marked with separate shipping marks and numbers and with the gross and tare weights so that the packages may reach their destination and their weights can be easily checked.

There is a growing demand for scrap-metal specialties (not specifically covered by the preceding classification), such as nickel alloys, German silver, Monel metal, cadmium, and molybdenum. Difficulties in making shipments to buyers' specifications have arisen, and with the object of eliminating some of the trouble the Waste Trade Journal published certain classifications used by one of its advertisers. A list of these was given on pages 338 and 339 of the 1930 report of this series (chapter in Mineral Resources of the Unites States, 1930, part I).

Copies of the codes adopted for scrap iron and nonferrous scrap metals submitted by the National Association of Waste Material Dealers, Inc., effective March 26, 1934, may be obtained at its office, 1109 Times Building, New York, N.Y.

# IRON ORE, PIG IRON, FERRO-ALLOYS, AND STEEL

By O. E. Kiessling and H. W. Davis [1]

SUMMARY OUTLINE



The American iron and steel industry, after experiencing one of the most disastrous years in its history in 1932, recovered substantially in 1933. The production of steel and of pig iron required 33 and 26 percent, respectively, of the potential productive capacities of steel mills and blast furnaces, compared with 19 and 17 percent, respectively, in 1932. While the increase over 1932 was impressive, a comparison of operations with 1922–29 and even with the initial depression year 1930 shows that activity in 1933 was still relatively low. Nevertheless the higher rate of operation in 1933 accompanied by slightly increased prices for iron and steel products and by savings achieved through economies resulted in the balance sheets of some companies showing a profit and in a material reduction in the losses of most other companies. Larger pig-iron and steel outputs also reacted to the benefit of producers of other mineral products such as iron ore, manganiferous iron ore, fluorspar, fluxing stone, and coke, who depend upon the iron and steel furnaces as their principal market. The trends in production of iron ore, pig iron, and steel in the United States for more than half a century are illustrated in figure 7.

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

The consumption of iron and steel products by consumer-goods industries showed a marked improvement in 1933. For example, the automobile industry produced 1,959,945 cars in 1933 and took about 21 percent of the total steel output, whereas in 1932 it produced only 1,370,678 cars and took about 18 percent of the total steel. Increased output of metal containers resulted in container fabricators taking 12.25 percent of the total steel compared with 10.79 percent in 1932. Demands from manufacturers of mechanical refrigerators and other household equipment were heavier. The return of beer created a market for considerable iron and steel in brewing plants and equipment. Although still poor customers of steel mills, farm-implement

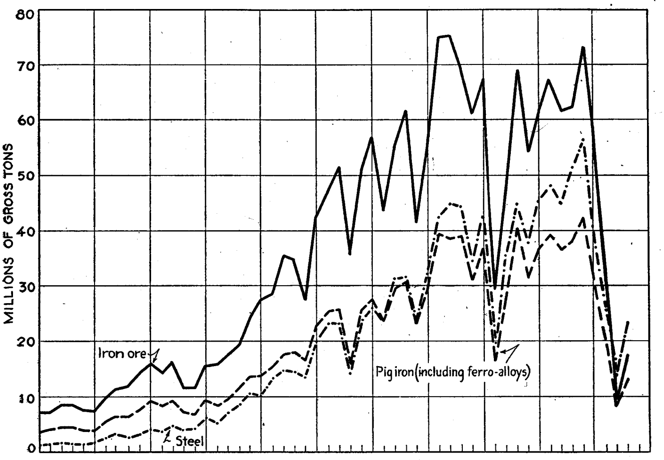


FIGURE 7.—Trends in production of iron ore, pig iron, and steel in the United States, 1880–1933.

manufacturers required more metal in 1933, the increased income of the farmer being shown by some improvement in his ability to purchase new farm equipment.

The purchases of iron and steel by capital-goods industries, on the other hand, showed little or no improvement. The railroads offered little support to the iron and steel industry in 1933, as purchases of rails and rolling stock were still at a low level. The demand for iron and steel for shipbuilding requirements improved during the last quarter of 1933, when the mills commenced rolling steel for naval vessels. Requirements of steel forms and beams for buildings again declined, and the demand for pipe was almost negligible compared with the requirements during years when the long-distance pipe lines for transmission of gas and oil were under construction.

*Salient statistics of iron ore, pig iron, ferro-alloys, and steel in the United States, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Gross tons | Value | Gross tons | Value |
| Iron ore: | | | | |
| Production: | | | | |
| Hematite | [1] 9,621,808 | (2) | 16,920,672 | (2) |
| Brown ore | 61,739 | | 235,297 | |
| Magnetite | [1] 162,892 | | 396,720 | |
| Carbonate | 477 | | 499 | |
| | 9,846,916 | (2) | 17,553,188 | (2) |
| Open pit | 3,413,486 | (2) | 11,241,705 | (2) |
| Underground | 6,432,673 | | 6,311,483 | |
| Undistributed | 757 | | ---------- | |
| | 9,846,916 | (2) | 17,553,188 | (2) |
| Shipments (exclusive of ore for paint) | 5,331,201 | $12,898,011 | 24,624,285 | $63,776,033 |
| Average value per ton at mines | ---------- | 2.42 | ---------- | 2.59 |
| Stocks at mines | 17,603,873 | (2) | 10,953,021 | (2) |
| Imported | 582,498 | 1,539,374 | 861,153 | 2,054,312 |
| Exported | 83,449 | 219,852 | 155,271 | 646,533 |
| Pig iron: | | | | |
| Production | 8,549,649 | (2) | 13,027,343 | (2) |
| Shipments | 8,518,400 | 126,032,714 | 14,353,197 | 213,347,583 |
| Average value per ton at furnaces | ---------- | 14.80 | ---------- | 14.86 |
| Imported | 130,630 | 1,301,625 | 158,596 | 1,439,206 |
| Exported | 2,324 | 53,966 | 2,750 | 63,985 |
| Ferro-alloys: | | | | |
| Production | 230,311 | (2) | 348,894 | (2) |
| Shipments: | | | | |
| Ferromanganese | 70,417 | 5,061,029 | 127,453 | 9,384,611 |
| Spiegeleisen | 31,071 | 745,966 | 50,218 | 1,144,642 |
| Ferrosilicon | 97,224 | 3,517,268 | 199,524 | 7,349,681 |
| Other varieties | 19,934 | 4,679,409 | 44,228 | 10,774,860 |
| | 218,646 | 14,003,672 | 421,423 | 28,653,794 |
| Imported for consumption: | | | | |
| Ferromanganese | 18,470 | 1,091,026 | 39,692 | 2,547,068 |
| Spiegeleisen | 8,364 | 192,037 | 26,277 | 640,613 |
| Ferrosilicon | 864 | 38,200 | 5,291 | 145,892 |
| Steel production: | | | | |
| Open hearth: | | | | |
| Basic | 11,742,682 | (2) | 20,057,146 | (2) |
| Acid | 164,648 | | 324,526 | |
| Bessemer | 1,532,076 | | 2,428,791 | |
| Crucible | 645 | | 681 | |
| Electric | 241,111 | | 421,203 | |
| | 13,681,162 | (2) | 23,232,347 | (2) |

[1] Some hematite included with magnetite.
[2] Figures not available.

The general trend of prices in 1933 was higher than in 1932. The price of tin plate, quoted at $4.25 a base box for 8 months, was advanced to $4.65 in September and to $5.25 in December. Quotations on bars, plates, and shapes were advanced during the last quarter. The price of rails was an exception to the tendency for moderate increases; in October quotations on rails dropped from $40 a ton to $37.75 a ton and again on November 6 to $36.37½.

The prices for pig iron, ferromanganese, iron and steel scrap, and fluorspar reflected the upward trend in steel quotations. Compared with 1932 the average price of pig iron advanced 6 cents a gross ton (from $14.80); ferromanganese increased $1.76 a ton (from $71.87); heavy melting steel scrap at Pittsburgh, $1.79 a ton (from $9.42); and fluorspar, 57 cents a ton (from $10.83). Spiegeleisen was an exception and showed a decline of $1.22 a ton (from $24.01). Price advances also were recorded for some raw materials used in blast-furnace burdens, such as iron ore and scrap. The price of coke and fluxing stone, however, declined. Figure 8 shows trends in prices of iron ore, pig iron, finished steel, and steel scrap.

Increased exports of iron and steel products and reduced imports accompanied the depreciation of the currency. Although most semi-finished and finished products shared in the improved export trade, the increased overseas movement of steel bars, galvanized sheets, tin and terne plates, rails, track fasteners, pipe, and wire was of particular interest. At the same time substantial decreases were recorded in imports of hoops, nails, sheets, bars, structural iron and steel, and tin

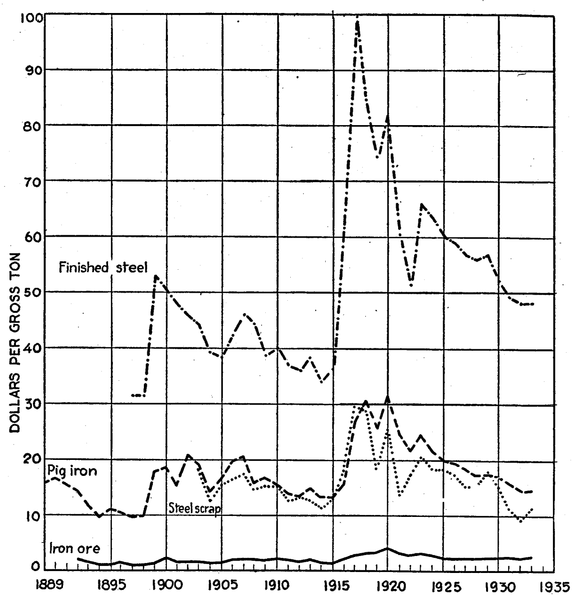


FIGURE 8.—Trends in prices of iron ore, pig iron, finished steel, and steel scrap. The prices of iron ore and pig iron are the averages f.o.b. mines and furnaces, respectively, as reported to the U.S. Bureau of Mines; the price of finished steel is an average composite computed by American Metal Market; that of steel scrap is an average at Pittsburgh of no. 1 heavy melting computed by Iron Age.

and terne plates. The imports of scrap increased from 9,775 tons in 1932 to 57,649 tons in 1933, wire rods from 7,933 tons to 12,814 tons in 1933, and pig iron from 130,630 tons to 158,596 tons in 1933.

*Code activity under NRA*—In accord with the spirit of the National Recovery Act, the iron and steel industry announced a general wage advance of 15 percent that was put into effect during July 1933. A Code of Fair Competition for the Iron and Steel Industry was submitted on July 15, 1933.. A hearing on this code was held on July 31, and it was approved by President Roosevelt for a 90-day trial period on August 19, 1933.

The industry, as defined in the code, included "all those producing * * * pig iron, iron or steel ingots, and rolled or drawn iron or steel products." Iron-ore mining was purposely excluded from the scope of the original code, and a separate code for this branch of the industry was filed in September 1933. Preliminary hearings on this draft were held in January 1934.

As specified in the trial code, approved August 19, 1933, administration was vested in the Board of Directors of the American Iron and Steel Institute. Other provisions of the code prescribed the conditions of employment, indicated prohibitions affecting "unfair practices" and the expansion of capacity, and required the filing of prices with the American Iron and Steel Institute. Labor clauses in the code established a maximum working week not to exceed an average of 40 hours over a 6-month period, with the general 8-hour day effective as soon after November 1, 1933, as operations reach 60 percent of capacity. Minimum rates of pay prescribed in the code ranged from 40 cents an hour in the northern and western districts to 25 cents an hour in the southern district. The part of the code on collective bargaining that has received much attention reads as follows:

> That employees shall have the right to organize and bargain collectively through representatives of their own choosing, and shall be free from the interference, restraint, or coercion of employers of labor, or their agents, in the designation of such representatives or in self-organization, or in other concerted activities for the purpose of collective bargaining or other mutual aid or protection.

After 3 months of operation under the trial code, the American Iron and Steel Institute filed a petition requesting extension of the trial period. This petition was accompanied by a statement reporting that pay rolls in the steel industry under the code had been increased $9,000,000 monthly, that 92,000 employees had been added, and that the industry had virtually eliminated the 10-hour day in favor of the 8-hour day, although the code provided that the 8-hour day would not become mandatory until operations in the industry reached 60 percent of capacity.

In his report to the President concerning the extension of the code, General Johnson said:

> During the 90 days' experimental period, provided in the code, it has been noteworthy and unfortunate that the operations of the members of the code have declined to an extent not paralleled by other industries. * * * Under these circumstances the maintenance of improved conditions of employment, of shorter hours and higher wages * * * shows that up to the present time the major benefits derived from the code operation have been those received by labor in this industry, with the evident prospect of an increase in these benefits with an improvement in the volume of operations.

Accordingly, the trial code was extended to May 31, 1934, and an indefinite extension of what is understood to be a somewhat revised draft of the original trial code was approved by the President on May 30, effective June 11.

Shortly after the first trial code went into effect, attention was drawn to the employment clauses, due to labor difficulties. These arose chiefly from differences of opinion as to how the collective-bargaining provisions of the code were to be carried out, as some of the steel companies desiring the company-employee representation plan were opposed by the national union organizations that sought to affiliate employees of steel plants with the national unions. The issue became acute at the plants of the Weirton Steel Co., where a strike was called in the latter part of September 1933. Attempts of the National Labor Board to arrange for an election of employee representatives met opposition from the advocates of the Weirton employee representation plan, and on May 29, 1934, Judge John P. Nields of the United States District Court (Wilmington, Del.) denied the Federal Government's petition for a preliminary injunction to restrain the Weirton Steel Co. from interfering or taking any part in the election of bargaining representatives by its employees. The denial of the injunction occurred at a time of considerable labor unrest and was followed almost immediately, as previously noted, by the President's action of May 30 in indefinitely extending the trial code in revised form.

*Men employed and output per man at iron-ore mines.*—Recent economic problems, such as those presented by the formulation and administration of NRA codes, have focused attention upon the frequent lack of adequate quantitative information on the volume of employment and the productivity of labor. Fortunately, there is virtually a complete statistical record covering this phase of the iron-ore mining industry. For many years iron-ore mining companies, whose interest in safety work is well known, have reported annual data on employment to the Bureau of Mines for use in the compilation of accident statistics. In collaboration with W. W. Adams of the Bureau's Demographical Division, the figures on the hours of labor and other detailed employment information have been correlated with the statistics on production also reported annually by iron-ore producers to the Bureau. This record for the 10-year period 1923–32 is given in the accompanying tables, segregated to show details by States and by mining districts.

The substantial reduction in the number of men needed to produce the annual iron-ore requirements of the United States, as shown strikingly in the compilations, illustrates that in iron-ore production improvements in technology have been consistently winning a battle over the difficulties of nature. In 1923, for instance, 41,294 men working 107,551,244 hours were required to produce 69,351,442 gross tons of merchantable ore, equivalent to an average output per man-hour of 0.645 ton. In 1929, however, only 30,763 men working 77,111,086 hours were required to produce 73,027,720 tons of merchantable ore, equivalent to an average output per man-hour of 0.947 ton. Thus, from 1923 to 1929 the average number of men working decreased 25.5 percent and the total man-hours worked decreased 28.3 percent, while the average output per man-hour increased 46.8 percent and total merchantable ore production 5.3 percent.

This remarkable performance in mining iron ore was closely related to advance in mechanization, improved mining methods, the operation of larger units, and efficient management of mines. In part, however, it was due, also, to the mining of richer ore and to the expansion of open-pit operations. Proportionately, more lean ore requiring beneficiation was mined in 1923 than in any year during the period 1924–29. In 1923, for instance, beneficiated ore represented 15.2 percent of the total merchantable ore produced compared with 12.8 percent in 1929 and with an average of 13.1 percent during the period 1924–29. Furthermore, proportionately less ore was produced from open-pit mines in 1923 than in 1929. Therefore, the higher production per man-hour in 1929 compared with 1923 was due partly to the mining of proportionately less lean ore requiring beneficiation and partly to the mining of relatively more ore from open-pit mines, which yield a larger output per man-hour of labor expended than underground mines.

The period from 1930 through 1932 stands in contrast to the statistical record from 1923–29 and represents years of sharply reduced ore demand and falling output per worker. While this period is too short and too irregular as an acute depression epoch to forecast a new trend, yet it does bring out the relationship between labor efficiency in iron-ore mining—as determined by the amount of ore a man-hour of labor will produce—and the volume of production.

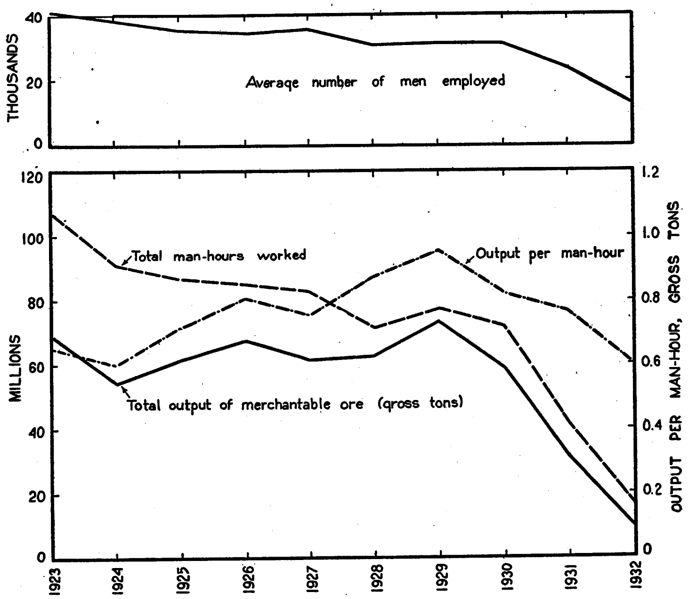


FIGURE 9.—Trends in the number of men employed at iron-ore mines, output of merchantable ore, man-hours worked, and output per man-hour in the United States, 1923–32.

Almost the same labor force is required to operate the extensive mechanical equipment of large mines at 60 to 70 percent as at 90 percent of capacity and, as shown in figure 9, the industry attained the highest production per man-hour in the boom production of 1929. On the other hand, when the market for a sizable part of the mines daily potential output disappears, production is curtailed more rapidly than the labor force and the man-hour cost of ore tends to increase. Decline in demand, moreover, is generally followed by a sharper curtailment in output at open-pit mines than at underground mines; this is due both to greater flexibility in reducing production at strip mines and to the tendency for underground mines to keep operating because of the need for constant dewatering as well as because of other technical considerations.

The 3 years following 1929 also indicate that either a relative increase in the production of lean ore or a relative decline in the output of ore from open-pit mines tends to be accompanied by a reduced output per man.

During the 7-year period 1923–29 beneficiated ore represented 13.4 percent of the total merchantable ore produced. During 1930, however, several new beneficiating plants were put into operation, and the capacity at some existing plants was enlarged; in the same year the output of beneficiated ore increased to 15.6 percent of the total output and still further to 16.1 percent in 1932. Obviously a mine that produces merchantable ore directly from the workings requires labor only for the primary operation; if, however, the material has to be washed or beneficiated in some other manner before it becomes merchantable, additional workers are required for this secondary process and a larger amount of human effort is necessary to produce a unit of salable product.

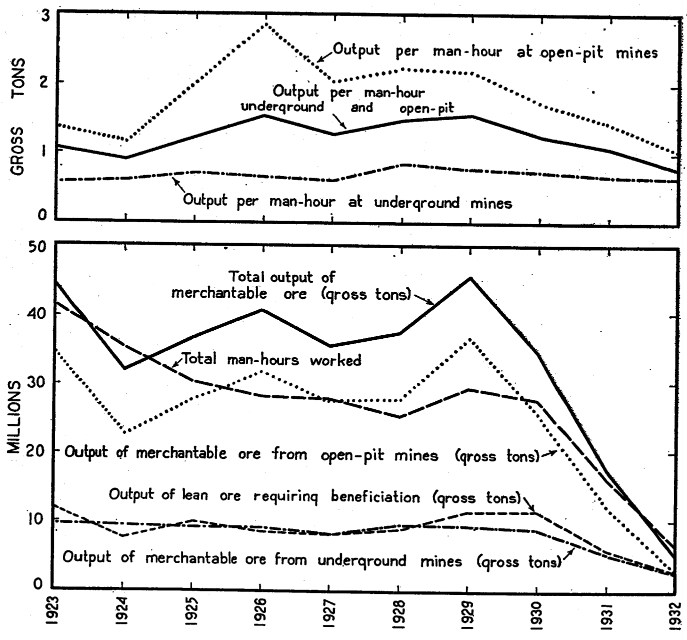


FIGURE 10.—Trends in the output of merchantable iron ore per man-hour at open-pit and underground mines in Minnesota, 1923–32, compared with the production of merchantable and lean ore and the total man-hours worked.

Accompanying the changes in the amount of ore beneficiated were also shifts in the source of ore that affect the productivity of the worker. For example, while about 75 percent of the merchantable ore produced in Minnesota from 1923 to 1929 came from open-pit mines, only 70 percent was so produced from 1930 to 1932. The significance of this shift is appreciated when it is recalled that Minnesota produces about three-fifths of the Nation's output and that men at open-pit operations normally show 2½ times the output per man-hour of men at underground mines.

Thus, if for geological or economic reasons the volume of production declines below a level that permits near-capacity utilization of the equipment at large plants, or if it becomes necessary to mine proportionately larger quantities of lean ore requiring beneficiation or to mine relatively more ore from underground mines, a reduced return of product per unit of labor may be expected at iron-ore mines in the United States.

In the Lake Superior district (Michigan, Minnesota, and Wisconsin), from which about 85 percent of the iron ore in the United States is mined, the average output of merchantable ore per man-hour increased from 0.8 ton in 1923 to a maximum of 1.15 tons in 1929, an increase of 43.8 percent. The increased productivity at underground mines in the Lake Superior district has been due, partly at least, to the marked

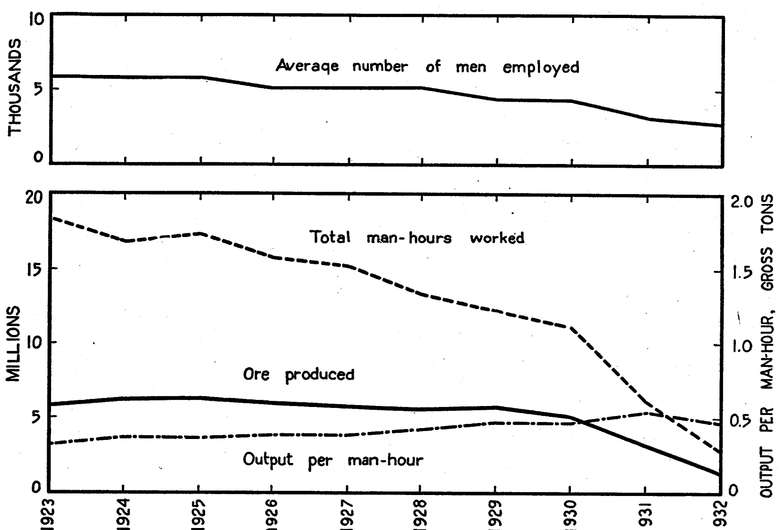


FIGURE 11.—Trends in production, man-hours worked, output per man-hour and number of men employed at iron-ore mines in Jefferson County, Ala., 1923–32.

progress made in the electrification of mines, such as electrically operated scraper loaders, electric motor-driven hoists, electrically driven power-plant equipment, and motor-driven pumps. The installation of larger shovels, electrically operated and equipped with caterpillar traction, and the use of ore cars of 75 and 85 gross tons capacity have been important factors in increased productivity at open-pit mines.

In the Southeastern district (Alabama, Georgia, North Carolina, Tennessee, and Virginia) the average output of merchantable ore per man-hour increased from 0.275 ton in 1923 to a maximum of 0.52 ton in 1931, an increase of 89 percent. The largest mining units as well as the most consistent producing mines are in Jefferson County, Ala., and these mines normally furnish about 85 percent of the total merchantable ore produced in the Southeastern district. The average output per man-hour improved from 0.311 ton in 1923 to a maximum of 0.548 ton in 1931, an increase of 76 percent, chiefly due to improved mining methods and to advances in mechanization, such as mechanical loading devices.

The introduction of mechanical improvements has not been confined to the Lake Superior and Birmingham districts during the decade 1923–32, as modern equipment has been installed at most all important mining units. In New Jersey, for instance, an ingenious method of drilling was developed at the Mt. Hope mine which increased the ore broken per man-shift from 15.5 to more than 60 tons.

The average number of men employed, as shown in the tables, includes all employees developing and mining iron ore at both open-pit and underground mines, those employed on the surface, and those employed in beneficiating plants; in other words, all men necessary to mine, beneficiate, and load the ore into cars for shipment to consuming plants. The average number of days worked each year and the average man-hours worked per day were calculated from the total man-shifts and from the total man-hours, respectively, worked by all men.

Considered as a whole the length of the workday has changed little during the decade 1923–32, but a study of the record of individual mines shows a reduction at some mines. The prevailing length of the workday at underground mines was 8 hours, except in Alabama, where the 10-hour day prevailed. The result of the abolition of the 12-hour day in effect at a few mines in Alabama in 1923, 1926, 1927, and 1928 is apparent from a study of the tables. At most open-pit mines a 10-hour day was worked, although at many mines a 9-hour day prevailed and at a few an 8-hour day.

The figures on crude-ore production include an estimate of the iron-bearing material produced at most brown-ore mines, as at most brown-ore mines only the cleaned ore is weighed. The ratio of ore-bearing material or dirt varies not only from one deposit to another but also from place to place in the same deposit. From data available, it is apparent that the ratio of ore-bearing material or dirt to cleaned ore ranges from about 2 cubic yards to 1 ton in the richer deposits to about 12 cubic yards to 1 ton in the poorer deposits. In the Birmingham and Russellville districts of Alabama, from which about three-fourths of the brown ore was mined, the average appears to be about 3.5 cubic yards of ore-bearing material to 1 ton of washed ore. About the same ratio prevails for Georgia, Missouri, and Tennessee. Thus the ratio of 3.5 cubic yards of ore-bearing material to 1 ton of washed brown ore was used as the factor in calculating the crude brown-ore production in Alabama, Georgia, Missouri, and Tennessee. In North Carolina and Virginia about 2 cubic yards of brown ore-bearing material is required for 1 ton of washed brown ore and this ratio was used in calculating the crude brown-ore production in these two States. The quantity of brown ore mined annually is comparatively small and averaged 1.3 percent annually during the 10 years under review, so that even a major error in the calculations would not seriously impair the value of the principal trends shown by the figures.

The uniformity in iron content maintained in the merchantable ore produced during the 10-year period 1923–32 is remarkable. During this period the iron content for the United States ranged from 49.91 to 50.43 percent (natural). This uniformity has been maintained by methods of beneficiation and by mixing ores from different deposits, chiefly in the Lake Superior district.

*Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man, 1923-32, by districts*

[Exclusive of ore containing 5 percent or more manganese]

| Year | Employment | | | | | Production | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number of men employed | Time employed | | | | Crude ore (partly estimated), gross tons | Merchantable ore | | | Average per man (gross tons) | | | | | |
| | | Average number of days | Total man-shifts | Man-hours | | | Gross tons | Iron (natural) contained | | Crude ore (partly estimated) | | Merchantable ore | | | |
| | | | | Average per day | Total | | | Gross tons | Percent | Per day | Per hour | Per day | Per hour | Iron (natural) contained | |
| | | | | | | | | | | | | | | Per day | Per hour |
| UNITED STATES | | | | | | | | | | | | | | | |
| 1923 | 41, 294 | 286 | 11, 797, 682 | 9. 1 | 107, 551, 244 | 80, 669, 623 | 69, 351, 442 | 34, 970, 464 | 50. 42 | 6. 838 | 0. 750 | 5. 878 | 0. 645 | 2. 964 | 0. 325 |
| 1924 | 38, 765 | 263 | 10, 201, 678 | 9. 0 | 91, 324, 498 | 61, 458, 841 | 54, 267, 419 | 27, 082, 183 | 49. 91 | 6. 024 | . 673 | 5. 319 | . 594 | 2. 655 | . 297 |
| 1925 | 35, 757 | 270 | 9, 665, 877 | 8. 9 | 86, 286, 684 | 70, 474, 965 | 61, 907, 997 | 31, 090, 824 | 50. 22 | 7. 291 | . 817 | 6. 405 | . 717 | 3. 217 | . 360 |
| 1926 | 34, 399 | 273 | 9, 395, 178 | 9. 0 | 84, 225, 524 | 75, 943, 775 | 67, 623, 000 | 34, 099, 262 | 50. 43 | 8. 083 | . 902 | 7. 198 | . 803 | 3. 629 | . 405 |
| 1927 | 34, 755 | 264 | 9, 177, 979 | 8. 9 | 82, 004, 761 | 69, 923, 057 | 61, 741, 100 | 30, 879, 989 | 50. 02 | 7. 619 | . 853 | 6. 727 | . 753 | 3. 365 | . 377 |
| 1928 | 30, 238 | 265 | 8, 008, 647 | 8. 9 | 71, 403, 631 | 70, 940, 916 | 62, 197, 088 | 31, 149, 584 | 50. 08 | 8. 858 | . 994 | 7. 766 | . 871 | 3. 889 | . 436 |
| 1929 | 30, 763 | 281 | 8, 638, 234 | 8. 9 | 77, 111, 086 | 83, 164, 881 | 73, 027, 720 | 36, 637, 660 | 50. 17 | 9. 628 | 1. 079 | 8. 454 | . 947 | 4. 241 | . 475 |
| 1930 | 30, 975 | 259 | 8, 037, 096 | 8. 9 | 71, 620, 115 | 68, 551, 913 | 58, 408, 664 | 29, 212, 457 | 50. 01 | 8. 529 | . 957 | 7. 267 | . 816 | 3. 635 | . 408 |
| 1931 | 22, 867 | 201 | 4, 596, 504 | 8. 9 | 40, 928, 283 | 35, 563, 994 | 31, 131, 502 | 15, 625, 050 | 50. 19 | 7. 737 | . 869 | 6. 773 | . 761 | 3. 399 | . 382 |
| 1932 | 12, 649 | 145 | 1, 828, 002 | 9. 0 | 16, 427, 009 | 11, 181, 678 | 9, 846, 916 | 4, 948, 243 | 50. 25 | 6. 117 | . 681 | 5. 387 | . 599 | 2. 707 | . 301 |
| LAKE SUPERIOR | | | | | | | | | | | | | | | |
| 1923 | 28, 756 | 292 | 8, 397, 782 | 8. 8 | 74, 197, 870 | 63, 737, 822 | 59, 394, 180 | 30, 860, 060 | 51. 96 | 7. 590 | . 859 | 7. 073 | . 800 | 3. 675 | . 416 |
| 1924 | 27, 651 | 269 | 7, 449, 720 | 8. 7 | 64, 679, 800 | 47, 561, 165 | 44, 942, 898 | 23, 351, 488 | 51. 96 | 6. 384 | . 735 | 6. 033 | . 695 | 3. 135 | . 361 |
| 1925 | 25, 472 | 268 | 6, 837, 245 | 8. 6 | 58, 916, 445 | 55, 569, 424 | 52, 163, 922 | 27, 160, 188 | 52. 07 | 8. 127 | . 943 | 7. 629 | . 885 | 3. 972 | . 461 |
| 1926 | 24, 483 | 271 | 6, 645, 613 | 8. 6 | 57, 094, 412 | 60, 410, 352 | 57, 272, 643 | 29, 737, 718 | 51. 92 | 9. 090 | 1. 058 | 8. 618 | 1. 003 | 4. 475 | . 521 |
| 1927 | 24, 904 | 258 | 6, 424, 947 | 8. 6 | 55, 268, 641 | 54, 744, 797 | 51, 627, 335 | 26, 647, 001 | 51. 61 | 8. 521 | . 991 | 8. 035 | . 934 | 4. 147 | . 482 |
| 1928 | 20, 881 | 266 | 5, 562, 599 | 8. 6 | 47, 996, 087 | 56, 059, 314 | 52, 525, 581 | 27, 061, 370 | 51. 52 | 10. 078 | 1. 168 | 9. 443 | 1. 094 | 4. 865 | . 564 |
| 1929 | 21, 811 | 286 | 6, 243, 609 | 8. 7 | 54, 615, 027 | 67, 609, 545 | 62, 825, 826 | 32, 294, 527 | 51. 40 | 10. 829 | 1. 238 | 10. 062 | 1. 150 | 5. 172 | . 591 |
| 1930 | 22, 301 | 261 | 5, 823, 736 | 8. 8 | 51, 197, 616 | 54, 323, 659 | 49, 383, 385 | 25, 295, 164 | 51. 22 | 9. 328 | 1. 061 | 8. 480 | . 965 | 4. 343 | . 494 |
| 1931 | 16, 487 | 207 | 3, 404, 984 | 8. 8 | 30, 017, 397 | 28, 188, 521 | 25, 877, 416 | 13, 408, 123 | 51. 81 | 8. 279 | . 939 | 7. 600 | . 862 | 3. 938 | . 447 |
| 1932 | 8, 768 | 163 | 1, 427, 926 | 8. 9 | 12, 638, 707 | 9, 160, 742 | 8, 139, 427 | 4, 267, 074 | 52. 42 | 6. 415 | . 725 | 5. 700 | . 644 | 2. 988 | . 338 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SOUTHEASTERN** | | | | | | | | | | | | | | | | |
| 1923 | 9,220 | 286 | 2,633,776 | 10.2 | 26,836,560 | 13,866,000 | 7,383,403 | 2,771,682 | 37.54 | 5.265 | .517 | 2.803 | .275 | 1.052 | .103 |
| 1924 | 8,428 | 267 | 2,254,179 | 9.9 | 22,394,244 | 11,791,000 | 7,388,822 | 2,742,748 | 37.12 | 5.231 | .527 | 3.278 | .330 | 1.217 | .122 |
| 1925 | 7,995 | 287 | 2,295,030 | 10.0 | 22,860,533 | 12,395,000 | 7,455,085 | 2,783,059 | 37.33 | 5.401 | .542 | 3.248 | .326 | 1.213 | .122 |
| 1926 | 6,992 | 285 | 1,989,600 | 10.4 | 20,608,685 | 11,674,198 | 7,102,607 | 2,659,468 | 37.44 | 5.868 | .566 | 3.570 | .345 | 1.337 | .129 |
| 1927 | 6,737 | 271 | 1,825,168 | 10.3 | 18,872,054 | 10,965,528 | 6,714,810 | 2,498,225 | 37.20 | 6.008 | .581 | 3.679 | .356 | 1.369 | .132 |
| 1928 | 6,383 | 259 | 1,654,319 | 10.2 | 16,827,784 | 11,281,000 | 6,537,726 | 2,451,191 | 37.49 | 6.819 | .670 | 3.952 | .389 | 1.482 | .146 |
| 1929 | 5,917 | 260 | 1,541,248 | 10.0 | 15,391,042 | 11,138,675 | 6,645,237 | 2,497,520 | 37.58 | 7.227 | .724 | 4.312 | .432 | 1.620 | .162 |
| 1930 | 5,303 | 254 | 1,347,721 | 9.8 | 13,145,780 | 10,039,100 | 5,838,105 | 2,196,940 | 37.63 | 7.449 | .764 | 4.332 | .444 | 1.630 | .167 |
| 1931 | 3,752 | 195 | 731,303 | 9.6 | 7,011,326 | 5,364,000 | 3,644,606 | 1,359,470 | 37.30 | 7.335 | .765 | 4.984 | .520 | 1.859 | .194 |
| 1932 | 2,891 | 106 | 305,489 | 9.7 | 2,964,520 | 1,634,925 | 1,375,459 | 514,142 | 37.40 | 5.352 | .551 | 4.502 | .464 | 1.683 | .173 |
| **NORTHEASTERN** | | | | | | | | | | | | | | | | |
| 1923 | 2,418 | 220 | 531,780 | 8.7 | 4,634,464 | 2,277,701 | 1,843,096 | 946,525 | 51.36 | 4.283 | .491 | 3.466 | .398 | 1.780 | .204 |
| 1924 | 1,790 | 151 | 270,748 | 8.9 | 2,414,316 | 1,253,305 | 1,128,481 | 549,179 | 48.67 | 4.629 | .519 | 4.168 | .467 | 2.028 | .227 |
| 1925 | 1,519 | 222 | 337,770 | 8.7 | 2,949,278 | 1,521,014 | 1,302,841 | 612,835 | 47.04 | 4.503 | .516 | 3.857 | .442 | 1.814 | .208 |
| 1926 | 2,077 | 250 | 519,808 | 8.8 | 4,594,321 | 2,395,664 | 1,943,471 | 997,575 | 51.33 | 4.609 | .521 | 3.739 | .423 | 1.919 | .217 |
| 1927 | 2,213 | 293 | 649,069 | 8.7 | 5,633,706 | 2,984,673 | 2,244,254 | 1,124,976 | 50.13 | 4.598 | .530 | 3.458 | .398 | 1.733 | .200 |
| 1928 | 1,977 | 244 | 482,305 | 8.5 | 4,093,401 | 2,381,804 | 1,986,959 | 1,034,908 | 52.09 | 4.938 | .582 | 4.120 | .485 | 2.146 | .253 |
| 1929 | 2,097 | 269 | 563,692 | 8.5 | 4,787,157 | 2,843,595 | 2,195,601 | 1,140,708 | 51.95 | 5.045 | .594 | 3.895 | .459 | 2.024 | .238 |
| 1930 | 2,731 | 262 | 714,189 | 8.5 | 6,058,999 | 3,107,185 | 2,248,682 | 1,238,005 | 55.05 | 4.351 | .513 | 3.149 | .371 | 1.733 | .204 |
| 1931 | 1,688 | 175 | 295,217 | 8.7 | 2,570,050 | 1,224,797 | 936,960 | 509,590 | 54.39 | 4.149 | .477 | 3.174 | .365 | 1.726 | .198 |
| 1932 | 585 | 101 | 58,906 | 9.0 | 530,682 | 218,990 | 165,009 | 78,960 | 47.85 | 3.718 | .413 | 2.801 | .311 | 1.340 | .149 |
| **WESTERN** | | | | | | | | | | | | | | | | |
| 1923 | 900 | 260 | 234,344 | 8.0 | 1,882,350 | 788,100 | 730,763 | 392,197 | 53.67 | 3.363 | .419 | 3.118 | .388 | 1.674 | .208 |
| 1924 | 896 | 253 | 227,031 | 8.1 | 1,836,138 | 853,371 | 807,218 | 438,768 | 54.36 | 3.759 | .465 | 3.556 | .440 | 1.933 | .239 |
| 1925 | 771 | 254 | 195,832 | 8.0 | 1,560,428 | 989,527 | 986,149 | 534,742 | 54.23 | 5.053 | .634 | 5.036 | .632 | 2.731 | .343 |
| 1926 | 847 | 284 | 240,157 | 8.0 | 1,928,106 | 1,463,561 | 1,304,279 | 704,501 | 54.01 | 6.094 | .759 | 5.431 | .676 | 2.934 | .365 |
| 1927 | 901 | 309 | 278,795 | 8.0 | 2,230,360 | 1,228,059 | 1,154,701 | 609,787 | 52.81 | 4.405 | .551 | 4.142 | .518 | 2.187 | .273 |
| 1928 | 997 | 310 | 309,424 | 8.0 | 2,486,359 | 1,218,798 | 1,146,822 | 602,115 | 52.50 | 3.939 | .490 | 3.706 | .461 | 1.946 | .242 |
| 1929 | 938 | 309 | 289,685 | 8.0 | 2,317,860 | 1,573,066 | 1,361,056 | 704,905 | 51.79 | 5.430 | .679 | 4.698 | .587 | 2.433 | .304 |
| 1930 | 640 | 237 | 151,450 | 8.0 | 1,217,720 | 1,081,969 | 938,492 | 482,348 | 51.40 | 7.144 | .889 | 6.197 | .771 | 3.185 | .396 |
| 1931 | 940 | 176 | 165,000 | 8.1 | 1,329,510 | 786,676 | 672,520 | 347,867 | 51.73 | 4.768 | .592 | 4.076 | .506 | 2.108 | .262 |
| 1932 | 405 | 88 | 35,681 | 8.2 | 293,100 | 167,021 | 167,021 | 88,067 | 52.73 | 4.681 | .570 | 4.681 | .570 | 2.468 | .300 |

*Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man, 1923–32, by districts and States*

[Exclusive of ore containing 5 percent or more manganese]

| District and State | Employment: Average number of men employed | Employment: Time employed: Average number of days | Employment: Time employed: Total man-shifts | Employment: Time employed: Man-hours: Average per day | Employment: Time employed: Man-hours: Total | Production: Crude ore (partly estimated), gross tons | Production: Merchantable ore: Gross tons | Production: Merchantable ore: Iron (natural) contained: Gross tons | Production: Merchantable ore: Iron (natural) contained: Percent | Production: Average per man (gross tons): Crude ore (partly estimated): Per day | Production: Average per man (gross tons): Crude ore (partly estimated): Per hour | Production: Average per man (gross tons): Merchantable ore: Per day | Production: Average per man (gross tons): Merchantable ore: Per hour | Production: Average per man (gross tons): Merchantable ore: Iron (natural) contained: Per day | Production: Average per man (gross tons): Merchantable ore: Iron (natural) contained: Per hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1923 | | | | | | | | | | | | | | | |
| Lake Superior: | | | | | | | | | | | | | | | |
| Michigan | 12,046 | 306 | 3,683,521 | 8.4 | 31,024,832 | 14,177,024 | 14,174,468 | 7,303,914 | 51.53 | 3.849 | 0.457 | 3.848 | 0.457 | 1.983 | 0.235 |
| Minnesota | 16,014 | 282 | 4,514,236 | 9.2 | 41,479,648 | 48,681,304 | 44,348,296 | 23,115,744 | 52.12 | 10.784 | 1.174 | 9.824 | 1.069 | 5.121 | .557 |
| Wisconsin | 696 | 287 | 200,025 | 8.5 | 1,693,390 | 879,494 | 871,416 | 440,402 | 50.54 | 4.397 | .519 | 4.357 | .515 | 2.202 | .260 |
| | 28,756 | 292 | 8,397,782 | 8.8 | 74,197,870 | 63,737,822 | 59,394,180 | 30,860,060 | 51.96 | 7.590 | .859 | 7.073 | .800 | 3.675 | .416 |
| Southeastern: | | | | | | | | | | | | | | | |
| Alabama | 7,710 | 294 | 2,263,760 | 10.3 | 23,303,607 | 11,781,000 | 6,783,146 | 2,525,067 | 37.23 | 5.204 | .506 | 2.996 | .291 | 1.115 | .108 |
| Georgia | 316 | 238 | 75,104 | 9.7 | 725,840 | 718,000 | 117,321 | 50,583 | 43.12 | 9.560 | .989 | 1.562 | .162 | .674 | .070 |
| North Carolina | 106 | 226 | 23,910 | 10.0 | 239,100 | 76,000 | 59,684 | 25,084 | 42.03 | 3.179 | .318 | 2.496 | .250 | 1.049 | .105 |
| Tennessee | 694 | 238 | 165,465 | 9.4 | 1,562,030 | 903,000 | 267,275 | 106,623 | 39.89 | 5.457 | .578 | 1.615 | .171 | .644 | .068 |
| Virginia | 394 | 268 | 105,537 | 9.5 | 1,005,983 | 388,000 | 155,977 | 64,325 | 41.24 | 3.676 | .386 | 1.478 | .155 | .610 | .064 |
| | 9,220 | 286 | 2,633,776 | 10.2 | 26,836,560 | 13,866,000 | 7,383,403 | 2,771,682 | 37.54 | 5.265 | .517 | 2.803 | .275 | 1.052 | .103 |
| Northeastern: | | | | | | | | | | | | | | | |
| New Jersey | 903 | 195 | 176,415 | 8.4 | 1,481,718 | 450,862 | 307,733 | 177,009 | 57.52 | 2.556 | .304 | 1.744 | .208 | 1.003 | .119 |
| New York | 1,099 | 243 | 267,126 | 8.7 | 2,333,490 | 832,226 | 541,922 | 330,785 | 61.04 | 3.115 | .357 | 2.029 | .232 | 1.238 | .142 |
| Pennsylvania | 416 | 212 | 88,239 | 9.3 | 819,256 | 994,613 | 993,441 | 438,731 | 44.16 | 11.272 | 1.214 | 11.259 | 1.213 | 4.972 | .536 |
| | 2,418 | 220 | 531,780 | 8.7 | 4,634,464 | 2,277,701 | 1,843,096 | 946,525 | 51.36 | 4.283 | .491 | 3.466 | .398 | 1.780 | .204 |
| Western: | | | | | | | | | | | | | | | |
| Colorado | 37 | 314 | 11,618 | 8.0 | 92,944 | 4,102 | 4,102 | 1,948 | 47.49 | .353 | .044 | .353 | .044 | .168 | .021 |
| Missouri | 267 | 246 | 65,650 | 8.1 | 531,800 | 110,883 | 53,546 | 27,414 | 51.20 | 1.689 | .209 | .816 | .101 | .418 | .052 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New Mexico | 164 | 361 | 59,180 | 8.0 | 473,440 | 205,218 | 205,218 | 107,652 | 52.46 | 3.468 | .433 | 3.468 | .433 | 1.819 | .227 |
| Utah | 148 | 126 | 18,603 | 8.0 | 149,572 | 57,752 | 57,752 | 28,461 | 49.28 | 3.104 | .386 | 3.104 | .386 | 1.530 | .190 |
| Wyoming | 212 | 309 | 65,508 | 8.0 | 524,064 | 378,747 | 378,747 | 212,136 | 56.01 | 5.782 | .723 | 5.782 | .723 | 3.238 | .405 |
| California | | | | | | 2,779 | 2,779 | 1,667 | 59.99 | | | | | | |
| Idaho | | | | | | 1,290 | 1,290 | 645 | 50.00 | | | | | | |
| Montana | 72 | 191 | 13,785 | 8.0 | 110,530 | 17,751 | 17,751 | 8,443 | 47.56 | 2.299 | .287 | 2.299 | .287 | 1.068 | .133 |
| Nevada | | | | | | 9,578 | 9,578 | 3,831 | 40.00 | | | | | | |
| Washington | | | | | | | | | | | | | | | |
| | 900 | 230 | 234,314 | 8.0 | 1,832,350 | 788,100 | 730,763 | 392,197 | 53.67 | 3.363 | .419 | 3.118 | .388 | 1.674 | .208 |
| | 41,294 | 286 | 11,797,682 | 9.1 | 107,551,244 | 80,639,623 | 69,351,442 | 34,970,464 | 50.42 | 6.838 | .750 | 5.878 | .645 | 2.964 | .325 |
| **1924** | | | | | | | | | | | | | | | |
| **Lake Superior:** | | | | | | | | | | | | | | | |
| Michigan | 12,418 | 271 | 3,365,543 | 8.3 | 28,034,192 | 12,352,254 | 12,350,755 | 6,368,914 | 51.57 | 3.670 | .440 | 3.670 | .440 | 1.892 | .227 |
| Minnesota | 14,660 | 268 | 3,925,174 | 9.0 | 35,238,049 | 34,518,853 | 31,902,085 | 16,623,410 | 52.11 | 8.794 | .980 | 8.128 | .905 | 4.235 | .472 |
| Wisconsin | 573 | 277 | 159,003 | 8.5 | 1,357,559 | 690,058 | 690,058 | 359,164 | 52.05 | 4.340 | .508 | 4.340 | .508 | 2.259 | .265 |
| | 27,651 | 269 | 7,449,720 | 8.7 | 64,679,800 | 47,561,165 | 44,942,898 | 23,351,488 | 51.96 | 6.384 | .735 | 6.033 | .695 | 3.135 | .361 |
| **Southeastern:** | | | | | | | | | | | | | | | |
| Alabama | 7,534 | 268 | 2,021,170 | 10.0 | 20,185,952 | 10,715,000 | 6,993,613 | 2,584,058 | 36.95 | 5.301 | .531 | 3.460 | .346 | 1.278 | .128 |
| Georgia | 256 | 236 | 60,535 | 10.0 | 605,350 | 581,000 | 113,039 | 47,044 | 41.62 | 9.598 | .960 | 1.867 | .187 | .777 | .078 |
| North Carolina | 25 | 160 | 4,000 | 10.0 | 40,000 | 28,000 | 12,525 | 5,972 | 47.68 | 7.000 | .700 | 3.131 | .313 | 1.493 | .149 |
| Tennessee | 390 | 284 | 110,740 | 9.2 | 1,022,056 | 234,000 | 179,853 | 69,845 | 38.83 | 2.113 | .229 | 1.624 | .176 | .631 | .068 |
| Virginia | 223 | 259 | 57,734 | 9.4 | 540,886 | 233,000 | 89,792 | 35,829 | 39.90 | 4.036 | .431 | 1.555 | .166 | .621 | .066 |
| | 8,428 | 267 | 2,254,179 | 9.9 | 22,394,244 | 11,791,000 | 7,388,822 | 2,742,748 | 37.12 | 5.231 | .527 | 3.278 | .330 | 1.217 | .122 |
| **Northeastern:** | | | | | | | | | | | | | | | |
| New Jersey | 165 | 231 | 38,131 | 8.3 | 317,034 | 96,321 | 65,197 | 36,536 | 56.04 | 2.526 | .304 | 1.710 | .206 | .958 | .115 |
| New York | 1,101 | 89 | 97,774 | 8.7 | 854,758 | 348,529 | 255,832 | 154,400 | 60.35 | 3.565 | .408 | 2.617 | .299 | 1.579 | .181 |
| Ohio | 524 | 257 | 134,843 | 9.2 | 1,242,474 | 244 | 244 | 101 | 41.39 | 5.996 | .651 | 5.988 | .650 | 2.657 | .288 |
| Pennsylvania | | | | | | 808,211 | 807,208 | 358,142 | 44.37 | | | | | | |
| | 1,790 | 151 | 270,748 | 8.9 | 2,414,316 | 1,253,305 | 1,128,481 | 549,179 | 48.67 | 4.629 | .519 | 4.168 | .467 | 2.028 | .227 |
| **Western:** | | | | | | | | | | | | | | | |
| Colorado | 39 | 309 | 12,051 | 8.0 | 96,408 | 4,702 | 4,702 | 2,008 | 42.71 | .390 | .049 | .390 | .049 | .167 | .021 |
| Missouri | 294 | 231 | 67,820 | 8.1 | 547,600 | 126,000 | 79,847 | 42,706 | 53.48 | 1.858 | .230 | 1.177 | .146 | .630 | .078 |
| New Mexico | 120 | 365 | 43,800 | 8.3 | 365,000 | 189,371 | 189,371 | 99,020 | 52.29 | 4.324 | .519 | 4.324 | .519 | 2.261 | .271 |
| Utah | 123 | 188 | 23,159 | 8.0 | 185,272 | 164,154 | 164,154 | 90,059 | 54.86 | 7.088 | .886 | 7.088 | .886 | 3.889 | .486 |
| Wyoming | 241 | 306 | 73,746 | 8.0 | 589,968 | 363,096 | 363,096 | 202,244 | 55.70 | 4.924 | .615 | 4.924 | .615 | 2.742 | .343 |
| California | | | | | | 435 | 435 | 261 | 60.00 | | | | | | |
| Montana | 79 | 82 | 6,455 | 8.0 | 51,890 | 3,913 | 3,913 | 1,705 | 43.57 | .937 | .117 | .937 | .117 | .423 | .053 |
| Washington | | | | | | 1,700 | 1,700 | 765 | 45.00 | | | | | | |
| | 896 | 253 | 227,031 | 8.1 | 1,836,138 | 853,371 | 807,218 | 438,768 | 54.36 | 3.759 | .465 | 3.556 | .440 | 1.933 | .239 |
| | 38,765 | 263 | 10,201,678 | 9.0 | 91,324,498 | 61,458,841 | 54,267,419 | 27,032,183 | 49.91 | 6.024 | .673 | 5.319 | .594 | 2.655 | .297 |

*Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man, 1923–32, by districts and States*—Continued

[Exclusive of ore containing 5 percent or more manganese]

| District and State | Employment: Average number of men employed | Employment: Time employed: Average number of days | Employment: Time employed: Total man-shifts | Employment: Time employed: Man-hours: Average per day | Employment: Time employed: Man-hours: Total | Production: Crude ore (partly estimated), gross tons | Production: Merchantable ore: Gross tons | Production: Merchantable ore: Iron (natural) contained: Gross tons | Production: Merchantable ore: Iron (natural) contained: Percent | Average per man (gross tons): Crude ore (partly estimated): Per day | Average per man (gross tons): Crude ore (partly estimated): Per hour | Average per man (gross tons): Merchantable ore: Per day | Average per man (gross tons): Merchantable ore: Per hour | Average per man (gross tons): Merchantable ore: Iron (natural) contained: Per day | Average per man (gross tons): Merchantable ore: Iron (natural) contained: Per hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1925** | | | | | | | | | | | | | | | |
| Lake Superior: | | | | | | | | | | | | | | | |
| Michigan | 11,463 | 283 | 3,241,247 | 8.4 | 27,177,548 | 14,490,529 | 14,490,529 | 7,464,302 | 51.51 | 4.471 | 0.533 | 4.471 | 0.533 | 2.303 | 0.275 |
| Minnesota | 13,306 | 257 | 3,419,837 | 8.8 | 30,233,987 | 40,261,746 | 36,856,244 | 19,269,806 | 52.28 | 11.773 | 1.332 | 10.777 | 1.219 | 5.635 | .637 |
| Wisconsin | 703 | 251 | 176,161 | 8.5 | 1,504,910 | 817,149 | 817,149 | 426,080 | 52.14 | 4.639 | .543 | 4.639 | .543 | 2.419 | .283 |
| | 25,472 | 268 | 6,837,245 | 8.6 | 58,916,445 | 55,569,424 | 52,163,922 | 27,160,188 | 52.07 | 8.127 | .943 | 7.629 | .885 | 3.972 | .461 |
| Southeastern: | | | | | | | | | | | | | | | |
| Alabama | 7,155 | 295 | 2,111,537 | 10.0 | 21,115,364 | 11,089,000 | 7,093,250 | 2,631,540 | 37.10 | 5.252 | .525 | 3.359 | .336 | 1.246 | .125 |
| Georgia | 247 | 185 | 45,601 | 9.8 | 445,094 | 499,000 | 78,835 | 33,903 | 43.01 | 10.943 | 1.121 | 1.729 | .177 | .743 | .076 |
| North Carolina | 82 | 93 | 7,610 | 10.0 | 76,100 | 29,000 | 22,011 | 9,532 | 43.31 | 3.811 | .381 | 2.892 | .289 | 1.253 | .125 |
| Tennessee | 309 | 295 | 91,252 | 9.5 | 866,607 | 528,000 | 164,717 | 66,591 | 40.43 | 5.786 | .609 | 1.805 | .190 | .730 | .077 |
| Virginia | 202 | 193 | 39,030 | 9.2 | 357,368 | 250,000 | 96,272 | 41,493 | 43.10 | 6.405 | .700 | 2.467 | .269 | 1.063 | .116 |
| | 7,995 | 287 | 2,295,030 | 10.0 | 22,860,533 | 12,395,000 | 7,455,085 | 2,783,059 | 37.33 | 5.401 | .542 | 3.248 | .326 | 1.213 | .122 |
| Northeastern: | | | | | | | | | | | | | | | |
| New Jersey | 457 | 237 | 108,452 | 8.1 | 878,240 | 286,999 | 202,942 | 119,008 | 58.64 | 2.646 | .327 | 1.871 | .231 | 1.097 | .136 |
| New York | 487 | 163 | 79,485 | 8.9 | 709,430 | 275,077 | 141,534 | 84,039 | 59.38 | 3.461 | .388 | 1.781 | .200 | 1.057 | .118 |
| Ohio } Pennsylvania } | 575 | 261 | 149,833 | 9.1 | 1,361,608 | 2,410 / 956,528 | 2,410 / 955,955 | 1,002 / 408,786 | 41.58 / 42.76 | 6.400 | .704 | 6.396 | .704 | 2.735 | .301 |
| | 1,519 | 222 | 337,770 | 8.7 | 2,949,278 | 1,521,014 | 1,302,841 | 612,835 | 47.04 | 4.503 | .516 | 3.857 | .442 | 1.814 | .208 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Western: | | | | | | | | | | | | | | | | |
| Colorado | 30 | 308 | 9, 240 | 8. 0 | 73, 920 | 8, 642 | 8, 642 | 3, 906 | 45. 20 | . 935 | . 117 | . 935 | . 117 | . 423 | . 053 |
| Missouri | 130 | 92 | 12, 000 | 8. 0 | 96, 000 | 43, 421 | 40, 043 | 20, 584 | 51. 40 | 3. 618 | . 452 | 3. 337 | . 417 | 1. 715 | . 214 |
| New Mexico | 166 | 326 | 54, 055 | 8. 0 | 432, 440 | 172, 959 | 172, 959 | 89, 765 | 51. 90 | 3. 200 | . 400 | 3. 200 | . 400 | 1. 661 | . 208 |
| Utah | 148 | 272 | 40, 219 | 7. 8 | 315, 524 | 270, 029 | 270, 029 | 143, 023 | 52. 97 | 6. 714 | . 856 | 6. 714 | . 856 | 3. 556 | . 453 |
| Wyoming | 265 | 296 | 78, 533 | 8. 0 | 628, 264 | 489, 622 | 489, 622 | 275, 168 | 56. 20 | 6. 235 | . 779 | 6. 235 | . 779 | 3. 504 | . 438 |
| California | | | | | | 352 | 352 | 211 | 59. 94 | | | | | | |
| Montana | 32 | 56 | 1, 785 | 8. 0 | 14, 280 | 3, 672 | 3, 672 | 1, 620 | 44. 12 | 2. 719 | . 340 | 2. 719 | . 340 | 1. 286 | . 161 |
| Washington | | | | | | 830 | 830 | 465 | 56. 02 | | | | | | |
| | 771 | 254 | 195, 832 | 8. 0 | 1, 560, 428 | 989, 527 | 986, 149 | 534, 742 | 54. 23 | 5. 053 | . 634 | 5. 036 | . 632 | 2. 731 | . 343 |
| | 35, 757 | 270 | 9, 665, 877 | 8. 9 | 86, 286, 684 | 70, 474, 965 | 61, 907, 997 | 31, 090, 824 | 50. 22 | 7. 291 | . 817 | 6. 405 | . 717 | 3. 217 | . 360 |
| 1926 | | | | | | | | | | | | | | | |
| Lake Superior: | | | | | | | | | | | | | | | |
| Michigan | 11, 088 | 282 | 3, 121, 885 | 8. 4 | 26, 199, 855 | 15, 248, 254 | 15, 248, 254 | 7, 763, 697 | 50. 92 | 4. 884 | . 582 | 4. 884 | . 582 | 2. 487 | . 296 |
| Minnesota | 12, 294 | 260 | 3, 196, 072 | 8. 8 | 28, 146, 105 | 43, 839, 322 | 40, 701, 613 | 21, 295, 041 | 52. 32 | 13. 717 | 1. 558 | 12. 735 | 1. 446 | 6. 663 | . 757 |
| Wisconsin | 1, 101 | 298 | 327, 656 | 8. 4 | 2, 748, 452 | 1, 322, 776 | 1, 322, 776 | 678, 980 | 51. 33 | 4. 037 | . 481 | 4. 037 | . 481 | 2. 072 | . 247 |
| | 24, 483 | 271 | 6, 645, 613 | 8. 6 | 57, 094, 412 | 60, 410, 352 | 57, 272, 643 | 29, 737, 718 | 51. 92 | 9. 090 | 1. 058 | 8. 618 | 1. 003 | 4. 475 | . 521 |
| Southeastern: | | | | | | | | | | | | | | | |
| Alabama | 6, 460 | 288 | 1, 857, 783 | 10. 4 | 19, 340, 090 | 10, 862, 000 | 6, 847, 789 | 2, 552, 216 | 37. 27 | 5. 847 | . 562 | 3. 686 | . 354 | 1. 374 | . 132 |
| Georgia | 101 | 287 | 29, 008 | 10. 0 | 290, 080 | 374, 000 | 51, 642 | 25, 024 | 48. 46 | 12. 893 | 1. 289 | 1. 780 | . 178 | . 863 | . 086 |
| North Carolina | 60 | 83 | 5, 002 | 10. 0 | 50, 020 | 15, 198 | 15, 198 | 6, 391 | 42. 05 | 3. 038 | . 304 | 3. 038 | . 304 | 1. 278 | . 128 |
| Tennessee | 301 | 263 | 79, 045 | 9. 4 | 740, 875 | 331, 000 | 138, 819 | 53, 548 | 38. 57 | 4. 187 | . 447 | 1. 756 | . 187 | . 677 | . 072 |
| Virginia | 70 | 268 | 18, 762 | 10. 0 | 187, 620 | 92, 000 | 49, 159 | 22, 289 | 45. 34 | 4. 904 | . 490 | 2. 620 | . 262 | 1. 188 | . 119 |
| | 6, 992 | 285 | 1, 989, 600 | 10. 4 | 20, 608, 685 | 11, 674, 198 | 7, 102, 607 | 2, 659, 468 | 37. 44 | 5. 868 | . 566 | 3. 570 | . 345 | 1. 337 | . 129 |
| Northeastern: | | | | | | | | | | | | | | | |
| New Jersey | 340 | 275 | 93, 552 | 8. 4 | 782, 998 | 312, 271 | 209, 117 | 124, 535 | 59. 55 | 3. 338 | . 399 | 2. 235 | . 267 | 1. 331 | . 159 |
| New York | 1, 163 | 224 | 260, 927 | 8. 8 | 2, 288, 055 | 987, 150 | 638, 849 | 401, 000 | 62. 77 | 3. 783 | . 431 | 2. 448 | . 279 | 1. 537 | . 175 |
| Pennsylvania | 574 | 288 | 165, 329 | 9. 2 | 1, 523, 268 | 1, 096, 243 | 1, 095, 505 | 472, 040 | 43. 09 | 6. 631 | . 720 | 6. 626 | . 719 | 2. 855 | . 310 |
| | 2, 077 | 250 | 519, 808 | 8. 8 | 4, 594, 321 | 2, 395, 664 | 1, 943, 471 | 997, 575 | 51. 33 | 4. 609 | . 521 | 3. 739 | . 423 | 1. 919 | . 217 |
| Western: | | | | | | | | | | | | | | | |
| Colorado | 35 | 268 | 9, 380 | 8. 0 | 75, 040 | 35, 535 | 35, 535 | 15, 671 | 44. 10 | 3. 788 | . 474 | 3. 788 | . 474 | 1. 671 | . 209 |
| Missouri | 216 | 282 | 60, 910 | 8. 1 | 493, 880 | 278, 742 | 124, 371 | 64, 801 | 52. 10 | 4. 576 | . 564 | 2. 042 | . 252 | 1. 064 | . 131 |
| New Mexico | 114 | 365 | 41, 610 | 8. 0 | 332, 880 | 221, 180 | 216, 269 | 110, 838 | 51. 25 | 5. 316 | . 664 | 5. 198 | . 650 | 2. 664 | . 333 |
| Utah | 151 | 218 | 32, 861 | 8. 0 | 262, 888 | 295, 009 | 295, 009 | 154, 315 | 52. 31 | 8. 977 | 1. 122 | 8. 977 | 1. 122 | 4. 696 | . 587 |
| Wyoming | 308 | 306 | 94, 308 | 8. 0 | 754, 464 | 630, 387 | 630, 387 | 357, 429 | 56. 70 | 6. 684 | . 836 | 6. 684 | . 836 | 3. 790 | . 474 |
| California | | | | | | 282 | 282 | 169 | 59. 93 | | | | | | |
| Montana | 23 | 47 | 1, 088 | 8. 2 | 8, 954 | 724 | 724 | 325 | 44. 89 | 2. 489 | . 302 | 2. 489 | . 302 | 1. 330 | . 162 |
| Washington | | | | | | 1, 702 | 1, 702 | 953 | 55. 99 | | | | | | |
| | 847 | 284 | 240, 157 | 8. 0 | 1, 928, 106 | 1, 463, 561 | 1, 304, 279 | 704, 501 | 54. 01 | 6. 094 | . 759 | 5. 431 | . 676 | 2. 934 | . 365 |
| | 34, 399 | 273 | 9, 395, 178 | 9. 0 | 84, 225, 524 | 75, 943, 775 | 67, 623, 000 | 34, 099, 262 | 50. 43 | 8. 083 | . 902 | 7. 198 | . 803 | 3. 629 | . 405 |

*Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man, 1923–32, by districts and States*—Continued

[Exclusive of ore containing 5 percent or more manganese]

| District and State | Employment | | | | | Production | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number of men employed | Time employed | | | | Crude ore (partly estimated), gross tons | Merchantable ore | | | Average per man (gross tons) | | | | | |
| | | Average number of days | Total man-shifts | Man-hours | | | Gross tons | Iron (natural) contained | | Crude ore (partly estimated) | | Merchantable ore | | | |
| | | | | Average per day | Total | | | Gross tons | Percent | Per day | Per hour | Per day | Per hour | Iron (natural) contained, Per day | Iron (natural) contained, Per hour |
| **1927** | | | | | | | | | | | | | | | |
| Lake Superior: | | | | | | | | | | | | | | | |
| Michigan | 10,691 | 277 | 2,964,954 | 8.4 | 24,798,798 | 15,075,079 | 15,075,079 | 7,673,923 | 50.90 | 5.084 | 0.608 | 5.084 | 0.608 | 2.588 | 0.309 |
| Minnesota | 13,218 | 239 | 3,159,948 | 8.8 | 27,940,067 | 38,578,600 | 35,461,138 | 18,413,192 | 51.92 | 12.209 | 1.381 | 11.222 | 1.269 | 5.827 | .659 |
| Wisconsin | 995 | 302 | 300,045 | 8.4 | 2,529,776 | 1,091,118 | 1,091,118 | 559,886 | 51.31 | 3.637 | .431 | 3.637 | .431 | 1.866 | .221 |
| | 24,904 | 258 | 6,424,947 | 8.6 | 55,268,641 | 54,744,797 | 51,627,335 | 26,647,001 | 51.61 | 8.521 | .991 | 8.035 | .934 | 4.147 | .482 |
| Southeastern: | | | | | | | | | | | | | | | |
| Alabama | 6,172 | 273 | 1,687,510 | 10.4 | 17,547,854 | 10,109,000 | 6,445,464 | 2,384,539 | 37.00 | 5.990 | .576 | 3.820 | .367 | 1.413 | .136 |
| Georgia | 117 | 248 | 28,968 | 10.0 | 289,680 | 365,000 | 50,312 | 22,312 | 44.35 | 12.600 | 1.260 | 1.737 | .174 | .770 | .077 |
| North Carolina | 75 | 156 | 11,700 | 10.0 | 117,000 | 32,528 | 32,528 | 13,662 | 42.00 | 2.780 | .278 | 2.780 | .278 | 1.168 | .117 |
| Tennessee | 301 | 249 | 75,030 | 9.3 | 697,920 | 338,000 | 121,914 | 48,386 | 39.69 | 4.505 | .484 | 1.625 | .175 | .645 | .069 |
| Virginia | 72 | 305 | 21,960 | 10.0 | 219,600 | 121,000 | 64,592 | 29,326 | 45.40 | 5.510 | .551 | 2.941 | .294 | 1.335 | .134 |
| | 6,737 | 271 | 1,825,168 | 10.3 | 18,872,054 | 10,965,528 | 6,714,810 | 2,498,225 | 37.20 | 6.008 | .581 | 3.679 | .356 | 1.369 | .132 |
| Northeastern: | | | | | | | | | | | | | | | |
| New Jersey | 333 | 275 | 91,612 | 8.1 | 739,972 | 326,935 | 220,660 | 134,874 | 61.12 | 3.569 | .442 | 2.409 | .298 | 1.472 | .182 |
| New York | 1,220 | 306 | 372,982 | 8.5 | 3,170,465 | 1,486,472 | 853,159 | 534,983 | 62.71 | 3.985 | .469 | 2.287 | .269 | 1.434 | .169 |
| Pennsylvania | 660 | 280 | 184,475 | 9.3 | 1,723,269 | 1,171,266 | 1,170,435 | 455,119 | 38.88 | 6.349 | .680 | 6.345 | .679 | 2.467 | .264 |
| | 2,213 | 293 | 649,069 | 8.7 | 5,633,706 | 2,984,673 | 2,244,254 | 1,124,976 | 50.13 | 4.598 | .530 | 3.458 | .398 | 1.733 | .200 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Western: | | | | | | | | | | | | | | | | |
| Colorado | 30 | 308 | 9,240 | 8.0 | 73,920 | 32,206 | 32,206 | 13,977 | 43.40 | 3.485 | .436 | 3.485 | .436 | 1.513 | .189 |
| Missouri | 202 | 318 | 64,154 | 8.0 | 513,232 | 144,155 | 78,605 | 40,312 | 51.28 | 2.247 | .281 | 1.225 | .153 | .628 | .079 |
| New Mexico | 109 | 365 | 39,785 | 8.0 | 318,280 | 222,555 | 214,747 | 109,542 | 51.01 | 5.594 | .699 | 5.398 | .675 | 2.753 | .344 |
| Utah | 54 | 260 | 14,049 | 8.0 | 112,392 | 222,879 | 222,879 | 115,860 | 51.98 | 15.864 | 1.983 | 15.864 | 1.983 | 8.247 | 1.031 |
| Wyoming | 483 | 309 | 149,247 | 8.0 | 1,193,976 | 602,877 | 602,877 | 328,568 | 54.50 | 4.039 | .505 | 4.039 | .505 | 2.202 | .275 |
| Montana } | 23 | 101 | 2,320 | 8.0 | 18,560 | 2,837 | 2,837 | 1,220 | 43.00 | 1.460 | .182 | 1.460 | .182 | .659 | .082 |
| Washington } | | | | | | 550 | 550 | 308 | 56.00 | | | | | | |
| | 901 | 309 | 278,795 | 8.0 | 2,230,360 | 1,228,059 | 1,154,701 | 609,787 | 52.81 | 4.405 | .551 | 4.142 | .518 | 2.187 | .273 |
| | 34,755 | 264 | 9,177,979 | 8.9 | 82,004,761 | 69,923,057 | 61,741,100 | 30,879,989 | 50.02 | 7.619 | .853 | 6.727 | .753 | 3.365 | .377 |
| 1928 | | | | | | | | | | | | | | | |
| Lake Superior: | | | | | | | | | | | | | | | |
| Michigan | 9,116 | 268 | 2,440,374 | 8.4 | 20,394,415 | 13,676,984 | 13,676,984 | 6,953,363 | 50.84 | 5.604 | .671 | 5.604 | .671 | 2.849 | .341 |
| Minnesota | 10,741 | 266 | 2,858,999 | 8.9 | 25,329,302 | 41,097,738 | 37,564,005 | 19,436,781 | 51.74 | 14.375 | 1.623 | 13.139 | 1.483 | 6.798 | .767 |
| Wisconsin | 1,024 | 257 | 263,226 | 8.6 | 2,272,370 | 1,284,592 | 1,284,592 | 671,226 | 52.25 | 4.880 | .565 | 4.880 | .565 | 2.550 | .295 |
| | 20,881 | 266 | 5,562,599 | 8.6 | 47,996,087 | 56,059,314 | 52,525,581 | 27,061,370 | 51.52 | 10.078 | 1.168 | 9.443 | 1.094 | 4.865 | .564 |
| Southeastern: | | | | | | | | | | | | | | | |
| Alabama | 5,979 | 259 | 1,550,459 | 10.2 | 15,822,034 | 10,304,000 | 6,307,844 | 2,357,532 | 37.37 | 6.646 | .651 | 4.068 | .399 | 1.521 | .149 |
| Tennessee | 224 | 271 | 60,770 | 9.5 | 574,850 | 412,000 | 128,928 | 48,553 | 37.66 | 6.780 | .717 | 2.122 | .224 | .799 | .084 |
| Georgia } | 180 | 239 | 43,090 | 10.0 | 430,900 | 565,000 | 73,052 | 33,297 | 45.58 | 13.112 | 1.311 | 2.343 | .234 | 1.047 | .105 |
| Virgina } | | | | | | | 27,902 | 11,809 | 42.32 | | | | | | |
| | 6,383 | 259 | 1,654,319 | 10.2 | 16,827,784 | 11,281,000 | 6,537,726 | 2,451,191 | 37.49 | 6.819 | .670 | 3.952 | .389 | 1.482 | .146 |
| Northeastern: | | | | | | | | | | | | | | | |
| New Jersey | 364 | 259 | 94,248 | 8.0 | 758,452 | 351,368 | 250,332 | 151,069 | 60.35 | 3.728 | .463 | 2.656 | .330 | 1.603 | .199 |
| New York | 1,152 | 242 | 278,213 | 8.3 | 2,319,298 | 1,005,970 | 712,757 | 450,000 | 63.14 | 3.616 | .434 | 2.562 | .307 | 1.617 | .194 |
| Pennsylvania | 461 | 238 | 109,844 | 9.2 | 1,015,651 | 1,024,466 | 1,023,870 | 433,839 | 42.37 | 9.327 | 1.009 | 9.321 | 1.008 | 3.950 | .427 |
| | 1,977 | 244 | 482,305 | 8.5 | 4,093,401 | 2,381,804 | 1,986,959 | 1,034,908 | 52.09 | 4.938 | .582 | 4.120 | .485 | 2.146 | .253 |
| Western: | | | | | | | | | | | | | | | |
| Colorado | 36 | 299 | 10,764 | 8.0 | 86,112 | 52,713 | 52,713 | 22,456 | 42.60 | 4.897 | .612 | 4.897 | .612 | 2.086 | .261 |
| Missouri | 171 | 258 | 44,090 | 8.2 | 363,280 | 157,997 | 94,899 | 47,294 | 49.84 | 3.584 | .435 | 2.152 | .261 | 1.073 | .130 |
| New Mexico | 138 | 346 | 47,690 | 8.0 | 381,520 | 188,981 | 184,623 | 94,158 | 51.00 | 3.963 | .495 | 3.871 | .484 | 1.974 | .247 |
| Utah | 88 | 293 | 25,742 | 8.0 | 206,043 | 320,655 | 320,655 | 165,715 | 51.68 | 12.456 | 1.556 | 12.456 | 1.556 | 6.438 | .804 |
| Wyoming | 547 | 329 | 179,963 | 8.0 | 1,439,704 | 495,800 | 491,280 | 271,187 | 55.20 | 2.755 | .344 | 2.730 | .341 | 1.507 | .188 |
| Montana } | 17 | 69 | 1,175 | 8.3 | 9,700 | 1,640 | 1,640 | 738 | 45.00 | 2.257 | .273 | 2.257 | .273 | 1.111 | .135 |
| Washington } | | | | | | 1,012 | 1,012 | 567 | 56.03 | | | | | | |
| | 997 | 310 | 309,424 | 8.0 | 2,486,359 | 1,218,798 | 1,146,822 | 602,115 | 52.50 | 3.939 | .490 | 3.706 | .461 | 1.946 | .242 |
| | 30,238 | 265 | 8,008,647 | 8.9 | 71,403,631 | 70,940,916 | 62,197,088 | 31,149,584 | 50.08 | 8.858 | .994 | 7.766 | .871 | 3.889 | .436 |

*Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man, 1923–32, by districts and States*—Continued

[Exclusive of ore containing 5 percent or more manganese]

| District and State | Employment | | | | | Production | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number of men employed | Time employed | | | | Crude ore (partly estimated), gross tons | Merchantable ore | | | Average per man (gross tons) | | | | | |
| | | Average number of days | Total man-shifts | Man-hours | | | Gross tons | Iron (natural) contained | | Crude ore (partly estimated) | | Merchantable ore | | | |
| | | | | Average per day | Total | | | Gross tons | Percent | Per day | Per hour | Per day | Per hour | Iron (natural) contained | |
| | | | | | | | | | | | | | | Per day | Per hour |
| **1929** | | | | | | | | | | | | | | | |
| Lake Superior: | | | | | | | | | | | | | | | |
| Michigan | 9,308 | 290 | 2,696,663 | 8.4 | 22,717,379 | 15,456,397 | 15,456,397 | 7,875,299 | 50.95 | 5.732 | 0.680 | 5.732 | 0.680 | 2.920 | 0.347 |
| Minnesota | 11,514 | 282 | 3,250,077 | 9.0 | 29,328,327 | 50,544,577 | 45,760,858 | 23,576,324 | 51.52 | 15.552 | 1.723 | 14.080 | 1.560 | 7.254 | .804 |
| Wisconsin | 989 | 300 | 296,869 | 8.7 | 2,569,321 | 1,608,571 | 1,608,571 | 842,904 | 52.40 | 5.418 | .626 | 5.418 | .626 | 2.839 | .328 |
| | 21,811 | 286 | 6,243,609 | 8.7 | 54,615,027 | 67,609,545 | 62,825,826 | 32,294,527 | 51.40 | 10.829 | 1.238 | 10.062 | 1.150 | 5.172 | .591 |
| Southeastern: | | | | | | | | | | | | | | | |
| Alabama | 5,498 | 265 | 1,458,896 | 10.0 | 14,595,242 | 10,367,000 | 6,453,075 | 2,417,833 | 37.47 | 7.106 | .710 | 4.423 | .442 | 1.657 | .166 |
| Georgia | 116 | 225 | 26,062 | 10.0 | 260,620 | 430,000 | 59,316 | 26,878 | 45.31 | 16.499 | 1.650 | 2.275 | .228 | 1.031 | .103 |
| North Carolina | 61 | 183 | 11,150 | 10.0 | 111,500 | 30,675 | 30,675 | 12,892 | 42.03 | 2.751 | .275 | 2.751 | .275 | 1.156 | .116 |
| Tennessee | 242 | 187 | 45,140 | 9.4 | 423,680 | 311,000 | 102,171 | 39,917 | 39.07 | 6.890 | .734 | 2.263 | .241 | .884 | .094 |
| | 5,917 | 260 | 1,541,248 | 10.0 | 15,391,042 | 11,138,675 | 6,645,237 | 2,497,520 | 37.58 | 7.227 | .724 | 4.312 | .432 | 1.620 | .162 |
| Northeastern: | | | | | | | | | | | | | | | |
| New York | 1,151 | 300 | 345,046 | 8.4 | 2,893,178 | 1,326,440 | 822,261 | 537,815 | 65.41 | 3.844 | .458 | 2.383 | .284 | 1.559 | .186 |
| New Jersey } Pennsylvania } | 946 | 231 | 218,646 | 8.7 | 1,893,979 | 424,598 | 281,327 | 171,539 | 60.97 | 6.939 | .801 | 6.281 | .725 | 2.757 | .318 |
| | | | | | | 1,092,557 | 1,092,013 | 431,354 | 39.50 | | | | | | |
| | 2,097 | 269 | 563,692 | 8.5 | 4,787,157 | 2,843,595 | 2,195,601 | 1,140,708 | 51.95 | 5.045 | .594 | 3.895 | .459 | 2.024 | .238 |
| Western: | | | | | | | | | | | | | | | |
| Colorado | 29 | 299 | 8,671 | 8.0 | 69,368 | 50,754 | 50,754 | 22,007 | 43.36 | 5.853 | .732 | 5.853 | .732 | 2.538 | .317 |
| Missouri | 282 | 293 | 82,687 | 8.0 | 661,496 | 316,031 | 168,934 | 83,077 | 49.18 | 3.822 | .478 | 2.043 | .255 | 1.005 | .126 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New Mexico | 112 | 365 | 40,880 | 8.0 | 327,040 | 235,016 | 171,585 | 87,011 | 50.71 | 5.749 | .719 | 4.197 | .525 | 2.128 | .266 |
| Utah | 104 | 291 | 30,230 | 8.0 | 241,920 | 324,985 | 324,985 | 167,880 | 51.66 | 10.750 | 1.343 | 10.750 | 1.343 | 5.553 | .694 |
| Wyoming | 396 | 317 | 125,532 | 8.0 | 1,004,256 | 639,477 | 639,477 | 341,992 | 53.48 | 5.094 | .637 | 5.094 | .637 | 2.724 | .341 |
| California | | | | | | 303 | 303 | 128 | 42.24 | | | | | | |
| Washington | 15 | 112 | 1,685 | 8.2 | 13,780 | 6,500 | 5,018 | 2,810 | 56.00 | 4.098 | .501 | 3.205 | .392 | 1.770 | .216 |
| Montana | | | | | | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| | 938 | 309 | 289,685 | 8.0 | 2,317,860 | 1,573,066 | 1,361,056 | 704,905 | 51.79 | 5.430 | .679 | 4.698 | .587 | 2.433 | .304 |
| | 30,763 | 281 | 8,638,234 | 8.9 | 77,111,086 | 83,164,881 | 73,027,720 | 36,637,660 | 50.17 | 9.628 | 1.079 | 8.454 | .947 | 4.241 | .475 |
| 1930 | | | | | | | | | | | | | | | |
| Lake Superior: | | | | | | | | | | | | | | | |
| Michigan | 9,466 | 270 | 2,558,955 | 8.4 | 21,558,824 | 13,544,277 | 13,544,277 | 6,956,301 | 51.36 | 5.293 | .628 | 5.293 | .628 | 2.718 | .323 |
| Minnesota | 12,007 | 251 | 3,018,630 | 9.1 | 27,544,613 | 39,458,022 | 34,517,748 | 17,640,469 | 51.11 | 13.071 | 1.433 | 11.435 | 1.253 | 5.844 | .640 |
| Wisconsin | 828 | 297 | 246,151 | 8.5 | 2,094,179 | 1,321,360 | 1,321,360 | 698,394 | 52.85 | 5.368 | .631 | 5.368 | .631 | 2.837 | .333 |
| | 22,301 | 261 | 5,823,736 | 8.8 | 51,197,616 | 54,323,659 | 49,383,385 | 25,295,164 | 51.22 | 9.328 | 1.061 | 8.480 | .965 | 4.343 | .494 |
| Southeastern: | | | | | | | | | | | | | | | |
| Alabama | 5,137 | 257 | 1,320,789 | 9.7 | 12,876,652 | 9,410,000 | 5,738,478 | 2,150,895 | 37.48 | 7.125 | .731 | 4.345 | .446 | 1.628 | .167 |
| Georgia | | | | | | | 52,221 | 23,726 | 45.43 | | | | | | |
| North Carolina | 166 | 162 | 26,932 | 10.0 | 269,128 | 629,100 | 100 | 50 | 50.00 | 23.359 | 2.338 | 3.699 | .370 | 1.710 | .171 |
| Tennessee | | | | | | | 27,710 | 12,863 | 46.42 | | | | | | |
| Virginia | | | | | | | 19,596 | 9,406 | 48.00 | | | | | | |
| | 5,303 | 254 | 1,347,721 | 9.8 | 13,145,780 | 10,039,100 | 5,838,105 | 2,196,940 | 37.63 | 7.449 | .764 | 4.332 | .444 | 1.630 | .167 |
| Northeastern: | | | | | | | | | | | | | | | |
| New York | 1,391 | 299 | 416,198 | 8.4 | 3,490,059 | 1,577,472 | 889,405 | 587,779 | 66.09 | 3.790 | .452 | 2.137 | .255 | 1.412 | .168 |
| New Jersey | 1,340 | 222 | 297,991 | 8.6 | 2,568,940 | 564,825 | 394,639 | 243,075 | 61.59 | 5.133 | .595 | 4.561 | .529 | 2.182 | .253 |
| Pennsylvania | | | | | | 964,888 | 964,638 | 407,151 | 42.21 | | | | | | |
| | 2,731 | 262 | 714,189 | 8.5 | 6,058,999 | 3,107,185 | 2,248,682 | 1,238,005 | 55.05 | 4.351 | .513 | 3.149 | .371 | 1.733 | .204 |
| Western: | | | | | | | | | | | | | | | |
| Colorado | 22 | 214 | 4,708 | 8.0 | 37,664 | 32,247 | 32,247 | 13,963 | 43.30 | 6.849 | .856 | 6.849 | .856 | 2.966 | .371 |
| Missouri | 244 | 212 | 51,786 | 8.1 | 419,328 | 229,815 | 132,749 | 64,562 | 48.63 | 4.438 | .548 | 2.563 | .317 | 1.247 | .154 |
| New Mexico | 96 | 365 | 35,040 | 8.0 | 280,320 | 219,843 | 173,432 | 89,193 | 51.43 | 6.274 | .784 | 4.950 | .619 | 2.545 | .318 |
| Utah | 91 | 319 | 28,996 | 8.0 | 232,748 | 279,118 | 279,118 | 145,104 | 51.99 | 9.626 | 1.199 | 9.626 | 1.199 | 5.004 | .623 |
| Wyoming | 175 | 173 | 30,345 | 8.0 | 242,760 | 320,023 | 320,023 | 168,972 | 52.80 | 10.546 | 1.318 | 10.546 | 1.318 | 5.568 | .696 |
| Arizona | | | | | | | | | | | | | | | |
| Montana | 12 | 48 | 575 | 8.5 | 4,900 | 923 | 923 | 554 | 60.00 | 1.605 | .188 | 6.105 | .188 | .963 | .113 |
| Washington | | | | | | | | | | | | | | | |
| | 640 | 237 | 151,450 | 8.0 | 1,217,720 | 1,081,969 | 938,492 | 482,348 | 51.40 | 7.144 | .889 | 6.197 | .771 | 3.185 | .396 |
| | 30,975 | 259 | 8,037,096 | 8.9 | 71,620,115 | 68,551,913 | 58,408,664 | 29,212,457 | 50.01 | 8.529 | .957 | 7.267 | .816 | 3.635 | .408 |

*Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output of ore per man, 1923–32, by districts and States*—Continued

[Exclusive of ore containing 5 percent or more manganese]

| District and State | Employment: Average number of men employed | Time employed: Average number of days | Time employed: Total man-shifts | Man-hours: Average per day | Man-hours: Total | Production: Crude ore (partly estimated), gross tons | Merchantable ore: Gross tons | Merchantable ore: Iron (natural) contained: Gross tons | Merchantable ore: Iron (natural) contained: Percent | Average per man (gross tons): Crude ore (partly estimated): Per day | Crude ore: Per hour | Merchantable ore: Per day | Merchantable ore: Per hour | Merchantable ore: Iron (natural) contained: Per day | Iron (natural) contained: Per hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1931 | | | | | | | | | | | | | | | |
| Lake Superior: | | | | | | | | | | | | | | | |
| Michigan | 7,570 | 197 | 1,495,018 | 8.5 | 12,665,311 | 7,552,581 | 7,552,581 | 3,914,557 | 51.83 | 5.052 | 0.596 | 5.052 | 0.596 | 2.618 | 0.309 |
| Minnesota | 8,375 | 210 | 1,760,152 | 9.1 | 16,096,418 | 19,756,108 | 17,445,003 | 9,026,505 | 51.74 | 11.224 | 1.227 | 9.911 | 1.084 | 5.128 | .561 |
| Wisconsin | 542 | 276 | 149,814 | 8.4 | 1,255,668 | 879,832 | 879,832 | 467,061 | 53.09 | 5.873 | .701 | 5.873 | .701 | 3.118 | .372 |
| | 16,487 | 207 | 3,404,984 | 8.8 | 30,017,397 | 28,188,521 | 25,877,416 | 13,408,123 | 51.81 | 8.279 | .939 | 7.600 | .862 | 3.938 | .447 |
| Southeastern: | | | | | | | | | | | | | | | |
| Alabama | 3,672 | 197 | 722,793 | 9.6 | 6,926,226 | 5,151,000 | 3,615,144 | 1,345,867 | 37.23 | 7.127 | .744 | 5.002 | .522 | 1.862 | .194 |
| Georgia } | 80 | 106 | 8,510 | 10.0 | 85,100 | 213,000 | 20,745 | 9,837 | 47.42 | 25.029 | 2.503 | 3.462 | .346 | 1.598 | .160 |
| Tennessee } | | | | | | | 8,717 | 3,766 | 43.20 | | | | | | |
| | 3,752 | 195 | 731,303 | 9.6 | 7,011,326 | 5,364,000 | 3,644,606 | 1,359,470 | 37.30 | 7.335 | .765 | 4.984 | .520 | 1.859 | .194 |
| Northeastern: | | | | | | | | | | | | | | | |
| New York | 544 | 175 | 95,233 | 8.4 | 804,304 | 418,796 | 275,075 | 180,832 | 65.74 | 4.398 | .521 | 2.888 | .342 | 1.899 | .225 |
| New Jersey } | 1,144 | 175 | 199,984 | 8.8 | 1,765,746 | 437,652 | 293,768 | 179,418 | 61.07 | 4.030 | .456 | 3.310 | .375 | 1.644 | .186 |
| Pennsylvania } | | | | | | 368,349 | 368,117 | 149,340 | 40.56 | | | | | | |
| | 1,688 | 175 | 295,217 | 8.7 | 2,570,050 | 1,224,797 | 936,960 | 509,590 | 54.39 | 4.149 | .477 | 3.174 | .365 | 1.726 | .198 |
| Western: | | | | | | | | | | | | | | | |
| Colorado | 36 | 180 | 6,480 | 8.0 | 51,840 | 26,202 | 26,202 | 11,345 | 43.30 | 4.044 | .505 | 4.044 | .505 | 1.751 | .219 |
| Missouri | 541 | 120 | 65,103 | 8.1 | 530,334 | 218,136 | 112,372 | 54,565 | 48.56 | 3.351 | .411 | 1.726 | .212 | .838 | .103 |
| Montana | 1 | 25 | 25 | 8.0 | 200 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| New Mexico | 144 | 365 | 52,560 | 8.0 | 420,480 | 176,467 | 168,075 | 88,408 | 52.60 | 3.357 | .420 | 3.198 | .400 | 1.682 | .210 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utah | 71 | 320 | 22,695 | 8.0 | 181,560 | 184,068 | 184,068 | 97,524 | 52.98 | 8.111 | 1.014 | 8.111 | 1.014 | 4.297 | .537 |
| Washington | 3 | 125 | 375 | 8.0 | 3,000 | 1,032 | 1,032 | 578 | 56.01 | 2.752 | .344 | 2.752 | .344 | 1.541 | .193 |
| Wyoming | 144 | 123 | 17,762 | 8.0 | 142,096 | 180,771 | 180,771 | 95,447 | 52.80 | 10.177 | 1.272 | 10.177 | 1.272 | 5.374 | .672 |
| | 940 | 176 | 165,000 | 8.1 | 1,329,510 | 786,676 | 672,520 | 347,867 | 51.73 | 4.768 | .592 | 4.076 | .506 | 2.108 | .262 |
| | 22,867 | 201 | 4,596,504 | 8.9 | 40,928,283 | 35,563,994 | 31,131,502 | 15,625,050 | 50.19 | 7.737 | .869 | 6.773 | .761 | 3.399 | .382 |
| **1932** | | | | | | | | | | | | | | | |
| Lake Superior: | | | | | | | | | | | | | | | |
| Michigan | 4,697 | 139 | 651,822 | 8.5 | 5,559,864 | 2,554,996 | 2,554,996 | 1,322,650 | 51.77 | 3.920 | .460 | 3.920 | .460 | 2.029 | .238 |
| Minnesota | 3,683 | 191 | 703,304 | 9.2 | 6,462,204 | 6,175,606 | 5,154,291 | 2,713,988 | 52.65 | 8.781 | .956 | 7.329 | .798 | 3.859 | .420 |
| Wisconsin | 388 | 188 | 72,800 | 8.5 | 616,639 | 430,140 | 430,140 | 230,436 | 53.57 | 5.909 | .698 | 5.909 | .698 | 3.165 | .374 |
| | 8,768 | 163 | 1,427,926 | 8.9 | 12,638,707 | 9,160,742 | 8,139,427 | 4,267,074 | 52.42 | 6.415 | .725 | 5.700 | .644 | 2.988 | .338 |
| Southeastern: | | | | | | | | | | | | | | | |
| Alabama | 2,891 | 106 | 305,489 | 9.7 | 2,964,520 | 1,634,000 | 1,374,534 | 513,722 | 37.37 | 5.352 | .551 | 4.502 | .464 | 1.683 | .173 |
| Georgia | | | | | | 925 | 925 | 420 | 45.41 | | | | | | |
| | 2,891 | 106 | 305,489 | 9.7 | 2,964,520 | 1,634,925 | 1,375,459 | 514,142 | 37.40 | 5.352 | .551 | 4.502 | .464 | 1.683 | .173 |
| Northeastern: | | | | | | | | | | | | | | | |
| New Jersey | 585 | 101 | 58,906 | 9.0 | 530,682 | 43,535 | 30,844 | 18,790 | 60.92 | 3.718 | .413 | 2.801 | .311 | 1.340 | .149 |
| New York | | | | | | 72,567 | 31,327 | 21,187 | 67.63 | | | | | | |
| Pennsylvania | | | | | | 102,888 | 102,838 | 38,983 | 37.91 | | | | | | |
| | 585 | 101 | 58,906 | 9.0 | 530,682 | 218,990 | 165,009 | 78,960 | 47.85 | 3.718 | .413 | 2.801 | .311 | 1.340 | .149 |
| Western: | | | | | | | | | | | | | | | |
| Missouri | 401 | 88 | 35,256 | 8.2 | 289,700 | 29,797 | 29,797 | 15,931 | 53.47 | 4.681 | .570 | 4.681 | .570 | 2.468 | .300 |
| Utah | | | | | | 137,224 | 137,224 | 72,136 | 52.57 | | | | | | |
| Montana | 1 | 25 | 25 | 8.0 | 200 | ------ | ------ | ------ | ------ | | | | | | |
| Washington | 1 | 150 | 150 | 8.0 | 1,200 | ------ | ------ | ------ | ------ | | | | | | |
| Wyoming | 2 | 125 | 250 | 8.0 | 2,000 | ------ | ------ | ------ | ------ | | | | | | |
| | 405 | 88 | 35,681 | 8.2 | 293,100 | 167,021 | 167,021 | 88,067 | 52.73 | 4.681 | .570 | 4.681 | .570 | 2.468 | .300 |
| | 12,649 | 145 | 1,828,002 | 9.0 | 16,427,009 | 11,181,678 | 9,846,916 | 4,948,243 | 50.25 | 6.117 | .681 | 5.387 | .599 | 2.707 | .301 |

69174—34——23

## IRON ORE

*Production and shipments.*—Iron ore was mined at 132 mines in 15 States in 1933 compared with 129 mines in 10 States in 1932. California, Tennessee, Virginia, Washington, and Wyoming reentered the list of iron-ore producing States. In 1933, 2 iron-ore mines produced a million tons or more each and 47 had an output of 100,000 tons or more, whereas in 1932 no mine produced a million tons and only 27 yielded 100,000 tons or more. The production of iron ore in 1933 was 17,553,188 gross tons, an increase of 78 percent over 1932 but 69 percent below the average for the 5-year period 1927–31. Shipments of iron ore were 24,624,285 gross tons in 1933, an increase of 362 percent over 1932 but 57 percent below the average for 1927–31. The greater part of the iron ore mined in the United States is used in the manufacture of iron and steel; but some of the ore produced in 1933 was used in making paint, cement, and ferromagnesite, and for 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 (1,125 gross tons in 1933 valued at $8,435—$7.50 a ton—compared with 1,567 gross tons in 1932 valued at $10,770—$6.87 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; 191,631 gross tons valued at $529,204 were shipped in 1933 compared with 25,434 gross tons valued at $92,135 in 1932. In Arkansas one producer shipped 1 gross ton 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 1933, 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 | 19 | 1,925,476 | 207,981 | | | 2,133,457 |
| California | 1 | | 25 | | | 25 |
| Georgia | 2 | | 1,302 | | | 1,302 |
| Michigan | 37 | 2,433,949 | | | | 2,433,949 |
| Minnesota | 58 | 11,948,596 | | | | 11,948,596 |
| Missouri | 1 | 395 | | | | 395 |
| New Jersey | 1 | | | 73,144 | | 73,144 |
| New York | 1 | | | 58,718 | | 58,718 |
| Pennsylvania | 3 | | 640 | 263,227 | 499 | 264,366 |
| Tennessee | 2 | | 24,912 | | | 24,912 |
| Utah | 2 | 95,129 | 150 | | | 95,279 |
| Virginia | 1 | | 287 | | | 287 |
| Washington | 1 | | | 1,631 | | 1,631 |
| Wisconsin | 2 | 228,487 | | | | 228,487 |
| Wyoming | 1 | 288,640 | | | | 288,640 |
| Total, 1933 | 132 | 16,920,672 | 235,297 | 396,720 | 499 | 17,553,188 |
| Total, 1932 | [1] 129 | [2] 9,621,808 | 61,739 | [2] 162,892 | 477 | 9,846,916 |

[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, 1931–33, by States and mining methods, in gross tons*

[Exclusive of ore containing 5 percent or more manganese]

| State | Open pit | Underground | Undistributed | Total |
|---|---|---|---|---|
| 1931 | | | | |
| Alabama | 245, 663 | 3, 369, 481 | | 3, 615, 144 |
| Colorado | | 26, 202 | | 26, 202 |
| Georgia | 20, 745 | | | 20, 745 |
| Michigan | 863, 840 | 6, 688, 741 | | 7, 552, 581 |
| Minnesota | 12, 055, 312 | 5, 389, 691 | | 17, 445, 003 |
| Missouri | 70, 093 | 20, 366 | 21, 913 | 112, 372 |
| New Jersey | | 293, 768 | | 293, 768 |
| New Mexico | 67, 695 | 100, 380 | | 168, 075 |
| New York | (1) | [1] 275, 075 | | 275, 075 |
| Pennsylvania | 314, 001 | 54, 116 | | 368, 117 |
| Tennessee | 8, 717 | | | 8, 717 |
| Utah | 184, 068 | | | 184, 068 |
| Washington | | 1, 032 | | 1, 032 |
| Wisconsin | 31 | 879, 801 | | 879, 832 |
| Wyoming | | | 180, 771 | 180, 771 |
| | [1] 13,830, 165 | [1] 17,098, 653 | 202, 684 | 31, 131, 502 |
| 1932 | | | | |
| 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 |
| | 3, 413, 486 | 6, 432, 673 | 757 | 9, 846, 916 |
| 1933 | | | | |
| Alabama | 208, 367 | 1, 925, 090 | | 2, 133, 457 |
| California | 25 | | | 25 |
| Georgia | 1, 302 | | | 1, 302 |
| Michigan | 210, 349 | 2, 223, 600 | | 2, 433, 949 |
| Minnesota | 10, 405, 709 | 1, 542, 887 | | 11, 948, 596 |
| Missouri | 395 | | | 395 |
| New Jersey | | 73, 144 | | 73, 144 |
| New York | | 58, 718 | | 58, 718 |
| Pennsylvania | 263, 814 | 552 | | 264, 366 |
| Tennessee | 24, 912 | | | 24, 912 |
| Utah | 95, 129 | 150 | | 95, 279 |
| Virginia | 287 | | | 287 |
| Washington | 1, 631 | | | 1, 631 |
| Wisconsin | | 228, 487 | | 228, 487 |
| Wyoming | 29, 785 | 258, 855 | | 288, 640 |
| | 11, 241, 705 | 6, 311, 483 | | 17, 553, 188 |

[1] Some open pit included with underground.

*Iron ore mined in the United States, 1932–33, by States and counties*

[Exclusive of ore containing 5 percent or more manganese]

| State and county | 1932 | | 1933 | |
|---|---|---|---|---|
| | Active mines | Gross tons | Active mines | Gross tons |
| Alabama: | | | | |
| Blount | | | 2 | 89, 782 |
| Butler | | | 2 | 4, 982 |
| Cherokee | 1 | 6, 977 | 1 | 12, 137 |
| Etowah | | | 1 | 386 |
| Franklin | 1 | 31, 218 | 2 | 64, 770 |
| Jefferson | 4 | 1, 332, 975 | 5 | 1, 925, 090 |
| Shelby | | | 1 | 26, 090 |
| Talladega | 1 | 34 | 4 | 7, 525 |
| Tuscaloosa | 1 | 3, 330 | 1 | 2, 695 |
| | 8 | 1, 374, 534 | 19 | 2, 133, 457 |
| California: Alameda | | | 1 | 25 |

*Iron ore mined in the United States, 1932–33, by States and counties*—Continued

| State and county | 1932 Active mines | 1932 Gross tons | 1933 Active mines | 1933 Gross tons |
|---|---|---|---|---|
| Georgia: | | | | |
| Floyd | 1 | 925 | 1 | 302 |
| Polk | | | 1 | 1,000 |
| | 1 | 925 | 2 | 1,302 |
| Michigan: | | | | |
| Baraga | 1 | 28,326 | | |
| Dickinson | 3 | 187,002 | 1 | 69,170 |
| Gogebic | 12 | 994,903 | 10 | 880,837 |
| Iron | 16 | 622,399 | 13 | 492,338 |
| Marquette | 12 | 722,366 | 13 | 991,604 |
| | 44 | 2,554,996 | 37 | 2,433,949 |
| Minnesota: | | | | |
| Crow Wing | 6 | 536,659 | 4 | 279,997 |
| Itasca | 11 | 1,890,681 | 16 | 3,053,634 |
| St. Louis | 25 | 2,726,951 | 38 | 8,614,965 |
| | 42 | 5,154,291 | 58 | 11,948,596 |
| Missouri: | | | | |
| Bollinger | (1) | 43 | | |
| Butler | (1) | 1,394 | | |
| Carter | (1) | 1,067 | | |
| Crawford | 2 | 2,311 | | |
| Dent | 1 | 740 | | |
| Franklin | 3 | 2,219 | | |
| Greene | (1) | 80 | | |
| Howell | (1) | 221 | | |
| Iron | [2] 3 | 371 | | |
| Madison | [2] 1 | 1,163 | | |
| Phelps | 2 | 773 | | |
| Reynolds | [2] 8 | 4,352 | | |
| Ripley | (1) | 248 | | |
| St. Francois | [2] 1 | 6,118 | 1 | 395 |
| Shannon | [2] 1 | 2,516 | | |
| Wayne | [2] 2 | 6,181 | | |
| | [2] 24 | 29,797 | 1 | 395 |
| New Jersey: | | | | |
| Morris | 1 | 30,844 | | |
| Warren | | | 1 | 73,144 |
| | 1 | 30,844 | 1 | 73,144 |
| New York: | | | | |
| Clinton | 1 | 31,327 (Clinton and Oneida) | 1 | 58,718 |
| Oneida | 1 | | | |
| | 2 | 31,327 | 1 | 58,718 |
| Pennsylvania: | | | | |
| Carbon | 1 | 477 | 1 | 499 |
| Lebanon | 1 | 100,721 | 1 | 263,227 |
| Venango | 1 | 1,640 | 1 | 640 |
| | 3 | 102,838 | 3 | 264,366 |
| Tennessee: | | | | |
| Hickman | | | 1 | 20,912 |
| Lawrence | | | 1 | 4,000 |
| | | | 2 | 24,912 |
| Utah: | | | | |
| Box Elder | 1 | 350 | 1 | 150 |
| Iron | 1 | 136,874 | 1 | 95,129 |
| | 2 | 137,224 | 2 | 95,279 |
| Virginia: Botetourt | | | 1 | 287 |
| Washington: Stevens | | | 1 | 1,631 |
| Wisconsin: Iron | 2 | 430,140 | 2 | 228,487 |
| Wyoming: Platte | | | 1 | 288,640 |
| Total for United States | [3] 129 | 9,846,916 | 132 | 17,553,188 |

[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.
[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 1933, in gross tons*

[Exclusive of ore containing 5 percent or more manganese]

| District | Hematite | Brown ore | Magnetite | Carbonate | Total |
|---|---|---|---|---|---|
| Lake Superior [1] | 14,611,032 | | | | 14,611,032 |
| Birmingham | 1,925,090 | 118,567 | | | 2,043,657 |
| Chattanooga | 386 | 20,964 | | | 21,350 |
| Adirondack | | | 58,718 | | 58,718 |
| Northern New Jersey and southeastern New York | | | 73,144 | | 73,144 |
| Other districts | 384,164 | 95,766 | 264,858 | 499 | 745,287 |
| Total, 1933 | 16,920,672 | 235,297 | 396,720 | 499 | 17,553,188 |
| Total, 1932 | [2] 9,621,808 | 61,739 | [2] 162,892 | 477 | 9,846,916 |

[1] Includes only those mines in Wisconsin that are in the true Lake Superior district.
[2] Some hematite included with magnetite.

*Quantity and tenor of iron ore mined in the United States, 1932–33*

[Exclusive of ore containing 5 percent or more manganese]

| State | 1932 | | 1933 | |
|---|---|---|---|---|
| | Gross tons | Iron content (natural) | Gross tons | Iron content (natural) |
| | | *Percent* | | *Percent* |
| Alabama | 1,374,534 | 37.37 | 2,133,457 | 37.46 |
| California | | | 25 | 42.00 |
| Georgia | 925 | 45.41 | 1,302 | 45.00 |
| Michigan | 2,554,996 | 51.77 | 2,433,949 | 51.55 |
| Minnesota | 5,154,291 | 52.65 | 11,948,596 | 51.84 |
| Missouri | 29,797 | 53.47 | 395 | 66.74 |
| New Jersey | 30,844 | 60.92 | 73,144 | 61.17 |
| New York | 31,327 | 67.63 | 58,718 | 68.75 |
| Pennsylvania | 102,838 | 37.91 | 264,366 | 39.76 |
| Tennessee | | | 24,912 | 45.21 |
| Utah | 137,224 | 52.57 | 95,279 | 52.21 |
| Virginia | | | 287 | 45.00 |
| Washington | | | 1,631 | 60.85 |
| Wisconsin | 430,140 | 53.57 | 228,487 | 53.42 |
| Wyoming | | | 288,640 | 53.42 |
| | 9,846,916 | 50.25 | 17,553,188 | 50.01 |

*Iron ore shipped from mines in the United States, 1932–33, by States*

[Exclusive of ore containing 5 percent or more manganese and ore sold for paint]

| State | 1932 | | 1933 | |
|---|---|---|---|---|
| | Gross tons | Value | Gross tons | Value |
| Alabama | 1,470,445 | $2,428,227 | 2,156,142 | $3,252,630 |
| Georgia | 925 | (1) | 302 | (1) |
| Michigan | 968,789 | 2,703,900 | 6,099,031 | 18,442.073 |
| Minnesota | 2,248,727 | 6,263,181 | 14,784,763 | 38,291,656 |
| Missouri | 25,418 | 72,144 | | |
| New Jersey | 14,966 | (1) | 73,385 | (1) |
| New York | 30,600 | (1) | 163,000 | (1) |
| Pennsylvania | 74,420 | 157,400 | 324,052 | 650,664 |
| Tennessee | | | 24,912 | 47,824 |
| Utah | 136,874 | (1) | 95,129 | (1) |
| Virginia | | | 287 | 574 |
| Washington | | | 1,631 | (1) |
| Wisconsin | 360,037 | 905,601 | 613,011 | 1,646,076 |
| Wyoming | | | 288,640 | (1) |
| Undistributed | | [2] 367,558 | | [2] 1,444,536 |
| | 5,331,201 | 12,898,011 | 24,624,285 | 63,776,033 |

[1] Included under "Undistributed."
[2] This figure includes value for States entered as "(1)" above.

*Principal iron-ore mines.*—In 1933, 47 iron-ore mines produced more than 100,000 gross tons each, compared with 27 in 1932. Of these 47 mines 2 (both in Minnesota) produced more than 1,000,000 tons each in 1933. The predominance of hematite as an iron ore is clearly shown by the fact that of these 47 mines, 46 produced hematite and 1 produced magnetite. The importance of large mining units is shown in the production of 84 percent of the output of the country by the 47 mines which yielded more than 100,000 tons each.

*Iron-ore mines of the United States (arranged in order of rank) that produced more than 100,000 gross tons each in 1933*

[All mines produced hematite except Cornwall, which produced magnetite]

| Name of mine | State | Nearest town | Gross tons |
|---|---|---|---|
| Hartley-Burt | Minnesota | Chisholm | 2,175,464 |
| Sellers | do | Hibbing | 1,082,435 |
| Red Mountain group | Alabama | Bessemer | 939,633 |
| Adams-Spruce group | Minnesota | Eveleth | 769,360 |
| Morrison | do | Coleraine | 588,319 |
| Hill Annex | do | Calumet | 564,398 |
| Missabe Mountain | do | Virginia | 549,306 |
| Minnewas | do | do | 505,581 |
| Woodward Nos. 1 and 3 | Alabama | Bessemer | 388,475 |
| St. Paul | Minnesota | Keewatin | 339,549 |
| Burt-Pool-Day | do | Hibbing | 333,043 |
| Dunwoody | do | Chisholm | 317,520 |
| Mesabi Chief | do | Nashwauk | 310,236 |
| Canisteo | do | Coleraine | 302,326 |
| Sloss Nos. 1 and 2 | Alabama | Bessemer | 290,767 |
| Sunrise | Wyoming | Sunrise | 288,640 |
| Raimund Nos. 1 and 2 | Alabama | Bessemer | 266,488 |
| Cambria-Lillie | Michigan | Negaunee | 264,066 |
| Cornwall | Pennsylvania | Miners Village | 263,227 |
| Hull-Rust | Minnesota | Hibbing | 257,648 |
| Susquehanna | do | do | 225,182 |
| Wacootah | do | Mountain Iron | 221,389 |
| Montreal | Wisconsin | Montreal | 210,289 |
| Leonidas | Minnesota | Eveleth | 186,667 |
| Alexandria | do | Hibbing | 168,701 |
| Godfrey-Wellington | do | Chisholm | 161,623 |
| Newport | Michigan | Ironwood | 157,414 |
| Wheeling | Minnesota | Virginia | 154,089 |
| Webb | do | Hibbing | 153,102 |
| Kinney | do | Kinney | 151,956 |
| Shenango | do | Chisholm | 151,010 |
| Patrick-Ann | do | Cooley | 150,954 |
| Ironton | Michigan | Bessemer | 147,700 |
| Maas | do | Negaunee | 144,707 |
| Hoadley | Minnesota | Nashwauk | 143,948 |
| Wakefield | Michigan | Wakefield | 135,390 |
| Pioneer | Minnesota | Ely | 134,691 |
| Genesee-Tobin | Michigan | Crystal Falls | 133,931 |
| Harrison | Minnesota | Cooley | 127,954 |
| Morris | Michigan | Ishpeming | 126,198 |
| North Harrison | Minnesota | Cooley | 125,048 |
| Hawkins | do | Nashwauk | 116,126 |
| Morris | do | Hibbing | 110,712 |
| Croft | do | Crosby | 110,297 |
| Norrie-Aurora | Michigan | Ironwood | 107,103 |
| Margaret | Minnesota | Buhl | 104,705 |
| Mace No. 2 | do | Nashwauk | 100,515 |
| Total (47 mines) | | | 14,757,882 |
| Output of 30 mines producing between 50,000 and 100,000 tons each | | | 2,044,310 |
| Output of 55 mines producing less than 50,000 tons each | | | 750,996 |
| Grand total of United States (132 mines) | | | 17,553,188 |

*Beneficiated iron ore.*—Beneficiation of iron ore was reported at 32 mines in 7 States in 1933 and at 17 mines in 5 States in 1932. 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 1933 amounted to 3,555,892 gross tons valued at $9,370,879 compared with 407,486 tons valued at $1,119,804 in 1932.

The quantity of crude ore beneficiated in the Lake Superior district in 1933 amounted to 4,639,776 gross tons and the beneficiated ore recovered to 2,642,234—a ratio of 1.756 : 1. In 1932 the crude ore treated amounted to 2,477,163 tons and the beneficiated ore recovered therefrom 1,455,848 tons—a ratio of 1.702 : 1.

*Beneficiated iron ore shipped from mines in the United States, 1932–33*

[Exclusive of ore containing 5 percent or more manganese and of ore sold for paint]

| State | Variety | 1932 | | 1933 | |
|---|---|---|---|---|---|
| | | Gross tons | Value | Gross tons | Value |
| Alabama | Brown ore | 31, 218 | $70, 241 | 183, 128 | $381, 074 |
| Michigan | Hematite | | | 2, 217 | (1) |
| Minnesota | do | 292, 458 | 782, 323 | 2, 908, 922 | 7, 404, 861 |
| New Jersey | Magnetite | 14, 966 | (1) | 73, 385 | (1) |
| New York | do | 30, 600 | (1) | 163, 000 | (1) |
| Pennsylvania | do | 38, 244 | 72, 663 | 200, 041 | 600, 123 |
| Tennessee | Brown ore | | | 24, 912 | 47, 824 |
| Virginia | do | | | 287 | 574 |
| Undistributed | | | 194, 577 | | 936, 423 |
| | | 407, 486 | 1, 119, 804 | 3, 555, 892 | 9, 370, 879 |

[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 for 1929–33. Corresponding figures for 1914 (the first year for which statistics were gathered) to 1928 are given in Mineral Resources for 1930.

*Iron ore shipped from mines in the United States, 1929–33, 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 |
|---|---|---|---|---|---|---|---|
| 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 | 1933 | 3, 555, 892 | 24, 624, 285 | 14. 4 |
| 1931 | 4, 676, 364 | 28, 516, 032 | 16. 4 | | | | |

*Average value of ore.*—The average value per ton of iron ore at the mines in 1933 was $2.59 compared with $2.42 in 1932.

The table that follows gives the average value at the mines of the different classes of iron ore in 1932–33 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 figure 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, 1932–33*

[Exclusive of ore containing 5 percent or more manganese and of ore sold for paint]

| State | Hematite | | Brown ore | | Magnetite | |
|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | 1932 | 1933 |
| Alabama | $1.64 | $1.45 | $2.10 | $2.08 | | |
| Michigan | 2.79 | 3.02 | | | | |
| Minnesota | 2.79 | 2.59 | | | | |
| Missouri | 3.21 | | 2.65 | | | |
| Pennsylvania | | | (1) | (1) | $1.99 | $2.00 |
| Tennessee | | | | 1.92 | | |
| Virginia | | | | 2.00 | | |
| Wisconsin | 2.52 | 2.69 | | | | |
| Other States [2] | (1) | 1.31 | (1) | 1.87 | (1) | 3.96 |
| | 2.41 | 2.59 | 2.39 | 2.08 | 2.87 | 2.83 |

[1] Less than 3 producers; permission to publish not given, therefore value may not be shown.
[2] 1932: Georgia, New Jersey, New York, and Utah; 1933: Georgia, New Jersey, New York, Utah, Washington, and Wyoming.

*Iron ore consumed.*—The production of 13,027,343 gross tons of pig iron in 1933 required 21,735,207 gross tons of iron ore and 2,763,242 tons of cinder, scale, and scrap, an average of 1.88 tons of metalliferous materials per ton of iron made.

The greater part of the iron ore used in Alabama furnaces in 1933 was hematite chiefly from mines in Jefferson County, Ala. Considerable brown ore and small quantities of ferruginous manganese ore, iron sinter, and imported iron ore also were used. The brown ore was chiefly from mines in the Birmingham and Russellville districts, Alabama; the ferruginous manganese ore was chiefly from mines in Alabama, Arkansas, and Georgia; and the iron sinter was from Tennessee. The furnaces in Alabama in making 1 ton of pig iron consumed in 1933 an average of 2.459 tons of ore, the highest average for any State.

In 1933 the furnaces in Maryland used foreign ores obtained from Australia, Africa, Chile, Cuba, Russia, and Sweden. The Maryland furnaces consumed an average of only 1.351 tons of ore in making 1 ton of pig iron in 1933; however, they used proportionately more cinder, scale, and scrap than the furnaces in any other State except Kentucky.

The blast furnaces in Illinois, Indiana, Kentucky, Michigan, Ohio, and West Virginia used Lake Superior iron ore and manganiferous iron ore exclusively in 1933. The consumption of ores per ton of iron made in this group of States ranged from 1.113 tons in Kentucky to 1.647 tons in Indiana.

In New York the furnaces in the Buffalo district used ores from the Lake Superior district; the furnaces at Port Henry used magnetite from the mines at Mineville, N.Y.; and the furnace at Standish used magnetite from the Chateaugay mine at Lyon Mountain, N.Y., and small quantities of ferruginous manganese ore from the Lake Superior district and Canada. In making 1 ton of pig iron the furnaces in New York used an average of 1.675 tons of ore in 1933.

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 mines in New Jersey, New York, and Pennsylvania and considerable quantities of ores from Africa, Australia, Brazil, Chile, Cuba, and Russia. An average of 1.614 tons of ore was used to make 1 ton of pig iron in Pennsylvania in 1933.

The blast furnaces at Pueblo, Colo., used hematite from the Sunrise mine in Wyoming and rhodochrosite from the Emma mine in Montana.

The blast furnace at Provo, Utah, used iron ore chiefly from the Desert Mound mine in the Iron Springs district, Utah. The manganiferous iron ore used was obtained chiefly from Montana and Utah.

The furnace at Wrigley, Tenn., used chiefly brown ore from the Johnson mine, also at Wrigley.

*Iron ore and other metallic materials consumed and pig iron produced in 1933, 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 | 2,203,840 | 9,476 | 93,230 | 2,306,546 | 900,170 | 2.459 | 0.103 | 2.562 |
| Illinois | 1,620,667 | | 158,193 | 1,778,860 | 1,012,676 | 1.600 | .157 | 1.757 |
| Indiana | 1,949,533 | | 251,678 | 2,201,211 | 1,183,405 | 1.647 | .213 | 1.860 |
| Kentucky | 114,685 | | 60,589 | 175,274 | 103,017 | 1.113 | .588 | 1.701 |
| Maryland | | 833,827 | 223,189 | 1,057,016 | 617,187 | 1.351 | .362 | 1.713 |
| Michigan | 469,335 | | 75,734 | 545,069 | 308,315 | 1.522 | .246 | 1.768 |
| New York | 1,115,153 | 260 | 104,081 | 1,219,494 | 665,933 | 1.675 | .156 | 1.831 |
| Ohio | 6,414,904 | | 845,982 | 7,260,886 | 3,918,723 | 1.637 | .216 | 1.853 |
| Pennsylvania | 5,817,897 | 209,407 | 905,614 | 6,932,918 | 3,733,570 | 1.614 | .243 | 1.857 |
| West Virginia | 666,234 | | 34,148 | 700,382 | 410,421 | 1.623 | .083 | 1.706 |
| Undistributed [1] | 309,989 | | 10,804 | 320,793 | 173,926 | 1.782 | .062 | 1.844 |
| | 20,682,237 | 1,052,970 | 2,763,242 | 24,498,449 | 13,027,343 | 1.668 | .212 | 1.880 |

[1] Includes Colorado, Iowa, Tennessee, and Utah.

*Foreign iron and manganiferous iron ore consumed in the manufacture of pig iron in the United States, 1932–33, by sources of ore, in gross tons*

| Source of ore | 1932 | 1933 | Source of ore | 1932 | 1933 |
|---|---|---|---|---|---|
| Africa | 13,898 | 89,973 | Russia | 71,426 | 183,766 |
| Australia | 39,423 | 51,399 | Sweden | 31,157 | 42,449 |
| Brazil | | 2,333 | Undistributed | 8,066 | |
| Canada | 143 | 260 | | | |
| Chile | 395,732 | 522,351 | | 652,352 | 1,052,970 |
| Cuba | 92,507 | 160,439 | | | |

*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 1933 amounted to 10,953,021 gross tons, a decrease of 38 percent from 1932. These stocks were about 509,000 tons below the average for the 5-year period 1928–32.

*Stocks of iron ore at mines, Dec. 31, 1932–33, by States, in gross tons*

| State | 1932 | 1933 | State | 1932 | 1933 |
|---|---|---|---|---|---|
| Alabama | 798,734 | 775,999 | New York | 180,790 | 74,009 |
| Georgia | | 1,000 | North Carolina | 200 | 200 |
| Iowa | 12,165 | 12,165 | Pennsylvania | 60,635 | 450 |
| Michigan | 10,260,532 | 6,675,360 | Virginia | 3,473 | 3,473 |
| Minnesota | 5,516,724 | 3,021,496 | Wisconsin | 630,930 | 258,562 |
| Missouri | 4,702 | 5,055 | | | |
| New Jersey | 134,988 | 125,252 | | 17,603,873 | 10,953,021 |

*Foreign trade in iron ore.*—The iron ore imported into the United States amounted to 861,153 gross tons valued at $2,054,312 in 1933, an increase of 48 percent in quantity and 33 percent in total value over 1932. Chile continued to be the chief source of imports, furnishing 54 percent of the total, while Cuba supplied 17 percent and Russia 16 percent.

*Iron ore imported into the United States, 1931–33, by countries*

| Country | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Gross tons | Value | Gross tons | Value | Gross tons | Value |
| Africa: | | | | | | |
| Algeria and Tunisia | 70,471 | $276,752 | 10,000 | $25,632 | 28,280 | $101,296 |
| Morocco | 15,509 | 53,643 | | | 15,510 | 63,181 |
| Australia | 39,979 | 147,584 | | | | |
| Belgium | 115 | 781 | 5,012 | 12,605 | | |
| Brazil | 25 | 416 | | | 3,600 | 14,757 |
| Canada | 1,490 | 4,913 | 807 | 2,584 | 90 | 316 |
| Chile | 750,702 | 1,819,355 | 218,492 | 517,725 | 467,650 | 940,753 |
| Cuba | 89,000 | 212,386 | 77,000 | 184,143 | 143,150 | 330,526 |
| Germany | 25 | 730 | 150 | 2,111 | 700 | 11,944 |
| India, British | | | | | 1,199 | 4,678 |
| Italy | | | | | 9 | 50 |
| Kwantung | 8 | 41 | | | | |
| Mexico | 1,456 | 3,150 | 281 | 622 | 148 | 310 |
| Netherlands | 1 | 19 | | | | |
| Newfoundland and Labrador | 22,920 | 77,939 | | | | |
| Norway | 73,082 | 262,527 | 99,911 | 399,943 | 62,334 | 247,202 |
| Persia | | | | | 1,500 | 25,549 |
| Philippine Islands | 3 | 20 | | | | |
| Soviet Russia in Europe | 278,612 | 571,290 | 162,740 | 356,775 | 135,840 | 297,574 |
| Spain | 38,191 | 121,179 | 245 | 1,952 | 900 | 8,711 |
| Sweden | 83,554 | 341,404 | 7,037 | 27,938 | 2 | 10 |
| United Kingdom | 470 | 7,646 | 822 | 7,324 | 241 | 7,455 |
| Venezuela | | | 1 | 20 | | |
| | 1,465,613 | 3,901,775 | 582,498 | 1,539,374 | 861,153 | 2,054,312 |

Exports of iron ore from the United States amounted to 155,271 gross tons valued at $646,533 ($4.16 a ton) in 1933 compared with 83,449 tons valued at $219,852 ($2.63 a ton) in 1932. All the iron ore exported in 1933 went to Canada.

*Iron-ore mining in Cuba.*—Shipments of iron ore from Cuba to the United States amounted to 166,813 gross tons in 1933, an increase of 105 percent over 1932. They consisted of 108,405 tons of hematite carrying 55.99 percent iron (dried) and 58,408 tons of siliceous ore carrying 31.45 percent iron from the Daiquiri and Juragua mines on the southern coast. The Mayari mines near the northern coast were inactive in 1933.

The total stock of ore reported on hand was 651,250 gross tons at the end of 1933 compared with 684,933 tons at the end of 1932.

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, 1884–1933, 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 |
|---|---|---|---|---|---|---|
| 1884–1931 | [1] 20,372,353 | 20,438 | 3,670,514 | 41,241 | 903,103 | 25,007,649 |
| 1932 | 69,870 | | 11,435 | | | 81,305 |
| 1933 | 166,813 | | | | | 166,813 |
| | 20,609,036 | 20,438 | 3,681,949 | 41,241 | 903,103 | 25,255,767 |

[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 14,611,032 gross tons in 1933, an increase of 80 percent compared with 1932. The output of the several ranges is shown in the following table. After 1905 the figures do not include manganiferous iron ore containing 5 percent or more manganese. The Mesabi Range produced 78 percent of the iron-ore output of the Lake Superior district (52 percent in 1932) and 65 percent of the total output of the United States (43 percent in 1932). The proportion contributed by this range was remarkably uniform from 1915 to 1931; for the Lake Superior district the proportion from 1915 to 1931 ranged from 60 to 71 percent and averaged 66 percent, and for the United States it ranged from 50 to 60 percent and averaged 56 percent.

*Iron ore mined in the Lake Superior district, 1854–1933, in gross tons*

[Exclusive after 1905 of ore containing 5 percent or more manganese]

| Year | Marquette | Menominee | Gogebic | Vermilion | Mesabi | Cuyuna | Total |
|---|---|---|---|---|---|---|---|
| 1854–1931 | 177,947,696 | 174,670,289 | 189,808,942 | 59,945,415 | 905,626,369 | 22,946,970 | 1,530,945,681 |
| 1932 | 750,692 | 809,401 | 1,425,043 | 362,137 | 4,255,495 | 536,659 | 8,139,427 |
| 1933 | 991,604 | 561,508 | 1,109,324 | 301,786 | 11,366,813 | 279,997 | 14,611,032 |
| | 179,689,992 | 176,041,198 | 192,343,309 | 60,609,338 | 921,248,677 | 23,763,626 | 1,553,696,140 |

The average daily wage in Michigan declined from $4.29 in 1932 to $3.92 in 1933.

The operators' gross loss (exclusive of idle mine cost) at underground mines in Michigan, according to the State mine appraiser, was $0.79 a ton in 1933 ($1.49 in 1932).

*Shipments.*—The shipments of ore from the Lake Superior district amounted to 21,674,972 gross tons (21,496,805 tons of iron ore and 178,167 tons of manganiferous iron ore containing 5 percent or more manganese) in 1933, compared with 3,588,534 tons (3,577,553 tons of iron ore and 10,981 tons of manganiferous iron ore) in 1932.

*Iron-ore analyses.*—The iron content of the ore shipped from the Lake Superior district in 1933 averaged 51.85 percent (natural) compared with 52.16 percent in 1932 and 51.53 percent in 1931, 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, 1929–33*

| Year | Gross tons | Iron (natural) | Phosphorus | Silica | Manganese | Moisture |
|---|---|---|---|---|---|---|
| | | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1929 | 65,443,546 | 51.18 | 0.100 | 8.48 | 0.80 | 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 |
| 1933 | 21,455,174 | 51.85 | .090 | 8.96 | .71 | 10.47 |

*Stocks of ore at Lake Erie ports.*—According to the Lake Superior Iron Ore Association, at the close of navigation in 1933, 5,405,691 gross tons of iron ore were in stock at Lake Erie ports compared with 5,191,114 tons on the corresponding date in 1932. At the opening of navigation in May 1934, 4,570,626 tons were in stock at these ports, indicating a withdrawal of 835,065 tons during the winter of 1933–34. The average quantity withdrawn each winter during the preceding 5 years was about 1,350,000 tons.

*Prices of Lake Superior ore.*—The unit prices established June 7, 1933, for the four standard grades of Lake Superior ore are the same as those for 1929–32, 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 1925–33 is a metallic-iron content of 51.5 percent (natural), instead of 55 percent, as for 1924 and many earlier years. The base of non-Bessemer ore, old-range and Mesabi, remains as heretofore at 51.6 percent (natural).

*Iron-ore reserves.*—Estimates of ore reserves for Minnesota, furnished by the Minnesota Tax Commission, and for Michigan, furnished by the Michigan Board of State Tax Commissioners, cover developed and prospective ore in the ground and ore in stock piles. These estimates show an increase from the previous year of 15,013,000 tons in Minnesota but a decrease of 610,000 tons in Michigan.

*Iron-ore reserves in Minnesota May 1, 1929–33, in gross tons*

| Range | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Mesabi | 1,178,855,601 | 1,154,434,031 | 1,162,776,979 | 1,190,295,183 | 1,205,213,398 |
| Vermilion | 14,939,704 | 14,250,540 | 14,789,137 | 14,237,637 | 14,007,192 |
| Cuyuna | 48,264,579 | 66,542,939 | 66,756,610 | 69,699,960 | 70,024,921 |
| | 1,242,059,884 | 1,235,227,510 | 1,244,322,726 | 1,274,232,780 | 1,289,245,511 |

*Iron-ore reserves in Michigan Jan. 1, 1930–34, in gross tons*

| Range | 1930 | 1931 | 1932 | 1933 | 1934 |
|---|---|---|---|---|---|
| Gogebic | 51,347,176 | 51,143,511 | 50,793,057 | 50,473,546 | 48,612,579 |
| Marquette | 55,655,383 | 57,665,510 | 56,335,788 | 55,894,039 | 54,564,005 |
| Menominee (including Iron River and Crystal Falls districts) | 61,347,264 | 62,178,324 | 59,940,058 | 58,264,532 | 60,845,357 |
| | 168,349,823 | 170,987,345 | 167,068,903 | 164,632,117 | 164,021,941 |

## IRON-ORE MINING, BY STATES

*Alabama.*—The production of iron ore in Alabama in 1933 was 2,133,457 gross tons (1,925,476 tons of hematite and 207,981 tons of brown ore), an increase of 55 percent over 1932. The hematite, much of which contains enough lime to make it self-fluxing or nearly so, was produced at the Raimund Nos. 1 and 2, Red Mountain group, Sloss Nos. 1 and 2, Spaulding, and Woodward Nos. 1 and 3 mines, all underground operations in Jefferson County, and at an open-pit property near Tumlin Gap in Etowah County. The iron content of the ore produced in 1933 averaged 36.16 percent (natural), the manganese content 0.16 percent, and the phosphorus content 0.30 percent. The Red Mountain group (939,633 tons) was the largest producing mine in Alabama and the third largest in the United States in 1933.

The brown ore mined in 1933 averaged 47.9 percent iron (natural) and 1.07 percent manganese; it was produced chiefly from the Russellville mines in Franklin County, the Champion mines in Blount County, and the Shelby mine in Shelby County.

*California.*—A small quantity of brown ore, sold for use in the manufacture of paint, was mined near Oakland, in Alameda County, in 1933.

*Georgia.*—Brown ore amounting to 1,302 gross tons was produced in Georgia from the Reed mine in Polk County and the Tecumseh mine in Floyd County, Ga., and Cherokee County, Ala. The ore averaged about 50 percent iron (dried).

*Michigan.*—Mining activity on the Michigan ranges in 1933 was again curtailed, as is shown by a production of 2,433,949 gross tons compared with 2,554,996 tons in 1932. This further curtailment was necessary to decrease the large stock piles of ore accumulated as a result of providing employment by keeping production schedules in 1931 and 1932 at levels greatly above what was warranted by current market trends. Shipments in 1933 were 3,665,082 tons in excess of production, resulting in a reduction in ore in stock piles from 10,260,532 tons in 1932 to 6,675,360 tons in 1933. The iron content (natural) of the ore mined in 1933 averaged 51.55 percent compared with 51.77 percent in 1932. Of the 37 active mines in Michigan in 1933 (44 in 1932), 8 (6 in 1932) yielded more than 100,000 tons each. The Cambria-Lillie mine in Marquette County had the largest output of any mine in Michigan in 1933—264,066 tons. The average production per mine in Michigan was 65,782 tons in 1933 compared with 58,068 tons in 1932.

The ore reserves in Michigan on January 1, 1934, amounted to 164,021,941 gross tons, a decrease of 610,176 tons from the previous year.

A report on the iron-ore mines of Michigan for 1933, published by the geological survey division of the Michigan Department of Conservation,[2] shows that the average number of men employed per day was 2,739 (3,529 in 1932), the average number of days worked 93 (88 in 1932), the average daily wage $3.92 ($4.294 in 1932), the average yearly earning $364.95 ($377.89 in 1932), and the average tons of ore mined per man per day 4.15 (4.06 in 1932).

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.

*Average per ton costs of mining iron ore at underground mines in Michigan in 1933, by counties*

| Item | Gogebic | Marquette | Dickinson and Iron | Total |
|---|---|---|---|---|
| Cost of mining | $2.1814 | $1.9426 | $2.0496 | $2.0594 |
| Deferred mining cost | .2082 | .1377 | .0543 | .1401 |
| Taxes | 1.2805 | .7726 | .5757 | .8925 |
| General overhead | .4227 | .4547 | .5113 | .4590 |
| Transportation | 1.6946 | 1.4879 | 1.5467 | 1.5756 |
| Marketing | .0478 | .0935 | .0620 | .0701 |
| Royalty | .3668 | .2446 | .2017 | .2750 |
| Interest on borrowed money | .0587 | .0519 | .0801 | .0623 |
| Total ore cost | 6.2607 | 5.1855 | 5.0814 | 5.5340 |
| Lake Erie value per ton | 4.9180 | 4.7503 | 4.5014 | 4.7440 |
| Gross ore loss [1] | 1.3427 | .4352 | .5800 | .7900 |

[1] This figure does not represent true loss, as much ore is sold below the Lake Erie price.

*Minnesota.*—Mining and shipping of iron ore in Minnesota were greatly stimulated in 1933. The production increased from 5,154,291 tons in 1932 to 11,948,596 tons in 1933, and shipments advanced from 2,248,727 tons in 1932 to 14,784,763 tons in 1933. Mining at underground mines was again curtailed sharply, decreasing from 2,232,807 tons in 1932 to 1,542,887 tons in 1933. Production at open-pit mines, however, increased from 2,921,484 tons in 1932 to 10,405,709 tons in 1933. Thus, 87 percent of the total iron ore mined in Minnesota in 1933 was from open-pit mines compared with 57 percent in 1932. The proportion produced from open-pit mines in Minnesota during the 3-year period 1930–32 averaged 71 percent. The iron content (natural) of the ore mined in 1933 averaged 51.84 percent compared with 52.65 percent in 1932. Of the 58 active mines in Minnesota in 1933 (42 in 1932), 32 (15 in 1932) yielded more than 100,000 tons each. The Hartley-Burt and Sellers mines, open-pit operations in St. Louis

[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), 1934.

County, which yielded 2,175,464 and 1,082,435 tons, respectively, were the only mines in the United States that yielded over a million tons each in 1933. The average production per mine in Minnesota was 206,010 tons in 1933 compared with 122,721 tons in 1932.

The reserves of ore in Minnesota on May 1, 1933, amounted to 1,289,-245,511 gross tons, an increase of 15,012,731 tons over the previous year.

*Missouri.*—The production of iron ore in Missouri dropped to 395 gross tons in 1933 from 29,797 tons in 1932. The output in 1933 was surface ore from the Iron Mountain mine in St. Francois County.

*New Jersey.*—The only active mine in New Jersey in 1933 was the Washington mine, an underground operation in Warren County; it yielded 73,144 gross tons of magnetite concentrates averaging 61.17 percent iron. The production of New Jersey in 1932 was 30,844 tons. A small quantity of magnetite concentrates averaging 61.67 percent iron was shipped from stock pile at the Mt. Hope mine in Morris County.

*New York.*—The production of iron ore in New York increased from 31,327 gross tons in 1932 to 58,718 tons in 1933. Shipments from New York in 1933 consisted of 135,080 tons of sinter averaging 67.47 percent iron, 382 tons of concentrates averaging 67.75 percent iron, and 27,538 tons of lump ore averaging 62.24 percent iron.

*Pennsylvania.*—Pennsylvania, the most important source of magnetite in the United States, produced 264,366 gross tons of ore in 1933 compared with 102,838 tons in 1932. The production consisted chiefly of 263,227 tons of magnetite from the Cornwall mines in Lebanon County; it averaged 39.75 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 1933.

*Tennessee.*—The production of iron ore (all brown-ore concentrates) in Tennessee in 1933 was 24,912 gross tons averaging about 45 percent iron (natural); no ore was produced in 1932. The output in 1933 consisted of 4,000 tons from the Van Leer mine in Lawrence County and 20,912 tons from the Johnson mine in Hickman County.

A considerable quantity of iron sinter recovered from copper sulphide ore mined in Polk County was shipped in 1933; this sinter averaged 65.9 percent iron, 0.17 percent manganese, and 0.0076 percent phosphorus. These shipments are not included in the statistics of iron ore.

*Utah.*—The production of iron ore in Utah in 1933 was 95,279 gross tons compared with 137,224 tons in 1932. It was chiefly hematite, averaging 52.2 percent iron (natural), from the Desert Mound mine in Iron County. A small quantity of iron ore for use in paint was produced at the Tecoma mine in Box Elder County.

*Virginia.*—The production of iron ore in Virginia in 1933 was limited to 287 gross tons of hand-picked brown ore from the Oriskany mine in Botetourt County; the ore was for use in hydrogen gas.

*Washington.*—The Big Iron mine in Stevens County was the only active mine in Washington in 1933. It produced 1,631 gross tons of magnetite, which was shipped for use in making ferromagnesite.

*Wisconsin.*—The production of iron ore in Wisconsin declined to 28,487 gross tons in 1933 from 430,140 tons in 1932. The Montreal mine (210,289 tons) and Cary mine (18,198 tons), both in Iron County, were the only productive operations.

*Wyoming.*—The Sunrise mine in Platte County, inactive in 1932, was reopened in 1933; it produced 288,640 gross tons of hematite averaging 53.42 percent iron (natural).

## WORLD PRODUCTION

The following table shows the production of iron ore by countries from 1929 to 1933, so far as figures are obtainable. Figures for preceding years appear in earlier volumes of Mineral Resources. Complete returns for 1933 are not yet available, but those for 1932 and earlier years are fairly complete. Thus, the figures for 1932 indicate a total world production of about 73,486,000 metric tons, of which the United States furnished about 14 percent. In 1931 the United States contributed a little more than one-fourth of the world total, which was about 119,000,000 metric tons.

*Iron ore produced, 1929–33, by countries, in metric tons*

[Compiled by M. T. Latus of the Bureau of Mines]

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Cuba [1] | 682,095 | 190,270 | 92,407 | 82,610 | 169,490 |
| Mexico | 112,749 | 106,979 | 65,156 | (2) | (2) |
| Newfoundland | [3] 1,541,334 | [3] 1,196,856 | [3] 716,579 | [3] 150,867 | [4] 326,041 |
| United States | 74,199,815 | 59,346,123 | 31,631,163 | 10,004,959 | 17,834,917 |
| South America: | | | | | |
| Brazil [5] | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 |
| Chile [6] | 1,812,343 | 1,695,089 | 741,650 | 172,681 | 559,598 |
| Europe: | | | | | |
| Austria | 1,891,381 | 1,180,451 | 511,945 | 306,776 | (2) |
| Belgium | 155,670 | 130,990 | 125,820 | 92,810 | (2) |
| Czechoslovakia | 1,807,663 | 1,652,920 | 1,235,078 | 602,215 | (2) |
| France | 50,731,100 | 48,570,980 | 38,558,650 | 27,554,000 | 30,400,000 |
| Germany [7] | 6,191,232 | 5,658,574 | 2,574,049 | 1,319,142 | (2) |
| Greece | 253,025 | 256,161 | 235,967 | 46,022 | (2) |
| Hungary | 251,711 | 157,421 | 84,033 | 52,864 | (2) |
| Italy | 715,171 | 718,124 | 560,853 | 458,362 | (2) |
| Luxemburg | 7,571,206 | 6,649,372 | 4,764,926 | 3,212,618 | 3,369,861 |
| Netherlands | 900 | ---------- | ---------- | (2) | (2) |
| Norway | 746,112 | 772,423 | 574,887 | 373,907 | (2) |
| Poland | 659,568 | 476,846 | 284,653 | 76,869 | (2) |
| Portugal | 8,507 | (8) | (8) | ---------- | (2) |
| Rumania | 90,014 | 92,517 | 61,907 | 8,051 | (2) |
| Spain | 6,546,648 | 5,517,211 | 3,190,203 | 1,760,471 | 1,836,000 |
| Sweden | 11,467,551 | 11,236,428 | 7,070,868 | 3,298,989 | (2) |
| Switzerland [10] | 88,445 | 101,925 | 34,239 | 11,862 | (2) |
| U.S.S.R. (Russia) | [9] 7,849,000 | [9] 10,425,000 | [9] 10,612,000 | (2) | (2) |
| United Kingdom: | | | | | |
| Great Britain [11] | 13,427,043 | 11,813,850 | 7,748,255 | 7,445,807 | (2) |
| Northern Ireland | 700 | ---------- | ---------- | ---------- | (2) |
| Yugoslavia | 427,946 | 431,189 | 133,411 | 26,635 | (2) |
| Asia: | | | | | |
| China | 2,672,400 | 2,261,200 | 2,242,200 | (2) | (2) |
| Chosen | 551,814 | 532,497 | 164,712 | 390,937 | (2) |
| India, British | 2,467,533 | 1,879,311 | 1,650,962 | 1,788,757 | (2) |
| Japan | 177,557 | 245,992 | (2) | (2) | (2) |
| Russia | (9) | (9) | (9) | (2) | (2) |
| Unfederated Malay States | 822,511 | 790,268 | 703,092 | 699,224 | (2) |

[1] Shipments.
[2] Data not available.
[3] Shipments from Wabana mines.
[4] Production.
[5] Approximate production.
[6] Production of Tofo mines.
[7] Exclusive of manganiferous iron ore carrying 12 to 30 percent manganese.
[8] Less than 1 ton.
[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.

*Iron ore produced, 1929–33, by countries, in metric tons*—Continued

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Africa: | | | | | |
| Algeria | 2,196,182 | 2,231,868 | 1,016,957 | 66,935 | (2) |
| Belgian Congo | 50,000 | 14,000 | 19,000 | 14,614 | (2) |
| Morocco, Spanish [10] | 1,061,424 | 752,715 | 500,650 | 171,182 | (2) |
| Rhodesia: | | | | | |
| Northern | 3,613 | 10 | 771 | 722 | |
| Southern | 3,406 | 2,524 | 535 | | |
| South-West Africa | 28,697 | 39,969 | 22,214 | (2) | (2) |
| Tunisia | 977,000 | 828,000 | 446,600 | 209,000 | 285,000 |
| Union of South Africa [1] | 38,270 | 51,662 | 15,447 | 16,024 | 60,060 |
| Oceania: | | | | | |
| Australia: | | | | | |
| New South Wales [12] | [13] 6,580 | | | | (2) |
| Queensland | 1,256 | 2,456 | 4,629 | 8,364 | (2) |
| South Australia | 861,420 | 943,293 | 293,820 | 546,562 | (2) |
| New Zealand [13] | 8,172 | 16,409 | 7,031 | | (2) |
| | 201,187,000 | 179,000,000 | 118,927,000 | 73,486,000 | (2) |

[1] Shipments.
[2] Data not available.
[10] Exports.
[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 13,027,343 gross tons in 1933 compared with 8,549,649 tons in 1932. The production in 1933 consisted of 12,994,452 tons made with coke as fuel and 32,891 tons made with charcoal. For the second consecutive year, the production of pig iron in Ohio exceeded that in Pennsylvania. Of the pig iron manufactured in 1933, it is calculated that 637,826 gross tons valued at $9,155,392 were made from 1,052,970 gross tons of foreign ore from Africa, Australia, Brazil, Canada, Chile, Cuba, Russia, and Sweden, indicating an average pig-iron yield of 60.57 percent from imported ore. Domestic ore and 2,763,242 gross tons of cinder, scale, and scrap, amounting in all to 23,445,479 tons, were reported as used in making 12,389,517 tons of pig iron, indicating an average pig-iron yield of 52.84 percent from domestic materials.

*Pig iron manufactured in the United States, 1932–33, by States, in gross tons*

| State | 1932 | 1933 | State | 1932 | 1933 |
|---|---|---|---|---|---|
| Alabama | 652,898 | 900,170 | New York | 624,169 | 665,933 |
| Illinois | 919,247 | 1,012,676 | Ohio | 2,387,028 | 3,918,723 |
| Indiana | 852,276 | 1,183,405 | Pennsylvania | 2,103,170 | 3,733,570 |
| Kentucky | 72,855 | 103,017 | West Virginia | 224,032 | 410,421 |
| Maryland | 378,739 | 617,187 | Undistributed [1] | 152,710 | 173,926 |
| Michigan | 182,525 | 308,315 | | | |
| | | | | 8,549,649 | 13,027,343 |

[1] 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 1932 and 1933, exclusive of electric-reduction furnaces, were as follows:

*Blast furnaces (including ferro-alloy blast furnaces) in the United States, 1932–33* [1]

| State | In blast June 30, 1932 | Dec. 31, 1932 | | | In blast June 30, 1933 | Dec. 31, 1933 | | |
|---|---|---|---|---|---|---|---|---|
| | | In | Out | Total | | In | Out | Total |
| Alabama | 4 | 3 | 22 | 25 | 7 | 10 | 15 | 25 |
| Colorado | | | 3 | 3 | | 1 | 2 | 3 |
| Illinois | 6 | 3 | 22 | 25 | 7 | 4 | 21 | 25 |
| Indiana | 5 | 4 | 14 | 18 | 7 | 5 | 13 | 18 |
| Kentucky | | 1 | 1 | 2 | 1 | 1 | 1 | 2 |
| Maryland | 2 | 2 | 4 | 6 | 3 | 3 | 3 | 6 |
| Massachusetts | | | 1 | 1 | | | 1 | 1 |
| Michigan | 2 | 2 | 6 | 8 | 3 | 4 | 4 | 8 |
| Minnesota | | | 3 | 3 | | | 3 | 3 |
| Missouri | | | 1 | 1 | | | 1 | 1 |
| New York | 3 | 1 | 18 | 19 | 4 | 7 | 12 | 19 |
| Ohio | 13 | 12 | 45 | 57 | 24 | 19 | 36 | 55 |
| Pennsylvania | 12 | 14 | 81 | 95 | 29 | 19 | 74 | 93 |
| Tennessee | | | 6 | 6 | 2 | | 6 | 6 |
| Utah | 1 | 1 | | 1 | 1 | 1 | | 1 |
| Virginia | | | 6 | 6 | | | 6 | 6 |
| West Virginia | 1 | 1 | 2 | 3 | 3 | 1 | 2 | 3 |
| | 49 | 44 | 235 | 279 | 91 | 75 | 200 | 275 |

[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 14,353,197 gross tons in 1933, valued at $213,347,583, an increase of 68 percent in quantity and 69 percent in total value over 1932. Compared with the 5-year average for 1927–31, which amounted to 32,487,488 tons, the 1933 shipments showed a decrease of 56 percent. The values given represent the approximate amounts received for the iron f.o.b. furnaces and do not include freight costs, selling commissions, and other items that are figured in some of the market prices of pig iron published in trade journals.

*Pig iron shipped from blast furnaces in the United States, 1932–33, by States*

| State | 1932 | | 1933 | |
|---|---|---|---|---|
| | Gross tons | Value | Gross tons | Value |
| Alabama | 733,774 | $8,076,727 | 987,606 | $11,385,080 |
| Colorado | (1) | (1) | (1) | (1) |
| Illinois | 731,872 | 11,544,298 | 1,269,940 | 20,063,481 |
| Indiana | 713,415 | 11,019,875 | 1,296,518 | 19,989,998 |
| Iowa | (1) | (1) | (1) | (1) |
| Kentucky | 74,431 | (1) | 103,017 | (1) |
| Maryland | 367,614 | (1) | 639,539 | (1) |
| Massachusetts | (1) | (1) | (1) | (1) |
| Michigan | 280,536 | 4,269,528 | 407,011 | 6,181,318 |
| Minnesota | 1,571 | (1) | (1) | (1) |
| New York | 594,350 | 8,546,837 | 851,496 | 12,344,827 |
| Ohio | 2,505,268 | 37,886,811 | 4,188,482 | 60,995,721 |
| Pennsylvania | 2,069,553 | 32,764,148 | 3,952,862 | 62,797,008 |
| Tennessee | 4,623 | (1) | 14,656 | (1) |
| Utah | (1) | (1) | (1) | (1) |
| Virginia | 1,710 | (1) | 3,092 | (1) |
| West Virginia | 245,869 | (1) | 449,219 | (1) |
| Undistributed | [2] 193,814 | [2] 11,924,490 | [2] 189,759 | [2] 19,590,150 |
| | 8,518,400 | 126,032,714 | 14,353,197 | 213,347,583 |

[1] Included under "Undistributed."
[2] Includes figures for States entered as "(1)" above.

*Pig iron shipped from blast furnaces in the United States, 1932–33, by grades*

| Grade | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Gross tons | Value | | Gross tons | Value | |
| | | Total | Average | | Total | Average |
| Charcoal | 23,852 | $437,591 | $18.35 | 53,678 | $1,038,716 | $19.35 |
| Foundry | 972,630 | 12,524,358 | 12.88 | 1,448,584 | 19,684,877 | 13.59 |
| Basic | 5,144,905 | 73,973,005 | 14.38 | 8,788,335 | 126,990,109 | 14.45 |
| Bessemer | 1,919,325 | 31,834,238 | 16.59 | 3,180,506 | 51,915,711 | 16.32 |
| Low-phosphorus | 67,584 | 1,387,267 | 20.53 | 121,076 | 2,487,060 | 20.54 |
| Malleable | 364,234 | 5,397,057 | 14.82 | 732,453 | 10,668,083 | 14.56 |
| Forge | 8,426 | 99,762 | 11.84 | 6,985 | 75,493 | 10.81 |
| All other (not ferro-alloys) | 17,444 | 379,436 | 21.75 | 21,580 | 487,534 | 22.59 |
| | 8,518,400 | 126,032,714 | 14.80 | 14,353,197 | 213,347,583 | 14.86 |

*Value at blast furnaces.*—The average value of all kinds of pig iron given in the accompanying table is based on the reports of the manufacturers to the Bureau of Mines. The figures represent the approximate values f.o.b. blast furnaces and do not include the values of ferro-alloys. The general average value for all grades of pig iron at the furnaces was $14.86 a gross ton in 1933—6 cents more than in 1932 but $2.60 less than the average for 1927–31.

*Average value per gross ton of pig iron at blast furnaces in the United States, 1929–33*

| State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Alabama | $16.19 | $13.55 | $12.38 | $11.01 | $11.53 |
| Illinois | 18.46 | 17.80 | 16.89 | 15.77 | 15.80 |
| Indiana | 16.69 | 16.54 | 16.53 | 15.45 | 15.42 |
| Michigan | 16.76 | 18.08 | 17.25 | 15.22 | 15.19 |
| New York | 17.88 | 17.80 | 15.35 | 14.38 | 14.50 |
| Ohio | 17.30 | 17.05 | 16.08 | 15.12 | 14.56 |
| Pennsylvania | 18.29 | 18.13 | 17.04 | 15.83 | 15.89 |
| Tennessee | 18.46 | 19.64 | 22.39 | (1) | (1) |
| Other States [2] | 16.83 | 15.85 | 14.81 | 13.40 | 14.00 |
| Average for United States | 17.61 | 17.13 | 16.01 | 14.80 | 14.86 |

[1] Included under "Other States."
[2] 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; 1932–33: 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, 1932–33* [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 | |
|---|---|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | 1932 | 1933 | 1932 | 1933 |
| January | $15.50 | $14.50 | $11.64 | $11.00 | $16.00 | $15.00 | $15.00 | $14.00 |
| February | 15.18 | 14.50 | 11.00 | 11.00 | 15.68 | 15.00 | 14.68 | 14.00 |
| March | 15.00 | 14.50 | 11.00 | 11.00 | 15.50 | 15.00 | 14.50 | 14.00 |
| April | 15.00 | 14.50 | 11.00 | 11.44 | 15.50 | 15.00 | 14.50 | 14.00 |
| May | 14.78 | 15.04 | 11.00 | 12.00 | 15.28 | 15.54 | 14.28 | 14.54 |
| June | 14.50 | 15.50 | 11.00 | 12.00 | 15.00 | 16.00 | 14.00 | 15.00 |
| July | 14.50 | 16.18 | 11.00 | 12.68 | 15.00 | 16.68 | 14.00 | 15.68 |
| August | 14.50 | 16.57 | 11.00 | 13.07 | 15.00 | 17.07 | 14.00 | 16.07 |
| September | 14.50 | 17.50 | 11.00 | 13.50 | 15.00 | 18.00 | 14.00 | 17.00 |
| October | 14.50 | 17.50 | 11.00 | 13.50 | 15.00 | 18.00 | 14.00 | 17.00 |
| November | 14.50 | 17.50 | 11.00 | 13.50 | 15.00 | 18.00 | 14.00 | 17.00 |
| December | 14.50 | 17.50 | 11.00 | 13.50 | 15.00 | 18.00 | 14.00 | 17.00 |
| Average | 14.75 | 15.94 | 11.05 | 12.35 | 15.25 | 16.44 | 14.25 | 15.44 |

[1] Metal Statistics, 1934.

*Foreign trade in pig iron.*—Imports of pig iron into the United States in 1933 were 158,596 gross tons—21 percent more than in 1932 and 23 percent more than the average for 1927–31. Netherlands (68,341 tons), India (68,036 tons), and Canada (12,259 tons) were the chief sources of supply.

*Pig iron imported into the United States, 1929–33, by countries, in gross tons*

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada | 7,382 | 664 | 2,789 | 2,113 | 12,259 |
| Mexico | 387 | 41 | | | |
| Europe: | | | | | |
| Belgium | 284 | 669 | 300 | 200 | 225 |
| France | 101 | | 25 | 97 | |
| Germany | 103 | 50 | 202 | 361 | 200 |
| Netherlands | 24,189 | 6,243 | 7,209 | 74,372 | 68,341 |
| Norway | 3,400 | 2,610 | 227 | 140 | 806 |
| Sweden | 3,534 | 4,092 | 1,900 | 561 | 632 |
| United Kingdom | 39,140 | 14,239 | 2,656 | 23,378 | 5,495 |
| Asia: | | | | | |
| Hong Kong | | | 2 | | |
| India, British | 69,243 | 108,261 | 67,930 | 28,820 | 68,036 |
| Japan | | 102 | 20 | 279 | 208 |
| Kwantung | | 60 | 1,098 | 309 | 2,394 |
| Oceania: Australia | | | 53 | | |
| | 147,763 | 137,031 | 84,411 | 130,630 | 158,596 |
| Value | $2,398,488 | $1,806,754 | $978,683 | $1,301,625 | $1,439,206 |

Exports of pig iron from the United States in 1933 were 2,750 gross tons—18 percent more than in 1932 but 93 percent below the average for 1927–31.

*Pig iron exported from the United States, 1932–33, by countries, in gross tons*

| Country | 1932 | 1933 | Country | 1932 | 1933 |
|---|---|---|---|---|---|
| North America: | | | Europe—Continued | | |
| Canada | 322 | 310 | Italy | 26 | 22 |
| Cuba | 65 | 40 | Poland and Danzig | | 100 |
| Mexico | 323 | 498 | United Kingdom | 136 | 10 |
| Panama | 60 | 9 | Asia: | | |
| Other countries | 1 | 18 | China | 100 | |
| South America: | | | Japan | 200 | 258 |
| Chile | 15 | 100 | Philippine Islands | 233 | 427 |
| Colombia | 96 | 172 | | | |
| Peru | 203 | 259 | | 2,324 | 2,750 |
| Other countries | 135 | 140 | Value | $53,966 | $63,985 |
| Europe: | | | | | |
| Belgium | 398 | 312 | | | |
| France | 11 | | | | |
| Germany | | 75 | | | |

*World production of pig iron.*—World production of pig iron (including ferro-alloys) in 1933 was approximately 49,000,000 metric tons, an increase of 26 percent over 1932 but 40 percent below the average for 1927–31. In 1933 the output of the United States represented about 28 percent (23 percent in 1932) of the world output, and it was about 57 percent (66 percent in 1932) less than that of the producing countries of Europe combined. The production of pig iron increased 20 percent in Europe in 1933, compared with an increase of 52 percent in the United States.

*Pig iron (including ferro-alloys) produced, 1929–33, by countries, in metric tons*

[Compiled by M. T. Latus, of the Bureau of Mines]

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Australia | 337,975 | [1] 447,000 | [1] 386,000 | [1] 400,000 | [1] 425,000 |
| Austria | 458,973 | 296,824 | 145,016 | 94,466 | 87,949 |
| Belgium | 4,040,530 | 3,365,240 | 3,197,790 | 2,783,469 | 2,744,560 |
| Brazil | 33,708 | 34,974 | [1] 35,000 | [1] 35,000 | [1] 35,000 |
| Canada | 1,189,037 | 825,440 | 474,294 | 162,179 | 263,813 |
| China | [1] 300,000 | [1] 300,000 | [1] 300,000 | [1] 300,000 | [1] 300,000 |
| Chosen | 155,514 | 151,378 | 147,855 | 163,653 | [1] 160,000 |
| Czechoslovakia | 1,644,515 | 1,437,089 | 1,164,726 | 450,106 | 498,900 |
| Finland | 10,677 | 10,379 | 12,329 | 13,671 | [1] 14,000 |
| France | 10,362,072 | 10,071,980 | 8,206,130 | 5,550,000 | 6,366,000 |
| Germany (exclusive of the Saar) | 13,239,455 | 9,698,421 | 6,061,068 | 3,932,364 | 5,265,000 |
| Saar | 2,104,940 | 1,912,444 | 1,515,429 | 1,349,493 | 1,591,200 |
| Great Britain | 7,701,200 | 6,296,259 | 3,833,150 | 3,630,347 | 4,190,000 |
| Hungary | 367,951 | 257,226 | 159,630 | 66,281 | [1] 66,000 |
| India, British | 1,417,563 | 1,198,802 | 1,089,919 | 928,345 | [1] 1,000,000 |
| Italy | 726,544 | 587,594 | 552,852 | 494,667 | 552,739 |
| Japan [2] | 1,561,448 | 1,687,435 | 1,408,204 | 1,542,000 | [1] 1,600,000 |
| Luxemburg | 2,906,093 | 2,473,714 | 2,053,158 | 1,958,930 | 1,887,910 |
| Mexico | 60,230 | 57,826 | 52,926 | [1] 60,000 | [1] 60,000 |
| Netherlands | 253,776 | 272,718 | 256,717 | 236,426 | 252,645 |
| New Zealand | 4,464 | 8,205 | 3,516 | [1] 4,000 | [1] 4,000 |
| Norway | 153,395 | 144,836 | 118,837 | 103,092 | [1] 110,000 |
| Philippine Islands | 166 | 173 | 163 | [1] 150 | [1] 150 |
| Poland | 705,532 | 477,949 | 347,114 | 198,674 | 305,000 |
| Rumania | 72,346 | 68,843 | 25,894 | 8,752 | [1] 10,000 |
| Spain | 752,618 | 621,891 | 479,215 | 302,617 | [1] 300,000 |
| Sweden | 523,829 | 496,410 | 417,506 | 282,163 | [1] 320,000 |
| U.S.S.R. (Russia) | [3] 4,018,700 | [3] 4,982,200 | 5,007,000 | [1] 5,000,000 | [1] 7,200,000 |
| Union of South Africa | 16,510 | 29,726 | 8,940 | 13,107 | [1] 15,000 |
| United States | 43,315,279 | 32,279,283 | 18,715,216 | 8,920,878 | 13,590,926 |
| Yugoslavia | 30,885 | 35,011 | 37,733 | 9,973 | [1] 20,000 |
| | 98,466,000 | 80,527,000 | 56,213,000 | 38,995,000 | 49,000,000 |

[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 348,894 gross tons in 1933, compared with 230,311 tons in 1932, an increase of 51 percent. Ferro-alloys were made in 1933 at 11 blast furnaces, 13 electric furnaces, and 2 alumino-thermic plants; in addition, 2 plants made ferrophosphorus and 1 plant made ferrosilicon as a byproduct.

The shipments of ferro-alloys of all classes in 1933 were 421,423 gross tons, valued at $28,653,794, an increase of 93 percent in quantity and 105 percent in total value compared with 1932. Compared with the 5-year average for 1927–31, which amounted to 663,861 tons, the 1933 shipments showed a decrease of 37 percent.

*Ferro-alloys shipped from furnaces in the United States, 1932–33, by varieties*

| Variety of alloy | 1932 | | 1933 | |
|---|---|---|---|---|
| | Gross tons | Value | Gross tons | Value |
| Ferromanganese | 70,417 | $5,061,029 | 127,453 | $9,384,611 |
| Spiegeleisen | 31,071 | 745,966 | 50,218 | 1,144,642 |
| Ferrosilicon (7 percent or more silicon) | 97,224 | 3,517,268 | 199,524 | 7,349,681 |
| Ferrotungsten | 295 | 525,239 | 952 | 1,550,854 |
| Ferrovanadium | 283 | 704,038 | 890 | 1,961,644 |
| Other varieties [1] | 19,356 | 3,450,132 | 42,386 | 7,262,362 |
| | 218,646 | 14,003,672 | 421,423 | 28,653,794 |

[1] Ferrochromium, ferromolybdenum and calcium-molybdenum compounds, ferrophosphorus, ferrotitanium, ferrozirconium, silicomanganese and silicospiegeleisen, and zirconium-ferrosilicon.

*Ferromanganese.*—The shipments of ferromanganese in 1933 were 127,453 gross tons, an increase of 81 percent over 1932. Compared with the 5-year average for 1927–31, which amounted to 273,630 tons, the 1933 shipments showed a decrease of 53 percent. The average value per ton f.o.b. furnaces reported for ferromanganese was $73.63 in 1933, compared with $71.87 in 1932.

Ferromanganese was made at five furnaces in both 1932 and 1933. The production of ferromanganese in 1933 was 136,267 gross tons, containing 108,059 tons of manganese, an average of 79.3 percent manganese. In the production of ferromanganese in 1933 there were used 233,607 gross tons of foreign manganese ore; 10,695 tons of domestic manganese ore; 10,795 tons of iron ore; and 1,655 tons of cinder, scale, and scrap. The quantity of manganese ore used per ton of ferromanganese made in 1933 was 1.793 tons; in 1932 it was 1.798 tons; and in 1931 it was 1.799 tons. Of the foreign manganese ore used in 1933, Russia supplied 108,555 gross tons; Brazil, 42,805 tons; Africa, 30,427 tons; Cuba, 28,275 tons; India, 22,499 tons; and Chile, 1,046 tons. The quantity of domestic manganese ore used in the manufacture of ferromanganese in 1933 represented 4.4 percent of the total manganese ore used, compared with 10.5 percent in 1932. The domestic manganese ore used in 1933 was produced in Georgia, Massachusetts, Montana, and Virginia.

*Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture, 1929–33*

| Year | Ferromanganese produced | | | Materials consumed (gross tons) | | | | Manganese ore used per ton of ferro-manganese made (gross tons) |
|---|---|---|---|---|---|---|---|---|
| | Gross tons | Manganese contained | | Manganese ore | | Iron and manga-niferous iron ores | Cinder, scale, and scrap | |
| | | Percent | Gross tons | Foreign | Domestic | | | |
| 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 |
| 1933 | 136,267 | 79.30 | 108,059 | 233,607 | 10,695 | 10,795 | 1,655 | 1.793 |

*Quantity and tenor of manganese ore used in manufacture of ferromanganese in the United States, 1932–33*

| Source of ores | 1932 | | 1933 | |
|---|---|---|---|---|
| | Gross tons | Manganese content (percent, natural) | Gross tons | Manganese content (percent, natural) |
| Africa | 5,135 | 49.44 | 30,427 | 49.12 |
| Brazil | 25,279 | 44.19 | 42,805 | 43.62 |
| Chile | | | 1,046 | 44.28 |
| Cuba | 2,126 | 54.26 | 28,275 | 50.61 |
| India | 11,541 | 51.04 | 22,499 | 51.12 |
| U.S.S.R. (Russia) | 46,596 | 49.45 | 108,555 | 49.49 |
| United States | 10,666 | 44.84 | 10,695 | 44.39 |
| | 101,343 | 47.94 | 244,302 | 48.45 |

*Spiegeleisen.*—The shipments of spiegeleisen in 1933 amounted to 50,218 gross tons (62 percent more than in 1932). Compared with the 5-year average for 1927–31, which amounted to 94,239 tons, the

1933 shipments showed a decrease of 47 percent. The average value per ton at the furnaces was $22.79 in 1933 and $24.01 in 1932.

The production of spiegeleisen in 1933 was 26,683 tons, averaging about 20 percent manganese. Spiegeleisen was made at four furnaces in 1933. In the production of spiegeleisen in 1933 there were used 9,808 gross tons of foreign manganese ore, 6,187 tons of domestic ferruginous manganese ore, 255 tons of manganese-bearing material, 22,705 tons of iron ore, and 8,329 tons of iron-bearing materials.

*Ferrosilicon.*—The shipments of ferrosilicon were 199,524 gross tons containing 42,765 tons of silicon in 1933 compared with 97,224 tons containing 21,255 tons of silicon in 1932. Compared with the 5-year average for 1927–31, which amounted to 248,203 tons, the 1933 shipments showed a decrease of 20 percent.

The production of ferrosilicon in 1933 was 139,717 gross tons, of which 65,257 tons were made by the blast-furnace process, 74,111 tons by the electric-furnace process, and 349 tons as a byproduct of the manufacture of artificial abrasives in electric furnaces.

*Ferrotungsten.*—The shipments of ferrotungsten in 1933 were 952 gross tons containing 1,706,084 pounds of tungsten, and the average value per pound of contained tungsten was 91 cents f.o.b. furnaces ($1 in 1932). Compared with the 5-year average for 1927–31, which amounted to 1,584 tons, the 1933 shipments showed a decrease of 40 percent.

The production of ferrotungsten in 1933 was 967 gross tons averaging 80 percent tungsten. The ferrotungsten produced in 1933 was made from ores from China, Bolivia, Arizona, Colorado, and Nevada.

*Ferrovanadium.*—The shipments of ferrovanadium in 1933 were 890 gross tons containing 747,629 pounds of vanadium and were valued at the furnaces at an average of $2.62 per pound of contained vanadium compared with $2.99 in 1932. Compared with the 5-year average for 1927–31, which amounted to 1,315 tons, the 1933 shipments showed a decrease of 32 percent.

The production of ferrovanadium in 1933 was 426 gross tons averaging 37.4 percent vanadium. It was reduced from vanadium oxide made from roscoelite-carnotite ores mined in Colorado and Utah, and from patronite and its oxidation products from Peru.

*Other ferro-alloys.*—The shipments of silicomanganese and silicospiegel in 1933 increased 181 percent over 1932 and were 119 percent more than the average for 1927–31. Shipments of ferrophosphorus in 1933 increased 139 percent over 1932 but were 9 percent less than the average for 1927–31. Those of ferrochromium increased 95 percent over 1932 but were 19 percent less than the average for 1927–31. Shipments of calcium-molybdenum compounds in 1933 increased 51 percent over 1932 but were 8 percent less than the average for 1927–31. Those of ferromolybdenum increased 140 percent over 1932 and were 107 percent more than the average for 1927–31. Shipments of ferrotitanium in 1933 increased 92 percent over 1932 but were 16 percent less than the average for 1927–31.

*Foreign trade in ferro-alloys.*—Imports of all alloys of the rarer metals are not recorded separately but are grouped as shown in the following table. Ferromanganese and spiegeleisen constituted the bulk of the imports in 1932 and 1933.

The imports for consumption of ferromanganese in 1933 (chiefly from Canada and Norway) were 39,692 gross tons, an increase of 115 percent over 1932. The imports from Canada and Norway in 1933 increased 182 percent and 158 percent, respectively, compared with 1932.

The imports for consumption of spiegeleisen in 1933 (chiefly from Canada and Norway) were 26,277 gross tons, an increase of 214 percent over 1932.

*Ferro-alloys and ferro-alloy metals imported for consumption in the United States, 1932–33, by varieties*

| Variety of alloy | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Gross weight (gross tons) | Content (gross tons) | Value | Gross weight (gross tons) | Content (gross tons) | Value |
| Ferromanganese: | | | | | | |
| Containing over 1 percent carbon | 18,443 | 14,756 | $1,085,691 | 39,520 | 31,616 | $2,521,349 |
| Containing not over 1 percent carbon | 27 | 23 | 5,336 | 172 | 143 | 26,719 |
| Manganese boron, manganese silicon, manganese metal, and spiegeleisen, n.e.s. | (1) | 329 | 31,451 | (1) | 24 | 11,773 |
| Spiegeleisen | 8,364 | (1) | 192,037 | 26,277 | (1) | 640,613 |
| Ferrochrome or ferrochromium containing less than 3 percent carbon | 159 | 106 | 30,984 | 168 | 109 | 34,353 |
| Ferrophosphorus | 711 | (1) | 48,251 | 55 | (1) | 1,994 |
| Ferrosilicon: | | | | | | |
| Containing 8 percent and less than 60 percent silicon | 864 | 312 | 38,200 | 5,291 | 927 | 145,892 |
| Chrome or chromium metal | (1) | 20 | 19,289 | 43 | (1) | 49,316 |
| Chromium and zirconium silicon and calcium silicide | 79 | (1) | 11,511 | 258 | (1) | 41,471 |
| Ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum | (1) | (2) | 89 | (1) | (3) | 158 |
| Ferrotitanium | 2 | (1) | 718 | 3 | (1) | 1,292 |
| Tungsten and combinations, in lump, grains, or powder: | | | | | | |
| Tungsten metal | (1) | 6 | 5,882 | (1) | 30 | 28,466 |
| Combinations containing tungsten or tungsten carbide | (1) | (4) | 332 | ------ | ------ | ------ |
| Tungstic acid and other compounds of tungsten, n.s.p.f. | (1) | 1 | 2,629 | (1) | (5) | 1,401 |

[1] Not recorded. [2] 44 pounds. [3] 40 pounds. [4] 131 pounds. [5] 779 pounds.

*Ferromanganese and ferrosilicon imported into the United States, 1932–33, by countries*

[General imports]

| Country | Ferromanganese (manganese content) [1] | | | | Ferrosilicon (silicon content) [2] | | | |
|---|---|---|---|---|---|---|---|---|
| | 1932 | | 1933 | | 1932 | | 1933 | |
| | Gross tons | Value | Gross tons | Value | Gross tons | Value | Gross tons | Value |
| Canada | 6,747 | $603,934 | 19,011 | $1,754,460 | 54 | $9,969 | 947 | $156,083 |
| France | 500 | 26,689 | 155 | 18,353 | ------ | ------ | ------ | ------ |
| Germany | 675 | 23,948 | 1,020 | 33,228 | 3 | 1,105 | ------ | ------ |
| Italy | 327 | 33,831 | 198 | 24,572 | 46 | 6,317 | 62 | 8,501 |
| Norway | 4,542 | 235,746 | 11,732 | 852,576 | 65 | 9,366 | 141 | 19,872 |
| Poland and Danzig | ------ | ------ | 218 | 8,779 | ------ | ------ | ------ | ------ |
| Sweden | ------ | ------ | 84 | 3,555 | ------ | ------ | ------ | ------ |
| United Kingdom | 1,402 | 72,618 | 24 | 11,773 | ------ | ------ | 2 | 300 |
| Yugoslavia and Albania | 393 | 14,452 | ------ | ------ | ------ | ------ | ------ | ------ |
| | [1] 14,586 | [1] 1,011,218 | [1] 32,442 | [1] 2,707,296 | [2] 168 | [2] 26,757 | [2] 1,152 | [2] 184,756 |

[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 1933 only 47 gross tons (probably ferromanganese) were exported compared with 33 tons in 1932. The exports of tungsten and ferrotungsten increased from 63 gross tons in 1932 to 381 tons in 1933.

*Ferro-alloys and ferro-alloy metals exported from the United States, 1931–33, by varieties*

| Variety of alloy | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Gross tons | Value | Gross tons | Value | Gross tons | Value |
| Ferromanganese [1] / Spiegeleisen [1] | 1,306 | $38,506 | 33 | $2,369 | 47 | $3,393 |
| Tungsten and ferrotungsten (including tungsten wire) | 472 | 624,412 | 63 | 172,585 | 381 | 460,906 |

[1] Not separately classified.

## STEEL

*Production.*—The following tables covering the production of steel were compiled by the American Iron and Steel Institute. No data whatever are available on the value of the output of crude steel at the mills, but the weekly issues and annual statistical reviews of Iron Age give market quotations of prices of steel billets and some of the leading forms of finished steel. The price of open-hearth steel billets at Pittsburgh in 1933 was $26 a gross ton; in 1932 it ranged from $26 to $27.75 a ton. Tank plates at Pittsburgh ranged from 1.6 to 1.7 cents a pound in 1933 and from 1.5 to 1.6 cents a pound in 1932. Structural shapes at Pittsburgh also ranged from 1.6 to 1.7 cents a pound in 1933 and from 1.5 to 1.6 cents a pound in 1932. Hot-rolled annealed sheets, no. 24 gage, at Pittsburgh ranged from 2 to 2.25 cents a pound in 1933 and from 2.1 to 2.22 cents a pound in 1932.

The production of steel in 1933 was 23,232,347 gross tons, of which 20,381,672 tons were open-hearth, 2,428,791 tons Bessemer, 681 tons crucible, and 421,203 tons electric steel. In 1932 the production was 13,681,162 tons, of which 11,907,330 tons were open-hearth, 1,532,076 tons Bessemer, 645 tons crucible, and 241,111 tons electric steel.

*Bessemer steel ingots and castings manufactured in the United States, 1929–33, by States, in gross tons*

| State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Ohio | 2,724,864 | 1,892,021 | 1,393,875 | 939,228 | 1,219,494 |
| Pennsylvania | 2,427,490 | 1,732,545 | 786,767 | 233,215 | 598,672 |
| Illinois | 1,073,790 | 718,104 | 420,569 | 250,983 | 379,483 |
| Other States | 896,365 | 692,789 | 422,235 | 108,650 | 231,142 |
| | 7,122,509 | 5,035,459 | 3,023,446 | 1,532,076 | 2,428,791 |

*Open-hearth steel ingots and castings manufactured in the United States, 1929–33, by States, in gross tons*

| State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| New England States | 325,232 | 214,425 | 175,673 | 128,227 | 227,445 |
| New York and New Jersey | 2,541,856 | 1,764,976 | 1,144,839 | 589,945 | 907,512 |
| Pennsylvania | 17,504,807 | 12,488,175 | 7,384,091 | 3,506,451 | 5,733,772 |
| Ohio | 10,241,579 | 7,152,526 | 4,954,069 | 2,849,170 | 5,285,122 |
| Indiana | 6,235,333 | 4,742,297 | 2,746,899 | 1,428,091 | 2,649,190 |
| Illinois | 3,607,810 | 2,514,799 | 1,450,637 | 695,936 | 1,407,581 |
| Other States | 7,896,271 | 6,171,974 | 4,653,358 | 2,709,510 | 4,171,050 |
| | 48,352,888 | 35,049,172 | 22,509,566 | 11,907,330 | 20,381,672 |

According to these tables there was an increase of 6 per cent in the production of Bessemer steel and of 7 percent in that of open-hearth steel in 1933 compared with 1932; the total production of steel increased 7 percent. Of the total output in 1933, 87.73 percent was open-hearth, 10.45 percent Bessemer, and 1.82 percent other classes of steel.

Of the total output of open-hearth steel 20,057,146 gross tons were made by the basic process and 324,526 tons by the acid process compared with 11,742,682 tons of basic steel and 164,648 tons of acid steel in 1932.

The production of steel by the electric process increased 75 percent compared with 1932.

*Steel electrically manufactured in the United States, 1929–33, in gross tons*

| Year | Ingots | Castings | Total | Year | Ingots | Castings | Total |
|---|---|---|---|---|---|---|---|
| 1929 | 532,392 | 419,039 | 951,431 | 1932 | 141,328 | 99,783 | 241,111 |
| 1930 | 307,418 | 305,181 | 612,599 | 1933 | | | |
| 1931 | 235,376 | 175,566 | 410,942 | | | | |

Figures for the total production of electric steel in 1933 include 296,210 tons of alloy-steel ingots and castings that were alloyed with nickel, vanadium, tungsten, chromium, molybdenum, and other metals (262,196 tons of ingots and 34,014 tons of castings) compared with 140,877 tons (116,765 tons of ingots and 24,112 tons of castings) so alloyed in 1932.

The number of completed plants equipped for the manufacture of steel by the electric process was 243 on December 31, 1933, compared with 247 at the end of 1932.

*Foreign trade in steel.*—With American producers enjoying competitive advantages formerly enjoyed by foreign producers, due to dollar depreciation, exports of iron and steel showed a substantial increase in 1933 over 1932, and imports were received in much smaller volume. Of the articles that constitute the bulk of the imports, hoop, band, and scroll iron or steel, nails, sheets, bars, structural iron and steel, tin and terne plates, barbed wire, and ingots were imported in 1933 in quantities substantially less than in 1932. The imports of iron and steel scrap and wire rods increased notably in 1933 over those in 1932, particularly scrap, which amounted to 57,649 tons compared with 9,775 tons in 1932.

*Iron and steel imported into the United States, 1931–33*

| Article | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Gross tons | Value | Gross tons | Value | Gross tons | Value |
| Bar iron | 854 | $48,323 | 505 | $25,713 | 535 | $33,469 |
| Boiler and other plate of iron and steel | 755 | 33,249 | 421 | 10,623 | 237 | 8,444 |
| Castings and forgings | 1,775 | 238,472 | 981 | 105,233 | 1,380 | 191,336 |
| Cast-iron pipe and fittings | 6,641 | 183,010 | 250 | 6,212 | 910 | 26,116 |
| Other pipes and tubes | 15,791 | 1,721,624 | 6,937 | 673,297 | 7,722 | 721,143 |
| Hoop, or band iron or steel, cut to length | 8,620 | 251,181 | 12,694 | 347,837 | 6,852 | 154,918 |
| Hoop, band, or scroll iron and steel | 19,371 | 657,811 | 19,284 | 459,317 | 14,235 | 429,730 |
| Iron and steel scrap | 16,279 | 117,954 | 9,775 | 59,210 | 57,649 | 429,489 |
| Nails | 8,106 | 633,032 | 10,876 | 721,296 | 6,472 | 518,351 |
| Rails for railways | 5,007 | 99,607 | 5,662 | 196,342 | 5,966 | 151,339 |
| Sheets of iron or steel, skelp, saw plates, and steel, n.e.s | 16,152 | 600,637 | 21,831 | 441,862 | 6,015 | 200,316 |
| Steel bars: | | | | | | |
| Reinforcement bars | 38,832 | 812,766 | 27,176 | 406,066 | 2,632 | 56,780 |
| Other bars | 51,540 | 1,748,620 | 31,997 | 834,105 | 20,742 | 628,288 |
| Steel ingots, blooms, slabs, etc | 20,023 | 518,563 | 2,396 | 74,941 | 893 | 34,929 |
| Structural iron and steel | 72,329 | 2,226,454 | 36,547 | 642,217 | 29,296 | 610,387 |
| Tin and terneplates | 196 | 42,704 | 7,245 | 471,939 | 260 | 40,185 |
| Round wire | 2,551 | 338,354 | 1,882 | 212,079 | 3,145 | 368,048 |
| Barbed wire | 10,613 | 433,612 | 14,542 | 587,827 | 8,301 | 381,624 |
| Wire rope and strand | 1,950 | 280,151 | 1,802 | 213,559 | 1,673 | 235,401 |
| Flat wire and steel strip | 720 | 464,288 | 998 | 480,241 | 1,320 | 720,433 |
| Telegraph, telephone, and other insulated wire | 45 | 26,063 | 17 | 8,085 | 28 | 5,004 |
| Wire rods | 7,114 | 472,240 | 7,933 | 397,354 | 12,814 | 694,086 |
| Other advanced manufactures | | 989,908 | | 461,218 | | 394,543 |

Some of the larger increases in exports of semimanufactured and manufactured iron and steel in 1933 over 1932 were recorded for steel bars, galvanized iron and steel sheets, tin and terne plate, railway track material, casing and oil-line pipe, and wire. The exports of iron and steel scrap increased from 227,522 gross tons in 1932 to 773,406 tons in 1933.

*Iron and steel exported from the United States, 1932–33*

| Article | 1932 | | 1933 | |
|---|---|---|---|---|
| | Gross tons | Value | Gross tons | Value |
| Semimanufactures: | | | | |
| Steel ingots, blooms, billets, slabs, and sheet bars | 1,627 | $63,889 | 3,159 | $114,035 |
| Iron and steel bars and rods: | | | | |
| Iron bars | 617 | 42,906 | 675 | 55,254 |
| Steel bars | 15,548 | 827,251 | 22,251 | 1,131,295 |
| Alloy-steel bars | 1,622 | 250,958 | 1,797 | 267,311 |
| Wire rods | 14,818 | 583,451 | 16,877 | 608,079 |
| Iron and steel plates, sheets, skelp, and strips: | | | | |
| Boiler plates | 818 | 45,692 | 827 | 40,025 |
| Other plates, not fabricated | 9,477 | 478,112 | 12,929 | 591,790 |
| Skelp iron or steel | 25,486 | 910,162 | 23,260 | 822,392 |
| Iron or steel sheets, galvanized | 26,924 | 1,982,002 | 53,856 | 3,681,783 |
| Steel sheets, black | 38,277 | 2,844,285 | 37,078 | 2,464,826 |
| Iron sheets, black | 2,461 | 175,995 | 2,751 | 195,940 |
| Strip steel, cold rolled | 5,558 | 500,170 | 8,032 | 624,399 |
| Hoop, band, and scroll iron or steel | 12,219 | 626,881 | 12,218 | 603,176 |
| Tin plate, terneplate, and taggers tin | 39,603 | 3,272,566 | 95,239 | 7,650,419 |
| Manufactures—steel-mill products: | | | | |
| Structural iron and steel: | | | | |
| Structural shapes: | | | | |
| Not fabricated | 14,885 | 589,847 | 14,089 | 535,364 |
| Fabricated | 8,639 | 628,713 | 13,893 | 939,967 |
| Ship and tank plates, punched or shaped | 1,072 | 64,396 | 1,400 | 82,418 |
| Metal lath | 1,471 | 182,931 | 1,006 | 135,439 |
| Other structural shapes | 7,365 | 335,924 | 3,045 | 183,739 |

*Iron and steel exported from the United States, 1932–33*—Continued

| Article | 1932 | | 1933 | |
|---|---|---|---|---|
| | Gross tons | Value | Gross tons | Value |
| Manufactures—steel mill products—Continued. | | | | |
| Railway track material: | | | | |
| Rails for railways | 11,320 | $427,924 | 41,481 | $1,226,929 |
| Rail joints, splice bars, fishplates, and tieplates | 1,969 | 121,006 | 9,128 | 478,010 |
| Switches, frogs, and crossings | 745 | 96,494 | 755 | 94,157 |
| Railroad spikes | 693 | 38,641 | 2,375 | 192,112 |
| Railroad bolts, nuts, washers, and nut locks | 336 | 43,156 | 1,278 | 174,244 |
| Tubular products: | | | | |
| Boiler tubes | 3,677 | 566,830 | 3,919 | 483,392 |
| Casing and oil-line pipe | 17,274 | 1,791,968 | 39,206 | 3,430,620 |
| Welded black pipe | 14,805 | 1,157,130 | 15,281 | 1,017,185 |
| Welded galvanized pipe | 16,082 | 1,305,992 | 22,912 | 1,477,441 |
| Malleable-iron screwed pipe fittings | 1,678 | 485,337 | 2,500 | 665,904 |
| Cast-iron screwed pipe fittings | 752 | 180,574 | 2,223 | 246,154 |
| Cast-iron pressure pipe and fittings | 4,723 | 217,736 | 6,622 | 323,323 |
| Cast-iron soil pipe and fittings | 2,940 | 191,997 | 3,658 | 232,383 |
| Wire and manufactures: | | | | |
| Barbed | 16,752 | 791,283 | 29,045 | 1,507,931 |
| All other | 13,754 | 1,864,744 | 28,630 | 2,679,971 |
| Nails and bolts (except railroad): | | | | |
| Cut nails | 158 | 21,481 | (1) | (1) |
| Horseshoe nails | 676 | 159,722 | 592 | 134,812 |
| Wire nails | 7,550 | 369,717 | 10,249 | 509,065 |
| All other nails, including tacks and staples | 2,543 | 274,619 | 3,374 | 341,041 |
| Bolts, nuts, rivets, and washers (except railroad) | 2,715 | 625,223 | 3,681 | 808,910 |
| Castings and forgings: | | | | |
| Horseshoes | 100 | 13,935 | 144 | 22,977 |
| Iron and steel, including car wheels and axles | 11,145 | 1,394,614 | 12,274 | 1,294,047 |
| Advanced manufactures: | | | | |
| Househeating boilers and radiators | | 246,561 | | 151,517 |
| Tools: | | | | |
| Axes | | 177,259 | | 378,767 |
| Hammers and hatchets | | 41,202 | | 80,277 |
| Saws, wood and metal cutting | | 673,013 | | 802,930 |
| Shovels and spades | | 67,736 | | 101,280 |
| All other tools | | 2,998,265 | | 3,708,626 |

[1] Included with "All other nails."

# BAUXITE AND ALUMINUM

By C. E. Julihn

## SUMMARY OUTLINE



In 1933 world production of aluminum continued to decline under the influence of a depressing accumulation of stocks, but consumption is believed to have held fairly well, and probably world production of bauxite increased to some extent. The quoted price of aluminum remained unchanged. The salient figures for 1932 and 1933 are as follows:

*Salient statistics of the bauxite and aluminum industries, 1932–33*

| | 1932 | 1933 | Increase (+) or decrease (−) percent |
|---|---|---|---|
| Bauxite: | | | |
| World production metric tons | 954,000 | (1) | (1) |
| United States: | | | |
| Production do | 97,895 | 156,651 | +60.0 |
| Do long tons | 96,349 | 154,176 | +60.0 |
| Value dollars | 548,168 | 923,259 | +68.4 |
| Price per ton do | 5.69 | 5.99 | +5.3 |
| Imports long tons | 205,620 | 149,548 | −27.3 |
| Exports do | 28,474 | 21,760 | −23.6 |
| Aluminum: | | | |
| World production metric tons | 151,800 | 135,600 | −10.7 |
| United States: | | | |
| Production do | 47,575 | 38,613 | −18.8 |
| Do short tons | 52,443 | 42,563 | −18.8 |
| Value dollars | 20,453,000 | 16,174,000 | −20.9 |
| Price per pound, new, 98–99 percent cents | 22.9 | 22.9 | |
| Secondary production short tons | 24,000 | 33,500 | +39.6 |
| Imports, value dollars | 1,822,202 | 3,212,418 | +76.3 |
| Exports, value do | 1,451,375 | 1,329,027 | −8.4 |

[1] Not available.

## BAUXITE

The bauxite output of the United States was 154,176 long tons valued at $923,259 in 1933 compared with 96,349 long tons valued at $548,168 in 1932. The increase thus amounted to 57,827 tons (about 60 percent). This represents, however, a decline since 1929 of about 58 percent. The percentage decline in total value from 1929 is virtually the same as that in quantity.

Bauxite is now the only commercial ore of aluminum, and the quantity known to exist throughout the world is limited. There is,

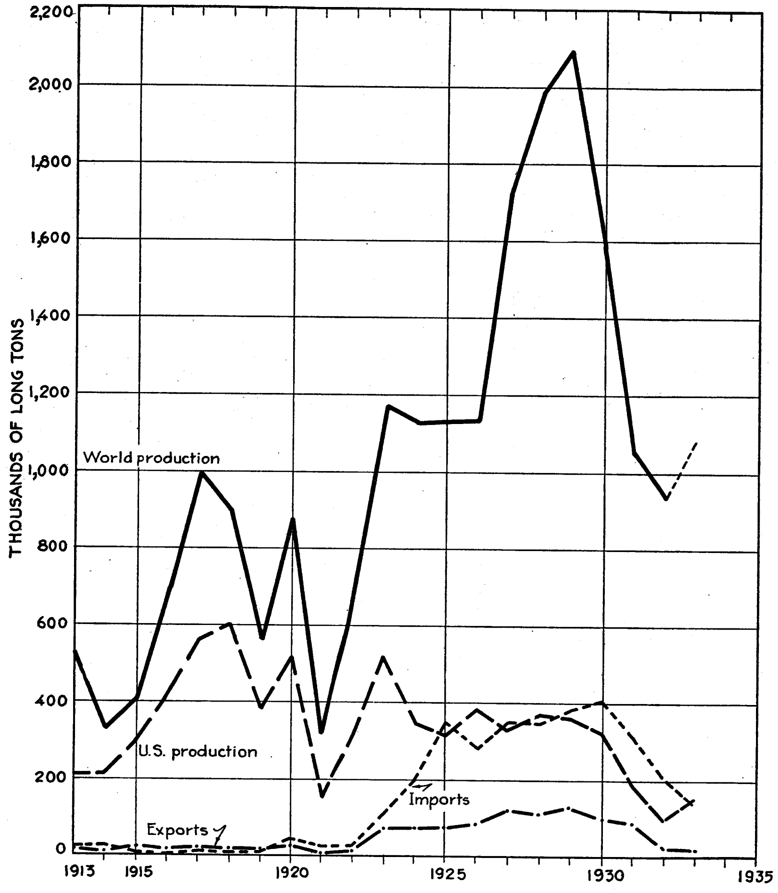


FIGURE 12.—Trends of bauxite production for the United States and for the world, 1913–33, compared with shipments into the United States and domestic exports.

however, a vast amount of other aluminous material, such as clays and feldspathic rocks, containing as much as 20 to 35 percent 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 percent 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 a very high content of water, usually about 30 percent; by a low content of ferric oxide, usually about 1 percent; and by a relatively high content of silica, usually about 2 percent. The alumina averages about 60 percent in the ores of the United States and somewhat higher in the ores of the Guianas.

Approximately one fourth of the bauxite produced in the world is usually consumed in the manufacture of chemicals, refractories, abrasives, and cement and for the filtering of oil; the balance is consumed in the production of aluminum.

Negotiations for the establishment of an Aluminum Code, conducted by the NRA, have not yet been brought to a conclusion. It is reported, however, that most of the difficulties have been met and establishment of a code at an early date is expected.

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 12.

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 alumina and 2 tons of alumina 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. Figure 13 shows the primary aluminum produced in the United States and in the world, 1913–33, compared with imports into the United States and with domestic consumption, exports, secondary production, and trend of the average New York quoted price (No. 1 virgin 98–99 percent).

*Bauxite produced in the United States, 1929–33*

| Year | Alabama and Georgia | | Arkansas | | Total | |
|---|---|---|---|---|---|---|
| | Long tons | Value f.o.b. mine | Long tons | Value f.o.b mine | Long tons | Value f.o.b. mine |
| 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 |
| 1933 | 11, 997 | 69, 541 | 142, 179 | 853, 718 | 154, 176 | 923, 259 |

The domestic production of bauxite was derived chiefly from Arkansas, which produced 92 percent of the total in 1933; Alabama and Georgia together provided 8 percent.

Arkansas shipped 142,179 long tons of bauxite in 1933, derived from four mines, the Bauxite mine and the Patricia No. 1 mine in Saline County and the Dixie No. 2 and the England in Pulaski County. This represented an increase of 58 percent compared with 1932 and resulted from an increase of 47 percent in shipments from Saline County and of 76 percent from Pulaski County. The former county provided the larger tonnage.

In Alabama bauxite was shipped in 1933 from the Eufaula and the Lennig mines in Barbour County. Shipments were 67 percent greater than in 1932. In Georgia bauxite was shipped in 1933 from the Hatton and Easterlin mines in Sumter County. Shipments were 110 percent greater than in 1932. The combined shipments from Alabama

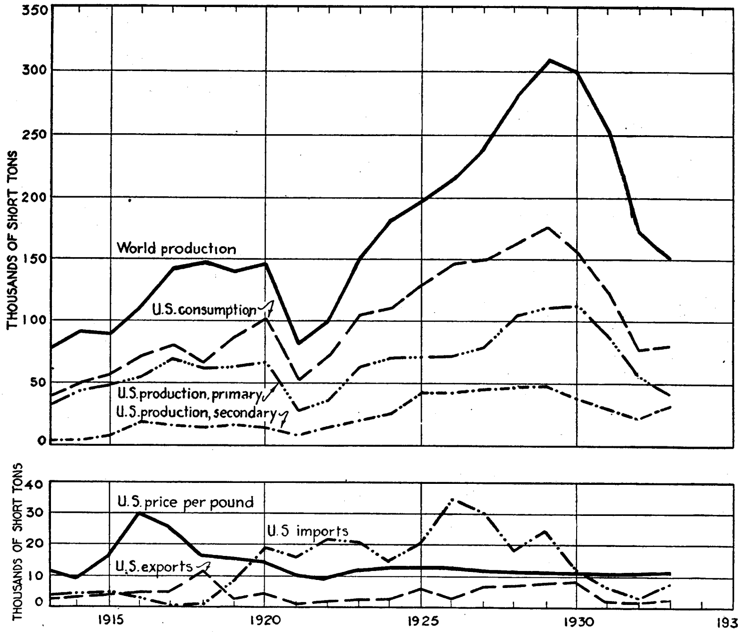


FIGURE 13.—Primary aluminum produced in the United States and in the world, 1913–33, compared with imports into the United States and with domestic consumption, exports, secondary production, and trend of the average New York quoted price (No. 1 virgin 98–99 percent).

and Georgia were 11,997 tons, all of which was taken by the chemical industry.

The first bauxite produced in the United States was obtained in 1889 from deposits in the north Georgia field, and in 1891 bauxite 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 domestic production of bauxite recorded from 1889 to 1933, inclusive, is 8,276,819 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 1933 at prices ranging from $4 to $11.50 a long ton. The average for Arkansas bauxite was $6 a ton, for Alabama and Georgia $5.80, and for United States $5.99. The quoted prices[1] for bauxite were as follows: Domestic—chemical ore, crushed and dried, 55 to 58 percent $Al_2O_3$ and 1.5 to 2.5 percent $Fe_2O_3$, $6 to $7.50 a long ton f.o.b. Alabama and Arkansas mines. Foreign—Dalmatian, 50 to 55 percent $Al_2O_3$ and 1 to 3 percent $SiO_2$, $4.50 to $6; Istrian, 54 to 57 percent $Al_2O_3$ and 3 to 5 percent $SiO_2$, $5.50 to $6; and French, 56 to 59 percent $Al_2O_3$ and 2 to 4 percent $SiO_2$, $5.50 to $6.50 a metric ton c.i.f. Atlantic ports.

Under the Tariff Act of 1930 crude bauxite is dutiable at the rate of $1 a ton, and alumina hydrate or refined bauxite at one-half cent a pound. (See par. 6, schedule 1; and par. 207, schedule 2.)

*Market and uses.*—The principal market for bauxite is east of the Mississippi River; it is sold chiefly to the manufacturers of aluminum, abrasives, commercial chemicals, and refractories. The manufacturers of alumina cements are supplied largely by imported bauxite. High-alumina (diaspore) clays produced in Missouri are now used in the manufacture of refractories and sold according to their alumina content; three grades, containing 55, 65, and 70 percent alumina ($Al_2O_3$), are 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 1933 were made to chemical industries, which took 89,226 tons or 58 percent of the total. For making aluminum 46,506 tons (30 percent) were shipped and 18,444 tons (12 percent) for use in abrasives, 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 79 percent and that by abrasive industries 75 percent, but that taken by chemical industries has increased 6 percent. In 1933 the consumption for aluminum increased 61 percent above that in 1932; consumption for chemicals increased 44 percent; and consumption for abrasives increased 229 percent. Makers of refractories took 11,809 short tons of high-alumina (diaspore) clay in 1933. The aluminous abrasives are used largely in powdered and granulated material for grinding wheels and sandpaper.

*Domestic bauxite sold by producers to industries in the United States, 1929–33, in long tons*

| Year | Aluminum | Chemical | Abrasive[1] | Cement and refractory[1] | Total | Year | Aluminum | Chemical | Abrasive[1] | Cement and refractory[1] | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 1933 | 46,506 | 89,226 | 18,444 | | 154,176 |
| 1931 | 83,340 | 58,424 | 53,631 | 500 | 195,895 | | | | | | |

[1] Small quantity of bauxite sold to makers of refractories probably included under "Abrasive."

[1] Metal and Mineral Markets, vol. 4, 1933.

*Value of aluminum and aluminum salts made from bauxite in the United States, 1929–33*

| Year | New aluminum | Aluminum salts | Year | New aluminum | Aluminum salts |
|---|---|---|---|---|---|
| 1929 | $51,864,000 | $11,677,728 | 1932 | $20,453,000 | [1] $7,669,075 |
| 1930 | 50,961,000 | 10,245,063 | 1933 | 16,174,000 | 8,816,681 |
| 1931 | 37,284,000 | 8,736,030 | | | |

[1] Revised figures.

*Aluminum salts.*—Manufacturers of aluminum salts reported a consumption of 178,000 long tons of bauxite in 1933, with an average value of $11.09 a ton at the plant, compared with 100,386 tons in 1932, with an average value of $10.89 a ton. An unrecorded quantity of high-alumina clay, 3,892 short tons of alumina hydrate, and some aluminum also were used in the preparation of aluminum salts. These figures do not include the bauxite made into alumina and sodium aluminate as a preliminary step in the manufacture of aluminum. Neither do the figures in the following tables include the alumina and sodium aluminate made as a preliminary step in the manufacture of aluminum.

*Aluminum salts, produced in the United States, shipped in 1932–33*

| Salt | 1932 | | | | 1933 | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of producers reporting | Short tons | Value | | Number of producers reporting | Short tons | Value | |
| | | | Total | Average | | | Total | Average |
| Alum: | | | | | | | | |
| Ammonia | 5 | 3,889 | $202,216 | $52 | 5 | 4,039 | $205,791 | $51 |
| Potash | 3 | 2,098 | 108,345 | 52 | 3 | 1,869 | 95,792 | 51 |
| Sodium-aluminum sulphate | 3 | 16,341 | 888,607 | 54 | 3 | 18,750 | 1,022,345 | 55 |
| Aluminum chloride: | | | | | | | | |
| Liquid | 5 | 1,829 | 105,669 | 58 | 5 | 1,437 | 76,247 | 53 |
| Crystal | 2 | [1] 2,495 | [1] 264,943 | [1] 106 | 2 | 3,328 | 308,334 | 93 |
| Anhydrous | 4 | | | | 4 | | | |
| Aluminum sulphate: | | | | | | | | |
| Commercial: | | | | | | | | |
| General | 11 | 261,254 | 5,309,149 | 20 | 11 | 305,001 | 6,077,410 | 20 |
| Municipal | 10 | 10,954 | 165,905 | 15 | 10 | 9,696 | 147,716 | 15 |
| Iron-free | 7 | 14,017 | 428,523 | 31 | 7 | 15,142 | 465,769 | 31 |
| Other aluminum salts and hydrate | [2] 4 | 2,497 | 195,718 | -------- | [2] 5 | 6,325 | 417,277 | -------- |
| | -------- | [1] 315,374 | [1] 7,669,075 | -------- | -------- | 365,587 | 8,816,681 | -------- |

[1] Revised figures.
[2] 1932: 2 producers each of alumina and sodium aluminate; 1933: 3 producers of alumina, 2 producers of sodium aluminate, and 1 producer of aluminum acetate.

The following table shows the recent record of actual production of aluminum salts, to indicate the difference between these figures and those for shipments shown in the preceding table.

*Aluminum salts produced in the United States, 1929–33, in short tons*

| Salt | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Alum: | | | | | |
| Ammonia | 5,712 | 4,489 | 4,085 | 4,032 | 4,156 |
| Potash | 6,235 | 1,984 | 2,404 | 1,198 | 1,858 |
| Other | | | | | |
| Sodium-aluminum sulphate | 14,947 | 14,776 | 15,945 | 16,428 | 18,941 |
| Aluminum chloride: | | | | | |
| Liquid | 2,524 | 3,323 | 1,589 | 1,998 | 1,595 |
| Crystal | 301 | 827 | 5,518 | 2,439 | 3,261 |
| Anhydrous | 13,891 | 11,543 | | | |
| Aluminum sulphate: | | | | | |
| Commercial | 326,549 | 314,870 | 299,864 | 271,537 | 316,608 |
| Iron-free | 20,181 | 23,217 | 14,636 | 14,029 | 16,016 |
| Other aluminum salts and hydrate | 2,414 | 3,915 | 3,044 | 2,421 | 5,534 |
| | 392,754 | 378,944 | 347,085 | 314,082 | 367,969 |

*Aluminum salts produced in, imported into, and exported from the United States 1929–33*

| Year | Domestic production | | Imports | | Exports (aluminum sulphate) [1] | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| 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 | [2] 315,374 | [2] 7,669,075 | 1,505 | 65,859 | [1] 21,550 | [1] 462,954 |
| 1933 | 365,587 | 8,816,681 | 301 | 22,877 | [1] 28,270 | [1] 543,945 |

[1] Also "other aluminum compounds" as follows: 1929, 275 short tons, valued at $65,458; 1930, 1,009 tons, $194,503; 1931, 875 tons, $170,585; 1932, 326 tons, $58,789; 1933, 428 tons, $70,011.
[2] Revised figures.

*Bauxite producers in the United States in 1933*

American Cyanamid & Chemical Corporation, 535 Fifth Avenue, New York, N.Y.
Crawford Bauxite Co., Bauxite, Ark.
Dixie Bauxite Co., Inc., Sweet Home, Ark.
Benjamin Easterlin, Americus, Ga.
General Abrasive Co., Inc., Niagara Falls, 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 1933*

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.
Delecarlia 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 of bauxite declined in 1933. Imports fell from 205,620 long tons in 1932 to 149,548 in 1933, or 56,072 tons (27 percent). Exports fell from 28,474 tons in 1932 to 21,760 in 1933, or 6,714 tons (24 percent). Total supply, including domestic production and the excess of imports over exports, increased from 273,495 tons in 1932 to 281,964 in 1933, or 8,469 tons (3 percent). The supply in 1933 was only 44 percent of that in 1930, which totaled 635,786 tons.

The higher unit value of exports compared with imports is due to the fact that they consist chiefly of so-called "concentrates"—purified alumina extracted from bauxite for use in the electrical reduction of aluminum. This alumina is extracted from bauxite at East St. Louis and shipped, chiefly to Canada, for reduction to aluminum.

The principal source of imports was Dutch Guiana, from which 104,571 long tons of bauxite were imported in 1933.

*Bauxite imported into and exported from the United States, 1929–33*

| 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 |
| 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 | 1933 | 149,548 | 899,696 | 21,760 | 645,688 |
| 1931 | 306,490 | 1,495,577 | 88,370 | 3,309,208 | | | | | |

## ALUMINUM

New aluminum produced in the United States in 1933 amounted to 85,126,000 pounds (42,563 short tons) valued at $16,174,000, representing decreases of 19 percent in quantity and 21 percent in total value compared with 1932. The total decline from maximum domestic production of aluminum, attained in 1930, was 63 percent. According to statistics collected by J. P. Dunlop, of the Bureau of

Mines, 33,500 short tons of secondary aluminum were recovered in 1933, 14,500 tons as metal and 19,000 as the aluminum content of casting alloys. Thus, in 1933 the combined domestic production of the new aluminum and of secondary aluminum recovered as metal and in alloys amounted to 76,063 tons, 56 percent of the total being new metal and 44 percent secondary or recovered material.

*Aluminum produced in the United States, 1929–33*

| Year | Primary metal | | Secondary metal | | Year | Primary metal | | Secondary metal | |
|---|---|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value [1] | | Pounds | Value | Pounds | Value [1] |
| 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 | 1933 | 85,126,000 | 16,174,000 | 67,000,000 | 15,343,000 |
| 1931 | 177,544,000 | 37,284,000 | 60,600,000 | 12,726,000 | | | | | |

[1] 1929: Value of secondary aluminum based on average price at New York as given by American Meta Market; 1930–31: Based on average price as reported to Bureau of Mines; 1932–33: 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 1933. 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 1933, 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 1933 transportation continued to consume the largest percentage of aluminum.

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.

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, but the more extensive use of high-compression motors is leading 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 the use of aluminum in the construction of railroad passenger cars has gradually been extended; 5 or 6 tons of weight are saved in an ordinary car. Tank cars for chemicals, saving 4 tons of weight, also have been built. Experiments in which aluminum was used as extensively as possible in building Pullman cars have led to the development of a light, stream-line railway car for main-line service, constructed almost entirely of light, strong aluminum alloys. These cars travel at unprecedented speed. Several trains of such construction were exhibited to the public in 1933.

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 increased rapidly. With marked curtailment in the production of aircraft the consumption of aluminum by the various aviation industries has diminished.

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.

Duralumin 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.

A notable use of aluminum in 1933 was for lightening the roadway of a bridge in Pittsburgh, Pa., where the traffic load had become excessive with respect to the understructure. Reducing the load by substituting aluminum for iron in the roadway postpones the early necessity of replacing the entire structure.

Aluminum foil has been used as an insulating material in several fields, either as a backing for 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 in sewage-disposal plants for more than a decade has shown higher resistance to certain types of corrosive conditions.

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 frequently is 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 increased 76 percent in total value—from $1,822,202 in 1932 to $3,212,418 in 1933. Imports of aluminum metal, scrap, alloy, etc., increased 87 percent in quantity in 1933 compared with 1932; imports of plates, sheets, bars, circles, disks, etc., increased 35 percent in quantity; imports of hollow ware decreased 40 percent in quantity; and imports of aluminum powders and foil decreased 9 percent in quantity.

Aluminum exports decreased 8 percent in value—from $1,452,375 in 1932 to $1,329,027 in 1933. Exports of crude and semicrude aluminum increased 29 percent in quantity in 1933 compared with 1932; exports of tubes, moldings, castings, and other shapes decreased 46 percent in quantity.

*Aluminum imported for consumption in the United States, 1932–33, by classes*

| Class | 1932 | | 1933 | |
|---|---|---|---|---|
| | Pounds | Value | Pounds | Value |
| Crude and semicrude: | | | | |
| Crude form, scrap, alloy, etc. | 8,064,830 | $1,310,228 | 15,109,084 | $2,710,244 |
| Plates, sheets, bars, rods, circles, squares, etc. | 119,883 | 29,227 | 161,375 | 45,186 |
| | 8,184,713 | 1,339,455 | 15,270,459 | 2,755,430 |
| Manufactures: | | | | |
| Leaf (5½ by 5½ inches) | (1) | 16,669 | (1) | 24,923 |
| Bronze powder and powdered foil | 598,417 | 159,831 | 587,927 | 173,948 |
| Foil less than 0.006 inch thick | 722,762 | 53,084 | 609,930 | 185,554 |
| Table, kitchen, and hospital utensils, and other similar hollow ware | 130,792 | 198,460 | 77,992 | 35,967 |
| Other manufactures | (2) | 54,703 | (2) | 36,596 |
| | | 482,747 | | 456,988 |
| Grand total | | 1,822,202 | | 3,212,418 |

[1] 1932: 13,723,695 leaves; 1933: 14,446,166 leaves; equivalent in pounds not recorded.
[2] Quantity not recorded.

*Aluminum imported for consumption in the United States, 1929–33*

| Year | Crude and semicrude[1] | | Manufactures of[2] | Total value | Year | Crude and semicrude[1] | | Manufactures of[2] | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Pounds | Value | | | | Pounds | Value | | |
| 1929 | 50,880,823 | $9,934,723 | $925,286 | $10,860,009 | 1932 | 8,184,713 | $1,339,455 | $482,747 | $1,822,202 |
| 1930 | 25,461,179 | 4,689,521 | 596,063 | 5,285,584 | 1933 | 15,270,459 | 2,755,430 | 456,988 | 3,212,418 |
| 1931 | 14,832,807 | 2,539,756 | 670,989 | 3,210,745 | | | | | |

[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, 1932–33, by classes*

| Class | 1932 | | 1933 | |
|---|---|---|---|---|
| | Pounds | Value | Pounds | Value |
| Crude and semicrude: | | | | |
| Ingots, scrap, and alloys | 3,904,802 | $317,571 | 5,514,759 | $539,130 |
| Plates, sheets, bars, strips, and rods | 531,888 | 151,221 | 192,902 | 60,831 |
| | 4,436,690 | 468,792 | 5,707,661 | 599,961 |
| Manufactures: | | | | |
| Tubes, moldings, castings, and other shapes | 839,043 | 336,766 | 454,200 | 160,325 |
| Table, kitchen, and hospital utensils | (1) | 201,979 | (1) | 197,333 |
| Other manufactures of aluminum | (1) | 444,838 | (1) | 371,408 |
| | (1) | 983,583 | (1) | 729,066 |
| Grand total | (1) | 1,452,375 | (1) | 1,329,027 |

[1] Quantity not recorded for table, kitchen, and hospital utensils and other manufactures.

*Aluminum and manufactures of aluminum exported from the United States, 1929–33*

| Year | Crude and semicrude[1] | | Manufactures | Total value | Year | Crude and semicrude[1] | | Manufactures | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Pounds | Value | | | | Pounds | Value | | |
| 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 | 1933 | 5,707,661 | 599,961 | [2]729,066 | 1,329,027 |
| 1931 | 4,700,878 | 985,870 | [2]1,868,875 | 2,854,745 | | | | | |

[1] Includes ingots, metal and alloys, plates and sheets, etc.
[2] Tubes, moldings, castings, and other shapes exported amounted to 2,466,508 pounds in 1929, 1,864,308 pounds in 1930, 1,292,400 pounds in 1931, 839,043 pounds in 1932, and 454,200 pounds in 1933; 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 1933 it appears that the total imports for which the weights are recorded were 8,273 short tons and the total exports 3,081 tons. The excess of imports over exports thus accounted for amounts to 5,192 tons, indicating an approximate total increase of supply of 47,755 tons of aluminum, other than domestic secondary, for domestic consumption.

## FOREIGN BAUXITE AND ALUMINUM INDUSTRIES

*World production of bauxite.*—World production of bauxite in 1932 was 954,000 metric tons, a decline of 11 percent from the production of the previous year. Europe supplied 70 percent of the total, South America 20 percent, and North America about 10 percent; in 1930 the respective percentage productions of these continents had been about 55 percent, 24 percent, and 21 percent. The 1932 output included 393,663 tons (41 percent) produced by France, 97,895 tons (10 percent) by the United States, 126,513 tons (13 percent) by Dutch Guiana, 63,510 tons (7 percent) by British Guiana, 111,558 tons (12 percent) by Hungary, 86,553 tons (9 percent) by Italy, and 67,086 tons (7 percent) by Yugoslavia. These seven countries thus accounted for 99 percent of the total, the balance being credited to Germany, northern Ireland, Greece, Rumania, Spain, and Australia.

The corresponding production for 1933 is not known as yet, but it is unlikely to present a further decline. The limited data available suggest that the world total for 1933 may approximate 1,060,000 metric tons.

*World production of bauxite, 1929–33, by countries, in metric tons*

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Australia: | | | | | |
| New South Wales | | | 199 | | (1) |
| Victoria | 555 | 802 | 1,406 | 1,147 | (1) |
| British Guiana [2] | 188,123 | 121,536 | 127,103 | 63,510 | (1) |
| France | 666,348 | 609,180 | 347,947 | 393,663 | 445,000 |
| Germany | 7,256 | 1,391 | | 1,638 | (1) |
| Greece | 6,280 | 2,280 | 1,150 | 590 | (1) |
| Hungary | 389,152 | 31,696 | 89,556 | 111,558 | (1) |
| India, British | 9,189 | 2,554 | | | (1) |
| Italy | 192,774 | 161,187 | 67,369 | 86,553 | (1) |
| Rumania | 926 | 678 | 381 | 612 | (1) |
| Spain | 975 | 323 | | 1,300 | (1) |
| Surinam (Dutch Guiana) | 209,998 | 264,556 | 173,154 | 126,513 | (1) |
| United Kingdom: Northern Ireland | 2,359 | 2,070 | 3,394 | 1,497 | (1) |
| United States | 371,648 | 335,918 | 199,039 | 97,895 | 156,651 |
| Yugoslavia | 103,366 | 94,700 | 64,842 | 67,086 | (1) |
| | 2,149,000 | 1,629,000 | 1,076,000 | 954,000 | (1) |

[1] Data not available. [2] Exports.

*World production of aluminum.*—World production of aluminum in 1933, exclusive of any Soviet production, is estimated at 135,600 metric tons, a drop of 11 percent from that in 1932 (151,800 metric tons). Of the total North America produced 40 percent compared with 43 percent in 1932. All other production was from Europe.

Production of the United States (38,613 metric tons, equivalent to 28 percent of world production) exceeded by a large margin that of any other country. Germany, with 18,300 metric tons (13.5 percent), was second; and Canada, with 16,155 tons (12 percent), was third. Other producers were Norway (14,936 tons), France (14,500 tons), followed in order of rank by Italy, Great Britain, Switzerland, Spain, and Austria.

*World production of aluminum, 1932–33, by countries (exclusive of U.S.S.R.), in metric tons*

| Country | 1932 | 1933 [1] | Country | 1932 | 1933 [1] |
|---|---|---|---|---|---|
| Austria | 2,032 | 914 | Norway | 17,787 | 14,936 |
| Canada | 17,781 | 16,155 | Spain | 1,100 | 1,000 |
| England | 10,161 | 11,583 | Switzerland | 8,500 | 7,500 |
| France | 14,400 | 14,500 | United States | 47,575 | 38,613 |
| Germany | 19,000 | 18,300 | | | |
| Italy | 13,414 | 12,072 | | 151,800 | 135,600 |

[1] Subject to revision.

## 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 virtually all foreign interests of the Aluminum Co. of America. Canada produced 16,155 metric tons of aluminum in 1933, compared with 17,781 metric tons in 1932 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 1933 Canada exchanged aluminum for mineral oil with the U.S.S.R.

*Greenland.*—Greenland is the only source of natural cryolite, annual exports of which recently averaged about 30,000 tons. In 1932 they were 17,592 long tons. The production goes to Denmark for refining and reexport to other countries of Europe, and to the United States.

## 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 63,510 metric tons in 1932. 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 1933 the Surinaamsche Bauxite Maatschappij exported to the United States 101,469 metric tons compared with 122,550 tons in 1932.

## 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 3,000 to 4,000 tons of aluminum a year, most of which was exported. In 1933 its production was only 914 metric tons compared with 2,032 tons in 1932. One of its two reduction plants, at Lend-Gastein, is owned by Aluminium Industrie, of Switzerland; the other, Aluminiumwerke Steeg, is 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. In 1933, approximately 445,000 metric tons were produced compared with 393,663 tons in 1932. 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. In both 1932 and 1933 about 14,500 metric tons were produced.

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 consolidated gradually 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. Imports totaled more than 400,000 metric tons in 1928 but have since been reduced by half. In 1933 about 239,000 metric tons were imported compared with 201,000 tons in 1932. In 1933 they included 114,100 tons derived from France, 53,170 tons from Hungary, 38,830 tons from Yugoslavia, and 29,740 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 from 18,000 to 30,000 metric tons. Production in 1933 was 18,300 metric tons compared with 19,000 tons in 1932. 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. Because of the import duty on new aluminum the imports consist chiefly of scrap.

*Greece.*—Greece has some bauxite from which sporadic production in small amounts is made. A recent dispatch says the reserves of Greece include 1½ to 2 million tons, contained in numerous and scattered small deposits; transport facilities are very unsatisfactory.

*Hungary.*—Hungary has enormous reserves of bauxite and in 1928 produced nearly 400,000 metric tons, largely for export, but in 1932 production had fallen to 111,558 metric tons. Although aluminous cements are manufactured, aluminum is not produced in Hungary.

Exports go to Germany, Austria, Czechoslovakia, and Rumania. Construction is being discussed of a 3,000-ton aluminum reduction plant near Budapest to provide an outlet for Hungarian ore. Bauxite exports have declined recently because of competition from Yugoslav ores of the Dalmatian coast.

*Italy.*—Italy not only has substantial reserves of bauxite but also 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 86,553 tons of bauxite in 1932, compared with 67,369 tons in 1931.

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 1933 was 12,072 metric tons, compared with 13,414 tons in 1932.

The aluminum industry has been carefully fostered by the Government so that 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 1933 was 14,936 metric tons compared with 17,787 in 1932.

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 is about 36,000 tons, of which the subsidiaries of Aluminium, Ltd., provide 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. These imports are derived from France.

*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 7,500 tons in 1933, compared with 8,500 tons in 1932. 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.

*U.S.S.R.* (*Russia*).—The ambitious plan of the Soviets to effect their own production of aluminum provides for 3 plants, 1 on the River Volkhov about 100 kilometers from Leningrad, a second near the great Dnieper River hydroelectric plant, and a third near the Urals in Kamensk.

The first two are to be provided with ore from deposits at Tikhvin 250 miles from Leningrad. The tonnage claimed is 4,500,000 tons of low-grade ore, said in Soviet publicity to have "a large percent of impurities, for instance, as high as 14 percent silicic acid." Scientists devised a "dry alkaline method" so that the industry "can use not only bauxites, but clays, alunite, and nepheline."

The Volkhov power is ample for the first plant which has a capacity of 5,000 tons a year. Seemingly some output ("68.7 percent of the planned amount") commenced in 1933 and gradually increased, but the tonnage of aluminum produced is not stated. Presumably difficulties have been encountered. In the middle of the year a production of 6 or 8 tons a day was mentioned by the Metal Bulletin.

The Dnieper plant was to provide 40,000 tons of aluminum a year, and evidently much building is going on there. In the middle of the year it was announced that the first electric unit (20,000 tons capacity) was complete, awaiting supplies of power and with a 2 months' supply of electrodes on hand. Later the "first 40 baths went into operation."

The third plant has been started, which "will utilize the rich deposits of high-grade bauxite, which have a particularly high content of aluminum oxide without silica."

Although it is not easy to determine the real situation, it is evident that a stupendous effort is being made by the Soviets to create a great aluminum industry and that much difficulty has been encountered.

*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, but the output in 1932 was only 1,497 metric tons.

Production of aluminum in 1933 amounted to 11,583 metric tons compared with 10,161 metric tons in 1932 and 14,300 in 1931.

Early in 1932 the United Kingdom exported to Germany for the first time. Evidently the exchange favored the British after they went off the gold standard.

The British Aluminium Co., Ltd., the chief producer, has two reduction works, both in Scotland. The North British Aluminium Co., Ltd., also has a plant in Scotland. A fourth plant is that of Aluminium Corporation, Ltd., in Wales. Imports of bauxite are derived chiefly from France.

*Yugoslavia.*—Yugoslavia has deposits of high-grade bauxite, providing very large reserves, but it has only one small reduction plant. Production of bauxite in 1932 was 67,086 metric tons compared with 64,842 tons in 1931.

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, dropped to 2,554 tons in 1930, and ceased during 1931 and 1932.

*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 declined to 2,500 tons in 1931. Much larger purchases have been made recently, so that Japanese stocks are said to amount to at least a year's supply.

It has been reported recently that a company for the production of 5,000 tons of aluminum a year has been organized, which will utilize an aluminum shale found in Manchuria; the plant will be in Toyama, Japan. The South Manchuria Railway is expected to participate as a stockholder.

## AUSTRALIA

Bauxite occurs in Australia, but only small production has been made chiefly from Victoria.

# MERCURY

By Charles F. Jackson and H. M. Meyer

SUMMARY OUTLINE



Following a drastic reduction in domestic production of mercury in 1932, the output was reduced further in 1933 to 9,402 flasks, about 75 percent of that in 1932. Although there was a sustained advance in the New York price during most of the year and the average December price was nearly 40 percent higher than that at the beginning of the year, prices were still below the figure required to encourage an increase in domestic production. Only 57 mines reported production in 1933 compared with 95 mines in 1932. Reports covering metal in the hands of producers at the end of the year indicate a sold-out condition of most of the producing companies. Production statistics for all of the principal foreign producing countries are not yet available for 1933, but it is noteworthy that imports for consumption increased from 3,886 flasks in 1932 to 20,315 flasks in 1933. At the end of 1932 there were known to be large stocks of metal in Spain and Italy, and apparently concessions in price (London) by producers in those countries attracted buying demand on the part of consuming, and possibly speculative, interests in the United States during the middle of the year, when the New York price was advancing and the gold value of the dollar was declining.

Principal trends in production and imports of mercury from 1915 to 1933 are shown in figure 14; fluctuation of imports and average prices of mercury by months during 1933 are plotted in figure 15.

On July 18, 1933, representatives from every producing State met in San Francisco and organized the National Quicksilver Producers Association. A Code of Fair Competition was drawn up, and maximum hours and minimum wages in the industry were agreed upon; the code was filed by the association with the National Recovery Administration but had not been approved up to the end of 1933.

Late in the year the association, representing producers in Oregon, Washington, California, Nevada, Arizona, Arkansas, Texas, and Alaska, filed a complaint with the Imports Division of the NRA under section 3 (e) of the National Industrial Recovery Act. This section deals with the possible restriction of imports where they are found to be competing seriously with codified American industries. A public hearing was held before the Tariff Commission on January 15, 1934. A report of the Tariff Commission dated May 2, 1934, stated that

In the investigation with respect to quicksilver and wool felt . . . the Commission found that conditions in these industries today in respect of imports since the adoption of agreements or codes of fair competition under the National Industrial Recovery Act are not such as to render ineffective or seriously to endanger the maintenance of the agreement and the code of fair competition under which these respective industries are now operating. Therefore, no basis of action by the President under this section 3 (e) is afforded at this time.

The report also stated that Commissioner Edgar B. Brossard had suggested that a fee on imports would relieve unemployment in the quicksilver industry.

Metal Bulletin (London), no. 1836, October 27, 1933, page 16, reported regarding the European Cartel as follows:

We are officially informed by Messrs. Roura & Forgas that at a recent meeting of the Directing Committee of Mercurio Europeo complete agreement was reached

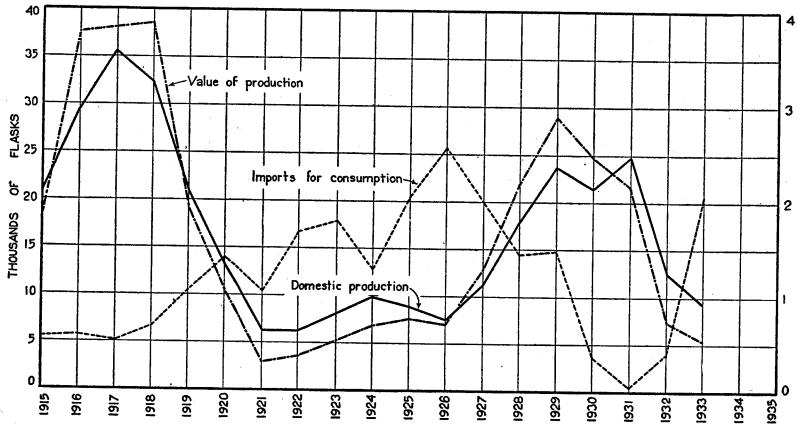


FIGURE 14.—Trends in domestic production, value, and imports of mercury, 1915–33.

to renew the Italian-Spanish Quicksilver Combine until the end of next year (1934).

*Salient statistics of the mercury industry in the United States, 1931–33*

[Flasks of 76 pounds]

| | 1931 | 1932 | 1933 |
|---|---|---|---|
| Production ... flasks | 24, 947 | 12, 622 | 9, 402 |
| Number of producing mines | 77 | 95 | 57 |
| Average price per flask: | | | |
| New York | $87. 35 | $57. 925 | $59. 227 |
| London | £19 15s. 10d. | £13 15s. 2d. | £9 16s. 7d. |
| Imports for consumption: | | | |
| Pounds | 41, 733 | 295, 348 | 1, 543, 935 |
| Equivalent flasks | 549 | 3, 886 | 20, 315 |
| Apparent supply ... flasks | 20, 512 | 16, 294 | 29, 500 |
| From domestic mines ... percent | 97 | 76 | 31 |
| Stocks in warehouses (bonded) at end of year ... flasks | 88 | [1] 3, 840 | 5, 370 |

[1] Probably includes about 3,550 flasks imported late in the year on 1 large contract.

*Prices.*—The trend of prices during 1933 is plotted in figure 15 which shows a rapid increase in the New York price from March 1 to July 30, a slower increase from then to the end of October, and little change during the rest of the year. The London price in pounds sterling declined rapidly from the beginning of the year to the end of August, increased sharply in October, and remained fairly constant to the end of the year. Exchange fluctuations during the year complicate the price picture, but from March to July, inclusive, the London

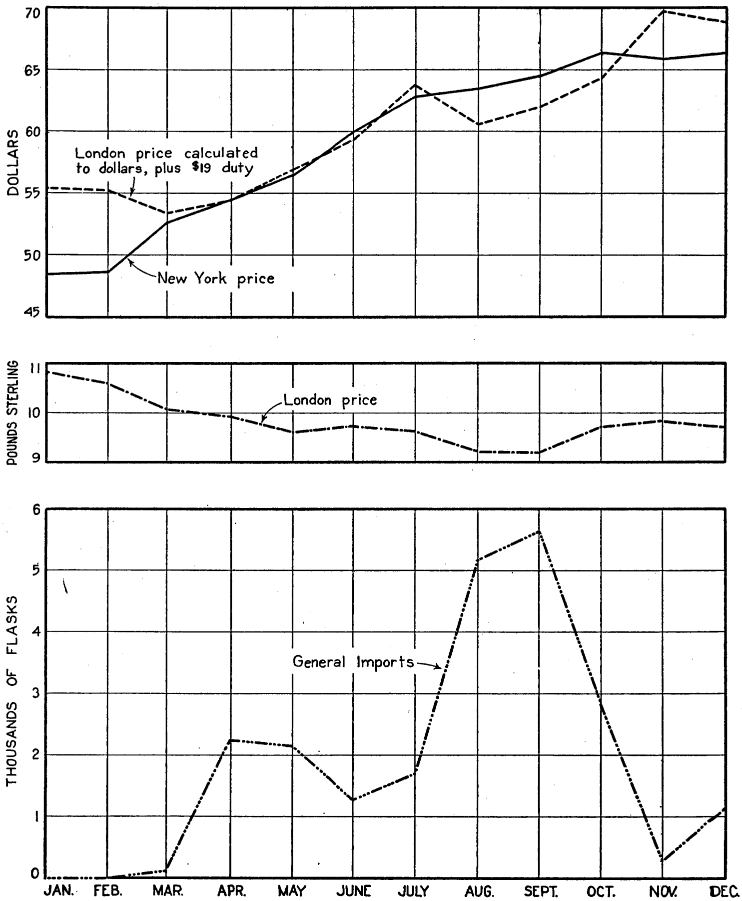


FIGURE 15.—Imports and average prices of mercury in 1933, by months.

don price converted to dollars at the average monthly rates of exchange, plus $19 duty, virtually coincided with the New York price. During August, September, and October, however, the London parity fell considerably below the New York price. Allowing for a lag of 1 month, this was a period when the dollar was falling rapidly in terms of the pound. It will be noted that imports were heaviest during this period, and various interpretations might be placed upon the relationships of the curves, depending upon the amount of information available covering the lag between delivery and purchase dates of foreign metal, exchange conditions, and other factors.

*Trend of domestic prices of mercury, 1932–33, at New York* [1]

[Per flask of 76 pounds]

| | 1932 | 1933 | | 1932 | 1933 |
|---|---|---|---|---|---|
| January | $64.900 | $48.500 | August | $47.444 | $63.500 |
| February | 66.304 | 48.614 | September | 47.500 | 64.580 |
| March | 72.537 | 52.676 | October | 47.600 | 66.500 |
| April | 72.125 | 54.580 | November | 48.750 | 66.000 |
| May | 66.380 | 56.500 | December | 48.500 | 66.330 |
| June | 59.481 | 60.038 | | | |
| July | 53.580 | 62.900 | Year | 57.925 | 59.227 |

[1] Engineering and Mining Journal, New York.

*Average yearly prices of mercury in the United States and the United Kingdom, 1929–33*

[Per flask of 76 pounds]

| Year | San Francisco (domestic) [1] | New York [1] | London [2] | Year | San Francisco (domestic) [1] | New York [1] | London [2] |
|---|---|---|---|---|---|---|---|
| | | | £. s. d | | | | £. s. d. |
| 1929 | [3] $124.00 | $122.15 | 22 5 2 | 1932 | (4) | $57.925 | 13 15 2 |
| 1930 | (4) | 115.01 | 21 15 8 | 1933 | (4) | 59.227 | 9 16 7 |
| 1931 | (4) | 87.35 | 19 15 10 | | | | |

[1] Engineering and Mining Journal, New York.
[2] Mining Journal (London).
[3] Quotations for San Francisco are on basis of "retail and small wholesale lots."
[4] Not given.

*Production costs.*—Reference has already been made to the public hearing before the Tariff Commission on January 15, 1934, and to the report of the Commission dated May 2. The following quotations from this report relate to the cost of production at domestic mines:

Testimony of domestic producers under oath at the public hearing was that at a price of $90 per flask they could produce sufficient quicksilver to supply the demand of the domestic market. Evidence before the Commission indicates that about 80 percent of the normal output is produced at a cost of around $90 or less per flask. . . . Apparently about 8,500 flasks can be produced at domestic properties at a cost of $75 or less.

In northern districts costs seem to have ranged from $55 to $118, including capital charges of $20 to $30 per flask.

*Consumption and uses.*—The following table shows the supply of mercury in the United States from 1923 to 1933.

*Supply of mercury in the United States, 1923–33*

[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) |
|---|---|---|---|---|---|---|
| 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 |
| 1933 | 9,402 | 20,315 | (1) | [2] 29,500 | 31.1 | 68.9 |

[1] Not separately classified for 1927–30 and 1933.
[2] Estimated by Bureau of Mines.
[3] From a special compilation by the customs statistics section, Bureau of Foreign and Domestic Commerce.

No new uses for mercury that might be expected to result in increased consumption were reported during 1933. Now and then new applications of mercury in scientific instruments and electrical apparatus have been announced which in the aggregate may in time amount to an appreciable increment in consumption requirements.

A new type of mercury lamp which is said to approximate sunlight more closely was shown publicly for the first time by scientists of Cincinnati at a meeting of the American Physical Society.[1] I. A. Balinkin and D. A. Wells discovered that by adding one five-hundredth part of the rare metal rubidium to the mercury red rays were added to the mercury spectrum sufficient to make the new light closely approximate sunlight. This lamp can be used in home lighting with 110 volts and is said to have a life ten times as long as that of ordinary lamps.

A new mercury switch announced by the Westinghouse Lamp Co. is refractory-protected to confine the arc and to obtain long life with dependability. It is made with nominal ratings from 3 to 50 amperes and comprises a new line of single-pole, single-throw switches for either a.c. or d.c. circuits.

Mercury-vapor grid-controlled rectifiers can be advantageously used for the direct-current supply of small telephone exchanges.[2] An arrangement is described in which the rectifier is installed in a manner that permits the automatic supply of current for recharging batteries during those hours when only part of the capacity of the rectifier is required for the operation of the telephone system. At night the rectifier is shut off, and the exchange operates on the batteries.

The Brown Instrument Co. has introduced the use of mercury switches to eliminate open make-and-break contacts controlled by the pen-arm automatic control thermometer.[3]

Butcher [4] has outlined the field of application of the multianode tank, mercury-cathode rectifier and its adaptability to industrial load.

Dupont Lignasan is an organic mercurial used to prevent fungus growth on freshly cut lumber in storage.[5]

Gas conduits are protected against damage from back fires by providing in the conduit a chamber containing a fire-clay or similar porous body covered with mercury, according to the claims of British Patent 381,832, October 13, 1932.[6]

## REVIEW BY STATES

Production of mercury was at low ebb during 1933, and appreciable activity in development and new construction was reported in Texas only.

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1 American Metal Market, vol. 40, no. 232, Dec. 6, 1933, p. 2.

2 John, H., Rectifiers for the Charging of Batteries in Telephone Exchanges: Elek. Mach.-Tech., vol. 10, 1933, pp. 386–8; Chem. Abs., vol. 28, no. 1, Jan. 10, 1934, p. 47.

3 Chemical Industries, vol. 33, no. 5, November 1933, p. 432.

4 Butcher, C. A., Mercury-Arc Rectifiers for 250-volt Supply: Elect. Eng., vol. 52, 1933, pp. 119–21.

5 Industrial and Engineering Chemistry (industrial edition), vol. 26, no. 1, January 1934, pp. 3–10.

6 Diedrix, Elionardus E. J., and Vlessing, Samuel, Preventing Fires: Chem. Abs., vol. 27, no. 22, Nov. 20, 1933, p. 5912.

*Mercury produced in the United States, 1930–33*

| | Producing mines | Flasks of 76 pounds | Value [1] | | Producing mines | Flasks of 76 pounds | Value [1] |
|---|---|---|---|---|---|---|---|
| 1930: | | | | 1932: | | | |
| California | 40 | 11,451 | $1,316,968 | California | 63 | 5,172 | $299,588 |
| Nevada | 20 | 3,282 | 377,460 | Nevada | 15 | 474 | 27,456 |
| Oregon | 7 | 2,919 | 335,711 | Oregon | 7 | 2,523 | 146,145 |
| Washington | 1 | 1,079 | 124,095 | Washington | 3 | 407 | 23,575 |
| Texas, Arizona, and Alaska | 7 | 2,822 | 324,555 | Texas, Arizona, Arkansas, and Alaska | 7 | 4,046 | 234,365 |
| | 75 | 21,553 | 2,478,789 | | 95 | 12,622 | 731,129 |
| 1931: | | | | 1933: | | | |
| California | 45 | 13,448 | 1,174,696 | California | 31 | 3,663 | 216,948 |
| Nevada | 16 | 2,217 | 193,657 | Nevada | 12 | 387 | 22,921 |
| Oregon | 5 | 5,011 | 437,716 | Oregon | 5 | 1,342 | 79,483 |
| Washington | 4 | 560 | 48,917 | Texas, Arkansas, Washington, and Utah | 9 | 4,010 | 237,500 |
| Texas, Arizona, Arkansas, and Alaska | 7 | 3,711 | 324,159 | | | | |
| | 77 | 24,947 | 2,179,145 | | 57 | 9,402 | 556,852 |

[1] Value calculated at average price for quicksilver at New York.

## ARKANSAS

Two properties in Pike County reported production during 1933.

## CALIFORNIA

Production in California amounted to 3,663 flasks in 1933 compared with 5,172 flasks in 1932 and 13,448 flasks in 1931. In 1933, as in 1932, a small production was reported from a few mines by "leasers" or former employees who were allowed to recover such mercury as they could and convert the proceeds to their own use, as a measure of unemployment relief, where the properties could not be operated on a company basis except at a loss.

*Fresno County.*—A few flasks of mercury were produced at each of two properties.

*Kings County.*—At the Fredanna mine working partners produced 48 flasks from retorting ore removed in prospect work.

*Lake County.*—The Sulphur Bank mine was the largest producer in California in 1933 and reported an output of 1,143 flasks of mercury from 13,174 short tons of ore treated. The Great Western mine was the second largest producer in Lake County and treated 2,344 tons of ore in its 20-ton Herreshoff furnace. Five other properties reported production.

*Napa County.*—The Oat Hill mine was the largest producer in Napa County in 1933; the second largest was the Aetna. Four other properties each reported a small production.

*San Benito County.*—The New Idria property was the largest producer in the county; the mine was closed down, and the production came from dumps and old pits. The Aurora property was the second largest producer, and a small quantity was produced at each of two other properties.

*San Luis Obispo County.*—The Cambria and Carson mines each reported some production during 1933.

*Santa Barbara County.*—Mercury was produced at the Red Rock mine in 1933.

*Santa Clara County.*—A small production was reported from each of two mines.

*Sonoma County.*—Four properties reported a small production.

*Trinity County.*—Two mines reported production during 1933.

### NEVADA

Production of mercury in Nevada fell to 387 flasks in 1933 from 474 flasks in 1932, 2,217 flasks in 1931, and 3,282 flasks in 1930, reflecting the continuation of low prices.

The production in 1933 came from 12 mines—2 in Elko County, 1 each in Esmeralda, Humboldt, Lander, Pershing, and Storey Counties, 3 in Mineral County, and 2 at unknown locations.

In August it was reported that the Castle Peak Quicksilver Co. was working four shifts of 6 hours each to spread employment.[7] In May it was reported[8] that the Mina Mercury Co. mine 11 miles northeast of Mina had been leased to Charles Anderson and that the property had been equipped with a new 25-ton rotary furnace, a two-drill compressor, and cook and bunk houses.

### OREGON

Production of mercury in Oregon was 1,342 flasks in 1933 compared with 2,523 flasks in 1932 and 5,011 flasks in 1931. Five mines reported some production in 1933, but 98 percent of the total came from the three largest producing properties.

A 6-ton revolving retort, a blacksmith shop, and drilling equipment were installed at the Steamboat mine, Jackson County, and 90 feet of tunnel were driven during the year. A few tons of ore were treated for test purposes only.

The Mining Journal (Phoenix, Ariz.), reported in June that machinery was arriving at Prineville for a 20-ton plant at the Keeton mine. Earlier in the year it was reported that Western Resources, Inc., successor to the Blue Ridge Mercury Co., was opening cinnabar deposits on Johnson Creek near Prineville and employing a gasoline shovel for mining. According to the Mining Journal[9] (Phoenix, Ariz.), the Pacific States Mines, Inc., opened a mercury deposit at the Platner mine, advanced a tunnel over 700 feet in ore giving a depth of 250 feet, and was installing a Marcy ball mill to bring the fine-grinding capacity above 200 tons per day.[10]

### TEXAS

Mercury was produced at four mines in Texas during 1933. Press reports during the year indicated some activity in development work. The Le Roi Cinnabar Co. of Minneapolis, Minn., was reported[11] to have purchased claims adjoining the Chisos holdings and to be proceeding with plans for development involving the sinking of a 750-foot two-compartment shaft and 600 feet of drifting. The Mining Journal (Phoenix, Ariz.) of April 30, 1933, reported that the Tarrant Mining

[7] Mining Journal (Phoenix, Ariz.), Aug. 30, 1933.
[8] Mining Journal (Phoenix, Ariz.), May 30, 1933.
[9] Mining Journal (Phoenix, Ariz.), Sept. 15, 1933.
[10] Mining Journal (Phoenix, Ariz.), Aug. 15, 1933.
[11] Mining Journal (Phoenix, Ariz.), May 30, 1933.

Co. was developing a group of claims in the Terlingua and Mariposa districts. This company joined the list of producing companies in 1933.

### UTAH AND WASHINGTON

Two properties in Washington and one in Utah each made a small output in 1933.

## PRODUCTIVITY OF LABOR IN MINES AND PLANTS

The following table presents data on productivity of labor at mercury mines and plants in terms of flasks per man-shift, together with figures upon which these data are based. This information was compiled under the supervision of W. W. Adams and O. E. Kiessling from records of the Demographical Division, Health and Safety Branch, and the Mineral Statistics Division, Economics Branch, Bureau of Mines.

*Employment at mercury mines and plants in the United States, mercury produced, and average output per man, 1924–32*

| Year | Employment | | | | | | | | | Production | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number of men employed | | | Time employed | | | | | | Total (flasks of 76 pounds) | Covered by study | | | Average pounds per man (mines and plants) | |
| | | | | Man-shifts | | | Man-hours | | | | | | | | |
| | Mines | Plants | Total | Mines | Plants | Total | Mines | Plants | Total | | Flasks | Equivalent pounds | Percent of total | Per shift | Per hour |
| TOTAL UNITED STATES | | | | | | | | | | | | | | | |
| 1924 | 304 | 43 | 347 | 101,025 | 14,139 | 115,164 | 808,200 | 113,112 | 921,312 | 9,952 | 9,308 | 707,408 | 94 | 6.14 | 0.77 |
| 1925 | 279 | 43 | 322 | 89,931 | 11,113 | 101,044 | 719,448 | 88,904 | 808,352 | 9,053 | 8,513 | 646,988 | 94 | 6.40 | .80 |
| 1926 | 283 | 30 | 313 | 89,606 | 8,175 | 97,781 | 716,848 | 65,400 | 782,248 | 7,541 | 6,559 | 498,484 | 87 | 5.10 | .64 |
| 1927 | 364 | 104 | 468 | 120,570 | 24,645 | 145,215 | 964,560 | 197,180 | 1,161,740 | 11,128 | 8,062 | 612,712 | 72 | 4.22 | .53 |
| 1928 | 517 | 141 | 658 | 167,184 | 38,080 | 205,264 | 1,358,277 | 304,540 | 1,662,817 | 17,870 | 14,251 | 1,083,076 | 80 | 5.28 | .65 |
| 1929 | 748 | 222 | 970 | 217,920 | 58,467 | 276,387 | 1,764,310 | 470,549 | 2,234,859 | 23,682 | 20,114 | 1,528,664 | 85 | 5.53 | .68 |
| 1930 | 665 | 231 | 896 | 201,695 | 58,852 | 260,547 | 1,778,830 | 470,816 | 2,249,646 | 21,553 | 19,731 | 1,499,556 | 92 | 5.76 | .67 |
| 1931 | 752 | 221 | 973 | 213,499 | 57,166 | 270,665 | 1,745,869 | 464,226 | 2,210,095 | 24,947 | 22,772 | 1,730,672 | 91 | 6.39 | .78 |
| 1932 | 331 | 137 | 468 | 75,810 | 26,761 | 102,571 | 606,498 | 214,087 | 820,585 | 12,622 | 10,580 | 804,080 | 84 | 7.84 | .98 |
| CALIFORNIA | | | | | | | | | | | | | | | |
| 1928 | 254 | 74 | 328 | 83,225 | 17,622 | 100,847 | 665,800 | 140,976 | 806,776 | 6,977 | 6,571 | 499,396 | 94 | 4.95 | .62 |
| 1929 | 419 | 134 | 553 | 116,413 | 29,316 | 145,729 | 931,304 | 235,088 | 1,166,392 | 10,139 | 9,214 | 700,264 | 91 | 4.81 | .60 |
| 1930 | 335 | 150 | 485 | 98,820 | 33,862 | 132,682 | 790,560 | 270,896 | 1,061,456 | 11,451 | 10,791 | 820,116 | 94 | 6.18 | .77 |
| 1931 | 396 | 136 | 532 | 105,710 | 31,420 | 137,130 | 846,497 | 256,105 | 1,102,602 | 13,448 | 12,547 | 953,572 | 93 | 6.95 | .86 |
| 1932 | 144 | 73 | 217 | 23,766 | 9,853 | 33,619 | 190,082 | 78,823 | 268,905 | 5,172 | 4,247 | 322,772 | 82 | 9.60 | 1.20 |
| OTHER STATES | | | | | | | | | | | | | | | |
| 1928 | 263 | 67 | 330 | 83,959 | 20,458 | 104,417 | 692,477 | 163,564 | 856,041 | 10,893 | 7,680 | 583,680 | 71 | 5.59 | .68 |
| 1929 | 329 | 88 | 417 | 101,507 | 29,151 | 130,658 | 833,006 | 235,461 | 1,068,467 | 13,543 | 10,900 | 828,400 | 80 | 6.34 | .78 |
| 1930 | 330 | 81 | 411 | 102,875 | 24,990 | 127,865 | 988,270 | 199,920 | 1,188,190 | 10,102 | 8,940 | 679,440 | 88 | 5.31 | .57 |
| 1931 | 356 | 85 | 441 | 107,789 | 25,746 | 133,535 | 899,372 | 208,121 | 1,107,493 | 11,499 | 10,225 | 777,100 | 89 | 5.82 | .70 |
| 1932 | 187 | 64 | 251 | 52,044 | 16,908 | 68,952 | 416,416 | 135,264 | 551,680 | 7,450 | 6,333 | 481,308 | 85 | 6.98 | .87 |

## METALLURGY

Two new isotropes of mercury with atomic weights of 197 and 203 were discovered by F. W. Aston, Cambridge University, England.[12]

*Purification of mercury.*—Air is passed through the mercury at 90°, in the light, when zinc, lead, and other metals oxidize readily and may be removed by filtration. Final treatment with $HNO_3$ is recommended. The air which has passed through the mercury should be bubbled through water to condense mercury vapor.[13]

An apparatus for purifying mercury is described by Burstyn.[14] Mercury is placed in a separating funnel, the upper stopper of which is replaced by a stopcock connecting to a vacuum pump. Air is drawn through the mercury until the less noble metals are oxidized and float on the surface. The oxides are removed by filtering through cotton. Electrolytic refining of mercury is described by Newberry and Naude.[15] Mercurous perchlorate electrolyte is used with a cathode of pure mercury, an e.m.f. of 0.5 volt, and a current density of about 1 amp./$dm^2$. Two types of apparatus are described.

*Solder.*—A patented aluminum solder is formed of zinc 24 parts, tin 12, mercury 4, and aluminum 1 part.[16]

*Flotation.*[17]— In general, direct roasting of mercury ores is preferred. Concentration by flotation is applicable to material containing barium sulphate and about 1.5 percent HgS.

The treatment of concentrates at Nikitovski Quicksilver Combine is described by Vanyukov.[18]

## FOREIGN TRADE[19]

*Imports.*—General imports increased to 1,714,164 pounds (22,555 flasks) in 1933 from 616,649 pounds (8,114 flasks) in 1932; the value of these imports is placed at $778,007 for 1933 and $231,414 for 1932. Approximately 75.4 percent of the total in 1933 came from Spain, 14.2 percent from Italy, 9.1 percent from Mexico, and 1.3 percent from the United Kingdom; 30 pounds came from Canada. Imports from Spain nearly quadrupled in 1933 compared with 1932, whereas there was a slight drop in those from Italy. Imports from Mexico totaled 156,056 pounds (2,053 flasks) in 1933; they were negligible in 1932.

Figure 15 shows graphically imports of mercury by months during 1933. They were negligible during the first 3 months of the year and ranged from 1,300 to 2,225 flasks per month during April, May, June, and July; 60 percent of the total arrived during August, September, and October; then imports declined again. The large imports during the early part of the second half of the year probably were prompted by rapidly rising prices during the months immediately preceding, by

[12] Aston, F. W., High Points in Chemistry: Ind. and Eng. Chem. (news ed.), vol. 11, no. 24, Dec. 20, 1933, p. 361.
[13] Alewijn, W. F., Purification of Mercury Containing Metallic Impurities: Chem. Weekblad, vol. 20, 1933, p. 687.
[14] Burstyn, W., An Apparatus for the Purification of Mercury: Ztschr. tech. Physik, vol. 13, 1932, p. 505; Chem. Abs., vol. 27, no. 3, Feb. 10, 1933, p. 451.
[15] Newberry, E., and Naude, S. M., The Electrolytic Refining of Mercury: Metal. Ind. (London), vol. 43, no. 17, Oct. 27, 1933, pp. 415–18.
[16] Smith, F. S., Aluminum Solder: U.S. Patent 1927052, Sept. 19, 1933; Chem. Abs., vol. 27, no. 22, Nov. 20, 1933, p. 5712.
[17] van de Putte, M., Flotation of Mercury Ores: Cong. Int. Mines, Met.; Sect. Met., vol. 6, 1930, pp. 465–7; Chem. and Ind., vol. 52, June 23, 1933, p. 510.
[18] Vanyukov, V. A., Treatment of Concentrates at Nikitovski Quicksilver Combine: Tzvetnuie Metal; no. 2, February 1932, pp. 136–46; Chem. Abs., vol. 27, no. 14, July 20, 1933, p. 3424.
[19] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

falling dollar exchange, by a sold-out domestic market, and by the low rate of domestic production.

*Mercury imported into the United States, 1929–33, by countries*

[General imports]

| Country | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value |
| Belgium | 94,969 | $129,083 | | | | | 7,606 | $3,100 | | |
| Canada | 37,500 | 52,195 | 5 | $9 | | | | | 30 | $7 |
| France | 24,587 | 33,966 | | | | | | | | |
| Germany | 53,259 | 70,677 | | | | | | | | |
| Hong Kong | 3 | 4 | | | | | | | | |
| Italy | 67,778 | 90,532 | | | | | 261,972 | 98,907 | 244,076 | 109,729 |
| Mexico | 91,854 | 122,229 | 10,716 | 13,747 | 445 | $622 | 221 | 199 | 156,056 | 74,464 |
| Peru | 960 | 700 | | | | | | | | |
| Spain | 715,311 | 947,756 | 212,965 | 282,073 | 26,609 | 32,027 | 346,090 | 128,637 | 1,292,553 | 584,769 |
| United Kingdom | | | | | | | 760 | 571 | 21,449 | 9,038 |
| | 1,086,221 | 1,447,142 | 223,686 | 295,829 | 27,054 | 32,649 | 616,649 | 231,414 | 1,714,164 | 778,007 |

*Mercury compounds imported for consumption in the United States, 1932–33*

| Compound | 1932 | | 1933 | |
|---|---|---|---|---|
| | Pounds | Value | Pounds | Value |
| Chloride (mercuric) (corrosive sublimate) | | | 33 | $35 |
| Chloride (mercurous) (calomel) | 1,302 | $1,352 | 1,050 | 1,002 |
| Oxide (red precipitate) | 7 | 19 | 8 | 14 |
| Mercury preparations (not specifically provided for) | 870 | 1,177 | 669 | 1,000 |
| Vermillion reds (containing quicksilver) | 15,620 | 15,301 | 25,559 | 20,147 |
| | | 17,849 | | 22,198 |

*Exports.*—Separate statistics on exports of mercury were discontinued during 1933. During the first 5 months 12,279 pounds (162 flasks) in all were exported. Total exports during 1932 were 16,281 pounds (214 flasks) and during 1931, 378,769 pounds (4,984 flasks). During most of 1933 the domestic price was well above that quoted by foreign producers, which, in the absence of any large surplus of domestic stocks, was not conducive to the exportation of mercury.

## WORLD PRODUCTION

The following table shows the world production of mercury by countries from 1929 to 1933.

*World production of mercury, 1929–33, by countries*

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

[1 metric ton=29.008 flasks of 76 pounds]

| Country [1] | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | (2) | (2) |
| Australia: Queensland | ----- | ----- | ----- | ----- | 11 | .4 | 26 | .9 | (2) | (2) |
| Austria | 113 | 3.9 | 72 | 2.4 | 72 | 2.5 | 23 | .8 | (2) | (2) |
| Bolivia [3] | 49 | 1.7 | ----- | ----- | 1,021 | 35.2 | 505 | 17.4 | (2) | (2) |
| China [4] | 580 | 20.0 | 725 | 25.0 | 638 | 22.0 | (2) | (2) | (2) | (2) |
| Chosen | 15 | .5 | 26 | .9 | 41 | 1.4 | 26 | .9 | (2) | (2) |
| Czechoslovakia | 1,897 | 65.4 | 2,060 | 71.0 | 2,222 | 76.6 | 1,305 | 45.0 | (2) | (2) |
| Italy | 57,966 | 1,998.3 | 56,069 | 1,932.9 | 37,652 | 1,298.0 | 29,480 | 1,016.3 | (2) | (2) |
| Japan | 41 | 1.4 | 121 | 4.2 | 101 | 3.5 | (2) | (2) | (2) | (2) |
| Mexico | 2,396 | 82.6 | 4,946 | 170.5 | 7,292 | 251.4 | 7,350 | 253.4 | 4,488 | 154.7 |
| New Zealand | ----- | ----- | 52 | 1.8 | 450 | 15.5 | ----- | ----- | (2) | (2) |
| Rumania | ----- | ----- | ----- | ----- | 8 | .3 | 2 | .1 | (2) | (2) |
| Spain | 71,832 | 2,476.3 | 19,221 | 662.6 | 19,786 | 682.1 | 23,656 | 815.5 | (2) | (2) |
| Turkey | 235 | 8.1 | 537 | 18.5 | 235 | 8.1 | (2) | (2) | (2) | (2) |
| U.S.S.R. (Russia) [5] | 3,771 | 130.0 | 3,278 | 113.0 | (2) | (2) | (2) | (2) | (2) | (2) |
| United States | 23,682 | 816.4 | 21,553 | 743.0 | 24,947 | 860.0 | 12,622 | 435.1 | 9,402 | 324.1 |
| | 162,699 | 5,608.8 | 108,985 | 3,757.0 | [6] 95,549 | [6] 3,294.0 | (2) | (2) | (2) | (2) |

[1] In addition to countries listed Chile reported 69 kilograms of metallic mercury produced in 1930, and Taiwan reported production of cinnabar as follows: 1929, 27,979 kilograms; 1931, 488 kilograms; mercury content not stated.
[2] Data not available.
[3] Exports.
[4] Approximate production (Imp. Inst., London).
[5] Year ended Sept. 30.
[6] Exclusive of U.S.S.R.

*Algeria.*—Official statistics on Algerian production of mercury have not yet been furnished to the Bureau of Mines. Metal and Mineral Markets (vol. 4, no. 51, p. 3), reports an estimated production of 51.2 metric tons (1,485 flasks) in 1933. The reduction of prices by the Spanish-Italian cartel is stated to have made exploitation of the Algerian deposits difficult.

*Australia.*—According to the Queensland Government Mining Journal of April 15, 1933, the Queensland Quicksilver Limited, at Kilkivan, has completed erection of its sluicing plant, consisting of two portable engines and boilers, gravel pumps, and 120 feet of sluice boxes. The plant made a 2-day test run in March and was reported to be capable of handling 80 yards of gravel per hour. It then shut down to await a wet season.

*Czechoslovakia.*—Official figures on production in 1933 have not yet been obtained. L. A. Helwich [20] is authority for the following statement at midyear.

> The only mercury mine now in operation, the property of the Société Minière de Cinabre at Vranov, employs about 100 men and in 1931 produced about 12 tons and in 1932 approximately 20 tons of mercury. This year the production is to be raised to 40 tons, which may cover the whole domestic consumption. The mining company applied for a customs duty of 40 koruny ($1.30) for 1 kilo of imported mercury, which would about double the market price, but consumers protested.

[20] Helwich, L. A., Czechoslovakia; Production of Mercury will Meet Domestic Demand: Ind. and Eng. Chem., vol. 11, no. 12, June 20, 1933, p. 191.

*Italy.*—With no official figures yet available for 1933 little can be said regarding Italian production during the year. Metal Bulletin (London), July 21, 1933, p. 16, records the following statement:

In its annual report the Monte Amiata Co. remarks that although there has been a slight increase in sales, prices are still very low. The company has been obliged to close its properties for a maximum period of 3 years from September 1, 1932, onward, in order to maintain the ratio between production and sales at a normal level.

*Mexico.*—Mexican production declined from 253.4 metric tons (7,350 flasks) in 1932 to 154.7 tons (4,488 flasks) in 1933. The low point in production was during April, when only 8.5 tons were produced. During the first 7 months of the year 30 tons were shipped to the United States, 17 tons to Germany, and 55 tons to Great Britain. Total shipments to the United States during 1933 amounted to 2,053 flasks (70.77 metric tons).

It was reported [21] during the year that the Cuarenta mercury properties near Santa Maria del Oro, Durango, developed by Cia. Minera Mercuriocrom, expected by the end of June to be treating from 50 to 100 tons of ore per day and that the ore runs 2.2 percent mercury. In its issue of May 15, 1933, the journal reported that work during April had uncovered a new blanket of high-grade ore at the property.

*Spain.*—The following table gives production and value of mercury ore and metal in Spain in 1931 and 1932, number of workmen employed, and production per man.

Exports from Spain totaled 833 metric tons in 1932 and 1,339 tons during the first 11 months of 1933. Of the 1933 exports 372 tons were shipped to England and 543 tons (15,751 flasks) to the United States.

*Mercury produced in Spain, 1931–32*

| Province | Ore mined | | | | | Metal produced | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number of mines | Number of workmen | Metric tons | Value [1] | Tons per man | Number of plants | Number of workmen | Flasks (76 pounds) | Value [1] | Flasks per man |
| 1931 | | | | | | | | | | |
| Ciudad Real | 1 | 1,584 | 27,497 | $448,819 | 17.36 | 1 | 418 | 19,496 | $930,221 | 46.64 |
| Granada | 1 | 30 | 2,179 | 7,223 | 72.63 | 1 | 24 | 290 | 18,835 | 12.08 |
| | 2 | 1,614 | 29,676 | 456,042 | 18.39 | 2 | 442 | 19,786 | 949,056 | 44.76 |
| 1932 | | | | | | | | | | |
| Ciudad Real | 1 | 1,541 | 10,334 | 127,604 | 6.71 | 1 | 440 | 23,401 | 940,871 | 53.18 |
| Granada | 1 | 30 | 1,697 | 4,741 | 56.57 | 1 | 24 | 255 | 13,650 | 10.63 |
| | 2 | 1,571 | 12,031 | 132,345 | 7.66 | 2 | 464 | 23,656 | 954,521 | 50.98 |

[1] Pesetas converted to dollars at the average annual rate of exchange, as published by the U.S. Federal Reserve Board.

[21] Mining Journal (Phoenix, Ariz.), The Cuarenta Mercury Properties: Vol. 16, no. 20, Mar. 16, 1933, p. 14.

# MANGANESE AND MANGANIFEROUS ORES

By Robert H. Ridgway

## SUMMARY OUTLINE



Improvement in the iron and steel industry virtually throughout the world in 1933 was reflected in the increased demand for manganese ores. Figures for the world production of manganese ore in 1933 are not yet available, but preliminary returns indicate that they exceeded those of the preceding year. Operations in Brazil and Egypt virtually were suspended during the year, but export figures indicate a larger production in the Gold Coast, India, and the U.S.S.R. The newer sources—the Union of South Africa and Cuba—reported increased shipments, but operations in Cuba were hampered by civil disorder.

In the United States production in 1933 remained at about the level of the preceding year, while imports, consumption, and prices increased. The withholding of appraisements of manganese ore, pending an investigation to determine the facts relative to dumping, as requested by the Treasury Department in October 1932, was modified in February 1933, permitting entry in the usual manner. 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, 1932–33, in long tons*

| | 1932 | 1933 |
|---|---|---|
| Manganese ore: | | |
| Total shipments containing 35 percent or more manganese | 17,777 | 18,558 |
| Shipments of metallurgical ore | 9,963 | 9,527 |
| Shipments of battery ore | 7,012 | 7,904 |
| Imports | 110,634 | 156,835 |
| Stocks in bonded warehouses at end of year | 622,489 | 490,819 |
| Indicated consumption (35 percent or more manganese) | 110,861 | 308,383 |
| Ferro-alloys: | | |
| Production of ferromanganese | 56,350 | 136,267 |
| Imports of ferromanganese [1] (manganese content) | 14,779 | 31,759 |
| Production of spiegeleisen | 37,317 | 26,683 |
| Imports of spiegeleisen [1] | 8,364 | 26,277 |
| Exports of spiegeleisen and ferromanganese | 33 | 47 |
| Stocks of ferromanganese in bonded warehouses | 6,173 | 6,424 |

[1] Imports for consumption.

The trend of imports and production of manganese ore from 1900 to 1933 is shown graphically in figure 16.

A proposed Code of Fair Competition of the Manganese Industry was submitted to the National Recovery Administration on August 24, 1933. At the same time a petition, presenting facts to be considered with the code, was submitted to the President of the United States by the American Manganese Producers Association. The petition requested that the President after proper investigation and hearing forbid importation, add such fees, or limits imports of all manganese-bearing ores, alloys, and/or products for use of the manganese content in the manufacture of other products in order that the domestic producers may supply the local market. No action on the proposed code was taken during 1933, but public hearings were held on January 26, 1934.

A report [1] published in 1933 by the American Institute of Mining and Metallurgical Engineers discusses, among other things, domestic

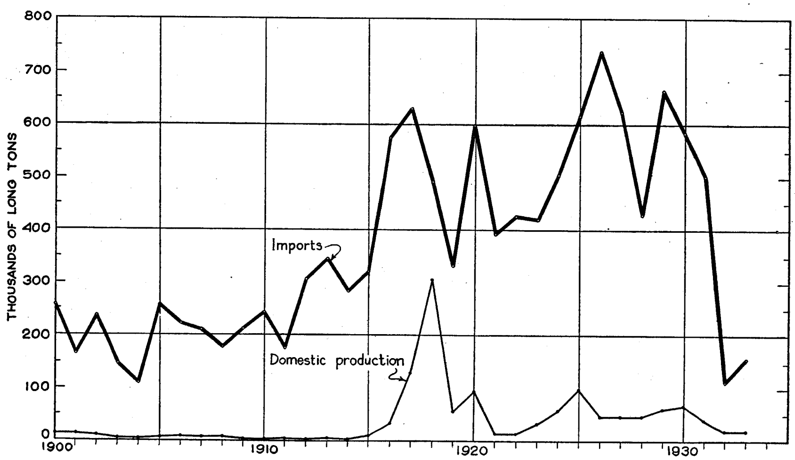


FIGURE 16.—Imports and domestic production of manganese ore, 1900–33.

reserves of manganiferous raw material. Reserves of ferro-grade ore at $1 per unit manganese index price were given as 4,356,600 long tons containing 1,652,690 tons of metallic manganese. This figure is a very substantial increase over the institute's estimate in 1924 and includes certain tonnages of leaner ores which by known concentration methods will yield ferro-grade concentrates.

## DOMESTIC PRODUCTION

The production of manganese ore in 1933 totaled 18,558 long tons containing about 45 percent manganese compared with 17,777 tons containing about 42 percent manganese in 1932. Operations in the steel industry, although somewhat improved, continued at a low rate during 1933, resulting in a subnormal demand for both foreign and domestic metallurgical-grade ore. Shipments of metallurgical-grade ore decreased slightly in 1933 and amounted to 9,527 tons. Although shipments of ferruginous manganese ores continued to decline, there was a large increase in the shipments of manganiferous iron ores.

[1] Subcommittee on Manganese, Manganese for National Defense: Am. Inst. Min. and Met. Eng. New York, 1933, pp. 1–35.

Battery-grade ores (concentrates) increased from 7,012 tons in 1932 to 7,904 in 1933. The following table covers the shipments of manganese-bearing ores for the last 5 years.

*Manganiferous raw materials shipped in the United States, 1929–33, in long tons*

| Year | Metallurgical ore [1] | | | | Battery ore [2] | Miscellaneous manganese ore |
|---|---|---|---|---|---|---|
| | Manganese ore (35 percent or more manganese) | Ferruginous manganese ore (10 to 35 percent manganese) | Manganiferous iron ore (5 to 10 percent manganese) | Manganiferous zinc residuum | | |
| 1929 | [3] 47,597 | 78,191 | 1,110,067 | 168,363 | 12,782 | (3) |
| 1930 | 53,326 | 77,417 | 707,973 | 113,060 | 11,757 | 1,952 |
| 1931 | 29,874 | 64,062 | 217,352 | 96,990 | 7,952 | 1,416 |
| 1932 | 9,963 | 15,635 | 9,799 | 25,320 | 7,012 | 802 |
| 1933 | 9,527 | 12,779 | 178,852 | ------ | 7,904 | 1,127 |

1 Ferrous metallurgy only.
2 Recorded as "chemical manganese ore" in reports of this series prior to 1930.
3 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 shipped from mines in the United States, 1929–33, by States, in long tons* [1]

| State | 1929 | 1930 | 1931 | 1932 | 1933 | State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | ------ | ------ | ------ | 267 | 806 | North Carolina | ------ | 60 | ------ | ------ | ------ |
| Arizona | 2,655 | 364 | ------ | ------ | ------ | Tennessee | 523 | 471 | 70 | ------ | ------ |
| Arkansas | 4,308 | 3,276 | 4,028 | 1,306 | 1,890 | Texas | 42 | 247 | 155 | ------ | ------ |
| California | 569 | 162 | 40 | ------ | ------ | Utah | 88 | ------ | ------ | ------ | ------ |
| Georgia | 2,521 | 18,897 | 6,491 | 200 | 1,565 | Virginia | 2,651 | 3,055 | 901 | ------ | 4,184 |
| Idaho | 1,326 | ------ | ------ | ------ | ------ | West Virginia | ------ | ------ | 29 | ------ | 95 |
| Montana | 29,945 | 22,731 | 17,088 | 8,190 | 987 | | | | | | |
| Nevada | ------ | 1,489 | ------ | ------ | ------ | | 47,597 | 53,326 | 29,874 | 9,963 | 9,527 |
| New Mexico | 2,969 | 2,574 | 1,072 | ------ | ------ | | | | | | |

1 Includes small quantities of miscellaneous ore in 1929.

*Ferruginous manganese ore shipped from mines in the United States, 1929–33, by States, in long tons*

| State | 1929 | 1930 | 1931 | 1932 | 1933 | State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 475 | 321 | 1,321 | 4,328 | 2,810 | Montana | 15,665 | 11,875 | 14,311 | ------ | ------ |
| Arizona | 45 | 48 | ------ | ------ | ------ | Nevada | 2,407 | 3,363 | ------ | ------ | ------ |
| Arkansas | 13,774 | 12,645 | 2,230 | 208 | 1,060 | Tennessee | 241 | 113 | ------ | ------ | ------ |
| Colorado | 17,770 | 19,730 | 3,685 | ------ | ------ | Utah | 5,942 | 10,972 | 1,501 | ------ | ------ |
| Georgia | 5,310 | 12,009 | 11,652 | 9,700 | 8,505 | Virginia | 80 | 193 | ------ | ------ | 404 |
| Idaho | 38 | 1,450 | 578 | ------ | ------ | | | | | | |
| Michigan | 11,023 | ------ | 2,217 | ------ | ------ | | 78,191 | 77,417 | 64,062 | 15,635 | 12,779 |
| Minnesota | 5,421 | 4,698 | 26,567 | 1,399 | ------ | | | | | | |

2 In addition, manganiferous zinc residuum was produced in New Jersey; miscellaneous ores came from Arizona, Montana, Tennessee, and Virginia.

*Manganiferous iron ore shipped from mines in the United States, 1929–33, by States, in long tons*

| State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Alabama | | | | 217 | 685 |
| Michigan | 38,089 | | | 9,582 | 6,445 |
| Minnesota | 1,004,420 | 693,546 | 217,352 | | 171,722 |
| New Mexico | 67,558 | 14,427 | | | |
| | 1,110,067 | 707,973 | 217,352 | 9,799 | 178,852 |

*Battery ore*[1] *shipped from mines in the United States, 1929–33, by States*

| Year | Montana (long tons) | Virginia (long tons) | Total | | Year | Montana (long tons) | Virginia (long tons) | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Long tons | Value | | | | Long tons | Value |
| 1929 | 12,382 | 400 | 12,782 | $576,158 | 1932 | 7,012 | | 7,012 | $239,267 |
| 1930 | 11,451 | 306 | 11,757 | 432,668 | 1933 | 7,904 | | 7,904 | 265,766 |
| 1931 | 7,802 | 150 | 7,952 | 281,523 | | | | | |

[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 1933 totaled 156,835 long tons, an increase of 42 percent over the preceding year. Manganese ore imported in 1933 contained nearly 51 percent manganese. Two countries—the U.S.S.R. and the Gold Coast—with large increases over 1932, accounted for 81 percent of the total imports, the U.S.S.R. alone supplying 53 percent. Imports from Cuba showed an increase of 319 percent over 1932, amounting to 28,257 long tons in 1933. Although Brazil and India usually are important sources of manganese ore, there were no imports from these countries into the United States in 1933.

The following table shows the imports of manganese ore into the United States from 1931 to 1933, by countries:

*Manganese ore imported into the United States, 1931–33, by countries*

[General imports]

| Country | Manganese ore (long tons) | | | Manganese content (long tons) | | | Value | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1931 | 1932 | 1933 | 1931 | 1932 | 1933 | 1931 | 1932 | 1933 |
| Brazil | 133,927 | 21,500 | | 59,174 | 9,494 | | $947,549 | $199,382 | |
| Canada | 18,832 | 27 | (1) | 9,958 | 13 | (1) | 251,679 | 1,000 | $20 |
| Chile | 1,748 | | 444 | 822 | | 211 | 17,484 | | 3,116 |
| China | | | 2 | | | 1 | | | 43 |
| Cuba | 3,804 | 6,749 | 28,257 | 1,199 | 3,417 | 14,573 | 19,891 | 111,770 | 430,906 |
| Germany | 30 | 25 | 14 | 17 | 13 | 8 | 1,951 | 1,380 | 988 |
| Gold Coast | 87,439 | 24,592 | 43,768 | 43,908 | 12,204 | 22,392 | 1,228,707 | 349,648 | 429,515 |
| Hong Kong | | | 1 | | | 1 | | | 32 |
| India (British) | 47,850 | 1,750 | | 24,646 | 909 | | 550,515 | 18,200 | |
| Java and Madura [2] | 1,754 | | | 972 | | | 34,961 | | |
| Netherland East Indies | | 529 | 526 | | 282 | 291 | | 14,817 | 11,317 |
| U.S.S.R. in Europe | 195,834 | 55,437 | 83,780 | 99,335 | 27,206 | 41,890 | 1,896,538 | 521,868 | 499,406 |
| Union of South Africa | 5,002 | | | 2,601 | | | 67,627 | | |
| United Kingdom | 6,298 | 25 | 43 | 3,278 | 15 | 24 | 87,688 | 1,318 | 2,979 |
| | 502,518 | 110,634 | 156,835 | 245,910 | 53,553 | 79,391 | 5,104,590 | 1,219,383 | 1,378,322 |

[1] Less than 1 ton.
[2] Included in Netherland East Indies beginning January 1932.

*Stocks.*—Stocks of manganese ore in bonded warehouses decreased materially and at the end of 1933 totaled 490,819 long tons containing 238,040 tons of manganese metal compared with 622,489 tons containing 299,504 tons of metal at the close of 1932.

*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 1933.

Late in 1932 the collectors of customs at various ports were requested to withhold appraisements of manganese ore (metallic) pending an investigation to determine the facts relative to dumping into the United States. In February 1933 this restriction was modified where the appraising officer was satisfied that the purchase price or exporter's sales price was not less than the fair value.

*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 1933:

Brazilian ore containing 46 to 48 percent manganese, which was quoted at 17 to 18 cents at the beginning of the year, increased slightly and at the end of the year was quoted at 19 to 20 cents.

Indian ore containing 48 to 50 percent manganese moved in a range from 18 to 21 cents during the year. The lower quotation prevailed from April through July.

Caucasian (Russian) ore containing 52 to 55 percent manganese was quoted at 21 cents until August, when the price was increased to 22 cents. The last quotation in December was 23 cents.

Prices of Chilean ore containing a minimum of 47 percent manganese opened the year at 20 cents. The quotation showed small increases beginning in July, and at the end of the year the quotation stood at 22½ cents.

The price of South African ore containing 52 to 54 percent manganese was 20 to 21 cents at the beginning of the year. Small declines beginning in January brought the quotation down to 18 to 19 cents in August, where it remained for the rest of the year. Second-grade ore containing 50 to 52 percent manganese was quoted at 1 cent per unit lower than first-grade; quotations on lower-grade ore (44 to 46 percent manganese) were 1 cent less than the second-grade ore.

According to the Engineering and Mining Journal the prices for chemical (battery) ores during 1933 were as follows: 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 still at a low level but made a substantial increase over 1932. This is reflected in the large increases in the consumption of manganese and manganiferous ores in 1933. The indicated consumption of foreign and domestic ferruginous manganese ore and residuum containing 10 to 35 percent manganese decreased in 1933 compared with 1932, due in part to the curtailment of shipments by one large domestic producer whose product falls in this class.

The indicated consumption of manganiferous raw materials in the United States in 1932–33 appears in the following table. The table does not consider differences in consumers' stocks at the beginning and end of the year. As such stocks are largely imported ore and the import figure used in the table is that for "imports for consumption", it is thought that the change in stocks would not be great because the manganese ore may be kept in bond until withdrawn for consumption. The duty is then paid, and the ore is reported as imports for consumption.

*Indicated consumption of manganiferous raw materials in the United States, 1931–33*

| | 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 | 48 | [3] 34,000 | 25 | [3] 65,000 | 6.8 |
| Total available for consumption | 334,753 | 47 | 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 | 7.2 |
| **1933** | | | | | | |
| Domestic shipments | [1] 20,196 | [2] 45 | 12,779 | 26 | 178,852 | 7.8 |
| Imports for consumption | 288,187 | 49 | [3] 260 | 25 | [3] 51,399 | 6.7 |
| Total available for consumption | 308,383 | 49 | 13,039 | 26 | 230,251 | 7.6 |

[1] Includes shipments from Puerto Rico. [2] Partly estimated. [3] Estimated.

Besides the material shown in the foregoing table 538,248 long tons of iron ore containing 2 to 5 percent manganese presumably were used in the manufacture of manganiferous pig iron in 1933 compared with 91,700 tons in 1932. 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 usually is 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, 1932–33, in long tons*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Alloy | Manganese | Alloy | Manganese |
| Ferromanganese: | | | | |
| Imported | 18,470 | 14,779 | 39,693 | 31,759 |
| Domestic production | 56,350 | 43,760 | 136,267 | 108,059 |
| From domestic ore [1] | 5,535 | 4,054 | 5,196 | 4,157 |
| From imported ore [1] | 50,815 | 39,706 | 131,071 | 103,902 |
| Total | 74,820 | 58,539 | 175,960 | 139,818 |
| Ratio (percent) of manganese in ferromanganese of domestic origin to total manganese in ferromanganese made and imported | | 6.93 | | 2.97 |
| Number of plants making ferromanganese | 5 | | 5 | |
| Spiegeleisen: | | | | |
| Imported | 8,364 | 1,673 | 26,277 | 5,255 |
| Domestic production | 37,317 | 7,461 | 26,683 | 5,306 |
| From domestic ore [1] | 28,545 | 5,718 | 4,998 | 994 |
| From imported ore [1] | 8,772 | 1,743 | 21,685 | 4,312 |
| Total | 45,681 | 9,134 | 52,960 | 10,561 |
| Ratio (percent) of manganese in spiegeleisen of domestic origin to total manganese in spiegeleisen made and imported | | 62.60 | | 9.41 |
| Number of plants making spiegeleisen | 4 | | 4 | |
| Total available supply of metallic manganese as alloys | | 67,673 | | 150,379 |
| Percentage of available supply of manganese in— | | | | |
| Ferromanganese and spiegeleisen imported | | 24.31 | | 24.61 |
| Ferromanganese made from imported ore | | 58.67 | | 69.09 |
| Spiegeleisen made from imported ore | | 2.58 | | 2.87 |
| Ferromanganese made from domestic ore | | 5.99 | | 2.77 |
| Spiegeleisen made from domestic ore | | 8.45 | | .66 |
| Ferromanganese and spiegeleisen made from domestic ore | | 14.44 | | 3.43 |
| Spiegeleisen made and imported | | 13.50 | | 7.02 |
| Total open-hearth and Bessemer steel | 13,439,406 | | 22,810,463 | |

[1] Estimated.

*Ferromanganese.*—Production of ferromanganese in 1933 totaled 136,267 long tons compared with 56,350 tons in 1932 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 in Niagara Falls. The following plants manufactured ferromanganese in 1933:

Bethlehem Steel Co., Johnstown, Pa.
Lavino Furnace Co., Sheridan, Pa.
Pittsburgh Metallurgical Co., Niagara Falls, N.Y.

Tennessee Coal, Iron & Railroad Co., Ensley, Ala.
United States Steel Corporation, Etna, Pa.

In addition to the above plants, shipments were reported from the following plants in 1933:

Colorado Fuel & Iron Co., Pueblo, Colo.
Lavino Furnace Co., Reusens, Va.
Ohio Ferro-Alloys Corporation, Philo, Ohio.
Republic Steel Corporation, Thomas, Ala.

In the domestic production of ferromanganese in 1933 there were used 233,607 long tons of foreign manganese ore, 10,695 tons of domestic manganese ore, 10,795 tons of domestic iron ore and 1,655 tons of cinder, scale, and scrap. The following table shows the production of ferromanganese during the last 5 years and the metalliferous materials consumed in its manufacture:

*Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture, 1929–33*

| 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 | | | |
| 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 |
| 1933 | 136,267 | 79.30 | 108,059 | 233,607 | 10,695 | 10,795 | 1,655 | 1.793 |

The following table shows by sources the foreign manganese ore consumed in the manufacture of ferromanganese from 1929 to 1933.

*Foreign manganese ore used in manufacture of ferromanganese in the United States, 1929–33, in long tons*

| Source of ore | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Africa | 28,592 | 62,913 | 26,133 | 5,135 | 30,427 |
| Brazil | 228,737 | 138,757 | 62,630 | 25,279 | 42,805 |
| Chile | 1,187 | 1,705 | 4,363 | | 1,046 |
| Cuba | 2,050 | | | 2,126 | 28,275 |
| India | 86,547 | 44,667 | 26,267 | 11,541 | 22,499 |
| Union of Soviet Socialist Republics | 267,600 | 211,436 | 168,580 | 46,596 | 108,555 |
| Turkey | 50 | | | | |
| Total | 614,763 | 459,478 | 287,973 | 90,677 | 233,607 |

Shipments of ferromanganese in 1933 were 127,453 long tons valued at $9,384,611. The trend of shipments during the last 5 years has been as follows:

*Ferromanganese shipped from furnaces in the United States, 1929–33*

| Year | Long tons | Value | Year | Long tons | Value |
|---|---|---|---|---|---|
| 1929 | 334,162 | $33,184,012 | 1932 | 70,417 | $5,061,029 |
| 1930 | 273,640 | 25,865,783 | 1933 | 127,453 | 9,384,611 |
| 1931 | 159,168 | 12,999,329 | | | |

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 1933 included 172 tons containing not over 1 percent carbon. Imports of ferromanganese for consumption in the United States and exports of ferromanganese and spiegeleisen in 1929–33 are given in the following table:

*Ferromanganese imported into and exported from the United States, 1929–33*

| Year | Imports for consumption [1] | | | Exports [2] | |
|---|---|---|---|---|---|
| | Gross weight (long tons) | Manganese content (long tons) | Value | Gross weight (long tons) | Value |
| 1929 | (3) | [1] 56,969 | [1] $6,126,056 | 1,574 | $59,036 |
| 1930 | (3) | 44,037 | 4,021,040 | 6,189 | 145,629 |
| 1931 | 24,664 | 19,836 | 1,751,646 | 1,306 | 38,506 |
| 1932 | 18,470 | 14,779 | 1,091,026 | 33 | 2,369 |
| 1933 | 39,692 | 31,759 | 2,548,068 | 47 | 3,393 |

[1] Figures for 1929 include small quantities of other manganese alloys.
[2] Include spiegeleisen; not separately classified.
[3] Not recorded.

Canada and Norway furnished the bulk of the imports into the United States in 1933. The following table shows the distribution of imports by countries for the last 2 years:

*Ferromanganese [1] imported into the United States, 1932–33, by countries*

[General imports]

| Country | 1932 | | 1933 | |
|---|---|---|---|---|
| | Manganese content (long tons) | Value | Manganese content (long tons) | Value |
| Canada | 6,747 | $603,934 | 19,011 | $1,754,460 |
| France | 500 | 26,689 | 155 | 18,353 |
| Germany | 675 | 23,948 | 1,020 | 33,228 |
| Italy | 327 | 33,831 | 198 | 24,572 |
| Norway | 4,542 | 235,746 | 11,732 | 852,576 |
| Poland and Danzig | | | 218 | 8,779 |
| Sweden | | | 84 | 3,555 |
| United Kingdom | 1,402 | 72,618 | 24 | 11,773 |
| Yugoslavia and Albania | 393 | 14,452 | | |
| | 14,586 | 1,011,218 | 32,442 | 2,707,296 |

[1] Includes small quantities of other manganese alloys.

Ports into which imported ferromanganese entered in 1932–33 were as follows:

*Manganese content of ferromanganese [1] imported into the United States, 1932–33, by ports of entry, in long tons*

[General imports]

| Port of entry | 1932 | 1933 | Port of entry | 1932 | 1933 |
|---|---|---|---|---|---|
| Buffalo | 5,252 | 16,100 | Ohio | 530 | |
| Chicago | | 2,140 | Philadelphia | 1,485 | 2,071 |
| Galveston | | 20 | San Francisco | | 500 |
| Maryland | 4,987 | 5,380 | Washington (State) | | 270 |
| Michigan | 1,024 | 3,260 | | | |
| New Orleans | 963 | 2,421 | | 14,586 | 32,442 |
| New York | 345 | 280 | | | |

[1] Includes small quantities of other manganese alloys.

Stocks of ferromanganese in bonded warehouses at the end of 1933 totaled 6,424 long tons containing 5,423 long tons of manganese metal.

The status of ferromanganese in the Tariff Bill of 1930 is given on page 321 of the Mineral Resources chapter on Manganese and Manganiferous Ores for 1930. The tariff was not changed in 1933.

The price of ferromanganese increased materially in 1933 and during the last five months was quoted at $87.24 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, 1931–33 [1]*

[80 percent—delivered at Pittsburgh]

| Month | 1931 | 1932 | 1933 | Month | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|
| January | $89.79 | $79.85 | $73.24 | July | $89.79 | $73.24 | $84.44 |
| February | 89.79 | 80.24 | 73.24 | August | 89.79 | 73.24 | 87.24 |
| March | 89.79 | 80.24 | 73.24 | September | 89.79 | 73.24 | 87.24 |
| April | 89.79 | 80.24 | 73.24 | October | 89.79 | 73.24 | 87.24 |
| May | 89.79 | 80.24 | 73.24 | November | 89.79 | 73.24 | 87.24 |
| June | 89.79 | 74.99 | 73.24 | December | 79.79 | 73.24 | 87.24 |

[1] Steel: Vol. 94, Jan. 1, 1934.

*Spiegeleisen.*—The production of spiegeleisen in 1933 declined to 26,683 long tons, a figure 28 percent below that for the preceding year. Shipments, however, increased from 31,071 tons in 1932 to 50,218 tons in 1933. Figures for the production and shipments during the last 5 years are shown in the following table:

*Spiegeleisen produced and shipped in the United States, 1929–33*

| Year | Produced (long tons) | Shipped from furnaces | | Year | Produced (long tons) | Shipped from furnaces | |
|---|---|---|---|---|---|---|---|
| | | Long tons | Value | | | Long tons | Value |
| 1929 | 137,143 | 123,146 | $3,336,703 | 1932 | 37,317 | 31,071 | $745,966 |
| 1930 | 87,059 | 94,918 | 2,469,861 | 1933 | 26,683 | 50,218 | 1,144,642 |
| 1931 | [1] 67,800 | 55,327 | 1,313,068 | | | | |

[1] Steel, Manganese Ore and Alloy Statistics: vol. 90, no. 1, Jan. 4, 1932, p. 198.

Spiegeleisen was manufactured at the following plants in 1933:

Lavino Furnace Co., Sheridan, Pa.
Tennessee Coal, Iron & Railroad Co., Ensley, Ala.
United States Steel Corporation, North Braddock and Rankin, Pa.

In addition to the above plants, spiegeleisen was shipped from the following plants in 1933:

Colorado Fuel & Iron Co., Pueblo, Colo.
Lavino Furnace Co., Reusens, Va.
Republic Steel Corporation, Thomas, Ala.
New Jersey Zinc Co., Palmerton, Pa.

In the past most of the spiegeleisen produced in the United States was made from domestic raw materials. In 1933, 9,808 long tons of foreign manganese ore containing 48.37 percent manganese were consumed in the manufacture of spiegeleisen.

Imports of spiegeleisen for consumption amounted to 26,277 long tons, valued at $640,613 in 1933, compared with 8,364 tons, valued at $192,037, in 1932. Nearly three-quarters of the imports in 1933 came from Canada and all of the remainder from England and Norway.

*Spiegeleisen imported for consumption in the United States, 1929–33*

| Year | Long tons | Value | Year | Long tons | Value |
|---|---|---|---|---|---|
| 1929 | 13,828 | $403,853 | 1932 | 8,364 | $192,037 |
| 1930 | 13,406 | 381,197 | 1933 | 26,277 | 640,613 |
| 1931 | 9,482 | 247,788 | | | |

The following table shows the price quotations of spiegeleisen by months for the last 3 years:

*Prices per long ton of spiegeleisen in the United States, 1931–33* [1]

[20 percent—at producers' furnaces]

| Month | 1931 | 1932 | 1933 | Month | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|
| January | $30 | $27.00 | $24 | July | $30 | $25.00 | $27 |
| February | 30 | 27.00 | 24 | August | 30 | 25.00 | 27 |
| March | 30 | 27.00 | 24 | September | 30 | 25.00 | 27 |
| April | 30 | 27.00 | 24 | October | 30 | 25.00 | 27 |
| May | 30 | 27.00 | 24 | November | 30 | 24.25 | 27 |
| June | 30 | 26.50 | 24 | December | 27 | 24.00 | 27 |

[1] Steel: Vol. 94, Jan. 1, 1934.

*Manganiferous pig iron.*—Precise data on the consumption of manganiferous ores in the production of manganiferous pig iron are not available; however, 178,852 long tons of domestic ore containing 5 to 10 percent manganese and 538,248 tons of domestic ore containing 2 to 5 percent were shipped in 1933. Foreign manganiferous iron ore amounting to 51,399 tons and foreign ferruginous manganese ore amounting to 260 tons were also consumed in the manufacture of pig iron. The sources of the foreign ores for the last 3 years appear in the following table. In 1931 and 1932 the ferruginous manganese ore contained 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, 1931–33, in long tons*

| Source of ore | Ferruginous manganese ore | | | Manganiferous iron ore | | |
|---|---|---|---|---|---|---|
| | 1931 | 1932 | 1933 | 1931 | 1932 | 1933 |
| Africa | | 91 | | 5,962 | 8,818 | |
| Australia | 7,949 | 6,213 | | 59,421 | 33,210 | 51,399 |
| Brazil | 7,034 | | | | | |
| Canada | 4,473 | 143 | 260 | | | |
| Cuba | 2,438 | 1,215 | | | | |
| India | 3,259 | | | | | |
| Palestine | 276 | | | | | |
| Undistributed | 8,623 | 6,705 | | | | |
| Total | 34,052 | 14,367 | 260 | 65,383 | 42,028 | 51,399 |

## BATTERY INDUSTRY

Shipments of manganese ore by domestic producers to battery makers in 1933 totaled 7,904 long tons, and shipments from Puerto Rico were 1,638 tons. These figures indicate a consumption of 9,542 tons of domestic materials in battery manufacture. Imported manganese ore also was 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 1,127 long tons in 1933.

## REVIEW BY STATES

The following table shows shipments of manganese-bearing ore in 1933 by States:

*Manganese and manganiferous ore shipped by mines in the United States in 1933, 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 | 806 | $9,930 | 8 | 2,810 | $17,267 | 1 | 685 | $1,416 |
| Arkansas | 1 | 1,890 | [1] | 1 | 1,060 | [1] | | | |
| Georgia | 3 | 1,565 | [1] | 7 | 8,505 | 36,386 | | | |
| Michigan | | | | | | | 1 | 6,445 | 19,817 |
| Minnesota | | | | | | | 4 | 171,722 | 450,134 |
| Montana | 1 | 987 | [1] | | | | | | |
| Virginia | [2] 7 | 4,184 | 60,111 | 1 | 404 | [1] | | | |
| West Virginia | 1 | 95 | [1] | | | | | | |
| Undistributed | | | 95,101 | | | 4,184 | | | |
| Total metallurgical | 15 | 9,527 | 165,142 | 17 | 12,779 | 57,837 | 6 | 178,852 | 471,367 |
| Battery: | | | | | | | | | |
| Montana | [2, 3] 2 | 7,904 | 265,766 | | | | | | |
| Total battery | 2 | 7,904 | 265,766 | | | | | | |
| Miscellaneous: | | | | | | | | | |
| Montana | [2] 2 | 429 | 21,265 (Montana and Virginia) | | | | | | |
| Virginia | [2] 5 | 698 | | | | | | | |
| Total miscellaneous | 7 | 1,127 | 21,265 | | | | | | |
| | 19 | 18,558 | 452,173 | 17 | 12,779 | 57,837 | 6 | 178,852 | 471,367 |

[1] Included under "Undistributed."
[2] One producer in Montana shipped both battery and miscellaneous ore and 4 producers in Virginia shipped both metallurgical and miscellaneous ore.
[3] Mills through which all ore was shipped; producers not counted.

*Alabama.*—Shipments of manganese ore from Alabama in 1933 totaled 806 long tons valued at $9,930. The shipments came from the Walnut Grove and the Midvale mines near Walnut Grove in Etowah County and averaged (dried) 43 percent manganese. Shipments of ferruginous manganese ore in 1933 were 2,810 tons containing (dried) 29 percent manganese. The output came from several producers in Blount, Cherokee, Etowah, and Talladega Counties. Shipments of manganiferous iron ores in Alabama in 1933 were 685 tons containing (natural) 5.42 percent manganese. The shipments were from Talladega County.

*Arkansas.*—Shipments of manganese ore from Arkansas in 1933 were 1,890 long tons containing (dried) 49.25 percent manganese. Walter H. Denison in Independence County was the only shipper in 1933. He also shipped 1,060 tons of ferruginous manganese ore containing (dried) 28.85 percent manganese.

*Georgia.*—All the shipments from Georgia in 1933 came from three mines in the Cartersville district. Shipments were 1,565 long tons containing (dried) about 44 percent manganese. The bulk of the production came from the mine of the Manganese Corporation of America near White in Bartow County.

The ore deposits in the Cartersville district, the principal manganese district in Georgia, have been described by Crickmay.[3]

*Michigan.*—Shipments of manganiferous iron ore from Michigan in 1933, which amounted to 6,445 long tons, came from the Rogers mine on the Menominee range and contained (dried) 8.57 percent manganese, 46.66 percent iron, 4.97 percent silica, and 0.368 percent phosphorus.

*Minnesota.*—There were no shipments of ferruginous manganese ore from Minnesota in 1933, but shipments of manganiferous iron ores totaled 171,722 long tons. All shipments were from the Cuyuna range and averaged (dried) 9.14 percent manganese. The bulk of the ore came from the Sagamore and the Milford mines; the Mahnomen and Hillcrest mines furnished much smaller amounts.

*Montana.*—Shipments of metallurgical ore in Montana in 1933 were 987 long tons, all from the mill of the Domestic Manganese & Development Co. at Butte, where a high-grade sinter containing 61.65 percent manganese is produced from the rhodochrosite ores from the Emma mine.

Shipments of battery-grade ore amounted to 7,904 long tons in 1933 and came from the Philipsburg district, where the Trout Mining Co. and the Moorlight Mining Co. produce battery-grade concentrates by magnetic separation.

Shipments of ores for miscellaneous purposes totaled 429 long tons in 1933. The Emma mine at Butte and the operators in the Philipsburg district supplied this class of ore.

*Virginia.*—Shipments of manganese ore from Virginia in 1933 were 4,882 long tons, an amount greater than has been shipped since 1918. Of the total shipments in 1933, 4,184 long tons were metallurgical ore and 698 tons were shipped for miscellaneous uses. Shipments were made by 7 producers in Augusta, Bland, Campbell, Giles, Page, and Shenandoah Counties.

[3] Crickmay, G. W., The Ore Deposits of the Cartersville District, Georgia; 16th Internat. Geol. Cong., Guidebook 2, Excursion A-2, Mining Districts of the Eastern States, Washington, D.C., pp. 126–139.

The largest shipments came from the operation at the Crimora and Old Dominion mines in Augusta County. Most of the ore came from the Old Dominion, which was reopened during 1933. The ore was mined with a gasoline shovel, crushed, and then concentrated by means of log washers, jigs, and hand picking.

The Stange Mining Co., Inc., and the Bruce & Horne Manganese Co. furnished the output from Bland County. The mill at the Stange mine was remodeled during July and August and produced concentrates until the advent of cold weather in November. The ore is mined in opencuts by power shovels, and concentration is done in log washers, jigs, and by hand picking. The Bruce & Horne Manganese Co. operates an adjacent property, where the ore is mined from opencuts by hand methods and concentrated in log washers.

Production was intermittent throughout the year at the Eureka mine of the Stanley Manganese Mines at Stanley, Page County. Shipments from Campbell County came principally from the mine of the Southern Mines & Metals, Inc. Much smaller shipments were reported by Joseph Taylor at Silver Creek in Giles County and from the Hy-Grade Manganese Co., Inc., in Shenandoah County.

*West Virginia.*—During 1933 the Jackson-Iden Corporation shipped 95 tons of manganese ore from a property near Alvon in Greenbrier County.

*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 1933 totaled 1,638 long tons containing 797 tons of manganese compared with 2,302 tons containing 1,102 tons in 1932.

*Producers of domestic manganese ore.*—The following list comprises producers and shippers of domestic manganese ore (35 percent or more manganese) in 1933:

*Producers and shippers of domestic manganese ore (35 percent or more manganese in natural state) in 1933*

Alabama:
- J. B. Bynum, Walnut Grove.
- Midvale Mining & Development Co., Montgomery.

Arkansas:
- Walter H. Denison, Cushman.

Georgia:
- Homer H. Green, Cartersville.
- Manganese Corporation of America, White.
- L. F. Richards, White.

Montana:
- Anaconda Copper Mining Co., Butte.
- Domestic Manganese & Development Co., Butte.
- Moorlight Mining Co., Philipsburg.
- Trout Mining Co., Philipsburg.

Virginia:
- R. S. Adams, Lynchburg.
- Bruce & Horne Manganese Co., Bland.
- O. J. Graham, Waynesboro.
- Hy-Grade Manganese Co., Inc., Woodstock.
- Southern Mines & Metals, Inc., Lynchburg.
- Stange Mining Co., Inc., Crandon.
- Stanley Manganese Mines, 1817 Thirty-seventh Street NW., Washington, D.C.
- Joseph Taylor, Crandon.

West Virginia:
- Jackson-Iden Corporation, White Sulphur Springs.

## WORLD PRODUCTION

The following table shows, so far as statistics are available, the world production of manganese ores from 1929 to 1933 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, 1929–33, in metric tons*

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

| Country [1] | Percentage of manganese | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| North America: | | | | | | |
| Canada (shipments) | | 273 | 497 | 176 | | |
| Cuba | 36–50+ | 972 | 762 | 96 | 9,800 | 28,000 |
| Mexico | 40+ | 650 | 732 | 731 | [2] 700 | (3) |
| United States: | | | | | | |
| Continental (exclusive of fluxing ore) | 35+ | 61,348 | 68,111 | 39,872 | 18,062 | 18,856 |
| Puerto Rico [4] | 48–58 | 2,353 | 2,577 | 2,412 | 2,339 | 1,664 |
| South America: | | | | | | |
| Argentina [5] | | 208 | 239 | 221 | 252 | (3) |
| Brazil | 38–50 | 316,172 | 206,831 | 147,349 | 20,300 | (3) |
| Chile [4] | 40–50 | 3,104 | 6,137 | 383 | 449 | (3) |
| Europe: | | | | | | |
| France | 30+ | 1,095 | 1,000 | [2] 1,000 | [2] 1,000 | (3) |
| Germany | 30+ | 475 | 2,349 | | 12 | (3) |
| Greece | 30+ | 1,600 | 655 | 356 | 745 | (3) |
| Hungary | 30 | 19,044 | 9,090 | 1,132 | 1,497 | (3) |
| Italy | 30–50 | 9,917 | 10,633 | 6,421 | 378 | (3) |
| Rumania | 42 | 35,038 | 33,528 | 18,787 | 5,051 | (3) |
| Spain | 29+ | 17,872 | 16,819 | 17,916 | 2,591 | (3) |
| Sweden | 35–45+ | 13,674 | 4,907 | 4,140 | 3,014 | (3) |
| U.S.S.R. (Russia) | 41–48 | [6] 1,183,880 | [6] 1,444,166 | 876,000 | 915,300 | (3) |
| Yugoslavia | 42–45 | 3,072 | 1,539 | 2,454 | 160 | (3) |
| Asia: | | | | | | |
| China [4] | 50–55 | 41,881 | 54,854 | 22,051 | 20,733 | (3) |
| India: | | | | | | |
| British | 47–52 | 1,010,237 | 843,267 | 546,476 | 216,016 | (3) |
| Portuguese | 42–50+ | 5,092 | 5,476 | 3,547 | 3,573 | (3) |
| Japan | 50+ | 18,446 | 19,588 | 12,849 | 20,895 | (3) |
| Netherland India (East Indies) | 45–56 | 20,892 | 16,690 | 14,541 | 8,287 | 10,402 |
| Portuguese East Indies (Timor) | | 3,300 | | | | (3) |
| Turkey | 40 | 151 | 900 | 1,000 | 2,800 | (3) |
| Africa: | | | | | | |
| Egypt | 30+ | 191,477 | 121,211 | 101,781 | 327 | (3) |
| Gold Coast [4] | 50+ | 465,282 | 453,773 | 226,889 | 51,502 | 269,395 |
| Morocco (French) | 40–50+ | 13,150 | 16,200 | 11,502 | 3,980 | 4,800 |
| Northern Rhodesia | 41–50 | 1,879 | 887 | 1,491 | | 5,453 |
| Tunisia | 30–43 | 200 | | | | (3) |
| Union of South Africa | 40–60 | 9,349 | 147,321 | 101,899 | | (3) |
| Oceania: | | | | | | |
| Australia: | | | | | | |
| New South Wales | | 237 | 127 | | 108 | (3) |
| South Australia | | | | 13 | | (3) |
| Western Australia [4] | 47+ | 81 | | | | (3) |
| New Zealand [4] | 52+ | | 2 | | | (3) |
| | | 3,452,000 | 3,491,000 | 2,163,000 | 1,310,000 | (3) |

[1] In addition to the countries listed Belgium is reported to produce a small quantity of manganese ore, but statistics of output are not available. Czechoslovakia reports a production of "manganese ore", but as it has been ascertained that the product so reported averages less than 30 percent manganese and therefore would be considered ferruginous manganese ore under the classification used in this report the output has not been included in the table.
[2] Approximate production.
[3] Data not available.
[4] Exports.
[5] Shipments by rail and river.
[6] Year ended Sept. 30.

*Brazil.*—Exploitation of manganese ore in Brazil was practically suspended during the entire year owing to the low demand for ore and keen competition from other sources. Exports increased slightly, from 20,885 tons in 1932 to 24,893 metric tons in 1933, but were still far below the 293,318 tons exported in 1929. Some Brazilian ore moved to Japan in 1933, as a result of agreements between the two nations.

*Cuba.*—The principal production in Cuba at present comes from the Cuban Mining Co., the operating company of the Cuban-American Manganese Corporation, a subsidiary of the Freeport Texas Co.

The present producing mine and concentrating plant is at Isabelita near the township of El Cristo in the municipality of El Caney, Oriente Province, approximately 20 kilometers north of Santiago de Cuba on the main line of the Cuba Railroad. The properties of the company, however, aggregate approximately 6,500 acres and embrace the more important of the known commercially practicable manganese oxide deposits in Oriente Province, which are situated tributary to water, transportation, and electric power. The principal deposits are within a radius of 1 to 15 kilometers of the Isabelita station, and it is reported that there are millions of tons of concentrating ore available in each of several deposits within 1 to 3 kilometers of the concentrating plant. The ore reserves average 18 to 25 percent manganese, but there are local occurrences of high-grade ore that could be hand-sorted to above 40 percent in grade.

Mining is being done on the Isabelita and the Quinto claims. The ore body, which is 30 to 100 feet thick, blankets the hills near the concentrating plant. Much of the ore is exposed, but the overburden on the rest ranges from a thin cover to 60 feet thick in places, but the average depth of the cover is about 14 feet. The ore is in the ratio of 2 to 5 cubic yards of ore to 1 of overburden. Owing to the uneven surface of the ore body and the waste occurrence, dragline operations were the only practical method of handling the overburden. The stripped material is loaded into 5-yard side-dump cars and hauled 2,000 feet to a waste dump in 10-car trains. Two 20-ton gasoline locomotives and one 35-ton geared, oil-burning steam engine pull the trains. All rolling equipment is 36-inch gage.

The ore is being mined by opencut methods on benches 50 feet wide, with an average face 12 feet high. The present development consists of 10 benches, which are being extended in a semicircle around three sides of the hill and are approximately 1,500 feet long. The ore is dug by two electric shovels, one with a 1½-yard dipper and the other with a 2-yard dipper, and is loaded into 6-ton side-dump cars. The same cars are used for stripping and for transporting the ore. The normal loading rate from each bench by one shovel is 1,200 tons per shift of 8 hours. The ore is hauled by rail 4,000 to 6,000 feet to the primary crushing plant adjacent to the concentrator.

The mill, of concrete and steel construction, has a capacity of 100,000 tons of sintered concentrates per annum. The ore from the mine is dumped into steel bins, which feed mechanically to grizzlies. The oversize is reduced to minus 4 inches in a 36- by 48-inch jaw crusher and together with the fines from the grizzlies is transported on a 36-inch belt conveyor to three cylindrical bins, each of 1,200 tons capacity, at the head of the mill. The ore then passes over a weightometer and into a 4-foot Symons cone secondary crusher, which reduces the ore to minus one-fourth inch and discharges it to a 10- by 9-foot Marcy ball mill. The ball mill operates in closed circuit with three Akins classifiers. The classifier overflow, which runs about 8 to 15 percent on 100 mesh, goes to flotation and is distributed to three sections of 24-inch 8-cell roughers and scavengers and three 6-cell 24-inch cleaners. The pulp dilution to the roughers is variable, ranging from 1.3–3.0 to 1.0, depending on the ore and the grinding desired. The reagents consist of vegetable or animal fatty acid saponified with caustic soda and gas oil. The reagent is fed to the ball mill. Quebracho (60 percent tannin) is fed to the cleaners.

The concentrates are delivered to the pool of a dewatering drag conveyor and then into a battery of steel drainage bins. A retention period of 1 to 2 hours drains the concentrates to the equivalent of filter cake. They are then fed by screw conveyors, which also carry coke and return sinter fines to the pug mill of the sinter plant. From the sintering machine the sinter is loaded into cars over vibrating screens.

The average grade of the ore treated has been about 19 percent, and the flotation extraction in the mill has ranged through the experimental stages from 65 to 87 percent. The sintered concentrates produced during 1933 averaged:

*Average content of sintered concentrates produced at Isabelita concentrating plant in 1933*

| | Percent |
|---|---|
| Mn | 52. 300 |
| Fe | 4. 3 |
| $SiO_2$ | 7. 8 |
| $Al_2O_3$ | 2. 8 |
| CaO | 3. 6 |
| BaO | . 870 |
| MgO | 1. 200 |
| P | . 096 |
| O | 26. 0 |
| Moisture | . 5 |
| Sulphur from coke | Trace |

The sinter is transported from the reduction plants at El Cristo to the wharf at Santiago, a distance of 12 miles, in standard-gage dump cars of 25 to 30 tons capacity. A concrete coastal wharf and docks have been constructed by the company at Santiago, where the present installed crane capacity for loading vessels is 150 tons per hour. The ore may also be railed to the port of Antilla on the north coast of Cuba, a distance of 60 miles from El Cristo, where the Cuba Railroad Co. has mechanical loading equipment.

During the first part of 1933, production was continued at a low rate owing to physical phenomena of the action of the manganese mineral not hitherto discovered, necessitating changes for correction in operation. Full operation was attained in July. The plant was shut down on August 8, owing to the revolution, and operations were not resumed in 1933. Production and shipment to the steel industry in the United States for the few months of activity in 1933 amounted to 28,348 long tons. Resumption of operations was scheduled for early in 1934.

*Gold Coast.*—Exports of manganese ore from the Gold Coast in 1933 were 269,395 metric tons, a substantial increase over the 51,502 tons exported in 1932. The only producing mine in the Gold Coast is the Nsuta mine of the African Manganese Co., Ltd.

*India.*—Manganese mining in India, normally the world's second largest producer, continued at a low level. The principal producer in the Central Provinces, the main manganese district, had closed its mines, and many smaller mines were also down. In the latter part of the year, however, improvement in the British steel trade resulted in an increase in sales of Indian ore. Exports in 1933, exclusive of exports through Mormugao, were 263,977 metric tons compared with 195,837 tons in 1932.

*U.S.S.R. (Russia).*—Figures on the production of manganese ore in the U.S.S.R. in 1933 are not available; but exports amounted to 655,007 metric tons, an increase of nearly 60 percent over the preceding year. France, the United States, Germany, Poland, Japan, and Italy were the principal markets for Russian ore in 1933.

It was reported during the year that the enterprise in the Chiaturi district was being reconstructed. The industry is to be centralized into larger units, mining will be mechanized, and washing-plant facilities will be concentrated into a smaller number of larger, better-equipped mills. Early in 1933 it was decided to draw on the Chiaturi mines, which until then had been producing only for export, for the needs of Russian industry. As transportation from Chiaturi to centers of the Russian steel industry is rather inconvenient, it is thought that the Chiaturi ores are to be used only in the new ferro-alloy plant at Sestafoni, near Chiaturi. Three furnaces are in operation at Sestafoni, but ultimate plans call for 18. Another new plant for the manufacture of ferromanganese has been erected at Kichkas, on the Dnieper River, not far from Nikopol. This plant will operate on ores from the Nikopol region.

Manganese-ore deposits are reported[4] to have been discovered in western Siberia on the Bija River, about 150 kilometers above the city of Bijsk. The ore is said to contain 48 percent manganese, and the deposits are much nearer the steel center of Kusnetsk than the lower grade (10 to 18 percent manganese) deposits near Achinsk.

*Union of South Africa.*—Sales and shipments of manganese ore in the Union of South Africa in 1933 were 28,169 metric tons compared with 3,116 tons in 1932. The entire amount came from the Postmasburg district in Cape Province, where the Manganese Corporation, Ltd., and the South African Manganese, Ltd., operate. Production by the former company was resumed in April 1933, after the mine had been shut down since October 1931. There were no sales or shipments during the first 3 months of the year, but the departure of the South African currency from the gold standard in 1932 caused serious efforts to revive manganese mining. Rail transportation is an important factor in the cost of placing Postmasburg ores on the market, and during the year the producing companies were working with the railway authorities to effect reduced rates.

The Union Steel Corporation made a trial production of ferromanganese at its Newcastle blast furnace in July. The ores used were supplied by the South African Manganese, Ltd., and were reported to be of good quality.

The geology of the Postmasburg deposits with particular reference to the origin of the manganese has been described by Du Toit.[5]

*Other countries.*—Morocco is the only French possession where valuable deposits of manganese ore have been found.[6] Although the deposits in western Morocco are unfavorably situated as to transportation, a shipload of ore was sent to Sweden in 1933 for experimental purposes. The mine at Bou Arfa in eastern Morocco was inactive during the year.

It was reported in 1933 that large deposits of manganese ore have been discovered in Yugoslavia (Serbia).[7]

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[4] Metallborss, Neue Manganerzvorkommen in Russland: Jahrg. 23, no. 65, Oct. 25, 1933, p. 1360.

[5] Du Toit, A. L., The Manganese Deposits of Postmasburg, South Africa: Econ. Geol., vol. 28, no. 2, March-April 1933, pp. 95–122.

[6] Echo des mines et de la métallurgie, Le Manganèse au Maroc: Year 61, no. 3132, Mar. 20, 1933, pp. 167–169.

[7] Iron and Coal Trades Review, Manganese Ore in Serbia: Vol. 126, no. 3406, June 9, 1933, p. 910.

# MOLYBDENUM

By Frank L. Hess

SUMMARY OUTLINE



*Growth of interest in molybdenum.*—The recent history of molybdenum is spectacular, and never before has there been shown in any one year so much activity in the mining, the use, and the investigation of this metal. Molybdenum has been known since 1782 when it was isolated by Hjelm in Sweden, and during more than a hundred succeeding years many attempts were made to find profitable uses for it. As ammonium molybdate it proved to be an excellent reagent in the determination of phosphorus, and for this purpose it remains the standard. Reduced to elemental form it is a powder, and its very high melting point 2,500° C. (4,532° F.) makes its production as molten metal impracticable although not impossible. In 1907, Colin G. Fink,[1] then in the employ of the General Electric Co., found that by compressing the pure powder into bars it could be heated and hammered into sheets or swaged into wire which could be drawn to very small diameters. Both were bendable and tough at ordinary temperatures, and the wire was found useful as filament supports in electric lamps and tubes of various types and in small electric resistance furnaces.

These uses required only small quantities of the metal, and meanwhile a great amount of effort was expended in attempting to find use for it in steel. No striking success was attained until about the time of the Great War. With faith in the metal's future the Climax Molybdenum Co. was formed to take over and operate large low-grade deposits at the little station of Climax on the Colorado & Southern Railroad about 70 miles in a direct line southwest of Denver and 13 miles northeast of Leadville. The company spent between $1,000,000 and $2,000,000 but found that there was insufficient market to keep the plant running, so operations ceased for some time. B. F. Phillipson, president of the company, then began a long series of experiments in making molybdenum steels which C. H. Wills

[1] Fink, Colin G., Ductile Tungsten and Molybdenum: Gen. Elec. Rev , vol. 13, 1910, pp. 323–324.

especially and some others had found useful. Before that time most, although by no means all, experiments had been directed toward using molybdenum in steels similarly to tungsten, usually on the basis that as the atomic weight of molybdenum (96) was only about half the atomic weight of tungsten (184) then about half as much molybdenum should do the work of tungsten, and some excellent steels were made; however, such steels did not become popular, tool users in general finding that tungsten steels gave better service.

Phillipson, following Wills, attacked the problem from a greatly different standpoint—that of adding fractional or small percentages of molybdenum to steel to toughen it, as had been done with vanadium and with nickel. Although he was not alone in proposing such uses it was apparently his work that made public the information and emphasized its value to steelmakers. At about the same time Alan Kissock forcefully brought to public attention the economy of introducing molybdenum into steel by adding calcium molybdate to the bath. By this means nearly all the molybdenum is absorbed and the calcium goes into the slag. The calcium molybdate is made by heating roasted molybdenite with lime, and the process is very much cheaper than making molybdenum metal or ferromolybdenum. A similar product was put out by the Molybdenum Corporation of America under the name "Molyte."

The molybdenum properties taken over by the Climax Molybdenum Co. had been held for many years by prospectors, but the demand for the metal was so slow in coming that they found the long wait discouraging. Companies with larger capital likewise became disheartened. At present between 3,000 and 4,000 tons of ore per day are being milled, making this one of the large metal-mining operations of the United States. Since 1918, the R. and S. mine of the Molybdenum Corporation of America in Sulphur Gulch east of Questa, N.Mex., also has been worked continuously. Although it is not of such spectacular size as the Climax deposit it has much richer ore in narrow veins. Molybdenum mining has prospered and grown during the past 4 years of general depression; and smaller properties also found a market during 1933 for both molybdenite and wulfenite ores.

*Production.*—The production of molybdenum in the United States during 1933 was far the greatest annual output yet made. With comparative figures for the 2 preceding years it is shown in the following table:

*Salient statistics of the molybdenum industry in the United States, 1931–33* [1]

| | 1931 | 1932 | 1933 |
|---|---|---|---|
| Production: | | | |
| Ore ... short tons | 434, 400 | 363, 400 | 705, 000 |
| Concentrates ... do | 3, 038 | 2, 387 | 5, 348 |
| Molybdenum contained: | | | |
| Average ... percent | 51. 56 | 50. 93 | 53. 12 |
| Total ... pounds | 3, 133, 000 | 2, 431, 000 | 5, 682, 000 |
| Shipments (molybdenum contained): | | | |
| Pounds | 3, 157, 000 | 2, 373, 000 | 5, 761, 000 |
| Value [2] | $1, 577, 000 | $1, 186, 000 | $4, 316, 000 |
| Imports (molybdenum contained): | | | |
| Pounds | 210, 766 | 44 | 40 |
| Value | $213, 660 | $89 | $158 |

[1] Figures for molybdenum exported not separately recorded. Producers report that probably four fifths of the domestic output was exported in 1933.
[2] Estimated by Bureau of Mines.

*Prices.*—Molybdenum for use in steel containing not more than 1½ percent molybdenum usually is sold as calcium molybdate (called by one firm "Molyte"). For steel containing larger percentages ferromolybdenum is used.

During 1933 prices were quoted by the Engineering and Mining Journal as follows:

Molybdenum, chemically pure powder, 10- to 50-pound lots: $9 to $9.50 per pound.

Molybdenum, 97 percent Mo, 10- to 50-pound lots: $4.10 to $4.50 per pound.

Molybdenite concentrates, 75 to 85 percent $MoS_2$, per pound $MoS_2$: 42 cents.

Calcium molybdate, Molyte: 85 cents per pound of contained Mo until December, then 80 cents.

Ferromolybdenum, 50 to 60 percent Mo: 95 cents per pound for contained Mo.

## USES OF MOLYBDENUM

Much the largest use of molybdenum is in steel, and the great interest in that use is shown by the number of patents issued and the articles published.

*Extra-hard tools.*—The influence of the popularity of tungsten carbide tools is reflected in the various proposals to use molybdenum carbide.

An alloy of molybdenum and titanium carbides[2] (the cement used is not given), called Cutanit, was described as being made and used in England. On cobalt magnet steel it was said to have cut 1½ hours at the rate of 164 feet per minute with a feed of 0.008 inch and 0.00625 inch deep. It also cuts bakelite, glass, porcelain, cement, marble, ebony, and other substances. A similar material said to be made in this country under a German patent was called Titanite, and analysis showed 51.2 percent titanium carbide and 48.8 percent molybdenum carbide cemented by 14 percent of their weight in nickel.[3] Another tool material is a mixture of molybdenum and titanium carbides cemented by nickel and chromium or other carbides of the fourth- and sixth-group[4] metals cemented by metals of the sixth and eighth groups.[5] The Fansteel Products Co. obtained a French patent[6] on a hard alloy made from a hard and refractory metal of the fifth group, a metal of the sixth group, and one or more metals of the iron group, for example, tantalum carbide 80, tungsten or molybdenum 9, nickel 11 percent.

A patent was issued to Voightlander and Kaufels[7] for articles shaped under pressure at 2,200° to 2,400° C. from a fused alloy of 80 percent of carbide of molybdenum or of carbide of tungsten, the remaining 20 percent being cobalt, silicon, or some other metal or metalloid. Schwartzkopf and Hirschl[8] patented the use of 15 to 50 percent of a carbide of chromium, tungsten or molybdenum, with 39 to 75 percent of a carbide of titanium or zirconium cemented by cobalt, iron or nickel. Floyd C. Kelley cements powdered tantalum

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[2] Iron Age, A New Carbide Cutting Tool: Vol. 132, 1933, p. 28; Machinery (London), Molybdenum-Titanium Carbide Cutting Tools: Vol. 40, 1933, pp. 355–7.

[3] Personal communication, Wm. S. Loach.

[4] "Group", of course, refers to a group of the Mendeleef periodic table of the elements; those included here would seem to be silicon, titanium, zirconium, and thorium, of the fourth group, and chromium, molybdenum, tungsten, and uranium, of the sixth group.

[5] N. V. Molybdenum Co.: British Patents 395719 and 395735, July 17, 1933. The metals of the eighth group usable as a cement are iron, cobalt, and nickel.

[6] French Patent 752049, Sept. 15, 1933, quoted by Chem. Abs., vol. 28, Feb. 10, 1933, p. 736.

[7] U.S. Patent 1895950, Jan. 31, 1933, assigned to Fried. Krupp. A.-G.

[8] Schwartzkopf, Paul, and Hirschl, Isidor: U.S. Patent 1925910, Sept. 5, 1933.

and columbium carbides with iron and molybdenum.[9] The use of molybdenum boride, carbide, nitride or silicide in percussion drills is proposed.[10]

John W. Genuit (assignor to the Stoody Co.)[11] patented a sintered compound containing 90–97 percent tungsten carbide, 0.5 to 5 percent molybdenum carbide, and 2 to 9.5 percent tantalum carbide. A hard-tool alloy patented by Poldihütte in Austria[12] contains cobalt 30 to 50 percent, chromium 22 to 37 percent, tungsten 17 to 27 percent, vanadium 1 to 20 percent, and carbon 2.4 to 7 percent, in which tungsten in excess of 17 percent may be replaced by molybdenum. Alfred Kropf[13] patented a high-melting-point hard-tool alloy containing tungsten 40 to 65, molybdenum 10 to 40, tantalum 1 to 20, and carbon 1 to 2.5 percent; Honda and Kase[14] have patented an alloy of tungsten 30–50, molybdenum 20–50, chromium 30–50, carbon less than 2, nickel less than 5, and manganese less than 4 percent. In the preceding year they took out a British patent on an alloy composed of tantalum or tungsten 35–70, or tungsten and tantalum 35–70, molybdenum 5–44.5 and chromium 20.5–50 percent. Molybdenum or chromium may be replaced in part by vanadium 2–10, and the alloy may also contain carbon 0.1–2, nickel 0.1–5, iron 0.1–15, and manganese 0.1–4 percent—a very comprehensive group of alloys.

A French patent[15] covers alloys containing molybdenum 0–10, tungsten 0–10, chromium 25–0.5, nickel 6.5–30, manganese 0.1–40, vanadium 0–2, titanium 0–0.5, zirconium 0–2, carbon less than 1 percent, and iron remainder. These alloys are hardened by adding one or more of the following: Aluminum 1–20, boron less than 5, beryllium less than 5, silicon less than 10 or copper less than 20 percent, and heat treatment. Even without the hardening elements the alloys are claimed to be harder than other steels and to be resistant to oxidation. This is comparable with Sykes' alloy given in the table on page 421.

A British patent[16] provides for hardened steel alloys, containing a nitrogenizing element (molybdenum, aluminum, chromium, or manganese), and a precipitation hardening element (copper, beryllium, boron, or titanium). Objects are roughly formed, properly heat-treated and tempered.

Since the beginning of its use attempts have been made to add molybdenum successfully to steels intended for high-speed lathes and other metal cutters. Joseph V. Emmons[17] has studied nine high-speed steels containing: Molybdenum 6.49–14.46, vanadium 0.79–1.37, chromium 2.66–4.26, and carbon 0.57–0.82 percent. Compared with tungsten high-speed steels, he found them to be generally as hard but lower in strength, plasticity, and cutting quality. An increase in carbon improved cutting quality. Nickel and cobalt made no improvement. An addition of one-fourth as much tungsten as molybdenum gave cutting properties approxi-

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[9] Kelley, Floyd C.: British Patent 396129, Aug. 3, 1933, assigned to The British Thompson-Houston Co., Ltd.

[10] Tool Metal Mfg. Co., Ltd.: British Patents 392038, May 11, 1933, and 396943, Aug. 17, 1933.

[11] U.S. Patent 1893078, Jan. 3, 1933.

[12] Austrian Patent 132695, Apr. 10, 1933.

[13] U.S. Patent 1893144, Jan. 3, 1933.

[14] Assignors to Research Inst. for Iron, Steel and Other Metals: U.S. Patent 1881315, Oct. 4, 1932.

[15] Commentry, Fourchambault, and Decazeville: French Patent 743179, Mar. 25, 1933.

[16] F. Krupp, A.-G.: British Patent 386665, 1933.

[17] Emmons, J. V., Some Molybdenum High Speed Steels: Am. Soc. Steel Treat., vol. 21, 1933, pp. 193–220.

mating those of 18 (tungsten)–4 (chromium)–1 (vanadium) steels. Should molybdenum be used successfully to partly or wholly replace tungsten in high-speed steels, the process would be very important from both military and economic standpoints. Molybdenum-bearing hacksaw blades are extensively marketed.

*Molybdenum-iron tools.*—Patents for the following molybdenum cutting-alloys were issued during the year:

*Composition of molybdenum tool steels patented during 1933, in percent*

| Patentee | Molybdenum | Tungsten | Chromium | Vanadium | Cobalt |
|---|---|---|---|---|---|
| Vereinigte Stahlwerke [1] | 2–40 and/or | 2–40 | And/or | And/or | And/or. |
| Becker & Allison [2] | 0.7–5 | | 0.7–5 | | |
| Compagnie Française pour l'Exploitation des Procédés Thomson-Houston. [3] | 8.0 | | 5.5 | | 36.0. |
| Joseph V. Emmons [4] | 0.6–15 | 0.2–6.0 | 0.2–10.0 | | |
| Laboratoire Industriel Métallurgique de la Vallée du Bois (Soc. à.r.l.). [5] | 5 | 4 | 18 | | |
| Leo Klüger [6] | 0.1–1.1 | 16.5–22.5 | | 0.5–1.75 | 3.5–19.0. |
| Wesley P. Sykes [7] | 10–30 | | | | |

| Patentee | Nickel | Manganese | Silicon | Carbon | Iron |
|---|---|---|---|---|---|
| Vereinigte Stahlwerke [1] | And/or | And/or | And/or | 0–low | Rem. |
| Becker & Allison [2] | 3–8 | | | 0.9–2.5 | Do. |
| Compagnie Française pour l'Exploitation des Procédés Thomson-Houston. [3] | | | | 1.0 | Do. |
| Joseph V. Emmons [4] | | | 0.1–0.45 | 0.5–1.3 | Do. |
| Laboratoire Industriel Métallurgique de la Vallée du Bois (Soc. à.r.l.). [5] | | 2 | | 1.7 | Do. |
| Leo Klüger [6] | Tantalum 0.1–2.15. | 0.0–0.35 | 0.1–0.4 | 0.9–1.25 | Do. |
| Wesley P. Sykes [7] | | | | 0.1 | 70–90. |

[1] Vereinigte Stahlwerke, Akt. Ges. 67, Breitestrasse, Dusseldorf: British Patent 373690; Metal Industry (London), vol. 42, no. 6, Feb. 10, 1933, p. 182.
[2] Becker, R. C., and Allison, F. H., Jr., Crucible Steel Co. of America: Canadian Patent 333399, June 20, 1933; Chem. Abs., vol. 27, Sept. 20, 1933, p. 4522.
[3] Compagnie Française pour l'Exploitation des Procédés Thomson-Houston: French Patent 42456, July 31, 1933.
[4] Emmons, Joseph V., to Cleveland Twist Drill Co.: U.S. Pat. 1937334.
[5] Laboratoire Industriel Métallurgique de la Vallée du Bois (Soc. à.r.l.): French Patent 736809, June 7, 1933; Chem. Abs., vol. 27, Sept. 20, 1933, p. 4524.
[6] Klüger, Leo, assignor to Oesterreichische Schmidtstahlwerke A.-G.: U.S. Patent 1910801, May 23, 1933; Chem. Abs., vol. 27, Aug. 20, 1933, p. 3908.
[7] Sykes, Wesley P., to General Electric Co.: U.S. Patent 1894836, Jan. 17, 1933.

Under the Sykes patent, alloys suitable for tools and dies are formed by heating iron with molybdenum or tungsten until a solid solution is formed. The alloy is cooled rapidly and then heated for several hours at a temperature below the initial heating temperature. "Alloy 548" is a related material for making steel-cutting tools; it contains about 30 Co, 19 W, 3 Mo, 2 V, low C, remainder Fe. It is given a high-temperature heat treatment at about 1,275° C., after which it has a hardness of about 45 Rockwell C and is machinable. It is then reheated to about 500°–700° C. for age-hardening by which a hardness of 45 to 70 Rockwell C can be obtained. Carbon is thought to have no place in the hardening.

*Special-purpose molybdenum steels.*—Molybdenum is said to be the only alloy metal used in steel which does not interfere with welding, and is, in fact, claimed to be helpful. It is being largely used in tubes for building airplanes.

A number of special purpose steels were made during the year, among them those in the following table:

*Composition of some special purpose molybdenum steels, in percent*

| Purpose | Molybdenum | Chromium | Carbon | Nickel | Vanadium |
|---|---|---|---|---|---|
| Tubes (low temperature) [1] | 0.50 | 6–8 | | | |
| Boilers [2] | 0.2–2.0 | 0.1–5 | Copper 0.3–6.0. | 0.1–6 | 0.2–2.0. |
| High-pressure vessels [3] | 0.3–1.2 | 2.0–4.0 | | | |
| Super heaters [4] | 0.4 | 5.0–7.0 | | | |
| Mill rolls [5] | 0.5 | 0.5–2.0 | Carbon 0.1–1.25. | | |
| Magnets [6] | 23 | | 0.00 | | |
| Magnets [7] | <10.0 | <10.0 | | <10.0 | |
| Razor blades [8] | 0.05–2.0 | 5–20 | 0.5–2.5 | 0.25–3.5 | 0.05–15. |
| Armor plate [9] | 0.15–1.0 | 2–5 | 0.12–0.45 | 0–3.0 | |
| Tool-proof [10] | 1.0–3.0 | 1.0–3.0 | 1.25–1.75 | 3.5–7.0 | |
| Nitrogen hardening [11] | 0.1–0.5 | 0.5–4 | $\ngtr$1.0 | | |
| Castings [12] | 0.05–0.5 | | 0.2–0.6 | Copper 0.9–1.5. | |
| Dies, for die-casting [13] | 1.5–2.75 | 3.0–8.0 | 0.2–0.5 | 0.5–2.0 | Tungsten 0.5–2.0. |
| Watch springs [14] | 6.5 | 15 | | 60 | Beryllium 0.5. |

| Purpose | Cobalt | Titanium | Manganese | Silicon | Aluminum |
|---|---|---|---|---|---|
| Tubes (low temperature) [1] | | | | | |
| Boilers [2] | 0.02–3.0 | 0.02–3.0 | 0.4–6 | 0.1–3.0 | |
| High-pressure vessels [3] | | | | | 0.2–0.6. |
| Super heaters [4] | | | | 0.7–0.3 | 0.5–0.9. |
| Mill rolls [5] | | | | 2.0 | |
| Magnets [6] | $\ngtr$25 | | | | |
| Magnets [7] | <10.0 | | <10.0 | 0.5–16 | 0.5–16. |
| Razor blades [8] | | | 0.1–1.75 | 0.1–2 | |
| Armor plate [9] | | | | | |
| Tool-proof [10] | | | | | |
| Nitrogen hardening [11] | | Sulphur 0.1–0.25. | | | 0.5–2.0. |
| Castings [12] | Zirconium 0.15–0.30. | | 1.0–1.5 | | |
| Dies, for die-casting [13] | | | 0.1–1.0 | 0.1–1.5 | |
| Watch springs [14] | Iron 16 | | 2.0 | | |

[1] Iron Age, Chrome-Molybdenum Castings for Oil Industry: Vol. 132, no. 5, Aug. 3, 1933, p. 5.
[2] Wallman, Carl, and Nehl, Franz: French Patent 739424, July 4, 1932.
[3] Schiffler, Herman J.: French Patent 747440, June 17, 1933.
[4] Schiffler, Herman J.: British Patent 369866, Sept. 18, 1930.
[5] Bethlehem Steel Co., Shimer, W. R., and Daniels, F. C. T.: U.S. Patent 1893004, Jan. 3, 1933.
[6] Dean, Reginald S., to Western Electric Co.: U.S. Patent 1904859, Apr. 18, 1933.
[7] Masumoto, Hakaru, to Kinzokuzairyō Kenkyucho: French Patent 749713, July 28, 1933. Less than 10 percent Ni, Co, Cr, W, Mo, Mn, V, Ti, Sn, and Zn; less than 5 percent Mg, Sb, Ta, and Be; and less than 2 percent B, Cu, or P may be used.
[8] Succop, John A., to Heppenstall Co.: British Patent 362900, Aug. 9, 1930.
[9] Fried. Krupp, A.-G.: British Patent 392117, May 11, 1933.
[10] Becker, Robert C., and Allison, Franklin H., Jr.: U.S. Patent 1934520, Nov. 7, 1933. For jail bars, etc
[11] Edlund, Daniel L., to Ludlum Steel Co.: U.S. Patent 1919211, July 25, 1933.
[12] Woodhall, Wm. H., to Harrison Steel Castings Co.: U.S. Patent 1885667, Nov. 1, 1932.
[13] Gill, James P., to Vanadium Alloys Steel Co.: U.S. Patent 1938221, Dec. 5, 1933.
[14] Straumann, Reinhard: French Patent 42520, Aug. 4, 1933 (addition to 735009).

*Chemically resistant molybdenum steels.*—A valve steel, in which tungsten is commonly used, may have molybdenum in place of part or all of the tungsten in a special heat-treated alloy.[18]

The constant effort to make iron and steel resistant to attack by weather and the elements and chemicals used and encountered in various commercial enterprises and at the same time retain the advantages of various alloys of iron has brought forth a number carrying molybdenum. The familiar 18-chromium–8-nickel steel is said to be improved by the addition of 2 to 4 percent molybdenum. Among the recently devised stainless steels are the following:

[18] Fried. Krupp, A.-G.: British Patent 396383, July 31, 1933.

*Composition of molybdenum-iron alloys devised for resistance to atmospheric and chemical attack, in percent*

| Purpose | Molybdenum | Copper | Manganese | Silicon | Carbon | Chromium | Vanadium | Iron |
|---|---|---|---|---|---|---|---|---|
| Weather resistant [1] | ≯0.3 | 0.25–0.6 | 0.8–1.4 | 0.4–0.7 | 0.20–0.25 | | | Rem. |
| Rust resistant [2] | 0.05–0.15 | 0.5 | 0.15–0.5 | 0.3 | | 0.05–0.6 | | Do. |
| Rustless [3] | 0.4–3.5 | 0.5–6 | | | ≯0.4 | 14.0–20.0 | | Do. |
| Rustless [4] | 1.0–3.0 | | | | 0.1 | 16–22 | | Do. |
| Rustless [5] | ≯6.0 | ≯6.0 | 0.8–40.0 | ≯6.0 | ≯1.0 | 15.0–25.0 | (or Ti) ≯4.0 | Do. |
| Rust resistant when hot.[6] | 0.05–0.07 | 0.25–0.35 | 0.45 | 0.01 | 0.04–0.05 | | | Do. |
| Corrosion resistant [7] | 17 | Tungsten 5. | 1.0 | 1.0 | ≯0.2 | 13 | 0.5 | Do. |
| Inoxidizable (for motor valves).[8] | 0.6–1.3 | Cobalt 2.0–3.5. | 0.3–0.6 | 1.3–2.5 | 0.45–0.65 | 11–14 | | Do. |
| Erosion resistant (for gas turbines).[9] | 0–10 | Tungsten 15–20. | | Aluminum 2.0–4.0. | | 0–20 | 1.0–3.0 | Do. |
| Resists hot hydrogen.[10] | 0.2–1.0 | | | | 0.05–0.2 | 5–12 | | Do. |
| Resists sulphur gases (for oil cracking).[11] | 1–10 | | 6–16 | | <0–3 | 16–22 | | Do. |
| Resists $H_2S$ [12] | 0.50 | | | | 0.15–0.35 | 4.5–6.5 | | Do. |
| Acid resistant [13] | 0.1–4.5 | Nickel 7–25. | Tantalum 0.1–5. | | (?) | 2–30 | 0.1–2.0 | Do. |
| Resistant to sulphuric or sulphurous acids.[14] | 1.5–4.0 | Nickel 8 | | | (?) | 18.0–28.0 | | Do, |

[1] Wiessner. Bautech., vol. 19, 1932, p. 472.
[2] Soc. Anon. des Hauts Fourneaux de la Chiers: French Patent 747774, June 23, 1933.
[3] Beck, Erich: French Patent 733921, Mar. 19, 1932.
[4] Hoesch-Köln Neuessen A. G. für Bergbau u. Hüttenbetrieb: French Patent 750197, Aug. 5, 1933.
[5] Soc. Industrielle et Com. des Aciers: French Patent 754263, Nov. 3, 1933. The preferred composition is given. Part of the Mn may be replaced by Ni; up to 6 percent Cu, Co, Mo, and Si combined and 10 percent Al may be present.
[6] Cuivre et Laiton, vol. 5, 1932, pp. 479–81.
[7] Franks, Russell, to The Electro Metallurgical Co. of Canada, Ltd.: Canadian Patent 331111, Mar. 21, 1933.
[8] Soc. Anon. des Aciéries et Forges de Firminy: French Patent 731940, Apr. 22, 1931.
[9] Holzwarth, Hans: British Patent 381851, Oct. 13, 1932.
[10] Strauss, Benno, to Fried. Krupp A.-G.: U.S. Patent 1876091, Sept. 6, 1932.
[11] Becket, Frederick M., to The Electro Metallurgical Co. of Canada, Ltd.: U.S. Patent 1916780, July 4, 1933.
[12] Iron Age, Chrome-Molybdenum Castings for Oil Industry: Vol. 132, no. 5, Aug. 3, 1933, p. 5.
[13] Armstrong, John J. V.: British Patent 383364, Nov. 17, 1932.
[14] Furman, W. F., High-Chromium Iron Alloys for Castings: Metals and Alloys. vol. 4, no. 11, November 1933, pp. 167–9.

*Abrasive-resistant molybdenum steels.*—Molybdenum has been used also in an effort to stop the waste of materials and power by abrasion as well as to resist chemical attack, and J. Mayer [19] reports the very satisfactory use of cast molybdenum-chromium steel muller tires for grinding clay, shale, sillimanite, emery, and silicon carbide.

[19] Mayer, J., Wear of Metal in Muller Tires in the Clay Industry. Report of tests made of chrome-molybdenum alloy steel casting: Bull. Am. Ceram. Soc., vol. 12, no. 11, 1933, pp. 312–13.

Other wear-resistant molybdenum steels which came to notice during 1933 are shown in the following table:

*Composition of molybdenum steels intended for wear resistance, in percent*

| Purpose | Molybdenum | Chromium | Manganese | Silicon | Tungsten | Vanadium | Carbon | Nickel |
|---|---|---|---|---|---|---|---|---|
| Crushing machinery.[1] | 0.35 | 1.50 | 0.90 | 0.30 | ---------- | ---------- | 0.75 | 0.70 |
| Wheel rims, etc.[2] | 0.22-0.65 | 0.3-0.8 | 0.4-0.85 | 0.45-1 | 0.25-0.7 | 0.18-0.6 | 0.65-0.78 | -------- |
| Tool points[3] | 0.5 -5 | 10-25 | Copper 1-5 | Aluminum 1-10 | 10-25 | 1-5 | 0.5 -4.0 | 15-35 |
| Machine parts[4] | 1.0 | 15-20 | ------------ | ------------ | 10 | 1.0 | 2-5 -4.5 | 2.0 |
| Welding - electrode.[5] | Steel has a coating of lime 1 part, quartz 1 part, and molybdenum 2 parts. | | | | | | | |
| Welding - electrode.[6] | Steel has a coating of ferrochromium 5.12 parts, manganese-titanium 1.75 parts, calcium molybdate 0.33 part, and fire clay 2 parts. | | | | | | | |

[1] Kissock, Alan, A Wear-Resistant Steel: Trade pub., Climax Molybdenum Co., 1933, 15 pp.
[2] Van Royen, Herman Johan: British Patent 389984, Mar. 30, 1933 (addition to 277631 and 340542).
[3] Gregg, Alfred W., and Frank, Raymond H., to Bonney-Floyd Co.: U.S. Patent 1876411, Sept. 6, 1932.
[4] Gregg, Alfred W., and Frank, Raymond H., to Bonney-Floyd Co.: U.S. Patent 1894819, Jan. 17, 1933.
[5] Southgate, Geo. T., to The Union Carbide & Carbon Research Laboratory, Inc.: Canadian Patent 331167, Mar. 21, 1933.
[6] Frickey, Royal E., and McClary, Archie W., to Welding Service, Inc.: U.S. Patent 1926090, Sept. 12, 1933.

The welding-electrodes are for surfacing worn or wearing surfaces, but a softer welding-electrode containing molybdenum as a deoxidizing substance was patented.[20]

An alloy wrought iron patented in Great Britain [21] contains 2 percent molybdenum.

*Nonferrous molybdenum alloys.*—Although it carries the date 1932 a monograph entitled "Alloys of Iron and Molybdenum", by J. L. Gregg,[22] under the auspices of the Battelle Memorial Institute did not become generally available until 1933. It gives an exhaustive review of the literature of the iron-molybdenum alloys, with general articles on iron, molybdenum, molybdenum minerals, iron-carbon, molybdenum-carbon, and iron-molybdenum-carbon, and more complex molybdenum steels.

Nonferrous alloys brought out during the year include an aluminum base to which is added 0.5–3 percent magnesium silicide ($SiMg_2$), 0.1–1.0 percent molybdenum or zirconium, uranium, or tungsten or 0.1–0.5 percent titanium.[23] An American patent[24] covers "alloys of good hardness" containing nickel with 8–30 percent molybdenum; an Austrian patent[25] covers a "refractory metallic composition composed of molybdenum treated with a small quantity of silicate, borate, or fluoride of the akali or akali earth metals"—just as lead is hardened by these metals; and a British patent provides for temperable alloys of copper, nickel, and one or more of the metals iron, chromium, molybdenum, cobalt, manganese, vanadium, or tungsten.[26]

[20] N. V. Machinerieen-en Apparaten Febricken: British Patent 396331, Aug. 3, 1933.
[21] Highland Iron & Steel Co., Terre Haute, Ind., assignee of F. H. Dechant, Reading, Pa.: British Patent 372915; Metal Ind. (London), vol. 42, no. 2, Jan. 13, 1933, p. 87.
[22] Gregg, J. L., Alloys of Iron and Molybdenum: Monograph, Battelle Memorial Institute as a part of the Institute's contribution to alloys of iron research; 1st ed., 1932, 507 pp., 154 figs. (mostly diagrams, a few photomicrographs and photographic reproductions).
[23] Aluminum Co. of America, Aluminum Alloys (Alliages d'Aluminium): U.S. Patents 1911079, 1911080, 1911081, 1911082, and 1911083. Dem. Nov. 30, 1932, del. May 23, 1933. Chim. et Ind., vol. 30, no. 4, October 1933, p. 587 D.
[24] Köster, Werner, to Vereinigte Stahlwerke A.-G.: U.S. Patent 1924244, Aug. 29, 1933.
[25] Watti. A. G., Austrian Patent 129950: Refractories Jour. (London), 9th year, no. 5, 1933, p. 208.
[26] Vereinigte Deutsche Metallwerke A. G.: British Patent 395720, July 21, 1933.

Illium[27] (60.5–62.5 percent Ni, 21.0 Cr, 6.5 Cu, 4.7–5 Mo, 2 W, 1 each of Mn, Si, Al, and Fe, with smaller quantities of Ti, B, and C) is used as a thermocouple with constantin (konstantin) and in high-pressure and turbine pumps.

## MOLYBDENUM INVESTIGATIONS

"A very few elements constitute all save a minute fraction of the material of which plants and animals are made; but the small residuum contains a considerable, even a large number of elements, stored up and accumulated by the organism and so present in larger amount than in the surrounding medium,"[28] but they may be very necessary, like iodine, phosphorus, iron, etc. The investigator, ter Meulen, who is quoted, found 21 parts of molybdenum in a million of coal; from that he tested various plants and vegetable products and always found very small quantities present. The largest quantities were found in peas and beans, 3 to 9 parts in a million. In a fertile soil he found 0.1 to 0.3 part per million. Minute quantities also were found in spring water, petroleum, and animal tissues. H. Bortels is quoted as finding that *Azobacter chroococcum*, which fixes atmospheric nitrogen, needs molybdenum for healthy growth.

W. A. Roach[29] adds that certain grafted apple trees had molybdenum in the rootstock but none in the wood of the graft.

It seems possible that under certain circumstances molybdenum, like zinc, manganese, magnesium, etc., may be found beneficial in fertilizers.

The preparation and properties of the permolybdates $Na_2MoO_6$ and $Na_2MoO_8$ were investigated by Kobozev and Sokolov.[30] R. C. Evans[31] studied ionization of potassium on a hot molybdenum surface.

Molybdenum and its salts are patented as catalysts in the manufacture of unsaturated ethers from acetals.[32]

The use of tungsten-molybdenum thermocouples was investigated by Osann and Schröder,[33] and a potentiometric determination of molybdenum in steel is described by Dickens and Brennicke,[34] its determination in steel by precipitation as "Johnson's Molybdenum Red" (a compound with cinchonine) by C. M. Johnson,[35] and von Hevesy and Hobbie discuss its determination in rocks.[36]

The treatment of coppery molybdenum ores by heating with sulphuric acid with subsequent solution of the anhydrous copper sulphate was patented by H. Morgan.[37] The separation of molybdenum, tungsten, and vanadium from ores by volatilization as oxychlorides was also patented.[38]

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[27] Metal Industry (London), Illium: Vol. 43, no. 2, July 14, 1933, p. 38.
[28] ter Meulen, H., Distribution of Molybdenum: Nature, London, vol. 130, Dec. 24, 1932, p. 966.
[29] Roach, W. A., Distribution of Molybdenum: Nature, London, vol. 131, Feb. 11, 1933, p. 202.
[30] Kobozev, N. I., and Sokolov, N. N., Ztschr. anorg. allgem. Chem., vol. 214, 1933, pp. 321–9; Chem. Abs., vol. 28, Jan. 10, 1934, p. 64.
[31] Evans, R. C., The Surface Ionization of Potassium on Molybdenum: Proc. Cambridge Phil. Soc., vol. 29, 1933, pp. 522–7; Chem. Abs., vol. 28, Feb. 10, 1934, p. 704.
[32] Bauer, Karl, to I. G. Farbenind. A. G.: U.S. Patent 1931858, Oct. 24, 1933.
[33] Arch. Eisenhüttenw., vol. 7, 1933, pp. 89–94.
[34] Mitt. Kaiser Wilh. Inst. Eisenforsch., vol. 14, 1932, pp. 249, 259; Chem. and Ind., vol. 52, Nov. 3, 1933, p. 870.
[35] Johnson, C. Morris, New Method for Determining Molybdenum in Alloy and Plain Steels: Iron Age, vol. 132, no. 2, July 13, 1933, pp. 16–17.
[36] Hevesy, G. v., and Hobbie, R., Determination of Molybdenum and Tungsten in Rocks: Ztschr. anorg. allgem. Chem., vol. 212, 1933, pp. 134–44; Chem. Abs., vol. 27, no. 14, July 20, 1933, pp. 3418–9.
[37] U.S. Patent 1895811, Jan. 31, 1933.
[38] Herold, Paul, and Krajewski, Gustav A., to I. G. Farbenind. A. G.: U.S. Patent 1911505, May 30, 1933; Chem. Abs., vol. 27, Aug. 20, 1933.

The Vereinigte Stahlwerke A. G. obtained a French patent [39] on the introduction of molybdenum and other metals into alloy steels by adding them to the slags.

During the year G. Burrows [40] described a resistance furnace heated by four molybdenum strips in an alumina tube by which a temperature of 1,850° C. was attained in an alundun tube surrounded by the resistors; Cournot and Challansonnet [41] described cast-iron containing as much as 3 percent Mo; Gillett and Gregg [42] discussed small quantities of molybdenum in steel castings; and J. E. Hurst [43] reviewed recent investigations on molybdenum-, tungsten-, and titanium-bearing cast irons.

## REVIEW OF INDUSTRY, BY STATES

*Arizona.*—At Nogales, Hugo W. Miller recovered a small tonnage of molybdenite concentrates from old tailings. In the Old Hat district near Mammoth, about 40 miles northeast of Tueson, the Molybdenum Corporation of America (500 Fifth Avenue, New York) took over and began mining the old Mohawk mine, once mined for gold, and the adjoining New Year claim which is mined by a subsidiary, the Molybdenum Gold Mining Co. Both claims have wulfenite with some vanadinite and other vanadium lead minerals, the oxidation products of galena-bearing veins. The country rock is andesite. The concentrates carry enough gold to be of economic interest. A large stope in the Mohawk is spectacular, as the light is reflected from thousands of faces of wulfenite and vanadinite crystals on the walls and roof. A small lot of wulfenite concentrates carrying 26 percent $MoO_3$ was produced by a lessee on the Mohawk claim.

At Copper Creek, about 6 miles east of Mammoth, the Childs molybdenite property, which has been prospected for a number of years, was operated by the Arizona Molybdenum Corporation (433 South Spring Street, Los Angeles, Calif.), and 62 short tons of molybdenite concentrates carrying 94 percent $MoS_2$ were produced. The ore carries some chalcopyrite.

Some work was done by the R. C. Huffman Construction Co.[44] (Cleveland, Ohio) for wulfenite and vanadinite on the Escapule claims in the Dragoon Mountains, but no production was made.

Near Gila Bend the Rowley claims were worked for wulfenite by A. H. Stout (Hayden Junction), and 15 short tons of concentrates carrying 25 percent $MoO_3$ were produced. L. Hovestadt (Hayden Junction) produced a small lot of wulfenite concentrates carrying about 26 percent $MoO_3$ from the 79 mine. The Kullman McCool Mining Co. (Tucson) produced 4 short tons of wulfenite concentrates, averaging 20 percent $MoO_3$, in Gila County near Hayden Junction.

*California.*—Herbert Salinger (112 Market Street, San Francisco) produced a small quantity of molybdenite concentrates from slime

[39] French Patent 752211, Sept. 19, 1933; Chem. Abs., vol. 28, Feb. 10, 1934, p. 734.

[40] Burrows, G., Molybdenum-Resistance Furnace of New Design: Jour. Sci. Instruments, vol. 10, no. 8, 1933, pp. 248–250; Ceram. Abs., vol. 13, no. 1, January 1934, p. 19.

[41] Cournot, J., and Challansonnet, J., Effect of Molybdenum on Cast Iron: Rev. Mét., vol. 30, 1933, pp. 260–265; Chem. and Ind. (London), vol. 52, no. 44, Br. Abs., Nov. 3, 1933, p. 869.

[42] Gillett, H. W., and Gregg, J. L., Molybdenum in Steel Castings: Foundry, vol. 61, 1933, pp. 27, 59–60; Chem. Abs., vol. 27, Sept. 20, 1933, p. 4508.

[43] Hurst, J. E., The Influence of Molybdenum, Tungsten and Titanium on Cast Iron: Iron and Steel Ind., vol. 6, 1933, pp. 205–208, 269–273, 315–316; Chem. Abs., vol. 27, no. 22, Nov. 20, 1933, p. 5698.

[44] Mining Journal (Phoenix, Ariz.), vol. 17, Jan. 15, 1934, p. 17.

middlings of the Pine Creek tungsten mine, 20 miles northwest of Bishop, Calif. The deposit is a tactite (contact metamorphosed limestone) at about 11,000 feet altitude and formerly was worked for scheelite which carried 2.4 to 2.8 percent molybdenum.

*Colorado.*—The Climax Molybdenum Co. property at Climax continues to be the world's premier molybdenum mine, both as to ore reserves and production, and produces the greatest daily tonnage of ore of any mine in Colorado. During 1933, 692,985 short tons of ore were mined and milled, containing 0.728 percent $MoS_2$ (0.437 percent Mo, or 8.74 pounds of molybdenum per ton), somewhat less than the average (0.85 percent $MoS_2$, 10.2 pounds of molybdenum per ton) of the 100,000,000 tons in reserve. The ore mined contained a total of 6,053,917 pounds of metal. From it were produced 4,624 short tons of concentrates carrying 90.63 percent $MoS_2$, or 54.38 percent Mo—a total of 5,028,695 pounds of metallic molybdenum and a recovery of 83.07 percent.

The oval "doughnut-shaped" ore body (as its cross-section is aptly called by Alan Kissock)[45] is 4,000 feet long and 3,000 feet wide with a quartz center probably formed by the continuous flow of quartz-bearing solutions which moved outward the molybdenite already deposited there. The huge size of the ring or shell, which is 465 feet thick on the side and 1,000 feet thick at the ends [46] with a maximum known depth of more than 1,100 feet, allowed a spectacular blast to be put in during the year. It was fired May 24. The volume of ore mined for the blast was 425 feet long, 150 feet wide, and 250 feet high. More than 55 tons of explosive, including 29,900 pounds of 50-percent and 26,300 pounds of 60-percent gelatin and 54,300 pounds of Gelex No. 2 were used. It was thought that 350,000 tons of ore was broken and 500,000 more would be broken by caving, thus giving a total breakage of about 8 tons of ore per pound of explosive. The ore is drawn through a grizzly with 3-foot openings and fed to a 48- by 60-inch jaw crusher. Concentration is by flotation. The improvements at the mine included the following: A concrete bunkhouse was erected at a cost of about $75,000; a new trolley-type electric motor weighing 19 tons, capable of hauling 300 tons or more of ore, was ordered; and a drying room for concentrates was erected at a cost of $45,000. A safety instructor was employed and every employee is required to take a course in first-aid training.[47]

Butler and Vanderwilt have published several papers on this huge deposit, the latest and most complete of which was issued by the United States Geological Survey at the end of 1933.[48] It is accompanied by excellent maps, cross-sections, and photographs. They received full cooperation from the Climax Molybdenum Co. and quote records of diamond drilling.

The occurrence of quartz-porphyry dikes 75 to 200 feet wide cutting through the granite and the deposit itself may be of significance as to the origin of the molybdenite. Similar dikes are found with molybdenite in other places. The molybdenum produced from the Climax property to the end of 1933 is as follows.

[45] Kissock, Alan, Molybdenum: Its Mining, Milling, and Uses: Min. and Met., vol. 14, April 1933, p. 181.
[46] Coulter, William J., and Romig, W. E., A Record Underground Blast: Eng. and Min. Jour., vol. 134, 1933, pp. 405–409. They refer to the ore body as a whole, also aptly, as "watermelon-shaped," the quartz center representing the core.
[47] Mining Journal (Phoenix, Ariz.), vol. 17, Dec. 30, 1933, p. 13.
[48] Butler, B. S., and Vanderwilt, J. W., The Climax Molybdenum Deposit, Colorado: U.S. Geol. Survey Bull. 846–C, 1933, pp. 195–237; history and production by Chas. W. Henderson, pp. 198–201.

*Molybdenum (element) contained in concentrates produced from the Climax deposit, Colorado, 1918–33* [1]

| Year: | Pounds | Year: | Pounds |
|---|---|---|---|
| 1918 | 342, 200 | 1928 | 2, 957, 845 |
| 1919 | 152, 648 | 1929 | 3, 529, 295 |
| 1924 | 156, 935 | 1930 | 3, 083, 000 |
| 1925 | 821, 757 | 1931 | 2, 644, 399 |
| 1926 | 1, 057, 367 | 1932 | 1, 913, 395 |
| 1927 | 1, 858, 228 | 1933 | 5, 028, 695 |

[1] None produced, 1920–23, inclusive.

The company has a plant at Langeloth, near Pittsburgh, Pa., to which concentrates are shipped for treatment to make calcium molybdate, ferromolybdenum, and other molybdenum compounds. In 1933 approximately four-fifths of the company output was shipped in oak kegs holding about 550 pounds each, via Galveston, to Europe.

The only other known operation on a molybdenum-bearing property in Colorado was at Fraser, where Fred Burrell was engaged in driving a tunnel to cut a molybdenite-bearing vein.

A paper on the long-known molybdenite-bearing pegmatitic quartz vein on Browns Creek, south slope of Mt. Antero, Chaffee County, was read by Kenneth K. Landes before the Geological Society of America at its December meeting in Chicago.

*Nevada.*—The California Molybdenum Corporation (727 West Seventh Street, Los Angeles) did development work at its wulfenite deposits on the Shenandoah Claim near Goodsprings, Nev., but made no production during 1933. A flotation mill and an aerial tramway from the mine to the mill were built,[49] and a well was drilled near Sandy in the Pahrump (Mesquite) Valley 3 miles from the mill. From 8 to 16 men were employed.

The mine is thought to contain 250,000 tons of ore carrying 2 to 3 percent molybdenum. The mill was to be ready to run about the first of 1934.

*New Mexico.*—The principal molybdenum mine of New Mexico is that of the Molybdenum Corporation of America in Sulphur Gulch, a tributary of Red River, 7 miles east of Questa, Taos County. It is at an altitude of 8,700 feet.

Molybdenite is mined from very irregular narrow veins, in and mostly near the margins of a mass of porphyritic alaskite, intruded into porphyritic granodiorite. In places the molybdenite forms solid masses weighing some pounds. The veins also carry quartz, sericite, fluorite, pyrite, chalcopyrite, and small quantities of rhodochrosite, biotite, chlorite, and calcite—an assemblage of minerals indicating only moderately high temperature of the ore-bearing solutions. No veins of economic value have been found in the granodiorite.

J. B. Carman [50] estimated the production of the mine from the beginning in 1918 to the end of 1931 as approximately 5,000,000 pounds of molybdenite ($MoS_2$), containing 3,000,000 pounds of elemental molybdenum; in 1932 and 1933 more than 1,000,000 pounds of molybdenum were produced.

From the mine the concentrates, carrying about 75 percent molybdenite (45 percent Mo), are in part shipped to the company smelting

[49] Mining Journal (Phoenix, Ariz.), Sept. 30, 1933, p. 15, and Oct. 15, 1933, p. 15.

[50] Carman has described the geology of the mine and more fully the mining and milling methods in the following excellent papers: 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.

plant at Washington, Pa., for conversion to calcium molybdate (Molyte) and ferromolybdenum; part is shipped to the company chemical plant at York, Pa., to be manufactured into ammonium molybdate; and a larger part is shipped to Europe.

The Hercules Molybdenum Corporation, which has claims between Questa and Sulphur Gulch, did not operate during 1933.

*Texas.*—A little prospecting for molybdenite was done, 14 miles southeast of Llano, Tex., by John Block (Llano). For many years molybdenite has been known to occur in the old crystalline rocks of this area but not in commercial quantity.

*Utah.*—Egidio Carnesecca (Utah Molybdenum Co., Springville, Utah) was developing a deposit of molybdenite in Millard County 50 miles southwest of Delta during the year.

*Washington.*—Molybdenite-bearing deposits were reported under development during 1933 in Washington on the Monitor claims near Fruitland, owned by the Deertrail Monitor Mines (409 Metals Building, Spokane), where a drift 300 feet below the outcrop is said to have been driven 400 feet; on the Egypt claim near Davenport (A. S. Newell, Fruitland, in charge); on Cougar Creek, 23 miles east of Snoqualmie Falls, where claims are owned by Cascade Mines, Inc., and Cougar Creek Mines, Inc. (both in Exchange Building, Seattle); and at Goose Prairie where the Tungsten Co. of America (The Dalles, Oreg.) prospected an occurrence of molybdenite found in doing work on its tungsten (scheelite) deposit. John Crosetti (Goose Prairie) is interested in other molybdenite deposits near Goose Prairie. Some work is said to have been done on the property of the Acme Molybdenum Association (Box 187, Seattle) on Railroad Creek near the north end of Lake Chelan. Probably few molybdenum properties in the West have been known for a longer time; a small production was made from it some years ago.

## FOREIGN TRADE [51]

The United States, being by far the largest producer of molybdenum concentrates in the world, is an exporter. Figures showing the exact quantity shipped are not available, but in round numbers four-fifths of the domestic output was exported in 1933. Imports during the past 10 years are shown in the following table:

*Ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum imported for consumption in the United States, 1924–33*

| Year | Molybdenum content (pounds) | Value | Year | Molybdenum content (pounds) | Value |
|---|---|---|---|---|---|
| 1924 | 431 | $802 | 1929 | 1,627 | $2,384 |
| 1925 | 274 | 1,184 | 1930 | 144,963 | [1] 283,846 |
| 1926 | 604 | 987 | 1931 | 210,766 | [1] 213,660 |
| 1927 | 1,657 | 5,712 | 1932 | 44 | 89 |
| 1928 | 576 | 1,385 | 1933 | 40 | 158 |

[1] Average value: 1930, $1.96; 1931, $1.01.

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

The normal foreign steel trade does not seem to be large enough to warrant in itself the large exports of molybdenum, yet at least one foreign buyer came to this country during the year to buy molybdenum- and nickel-scrap materials.[52] Other materials, such as scrap iron and steel, nitrate of soda, copper, manganese ore, and tungsten ore, usable in the manufacture of war materials have also been bought by a number of foreign countries in quantity far beyond apparent present needs.

The production of molybdenum in Mexico and Morocco and the increased production in Norway, together with that of other small producers who may be induced to begin mining molybdenum ore through the apparent present prosperity of the business, may within a year or two cut severely into the foreign trade of American producers.

*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

As far as figures are available the world production of molybdenum ores from 1931 to 1933 is shown in the following table:

*World production of molybdenum ores and concentrates, 1931–33*

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

| Country | Mineral | Concentrates | Percent $MoS_2$ | Contained molybdenum | Value |
|---|---|---|---|---|---|
| 1931 | | *Metric tons* | | *Metric tons* | |
| Australia: | | | | | |
| New South Wales | Molybdenite | 0.3 | (1) | (1) | $245 |
| Queensland | do | .3 | (1) | (1) | 218 |
| Canada | do | (1) | (1) | 0.6 | 270 |
| Chosen | do | 23.9 | (1) | (1) | 12,377 |
| Mexico | do | (1) | (1) | 3.4 | 6,789 |
| Morocco, French [2] | do | 4.6 | (1) | (1) | 3,136 |
| Norway | do | 223 | 77 | 103 | 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 | 3.6 | (1) | (1) | 3,423 |
| Queensland | do | 1.6 | (1) | (1) | 1,038 |
| Chosen | do | 44.7 | (1) | (1) | 15,640 |
| Mexico | do | (1) | (1) | 3.1 | 4,342 |
| Morocco, French [2] | do | .1 | (1) | (1) | 4 |
| Norway | do | 329 | 80 | 157.9 | 262,000 |
| Peru | do | (1) | (1) | 4.6 | 3,114 |
| United States | do | 2,165 | 84.89 | 1,103 | 1,216,000 |

[1] Data not available.
[2] Exports.

[52] American Metal Market, vol. 40, Dec. 23, 1933, p. 5.

*World production of molybdenum ores and concentrates, 1931–33*—Continued

| Country | Mineral | Concentrates | Percent $MoS_2$ | Contained molybdenum | Value |
|---|---|---|---|---|---|
| 1933 | | *Metric tons* | | *Metric tons* | |
| Australia: | | | | | |
| New South Wales | Molybdenite | (1) | (1) | (1) | (1) |
| Queensland | do | (1) | (1) | (1) | (1) |
| Chosen | do | (1) | (1) | (1) | (1) |
| Mexico | do | (1) | (1) | (1) | (1) |
| Morocco, French [2] | do | 120 | (1) | (1) | (1) |
| Norway | do | 415 | (1) | (1) | (1) |
| Peru | do | (1) | (1) | (1) | (1) |
| United States | do | 4,833 | 88.82 | 2,574.3 | $4,252,000 |
| | Wulfenite | 19 | (3) | 3 | 1,800 |

[1] Data not available.
[2] Exports.
[3] Average content of $MoO_3$ reported as 15.97 percent.

*Australia.*—Molybdenite has been produced in small quantity in New South Wales since 1901 from the Kingsgate and Deepwater districts 20 miles northeast of Glen Innes. The molybdenite is found in pegmatitic pipes with bismuth, cassiterite, and other metallic minerals. A mass of pure molybdenite weighing more than a ton was found at one time.[53]

To the end of 1932, 988 short tons of concentrates valued at $1,187,000 had been produced and sold.

The Bow Creek and Allies properties at Deepwater were worked in a small way during 1933.

Molybdenite occurs in all the States of Australia, but the principal production in the past has been in Queensland and New South Wales. Prior to 1916 Queensland produced 70 percent of the world's supply, and New South Wales, 25 percent. In 1915 the Queensland output was 97½ tons valued at £45,060, and the New South Wales output 31.70 tons valued at £16,937.

The difficulty with regard to Australian molybdenite ore and concentrates has been the fact that, with one or two exceptions during the last 30 years, only spasmodic parcels varying between a few hundred pounds and five tons have become available at very irregular intervals. During 1905 to 1920 there was, in the aggregate, a steady output from New South Wales and Queensland—the former varying between 20 and 80 tons, and the latter between 60 and 120 tons, but since then the only producer showing any regularity whatever was the Standard Molybdenite Co., of Victoria, which produced about 40 tons in each of the years 1923 to 1926. This producer is closed down at present.

Molybdenite from the New England district, New South Wales, consisting of huge flakes of practically pure mineral, was shipped to London during the latter part of last century, and the first few years of this, and Australian molybdenite was considered the standard of the world. The position today, however, is changed, and Australian producers are faced with the fact that all the important users of molybdenite throughout the world now associate themselves with productions which are thoroughly well established, and the grade and mechanical condition of which can be relied upon. Such a condition is, of course, the chief essential of ny process company.

The Australian deposits have not been exhausted by any means, though actual reserves of ore in sight are not extensive. A strong company with a good mine, equipped with modern treatment plant which would purchase ore and concentrates from small producers, should be able to hold its own in the world market, particularly if it were able to arrange contracts for the supply of stipulated quantities to some of the principal European consumers.[54]

[53] Chem. Eng. and Mining Rev. (Melbourne), vol. 25, Jan. 5, 1934, pp. 217–218.
[54] Chem. Eng. and Mining Rev. (Melbourne), work cited.

*Canada.*—The Phoenix Molybdenite Corporation has been prospecting molybdenite deposits at Bagot, Renfrew district, Ontario, and is said to have three veins, one of which has been followed for 1,700 feet. Plans were said to be matured for a mill.[55]

The occurrences of molybdenite in Nova Scotia were described by J. P. Meservy,[56] and an occurrence at Square Lake, New Brunswick, was described by E. Poitvin.[57]

*China.*—Some molybdenite occasionally is shipped from China, but little has been published about the occurrences. It is reported that the principal deposits are at Ning-te and Yung-tai-hsien in Fou-kien and at Ching-hsien in south Che-kiang. The deposits are said to be in pegmatites and metamorphosed granites.[58] Other occurrences, probably of only mineralogical value, are reported in Shantung, Kwangsi, and Kiangsi.[59]

*Kenya.*—The Molite Syndicate of Nairobi, Kenya Colony, British East Africa, has been formed to exploit molybdenite deposits in the Colony. In a report dated August 25, 1933, Leo J. Callanan, American consul at Nairobi, says:

> The Molite Syndicate has opened up a molybdenite deposit on a group of claims comprising some 500 acres in the Yala district, Central Kavirondo, Kenya, British East Africa. Transportation facilities are afforded by the Kisumu-Yala-Butere Railway of the Kenya Uganda Railways which traverses the property and by a Government-maintained road 2 miles to the east. Timber, water, labor, and other conditions are reported as favorable, and hydroelectric power can be readily developed. According to the engineer's report "Molybdenite occurs in veins, impregnations, also massive, foliated and finely distributed through and as contact deposits in syenite." Iron sulphide and traces of millerite accompany molybdenite on the west side of the ore body. The ore body is said to be of good width and probably at least 2 miles long.

*Mexico.*—Mexico has many known occurrences of molybdenite and at present gives promise of being the largest producer outside the United States.

During the Great War very pure molybdenite was shipped from the San Julian mine (owned by Frank Fast, Douglas, Ariz.) in the Tonichi district near La Trinidad, Sonora, and since then small quantities have been shipped from time to time from it and from other parts of Mexico.

Molybdenite usually is found, at least in small quantity, with all large copper sulphide deposits and has been known for many years on the property of the Cananea Consolidated Copper Co. at Cananea. It has been found all through the great Colorada ore body and forms about 0.25 percent of the ore mined. The ore body is a brecciated pipe in quartz-porphyry. Alone, the molybdenite would not pay for mining, but it can be floated from the finely crushed tailings, and the concentrate thus made carries 98.5 to 99 percent $MoS_2$—probably the purest molybdenite on the market. The first shipment of concentrates was made in May, to Great Britain.[60] It is estimated that 800 tons of contained molybdenum in concentrates can be shipped annually. Thirty tons of concentrates are said to have been shipped in 1933.

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55 Northern Miner (Toronto), quoted by Metal Bull., Mar. 31, 1933, p. 15.

56 Meservy, J. P., Molybdenum in Nova Scotia: N.S. Dept. Pub. Works and Mines Pamph. 19, Ann. Rept. for 1932, 1933, pp. 199–210.

57 Poitvin, E., The Occurrence of Wolframite, Molybdenite, and Other Minerals at Square Lake, Queens County, New Brunswick: Geol. Survey Canada Sum. Rept. 1932, Part D, 1933, pp. 56d–57d.

58 Kuklops, M., La Chine: Mines Carrières, vol. 12, September 1933, p. 3.

59 T. F. Hou, General Statement on the Mining Industry, 1929, table 20. The text is in Chinese.

60 American Metal Market, vol. 40, May 16, 1933, p. 2.

*Morocco.*—In the Atlas Mountains, Azegour district, 12 miles from Amismiz, south of Marrakech, Morocco, Société de Recherches Minières du Falta, Paris, and Société le Molybdène of Geneva, Switzerland, are exploiting a molybdenite deposit discovered a few years ago, in contact metamorphosed limestone. The mines are at an altitude of 1,525 meters (5,003 feet), in an excellent climate.

Molybdenite is known in many tactites (contact metamorphosed rocks) but seldom in economically valuable quantity, although it has been mined at several places in the Santa Rita Mountains near Patagonia, Ariz., at Quyon, Quebec, and, as previously stated, a small output was made at the Pine Creek mine near Bishop, Calif.; the deposits near La Trinidad, Mexico, may be of the same type. At Azegour the limestone beds (shown by the illustrations to be rather thinly bedded) stand on edge.[61] They are intruded by granite, quartz-porphyry, and basic dikes. In such deposits ore bodies usually are very irregular and uncertain, but at Azegour it is said that operations to date indicate large reserves of ore.[62] The deposit has been followed for 3.5 kilometers (2¼ miles).[63] and reaches a width of 20 meters (66 feet). Masses of pure molybdenite are said to have reached a cubic meter (35 cubic feet) in size. The molybdenite is accompanied by chalcopyrite, which must be separated during flotation. Zinc and lead minerals also are found in the tactite but are said to be separate from the molybdenite.

One ton of molybdenite was produced from the property in 1929, 10 tons in 1930, and then it lay idle for 2 years.[64]

A Krupp-Grusonwerk flotation mill with a daily capacity of 100 tons of mine ore was erected by Société le Molybdène and began operation early in 1933. It produces monthly about 25 tons of concentrates, carrying 85 percent $MoS_2$, from hand-picked ore. The feed averages 1.08 percent $MoS_2$ and 0.05 percent copper. The ratio of concentration is 1:79. Copper in the concentrates must not exceed 0.4 percent. Concentrates are shipped in iron barrels.

A study of the opaque minerals has been made by Galopin.[65] He describes the molybdenite and the accompanying minerals—chalcopyrite, hematite, linnaeite, sphalerite, arsenopyrite, löllingite, galena, pyrite, pyrrhotite, and magnetite—all of which are present in small quantity only. In a thesis on the deposits R. E. Grosclaude [66] reports that in laboratory tests he found that the best separation of molybdenite was made by floating with cresol and some sulphuric acid. Lodane [67] has described the flotation practice of the plant.

*Norway.*—In 1933 Norway produced 415 metric tons of molybdenum concentrates, making the reported total to the end of the year 3,427 metric tons of concentrates averaging about 80 percent $MoS_2$ (48 percent Mo).

The Knaben mine in southern Norway, 25 miles from Flekkefjord, is the only known producer in Norway and, except for 4 years, has been operated since 1901. The ore averages about 0.5 percent

[61] Heim, Arnold, The Molybdenum Mine at Azegour, Morocco: Econ. Geol., vol. 29, January 1933. pp. 76–82.
[62] Engineering and Mining Journal, Floating Molybdenite in Morocco: Vol. 135, no. 2, 1934, p. 58.
[63] Heim, Arnold, work cited, p. 80.
[64] La Chronique des mines coloniales (Maroc), Year 2, no. 14, Paris, 1933, p. 263.
[65] Galopin, R., Esquisse d'Étude sur les mineraux opaques du gisement d'Azegour (Maroc): Sci. Phys. et Nat. Archives, Period 5, vol. 15, Geneva, 1933, sup. pp. 164–168.
[66] Grosclaude, R. E., Étude du gisement de molybdénite d'Azegour (Maroc): Work cited, pp. 93–126.
[67] Lodane, G., La Flotation de la molybdenite à Azegour (Maroc): Mineral. u. Petrogr. Mitt., vol. 13, no. 2, Zurich, 1933, pp. 397–404.

$MoS_2$. It is owned by the Knaben Molybdenite Mines, Ltd., Oslo. The output for the past 4 years has been:[68]

*Molybdenum concentrates produced at the Knaben mine, Norway, 1930–33*

| Year | Concentrates produced | | Molybdenum contained | |
|---|---|---|---|---|
| | Metric tons | Percent $MoS_2$ | Metric tons | Percent |
| 1930 | 284 | 75 | 128 | 45.0 |
| 1931 | 223 | 77 | 103 | 46.2 |
| 1932 | 329 | 80 | 158 | 48.0 |
| 1933 | 415 | 80 | 199 | 48.0 |

*U.S.S.R. (Russia).*—Little is known of the molybdenum deposits in Soviet Russia, but it may be taken for granted that every country having extensive areas of deep-seated igneous rocks will have at least mineralogical occurrences of the element.

An abstract [69] of an article by V. P. Kullanda and K. V. Landsberg refers to ores from the Khibin Peninsula carrying 0.7 to 2.65 percent Mo, which were tested for flotation processes. By the use of 0.25 to 1.0 kilogram of kerosene and 0.1 kilogram of pine tar per ton and repetition four times of the process, a concentrate carrying 30 percent Mo (50 percent $MoS_2$) was obtained.

The presence of molybdenite in the Kuznetsk Alatau ores has been noted by V. Domarev.[70]

The Zestofan Ferroalloys Combinat was reported to be erecting at Zestofan in southern Russia a ferro-alloy plant which would produce annually among other alloys, 300 tons of ferromolybdenum.[71]

The Moscow News for January 27, 1934, carries the following item on page 9:

> The first Ural molybdenum ore has been obtained at a depth of 140 meters (455 feet) in the Archangel mine near Nadezhdinsk. The discovery of molybdenum deposits in Nadezhdinsk is of great importance. Walter, a foreign specialist, having examined the first data, declared that the Nadezhdinsk ore contains up to 5 percent of molybdenum and will be of great industrial importance, since it will provide, after enrichment, a most valuable raw material for the smelting of ferromolybdenum. The first lot of ore, 15 tons, was sent a few days ago to the Chelyabinsk Iron-Smelting Plant, which is now carrying out experimental smelting of ferromolybdenum.
>
> The workers of the Nadezhdinsk and Chelyabinsk Iron-Alloy Factories are preparing as a present to the 17th Party Congress the first tons of molybdenum alloy from the ore obtained near Nadezhdinsk.

[68] Letter, H. H. Smith, Oslo, dated Mar. 3, 1934.
[69] Chemical Abstracts, vol. 27, 1933, p. 3174.
[70] Domarev, V., Presence of Molybdenite in the Ores of the Kuznetsk Alatau Deposits: Russia Geol. Com. Bull. (Isvestia), vol. 48, 1929 (in Russian).
[71] Quoted by G. C. Ridell from the Moscow News.

# TUNGSTEN

By Frank L. Hess

## SUMMARY OUTLINE



The most notable features of the general tungsten situation during 1933 were the movements in prices. During the early part of the year world prices for concentrates were the lowest in the history of the tungsten trade, but they increased so greatly that by the end of the year, even allowing for the debasement of American currency, they were about 175 percent higher and in the cheaper money more than 300 percent higher. This general rise in price, due in part to the munitions value of tungsten, was reflected in increased American prices, and American production rose accordingly.

*Salient statistics of the tungsten industry in the United States, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| Concentrates shipped (60 percent $WO_3$) | 396 | $218,394 | 895 | $514,234 |
| Imported for consumption (W content) | 53 | 30,700 | 190 | 108,089 |
| Stocks in bonded warehouses, Dec. 31: | | | | |
| Ore (W content) | 537 | 238,553 | 449 | 214,194 |
| Metal (W content) | 40 | 33,725 | 12 | 10,855 |

*Prices.*—Prices as quoted in the Mining Journal of London and the Engineering and Mining Journal of New York on the first of each month and the last of December, or in the issues nearest to those dates, are given in the following table as representing world prices and domestic prices, respectively. As London prices for concentrates are quoted for the long-ton unit of 22.4 pounds of tungsten trioxide ($WO_3$) they are changed to an equivalent price on the short-ton unit of 20 pounds. The value for the British pound is taken from the monthly averages in the Federal Reserve Board Bulletin.



69174—34——29

*London and New York prices for tungsten concentrates and products*

| Month | Tungsten concentrates: London, 65-percent $WO_3$: Long-ton unit (22.4 pounds $WO_3$) | Tungsten concentrates: London, 65-percent $WO_3$: Equivalent price for short-ton unit (20 pounds $WO_3$) | Tungsten concentrates: New York 60-percent $WO_3$ short-ton unit (20 pounds $WO_3$) | Ferrotungsten—per pound of contained tungsten (W): London 80-percent W standard | | Ferrotungsten—per pound of contained tungsten (W): New York 75-percent W standard | Tungsten powder—per pound of contained tungsten (W) (98-percent or more W): London | | Tungsten powder—per pound of contained tungsten (W) (98-percent or more W): New York | Sodium tungstate domestic C.P. per pound (1,000-pound lots) | Average value of British pound in United States dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1933: | *s. d.* | | | *s. d.* | | | *s. d.* | | | | |
| January | 10 3 | $1.54 | $9.50–$9.85 | 1 7½ | $0.273 | $0.94–$1.00 | 1 10½ | $0.315 | $1.45 | | $3.36 |
| February | 9 9 | 1.49 | 9.65– 9.85 | 1 7½ | .278 | .94– 1.00 | 1 10½ | .321 | 1.45 | | 3.42 |
| March | 10 3 | 1.56 | 9.65– 9.85 | 1 10½ | .309 | .94– 1.00 | 1 7½ | .279 | 1.45 | | 3.43 |
| April | 10 3 | 1.64 | 9.65– 9.85 | 1 7½ | .276 | .94– 1.00 | 1 10½ | .336 | 1.45 | | 3.58 |
| May | 10 9 | 1.88 | 9.60– 9.75 | 1 6 | .283 | .94– 1.00 | 1 9 | .344 | $1.25–1.45 | $0.50 | 3.93 |
| June | 10 6 | 1.94 | 10.00–10.25 | 1 6 | .298 | .94– 1.00 | 1 9 | .362 | 1.25–1.45 | .50 | 4.14 |
| July | 13 3 | 2.75 | 10.10–10.25 | 1 6 | .349 | .94– 1.00 | 1 9 | .407 | 1.25–1.45 | .50 | 4.65 |
| August | 17 0 | 3.42 | 12.00–12.25 | 1 9 | .394 | 1.05– 1.20 | 2 0 | .450 | 1.25–1.45 | .65 | 4.50 |
| September | 17 9 | 3.69 | 12.00–12.50 | 1 9 | .408 | 1.05– 1.20 | 2 0 | .483 | 1.25–1.40 | .65 | 4.66 |
| October | 25 0 | 4.79 | 12.00–12.50 | 2 0 | .467 | 1.05– 1.20 | 2 3 | .525 | 1.25–1.40 | | 4.67 |
| November | 26 0 | 5.87 | 12.25–12.50 | 2 6 | .644 | 1.05– 1.20 | 2 9 | .708 | 1.50–1.75 | .65 | 5.15 |
| December 1 | 25 0 | 5.79 | 14.25 | 2 6 | .640 | 1.15– 1.25 | 2 9 | .704 | 1.50–1.75 | | 5.12 |
| December 31 | 27 6 | 6.29 | 14.50–15.00 | 2 6 | .640 | 1.15– 1.25 | 2 9 | .704 | 1.60–1.75 | | 5.12 |
| Equivalent price, Dec. 31 in gold standard of Jan. 1, 1933 | | 4.13 | 9.51– 9.84 | | .418 | .75– .82 | | .462 | 1.05–1.15 | | |

*Imports.*—The United States uses more than it produces and consequently imports tungsten concentrates and products.

In order that the duties will not have to be paid until the purchaser is ready to use the tungsten it is usually left in a bonded warehouse until needed. The imports for consumption and the stocks in bonded warehouses are shown in the following tables, which were compiled from the records of the Bureau of Foreign and Domestic Commerce.

*Tungsten imported for consumption in the United States, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Pounds | Value | Pounds | Value |
| Tungsten ore and concentrates (W content) | 92,284 | $21,857 | 310,540 | $78,222 |
| Tungsten metal and alloys | 12,472 | 5,882 | 68,016 | 28,466 |
| Combinations containing tungsten or tungsten carbide (W content) | 131 | 332 | | |
| Tungstic acid and other compounds of tungsten, not specially provided for (W content) | 1,315 | 2,629 | 779 | 1,401 |
| | 106,202 | 30,700 | 379,335 | 108,089 |

*Tungsten stocks in bonded warehouses on Dec. 31, 1932 and 1933, by customs districts*

| Customs district | Ore | | | |
|---|---|---|---|---|
| | Tungsten content (pounds) | | Value | |
| | Dec. 31, 1932 | Dec. 31, 1933 | Dec. 31, 1932 | Dec. 31, 1933 |
| New York | 827,116 | 143,812 | $168,713 | $24,958 |
| Pittsburgh | 36,930 | 602,118 | 7,135 | 150,329 |
| Buffalo | 172,583 | 110,327 | 57,379 | 28,248 |
| Philadelphia | 32,280 | 35,806 | 3,743 | 9,076 |
| Ohio | 5,276 | 5,276 | 1,583 | 1,583 |
| | 1,074,185 | 897,339 | 238,553 | 214,194 |
| | Tungsten (metal) | | | |
| Los Angeles | 43,647 | 5,486 | $18,594 | $2,343 |
| Galveston | 35,490 | 19,019 | 14,615 | 7,829 |
| New York | 240 | 243 | 516 | 683 |
| | 79,377 | 24,748 | 33,725 | 10,855 |

*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.

A movement was started during 1933 to obtain a reduction in the rates, but so far as is known no Government action was taken.

*Uses and metallurgy.*—The principal use of tungsten is in making 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 are used for valves in explosion engines which must stand considerable heat. Tungsten carbide cemented with cobalt is one of the hardest artificial cutting materials. Carbides of molybdenum, tantalum, columbium, titanium, and boron are also exceedingly hard and are used in similar ways. Saws tipped with tungsten carbide cemented with cobalt 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."[1]

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.

The use of tungsten which touches most people is in the filaments of incandescent lights, for which it has no rival for general purposes, effecting enormous saving in power, with increased quality of the light. Tungsten filaments are also used in radio tubes.

Tungsten is employed extensively in intermittent electrical contacts, such 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. Sodium tungstate and oxide are utilized in making lakes, mordants, and some other chemicals and sodium tungstate in making white leather. Tungsten can be employed for making a beautiful plating on iron and steel, but so far as known it is not yet used in commercial work.

The apparent consumption of new tungsten in the United States during the past 10 years is shown in the table following. It does not distinguish any quantities put in stock, but such quantities are comparatively small on account of the large sums that must be paid for duties.

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[1] Asbestos, Two Million Feet of Asbestos Pipe Covering Cut by a Disston Carboloy Saw: Vol. 14, December 1932, pp. 15–16.

*Apparent consumption of new tungsten in the United States, 1924–33, as shown by imports and production less exports*

| Year | Supply (contained tungsten—pounds of metal) | | | Exports of ferrotungsten, tungsten metal, and wire (contained tungsten—pounds of metal, estimated) | Apparent consumption of new tungsten | |
|---|---|---|---|---|---|---|
| | In ore and alloys imported | In domestic ore shipped | Total | | Pounds of metal | Equivalent (short tons of 60-percent $WO_3$ concentrates) |
| 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] 846,200 | 679,291 | 714 |
| 1932 | 106,202 | 376,881 | 483,083 | [1] 112,626 | 370,457 | 389 |
| 1933 | 379,335 | 851,789 | 1,231,124 | 683,130 | 547,994 | 576 |

[1] Of these quantities, in 1931, 802,609 pounds and, in 1932, 90,000 pounds were shipped to U.S.S.R. (Russia) as ferrotungsten.

## REVIEW BY STATES

The output of tungsten ore in the United States in 1933 was more than double that of 1932, although it was still below the average.

The production of tungsten concentrates in the United States during the past 5 years, reduced to a common equivalent of 60 percent tungsten trioxide ($WO_3$), is shown in the following table:

*Concentrated tungsten ores (reduced to equivalent of 60 percent $WO_3$) produced in the United States, sold in 1929–33, and average price per unit*

| Year | Short tons | Value | Average price per unit | Year | Short tons | Value | Average price per unit |
|---|---|---|---|---|---|---|---|
| 1929 | 830 | $654,000 | $13.13 | 1932 | 396 | $218,394 | $9.20 |
| 1930 | 702 | 509,000 | 12.09 | 1933 | 895 | 514,234 | 9.58 |
| 1931 | 1,404 | 928,000 | 11.02 | | | | |

*Arizona.*—The Boriana Mining Co. (Whittier, Calif.) was the principal tungsten operator in Arizona during 1933. It mined wolframite mixed with more or less scheelite and chalcopyrite from its property near the north end of the low Hualpai Mountains northeast of Yucca.

Some rich, hand-picked wolframite was produced from the Lawler & Wood (Prescott) claims 40 miles west of Prescott, and Ben S. Wilson (Tucson) produced a little wolframite. The Tungsten Alloys Corporation, 75 Federal St., Boston, Mass., which had mined huebnerite in Las Guigas Mountains near Amado, closed operations and sold its machinery.

*California.*—The Atolia Mining Co. (Atolia) continued deepening its shaft and drifting, and increased its production over that of 1932. The shaft has passed the 1,300-foot level on the dip of the vein, about 1,000 feet vertically, and new ore bodies are being found. This is the deepest tungsten mining known. A little huebnerite was found at a somewhat greater depth at White Oaks, N.Mex., but not in commercially valuable quantity, and the Nevada-Massachusetts Co. was approaching 1,000 feet vertical depth in its Stank shaft.

Herbert Salinger (112 Market Street, San Francisco) recovered a little scheelite, molybdenite, and chalcopyrite in separate concentrates from slime tailings made some years ago by the Pine Creek Mining Co. 20 miles northwest of Bishop.

*Colorado.*—The once prominent Boulder tungsten field produced very little tungsten ore during 1933. The Tungsten Production Co. (Inc.), and the Wolf Tongue Mining Co., both of Boulder, each shipped some ore. About December 1, the Wolf Tongue Mining Co. issued a schedule of prices to be paid for ferberite ores, as follows:

*Schedule of prices paid for crude ferberite ore delivered at Wolf Tongue mill, Nederland, Colo., December 1, 1933* [1]

| $WO_3$ (percent) | Cents per pound of $WO_3$ | Price per ton of crude ore | $WO_3$ (percent) | Cents per pound of $WO_3$ | Price per ton of crude ore |
|---|---|---|---|---|---|
| 1 | 6.0 | $1.20 | 31 | 43.5 | $269.70 |
| 2 | 7.2 | 2.88 | 32 | 44.2 | 282.88 |
| 3 | 10.8 | 6.48 | 33 | 44.9 | 296.34 |
| 4 | 21.6 | 17.28 | 34 | 45.5 | 309.40 |
| 5 | 26.4 | 26.40 | 35 | 46.2 | 323.40 |
| 6 | 29.4 | 35.28 | 36 | 46.8 | 336.96 |
| 7 | 32.4 | 45.36 | 37 | 47.5 | 351.50 |
| 8 | 33.0 | 52.80 | 38 | 48.1 | 365.56 |
| 9 | 34.2 | 61.56 | 39 | 48.8 | 380.64 |
| 10 | 35.4 | 70.80 | 40 | 49.4 | 395.20 |
| 11 | 37.8 | 83.16 | 41 | 50.1 | 410.82 |
| 12 | 38.4 | 92.16 | 42 | 50.7 | 425.88 |
| 13 | 39.0 | 101.40 | 43 | 51.5 | 442.90 |
| 14 | 39.6 | 110.88 | 44 | 52.1 | 458.48 |
| 15 | 40.2 | 120.60 | 45 | 52.8 | 475.20 |
| 16 | 40.8 | 130.56 | 46 | 52.8 | 485.76 |
| 17 | 41.4 | 140.76 | 47 | 52.8 | 496.32 |
| 18 | 42.0 | 151.20 | 48 | 52.8 | 506.88 |
| 19 | 42.0 | 159.60 | 49 | 52.8 | 517.44 |
| 20 | 42.6 | 170.40 | 50 | 52.8 | 528.00 |
| 21 | 42.6 | 178.92 | 51 | 52.8 | 538.56 |
| 22 | 42.6 | 187.44 | 52 | 52.8 | 549.12 |
| 23 | 42.6 | 198.36 | 53 | 53.4 | 566.04 |
| 24 | 42.6 | 204.48 | 54 | 54.6 | 589.68 |
| 25 | 42.8 | 214.20 | 55 | 55.2 | 607.20 |
| 26 | 43.0 | 223.60 | 56 | 56.4 | 631.68 |
| 27 | 43.0 | 232.20 | 57 | 57.0 | 649.80 |
| 28 | 43.2 | 241.92 | 58 | 58.2 | 675.12 |
| 29 | 43.2 | 250.56 | 59 | 58.5 | 690.30 |
| 30 | 43.5 | 261.00 | 60 | 60.0 | 720.00 |

[1] Schedule does not apply on any milled ores, such as "jigs" and concentrates regardless of their assay value. A charge of $3 will be made for sampling and assaying on lots having a value of less than $100. Schedule subject to change without notice.

M. C. Morrison (Boulder) reports having cut a body of ore carrying both gold and tungsten.

George Cowdery (Nederland) shipped some concentrates mined previously. He mined no ore during 1933.

*Montana.*—The Spokane-Idaho Copper Co. (Spokane, Wash.) cut a vein carrying scheelite in the Midas mine 36 miles southeast of Libby, Mont. The scheelite is mixed with lead minerals and so far has not been found in large quantity.

*Nevada.*—The Nevada-Massachusetts Co. (Mill City) remains much the largest tungsten miner in the United States. It is mining remarkably continuous tactites (contact-metamorphosed limestones). Its concentrates are of exceptionally high grade, and 460 short tons that averaged 71.34 percent $WO_3$, equivalent to 546 short tons carrying 60 percent $WO_3$, were sold during 1933.

Charles H. Segerstrom, president, writes:

Prices opened so low in 1933 that in the first half of the year we mined only a little ore in order to hold down expenses while keeping the water out of the mine, but we did not get anywhere near the cost of production out of this material. In July we obtained some contracts for concentrates and began operating the mill 24 hours per day. The mill has been enlarged, new machinery and equipment, including a deck on which are 10 new concentrators, have been installed, and now has a capacity of 250 tons per day. A new flotation section was installed to clean up the concentrates, and it has cut down the sulphur content of the concentrates to less than 0.20 percent and the grade has been raised so that the concentrates carry 72 to 76 percent $WO_3$. We also repaired our old roasting units and installed new ones. The mill is now in prime condition.

We have sunk the Humboldt shaft from the 600-foot to the 800-foot level and the entire 200 feet sunk was through good ore. The ore increased in value with depth and on the 800-foot level averages about 2 percent $WO_3$, is 5 feet thick and 2,000 feet long.

Levels have been run at each 100 feet of depth, and on each level we have developed about 75,000 tons of ore with an average grade for the whole of 1 percent $WO_3$, although some carries 10 percent.

At the Stank mine we are sinking from the 800-foot to the 1,000-foot level and are in a fine grade of ore, but a heavy flow of water makes costs very high. We have handled as much as 350 gallons per minute from the 800-foot level. The greater depth will add about 50,000 tons of ore, and we now have total reserves of about 1,000,000 tons.

No work was done in the Sutton mine during the year. We have put up new shaft buildings, a new hoist frame and concrete ore bins at the Humboldt mine. We have also installed a new Ingersoll Rand 1,000-cubic foot, two-stage compressor, and with our other compressors now have plenty of air. With the new equipment we can increase production as needed.

The Humboldt mill was not operated during the year. We are keeping it in reserve and can operate it in case of emergency.

At the Silver Dyke mine near Mina no mining was done, but late in 1933 new screens, rolls, and tables were placed in the mill and the capacity raised to 100 tons per day. The mine was cleaned out, and development of ore reserves was begun.

A severe earthquake took place late in 1933 and shook large rocks loose from the hillsides. As they rolled downward they blocked the road and badly damaged buildings, pumps, and pipes. Men below ground thought the mine had collapsed. Water is scarce and may have to be pumped from Sodaville, 7 or 8 miles away and considerably below the mine.

Some scheelite was sold by the Tungsten Production Co. (Inc.) (Boulder, Colo.) from its mine on the east side of the Nightingale Mountains, Pershing County, and by E. Succetti, of Mina.

*Washington.*—The Tungsten Producers, Inc. (Fruitland), reported that it mined 2,067 short tons of wolframite-bearing ore from which 35 short tons of concentrates carrying 70 percent $WO_3$ were produced and sold in 1933. About 100 feet of adit were driven during 1933. The mine was operated only from August 28 to December 10, but work was begun again on December 28.

James Keeth (E. 1827 Sprague Ave., Spokane) shipped a small quantity of very high-grade (72 percent $WO_3$) wolframite from a deposit leased on the Spokane Indian Reservation.

The Tungsten Co. of America (Goose Prairie) took out a small quantity of scheelite during development work. It drove 400 feet of adit, put in a compressor, built snowsheds, etc.

## THE WORLD TUNGSTEN INDUSTRY

Figures for their production of tungsten concentrates are available from all countries producing the larger quantities, though the Burmese figures probably will require revision. The world production as shown by shipments increased almost 5,000 metric tons over 1932 and was apparently between 11,500 and 12,000 metric tons (12,680 and 13,230 short tons), which is about equal to the world peace time needs.

World tungsten production during the past 5 years, insofar as the figures are available, is shown in the following table.

*World production of tungsten ore, 1929–33, in metric tons of concentrates containing 60 percent $WO_3$*

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

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Mexico | 11 | 28 | --------- | --------- | (2) |
| United States | 753 | 637 | 1,274 | 359 | 812 |
| | 764 | 665 | 1,274 | 359 | (2) |
| South America: | | | | | |
| Argentina | 63 | 98 | 20 | 6 | (2) |
| Bolivia [3] | 1,630 | 888 | 410 | 686 | 216 |
| | 1,693 | 986 | 430 | 692 | (2) |
| Europe: | | | | | |
| Czechoslovakia | 75 | 74 | 17 | --------- | (2) |
| France | 1 | --------- | --------- | --------- | (2) |
| Germany (Saxony) | --------- | --------- | 5 | --------- | (2) |
| Great Britain (Cornwall) | 27 | 153 | 121 | 2 | (2) |
| Portugal | 358 | 499 | 274 | 272 | 249 |
| Spain | 257 | 254 | 135 | 43 | (2) |
| | 718 | 980 | 552 | 317 | (2) |
| Asia: | | | | | |
| China [3] | 9,978 | 9,454 | 7,492 | 2,249 | 6,104 |
| Chosen | 15 | 13 | 17 | 62 | (2) |
| India (Burma) | 1,484 | 2,699 | 2,474 | 2,226 | [3] 2,633 |
| Indo-China (Tonkin) | 198 | 220 | 248 | 247 | 165 |
| Japan | 61 | 81 | 56 | (2) | (2) |
| Malay States: | | | | | |
| Federated Malay States | 356 | 1,054 | 462 | 378 | 1,188 |
| Unfederated Malay States | 157 | 178 | 241 | 175 | (2) |
| Netherland India | 10 | 15 | 1 | --------- | (2) |
| Siam | 62 | 7 | 12 | --------- | (2) |
| | 12,321 | 13,721 | 11,003 | 5,400 | (2) |
| Africa: | | | | | |
| Southern Rhodesia | 28 | 38 | 24 | 14 | 33 |
| Union of South Africa | --------- | --------- | 2 | --------- | --------- |
| | 28 | 38 | 26 | 14 | 33 |
| Oceania: | | | | | |
| Australia: | | | | | |
| New South Wales | 25 | 17 | 62 | 27 | (2) |
| Northern territory: | | | | | |
| Central Australia | 20 | 67 | } 29 | 15 | 11 |
| North Australia | 1 | (4) | | | |
| Queensland | 22 | 24 | 3 | 8 | 13 |
| Tasmania | 180 | 133 | (4) | --------- | 123 |
| New Zealand [3] | 39 | 21 | 6 | 9 | (2) |
| | 287 | 262 | 100 | 59 | (2) |
| | 15,800 | 16,700 | 13,400 | 6,800 | (2) |

[1] In addition to the countries listed, tungsten ore is produced in the U.S.S.R. (Russia), but no data of production are available for the period under discussion.
[2] Data not available.
[3] Exports.
[4] Less than 1 ton.

*Argentina.*—A small lot of excellent wolframite concentrates was shipped to the United States from Argentina during 1933. According to an analysis furnished by Charles Hardy, Inc., the content was: $WO_3$, 71.30; MnO, 18.10; FeO, 7.02; $Fe_2O_3$, 0.21; MgO, 1.56; $SiO_2$, 1.75; P, Sn, S, Pb, and Zn, none.

*Burma.*—The exports of tungsten concentrates from Burma during 1933 amounted to 3,874 long tons[2] (4,339 short tons). Mawchi Mines, Ltd., which mines mixed tin and tungsten from veins at Mawchi in the Karenni State of Bawlake, one of the Southern Shan States, produced 2,869 long tons of mixed tin-tungsten concentrates.[3] which are shipped to Murex, Ltd., London, for separation. The concentrates are assumed to carry 57 percent $SnO_2$ and 43 percent wolframite,[4] which as offered in the United States carry somewhat more than 69 percent $WO_3$. Accepting these figures, the Mawchi output would be equivalent to 1,419 long tons carrying 60 percent $WO_3$ (1,589 short tons, or 1,442 metric tons).

Supposing the Mawchi output of 2,869 long tons to account for that much of the exports it seems probable that the remainder (1,005 long tons) was from Tavoy. The Tavoy ores are treated magnetically before shipment, and assays show somewhat more than 70 percent $WO_3$, which would make the concentrates equivalent to 1,173 long, 1,191 metric, or 1,313 short tons of 60 percent $WO_3$ and the 1933 Burmese exports equivalent to 2,633 metric or 2,902 short tons carrying 60 percent $WO_3$.

*China.*—China has been and remains much the largest producer of tungsten concentrates. Virtually the only ore mineral is wolframite, though a little scheelite is found in much of the ore.

The most important deposits are in the mountainous country of southern Kiangsi, near Nananfu (also known as Tayu) and southeast of Kanchow; in southeastern Hunan; northern Kwantung; and northeastern Kwangsi, all of which cover parts of the same mountain group. Hunan produces possibly 150 tons per month, and Kiangsi may produce 3 to 10 times as much. Very little comes from the other provinces. Kiangsi is a poor province, and the miners have suffered greatly from the low prices due to world-wide depression and from bandits, military operations, and other troubles.

Formerly all Kiangsi ore went down the Kan River to the Yangtse thence to Shanghai, but since 1931 in order to escape taxation it has gone southward by an arduous journey on coolies' shoulders, ponies, and boats to Canton and Hong Kong. The Hunan ore goes north to Changsha, thence by the Yangtse to Shanghai.

There has been disagreement between the National Government and the Kiangsi Government over control of the tungsten mines and the income from their taxation, with consequent ruin of companies engaged in collecting and selling the ore. It was reported[5] that the National Government has initiated negotiations for exploiting the Kiangsi deposits on a plan by which German interests were to furnish a loan of $6,000,000; a Chinese-German mining corporation was to be formed, and the loan was to be repaid from profits from the mining operations, from which a percentage was also to be paid to the Govern-

[2] Scott, Winfield, H., American consul, Burma: U.S. Dept. of Commerce Foreign Trade Notes, vol. 3, Feb. 27, 1934, p. 2.
[3] Skinner, Walter E., The Mining Year Book for 1934, p. 319.
[4] Mining Journal, London, The Mineral Industry of India in 1930: Vol. 175, 1931, p. 955.
[5] Mitchell, Reginald P., Am. vice consul, Hankow Tungsten Market: U.S. Dept. of Commerce Foreign Trade Notes, Minerals and Metals, vol. 2, June 14, 1933, p. 2.

ment. Fourteen new wolframite deposits were reported to have been found by representatives of the Government, 10 of which were to be operated by the proposed company. The various provincial and district governments were not to be allowed to open mines.

This arrangement apparently did not materialize and in June it was announced [6] at Nanking that the British firm of Arnhold & Co., Ltd., of Shanghai had been appointed sales agents for 2 years, the Chinese Government to intervene only to fix prices. This arrangement was said to have become effective August 1, 1933, but it was reported that the action had been protested by the Southwest Political Council on the ground that it caused Chinese merchants to lose large sums already invested and that many Chinese workmen would lose their jobs.

A government tungsten monopoly, details of which have not been learned, went into effect November 25, 1933 [7] and was said to affect Kwangtung and the tungsten region in southern Kiangsi. Prices were fixed daily on the basis of firm offers made by buyers on a special contract form. Stocks on hand at the end of 1933 were said to be the lowest in 5 years.

In spite of all China's troubles the shipments of tungsten concentrates during 1933 amounted to an equivalent of 6,104 metric tons (6,729 short tons) carrying 60 percent $WO_3$.

*Federated Malay States.*—The Kramat Pulai mine at Kramat Pulai 7 miles east of Ipoh produced much the larger part of the tungsten ore exported by the Federated Malay States during 1933. The mineral is scheelite, with a gangue of white fluorite, and furnishes a remarkably pure concentrate. An excellent description of the mine was published during the year by Willbourn and Ingham.[8] The exports for the year amounted to 15,430 pikuls of scheelite and 553 pikuls of wolframite, a total of 1,066 short tons. One lot of 25 long tons received in New York carried 73.21 percent $WO_3$ and no metals precipitated by $H_2S$.

*Portugal.*—Of the Portuguese output 197 long tons came from the tin- and wolframite-bearing veins of the Beralt Tin and Wolfram, Ltd., Panasqueira, Portugal.[9] The company also has alluvial ground carrying both cassiterite and wolframite near Viseu and has its own ferrotungsten plant at Barking, England. Other production is not yet known.

[6] Mitchell, Reginald P., Am. vice consul, Hankow Tungsten Market: U.S. Dept. of Commerce Foreign Trade Notes, vol. 2, Sept. 13, 1933, p. 3.

[7] Paxton, J. Hall, Am. consul, Canton Tungsten Industry, Fourth Quarter, 1933: U.S. Dept. of Commerce Foreign Trade Notes, vol. 3, Feb. 27, 1934, p. 3.

[8] Willbourn, E. S. and Ingham, F. T., The Geology of the Scheelite Mine, Kramat Pulai Tin Limited, Kinta, Federated Malay States: Geol. Soc. London, Quart. Jour., vol. 89, Nov. 28, 1933, pp. 449–479.

[9] Skinner, Walter E., The Mining Year Book for 1934, p. 59.

# TIN

By Charles White Merrill

## SUMMARY OUTLINE



Tin is by far the most valuable mineral product furnished the United States almost exclusively from foreign mines. Imports in 1933 exceeded $51,000,000, but domestic mine production was valued at only about $2,100. Maintenance of an uninterrupted flow of tin into the United States is imperative because it is indispensable to two of the largest domestic industries—automobile manufacture and food packing.

*United States production.*—The domestic output of tin in 1933 was 2.4 long tons, valued at $2,100, most of which was produced in Alaska. However, recovery of secondary tin—that is, production of tin from sources other than ore—provides nearly one-fourth of the United States supply.

*Salient statistics for tin in the United States, 1924–33*

| | 1924–28 average | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| Production: | | | | | | |
| From domestic mines ... long tons | 18 | 35 | 15 | 3.7 | 0.4 | 2.4 |
| From secondary sources ... do | 30,062 | 30,625 | 23,393 | 17,679 | 13,170 | 19,732 |
| Imports for consumption ... do | 73,595 | 87,127 | 80,734 | 66,064 | 34,819 | 63,718 |
| Exports (domestic and foreign) ... do | 1,546 | 1,930 | 2,233 | [1] 1,661 | [1] 1,116 | [1] 1,041 |
| Monthly price of Straits tin at New York: | | | | | | |
| Highest ... cents per pound | 70.67 | 49.37 | 38.91 | 27.07 | 24.76 | 53.07 |
| Lowest ... do | 42.72 | 39.79 | 25.27 | 21.35 | 19.24 | 22.70 |
| Average ... do | 57.65 | 45.19 | 31.70 | 24.46 | 22.01 | 39.12 |

[1] Foreign only. Domestic not separately recorded.

*World output, price, and stocks.*—The world production of tin (tin content of ores) in 1933 was 85,000 long tons, a decrease of 10 percent from the 94,000 tons produced in 1932 and 56 percent from the 193,000 tons produced in the record year 1929. Thus the world output dropped below that for any year since 1900. The output of the four leading producing countries was 62,026 tons (73 percent of the world total), as follows: Federated Malay States, 22,800 tons (27 percent); Bolivia, 14,721 (17 percent); Netherland India, 14,181 (17 percent); and Siam, 10,324 (12 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 is imported into the domestic market as refined pig tin, and most of it comes from two countries; the Straits Settlements furnished 50 percent of the 1933 total and the United Kingdom 33 percent. Imports of tin in 1933 totaled 62,842 long tons, an increase of 80 percent from the 34,819 tons imported in 1932. In value, however, there was an increase of 211 percent from $16,473,998 in 1932 to $51,188,392 in 1933. Even this tremendous increase in value did not mean complete recovery, as the average value for the 6-year period ended in 1929 exceeded $91,000,000 annually. There was a great decline in the proportion of Straits tin included in the imports; its place was taken largely by English brands, but Banka, Billiton, and Chinese brands also gained. This trend was reflected in the decline of the Straits Settlements and the rise of the United Kingdom as sources of the domestic supply.

The average price of Straits tin at New York was 39.12 cents a pound for 1933 compared with 22.01 cents for 1932. The average price for the two last months of 1933 exceeded 52 cents. Thus the devaluation of the dollar, the international production-curtailment program, and the recovery in tin-consuming industries in the United States combined to raise the price of tin well above its 1929 level.

The decline in world "visible" stocks (in Government warehouses and in transit) that started in the middle of 1932 gathered speed during 1933. From an all-time high of 51,707 long tons at the end of July 1931 the stocks remained virtually static until the end of May 1932, decreased to 45,796 tons at the close of 1932, and then fell rapidly to 23,812 tons at the close of 1933, the lowest point since the end of July 1929. This supply did not oppress the market greatly because over half of it is considered requisite to the normal flow of tin from producer to consumer. Moreover, it appears that there was a considerable reduction in invisible stocks.

The accompanying graph (fig. 17) 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 lower inclination than that of many other metals. The effects of the post-World War depression and the boom of the late twenties are clearly seen. In 1933, however, production sank slightly below that of 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, but the automobile industry is subject to wide variation. During 1933 there was unusual activity in the food-packing industry because of the prospect of a rising general price level. The automobile industry made a marked recovery, although its output was far below the normal level. Continued recovery in the latter industry was widely prophesied for 1934. 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.

Much of the improvement in the tin market during 1933 can be credited to the recovery of the domestic tin-using industries; in fact, the United States was the only important consumer of tin to report an appreciable increase in its tin imports for consumption in 1933 over 1932.

*International control of production.*—The high tin prices of 1926–27 caused a boom in the development of tin mines that led to overproduction of tin as early as 1928. Stocks began to rise and prices to fall. During the summer of 1928 the Tin Producers' Association

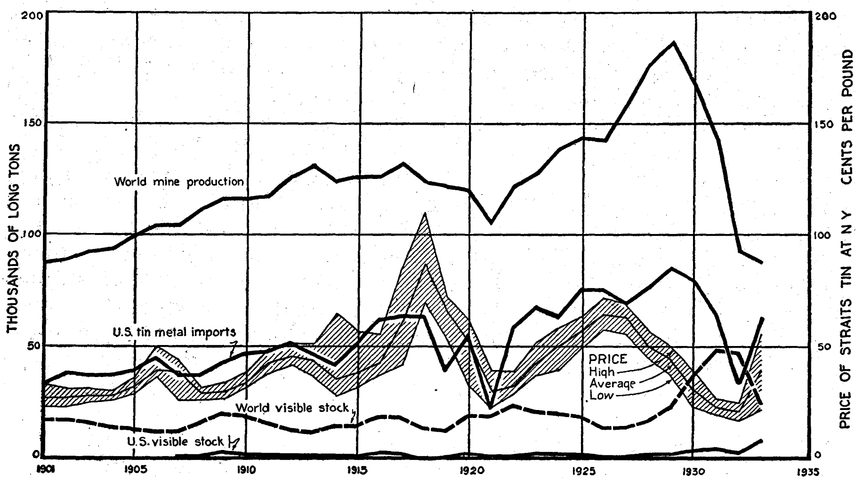


FIGURE 17.—Trends in production, imports, stocks, and prices of tin, 1901–33.

was formed to regulate the output of tin mines, but the general industrial depression caused a decline in consumption that nullified all benefits from controlled production. In 1930 a move was started to effect a legally enforceable curtailment program.

The Governments of British Malaya, Bolivia, Netherland India, and Nigeria finally agreed to a production-curtailment plan that went into effect March 1, 1931. The organization for carrying out these plans was called the International Tin Committee and had its headquarters at The Hague. The committee assigned an export quota to each of the four participating countries with the understanding that each would translate its quota into controlled production by assigning output quotas to its several producers. Each Government, supported by the necessary legislation, issued individual production permits; disregard of these made 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.

Acceptance of this final reduction may be said to have been the turning point in the fortunes of the tin industry because the date of its application roughly coincides with the high point in visible stocks and the low point in price (gold) of tin. Recovery, however, was slow until the spring of 1933.

Negotiations were begun in 1933 to extend the production-curtailment plan beyond August 31, 1934, its expiration date. A new agreement was finally accepted that was to run for 3 years from January 1, 1934. The basis for computing quotas was slightly revised; the quotas for the first period were assessed at 44 percent of the new basic capacity. The table on page 461 summarizes the quota data.

Another development was the Tin Pool, an international organization for controlling surplus stocks of tin. This organization was formed during August 1931 and soon prevailed on the holders of 21,000 long tons of tin to permit it to regulate the liquidation of their holdings. It was announced that a part of the controlled tin would be released to its owners when a minimum price of £165 a long ton was reached. Further releases were to be made as the price rose. All the pool's holdings were said to appear in current statistics as "visible" stocks. Release of the pooled tin was started in July 1933, and its absorption has proceeded rapidly.

During the fall of 1933 another pool, spoken of as the "Buffer Pool", was proposed. It was to accumulate 8,282 long tons of tin by permitting the quota countries to mine extra allotments of 5 percent of their so-called "standard" 1929 outputs. The sponsors claimed that the pool would prove an instrument by which the market would be stabilized. Determined opposition to the plan was voiced by brokers, speculators, and many producers who held that stabilization could be obtained as easily by adjusting mine-production quotas from time to time and that the latter method would protect the market from the constant suspicion that certain traders might be receiving inside information on pool moves. The Buffer Pool is still being considered.

One of the original objectives of the Tin Producers' Association was to provide the whole tin industry with better statistics and with a research organization. During 1933 this program began to bear important fruit. The International Tin Research and Development Council Statistical Office at The Hague is now publishing comprehensive data on the tin industry. The Council also is cooperating with the United States Tin Research and Development Committee of the American Tin Trade Association. This committee proposes to expand the present uses of tin, develop new uses, and preserve and strengthen existing markets where tin meets competition.

Despite 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. Until 1933, however, the supply and price of tin gave them little cause for complaint, but the events of 1933 have dispelled any illusion regarding the so-called "tin-market stabilization" promised by the proponents of production regulation. In fact, at the close of the year the New York dollar price was well above its 1929 level, but world production was at less than half its 1929 mark. The following extract from a British editorial [1] points out some of the weaknesses in the production-control program resulting from disregard of the consumers' interest:

The international restriction scheme has been essentially one of producers, and no international cartel can be regarded as permanently satisfactory in which the views of consumers are not as strongly represented as those of producers. Space does not permit here of our attempting any kind of computation of the ratio between production, stocks, and consumption as they project themselves at the moment, but we would venture to reiterate one or two of the cautions which we have over a long period uttered in regard to the dangers of not allowing sufficiently for counter-organization among consumers who may choose to consider that they are the victims of a hold-up. It is very easy, if American consumption continues on the basis since the spring, to calculate that the world's supply should be reduced from 2,000 to 2,500 tons per month, so that by the end of April we shall be down to a visible supply of, say, from 16,000 tons to 18,000 tons, and in view of the amount of tin which might be in pool hands a very considerable further rise in the price of the metal might be looked for. This is a possibility which the big consumers in the United States are bound to be taking into consideration. Already the price of tin is high in relation to pre-war levels, and in view of the fact that the tin control is now at least semipermanent we cannot suppose that they are ignoring the prospect of having to pay increasingly high prices for their supplies. As a matter of fact, we are informed that vigorous research work is even now being prosecuted with a view of developing substitutes for food containers, with all the unrivaled research organization which America possesses, especially along the line of cartons and some aluminum combinations, in the applications of which considerable strides had been made prior to the great slump in tin prices. It is all very well to feel satisfaction that through restriction tin is the only one of the base metals which has been revalorized, but it will be a very poor result for the industry if the cartel succeeds in advancing prices to say £300 per ton and upwards only to discover that it has forced other materials into the permanent substitution of a large proportion of its normal market. The experience of the copper industry, not only in regard to aluminum but in the utilization of secondary supplies, is a present-day warning of what such a policy leads to, were common sense not sufficient guide.

The higher tin prices have renewed prospecting and development in stanniferous areas throughout the world, particularly in countries not parties to the production-restriction plan. Although the new production resulting from these activities has not yet greatly affected the world tin market it already is causing grave anxiety to the International Tin Committee. From the standpoint of the consumer these new developments should prove very beneficial in future. The most favorable developments are reported in the old tin fields of China and in the more recently opened tin areas in the Belgian Congo.

## 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.

[1] The Mining Journal (London), The Three Years Tin Restriction Outlook, vol. 183, no. 5130, Dec. 16, 1933, pp. 868-869.

*Tin mined in the United States (including Alaska), 1924–33, in long tons*

[Metallic tin obtainable from concentrates produced in tin mining]

| | | | |
|---|---|---|---|
| 1924–28 (average) | 18 | 1931 | 3.7 |
| 1929 | 35 | 1932 | .4 |
| 1930 | 15 | 1933 | 2.4 |

Alaska has been the chief source of tin for many years and produced 2.3 long tons in 1933. South Dakota produced the remaining 0.1 ton. No other production was reported; but areas in North Carolina, California, Virginia, South Carolina, and Texas have produced small quantities in the past, and tin minerals are known to occur in many other States.

*Secondary tin.*—During 1933, 19,732 long tons of secondary tin were recovered in the United States, an increase of 50 percent from that recovered in 1932 and equivalent to 31 percent of the virgin tin imported in 1933. If the recovery of secondary tin were included with primary production the United States would rank second among tin-producing countries.

*Tin content and value of secondary tin recovered in the United States, 1924–33* [1]

| Year | Recovered at detinning plants | | | Recovered from all sources | | | |
|---|---|---|---|---|---|---|---|
| | As metal (long tons) | As chemicals (long tons) | Total (long tons) | As metal (long tons) | As alloys and chemicals (long tons) | Total: Long tons | Total: Value |
| 1924–28 (average) | 920 | 1,901 | 2,821 | 7,571 | 22,491 | 30,062 | $38,143,900 |
| 1929 | 763 | 2,402 | 3,165 | 6,607 | 24,018 | 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 |
| 1933 | 838 | 1,792 | 2,630 | 6,473 | 13,259 | 19,732 | 16,508,700 |

[1] Figures compiled by J. P. Dunlop of the Bureau of Mines.

The principal source of secondary tin is the scrap that results from the manufacture of tin-bearing articles, but junk also provides material from which a large quantity of tin is reclaimed. The quantity of secondary tin recovered fluctuates sympathetically with industrial activity and the price of virgin tin. In addition, the profits of secondary tin production are affected by the markets for the byproducts of tin reclamation, such as the steel scrap yielded by the detinning of tin plate, and for the metals, such as lead and copper, recovered in the reclamation of tin-bearing alloys and drosses. Improvements in all these factors accounted for the great increase in the quantity of secondary tin recovered in the United States in 1933 compared with 1932.

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 detinning plants, but at the present prices for reclaimed metals the recovery of tin from this source is unprofitable in the United States.

During 1933 domestic detinners met some competition from Japanese buyers for tin-plate scrap produced at seaboard points. The Japanese detinners have an advantage over domestic buyers resulting from the fact that Japan's tin import duty does not apply to the tin content of tin-plate scrap. Consequently the Japanese detinning plants enjoy a premium on the tin they reclaim equal to their country's import duty on pig tin. A bill pending in the United States Congress at present provides for an embargo on the export of tin-bearing scrap except under permit by the Secretary of War.

## 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 and was 24 tons in 1933.

*Foreign trade of the United States in tin and tin concentrates, 1924–33*

| 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] |
| 1924–28 (average) | 73,595 | $91,343,216 | 180 | $101,059 | 563 | 983 |
| 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 | (5) | 1,661 |
| 1932 | 34,819 | 16,473,998 | 17 | 4,364 | (5) | 1,116 |
| 1933 | 63,718 | 51,240,829 | 24 | 10,630 | (5) | 1,041 |

[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] Not separately recorded.

In 1933, 62,842 long tons of tin (bars, pigs, blocks, grains, and granulated) were imported into the United States compared with 34,819 tons in 1932 and 66,064 tons in 1931. The Straits Settlements supplied 50 percent of the tin imported in 1933, the United Kingdom 33 percent, the Netherlands 5 percent, and all others 12 percent. In 1932 the proportions furnished by the Straits Settlements (63 percent) and the Netherlands (8 percent) were larger, but the proportion furnished by the United Kingdom (16 percent) was much smaller. In 1931 the Straits Settlements supplied 75 percent of the United States tin imports, while the United Kingdom furnished only 12 percent.

Straits tin made up over three-quarters of the tin imported in 1929, but since that year its predominance has declined. The greatest gains have been made by the English brands, but Banka, Billiton, and Chinese tins have shared in the redistribution of the United States market. The recent interference with the flow of Straits tin into trade, caused by the production-curtailment program and the tin

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pools, appears to have accelerated the acceptance of other brands of tin by domestic consumers. Moreover, the diversion of the Netherland India concentrates from the smelters of the Straits Settlements has decreased the supply of Straits tin. The net result of this change in demand by the United States consumers probably will take the form of a permanent shrinkage in the premium offered for Straits tin.

*Metallic tin (bars, pigs, blocks, grains, and granulated) imported into the United States, 1932–33, by countries*

[General imports]

| Country | 1932 | | 1933 | |
|---|---|---|---|---|
| | Long tons | Value | Long tons | Value |
| Australia | 240 | $114,906 | 170 | $142,662 |
| Belgium | 50 | 23,040 | 75 | 63,234 |
| Belgian Congo | | | 50 | 49,869 |
| Canada | 42 | 8,181 | 42 | 18,592 |
| China | 476 | 220,141 | 2,001 | 1,378,168 |
| Germany | 176 | 61,165 | 1,516 | 796,776 |
| Hong Kong | 3,376 | 1,536,078 | 1,982 | 1,402,363 |
| Japan | 25 | 10,855 | | |
| Malaya (British) (Straits Settlements) | 21,784 | 10,352,863 | 31,621 | 24,093,380 |
| Netherlands | 2,680 | 1,297,140 | 3,203 | 2,524,216 |
| Netherland India | 524 | 261,160 | 1,278 | 1,060,067 |
| New Zealand | | | (1) | 66 |
| Panama | 1 | 319 | | |
| United Kingdom | 5,445 | 2,588,150 | 20,904 | 19,658,999 |
| | 34,819 | 16,473,998 | 62,842 | 51,188,392 |

1 Less than 1 ton.

Exports of metallic tin continued small; tin exported in the form in which it was imported decreased from 1,116 long tons in 1932 to 1,041 tons in 1933.

*Tin manufactures.*—Imports of tin plate, terneplate, and taggers tin amounted to 261 long tons valued at $40,185 in 1933 compared with 7,246 tons valued at $471,939 in 1932. Thus the United States imports returned to the level at which they had stood for a number of years prior to 1932. In 1933 the United Kingdom furnished 98 percent of the tin-plate imports.

For the year 1933 the exports of tin plate, terneplate, and taggers tin totaled 95,239 long tons valued at $7,650,419 compared with 39,603 long tons valued at $3,272,566 for 1932, an increase of 140 percent in quantity and 134 percent in value. The world export market for tin plate appears to have expanded during 1933, with the United States getting the principal share of the increase. German tin-plate exports increased substantially, but the exports of the United Kingdom declined slightly. Devaluation of the dollar permitted United States to regain markets lost to the United Kingdom when it devalued its pound sterling.

Competition in the export market probably will increase in the next few years as a result of the expanding plants in a number of countries that produced little or no tin plate until recently. The following is quoted [2] from a review of the Welsh tin-plate industry in 1933 by Sim and Coventry:

2 Metal Bulletin (London), Welsh Tin Plates in 1933: No. 1863, Feb. 2, 1934, p. 12.

During the year the tin-plate trade has had to meet continued competition, first from German, Italian, and French works and later on from the United States, whose depreciated dollar put them in a position similar to our own when Britain went off the gold standard. In addition, the Norwegian works have also supplied some of their neighbors. India continues to manufacture a considerable portion of her own needs, and Japan is making more of her own requirements, and in the not distant future may be looking out for orders from China and elsewhere.

*Tin plate, terneplate, and taggers tin exported from the United States, 1924–33*

| Year | Long tons | Value | Year | Long tons | Value |
|---|---|---|---|---|---|
| 1924–28 (average) | 215, 339 | $24, 438, 322 | 1931 | 84, 433 | $7, 841, 193 |
| 1929 | 258, 964 | 28, 566, 189 | 1932 | 39, 603 | 3, 272, 566 |
| 1930 | 216, 516 | 24, 201, 977 | 1933 | 95, 239 | 7, 650, 419 |

During 1933 approximately two-thirds of the United States tin-plate exports went to the Orient, where Japan and China were the principal customers. Most of the rest of the exports were taken by countries in the Western Hemisphere, the leading customer there being Argentina. Most of the tin plate was exported through the Maryland and New York port districts; the former port accounted for twice as much as the latter.

*Exports of tin plate, terneplate, and taggers tin from the United States, by principal countries and districts, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Long tons | Value | Long tons | Value |
| *Country* | | | | |
| Argentina | 2, 326 | $188, 917 | 9, 668 | $776, 328 |
| Brazil | 304 | 24, 086 | 3, 215 | 259, 276 |
| China | 9, 855 | 826, 928 | 14, 326 | 1, 174, 169 |
| Hong Kong | 4, 428 | 334, 016 | 5, 970 | 450, 146 |
| Japan | 7, 058 | 580, 292 | 23, 943 | 1, 924, 639 |
| Kwantung | 275 | 22, 930 | 3, 632 | 273, 998 |
| Mexico | 2, 830 | 245, 212 | 3, 334 | 301, 551 |
| Netherland India | 2, 001 | 147, 795 | 6, 487 | 491, 849 |
| Philippine Islands | 4, 555 | 375, 071 | 6, 406 | 516, 639 |
| Others [1] | 5, 971 | 527, 319 | 18, 258 | 1, 481, 824 |
| Total | 39, 603 | 3, 272, 566 | 95, 239 | 7, 650, 419 |
| *District* | | | | |
| Maryland | 24, 561 | 1, 991, 836 | 60, 685 | 4, 805, 202 |
| New York | 11, 302 | 925, 909 | 29, 962 | 2, 439, 174 |
| Others [1] | 3, 740 | 354, 821 | 4, 592 | 406, 043 |
| Total | 39, 603 | 3, 272, 566 | 95, 239 | 7, 650, 419 |

[1] Includes all exports not exceeding $250,000 in 1932 or 1933.

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.[3] The results of this work are presented in the following table. As the earlier estimates of the War Industries Board (1917) and the Bureau of Mines (1925)[4] 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 estimated 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.

[3] Umhau, J. B., Consumption of Primary Tin in the United States During 1930: Information Circular 6564, Bureau of Mines, 1932, 7 pp.
[4] Furness, J. W., Consumption of Tin in the United States, 1925: Information Circular 6019, Bureau of Mines, 1927, 3 pp.

*Apparent consumption of virgin tin in the United States, 1924–33, in long tons*

| | 1924–28 average | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| Supply: | | | | | | |
| Domestic production | 18 | 35 | 15 | 4 | ---------- | 2 |
| Imports of tin as metal | 73,595 | 87,127 | 80,734 | 66,064 | 34,819 | 63,718 |
| Imports of tin in concentrates | 180 | 128 | 289 | 30 | 17 | 24 |
| Visible stocks, Jan. 1 | [1] 1,652 | 2,428 | 2,820 | 4,693 | 6,254 | 4,496 |
| Consumers' stocks, Jan. 1 | [2] 8,534 | 8,534 | 10,606 | 15,500 | [3] 15,500 | [3] 15,500 |
| Total available | 83,979 | 98,252 | 94,464 | 86,291 | 56,590 | 83,740 |
| Withdrawals: | | | | | | |
| Exports of tin as metal | 1,546 | 1,930 | 2,233 | [4] 1,661 | [4] 1,116 | [4] 1,041 |
| Exports of tin in concentrates | 18 | 35 | 15 | 4 | ---------- | 2 |
| Visible stocks, Dec. 31 | [1] 2,428 | 2,820 | 4,693 | 6,254 | 4,496 | 7,504 |
| Consumers' stocks, Dec. 31 | [1] 8,534 | 10,606 | 15,500 | [3] 15,500 | [3] 15,500 | [3] 15,500 |
| Total withdrawn | 12,526 | 15,391 | 22,441 | 23,419 | 21,112 | 24,047 |
| Apparent consumption | 71,453 | 82,861 | 72,023 | 62,872 | 35,478 | 59,693 |
| Consumption accounted for in Bureau of Mines canvass | (5) | (5) | 65,448 | (5) | (5) | (5) |

[1] Stocks for Jan. 1 and Dec. 31 are stocks at the beginning and end of the 5-year period and not averages of stocks on Jan. 1 and Dec. 31 of each year.
[2] Stocks at the end of the period. Stocks for Jan. 1, 1924 are not available.
[3] 1930 figure repeated in absence of more recent data.
[4] Foreign exports only for 1931–33.
[5] No canvass by Bureau of Mines for 1924–26, 1929, and 1931–33.

The apparent consumption of virgin tin in the United States was 59,693 long tons in 1933 compared with 35,478 tons in 1932 and 62,872 tons in 1931. The 1933 consumption represents a 68-percent increase over 1932 but a 28-percent decrease from the peak year 1929. There have been no precise data on consumers' stocks since 1930, but this lack did not seriously affect the accuracy of the apparent consumption figure until 1933. During 1933, however, it is probable that there was a considerable increase in consumers' stocks, and it has been rumored that some speculative stocks were accumulated but concealed in the United States. Consequently it seems likely that the figure given as apparent consumption for 1933 errs by being too high.

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, 1924–33, in long tons* [1]

| Year | Tin plate | Terneplate | Total | Year | Tin plate | Terneplate | Total |
|---|---|---|---|---|---|---|---|
| 1924-28 (average) | 1,568,986 | 108,296 | 1,677,282 | 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 |
| 930 | 1,660,325 | 103,118 | 1,763,443 | 1933 | 1,685,826 | 83,272 | 1,769,098 |

[1] From Annual Report of American Iron and Steel Institute.

In 1933 tin was used in the manufacture of 1,685,826 long tons of tin plate and 83,272 tons of terneplate in the United States compared with 986,217 and 46,290 tons, respectively, in 1932. Exports of tin plate, terneplate, and taggers tin were 95,239 long tons in 1933, an increase of 140 percent from 1932. Imports of tin plate, terneplate, and taggers tin virtually disappeared in 1933. The United States produced over twice as much tin plate and terneplate as Great Britain but exported less than one-fourth as much.

During 1933 a new outlet for tin plate developed in the petroleum industry, when a number of firms commenced packing their automoble lubricating oils in small nonrefillable cans. The purpose of this method of packing was to insure that the consumer would receive the quality of oil he ordered. Formerly when all grades of oil were sold in bulk, dishonest retailers were said to have frequently substituted cheaper oils.

*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, a recent development in the industry, has been widely adopted. The trend in the low-price class from the 4-cylinder type of engine to the 6- and 8-cylinder types has increased the requirements of tin for babbitted engine bearings.

*Production, registration, and exports of motor vehicles in the United States, 1924–33*

| Year | Production [1] | | | Registration [2] (all classes) | Exports [3] (all classes) |
|---|---|---|---|---|---|
| | Passenger cars | Trucks and busses | Total | | |
| 1924–28 (average) | 3,491,398 | 494,480 | 3,985,878 | 21,564,800 | 335,675 |
| 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 | 24,115,000 | 66,404 |
| 1933 | 1,606,703 | 353,242 | 1,959,945 | 23,827,290 | 108,027 |

[1] Bureau of the Census. [2] Bureau of Public Roads. [3] Bureau of Foreign and Domestic Commerce.

In 1933 there was an increase of 43 percent over 1932 in the number of automobiles produced as well as a marked recovery in the industry's export business. The number of units produced, however, was only 37 percent of that for 1929, the peak year. Another favorable feature was the increase in the number of motor vehicles registered, which reversed a downward trend since 1930. The maintenance and repair of these cars are substantial items in the consumption of tin.

*Other manufactures.*—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 has increased 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 is being consumed in manufacturing the refrigerating equipment used by the retail beer trade.

## SUBSTITUTES

Tin returned during 1933 to its position as the highest priced of the common base metals. This fact, in conjunction with the prospect of monopolistic manipulation of its production, turned the attention of many United States consumers toward research for substitutes. Substitution is virtually the only weapon available to the consumer of tin with which to combat excessive price. Moreover, substitution would prove invaluable to national defense should war curtail the flow of tin to the United States.

## PRICES AND STOCKS

*Prices.*[5]—The break in the tin market that began in April 1927 continued with only minor recoveries until a low monthly average of 19.24 cents a pound was reached in April 1932. There was little recovery in price until April 1933, when abandonment of the gold standard combined with an increased demand for tin to more than double its price before the year closed. The price record of tin in 1933 includes a high monthly average of 53.07 cents for November, a low monthly average of 22.70 cents for January, and an average of 39.12 cents for the year, compared with the 1932 record of a high average monthly price 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. The average price for 1933 was thus 17.11 cents (78 percent) greater than that for 1932. The average price for December 1933, however, was 30.18 cents (133 percent) above that for December 1932.

[5] Prices used in this discussion refer to Straits tin at New York, as quoted in the American Metal Market and published in Metal Statistics, 1934, pp. 323-325.

*Monthly price of Straits tin for prompt delivery in New York, 1931–33, in cents per pound* [1]

| | 1931 | | | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|---|---|---|
| | High | Low | Average | High | Low | Average | High | Low | Average |
| January | 27.25 | 25.40 | 26.10 | 22.37½ | 20.75 | 21.84 | 23.45 | 21.80 | 22.70 |
| February | 27.20 | 25.25 | 26.31 | 22.30 | 21.50 | 22.03 | 23.80 | 23.20 | 23.50 |
| March | 27.50 | 26.50 | 27.07 | 22.35 | 20.80 | 21.86 | 25.50 | 23.50 | 24.34 |
| April | 26.62½ | 23.35 | 25.12 | 20.25 | 18.35 | 19.24 | 30.25 | 24.70 | 27.15 |
| May | 24.15 | 22.50 | 23.20 | 22.12½ | 20.00 | 20.95 | 40.75 | 32.37½ | 35.90 |
| June | 26.00 | 22.30 | 23.41 | 20.75 | 18.65 | 19.64 | 46.50 | 40.62½ | 44.21 |
| July | 26.75 | 24.12½ | 25.02 | 21.37½ | 20.40 | 20.93 | 48.00 | 44.62½ | 46.38 |
| August | 27.15 | 24.30 | 25.75 | 24.37½ | 21.50 | 22.96 | 46.12½ | 43.37½ | 44.74 |
| September | 26.75 | 22.25 | 24.68 | 25.62½ | 23.87½ | 24.76 | 48.25 | 44.75 | 46.65 |
| October | 23.37½ | 22.12½ | 22.76 | 24.50 | 23.25 | 23.92 | 49.00 | 46.00 | 47.92 |
| November | 23.55 | 21.40 | 22.80 | 24.15 | 22.00 | 23.32 | 55.80 | 49.00 | 53.07 |
| December | 21.95 | 20.60 | 21.35 | 22.85 | 22.45 | 22.69 | 53.50 | 52.35 | 52.87 |
| Year | 27.50 | 20.60 | 24.46 | 25.62½ | 18.35 | 22.01 | 55.80 | 21.80 | 39.12 |

[1] Metal Statistics, 1934, pp. 323 and 325.

The price of tin at the close of 1933 was well above the 1929 level, a condition enjoyed by no other important metal except gold. The principal factors in the higher price in the United States were devaluation of the dollar, curtailment of tin mine production, and domestic industrial recovery.

*Prices of tin plate and sheet bars at Pittsburgh and pig tin at New York on dates of principal price changes of tin plate, 1929–33* [1]

| Date | Tin plate (per base box) | Sheet bars (per long ton) | Pig tin (per pound) | Date | Tin plate (per base box) | Sheet bars (per long ton) | Pig tin (per pound) |
|---|---|---|---|---|---|---|---|
| | | | *Cents* | | | | *Cents* |
| 1929: Dec. 31 | $5.25 | $34.00 | 39.75 | 1932: Nov. 17 | $4.25 | $26.00 | 23.35 |
| 1930: Oct. 1 | 5.00 | 31.00 | 28.00 | 1933: Aug. 29 | 4.65 | 26.00 | 46.00 |
| 1931: Oct. 1 | 4.75 | 29.00 | 22.12½ | Dec. 1 | 5.25 | 26.00 | 53.50 |

[1] Metal Statistics, 1934, p. 149.

*Stocks.*—The monthly average of the world "visible supply" of tin was 36,239 long tons in 1933 compared with 48,892 tons in 1932 and 49,900 tons in 1931. The supply averaged 14,925 tons in 1927 but thereafter 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 23,812 tons at the end of December 1933. The early months of 1934 have witnessed continuance of this decline.

*Visible stocks of tin in the world and in the United States at end of each month, 1924–33, in long tons*[1]

| Month | 1924–28 (average) | | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | World | U.S. | World | U.S. | World | U.S. | World | U.S. | World | U.S. | World | U.S. |
| January | 18,939 | 3,026 | 24,237 | 2,611 | 29,032 | 3,081 | 43,619 | 4,904 | 50,043 | 5,342 | 44,223 | 3,461 |
| February | 18,706 | 3,026 | 26,402 | 3,307 | 33,581 | 3,626 | 49,339 | 5,862 | 51,300 | 4,578 | 43,160 | 2,741 |
| March | 17,641 | 2,653 | 26,632 | 2,550 | 32,972 | 3,566 | 48,607 | 7,917 | 50,780 | 3,841 | 43,528 | 2,281 |
| April | 16,299 | 2,332 | 26,353 | 3,603 | 36,595 | 5,687 | 48,462 | 6,212 | 50,716 | 3,546 | 42,541 | 2,040 |
| May | 18,074 | 2,504 | 24,765 | 3,464 | 39,771 | 6,767 | 51,231 | 5,698 | [2]50,562 | 3,981 | 41,883 | 3,036 |
| June | 17,518 | 2,413 | 23,751 | 3,830 | 42,611 | 7,728 | 51,626 | 5,633 | [2]48,945 | 3,759 | 39,964 | 3,474 |
| July | 17,439 | 2,857 | 23,789 | 3,087 | 41,950 | 6,786 | 51,707 | 5,838 | 49,125 | 4,559 | 38,043 | 4,549 |
| August | 17,519 | 2,569 | 26,400 | 2,858 | 43,805 | 7,533 | 50,987 | 6,213 | 47,177 | 4,459 | 33,534 | 5,788 |
| September | 17,452 | 2,724 | 24,556 | 2,479 | 40,150 | 6,323 | 50,722 | 5,868 | 47,739 | 4,191 | 30,162 | 6,003 |
| October | 17,035 | 2,839 | 25,580 | 2,720 | 39,676 | 4,823 | 50,602 | 6,773 | 47,048 | 4,291 | 27,940 | 6,664 |
| November | 18,219 | 2,381 | 25,171 | 2,050 | 40,811 | 5,372 | 50,583 | 7,458 | 47,471 | 3,441 | 26,075 | 6,769 |
| December | 19,947 | 2,282 | 28,140 | 2,820 | 42,498 | 4,693 | 51,313 | 6,254 | 45,796 | 4,496 | 23,812 | 7,504 |
| Average | 17,899 | 2,634 | 25,481 | 2,947 | 38,621 | 5,499 | 49,900 | 6,219 | 48,892 | 4,207 | 36,239 | 4,526 |

[1] Metal Statistics, 1934, pp. 315 and 317.
[2] Shipments of Chinese tin not included.

Visible stocks of tin held in the United States have averaged approximately 2,500 long tons for many years, seldom dropping below 1,500 tons and seldom exceeding 7,500 tons, but during the last 4 years the average has been somewhat higher. In 1933 stocks at the close of the month recorded a high point of 7,504 tons in December and a low of 2,040 tons in April; the average for the year was 4,526 tons. This supply, however, would have satisfied the requirements of domestic industry for less than 4 weeks had all other sources been cut off. The steady increase in stocks following the low point reached in April reflects the requirements of recovery in industry. It is probable, however, that the larger part of the additional stocks was accumulated by speculators during the period of dollar devaluation. The Commodity Exchange, Inc., which absorbed the former National Metal Exchange, provided a growing market for trading in tin.

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. At times, smelters hold considerable quantities of tin and tin-bearing materials that do not appear in the world's visible stocks. During 1933 discrepancies between the figures for mine production, smelter production, and deliveries indicated that invisible stocks decreased greatly, except in the United States. One authority estimates that 14,000 long tons of invisible stocks were absorbed during the year and that further supplies from this source will not appear. In the United States the questionnaires that have formed the basis of the Bureau of Mines studies of tin consumption since 1928 disclose that manufacturing requirements rather than current price of the metal determine the stocks carried by consumers of virgin tin. During the past year, however, there have been reports that larger invisible stocks have accumulated here.

## WORLD PRODUCTION AND RESOURCES

The world production of tin in 1933 was 85,000 long tons compared with 94,000 tons in 1932, 145,000 tons in 1931, and 193,000 tons in the all-time peak year 1929. The production in 1933 was 10 percent less than that in 1932 and was smaller than that for any year since 1900. The Bureau of Mines has made available recently a detailed record[6] 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.

*World production of tin (content of ore), 1924–33, by countries, in long tons*

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

| Country | 1924–28 (average) | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| Australia | 2,996 | 2,239 | 1,451 | 1,750 | 2,138 | 2,300 |
| Belgian Congo | 971 | 971 | 652 | (1) | 689 | 1,693 |
| Bolivia [2] | 34,222 | 46,343 | 38,161 | 31,137 | 20,589 | 14,721 |
| China [2] | 7,128 | 6,778 | 6,483 | 3,478 | 2,009 | [3] 4,000 |
| India (British) | 1,962 | 2,649 | 2,990 | 2,979 | 3,168 | 3,200 |
| Indo-China | 619 | 829 | 992 | 881 | 1,010 | 1,000 |
| Japan | (1) | 1,092 | 1,496 | 1,577 | [3] 1,600 | [3] 1,600 |
| Malay States: | | | | | | |
| Federated [2] | 50,006 | 67,042 | 62,065 | 51,250 | 27,091 | 22,800 |
| Unfederated | 2,143 | 2,326 | 1,910 | 1,377 | 1,286 | 1,000 |
| Mexico | (1) | (1) | (1) | 761 | 751 | (1) |
| Netherland India | 32,340 | 35,236 | 34,586 | 27,375 | 16,789 | 14,181 |
| Nigeria | 7,412 | 10,734 | 8,570 | 7,056 | 4,320 | 3,700 |
| Portugal | 556 | (1) | (1) | (1) | 550 | [3] 600 |
| Siam | 7,691 | 10,517 | 11,526 | 12,495 | 9,276 | 10,324 |
| Union of South Africa | 1,163 | 1,218 | 930 | (1) | 541 | 594 |
| United Kingdom (England) | 2,401 | 3,271 | 2,488 | 598 | 1,337 | 1,400 |
| Other countries [4] | 800 | 1,500 | 1,900 | 1,900 | 1,000 | 1,900 |
| | 152,000 | 193,000 | 176,000 | 145,000 | 94,000 | 85,000 |

[1] Less than 500 tons; included under "Other countries."
[2] Exports.
[3] Estimated.
[4] Includes countries producing less than 500 tons.

The very small output of tin in 1933 was due mainly to the production-curtailment program of the International Tin Committee; 1933 output was only 48 percent of that in 1930, the last year of unrestricted tin mine operation. The reduction, however, has not been borne evenly. In the four countries that originated the curtailment scheme, 1933 outputs bore the following ratios to 1930 outputs: British Malaya, 37 percent; Bolivia, 39 percent; Netherland India, 41 percent; and Nigeria, 43 percent. Siam, which joined later and on very liberal terms, produced 90 percent as much tin in 1933 as in 1930, but the countries outside the plan reported an average decline of only 6 percent.

During 1933 production was continued under quotas that had been in effect since July 1, 1932; but late in the year the whole problem of production control was reconsidered, and a new agreement for the 3-

[6] Umhau, J. B., Summarized Data of Tin Production: Econ. Paper 13, Bureau of Mines, 1932, 34 pp.

year period, 1934–36, was reached. The basic 1929 outputs were revised slightly, and quotas were set at 40 percent effective January 1, 1934. An extra quota of 4 percent was provided for 1934, which is to be applied in such a way that past quota excesses will be absorbed. Siam's quota was reset at 9,800 tons of tin, computed on the basis of its concentrates containing 72 percent tin. As its concentrates are richer than 72 percent, this will make its output approximately 10,000 long tons of metallic tin. Although provision was made in the agreement for its abrogation under certain circumstances, there seems to be little likelihood that it will not survive its 3-year term.

*Tin-production quotas (annual) for countries signatory to the tin-production curtailment plan, in long tons*

| Country | Production (1929) | | Quota | | | | | New quota basis effective Jan. 1, 1934 | Quota[1] Jan. 1 1934 |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1931 | | 1932 | | | | |
| | Reported by Bureau of Mines | Agreed upon as quota basis | Mar. 1 | June 1 | Jan. 1 | June 1 | July 1 | | |
| British Malaya | 69,371 | 69,366 | 53,928 | 45,375 | 38,960 | 30,406 | 23,115 | 71,940 | 28,776 |
| Bolivia | 46,343 | 92,480 (Bolivia, Netherland India, Nigeria) | 34,260 | 28,826 | 24,751 | 19,317 | 14,687 | 46,490 | 18,596 |
| Netherland India | 35,236 | | 29,916 | 25,171 | 21,612 | 16,867 | 12,823 | 36,330 | 14,532 |
| Nigeria | 10,734 | | 7,992 | 6,724 | 5,773 | 4,506 | 3,431 | 10,890 | 4,356 |
| Siam | 10,517 | 24,672 (Siam and other countries) | (2) | [3] 10,000 | 10,000 | 10,000 | 10,000 | 9,800 | 9,800 |
| Other countries | 19,452 | | (2) | (2) | (2) | (2) | (2) | 14,872 | -------- |
| Total production | 192,000 | 186,518 | -------- | -------- | -------- | -------- | -------- | 190,322 | -------- |
| Reduction | -------- | -------- | 36,000 | 20,000 | 15,000 | 20,000 | 17,040 | -------- | -------- |
| Cumulative reduction | -------- | -------- | 36,000 | 56,000 | 71,000 | 91,000 | 108,040 | -------- | 99,390 |

[1] An additional 4-percent quota is to be distributed between the first 4 countries.
[2] No restriction of output.
[3] 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 22,800 long tons of metallic tin in 1933, compared with 27,091 tons in 1932 and 51,250 tons in 1931. The legally enforced curtailment program was the principal factor in the reduction of output. Of the 117 dredges in use 94 were temporarily idle at the end of 1933. Employment in the mining industry in the last month of the year has been as follows: 1933, 41,740; 1932, 42,556; 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.

The export duty rates on tin and tin concentrates were revised twice during 1933. The revisions raised the minimum price of tin below which the sliding scale of rates would not apply, but the shippers have not been affected so far because the price of tin has never fallen below the new minimum. The object of the new law was to protect the Government's revenue during periods of low tin prices, but it also has the effect of placing a tremendous burden on the tin-mining industry at times when it is least able to bear it.

There was much difficulty in keeping Malaya within the quota during 1931, but administration of the curtailment plan appears to have run smoothly since then. The 1934 basis for computing quotas slightly improves the relative position of Malayan tin miners.

The Straits Settlements, the world's leading producer of smelted tin, decreased its output in 1933 because of smaller mine production in the countries supplying the bulk of the tin concentrates to its smelters. Moreover, the flow of concentrates that the Billiton Co. has been supplying for almost 40 years was diverted during 1933 to its company smelter at Arnhem, the Netherlands.

The Unfederated Malay States together produced concentrates containing 1,000 long tons of metallic tin in 1933, compared with 1,286 tons in 1932 and 1,377 tons in 1931.

*Bolivia.*—Bolivia, the second largest producer of tin and the largest producer of lode tin, exported concentrates and ore containing 14,721 long tons of tin in 1933, compared with 20,589 tons in 1932 and 31,137 tons in 1931. The Patiño Mines & Enterprises Consolidated (Inc.), the world's greatest tin-mining company, produced almost half of Bolivia's tin in 1933. Early in 1934 this company announced its acquisition of the controlling interest in the British Tin Investment Co., an organization that has extensive holdings in Malayan tin-mining companies and in Consolidated Tin Smelters, Ltd.

Military operations against Paraguay in the Gran Chaco area, though not directly interfering with the tin industry, have increased the difficulties of the tin producers because of the added taxation required and the enlistment of many of the best workmen in the army.

*Netherland India.*—Netherland India produced concentrates containing 14,181 long tons of tin in 1933, compared with 16,789 tons in 1932 and 27,375 tons in 1931. As in the past, virtually all the production came from mines operated by the Government, the Billiton Mining Co., and the Singkep Tin Co. The Singkep Tin Co. was taken over by the Billiton Joint Mining Co. on July 1, 1933. Until April 1, 1933, concentrates not smelted locally were shipped to the Straits Settlements for treatment, but thereafter the exported concentrates were largely diverted to the Netherlands. By the end of the year virtually no Netherland India concentrates were reaching the Straits Settlements.

*Siam.*—Siam produced concentrates containing 10,324 long tons of tin in 1933, compared with 9,276 tons in 1932 and 12,495 tons in 1931. Siam's acceptance of an annual quota of 10,000 tons ended the steady climb in production that had continued through 1931.

*China.*—Shipments from China in 1933 were reported as 4,000 long tons of tin, compared with 2,009 tons in 1932, and 3,478 tons in 1931. The refinery built in conjunction with the tin smelter at Kotchiu in southern Yunnan started operating during 1933. A shipment of its product analyzed in London revealed that its purity compared favorably with leading brands. Reports about the refinery have been vague, however.

*Nigeria.*—Nigeria produced concentrates containing 3,700 long tons of tin in 1933, compared with 4,320 tons in 1932, and 7,056 tons in 1931; 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 half of the Nigerian tin production.

*India.*—India continued to increase its tin output notwithstanding the vigorous efforts to induce it to accept production restriction; in 1933 its output was 3,200 long tons, compared with 3,168 tons in 1932 and 2,979 tons in 1931. Production control in Burma would be very complicated because most of the tin mines yield tungsten as a by-product, and any curtailment of tin output would affect the tungsten business adversely.

*Australia.*—Australia likewise found production control unacceptable and produced 2,300 long tons of tin in 1933, compared with 2,138 tons in 1932 and 1,750 tons in 1931.

*Belgian Congo.*—Although the Belgian Congo never has been an important tin ore producer, its increase from 689 long tons of tin in 1932 to 1,693 tons in 1933 probably marks the beginning of a climb into the ranks of the large producers. An output as high as 8,000 tons has been forecast [7] for 1935. The International Tin Committee has made every effort to bring the Belgian Congo into the production-control scheme, but so far the Belgians have refused to consider any terms that would seriously impede the rapid development of the colony's tin resources. The vast possibilities of the country are indicated by reports that an area 1,000 miles long by 300 miles wide is being prospected for tin.

*United Kingdom.*—The production of tin (content of domestic ores) in the United Kingdom was 1,400 long tons in 1933, compared with 1,337 tons in 1932 and 598 tons in 1931. The increased production since 1931 appears to have resulted largely from the cutting of costs made possible by Great 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 79,000 long tons (93 percent of the total production) in 1933. The remaining 6,000 tons were produced largely by Japan, Indo-China, Portugal, and the Union of South Africa, but small outputs were reported for Cameroun (French), France, Mexico, Southern Rhodesia, Southwest Africa, Spain, Swaziland, Tanganyika Territory, and Uganda Protectorate. Moreover, the higher price level for tin has increased prospecting for it in a number of other countries.

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[7] The Mining Journal (London), The Role of the Congo as a Tin Producer: Vol. 194, no. 5142. Mar. 10, 1934, pp. 157–158.

# CHROMITE

By Robert H. Ridgway

SUMMARY OUTLINE



World production of chromite is consumed principally in the ferrous metallurgical industry. The general improvement in iron and steel production throughout the world in 1933 is reflected in the increased world exports of chromite. Data are not available to justify a tonnage estimate of world chromite production, but it is believed that production increased perhaps 30 percent over 1932. Production in Southern Rhodesia, normally the world's largest producer, increased but was still at a low level. The rise in the production and exports of chromite from Turkey during the last 2 years has been a significant feature of the industry from an international standpoint.

The mining of chromite in the United States is of little consequence in the light of world production or domestic consumption. The domestic output in 1933 was 966 long tons, compared with 200 tons in 1932. The United States, however, ranks first in the consumption of chromite and, like most of the other large consuming nations, depends on foreign sources. The supply available for consumption was 31 percent above that in 1932. For the second consecutive year Turkey was the largest source of American imports, while Cuba, after shipping no chromite in 1932, ranked second in 1933. The following table compares salient statistics of the chromite industry in the United States during the last 4 years with the yearly average from 1925 to 1929.

*Salient statistics of the chromite industry of the United States, 1925–33*

| | 1925–29 average | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Production ... long tons | 262 | 310 | 762 | 200 | 966 |
| Consumption: | | | | | |
| Imports ... do | 224, 357 | 326, 617 | 212, 528 | 89, 143 | 116, 511 |
| Domestic shipments ... do | 276 | 80 | 268 | 155 | 843 |
| Apparent available supply ... do | 224, 633 | 326, 697 | 212, 796 | 89, 298 | 117, 354 |
| Prices per ton at New York, approximate average of all grades | $22. 46 | $21. 50 | $18. 50 | $18. 00 | $17. 00 |
| Origin of imports: | | | | | |
| Southern Rhodesia ... percent of total | 52 | 45 | 32 | 17 | 10 |
| New Caledonia ... do | 6 | 10 | 19 | 13 | 13 |
| Turkey ... do | ---------- | 1 | 1 | 20 | 24 |
| Greece (largely transshipments from Yugoslavia) percent of total | 9 | 14 | 14 | 18 | 10 |
| U.S.S.R. (Russia) ... do | ---------- | 4 | 8 | 5 | 11 |
| Cuba ... do | 15 | 13 | 7 | ---------- | 20 |
| Others ... do | 18 | 13 | 19 | 27 | 12 |
| World production ... long tons | 428, 000 | 550, 000 | 378, 000 | 300, 000 | (1) |

[1] Data not available.

Figure 18 shows the trend of domestic consumption and prices during the last decade.

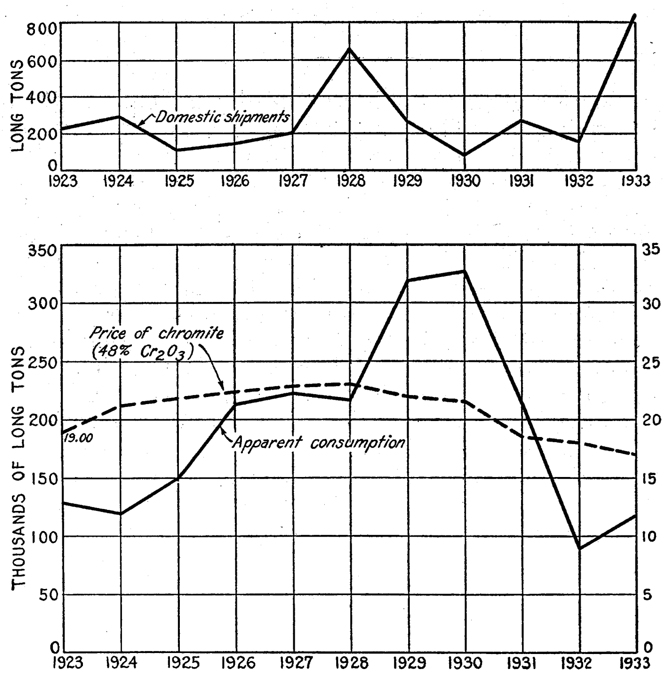


FIGURE 18.—Trends in consumption, price, and domestic shipments of chromite in the United States, 1923–33

No code of fair competition was signed or submitted for the chromite mining industry during 1933. The industry is very small and, so far as is known, has no organization for the formulation of a code.

## DOMESTIC PRODUCTION

In the United States 966 long tons of chromite were mined and 843 tons shipped during 1933, compared with 200 tons mined and 155 tons shipped in 1932. All production and shipments in both years were from California.

It was reported during the year that the Montana Chrome, Inc., had started construction of a 30-ton mill at the mouth of Hell Roaring Creek in Rock Creek Canyon about 15 miles south of Red Lodge in Carbon County. The company plans to refine its chromium concentrates at the Great Falls reduction works of the Anaconda Copper Mining Co.

The following table shows the production and shipments of chromite in the United States from 1929 to 1933.

*Crude chromite mined and shipped from mines in the United States (all from California), 1929–33*

| 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 |
| 1933 | 879 | 743 | (1) | 87 | 100 | (1) | 11,585 |

1 Figures included in total value only. Bureau of Mines not at liberty to publish separately.

## IMPORTS

Imports of chromite into the United States were 116,511 long tons in 1933, compared with 89,143 tons in 1932, an increase of 31 percent. The chromite imported into the United States in 1933 had a chromic oxide content of nearly 44 percent. Of the larger imports in 1933 the quantity from Turkey had the highest content of chromic oxide (51 percent), while that from Cuba had the lowest (32 percent).

Imports of chromite into the United States from Turkey have increased greatly in recent years, and in 1933 Turkey was the principal source, furnishing 24 percent of the total imports. Cuba furnished 20 percent, New Caledonia 13 percent, U.S.S.R. 11 percent, Southern Rhodesia 10 percent, and Greece 10 percent.

The following table shows the imports of crude chromite into the United States by countries, from 1929 to 1933.

69174—34——31

*Crude chromite imported into the United States, 1929–33, by countries*

[General imports]

| Country | 1929 (long tons) | 1930 (long tons) | 1931 (long tons) | 1932 (long tons) | 1933 | | |
|---|---|---|---|---|---|---|---|
| | | | | | Long tons | | Value |
| | | | | | Gross weight | Chromic oxide content | |
| Africa: | | | | | | | |
| British—Union of South | 17,545 | 24,376 | 5,379 | ---------- | 986 | 434 | $6,373 |
| French—Algeria and Tunisia | ---------- | ---------- | ---------- | 2,206 | ---------- | ---------- | ---------- |
| Portuguese: | | | | | | | |
| Mozambique | 167,381 | 145,709 | 68,291 | 15,496 | 12,200 | 5,730 | 117,583 |
| Other | ---------- | 2,000 | 2,000 | ---------- | ---------- | ---------- | ---------- |
| Belgium | 1,367 | 1,595 | 482 | ---------- | ---------- | ---------- | ---------- |
| Brazil | 462 | 10 | ---------- | ---------- | ---------- | ---------- | ---------- |
| Canada | ---------- | ---------- | ---------- | ---------- | 49 | 24 | 584 |
| Cuba | 52,949 | 40,982 | 14,957 | ---------- | 23,772 | 7,681 | 186,419 |
| Germany | 1,700 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- |
| Greece | 26,647 | 45,822 | 28,893 | 16,395 | 11,499 | 4,951 | 166,321 |
| Guatemala | ---------- | 89 | 91 | ---------- | 2,061 | 1,030 | 37,089 |
| India (British) | 21,033 | 14,542 | 8,664 | 7,857 | 4,152 | 2,189 | 40,741 |
| Oceania (French) | 26,846 | 31,022 | 39,579 | 11,550 | 15,150 | 6,363 | 121,200 |
| Turkey in Asia | 1,700 | 2,591 | 2,198 | 17,602 | 27,854 | 14,120 | 495,150 |
| U.S.S.R | ---------- | 13,878 | 17,736 | 4,800 | 13,261 | 5,973 | 152,688 |
| United Kingdom | ---------- | 4,001 | 24,258 | 13,237 | ---------- | ---------- | ---------- |
| Yugoslavia | ---------- | ---------- | ---------- | ---------- | 5,527 | 2,670 | 102,302 |
| | 317,630 | 326,617 | 212,528 | 89,143 | 116,511 | 51,165 | 1,426,450 |

The following tables show the imports of chromium alloys and compounds into the United States from 1929 to 1933.

*Ferrochrome or ferrochromium and chrome or chromium metal imported for consumption in the United States, 1929–33, in long tons*

| | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Ferrochrome or ferrochromium: | | | | | |
| Containing 3 percent or more carbon (chromium content) | 37 | ------ | ------ | ------ | ------ |
| Containing less than 3 percent carbon, gross weight | 638 | 153 | 135 | 159 | 188 |
| Chrome or chromium metal | 21 | ------ | ------ | 20 | 48 |

*Chromium compounds imported for consumption in the United States, 1929–33*

| 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 |
| 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 | ---------- | ---------- |
| 1933 | 2,040 | 629 | 1,892 | 417 | ---------- | ---------- | ---------- | ---------- |

## CONSUMPTION

Owing to lack of data concerning consumers' stocks, it is impossible to estimate accurately the actual consumption of chromite in the United States. However, the apparent available supply increased from 89,298 long tons in 1932 to 117,354 tons in 1933 but was still far below the 5-year average from 1925 to 1929.

The lower consumption of chromite during the past few years reflects the slump in the steel industry, the principal consumer. The automobile industry in the United States, one of the principal users of chromium-alloy steels as well as chromium plating, experienced a dull year in 1933, only 1,959,945 cars being made. The continued low rate of steel production also affected the consumption of chromite refractories. Another contributing factor to the low consumption of chromite was the inactivity in building construction, which uses stainless steel for decorative purposes and large quantities of chromium-plated plumbing fixtures.

The following table shows the apparent available supply of chromite in the United States from 1929 to 1933.

*Domestic sales, imports, and supply of crude chromite in the United States, 1929–33, in long tons*

| Year | Sales from domestic mines | Imports (general) | Apparent available supply | Year | Sales from domestic mines | Imports (general) | Apparent available supply |
|---|---|---|---|---|---|---|---|
| 1929 | 269 | 317, 630 | 317, 899 | 1932 | 155 | 89, 143 | 89, 298 |
| 1930 | 80 | 326, 617 | 326, 697 | 1933 | 843 | 116, 511 | 117, 354 |
| 1931 | 268 | 212, 528 | 212, 796 | | | | |

## USES

### METALLURGICAL

*Alloy steels.*—Throughout the depression the production of alloy steel has fared better than that of ordinary steel. In 1933 alloy-steel output increased 121.8 percent over 1932.[1]

Chromium is one of the more important metals used in the manufacture of alloy steel. It finds its principal application in the group of rust- and heat-resisting steels of which the 18–8 type (18 percent chromium, 8 percent nickel) is the best known. Utilization in the automobile, building, dairy, paper, petroleum, and chemical industries, as well as in kitchen equipment for restaurants, hotels, and hospitals, indicates the potential usefulness of this type of steel. Advances in land, air, and water transportation offer new developments which increase consumption of the alloying elements. Welded stainless steel has been utilized recently in the fabrication of fast-service trains where strength and reduced weight are desired. The legalization of beer and other alcoholic beverages has brought about the use of new stainless-steel equipment in manufacturing and dispensing establishments.

The field of alloy steels is constantly being broadened by the development of new alloys or alloying elements that produce desired properties in steel for specific uses. Titanium has been added to the 18–8 type alloy to improve its welding properties. F. M. Beckett and Russel Franks have reported that columbium used in plain high-chromium steel (in amounts 8 to 10 times the carbon content) and titanium (5 to 7 times the carbon content) render the steel soft and workable,

[1] Steel, Alloy Steel Is Destined to Become Tonnage Product of Wide Use: Vol. 94, no. 1, Jan. 1, 1934, p. 99.

both hot and cold. A new manganese-chrome-vanadium steel has recently been developed for automotive forgings, and a nickel-chrome-molybdenum steel has been developed for heavy forgings.

The increasing demand for metal that can withstand corrosive attack has made the manufacture of rust-resisting steels a significant feature of the steel casting industry. Development of machinable 18–8 chrome-nickel steel castings and of 18-percent chromium castings with a fine grain, brought about by the addition of nitrogen in the form of high-nitrogen ferrochrome, has been cited [2] as a particularly interesting advance during 1933.

During recent years stainless clad steel has been adapted to tonnage production. Mild steel clad with stainless steel is now available at a cost that will bring it within the reach of countless applications. This steel can be fabricated with the same equipment used for ordinary soft steel.

The manufacture of most alloy steels, including the stainless steels, is under the Code of Fair Competition for the Iron and Steel Industry, which was approved by the President on August 19, 1933, for an observation period of 90 days. At the request of the industry the Iron and Steel Code was extended from November 19, 1933, until May 31, 1934. The manufacture of ferrochrome, however, will come under a Code of Fair Competition for Primary Alloying Materials, which was under consideration during the early months of 1934.

*Chromium plating.*—Chromium plating may be divided into two classes—decorative and wear-resisting. The former is the most commonly encountered, being used extensively in automobile fittings and hardware, plumbing fixtures, and miscellaneous hardware and cutlery. The bluish white color, hardness, and high resistance to ordinary atmospheric corrosion make chromium plate a desirable finish. The decorative chromium plate is extremely thin (approximately 0.00002 to 0.00004 inch) and usually is put on a soft-steel base on which successive layers of copper and nickel have been applied.

Wear-resisting plate, while not as well known as decorative plate, has many important industrial applications. Usually this type of plate is applied to a steel base of sufficient hardness to suit the service required. The depth of the plate ranges from 0.0001 inch up to any reasonable amount.[3] A depth of 0.050 inch is not uncommon.

The deposition of chromium from solutions of chromic and chromous salts has been studied by Kasper, who published the following conclusions:[4]

> (*a*) Simple trivalent chromium baths yield poor deposits at low efficiencies. The bright plating range is exceedingly narrow; (*b*) chromous baths give results which are similar to those of the trivalent baths; (*c*) the use of complexes in order to solve the difficulties inherent in the trivalent bath is unsound; (*d*) the chromic acid bath is inherently superior to solutions containing lower valence compounds.

The chromium-plating industry is governed by the Code of Fair Competition for the Fabricated Metal Products, Manufacturing and Metal-Finishing and Metal-Coating Industry, which was approved

[2] Steel, Age of Alloys Ushers in New Markets for Foundries: Vol. 94, no. 1, Jan. 1, 1934, p. 130.
[3] Nemser, D. A., Industrial Chromium Plating: Iron Age, vol. 133, no. 5, Feb. 1, 1934, p. 14.
[4] Kasper, Charles, The Deposition of Chromium from Solutions of Chromic and Chromous Salts: U.S. Bureau of Standards, Research Paper 604, October 1933, p. 525.

by the President on November 2, 1933. On May 18, 1934, public hearings were held on a supplementary Code of Fair Competition for the Electroplating and Metal Polishing and Finishing Industry, a division of the fabricated metal products, manufacturing and metal-coating industry.

## REFRACTORIES

The second largest use of chromite in the United States is in the manufacture of refractory materials, such as brick and cement. Chrome refractories are neutral metallurgically and quite resistant to many types of slag. Curtailed operations in the metallurgical industry in 1933 resulted in a subnormal demand for chromite for refractory purposes. The ore used for this purpose is imported largely from Cuba, Greece, and the Union of South Africa. The following representative analyses show the types of commercial refractory ores by foreign sources.[5]

*Chemical analyses of commercial refractory chrome ores, percent*

| Country | Chromic oxide | Silica | Iron | Alumina | Magnesia |
|---|---|---|---|---|---|
| Brazil | 42 | 5 | 15 | 16 | 17 |
| Cuba | 32 | 4 | 13 | 29 | 16 |
| Greece | 38 | 4 | 16 | 22 | 17 |
| India | 44 | 5 | 22 | 10 | 13 |
| Rhodesia | 45 | 7 | 13 | 13 | 14 |
| U.S.S.R. (Russia) | 42 | 6 | 11 | 19 | 17 |
| Union of South Africa (Transvaal) | 43 | 5 | 27 | 7 | 10 |

The improved quality of chrome refractories during the last few years is due to better and more scientific methods of manufacture and to the development of more precise ways of selecting the right chrome ore.[6]

A development of 1933 was the production of both chrome and magnesite brick that will not shear under normal loads at temperatures as high as 2,700° to 2,900° F. A chrome-base castable refractory was introduced as a furnace-bottom material during 1933. It is claimed to embody all the advantages of chrome refractory materials—longer life and resistance to slag and abrasion—as well as mechanical and chemical stability.[7]

The price of chrome brick in 1933, as quoted by the trade journals, opened the year at $42.50 per net ton. The quotations jumped in May to $45 and remained there for the rest of the year.

A Code of Fair Competition for the Refractories Industry was approved by the President on December 18, 1933.

## CHEMICALS

In addition to that used in the manufacture of chromic acid for electroplating, considerable chromite is consumed in the manufacture of chemicals used principally in the dyeing, tanning, and pigment

[5] De Macedo, A., Selecting the Right Chrome Ore: Blast Furnace and Steel Plant, vol. 21, no. 5, May 1933, pp. 279–280.
[6] See footnote 5.
[7] Steel, Insulating Refractories Gain More General Application: Vol. 94, no. 1, Jan. 1, 1934, p. 133.

industries. Figures on the production of chromium chemicals are collected biennially by the Bureau of the Census. Production figures for 1933 are not yet available. Figures for 1931 are given on page 305 of the Minerals Yearbook, 1932–33.

There has been some improvement in chrome pigments during the past few years. Production of a chrome yellow fast to light was described in 1933.[8]

The manufacture of chromium chemicals, chrome pigments, comes under the Code of Fair Competition for the Chemical Manufacturing Industry, which was approved by the President on February 10, 1934. The manufacture of chromium pigments comes under the Code of Fair Competition for the Dry Colors Industry, which was approved by the President on April 25, 1934.

Because of the increasingly diverse and numerous industrial applications of chromium and its compounds, efforts have been made toward methods of protecting exposed workers. In 1928 the United States Public Health Service issued a report [9] on health hazards in chromium plating. A pamphlet discussing the causes and effects of the action of chromium and its compounds on the skin of exposed workers, as well as preventative measures, was issued in 1933 by the Industrial Health Section of the Metropolitan Life Insurance Co.[10]

## PRICES

The prices of chromite quoted in the domestic trade journals are for imported ore and are given in dollars per long ton c.i.f. North Atlantic ports. According to Steel, chromite containing 48 percent chromic oxide was quoted at $18 at the beginning of the year, but declines reduced the price to $15.50–$16.50 in May. Later the price increased and was given as $18 in December. Ore with a lower chromic oxide content usually brings a lower price. The quotation on 45-percent ore is about $2 below that on 48-percent ore.

## WORLD PRODUCTION

The following table shows the available statistics on world production from 1929 to 1933, inclusive:

[8] Oil, Paint and Drug Reporter, Chrome Yellow Fast to Light: Vol. 124, no. 18, Oct. 23, 1933, p. 28A.
[9] Bloomfield, J. J., and Blum, W., Health Hazards in Chromium Plating: U.S. Public Health Service, Public Health Repts., vol. 43, no. 26, Sept. 7, 1928.
[10] Metropolitan Life Insurance Co., Industrial Health Section, Protection of Workers Exposed to Chromium and Its Compounds: New York, 1933, pp. 1–15.

*Production of crude chromite, 1929–33, by countries, in metric tons*

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

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Australia | 131 | 171 | 26 | 99 | (2) |
| Brazil [3] | 70 | 10 | ---------- | ---------- | (2) |
| Canada (shipments) | 114 | ---------- | ---------- | 71 | 27 |
| Cuba [4] | 53,799 | 41,640 | 15,197 | ---------- | 24,154 |
| Cyprus (shipments) | 2,483 | 1,569 | 203 | 1,000 | (2) |
| Greece | 24,214 | 23,402 | 5,634 | 1,555 | (2) |
| Guatemala [4] | ---------- | 90 | 92 | ---------- | 2,094 |
| India (British) | 50,361 | 51,497 | 20,233 | 18,152 | (2) |
| Indo-China | 11 | 1,451 | 2,800 | (2) | (2) |
| Japan | 9,163 | 11,348 | 9,675 | [5] 11,727 | (2) |
| New Caledonia | 52,594 | 61,894 | 74,150 | 69,429 | 50,072 |
| Norway | ---------- | ---------- | ---------- | 409 | (2) |
| Southern Rhodesia | 265,909 | 205,631 | 81,623 | 15,692 | 35,046 |
| Turkey (Asia Minor) | 16,178 | 28,195 | 25,382 | 55,196 | (2) |
| U.S.S.R. (Russia) | [6] 52,889 | [6] 66,720 | [7] 67,000 | [7] 68,000 | [7] 68,000 |
| Union of South Africa | 63,974 | 13,725 | 23,335 | 19,371 | [8] 24,439 |
| United States (shipments) | 273 | 81 | 272 | 157 | 857 |
| Yugoslavia | 43,022 | 51,576 | 58,384 | 43,925 | 23,427 |
| | 635,200 | 559,000 | 384,000 | 305,000 | (2) |

[1] In addition to the countries listed, Portugal reported a production of 30 kg of chromite in 1931; average content, 38 percent $Cr_2O_3$.
[2] Data not available.
[3] Exports.
[4] Imports into the United States.
[5] Output of principal mines.
[6] Year ended Sept. 30.
[7] Approximate production.
[8] Shipments.

Complete data are not yet available regarding world output in 1933, but increases in exports of chromite and in steel production indicate that world production of chromite may have increased as much as 30 percent over that in 1932. The increased production from Turkey was probably the most significant factor in world production in 1933.

## WORLD TRADE

Chromite is an important commodity in world trade. With the exception of the U.S.S.R. the main producing countries consume only small quantities, while the main consuming countries produce only a small fraction of their requirements. World exports in 1933 were about 298,000 metric tons compared with 210,000 tons in 1932, an increase of 42 percent. Turkey, showing a substantial increase, was the principal exporting country in 1933, supplying 34 percent of the total. The U.S.S.R. supplied 14 percent, Southern Rhodesia 11 percent, Union of South Africa 9 percent, New Caledonia 8 percent, Cuba 8 percent, Yugoslavia 6 percent, and India and Greece 5 percent each. Cuba increased its exports by a large amount, while Greece, New Caledonia, and the Union of South Africa showed smaller increases. India, Southern Rhodesia, Yugoslavia, and U.S.S.R. all registered decreases ranging from a few hundred tons to 7,300 tons for India.

Figures on imports of chromite into the principal consuming countries in 1933 are not yet complete, but data available indicate that the three principal importing countries, in order of importance, are the United States, Germany, and Sweden.

A brief summary of activities in the principal chromite producing and consuming countries in the world follows.

*Canada.*—Canada produced 30 tons of chromite in 1933 compared with 78 tons in 1932. The 1933 output came from Quebec. The chromite deposits of the eastern townships of the Province of Quebec were described by Denis.[11]

*Cuba.*—Imports of chromite from Cuba into the United States in 1933 were 24,154 metric tons, compared with none for 1932 and 15,197 tons in 1931. Cuban ores are of low grade and are used primarily for refractories.

*France.*—France is an important consumer of chromite. Imports increased from 13,399 metric tons in 1932 to 20,511 tons in 1933. Turkey and New Caledonia furnished a large proportion of the French imports in 1933.

*Germany.*—Germany's consumption of chromite is supplied by imports which in 1933 amounted to 47,704 metric tons compared with 42,653 tons in 1932. The bulk of the imports for 1932 and 1933 came from British South Africa and Turkey.

*Greece.*—Exports of chromite in 1933 were 13,713 metric tons, a large increase over the 1,102 tons exported in 1932; 40 percent of the exports in 1933 went to the United States.

*Guatemala.*—The production of chromite in Guatemala in 1933 as represented by the amount imported into the United States was 2,094 metric tons. The Vanadium Corporation of America is producing high-grade chromite ore from a property about 110 miles from Porto Barrios.

*India.*—Production figures for India in 1933 are not available, but exports declined from 20,971 metric tons in 1932 to 13,625 tons in 1933. During 1932 operations in Baluchistan were curtailed and at the beginning of 1933 had virtually ceased. At the same time production was increasing in Singhbhum and in the Mysore district.

*New Caledonia.*—Production of chromite in New Caledonia in 1933 was 50,072 metric tons compared with 69,429 tons in 1932. Exports during 1933 were 24,564 metric tons compared with 14,235 tons in 1932.

The most important mines are operated by Société Tiébaghi and Société Chimique du Chrome which operates the Fantoche and Alpha mines.

*Norway.*—Imports of chromite into Norway in 1933 are not available, but in 1932 Norway imported 11,502 metric tons.

*Philippine Islands.*—The Benguet Consolidated Mining Co. was developing a group of 66 chromite claims in the Province of Camarines Sur, Island of Luzon. The deposit is about 10 kilometers northwest of the town of Lagonoy and 14 kilometers from the coast. It was reported that the properties contained some 58,000 tons, analyzing 50 percent chromic oxide. Mining will be largely opencast.

*Southern Rhodesia.*—During the decade 1922 to 1931, inclusive, Southern Rhodesia ranked first in chromite production by a wide margin. Subsequently production declined and in 1932 only 15,692 metric tons were produced. Production for 1933, however, more than doubled and amounted to 35,046 tons. This figure is still far below the 10-year average from 1922 to 1931. Exports from Southern Rhodesia in 1933 were 32,197 tons compared with 35,387 tons in 1932. The low production rate for the last 2 years may be due to stocks of chro-

[11] Denis, Bertrand T., The Chromite Deposits of the Eastern Townships of the Province of Quebec: Ann. Rept., Quebec Bureau of Mines, for the Calendar Year 1931, pt. D, Quebec, 1932, pp. 1–106.

mite and competition from other sources, particularly from Turkey and the U.S.S.R.

*Sweden.*—Imports of chromite into Sweden in 1933 increased from 9,534 metric tons in 1932 to 38,981 tons in 1933.

*Turkey.*—According to preliminary reports the production of chromite in Turkey in 1933 amounted to 89,000 metric tons, compared with 55,196 tons in 1932 and 25,382 tons in 1931. Exports in 1933 may have reached 100,000 tons compared with 55,216 tons in 1932.

The principal mines in Turkey are in the northwestern part of the country near Brusa. Important deposits also occur near Dagardi.

Early in the year, the Turkish Government reduced taxes on chromite mining. The new schedule is reported [12] as follows: If the output is the same as that of last year the tax on chrome will be 5 percent; if it decreases by 25 percent the tax will be 7.5 percent; and if by 50 percent the tax will be 10 percent. If, on the other hand, the output increases by 25 percent the tax will be 2.5 percent and if by 50 percent the tax will be only 1 percent. As the full rate of 10 percent was paid up to the end of March 1933, the excess will be refunded by the Government.

*U.S.S.R.*—The production of chromite in the U.S.S.R. in 1933 was 68,000 metric tons—about the same as in 1932. Exports in 1933 were 41,037 tons, compared with 41,527 tons in 1932. Exports in 1933 were valued at 592,000 gold rubles.

The chromite resources of the U.S.S.R. are very large, and deposits are found in many sections, particularly in the Ural Mountains. At some mines the ores may be used as mined without concentration, while at other mines plants are being built for concentrating low-grade ores.

*Union of South Africa.*—Shipments from the Union of South Africa in 1933 were 24,439 metric tons compared with a production of 19,371 tons in 1932. The ore, all of which is produced in the Transvaal, is usually of low grade, assaying 40 to 45 percent chromic oxide with high iron content. Its principal outlet is for refractories and the manufacture of bichromate. Exports in 1933 increased to 26,683 tons from 20,614 tons in 1932.

The Isitilo mine in Natal (Zululand) was being equipped with a mill for the production of high-grade chromite concentrates. The mill will have a capacity of 100 tons of concentrates per month.

*United Kingdom.*—The steel industry in the United Kingdom consumes considerable chromite. Data on imports for 1933 are not available, but 22,012 metric tons were imported in 1932, largely from Southern Rhodesia and India.

*Yugoslavia.*—Preliminary figures indicate a production of 23,427 metric tons of chromite in 1933 compared with 43,925 in 1932. Exports declined slightly to 19,157 tons in 1933 from 20,122 in 1932. The principal market for this ore is the United States, which in 1933 took 55 percent of the total. France, Austria, Germany, and Sweden also imported significant quantities from that country in 1933.

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[12] Metal Bulletin, London, Turkish Duties: No. 1795, May 30, 1933, p. 15.

# ANTIMONY

By F. M. Shore

SUMMARY OUTLINE



The antimony trade shared the improvement which characterized the general business situation in 1933 compared with the level of 1932. Antimony is used largely in storage-battery plates, bearing and babbitt metals, solder, type metal, rubber goods, paints, and fixtures, and its market therefore depends upon the rate of general industrial activity. The trend of improvement in the demand situation in 1933 is indicated by the increased production of automobiles—about 43 percent—and an estimated increase of about one-third in the output of babbitt metal. Bearing metals and storage batteries normally acount for a substantial proportion of the domestic consumption of antimony.

Virtually all factors of the antimony situation shared the upturn in 1933, reversing the general trend of the preceding year. New supplies of antimony were larger in all items, except for antimony produced in antimonial lead. Imports of all classes, as well as production from domestic ores, improved substantially, and supplies from secondary sources also registered a definite increase. Prices were distinctly higher than in 1932. World production figures are as yet incomplete, but returns received from countries which normally account for about 80 percent of the world total show increases over 1932. Although the improvement in 1933 did not by any means restore the antimony industry to the level in the years immediately preceding the depression, the figures do reveal definite and encouraging progress. The course of the significant factors in the domestic trade during the past 5 years is shown in the following table of salient statistics for antimony.

*Salient statistics for antimony in the United States, 1929–33*

| | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Average price for year of antimony at New York[1] cents per pound | 8.94 | 7.67 | 6.72 | 5.62 | 6.51 |
| Imports for consumption: | | | | | |
| Antimony in ore short tons | 1,865 | 863 | 4,863 | 1,328 | 2,128 |
| Liquated antimony sulphide do | 1,803 | 713 | 650 | 435 | 707 |
| Metal do | 11,073 | 7,700 | 3,753 | 1,508 | 1,934 |
| Oxide do | 1,892 | 690 | 746 | 403 | 651 |
| Exports of foreign antimony do | 509 | 493 | 697 | 123 | 98 |
| Stocks of antimony in bonded warehouse at end of year do | 1,461 | 705 | 702 | 705 | 523 |
| Production of antimony ore and concentrates do | | | | 900 | 1,133 |
| Antimony contained do | | | | 419 | 587 |
| Antimony contained in antimonial lead produced from domestic and foreign ores short tons | 3,052 | 1,685 | 964 | 1,085 | 927 |
| Recovery of secondary antimony do | 11,131 | 8,082 | 7,900 | 6,450 | 7,400 |

[1] According to the American Metal Market

*Prices.*—The price of ordinary brands of antimony metal in the New York market maintained a fairly consistent upward trend throughout 1933. In part, this result may be accounted for by the improvement in demand; and it has been attributed in part, also, to the decline in the exchange value of the dollar and the accompanying increase in the price of silver, the monetary standard of China, which is the world's principal supplier of antimony. The average price of antimony for 1933 represented an increase of 16.7 percent over 1932 and almost restored the level of the 1931 average. The price of metal varied over a wider range in 1933 than in the previous year. Whereas the monthly average price of antimony declined 0.576 cent per pound (9.6 percent) from January to December in 1932, it recovered 1.528 cents (26.7 percent) during the corresponding period in 1933. The spread between the high and low quotations of the year was 2.35 cents per pound, compared with a spread of 2 cents in 1932. Although the gain in the yearly average quoted price of antimony over 1932 was relatively important, it was less than the percentage of increase registered by many of the leading metals, including silver, lead, zinc, tin, and copper.

The price of antimony metal in the New York market began the year with an average in January of 5.722 cents per pound, a definite advance over the December 1932 average price of 5.400 cents. After beginning the month of January at the level which prevailed at the end of December 1932 the price soon advanced on reports from China of the formation of a Government-sponsored association to control the production and price of antimony. The price range through the first quarter of the year exhibited an upward trend, despite the apparently low level of demand. Reported Chinese production and exports from China to the United States in the first quarter were the lowest of the year. After losses in the first half of April the price recovered toward the end of the month and brought the month's average almost to the March level. Prices were steady through May but advanced at the end of the month and continued to improve through June and the first half of July to reach the high point of the year—7.75 cents per pound—in the middle of the month.

The rise from April to July coincided with the general upturn in industrial activity and the increase in other metal prices, including silver. The average monthly price of antimony receded gradually through August, September, and October, but November marked a distinct advance, and the December average price almost equaled the high average of July. According to trade reports, the improvement in prices in the last quarter of the year was largely influenced by increases in the price of Chinese grades, due to higher exchange rates based on advances in the price of silver. The course of prices for antimony metal throughout the year is outlined by the monthly averages of 5.722 cents per pound in January, 5.901 in March, 5.876 in April, 7.262 in July, 6.843 in October, and 7.250 in December.

The weekly average price of needle antimony (powdered), as quoted by the Oil, Paint and Drug Reporter, was 6–7 cents per pound at the opening of the year, advanced to 7–8 cents at the end of January, again advanced to 8–9 cents—the high of the year—at the end of July, and receded in late October to 7–8 cents, which was maintained for the balance of the year. Oxide opened the year at 7½–10 cents per pound; this price obtained until the end of July, when the high price of the year, 8½–11 cents, was reached. This price continued until late October, when it receded to 8–11 cents, and ended the year at that level.

London prices of foreign antimony metal, as quoted by Metal Industry, opened the year at £28 per long ton but advanced to £29 before the close of January. The price returned to £28 per ton early in February and continued at that figure to the early part of June when it rose to £29. The price remained at this level until the end of July, when it returned to the figure of £28, which prevailed to the end of November. December opened with a price of £27/10, which soon declined to £27, where it remained for the balance of the year.

New York prices for recent years are shown in the following table:

*Prices of antimony (chinese brands) per 100 pounds at New York City, 1929–33* [1]

| Year | High | Low | Average | Year | High | Low | Average |
|---|---|---|---|---|---|---|---|
| 1929 | $9.750 | $8.250 | $8.956 | 1932 | $7.000 | $5.000 | $5.592 |
| 1930 | 8.875 | 6.750 | 7.667 | 1933 | 7.750 | 5.400 | 6.528 |
| 1931 | 7.625 | 6.050 | 6.720 | | | | |

[1] Compiled from Engineering and Mining Journal.

*Stocks.*—Stocks of antimony metal in bonded warehouses were lower at the end of each month in 1933 than for the corresponding dates in 1932. At the end of the year stocks were 25.8 percent lower than at the close of 1932. The 1933 monthly average of stocks was 42.4 percent below that of the preceding year. From a total of 1,312,971 pounds at the end of January, stocks of metal in bonded warehouses declined to 1,053,762 at the end of March, rose slightly to 1,118,722 at the end of April, receded to 763,202 at the end of July, increased monthly to 1,193,282 at the end of October, and ended the year at the figure of 1,046,819 pounds, compared with 1,409,174 at the close of 1932.

## DOMESTIC CONSUMPTION

The annual consumption of antimony in the United States is approximately indicated by the total of the supplies made available from domestic and foreign sources. In 1933 this total, including ores (antimony content), metal, liquated antimony sulphide, and oxides and other compounds, increased 23 percent over the figure for the preceding year. All items of supplies increased, except the primary antimony content of byproduct antimonial lead. The largest single item—secondary antimony—increased 14.7 percent, while total imports for consumption, including antimony content of ore, increased 46.4 percent.

It is of interest to note the country's increasing reliance upon its supplies of antimony recovered from secondary sources. The proportion of secondary antimony in the total of new supplies of all classes made available for consumption annually in the United States, including antimony content of ores, and of antimonial lead and type metal, based on averages for the 5-year period 1921–25, was 34.6 percent. For the period 1929–33 secondary antimony averaged 42.5 percent of total supplies.

## DOMESTIC PRODUCTION

The antimony content of the 1,133 short tons of antimony concentrates produced in the United States in 1933 totaled 587 tons, which represented an increase of 40.1 percent over the figure for the previous year. All of this production came from the operations of the Yellow Pine Co. in Valley County, Idaho.

Production of antimony oxides and other salts totaled 1,993,931 pounds in 1933, an increase of 5.6 percent over the 1,887,671 pounds produced in 1932.

The quantity of metallic antimony produced in 1933 cannot be published. The Texas Smelting & Refining Co. is reported to have produced each month of the year, but at a small fraction of capacity and at an average rate of output substantially lower than during the previous year. This company operates a plant at Larèdo, Tex., and uses ores imported from Mexico.

Late in 1933 the Texas Smelting & Refining Co. filed a complaint under section 3 (e) of the National Industrial Recovery Act alleging that imports of antimony metal were being brought into the United States on such terms or under such conditions as to render ineffective or seriously to endanger the maintenance of the President's Reemployment Agreement under which the company operated, pending approval of a code. It was requested that the President cause an investigation to be made and direct that antimony metal be permitted entry into the United States only upon such terms and conditions and subject to such limitations that entry would not render or tend to render ineffective any code or agreement applying to the antimony industry. In February 1934 the National Recovery Administration announced dismissal of the complaint.

The primary antimony contained in byproduct antimonial lead produced from both foreign and domestic ores in 1933 was 927 short tons, a decrease of 14.6 percent from the quantity produced in the preceding year. In the 17,805 short tons of antimonial lead produced at primary plants in 1933 from primary and secondary sources, 793 tons of the antimony content were secondary antimony. These figures compare with a production of 21,024 tons of antimonial lead at primary plants in 1932 containing 2,495 tons of antimony, of which 1,085 tons were primary and 1,410 tons secondary antimony. Of the new antimony contained in the antimonial lead produced in 1933, 6.1 percent was of foreign origin compared with 19.1 percent in 1932.

No antimony production was reported from Alaska in 1933. The report of the United States Geological Survey covering the mineral industry of Alaska for 1932 includes the following comment regarding antimony [1]:

> Antimony ores are widely distributed throughout Alaska, and in the past considerable quantities were produced and shipped from the Territory. In 1932, however, so far as reported to the Geological Survey, no antimony ores were sold, and no prospecting is known to have been done on lodes solely valuable for the antimony they contain. However, according to reports received from the owner, the annual assessment work required by law was kept up on 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

[1] Smith, Philip S., Mineral Industry of Alaska in 1932: U.S. Geol. Survey Bull. 857-A, 1934, p. 75.

laid aside until enough has accumulated to be worth shipping. The present low price of antimony of less than 6 cents a pound and the remoteness of most of these deposits in interior Alaska do not encourage their development at this time. Prospecting is said to have been continued on the known nickeliferous sulphides of the Chichagof district, in southeastern Alaska, but no ore is reported to have been produced for sale during the year.

*Mine production of antimony ores and concentrates in the United States, 1929–33, in short tons* [1]

| Year | Ore and concentrates | Antimony content | Year | Ore and concentrates | Antimony content |
|---|---|---|---|---|---|
| 1932 | 900 | 419 | 1933 | 1,133 | 587 |

[1] No production reported for 1929–31.

*Byproduct antimonial lead produced in the United States from both foreign and domestic ores, 1929–33*

| Year | Short tons | Antimony content | | Year | Short tons | Antimony content | |
|---|---|---|---|---|---|---|---|
| | | Short tons | Value [1] | | | Short tons | Value [1] |
| 1929 | 25,669 | 3,052 | $545,700 | 1932 | (2) | 1,085 | $122,000 |
| 1930 | 13,711 | 1,685 | 258,500 | 1933 | (2) | 927 | 121,000 |
| 1931 | (2) | 964 | 129,600 | | | | |

[1] Calculated at average yearly price for ordinary brands of antimony as given by American Metal Market.
[2] Figures not available. Total byproduct antimonial lead produced at primary plants from primary and secondary sources in 1931 was 21,842 tons, in 1932, 21,024 tons; and in 1933, 17,805 tons.

*Recovery of secondary antimony.*—In 1933, 7,400 short tons of antimony valued at $963,500 were recovered from old alloys, scrap, and dross, according to J. P. Dunlop, of the Bureau of Mines. This quantity, most of which was recovered in the form of alloys, is 14.7 percent greater than the amount recovered in 1932. The total value increased 32.9 percent over the preceding year. Of the 1933 total 793 tons, representing a decrease of 43.8 percent from 1932, were recovered from antimonial lead scrap treated at regular smelters, while 6,607 tons, an increase of 31.1 percent, were recovered as metal and in alloys at secondary smelters.

*Secondary antimony and antimony content of secondary alloys recovered from old alloys, scrap, and dross in the United States, 1929–33*

| Year | Short tons | Value [1] | Year | Short tons | Value [1] |
|---|---|---|---|---|---|
| 1929 | 11,131 | $1,990,200 | 1932 | 6,450 | $725,000 |
| 1930 | 8,082 | 1,239,800 | 1933 | 7,400 | 963,500 |
| 1931 | 7,900 | 1,061,800 | | | |

[1] Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

## IMPORTS AND EXPORTS

*Imports.*—All classes of antimony imported for consumption in 1933 showed marked gains over the preceding year. The antimony content of ore increased 60.2 percent in quantity and 43.4 percent in value; imports of liquated antimony sulphide rose 62.5 percent in quantity and 195.6 percent in value; and metal increased 28.2 percent in quantity and 27.1 percent in value, while the quantity and value of oxides and other compounds increased 50.5 and 93.9 percent, respectively. The total quantity of the classes named increased 46.4 percent over 1932.

General imports of ore and metal in 1933 likewise made important gains over the preceding year—60.2 percent for ore (antimony content) and 27.6 percent for metal. As in the 2 years preceding, Mexico was the principal source of antimony ores imported, while China held its customary predominance as the source of antimony metal.

Imports of type metal, although not of important volume, were the largest since 1929.

Exports of antimony from the United States are never important in volume, and exports of domestic origin are seldom recorded. In 1933 exports of foreign antimony were only 98 short tons.

*Antimony imported for consumption in the United States, 1929–33*

| 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 | | | | | | |
| 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 |
| 1933 | 5,445 | 2,128 | 106,662 | 707 | 42,727 | 1,934 | 137,541 | 709 | 81,454 |

*Antimony imported into the United States, 1932–33*

[General imports]

| Country | Antimony ore | | | Antimony metal | |
|---|---|---|---|---|---|
| | Gross weight (short tons) | Antimony content | | Short tons | Value |
| | | Short tons | Value | | |
| **1932** | | | | | |
| Argentina | 278 | 115 | $11,869 | | |
| Belgium | | | | 2 | $174 |
| Bolivia | 39 | 10 | 1,636 | | |
| Chile [1] | 7 | 2 | 237 | | |
| China | | | | 1,895 | 106,882 |
| Germany | | | | (2) | 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 |
| **1933** | | | | | |
| Belgium | | | | 2 | 178 |
| Bolivia | 585 | 376 | 24,674 | | |
| Chile [1] | 22 | 11 | 1,060 | | |
| China | | | | 2,447 | 158,678 |
| Germany | | | | 2 | 172 |
| Mexico | 4,838 | 1,741 | 80,928 | 84 | 10,741 |
| United Kingdom | | | | 23 | 3,736 |
| | 5,445 | 2,128 | 106,662 | 2,558 | 173,505 |

[1] Imports credited to Chile originated mainly in Bolivia.
[2] Less than 1 ton.

*Type metal imported for consumption in the United States, 1929–33* [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 |
| 1929 | 2,720 | $180,679 | 295 | 10.8 | 1932 | 6 | $479 | 1 | 16.7 |
| 1930 | 328 | 32,934 | 53 | 16.2 | 1933 | 371 | 39,212 | 301 | 81.1 |

[1] No imports reported for 1931.

*Foreign antimony (matte, regulus, or metal) exported from the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 509 | $71,415 | 1932 | 123 | $11,820 |
| 1930 | 493 | 54,634 | 1933 | 98 | 9,321 |
| 1931 | 697 | 74,668 | | | |

## WORLD SOURCES AND PRODUCTION

Antimony ores are distributed widely 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 sources are apparently unable to compete successfully in the world market except in periods of large demand with accompanying high prices. Accurate figures of total world reserves are lacking, but known deposits are sufficient to indicate that fear of exhaustion can be postponed to the distant future.

That the potential productive capacity of the world is greatly above normal requirements is indicated by the record of high production during the period of the World War compared with the output in later years of industrial activity. World output, for example, averaged about 440,500 metric tons of recoverable content of antimony ores in the 5-year period 1914–18 compared with an average production of 28,500 tons in the 1925–29 period and 23,000 tons in the period 1928–32.

In recent years antimony has been produced with considerable regularity in about a dozen countries, but in most of them the annual output was small. In times of large demand and high prices the sources having high production costs enter the competitive situation and eventually help to bring about a state of overproduction which leads to a return of prices to the level at which the world's demand has been supplied under normal conditions. Other factors that tend to restrain excessive prices are the use of substitutes and curtailment of consumption. These considerations, together with the world-wide distribution of antimony deposits, are a measure of assurance against any sustained period of excessive prices of antimony in the world's markets.

Because of the various and not strictly comparable terms in which production is reported in most foreign countries, the Bureau of Mines endeavors to reduce all statistics of production to a common basis—the recoverable metal content of the ore produced. Figures of the antimony content of antimonial lead ores are, as far as possible, excluded from the statistics of world production published by the Bureau.

Since antimony is a factor in the metal markets of the leading industrial countries its price in each country is related to world demand. The relation of world demand, as indicated by world production, and the price of metallic antimony in New York is indicated for the period 1912–33 in the accompanying chart (fig. 19). The production curve represents the estimated recoverable content of antimony ore exclusive of antimonial lead ore while the price curve shows the annual average price per pound, duty paid.

Figures of world production for 1933 are as yet incomplete, but the data at present available indicate an increase in world production over 1932. Among the producing countries China has been the leading source of supply for many years. In 1932, the latest year for

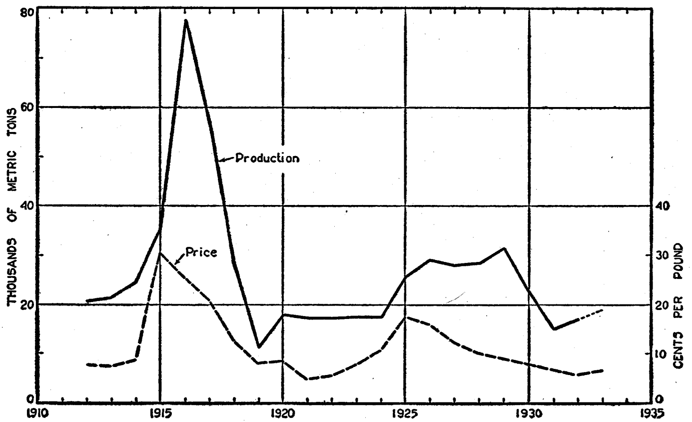


FIGURE 19.—World production of antimony (approximate recoverable metal content of antimony ore produced), and average price per pound in New York, 1912–33. Data on world production in 1933, as shown by the dotted line, are subject to revision.

which virtually complete data are available, China's proportion of the world production was approximately 70 percent. Her annual percentage of world production during the 10 years ended in 1932 has averaged substantially this same figure. Mexico was in second place in 1932, with Bolivia, Czechoslovakia, and France following in order. These five leading countries accounted for about 90 percent of the world production in 1932.

As in other recent years, Mexico supplied the bulk of the antimony ore imported by the United States in 1933; Bolivia was the only other important contributor.

*China.*—Exports of antimony from China increased moderately in 1933. As in the preceding year Great Britain was the leading customer of China in 1933, and the United States, Japan, and Germany followed in order, the same as in the preceding year. Substantial quantities of antimony were exported also to the Netherlands, Belgium, Italy, and France in 1933. Of the exports from China in

1933, 80.2 percent was regulus, 11.7 percent crude, and 8.1 percent "refuse and oxide." [2]

The estimated production of antimony in Hunan Province, the source of more than 90 percent of China's annual output, rose from 700 long tons in each month of the first quarter to 1,000 tons in each month of the last quarter of 1933. Stocks at Changsha (the outlet for all antimony products from Hunan Province) at Hankow, and at the Hunan mines, believed to be mostly regulus, were 5,640 long tons at the end of January, receded gradually to 3,346 tons at the end of July, advanced to 5,315 at the end of October, and were about 4,850 at the end of the year. Declared exports from China to the United States, mostly regulus, were 360 long tons in the first quarter, 1,085 tons in the second quarter, 1,188 tons in the third quarter, and 680 tons in the last quarter of the year.[3]

The Antimony Trade Association for Hunan, sponsored and controlled by the Provincial Government and designed to monopolize and control the production and export prices of antimony from Hunan, began operations the first of the year. This is said to be the first instance of Government control of the antimony trade in the region which furnished approximately 95 percent of the Chinese output of antimony. In March 1933 the Hunan Provincial Government announced that it had withdrawn as an active participant in the association and would confine its interest to supervision. Although unsuccessful in its efforts to dominate the antimony trade in China generally, the association did exercise considerable influence, in spite of predictions that it would soon collapse. The association continued to function throughout the year but with reduced membership and curtailed activities. During the last quarter of the year it functioned mainly as a trader.[4] Reports from China indicate that the antimony market was highly unstable throughout 1933.

Early in 1934 it was reported that the Hunan Provincial Government had ordered antimony production restricted to 500 tons monthly, beginning February 1. Subsequent reports of production in China do not indicate adherence to the production limit prescribed in the order.[5]

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[2] Statistical Department of the Inspectorate General of Customs, Monthly Return of the Foreign Trade of China, December 1933, The Maritime Customs, China. I: Statistical Series 8, Shanghai, 1934, pp. 26 and 88.

[3] Bureau of Foreign and Domestic Commerce monthly reports of the antimony situation in the Hankow-Changsha-Shanghai districts, 1933.

[4] Bureau of Foreign and Domestic Commerce, Foreign Trade Notes.

[5] Bureau of Foreign and Domestic Commerce monthly reports of the antimony situation in the Hankow-Changsha-Shanghai districts, 1934.

*World production of antimony, 1929–33, in metric tons* [1]

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

| Country [2] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada | | | 6 | | |
| Mexico | 3,096 | 3,042 | 2,230 | [3] 1,388 | [3] 1,559 |
| United States | | | | 304 | 426 |
| South America: | | | | | |
| Bolivia [4] | 3,023 | 927 | 1,078 | 1,176 | (5) |
| Peru [4] | 86 | 47 | 24 | 14 | (5) |
| Europe: | | | | | |
| Austria | 560 | | | | (5) |
| Czechoslovakia | 556 | 307 | 513 | 480 | (5) |
| France | 1,021 | 992 | 660 | 344 | (5) |
| Greece | 55 | 54 | 217 | 262 | (5) |
| Italy | 306 | 330 | 269 | 302 | (5) |
| Yugoslavia | 210 | 3 | 286 | (5) | (5) |
| Asia: | | | | | |
| China [4] | 22,401 | 17,419 | 9,842 | 12,002 | 13,374 |
| India, British | 38 | 1 | | | (5) |
| Japan | 22 | | 1 | 3 | (5) |
| Turkey (Asia Minor) | 6 | 26 | 34 | (5) | (5) |
| Africa: | | | | | |
| Algeria | | | 6 | 214 | 422 |
| Morocco, Spanish | [4] 180 | | 80 | 121 | 120 |
| Southern Rhodesia | | 27 | | | (5) |
| Oceania: | | | | | |
| Australia: | | | | | |
| New South Wales | 25 | 42 | 38 | 61 | (5) |
| Victoria | 1 | | | | (5) |
| | 31,600 | 23,200 | 15,000 | 17,000 | (5) |

[1] Approximate recoverable metal content of ore produced (80 percent of reported content), exclusive of antimonial lead ores.
[2] In addition to the countries listed, Chosen is reported to have produced 7 tons of antimony ore in 1932, but no data are available on the antimony content of the ore.
[3] Includes antimony content of antimonial lead.
[4] Exports.
[5] Data not available.

# ARSENIC

By A. V. Petar and C. N. Gerry

SUMMARY OUTLINE



A sharp upturn in the domestic consumption of arsenic marked the year 1933; the total supply as indicated by domestic sales plus imports was 22,380 short tons, which compares favorably with the figures for any previous year except 1929 and 1930, when apparent consumption exceeded 27,000 tons annually. For several years prices had remained nominally unchanged, but in 1933 the average receipts for sales, as reported to the Bureau of Mines, showed marked increases both for refined and crude. Sales of crude arsenic increased more than 50 percent in 1933 compared with 1932, whereas sales of domestic refined arsenic were lower than those of any previous year since 1928. The latter circumstance may doubtless be attributed in part to the resumption of imports on a substantial scale, but an increasing trend toward the use of crude in preference to refined arsenic appears to be in progress. Perhaps in consequence of this trend the differential between the average value of crude and refined arsenic as reported by producers has narrowed to about four-tenths of a cent per pound in 1932 and 1933 compared with more than double this figure in previous years. Of special interest is an increased use of crude arsenic in wood preservation. Sales of refined arsenic exceeded production, indicating a decrease in stocks. Stocks of crude arsenic, however, evidently increased by more than 400 tons, but this was largely explained by the considerable output of high-grade (95 to 99 percent) material by the Jardine Mining Co., which output remained unsold at the end of the year. No figures are available relative to stocks in consumers' hands, but there is no reason to expect that they increased materially.

*Salient statistics for arsenic in the United States, 1925–33*

| | 1925–29 average | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| WHITE ARSENIC | | | | | |
| Domestic sales: [1] | | | | | |
| Crude.....short tons.. | 2,364 | 2,771 | 1,795 | 1,975 | 3,029 |
| Refined.....do.... | 10,035 | 14,654 | 11,982 | 10,508 | 8,768 |
| Imports for consumption.....do.... | 10,769 | 10,471 | 7,791 | 6,882 | 10,583 |
| Apparent supply [1].....do.... | 23,168 | 27,896 | 21,568 | 19,365 | 22,380 |
| Average reported value: | | | | | |
| Domestic, crude.....cents per pound | 2.82 | 2.09 | 2.18 | 2.28 | 2.40 |
| Domestic, refined.....do.... | 3.54 | 3.05 | 3.00 | 2.67 | 2.80 |
| OTHER ARSENICALS | | | | | |
| Imports for consumption: | | | | | |
| Metallic arsenic.....pounds.. | 208,672 | 113,440 | 28,661 | 45,474 | 100,258 |
| Sulphide (orpiment and realgar)..do.... | 575,506 | 554,902 | 598,194 | 502,531 | 674,002 |
| Arsenic acid ($H_3AsO_4$).....do.... | 14,692 | 201 | 12,061 | 1,703 | 150 |
| Calcium arsenate.....do.... | 1,815 | 6,359 | 40,950 | 4,500 | 11,023 |
| Lead arsenate.....do.... | [2] 5,334 | 800 | ..... | ..... | 1,000 |
| Sheep dip.....do.... | 135,929 | 174,215 | 154,530 | 62,509 | 106,751 |
| Paris green and london purple....do.... | 5,502 | 19,024 | 2,340 | 2,364 | 46,051 |
| Exports: | | | | | |
| Calcium arsenate.....do.... | [3] 2,159,168 | 3,177,335 | 2,145,653 | 2,533,599 | 2,585,824 |
| Lead arsenate.....do.... | [3] 1,328,828 | 2,270,980 | 1,788,345 | 1,189,629 | 598,699 |

[1] Includes sales by domestic producers for export.
[2] 10,467 pounds in 1925 and 200 pounds in 1929; no imports of lead arsenate reported from 1926 to 1928, inclusive.
[3] Averages for 1928–29; exports of calcium arsenate and lead arsenate not separately recorded by Bureau of Foreign and Domestic Commerce prior to 1928.

*Domestic production and sales.*—Reflecting the continued shrinkage in copper and lead smelter output the production of arsenious oxide (white arsenic) in the United States dropped in 1933 to 10,650 short tons—the smallest quantity since 1926. Approximately two-thirds (7,181 tons) was refined, and the remainder (3,469 tons) was crude. Three of the producing companies—the Anaconda Copper Mining Co., U.S. Smelting, Refining & Mining Co., and the American Smelting & Refining Co.—recovered arsenic as a byproduct from smelting copper and lead ores; the fourth producer—the Jardine Mining Co.—saved a few hundred tons of white arsenic in connection with its gold-mining operations at Jardine, Mont. The products for the market were refined white arsenic, crude white arsenic, refinery crude, treater dust, and flue dust. No production of red or yellow arsenic sulphide or elemental arsenic was reported in 1933.

Sales of domestic refined and crude arsenic amounted to 11,797 tons valued at $636,132. Approximately 75 percent (8,768 tons) was sold as refined white arsenic for $489,549, and the rest (3,029 tons) was sold as crude arsenic for $146,583.

*Prices.*—The price of 4 cents a pound for white arsenic delivered at New York, in barrels, was not revised; since 1927 this quotation has become a fixture. Inasmuch as the freight to New York is roughly one-half cent and another half cent covers the cost of packing in barrels, tank-car shipments to certain plants may be made at some discount under 4 cents.

The average receipts actually obtained from sales by producers in 1933, as reported to the Bureau of Mines, were 2.80 cents per pound for refined and 2.40 cents for crude arsenic. These prices of course do not include freight. The averages reported in 1932 were 2.67 and 2.28 cents, respectively.

A sharp downward revision occurred in the London market early in the year, but although both the American dollar and Mexican peso slumped in terms of the British pound, fluctuations were soon reduced to narrow limits and at the end of the year there was a perceptible stiffening tendency. At the beginning of the year both Cornish white and Mexican arsenic were selling around £20 a ton or about 3 cents a pound, with sterling at $3.28, but by mid-January £1 had been shaded off this price. Cornish white later dropped to about £16, and the Mexican producers somewhat more reluctantly followed suit and eventually cut as much as 10s. below this figure, thereby tending to restore the differential which had favored the Cornish product prior to 1932. On the basis of the average exchange rate for December ($5.116) the British market was equivalent to about 3.67 cents a pound, substantially higher in terms of American money than at the beginning of the year although actually much lower as measured in gold.

Quotations for arsenic compounds rose in 1933, and at the end of the year red arsenic and arsenic metal were quoted at higher figures than at any time since 1925 and 1929, respectively. The price of imported red arsenic climbed gradually from 10¾ to 11½ cents per pound in June to 14¾ cents in December. Calcium arsenate remained at the 1932 quotation of 5½ to 6½ cents during the first half of the year but beginning in mid-June and for the remainder of the year was quoted at 7 to 8 cents. The price of lead arsenate also changed in June from 9 to 10½ cents to 10 to 11½ cents. Sodium arsenate was quoted at 7¾ to 8¾ cents throughout the year. The decline in the price of arsenic metal which began in 1932 continued in 1933, reaching 25¾ to 28 cents in February and remaining at this level until the latter part of July, when it rose to 31 to 33 cents; there was a further increase to 40 to 43 cents early in October, and this price was in effect for the rest of the year.

*Uses.*—A symposium on insecticides in connection with the 85th meeting of the American Chemical Society in March 1933 uncovered many interesting facts in connection with the use of arsenic compounds as insecticides. The origin of the insecticide industry was traced back to 1860, when green paint made from arsenic and copper was one day diverted from its intended use on shutters to a poison for the potato beetle, which was proving troublesome at the time.[1] Since then the employment of arsenicals as insecticides has developed into an important industry. Calcium arsenate and lead arsenate maintain leading importance in this field, but in recent years other compounds, such as magnesium arsenate and manganese arsenate, have come into use. The latter compound is said to be sold in fairly large quantities in the Northwest and to give promise as a substitute for lead arsenate.[2] The value of arsenic in insecticides is the fact that it is poisonous, but this same property leads to troublesome complications. An early indication of the problem was recognized in 1900, when in England and Wales more than 6,000 persons were made ill and 70 killed by the consumption of beer containing traces of arsenic.[3] In the United States the Federal Food and Drug Act of 1906 limited the arsenic

[1] Myers, C. N., Throne, Binford, and others, Significance and Danger of Spray Residue: Ind. and Eng. Chem. (Indust. Ed.), vol. 25, no. 6, June 1933, p. 624.

[2] Alvord, Earl B., and Dietz, Harry F., Control of Insects on Plants by Chemical Means: Ind. and Eng. Chem. (Indust. Ed.), vol. 25, no. 6, June 1933, p. 631.

[3] White, W. B., Poisonous Spray Residues on Vegetables: Ind. and Eng. Chem. (Indust. Ed.), vol. 25, no. 6, June 1933, p. 622.

residue on apples to the equivalent of 0.01 grain of arsenic trioxide per pound of fruit, but this regulation was not enforced until 1927, when a tolerance of 0.25 grain was set for that year but subject to progressive reductions to 0.01 grain in 1932. This led to successful experimentation in washing fruit to keep the arsenic within the specified limits. In 1933, however, further limitations were imposed by a Department of Agriculture ruling which restricted the lead content of apples and all other fruit to 0.014 grain per pound.

Methods that have been employed for removing spray residue include the simple expedient of wiping the fruit by hand or using mechanical wiping machines, and the more recent solvent methods, involving dilute acid or alkaline washes. Several State agricultural experiment stations have studied the problem. At the Oregon Agricultural Experiment Station, Corvallis, Oreg.,[4] several years' experience has shown that hydrochloric acid is probably the most generally satisfactory solvent. A 1.0-percent solution is strong enough to remove both arsenic and lead within the tolerance, irrespective of the arsenical load, provided no wax has formed on the fruit and no oil has been used after the early cover sprays. Some alkaline washes, such as sodium hydroxide, sodium carbonate, trisodium phosphate, and sodium silicate, have proved effective for the removal of the arsenical residue, particularly when the fruit has become very waxy or where fish oil or mineral oil residues are present. In general, however, hydrochloric acid is apparently more effective in dissolving the lead than alkaline solvents. Somewhat similar conclusions were reached at the Washington Agricultural Experiment Station.[5] In Pennsylvania it was found that heavy rains in late August and early September do not appreciably reduce the amount of arsenic adhering to apples sprayed with lead arsenate, but that the removal of arsenic is facilitated if lime is added to the lead arsenate sprays.[6]

The effects of repeated applications of calcium arsenate dusting and other arsenical applications upon soil fertility likewise have aroused considerable interest in recent years. Soil poisoning has been definitely traced to this cause in the case of certain grains and forage crops. Trouble of this character does not seem to be serious where soils are iron-rich and doubtless can be greatly reduced by treatment with sulphate of iron. It has recently been shown, however, that certain fungi feed on arsenic, converting it into gases and consequently eliminating it from the soil.

A Swedish patent [7] covers the treatment of crude arsenical dusts with lime in excess of the amount required to form a basic arsenate; this is melted later, producing an insoluble or slightly soluble and hence less dangerous form.

*Imports.*—In 1933, imports of white arsenic (arsenious acid) rose to 10,583 short tons valued at $512,542, the highest figure since 1929; in 1932, only 6,882 short tons valued at $357,991 were imported. Imports from Mexico, which formerly furnished the bulk of the foreign arsenic used in the United States, gained a few hundred pounds (4,040 short tons valued at $256,611 in 1933 compared with 3,325

[4] Robinson, R. H. Removal of Poisonous Spray Residues on Fruit: Ind. and Eng. Chem. (Indust. Ed.), vol. 25, no. 6, June 1933, p. 617.
[5] Webster, R. L., Spuler, Anthony, and Marshall, James, Toxicity of Arsenicals: Washington Agric. Exper. Sta. Bull. 275, 1932, pp. 32-3.
[6] Ingerson, H. G., The Future of Spray-Residue Removal (from apples) in Pennsylvania: State Hort. Assoc. News, vol. 9, no. 1, 1932, pp. 37-44, 46-9.
[7] Lindblad, A. R., Working up Arsenic Ore: Swedish Patent 74722, July 12, 1932.

short tons valued at $182,671 in 1932). The greater part of the increase resulted from a sudden influx of shipments from France. Except for 537 short tons brought in during 1932, imports of white arsenic from France had not exceeded 60 tons annually at any time during the past 10 years, but in 1933 the quantity rose sharply to 3,810 short tons valued at $113,606, second only to Mexico. Next in importance was Japan, which furnished 1,338 tons compared with 1,643 tons in 1932. Imports from Canada continued to decline, and only 457 tons were brought in during 1933 (compared with 841 tons in 1932 and 1,532 tons in 1931), only slightly in excess of importations from Australia (452 tons), which made an initial shipment of 6 tons to the United States in 1932. Imports from Belgium and Germany were slightly less than in 1932; and Sweden, which is now a dominant figure in the world's supply of arsenic, shipped only 28 tons of white arsenic to the United States.

*White arsenic imported into the United States, 1929–33, by countries*

[General imports]

| Source | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| Australia | ------- | ------- | ------- | ------- | ------- | ------- | 6 | $380 | 452 | $23,001 |
| Belgium | 964 | $68,053 | 400 | $27,130 | 321 | $23,203 | 278 | 18,698 | 239 | 13,760 |
| Canada | 1,489 | 113,522 | 1,109 | 81,543 | 1,532 | 114,324 | 841 | 60,462 | 457 | 31,404 |
| France | ------- | ------- | 27 | 1,761 | 17 | 1,079 | 537 | 16,194 | 3,810 | 113,606 |
| Germany | 30 | 2,694 | 11 | 909 | 66 | 4,626 | 252 | 15,927 | 219 | 12,482 |
| Japan | 708 | 23,721 | 674 | 27,870 | 1,546 | 66,324 | 1,643 | 63,659 | 1,338 | 60,397 |
| Mexico | 9,966 | 748,186 | 8,234 | 585,705 | 4,298 | 241,053 | 3,325 | 182,671 | 4,040 | 256,611 |
| Sweden | ------- | ------- | 325 | 19,500 | ------- | ------- | ------- | ------- | 28 | 1,281 |
| Netherlands | ------- | ------- | ------- | ------- | 11 | 859 | ------- | ------- | ------- | ------- |
| | 13,157 | 956,176 | 10,780 | 744,418 | 7,791 | 451,468 | 6,882 | 357,991 | 10,583 | 512,542 |

Imports of arsenical compounds other than white arsenic were generally larger in 1933 than in 1932; metallic arsenic, arsenic sulphide, calcium arsenate, and paris green and london purple importations were unusually heavy.

*Exports.*—Exports of white arsenic are not reported in the export statistics, but reports of individual domestic producers indicate that, as in 1932, nearly 2,000 tons of white arsenic were sold for export in 1933. Calcium arsenate was exported from the United States in somewhat larger quantities than in 1932, but exports of lead arsenate were at the lowest figure in a number of years.

*World production.*—The total annual production of arsenic increased from about 10,000 tons before the World War to more than 25,000 tons in 1920 and subsequently to 45,000 tons. Recent developments in foreign countries may be summarized briefly as follows:

In Western Australia the facilities for recovering arsenic at the Wiluna Gold Mines have been enlarged by the installation of a Cottrell unit to collect fumes from roasting the gold-arsenic flotation concentrate.[8]

The production of arsenic in Canada continued to decline and was probably less in 1933 than in any year since 1925; the value dropped

[8] Chemical, Engineering, and Mining Review, Arsenic Collection at Wiluna: Vol. 26, no. 306, Mar. 5, 1934, p. 255.

from $135,170 in 1931 to $98,714 in 1932 and only $56,534 in 1933. Exports of arsenic from the Dominion showed a 50-percent reduction, and a like decrease in imports of arsenicals indicates a falling off in Canadian consumption.

After a fairly steady increase from 447 tons in 1920 to 3,950 tons in 1930 the output of white arsenic in France jumped to 4,725 tons in 1931 and apparently has continued to rise rapidly. French consumption has been growing, but an export surplus—perhaps only temporary in character—is indicated by the sudden increase in exports to the United States. Expanded production is due to stimulated activity in the production of gold-bearing mispickel and pyrite, the production of which, after paralleling the expansion in white arsenic production for several years, advanced suddenly from 48,795 metric tons in 1930 to 105,635 tons in 1931 and probably 145,000 tons in 1933. The Salsigne mine in the Department of Aude, southern France, is the leading producer, and the product exported to the United States contains over 98 percent $As_2O_3$.

German export trade mounted to a peak of 4,614 tons valued at 2,485,000 reichsmarks in 1930 but has since declined. Recent fluctuations are attributable mainly to a sharp increase followed by a substantial drop in shipments to the U.S.S.R. Early in 1934 the German Minister of Economics issued a decree forbidding expansion of productive capacity for metallic arsenic or red arsenic.[9]

Arsenic is produced in Mexico in American-owned plants. The output, which in 1928 and 1929 averaged nearly 13,000 metric tons, dropped to only 3,991 tons in 1932, and preliminary figures for 1933 indicated only a slight recovery to 4,696 metric tons. In addition to exports to the United States shipments of Mexican arsenic are made to Great Britain, Italy, and South Africa.

Of world-wide interest are the efforts to dispose of the huge accumulations of arsenic at the Boliden smelter in northern Sweden. A plain statement of the problem was recently made by the chief engineer of the Boliden Co., A. G. P. Palén, in a paper before the Association of Swedish Inventors. A complete history of the arsenic phase of this enterprise is contained in an abstract of the aforementioned paper.[10]

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[9] Bureau of Foreign and Domestic Commerce, World Trade Notes on Chemicals and Allied Products: Vol. 8, no. 17, Apr. 21, 1934, p. 4.

[10] Robak, C. A., Further Uses for Arsenic Trioxide Are Urgently Needed: Ind. and Eng. Chem. (News Ed.), vol. 12, no. 6, Mar 20, 1934, p. 101.

World production of arsenic is summarized in the following table:

*World production of arsenic ore and white arsenic, 1928–32, in metric tons*

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

| Country and product | 1928 | 1929 | 1930 | 1931 | 1932 |
|---|---|---|---|---|---|
| Algeria: Arsenate of lead: | | | | | |
| Gross weight | 1,201 | 2,541 | 1,175 | ---------- | ---------- |
| Arsenic content | 144 | 305 | 353 | ---------- | ---------- |
| Australia: | | | | | |
| New South Wales: | | | | | |
| Ore and concentrates [1] | 5,924 | 2,814 | 6,809 | 3,977 | (2) |
| White arsenic | 50 | 255 | 809 | 672 | 495 |
| Western Australia—White arsenic | ---------- | ---------- | ---------- | 416 | 1,501 |
| Austria: Arsenic content of gold ores | 14 | ---------- | ---------- | ---------- | ---------- |
| Belgium: Luxemburg Economic Union: White arsenic [3] | 2,659 | 3,717 | 3,111 | 2,502 | 2,045 |
| Brazil: White arsenic | ---------- | ---------- | ---------- | 179 | 211 |
| Canada: | | | | | |
| White arsenic | 1,821 | 1,678 | 1,248 | 1,622 | 1,100 |
| Arsenic content of ores and concentrates exported | 643 | 694 | 804 | ---------- | ---------- |
| China: White arsenic | (2) | 2,387 | 983 | 500 | (2) |
| Czechoslovakia: Ore: | | | | | |
| Gross weight | 6 | 38 | ---------- | ---------- | ---------- |
| Arsenic content | 1 | 8 | ---------- | ---------- | ---------- |
| France: | | | | | |
| Ore: [4] | | | | | |
| Gross weight | 69,362 | 43,263 | 48,795 | 105,635 | 109,268 |
| Arsenic content [5] | 3,703 | 3,622 | 4,970 | 5,774 | (2) |
| White arsenic | 2,947 | 3,372 | 3,950 | 4,725 | (2) |
| Germany: | | | | | |
| Ore: | | | | | |
| Gross weight | 25,710 | 27,866 | 29,437 | 27,935 | 2,824 |
| Arsenic content | 1,619 | 1,756 | 1,858 | 1,850 | (2) |
| White arsenic [3] | 2,711 | 2,578 | 4,614 | 4,425 | 3,459 |
| Great Britain: | | | | | |
| Ore [1] | ---------- | 20 | ---------- | ---------- | ---------- |
| White arsenic and arsenic soot | 1,314 | 968 | 588 | 180 | 251 |
| Greece: White arsenic | 709 | 763 | 841 | 659 | 385 |
| Japan: White arsenic | 1,829 | 1,963 | 1,654 | 2,588 | (2) |
| Mexico: White arsenic | 12,933 | 12,785 | 9,476 | 7,956 | 3,991 |
| Portugal: | | | | | |
| Ore [1] | (2) | 9 | (2) | (2) | (2) |
| White arsenic | 134 | 105 | 176 | 159 | 59 |
| Southern Rhodesia: White arsenic | 102 | 52 | 50 | ---------- | ---------- |
| Sweden: Ore: | | | | | |
| Gross weight | 22,728 | 22,919 | 24,316 | 54,355 | 198,231 |
| Arsenic content | 4,546 | 4,584 | 4,350 | 11,182 | 20,035 |
| Turkey: Ore: | | | | | |
| Gross weight | 10 | 14 | 55 | 54 | 306 |
| Arsenic content | (2) | 6 | 22 | 22 | 3 |
| Union of South Africa: White arsenic | 17 | 33 | 15 | 9 | 4 |
| United States: White arsenic | 10,675 | 13,196 | 15,808 | 12,498 | 11,324 |
| 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: 1928, 359 tons; 1929, 410 tons; 1930, 137 tons. Data not available for later years.

# RADIUM, URANIUM, AND VANADIUM

By Frank L. Hess

## SUMMARY OUTLINE



During 1933 the radium-, uranium-, and vanadium-mining industry of the United States was still oppressed by its twin troubles, the business depression and the competition of rich or easily mined foreign deposits. Combined outputs of the ores produced during 1933 were only 105 short tons containing 256.3 milligrams of radium, 1,998 pounds of uranium oxide ($U_3O_8$), and 7,180 pounds of vanadium pentoxide ($V_2O_5$). This ore was valued at $4,119.

Carnotite ores furnished the radium and uranium and more than half of the vanadium. The remainder of the vanadium was contained in vanadinite and related ores.

No uranium or vanadium ores were imported or exported during 1933, but some radium and uranium salts were imported.

The salient statistics for 1932–33 are shown in the table following:

*Salient statistics of radium, uranium, and vanadium, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Quantity | Value | Quantity | Value |
| Production: | | | | |
| Carnotite ores ... short tons | 61 | $6,150 | 52 | $3,099 |
| Radium contained ... milligrams | 481 | (1) | 256 | (1) |
| Uranium contained ... pounds | 3,186 | (1) | 1,694 | (1) |
| Vanadium contained ... do | 3,024 | (1) | 2,240 | (1) |
| Vanadium ores ... short tons | 25,465 | 473,418 | 53 | 1,020 |
| Vanadium contained ... pounds | 537,874 | (1) | 1,781 | (1) |
| Imports: | | | | |
| Uranium oxide and salts of ... do | 122,229 | 146,051 | 186,461 | 245,656 |
| Radium salts ... grams [2] | 9.14 | 479,028 | 11.6 | 572,026 |

[1] Figures not available.
[2] Bureau of Foreign and Domestic Commerce publishes quantities as follows: 1932, 141 grains; 1933, 179 grains.

*Prices.*—Radium was quoted by Metal and Mineral Markets during 1933 at a nominal price of $50 per milligram of radium content in lots of 2 grams or more; $55 for 1 gram; and $55 to $60 for smaller quantities.

Vanadium in ore (vanadinite, etc.), 26 cents per pound of contained vanadium pentoxide ($V_2O_5$); fused vanadium oxide, 66⅔ cents per pound of $V_2O_5$ in material carrying 85 percent $V_2O_5$ or more; sodium uranate, $1.30 to $1.35 per pound.

*Imports.*—Imports into the United States of radium and uranium salts and of vanadium ores during 1933 and preceding years are shown in the following tables, which were compiled from the records of the Bureau of Foreign and Domestic Commerce:

*Radium and uranium salts imported for consumption in the United States, 1930–33*

| Class | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value |
| Radioactive substitutes | (1) | $971 | (1) | $267 | (1) | $2,513 | (1) | $74 |
| Radium salts grams [2] | 16.86 | 924,852 | 13.41 | 731,204 | 9.14 | 479,028 | 11.6 | 576,026 |
| Uranium oxide and salts of pounds | 231,194 | 306,566 | 180,049 | 233,601 | 122,229 | 146,051 | 186,461 | 245,656 |
| | | 1,232,389 | | 965,072 | | 627,592 | | 821,756 |

[1] Weight not recorded.
[2] Bureau of Foreign and Domestic Commerce publishes quantities as follows: 1930, 260 grains; 1931, 207 grains; 1932, 141 grains; 1933, 179 grains.

*Vanadium ore (steel-hardening) imported for consumption in the United States, 1928–33* [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 1931–33.

## 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 viewpoints 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 treatment of 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 is very great.

[1] Manufacture of One Gram of Radium: Hearing before a subcommittee 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.

Radium is now used in the examination of steel for flaws. A tube containing radium is placed on one side of the metal and a photographic plate in a holder is held on the other side. After the plate is developed flaws in the metal will be shown by differences in exposure. This practice has been described in considerable detail by V. E. Pullin,[2] who finds that the smallest detectable flaws are of the order of 1 percent of the thickness of the object examined. In Germany mesothorium is used in place of radium; although its cost is two-thirds that of radium, it is "by no means as efficient and its life is very limited." X-rays have overwhelming advantages for examining steel not much more than 3 inches thick.

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, and the Treibacher Chemical Works, A. G., of Germany is said[3] to have found advantageous the addition of radium salts to spinning solutions from which rayon fiber is made, presumably to prevent their accumulation of static electricity with the consequent standing apart of the fibers.

*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, and although such steels can be made without vanadium much manipulation, labor, and time are saved by its use. It is also used in cast iron.

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; iron, remainder.

In adding vanadium to steel the practice is usually to introduce it in the form of ferrovanadium, but some steel makers add vanadium oxide to the molten slag from which it is absorbed into the steel.

In the contact process of manufacturing sulphuric acid and in the making of certain organic chemicals the use of vanadium is apparently increasing. For these purposes a few tons of the element suffice.

About 95 percent of the vanadium produced is thought to go into steel.

## THE DOMESTIC INDUSTRY

Most of the carnotite was mined by the Shattuck Chemical Co. from claims formerly controlled by the American Rare Metals Co. on the Dolores River in the McIntyre district, San Miguel County, Colo. Frank Silvey mined a little carnotite ore near Summit Point, a post office on the Utah side of the State line. The known carnotite deposits in the immediate vicinity, however, are in Colorado. Shumway Bros. shipped a few pounds of rich ore from their claims near Blanding, Utah, and were said to have some rich ore sacked.

There was some effort to obtain funds from the Federal Government with which to establish a custom sampler and laboratory at Moab,

[2] Pullin, V. E., Radium in Engineering Practice: Proc. Inst. Mech. Eng. (London), vol. 124, 1933, pp. 305-322; discussion, pp. 323-332.

[3] Industrial and Engineering Chemistry (news edition), Radioactive Substances Are Added to Spinning Solutions: Vol. 12, Jan. 20, 1934.

Utah, for sampling and analyzing carnotite ores, and the Pioneer Radium Research Corporation was said to have been formed for the purpose. Another proposal was to have the Federal Government establish a plant in Long Park near Naturita, Colo., for the extraction of radium, uranium, and vanadium from carnotite ores. The ores were to be bought from claim owners or others.

At Kingman, Ariz., the Kingman Refining & Smelting Corporation made some lead vanadate and vanadium oxide from vanadinite, descloizite, and related minerals from Goodsprings, Nev. The Molybdenum Corporation of America was reported to have bought a group of carnotite claims from the International Vanadium Corporation on the south side of Dry Valley, Utah, and another group at Gateway, Colo.

The United States Bureau of Standards measured approximately 12 grams of radium, which presumably represents the quantity sold

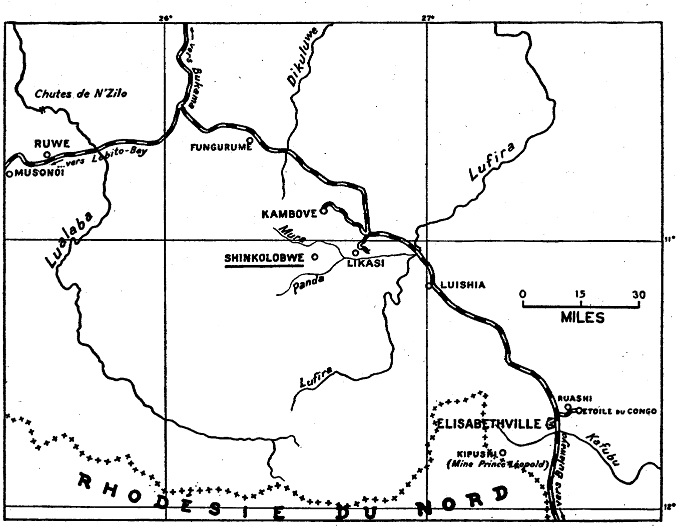


FIGURE 20.—Location of Shinkolobwe (Chinkolobwe), Belgian Congo; after Thoreau and du Trieu de Terdonck.

in this country during the year. Four grams of radium (in 80 platinum tubes) were bought by the American Oncologic Hospital, Thirty-third Street and Powelton Avenue, Philadelphia.

At the beginning of the year considerable stocks of fused vanadium oxide were on hand, but in the second half of the year these were largely reduced. Sale prices were low, averaging about 66⅔ cents per pound for the contained vanadium.

## THE FOREIGN INDUSTRY

*Belgian Congo.*—The deposits of uraninite (the visibly crystallized form of pitchblende, $UO_2$), with its alteration products, at Shinkolobwe (also spelled Chinkolobwe) and Kasolo (see fig. 20) in Katanga, the southeast part of Belgian Congo, Central Africa, operated by the Union Minière du Haut Katanga, remained the dominating deposits but like all others felt the effects of the world depression in business, and it is said Belgium[4] had 160 grams of radium. What part was held by the company is unknown. No figures for the output during 1933 are yet available, but in 1931, 252 metric tons, and in 1932, 130 metric tons (278 and 143 short tons, respectively) of uranium ore were shipped.[5]

It was reported that among other transactions in radium the Union Minière du Haut Katanga was "to lend 5, and if necessary 10 grams of radium to the London Radium Institute for its therapeutic researches",[6] and 4 grams were leased to the Province of Ontario.[7]

Although 18 years had passed since their discovery the first description giving any considerable amount of detail of the Katanga uranium deposits was published during the year by Thoreau and du Trieu de Terdonck.[8] No reference is made to quantity of ore produced or producible or to the deposit at Kasolo, although it is mentioned in the title. A digest of the description of the deposits follows:

Major Sharp discovered the uranium deposit at Shinkolobwe in 1915 while making surveys. At that time the deposit seemed insignificant, presenting the general appearance of the silicified copper outcrops. Small fragments of a yellow mineral attracted attention, and crosscuts showed a new uranium mineral in place.

Systematic mining begun in 1921 showed the value of the deposit. The deposit is 15 kilometers south of Kambove in an isolated mass of silicified friction breccia on the divide between the drainage basins of the Mura and Panda Rivers. The rocks formed a crest 40 to 45 feet high and 250 feet long. No native workings (common on the copper deposits of Katanga) were found here. The crest was covered by rather poorly developed trees, and no special influence of the radium on the vegetation could be found.

A mass of many tons of pitchblende was found under a few centimeters of soil, that trifling cover hiding all evidence of its presence, and two crosscuts exposed superb mineralization in successive multicolored zones. Specimens obtained from this first work are in the Geological Museum of the University of Louvain.

The occurrence of the uranium minerals is so sporadic that an estimate of reserves can be made only by a network of shafts and tunnels (see fig. 21). Workings have not yet gone beyond the oxidized zone, and publication on the deposits has not been made on account of the lack of data. All work is under the observation of geologists; data are kept, and specimens of interest are placed in the museum at Jadotville.

The mass containing the ore deposits is made up of altered carbonate rocks of the "série des Mines" and is surrounded by the Kundelungu formation (a group of argillaceous and talcose schists) in comparatively undisturbed layers. Such a condition is merely an exaggeration of the structure commonly found in numerous copper deposits of Katanga. The maps of the deposits show mineral deposits at 16 places and a great number of discontinuous uranium-bearing veins in the workings. Movements similar to those which produced

[4] Fortune, The Great Radium Mystery: Vol. 9, February 1934, p. 70.
[5] Mining Journal (London), Congo Mineral and Metal Exports in 1932: Vol. 181, May 20, 1933, p. 343.
[6] Rhodesian Mining Journal, item quoted from Illustration Congolaise (Brussels): Vol. 7, September 1933, p. 301.
[7] Northern Miner, vol. 19, Feb. 1, 1934, p. 5.
[8] Thoreau, J., and du Trieu de Terdonck, R., Le gite d'uranium de Shinkolobwe-Kasolo (Katanga): L'Institut colonial belge (Section des sci. nat. et med.), tome 1, fasc. 8, collection 4, 46 pp., 11 pl. of 91 figs., 7 sketch maps, and plans.

the deposit at Shinkolobwe but on a grand scale have taken place at Kambove (copper deposit). The dislocations in the rocks of the "série des Mines" permitted metallization from the depths; besides uranium, which occurs only in deposits at the west end of the "série

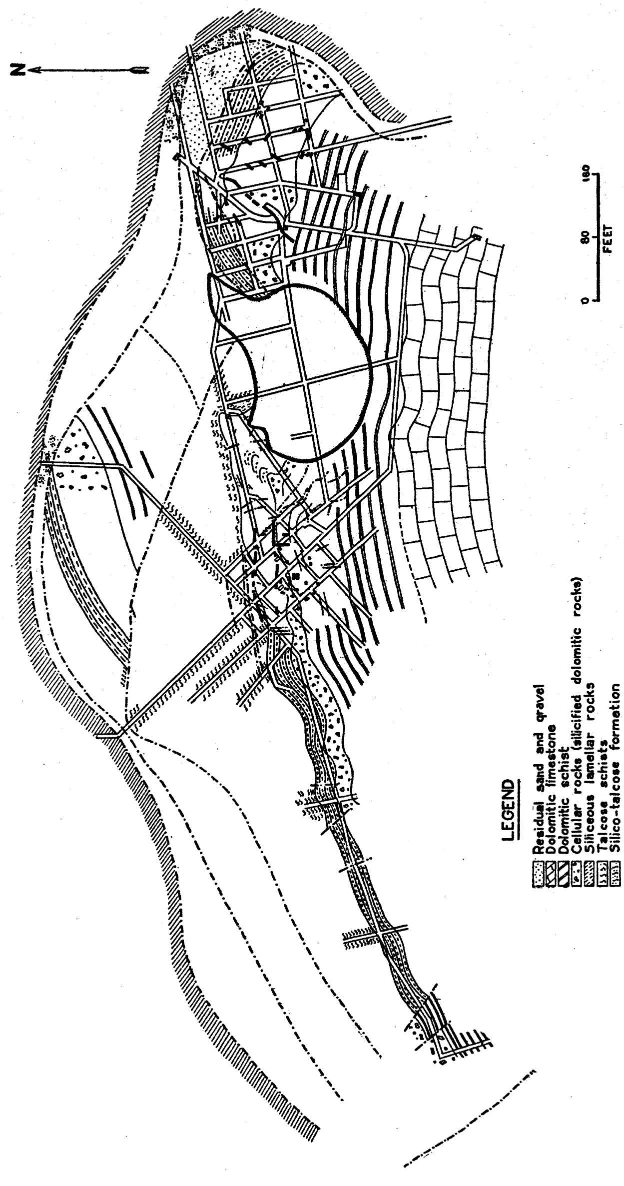


Figure 21.—Plan of the Shinkolobwe (Chinkolobwe) uranium deposits, Katanga, Belgian Congo; after Thoreau and du Trieu de Terdonck.

des Mines" block, there are found at Shinkolobwe copper, cobalt, nickel, vanadium, iron, and precious metals, but none occur in the Kundelungu formation.

The "série des Mines", in which the uranium deposits are found, contains a total thickness of about 200 meters (656 feet) of dolomitic limestone and interbedded dolomitic and carbonaceous or graphitic schist.

Uranium minerals are found as isolated masses only in the crushed rocks. Some of the limestone has been altered to talc, but the question of alteration is not local but part of the general tectonic effects in Katanga.

The uranium minerals are free from visible gangue minerals, whether found in massive veins or disseminated through the country rock. The veins are either alone, or more commonly, are in groups. All are capricious. It is rare that a vein can be followed more than a dozen meters (39 feet). A vein a few centimeters wide may swell to a meter and yield masses of compact mineral weighing several tons. In mining the entire mass of rock is removed to reduce losses to a minimum.

The deposits tend to parallel the main faults, although they are not in them. They also follow small cross fractures. Veins form stockwerklike masses; as they are followed downward they coalesce and pinch out, and new veins are found. A vein 20 meters (66 feet) long pinched at 15 meters (49 feet) depth with no trace of extension, and new veins appeared at a depth of 30 meters (98 feet).

As in the copper deposits there is no post-mineral faulting. The mineralization is later than both folding and faulting.

Disseminated minerals are found: (1) For a short distance outward from the veins, all being now altered to other minerals; and (2), distributed with no apparent relation to the veins, mostly as individual plates of torbernite (green, $CuO.2UO_3.P_2O_5.8H_2O$) or lining cavities in the cellular magnesian limestone, either near or far from the veins. More than half of the uranium in the oxidized zone is found in such disseminated torbernite. There is no intimation as to whether the disseminated mineral has been mined and concentrated. Kasolite (ocher yellow, $3PbO.3UO_3.3SiO_2.4H_2O$) and sklodowskite (pale yellow, $MgO.2UO_3.2SiO_2$) are also found as disseminated minerals, the latter lining cavities like torbernite. Small quantities of copper, cobalt, and nickel sulphides are found in the uranium veins but occur in much greater quantities in other parts of the "série des Mines." In the thick magnesian limestone in the southern part of the outcrop of the carbonate rocks are sulphide deposits like those of Luishia but with more copper and much more nickel. The sulphides are oxidized at the surface. Molybdenum has been bound as microscopic plates of molybdenite ($MoS_2$) and as wulfenite.

Gold can be panned from the uranium veins and is occasionally seen in them. A little palladium and platinum are shown by assays, but in what form they occur in the ore is unknown.

A magmatic source for the deposits cannot be doubted. Monazite is found in all surrounding rocks, as are tourmaline (though less widely distributed) and apatite. Chlorite and talc occur in quartz veins or immediately adjacent to them, but the two minerals of this association are difficult to distinguish from those caused by deep-seated metamorphism of the schists.

The pitchblende is crystalline [crystalline pitchblende is uraninite], and is later than and replaces quartz in small veins and impregnates (replaces) carbonate rocks. Thoreau and du Trieu de Terdonck believe that the uranium replaces earlier minerals, even in the large veins. Pyrite, linnaeite, and chalcopyrite are later than the pitchblende. The time of deposition of the molybdenite among the other minerals is not determined. The sulphide deposition is much more abundant than the uranium deposition but is largely separate. It is thought that the sulphides also replace quartz, and they likewise impregnate the schist of the "série des Mines" and the dolomite. The origin of bornite found among the sulphides is uncertain.

Although the uranium ore of Shinkolobwe is exceptional in its tonnage and quality uranium is not an abnormal occurrence in the mineralization of Katanga. Pitchblende or minerals formed by its alteration have been found in seven deposits from Ruashi on the southeast to the extreme northwest of the copper zone, passing through Luishia and Kambove. The occurrence of copper and nickel is very similar.

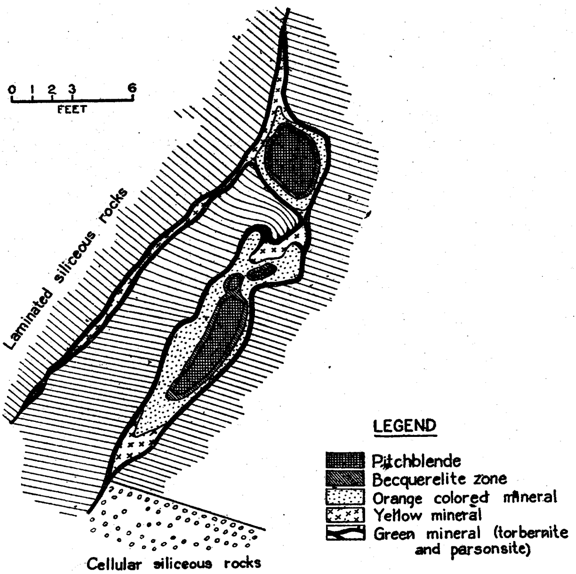


FIGURE 22.—Vertical cross-section of a pitchblende vein at Shinkolobwe (Chinkolobwe), Katanga, Belgian Congo; after J. Nève, from Thoreau and du Trieu de Terdonck.

The deposits are probably connected with a granitic intrusion, but it is unsafe to speak positively.

There is a comparatively large quantity of lead in the uranium minerals. (Kasolite, dewindtite, and parsonsite are lead-uranium minerals, and wulfenite is a lead molybdate.) All of the lead has been formed through the degradation of the uranium of the pitchblende. The form of the deposits suggests that they are replacements of the carbonate rocks (fig. 22).

*Canada.*—Considerable work was done on the radium-bearing veins at and near LaBine Point on the east side of Great Bear Lake, Mackenzie District, Northwest Territories, but the original discovery on the property of Eldorado Gold Mines, Ltd., remains the most important.

During 1933, 828 feet of drifting were done by the company[9] besides crosscutting, raising, and surface trenching. From this work 5¼ tons of silver ore carrying 4,329.35 ounces per ton, with a gross value of

[9] Data from the annual report of Eldorado Gold Mines, Ltd.

$8,509.24, and 24 tons of pitchblende ore, with a gross value of $48,000, were extracted. Besides the rich ores, 1,500 tons of milling ore, thought to be of high grade, were taken out. On no. 2 vein an ore shoot was shown to be 200 feet long and 4 feet wide. The material from this shoot was reported to carry "30 ounces of silver to the ton and important quantities of pitchblende in the form of lenses and finely disseminated."

The company extraction plant at Port Hope, Ontario, treated 58 tons of ore, from which were extracted 3.021 grams of radium in a salt 98 percent pure; 34,940 pounds of uranium salts were also produced. There remained in process 1.5 grams of radium and 5,000 pounds of uranium salts. The plant is designed to treat 3 to 4 tons of pitchblende per week. The company erected a concentrating mill of about 50 tons daily capacity at LaBine Point.

The B.E.A.R., S.G.R. Mines, Ltd., and Northwest Radium Minerals, Ltd., report finding pitchblende on their claims near Great Bear Lake.

Some work was done near Wilberforce, Haliburton Township, Ontario, by the International Radium and Resources, Ltd.,[10] and Canadian Radium Mines, Ltd.[11] on pegmatites said to carry uranium minerals. So far no production is known to have been made, and except in the decayed bodies of Madagascar no pegmatite anywhere has been known to yield uranium minerals in quantities sufficient for the commercial extraction of radium. In Madagascar betafite and related minerals have been extracted from the soft rock by cheap native labor.

The Great Bear Lake region was described by H. S. Robinson [12] and methods used in extracting radium from the Great Bear Lake pitchblende were described by R. J. Traill.[13] Extraction is complicated by the large quantity of silver in the concentrates.

Palache and Berman [14] described the weathering products of the pitchblende and found uranophane, zippeite, a mineral "X" closely related to becquerelite, another "Y" near curite, and several colloidal substances.

*Czechoslovakia.*—Figures for the production of radium and uranium in Czechoslovakia during 1933 are not available at the time this chapter is being written, but the radium output is usually between 3 and 4 grams per year, which would entail ore carrying 13 to 17 tons $U_3O_8$.

All the uranium and radium comes from veins at Jachymov. Besides uranium, the veins carry quartz, dolomite, cobalt, nickel, and bismuth minerals. Five metric tons of the picked ore are said to produce 1 gram of radium,[15] although this seems too rich. All operations are conducted by the State. The following is quoted from Industrial and Engineering Chemistry.[16]

> Since the ore is insoluble in acids, it is calcined with soda and nitrate, dilute sulphuric acid is added and about one-third of the material remains as insoluble residue which contains all the radium as insoluble sulphate. Residue treated

[10] Chemistry and Industry (London), vol. 53, Jan. 5, 1934, p. 12.
[11] Northern Miner, Canada Radium Progress: Vol. 19, Jan. 11, 1934, p. 20.
[12] Robinson, H. S., Notes on the Echo Bay district, Great Bear Lake, Northwest Territories: Canadian Min. and Met. Inst. Bull. 258, October 1933, pp. 609–628.
[13] Traill, R. J., Extraction of Radium from Great Bear Lake Pitchblende: Canadian Min. and Met. Inst. Bull. 257, September 1933, pp. 448–467.
[14] Palache, Charles, and Berman, Harry, Oxidation Products of Pitchblende from Bear Lake: Am. Mineral., vol. 18, January 1933, pp. 20–24.
[15] Industrial and Engineering Chemistry (news edition), vol. 11, Dec. 10. 1933, p. 348.
[16] See footnote 15.

with alkaline hydroxide and hydrochloric acid to isolate radium sulphate, which is then transformed into carbonate, chloride, etc., and at the end of the refining processes a mixture of radium and barium chlorides is obtained which is separated by multiple recrystallization. The pure radium chloride is placed in glass tubes, its radium content is measured, and it is ready for the market. The radium is virtually free from mesothorium.

A movement to abolish the Czechoslovak Radiological Institute in Prague has caused protests. The Institute is said to measure about 8 grams of radium annually.[17]

Two grams of radium were shipped to the London Medical Institute in August,[18] and the lot was enclosed in 596 kilograms (1,314 pounds), almost 2 cubic feet, of lead for shipment. Export sales are made through the Frankfurt-am-Main, Germany, office on a quota scheme with Belgian products—the Belgians being allowed sales of twice that of Czechoslovakia.

It was announced that uranium was reported to have been found near Sumperk, Moravia,[19] but no details regarding the discovery have been received.

Doctor Stoktasa [20] of Prague has made a study of the radioactivity of the air in the mines at Joachimsthal and Schneeberg and has come to the conclusion that it may cause certain pulmonary cancers.

Lungs of animals subjected to the protracted action of radium rays produced large amount of lactic acid, which in turn affected the action of respiratory enzymes, especially the oxidases and peroxidases. The oxidation of lactic acid was thus inhibited, as was the oxidation of ethanol and acetaldehyde. Irritations are caused by this accumulation of lactic acid, and these seem to lead to the growth of tumors and cancers. Emanations absorbed by a miner in the radium mines at Joachimsthal or at Schneeberg, who works 7 hours a day and some 300 days a year, may reach 4.2 to 8.4 million Machê units, corresponding to a weight of 1.55 to 3.1 milligrams of radium per annum. The cumulative action of the radium emanations explains the occurrence of cancer of the lungs in those mines in which the air shows an activity of 10 to 14 Machê units. The only practical precaution than can be taken is ventilation under pressure."

A survey of the Czechoslovak Erzgebirge has been undertaken by Santholzer and Ulrich,[21] and maps following Vernadsky's type are being made.

*Germany.*—Previous to 1913 a little pitchblende had been produced in Germany from the Erzgebirge, Saxony, and from 1927 to 1930 the Bergfreiheitsgrube (a magnetite mine) at Schmiedeberg in the Riesengebirge, produced 8 tons of ore of unknown uranium content. The largest annual output—12 tons of ore of unknown tenor—was produced from the Erzgebirge in 1886.[22]

In the Bergfreiheitsgrube small masses of pitchblende were found at depths ranging from 100 to 150 meters (328 to 492 feet). Mining did not pay at either locality, and the mines were closed.

At Wölsendorf in the Upper Palatinate a little pitchblende and minerals formed by its weathering are found with a very dark purple fluorite; a few other occurrences of uranium minerals are known in Germany, but the deposits are not of economic importance.

[17] See footnote 15.
[18] Narodni Politika, Sept. 5, 1933, quoted by American Consulate General, Prague, Weekly Rep. of Current Econ. Events, Sept. 1–7, 1933.
[19] Mining Journal (London), vol. 182, Aug. 26, 1932, p. 600.
[20] Industrial and Engineering Chemistry, Radioactive Air May Cause Pulmonary Cancer: Vol. 11, Nov. 20, 1933, p. 329.
[21] Santholzer, W., and Ulrich, F., Radio-Geological Survey of Czechoslovakia: Nature, vol. 133, Mar. 24, 1934, p. 461.
[22] Heingartner, R. W., United States consul, Radioactive Springs in Germany: Rept., Dec. 29, 1933.

As noted in this chapter for 1932 a small quantity of radium is being extracted from the deposits made by the waters of Bad Kreuznach. From 10 to 20 tons of the deposits are formed per year and yield about 1.75 milligrams of radium per ton. The radioactivity of other springs in Germany has been tested and those following carry more than 100 Machè units.[23]

| | Machè units |
|---|---|
| Radium Bad Oberschlema, as much as | 13, 500 |
| Bad Brambach | 2, 000 |
| Bad Landeck | 206 |
| Bad Kreuznach | 171 |
| Bad Steben | 154 |
| Baden-Baden | 126 |
| Bad Flinsberg | 107 |

In accordance with Germany's movement to increase the use of domestic materials the Erzgebirge and Freiheits mines are to be reopened.[24]

*Kenya.*—Radioactive minerals are reported from the Loldyka range in the Nyeri Nanuki district of Kenya, but the discovery so far seems to have little importance.[25]

*Portugal.*—The British-owned uranium mines at Urgeirica are said to have increased their output during 1933,[26] although no data are available on the quantity of ore produced.

According to a short history of Portuguese radium mining published in 1933 by Lepierre and Leite:[27]

In 1908 a French company, L'Urane, Urbain, Feige & Cie, began work at Barracao, near Guarda in the northeast part of Portugual on the mining properties Rosmaneira, Coitos, Corredoura, Senhora do Remedio, Rebeiro dos Agudes, etc., and for 5 years prospected the mines and made salts of uranium without trying to fractionate them. From 1908 to 1910 the uranium ores were sent to Armet de l'Isle, Nogent, a trip of about 2,000 kilometers by rail or several days by sea. There was, then, a plant erected in Portugual to make pure radium salts or concentrates, and later radium-bearing barium-sulphate was made and sent to France for further treatment.

In 1912 the company became the Society Urane-Radium and began to produce in 1913. The bank H. Burnay of Lisbon was a silent partner and sold to the company the ore of the Urgeirica near Nellas, in Mondego Valley. The mines of the older company were abandoned.

During 1915 pure radium salts and alkaline uranates were produced. From 1925 to 1927 radium-bearing sulphates were made first at Barracao, then at the Urgeirica. In 1920, Urane-Radium was changed to Sociètè des Applications Scientifique du Radium (A.S.R.).

From the beginning of 1908 to 1926, 10 grams of radium were produced.

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[23] A Machè unit is defined as a unit equal to the quantity of radon (radium emanation) in equilibrium with 0.364 millimicrocurie of radium per liter. The millimicrocurie is one billionth (0.000,000,001) of the radon in equlibrium with 1 gram of pure radium, so that the Machè unit equals a quantity of radon in a liter of water that is 0.000,000,000,364 of the radon in equilibrium with 1 gram of pure radium.

[24] Berliner Tageblatt Jan. 16, 1934; quoted by C. T. Zawadski, United States vice consul, Berlin, Jan. 20, 1934.

[25] Rhodesian Mining Journal, Gold Discovery; Radioactive Minerals: Vol. 7, February 1933, p. 91.

[26] Mining Journal (London), Portugual in 1933: Vol. 184, Feb. 17, 1934, p. 40.

[27] Lepierre, Charles, and Leite, A. Pio., L'Industrie du radium au Portugal: Chim. et ind., vol. 29, num. spec. 12 Cong. chim. ind., June 1933, pp. 797–804.

*U.S.S.R.*—Since 1925 Russia has had an organization to handle radium and other rare metal ores which is now known as Sojusredmet.[28]

The first operations regarding rare elements undertaken in the Union occurred in 1918, and concerned the recovery of radium from residues of the Fergansk concern, which had been liquidated before the war without ever having produced even a milligram of radium, due to the absence of technical equipment.

Systematic exploitation of rare elements started only in 1925, with the foundation of a central organization for handling all questions pertaining to them which, after numerous changes, now functions under the name of "Sojusredmet." This organization concerns itself with the exploitation, as well as the study of scientific experimental and plant questions, regarding the following rare elements: Tungsten, molybdenum, uranium, vanadium, beryllium, bismuth, lithium, titanium, tantalum; the minerals thorium, rubidium, caesium, rhenium, gallium and some other combined elements; and also cobalt, tin, antimony and mercury. Sojusredmet also embraces the scientific experimental institute for rare elements "Giredmet", with its branches at Odessa and Aserbaidshan, as well as a number of mining enterprises in the Urals, East Siberia, Turkestan, and the Ukraine, and also a plant for rare elements at Moscow. The construction of new plants for the production of finished goods embracing rare elements is planned.

In addition to the "Sojusredmet" a number of other scientific institutes concern themselves with rare elements, including the Academy of Sciences of the Union of Socialist Soviet Republics conducting scientific work regarding zircon based upon the Chibinsk eudialyte deposits; the Leningrad Institute for Metals covering vanadium; the Trust Lakokraska, for titanium-white; the Institute for Applied Mineralogy, regarding the industrial utilization of titanium-magnetic-iron-ores; the Electric Works for alloys of tungsten, titanium, tantalum, and molybdenum; the Wochimfram Works, recovery of selenium and strontium from Russian ore deposits. The activities of the State Radiological Institute are also to be mentioned.

A number of new methods in the technological processes have been introduced for the working of radioactive materials. Numerous natural springs have been discovered in petroleum districts which, aside from barium, have revealed a radium content. A new process for the recovery of radium, discovered by I. J. Baschilow, is being put into operation.

The results of work conducted in the Laboratory for Rare Elements have made possible the production of luminous materials on the basis of zinc sulphide.

New methods have also been developed for the recovery of chemically pure compounds from uranium and vanadium salts. The rare element plant of the Sojusredmet has recently instituted the production of high-content ferrovanadium from vanadium compounds, according to the aluminum-thermit process.

The laboratories of the Institute for Applied Mineralogy have developed the preparation and application of vanadium catalyzers in substitution for platinum catalyzers, for the sulphuric acid industry.

Experimental work conducted by the Laboratory for Rare Elements regarding the technology of the vanadium deposits which were discovered not long ago in Kasakstan, achieved the development of a method for the recovery of vanadium from the slag remaining from the smelting of phosphorus ores (phosphatic iron ores) by the Thomas process, according to the principle developed by the Swedish investigator, F. Von-Seth [29] which also makes possible the recovery of vanadium from titanium-magnetic iron ores. Enormous deposits of these ores exist in the Urals which hitherto have not been utilized but which will now completely offset the lack of natural deposits of high-content (ilmenite) titanium ore.

Experiments are also being conducted regarding the smelting of titanium-magnetic-iron ores with coke in blast furnaces designed to improve the separation of the vanadium-containing raw iron from the titanium-containing slag with sodium chloride.

*South Australia.*—The Radium Corporation (S.A.), which holds claims on Mount Painter, apparently did little work on them during 1933. The company was reported to have sold a small quantity of radium and was negotiating for the sale of the claims.[30]

[28] Redecker, Sydney B., American consul, Russia's Increasing Importance in Rare Elements: German Metal and Mineral Notes, June 24, 1933.
[29] Mineral Resources of the United States, pt. I, 1925, p. 621.
[30] Industrial and Australian Mining Standard, Radium Corporation (S.A.): Vol. 188, Oct. 1, 1933, p. 299.

# PLATINUM AND ALLIED METALS

By H. W. Davis

SUMMARY OUTLINE



Although platinum occurs over a wide area in Alaska, California, and Oregon (the chief producing localities of this country) the proportion of the platinum metals present usually is small, and the deposits could not be worked profitably if it were not for the gold content. The quantity of platinum metals recovered annually from these placer deposits averaged about 300 ounces for the past 10 years, and was almost negligible in the world supply. Much larger quantities of platinum metals are obtained in the United States as byproducts of gold and other metals (about 7,000 ounces annually during the 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, as it has furnished about 50,000 ounces annually for the past 10 years. The bulk of this output comes from crude platinum imported from foreign sources, notably Colombia. In addition, this country has supplied about 46,000 ounces of secondary platinum metals annually for the past 10 years.

*Salient statistics of platinum and allied metals in the United States, 1932–33, in troy ounces*

| | 1932 | 1933 |
|---|---|---|
| Production: | | |
| Crude platinum from placers | 1,074 | 1,223 |
| New metals: | | |
| Platinum | [1] 14,666 | [1] 48,581 |
| Palladium | 1,252 | 942 |
| Other | 1,698 | 2,016 |
| | 17,616 | 51,539 |

[1] 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; in 1933 includes 1,298 ounces of new platinum from domestic sources comprising 248 ounces derived from crude placer platinum and 1,050 ounces obtained from domestic gold and copper ores as a byproduct of refining.

*Salient statistics of platinum and allied metals in the United States, 1932–32, in troy ounces*—Continued

| | 1932 | 1933 |
|---|---|---|
| Production—Continued. | | |
| Secondary metals: | | |
| Platinum | 21, 635 | 35, 073 |
| Palladium | 5, 783 | 4, 814 |
| Other | 5, 170 | 1, 475 |
| | 32, 588 | 41, 362 |
| Stocks in hands of refiners, Dec. 31: | | |
| Platinum | 37, 976 | 41, 204 |
| Palladium | 19, 707 | 20, 581 |
| Other | 18, 228 | 15, 237 |
| | 75, 911 | 77, 022 |
| Imports for consumption: | | |
| Platinum | 33, 218 | 111, 283 |
| Palladium | 15, 445 | 37, 790 |
| Other | 7, 384 | 13, 008 |
| | 56, 047 | 162, 081 |
| Exports: | | |
| Unmanufactured | 20, 106 | 23, 686 |
| Manufactures (except jewelry) | 2, 032 | 1, 323 |

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; the Soviet Union (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 1933 indicate a production of 793 troy ounces of crude platinum in Alaska, 417 ounces in California, and 56 ounces in Oregon—a total of 1,266 ounces (1,074 ounces in 1932). The greater part of the production in Alaska came from placers in the Goodnews Bay district south of the mouth of the Kuskokwim River. In California most of the platinum produced was a byproduct of dredges working the gold placers in Merced and Sacramento Counties. Virtually all the production in Oregon came from the ocean beach near Cape Blanco in Curry County.

Many gold and copper ores in the United States contain comparatively small quantities of platinum. These ores furnish the greater part of the new platinum recovered annually from domestic sources. In 1933, 1,050 ounces of platinum were recovered as a byproduct of refining gold and copper ores compared with 1,694 ounces in 1932.

*Purchases.*—Platinum refiners in the United States reported purchases of domestic crude platinum from the following sources in 1933: Alaska, 145 ounces; California, 297 ounces; and Oregon, 66 ounces—a total of 508 ounces (481 ounces in 1932). Refiners in the United States also reported purchases of 58,897 ounces (19,043 ounces in 1932) of foreign crude platinum in 1933—12 ounces from Canada, 54,784 ounces from Colombia, and 4,101 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 \$23 to \$26 an ounce for domestic and \$17 to \$29 an ounce for foreign crude platinum. A list of buyers of foreign and domestic crude platinum in the United States who reported purchases in 1933 follows:

American Platinum Works, 225 New Jersey Railroad Avenue, Newark, N.J.
Baker & Co., Inc., 54 Austin Street, Newark, N.J.
Thomas J. Dee & Co., 1010 Mallers Building, Chicago, Ill.
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.
Wildberg Bros. Smelting & Refining Co., 742 Market Street, San Francisco, Calif.

## REFINED PLATINUM METALS

*New metals recovered.*—Reports from refiners of crude platinum, gold bullion, and copper indicate that 51,539 ounces of platinum metals were recovered in the United States from these sources in 1933, an increase of 193 percent compared with 1932. It is estimated that 2,107 ounces of the total in 1933 were derived from domestic sources.

*New platinum metals recovered by refiners in the United States, 1932–33, by sources, in troy ounces*

| | Platinum | Palladium | Iridium | Osmiridium | Others | Total |
|---|---|---|---|---|---|---|
| 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 |
| 1933 | | | | | | |
| Domestic: | | | | | | |
| Crude platinum | 248 | 2 | 41 | 55 | 4 | 350 |
| Gold and copper refining | 1,050 | 698 | 8 | | 1 | 1,757 |
| | 1,298 | 700 | 49 | 55 | 5 | 2,107 |
| Foreign: Crude platinum | 47,283 | 242 | 1,385 | 437 | 85 | 49,432 |
| Total recovery | 48,581 | 942 | 1,434 | 492 | 90 | 51,539 |

*New platinum metals recovered by refiners in the United States, 1929–33, in troy ounces*

| Year | Platinum | Palladium | Iridium | Osmiridium | Others | Total |
|---|---|---|---|---|---|---|
| 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 |
| 1933 | 48,581 | 942 | 1,434 | 492 | 90 | 51,539 |

*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 1933 were 41,362 ounces, an increase of 27 percent over 1932.

*Secondary platinum metals recovered in the United States, 1929–33, in troy ounces*

| Year | Platinum | Palladium | Iridium | Others | Total |
|---|---|---|---|---|---|
| 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 |
| 1933 | 35, 073 | 4, 814 | 692 | 783 | 41, 362 |

*Prices.*—Refiners reported the following prices for platinum in 1933: High $44.50, low $18.50, and average for the year $30.75 an ounce, compared with $42.50, $20, and $32 an ounce, respectively, for 1932. They gave the following prices for palladium: High, $28.50, low $11.50, and average for the year $18.30 an ounce, compared with $40, $14.50, and $18 an ounce, respectively, for 1932.

Figure 23 shows the average monthly official prices quoted for the platinum metals from 1931 to 1933. The effect of the world platinum

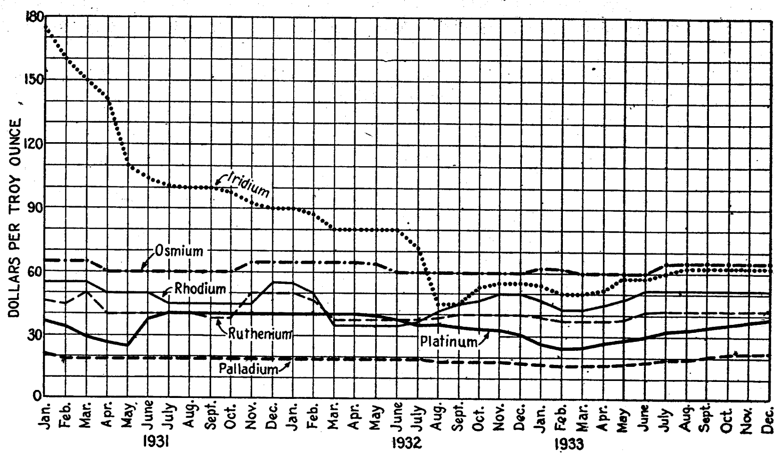


FIGURE 23.—Average monthly price per troy ounce of platinum and allied metals at New York, 1931–33.

accord, resulting in the formation of Consolidated Platinums (Ltd.), which maintained the price of platinum at relatively high levels during its existence, is evidenced by the horizontal part of the platinum curve.

*Consumption.*—The next table shows the sales of platinum metals to consumers by refiners in the United States in 1932 and 1933. 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 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.

Improved activity in the industries using platinum and restrictions on the use of gold for industrial purposes are reflected in the sales of platinum metals in 1933, which amounted to 107,821 ounces, an increase of 29 percent over 1932.

The uses of platinum and its allied metals are many and varied. The most widely used metal of the group is platinum, which constituted 76,193 ounces (71 percent) of the total platinum metals sold by domestic refiners in 1933. The principal consumer of platinum was the jewelry industry. The lower prices for platinum have led to wider distribution and sale of certain platinum articles, such as wedding rings, settings for remounting old jewelry, collar pins, cuff links, pencils, and knives. Platinum-clad nickel has been produced for dresser sets, after-dinner coffee services, trophies, medals, and watchcases. Second in magnitude as a consumer of platinum in 1933 was the chemical industry, where the metal is used chiefly for catalyzers in the manufacture of sulphuric, acetic, and nitric acids, for stills for sulphuric acid, for anodes for electrochemical processes, and as chemical ware in the form of crucibles, dishes, and other laboratory equipment. Third as a consumer in 1933 ranked the dental industry, where platinum is used chiefly in posts and pins for artificial teeth. The electrical industry was the fourth largest consumer of platinum in 1933, the metal being used chiefly in contact points, in telephone and telegraph apparatus, and in magneto contacts.

Next to platinum, palladium is the most extensively used of the metals of the platinum group; it constituted 26,164 ounces (24 percent) of the total platinum metals sold by domestic refiners in 1933. It is by far the cheapest metal of the platinum group, especially volume for volume, and tends more and more to replace other metals. The largest consumer of palladium in 1933 was the dental industry, which purchased 15,946 ounces from domestic refiners compared with 12,900 ounces in 1932. An 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. Recognition of the fact that dental alloys of high palladium content are less conspicuous than gold has led to a growing demand for palladium in dentistry. The next largest quantities of palladium are used in the electrical and jewelry industries, and smaller quantities are used in chemical ware and for miscellaneous purposes. Palladium leaf, which is nontarnishable and silver-colored, is finding wider use for decorative effects on shoes, hats, gloves, pocketbooks, picture frames, and display signs. Some palladium-clad molybdenum has been produced for special purposes.

The uses of iridium are few compared with those of platinum and palladium, but it ranks third among the platinum group as regards total consumption; in 1933 sales of iridium were 4,476 ounces (4 percent) of the total sales of platinum metals. It is employed chiefly as a hardener for platinum, principally in jewelry, which uses a 10-percent iridium alloy, and in the electrical industry, where an alloy containing 15 percent or more is used. Some iridium is used in making fountain-pen points.

The consumption of the other platinum metals—osmium, rhodium, and ruthenium—is very small, amounting to only 0.92 percent of the total for the group in 1933. The superiority of rhodium to platinum alloys as resistance units of electric furnaces designed for high-temperature use has been demonstrated. Rhodium electroplates are being used for a nontarnishing white finish for jewelry and for surfacing reflectors in searchlights.

*Platinum metals sold by refiners in the United States, 1932–33, by consuming industries, in troy ounces*

| Industry | Platinum | Palladium | Iridium | Others | Total | Percentage of total |
|---|---|---|---|---|---|---|
| **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 |
| **1933** | | | | | | |
| Chemical | 14,085 | 338 | 82 | 173 | 14,678 | 14 |
| Electrical | 3,422 | 5,367 | 526 | 30 | 9,345 | 9 |
| Dental | 11,149 | 15,946 | 116 | 19 | 27,230 | 25 |
| Jewelry | 41,263 | 4,413 | 3,608 | 508 | 49,792 | 46 |
| Miscellaneous | 6,274 | 100 | 144 | 258 | 6,776 | 6 |
| | 76,193 | 26,164 | 4,476 | 988 | 107,821 | 100 |

*Stocks.*—Stocks of platinum metals in the hands of refiners on December 31, 1933, amounted to 77,022 ounces compared with 75,911 ounces in 1932.

*Stocks of platinum metals in the hands of refiners in the United States, Dec. 31, 1929–33, in troy ounces*

| Year | Platinum | Palladium | Iridium | Others | Total |
|---|---|---|---|---|---|
| 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 |
| 1933 | 41,204 | 20,581 | 7,622 | 7,615 | 77,022 |

## FOREIGN TRADE [1]

*Imports.*—The following tables show the imports into the United States of platinum metals. The imports increased from 56,047 ounces in 1932 to 162,081 ounces in 1933. The imports of platinum from the United Kingdom increased from 14,555 ounces in 1932 to 63,065 ounces in 1933, and the imports from Soviet Russia increased from 76 ounces in 1932 to 21,945 ounces in 1933. The imports from Colombia decreased from 16,380 ounces in 1932 to 15,608 ounces in 1933. Palladium imports, virtually all from the United Kingdom, increased from 15,445 ounces in 1932 to 37,790 ounces in 1933.

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

*Platinum metals imported for consumption in the United States, 1932–33, by metals*

| Metal | 1932 | | 1933 | |
|---|---|---|---|---|
| | Troy ounces | Value | Troy ounces | Value |
| Platinum: | | | | |
| Ores of platinum metals (platinum content) | 160 | $4,782 | 5 | $90 |
| Grains, nuggets, sponge, or scrap | 25,440 | 722,353 | 71,511 | 1,819,565 |
| Ingots, bars, sheets, or plates, not less than ⅛-inch thick | 7,618 | 237,086 | 39,767 | 1,125,763 |
| | 33,218 | 964,221 | 111,283 | 2,945,418 |
| Manufactures of, not jewelry | (1) | 15 | 1 | 15 |
| Iridium | 1,397 | 69,359 | 5,513 | 206,744 |
| Osmiridium | 5,195 | 188,634 | 5,667 | 158,366 |
| Osmium | 131 | 4,815 | | |
| Palladium | 15,445 | 167,804 | 37,790 | 574,038 |
| Rhodium | 436 | 16,537 | 1,512 | 46,456 |
| Ruthenium | 225 | 5,652 | 315 | 8,809 |
| | 56,047 | 1,417,037 | 162,081 | 3,939,846 |

[1] Not recorded.

*Platinum metals (unmanufactured) imported into the United States in 1933, 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 | | | | | |
| Australia | | | | | 100 | | | 100 |
| Canada | | 180 | 56 | | | | | 236 |
| Colombia | | 15,608 | | | | | | 15,608 |
| France | | 99 | | | | | | 99 |
| Germany | | 500 | | 274 | | 12 | | 786 |
| Japan | | 400 | 9,430 | | | | | 9,830 |
| U.S.S.R. (Russia) | | 17,287 | 4,658 | 1,590 | | | 300 | 23,835 |
| United Kingdom | 5 | 37,437 | 25,623 | 3,649 | 5,567 | 37,778 | 1,527 | 111,586 |
| | 5 | 71,511 | 39,767 | 5,513 | 5,667 | 37,790 | 1,827 | 162,080 |

*Platinum metals imported for consumption in the United States, 1929–33*

| Year | Troy ounces | Value | Year | Troy ounces | Value |
|---|---|---|---|---|---|
| 1929 | 155,075 | $9,119,479 | 1932 | 56,047 | $1,417,037 |
| 1930 | 139,246 | 5,836,492 | 1933 | 162,081 | 3,939,846 |
| 1931 | 129,632 | 3,531,071 | | | |

*Exports.*—The export trade in unmanufactured platinum again increased, but there was a decrease in platinum manufactures in 1933 compared with 1932. Unmanufactured products increased from 20,106 ounces in 1932 to 23,686 ounces in 1933. Japan (7,765 ounces) and Germany (6,936 ounces) were the chief purchasers of unmanufactured platinum, though the United Kingdom (3,825 ounces) and France (3,524 ounces) took rather large quantities. The exports of platinum manufactures decreased from 2,032 ounces in 1932 to 1,323 ounces in 1933. The United Kingdom again was the main purchaser of manufactured platinum.

*Platinum exported from the United States in 1933, by countries*

| Country | Unmanufactured (ingots, sheets, wire, alloys, and scrap) | | Manufactures of, except jewelry | |
|---|---|---|---|---|
| | Troy ounces | Value | Troy ounces | Value |
| Argentina | 891 | $24,055 | | |
| Australia | | | 1 | $42 |
| Canada | 729 | 22,641 | 112 | 5,280 |
| Chile | | | 12 | 552 |
| China | 5 | 185 | 22 | 1,045 |
| Colombia | 6 | 152 | | |
| France | 3,524 | 92,346 | | |
| Germany | 6,936 | 174,480 | | |
| Guatemala | 5 | 242 | | |
| Japan | 7,765 | 178,012 | 106 | 5,693 |
| Mexico | | | 3 | 99 |
| Palestine | | | 105 | 2,780 |
| Peru | | | 1 | 46 |
| Philippine Islands | | | 7 | 242 |
| Siam | | | 1 | 25 |
| Union of South Africa | | | 54 | 2,550 |
| United Kingdom | 3,825 | 116,439 | 899 | 38,458 |
| | 23,686 | 608,552 | 1,323 | 56,812 |

*Platinum exported from the United States, 1929–33*

| Year | Unmanufactured | | Manufactures of, except jewelry | |
|---|---|---|---|---|
| | Troy ounces | Value | Troy ounces | Value |
| 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 |
| 1933 | 23,686 | 608,552 | 1,323 | 56,812 |

## PRODUCTION IN FOREIGN COUNTRIES

*Canada.*—Metals of the platinum group are recovered in refining nickel-copper matte from the Sudbury district of Ontario. A minor amount of stream platinum is yielded by British Columbia placers, and platinum and palladium are sometimes obtained in small quantities in the smelting operations at Trail, B.C. The residues obtained in the metallurgical treatment of the nickel-copper matte are refined by the International Nickel Co., Ltd., in its refinery at Acton, England, which has an annual capacity of 300,000 ounces of platinum-group metals.

The production of crude platinum from placers in Canada in 1933 was 40 ounces compared with 59 ounces in 1932.[2] Recoveries of platinum metals in 1933 from the copper-nickel ores of the Sudbury area were 24,746 ounces of platinum and 31,009 ounces of other platinum-group metals, compared with 27,284 ounces of platinum and 37,613 ounces of other platinum-group metals in 1932.

*Colombia.*—The exports of crude platinum from Colombia in 1933 were 44,543 ounces, of which 31,173 ounces were the product of dredges and 13,370 ounces were the product of hand-working by native operators.

[2] Dominion Bureau of Statistics, Preliminary Report on the Mineral Production of Canada during the Calendar Year 1933; Ottawa, 1934.

The South American Gold & Platinum Co. in 1933 produced 18,074 ounces of crude platinum and 31,789 ounces of crude gold, compared with 31,175 ounces of crude platinum and 18,285 ounces of crude gold in 1932. The smaller production of platinum was chiefly due to the fact that Dredge No. 3, which had been inactive since September 1932, was not put back into operation until the latter part of September 1933.

*Ethiopia.*—The production of crude platinum in Ethiopia in 1933 was 3,215 ounces compared with 4,823 ounces in 1932.

*Germany.*—Although Germany produces no crude platinum it is important in the international platinum trade. That country is the largest European consumer of platinum, has an important fabricating industry, and is the central European distributing center for Russian platinum. Moreover, large quantities of Russian platinum have been on deposit with a German bank as a pledge for the payment of orders for manufactured goods placed by the Soviet Union with German firms.

In 1928 Germany consumed 50,959 ounces of platinum metals (45,719 ounces of platinum, 4,083 ounces of palladium, and 1,157 ounces of iridium), of which 18,840 ounces were consumed by the jewelry industry, 16,397 ounces by the chemical industry, 6,752 ounces by the electrotechnical industry, 1,511 ounces by the dental industry, and 7,459 ounces for various other purposes. Although the depression naturally caused a downward trend in the quantity used in the various industries the consumption in the chemical and other industrial industries held up much better than in the jewelry industry.

Before the World War, Germany had an important platinum smelting industry at Hanau, a suburb of Frankfort on the Main, which depended chiefly on Russia for its crude material. After the war, with distribution of Russian platinum in the form of metal, Germany had to discontinue the smelting of ore. The plants at Hanau, however, import platinum metals, which are fabricated into products for the various industries.

The following table on platinum metals and alloys imported into and exported from Germany furnishes an index to the trend in consumption, because the country depends entirely on imports; it also reflects the trend in Russian platinum production, as the Soviet Union distributes the bulk of its platinum output for sale in Continental Europe through its German distributing organization.

*Platinum metals and alloys imported into and exported from Germany, 1928–32, in ounces*

| Year | Imports | Exports | Year | Imports | Exports |
|---|---|---|---|---|---|
| 1928 | 98,871 | 83,397 | 1931 | 110,422 | 84,765 |
| 1929 | 125,986 | 88,306 | 1932 | 107,605 | 22,342 |
| 1930 | 109,525 | 58,762 | | | |

During the first 5 months of 1933 the imports of platinum metals into Germany were 32,845 ounces (of which the U.S.S.R. (Russia) supplied 18,426 ounces) and the exports 41,844 ounces. This divergence in trends in German foreign trade would seem to indicate a notable lowering of the very large stocks of Russian platinum believed to be held in Germany by banking institutions.

*Sierra Leone.*[3]—The following information is given by the Geological and Mines Department of Sierra Leone:

York area: The two exclusive prospecting licenses held by the Africa and Eastern Trade Corporation (now United Africa Co., Ltd.) expired, but the company took up a mining right on Alako Water. Very little ground is left to be mined in the upper part of the Big Water Stream, but the mining right at the lower end has been a steady producer. The Alako Water right covers a shallow flat near the head of the stream. This flat is easily and cheaply worked, as the stream can be diverted where necessary.

Toke area: The United Africa Co. took up a mining lease on Ginda Water and a mining right on Toke River. Work on these areas started in October, and at the end of the year Mr. Hereford's camp was being moved to Toke. The area yielded 72 ounces.

The production of crude platinum in Sierra Leone in 1933 was 431 ounces compared with 531 ounces in 1932.

*Tasmania.*—The production of osmiridium in Tasmania in 1933 was 548 ounces compared with 785 ounces in 1932. The Adams River field continues to be the chief producing area, although the northwestern fields are still yielding small quantities.

*U.S.S.R. (Russia).*—No authentic statistics on the production of platinum in the U.S.S.R. in 1932 and 1933 are available.

*Union of South Africa.*—According to the Department of Mines and Industries the sales of platinum in South Africa in 1933 were 27,759 ounces valued at £168,105 (£6.06 an ounce) compared with 7,086 ounces valued at £42,352 (£5.98 an ounce) in 1932. The average composition of the product shipped in 1932 was: Platinum 55.20 percent, palladium 29.78 percent, iridium 0.24 percent, osmium and osmiridium 0.04 percent, ruthenium 0.84 percent, and gold 13.90 percent.

The sales of osmiridium in 1933 were 7,009 ounces valued at £38,586 (£5.50 an ounce) compared with 4,998 ounces valued at £39,936 (£7.99 an ounce) in 1932. The average composition of the product shipped in 1932 was: Osmium 32.06 percent, iridium 27.31 percent, ruthenium 13.11 percent, platinum 12.33 percent, rhodium 0.49 percent, gold 0.91 percent, and undetermined 13.79 percent.

## WORLD PRODUCTION

*World production of crude platinum from placers, 1929–33, in troy ounces*

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

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Australasia: | | | | | |
| New South Wales | 128 | 155 | 283 | 336 | (1) |
| New Zealand | 7 | 3 | 1 | | (1) |
| Papua: | | | | | |
| Osmiridium [2] | 29 | 11 | 20 | 1 | (1) |
| Platinum [2] | | | | 2 | (1) |
| Tasmania (osmiridium) | 1,360 | 953 | 1,280 | 785 | 548 |
| Canada | 28 | 17 | 50 | 59 | 40 |
| Colombia [3] | 45,577 | 42,382 | 44,311 | 16,055 | 44,543 |
| Ethiopia | 7,716 | 8,038 | 6,430 | 4,823 | 3,215 |
| Japan | 147 | 128 | 100 | (1) | (1) |
| Sierra Leone | 26 | 546 | 594 | 531 | 431 |
| U.S.S.R. (Russia) | [4] 99,667 | [5] 100,000 | [5] 100,000 | [5] 100,000 | [5] 100,000 |
| United States | 797 | 527 | 885 | 1,074 | 1,266 |

1 Data not available.
2 Year ended June 30 of year stated.
3 Exports, as reliably reported to the author.
4 Year ended Sept. 30.
5 Approximate production.

3 Sierra Leone, Report of the Geological and Mines Department for the year 1932: Freetown, 1934.

# MINOR METALS: BERYLLIUM, BISMUTH, CADMIUM, COBALT, SELENIUM AND TELLURIUM, TANTALUM AND COLUMBIUM, TITANIUM, AND ZIRCONIUM

By Paul M. Tyler and A. V. Petar [1]

SUMMARY OUTLINE



## BERYLLIUM

The use of beryllium increased approximately fourfold during 1933. Beryllium-copper alloys continued to provide the principal commercial outlet for the metal, and approximately 90 percent of the domestic consumption was used for this purpose. Another growing application is the utilization of beryllium oxide as a refractory.

The consumption of beryl increased to approximately 35 tons monthly at the end of the year. A considerable part of the supply was drawn from the Black Hills of South Dakota, but additional quantities were obtained from scattered pegmatites in other States. Beryl deposits in Idaho were investigated by the Idaho School of Mines, and a deposit in Colorado 2 miles southwest of Ohio City was described.[2] Arrangements were perfected for obtaining additional quantities of beryl from British India, and deposits in other foreign countries were investigated as potential sources. However, there is reason to believe that domestic deposits are available to supply anticipated requirements for some years to come, and the program of developing additional markets is proceeding cautiously. The raw-material situation does not indicate that beryllium is likely to become a cheap metal soon, but the probabilities are that its use will continue to grow at an accelerated pace, and resulting savings in cost will be

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

[2] Eckel, Edwin B., A New Lepidolite Deposit in Colorado: Jour. Am. Ceram. Soc., vol. 16, no. 5, May 1933, pp. 239-245.

shared with consumers. Available ore supplies may be increased somewhat as a result of flotation processes; one such method employs a mixture of sodium oleate, pine oil, and lead nitrate or barium nitrate.[3]

*Prices.*—In 1933, as in 1932, imported beryllium metal was nominally quoted at $135 per pound. Quotations for the beryllium master alloys produced in this country likewise remained unchanged at $6.25 per pound for beryllium-copper containing 12.5 percent Be; $5 for beryllium-iron containing 10 percent Be; and $5 for beryllium-nickel containing 10 percent Be; late in the year, however, a considerably reduced price was quoted on the basis of sales in lots of 51 to 200 pounds. The price per pound of contained Be is only $25 a pound on large lots compared with $50 in smaller lots.

Commercial beryllium-copper containing up to 2.5 percent Be was quoted at a trifle over 90 cents a pound base price, or something over 60 cents more than phosphor bronze. Wire or strip with the usual extras as purchased by fabricators costs in the range of 95 cents to $1.50 a pound, depending on size and quantity. Despite this wide differential there are various applications, chiefly in the form of light springs, where beryllium-copper is the most economical material. A generous policy for buying back scrap is pursued by the leading companies.

Quotations for beryllium ore were slightly higher in 1933 than in 1932. The principal consumer, the Beryllium Corporation, was offering $3.50 per unit of contained BeO, f.o.b. mine. Nominally this price applied only to material averaging at least 10 percent beryllium oxide, with the privilege of rejection if the content dropped below this minimum figure. Actually, however, many shipments were found to be diluted with feldspar and other waste material; and, where this could be removed readily by hand-sorting, payment was made on the clean beryl that could be separated. Consuming centers are at Marysville near Detroit and at Cleveland. Delivered at these points, the current price was around $4 a unit or about $40 a ton for ordinary good-grade beryl, with a substantial premium for high-grade material. This compares with trade-journal quotations of $30 and $35 for ores containing a minimum of 10 percent and 12 percent BeO, respectively, f.o.b. mines.

In Germany the metal (98 percent) was quoted at around 600 marks per kilogram, equivalent at December 1933 exchange rates to slightly over $100 a pound.

*Uses.*—By adding 1.5 to 2.5 percent beryllium and heat treating, the tensile strength of copper can be raised from 33,000 to nearly 200,000 pounds per square inch. One authority states that beryllium-copper alloys are 50 percent better than the best copper alloys heretofore available. High fatigue-resistance, comparable to that of spring steel, attainable hardness of 350 to 400 Brinell, good electrical properties, and satisfactory machining qualities are among the factors that favor the expanding use of these alloys. Castings, drop forgings, and various rolled or wrought forms are furnished by three American companies. Commercial applications include electrical devices such as electrical springs, contact clips, thermostat controls, contact springs, and telegraph relay parts; various springs for moving-picture

[3] Usoni, L., Contributo allo studio dell'arricchimento meccanico delle rocce a berillo (Enriching Beryllium Ores Mechanically): Giornale di chimica industriale et applicata, vol. 15, January 1933, pp. 13–15.

cameras, pontoon rudders, sprinkler heads, and switches; nonferrous tools such as chisels, paint scrapers, and wrenches; cams and firing pins; and instrument springs.

Nickel-beryllium alloys also are available, but their use apparently has not yet assumed commercial proportions. In Germany a special alloy for balance wheels of watches (Nivarox) is claimed to be nonmagnetic and virtually rustproof.

In the field of light alloys, patents have been issued covering beryllium-aluminum alloys suitable for pistons (Be 55 to 70 percent, Al 25 to 40 percent, and 0.5 to 2.5 percent each of Mn, Mo, and V or Zr),[4] and for airplane construction (Al 55 to 70 percent, Be 25 to 40 percent, remainder, not exceeding about 2 percent, Mo).[5] Alloys of silver and beryllium have also been patented in which the beryllium content may be from 0.5 to 2.5 percent.[6]

The role of beryllium in steel does not seem to be definitely established. Although it is stated that the hardness of chromium-nickel stainless steel may be increased to 680 Brinell by the addition of 1 percent beryllium,[7] Dickenson and Hatfield [8] report that their investigations indicate little or no prospect of beryllium becoming a useful addition to the group of metals used in the manufacture of special steels, due chiefly to the cost of the metal and technical difficulties which they believe would render introduction of beryllium uneconomical. They also failed to find the addition of 1 percent beryllium to nickel and nickel-chromium steels beneficial.

Industrial applications for beryllium oxide also are being developed. When carefully freed of alkalies and alkaline-earth impurities, beryllium oxide has some highly useful properties—a melting point of 2,570° C., great strength, low density, retention of electrical insulation properties at high temperatures, and extraordinary resistance to thermal shock. When made into shapes used for refractory purposes it can be heated to, or cooled very quickly from, 2,000° C. without cracking, and at this temperature it will operate for long periods in contact with tungsten. Suggested uses are in crucibles, boats, electric-furnace walls, vacuum tubes, and electric-lamp parts.[9]

Alkali beryllium borate glasses (4.4 percent BeO) may be used to replace quartz lenses for transmitting ultraviolet radiation and can be sealed like ordinary glass.[10]

A French patent describes a material suitable for insulation in spark plugs, made by fusing together crystallized quartz and beryl (3 to 5 percent).[11]

The radioactivity of beryllium and its relation to the helium content of beryl has been studied by investigators at the California Institute of Technology and in England.

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[4] Smith, Joseph K. (to Beryllium Development Corporation), Beryllium-Aluminum Alloys: U.S. Patent 1905312, Apr. 25, 1933.

[5] Smith, Joseph K. (to Beryllium Development Corporation), Alloys of Aluminum and Beryllium: U.S. Patent 1924168, Aug. 29, 1933.

[6] Handy & Harman, Hardening Silver Alloys: U.S. Patent 1928429, Sept. 26, 1933.
Sloman, H. A., Alloys Containing Beryllium and Silver: British Patent 399261, May 25, 1932.

[7] Huey, W. R., Development of New Equipment Materials for Chemical Manufacture: Ind. and Eng. Chem. (Ind. ed.), vol. 26, no. 1, January 1934, pp. 10–16.

[8] Dickenson, J. H. S., and Hatfield, W. H., Influence of Beryllium on Steel: Iron and Coal Trades Rev., vol. 127, no. 3424, Oct. 13, 1933, and no. 3425, Oct. 20, 1933, pp. 556–7 and 589–90 (abridged).

[9] Sawyer, C. B., Beryllium Developments and the Outlook for Supply: Min. and Met., vol. 15, no. 2, February 1934, p. 93.

[10] Ziegler, W., and Wellman, M., Alkali Beryllium Borate Glasses Transmitting Ultraviolet Radiation: Ztsche. tech. Physik, vol. 14, no. 7, 1933, pp. 288–9.

[11] Compagnie Française pour l'Exploitation des Procédés Thomson-Houstin, Transparent Siliceous Materials: French Patent 749436, July 24, 1933.

In a paper [12] presented before the London section of the Institute of Metals, Sloman reviews the uses as well as the history and technology of beryllium and its alloys.

## THE INDUSTRY IN FOREIGN COUNTRIES

*Africa.*—The discovery of large deposits of beryl in the Ghedem Mountains in Eritrea was reported. The mineral is said to differ from ordinary beryl in that it is an amorphous mixture of metasilicate of beryllium and a double metasilicate of beryllium and aluminum corresponding to the formula $4BeSiO_3$, $Al_2(SiO_3)_3$, compared with the usual formula $3BeSiO_3$, $Al_2(SiO_3)_3$.[13] In Madagascar the two principal localities are Ankazobe northwest of Tananarive, and Tongafeno to the southwest. No other sources in French territory are known.[14] Exports since 1928 have been about 15 tons annually. As noted in the chapter of this series in Minerals Yearbook, 1932–33, exports to foreign countries have been prohibited.

*Brazil.*—The following excerpts are quoted from a paper by Luciano J. Moraes:[15]

> Although the best-known occurrences and most productive deposits of beryl minerals in Brazil are found in the contiguous regions of southern Bahia and eastern Minas Geraes, the mineral is also found in many other regions of this country where, as yet, it has not been explored or studied to any considerable extent. The better known Bahia-Minas region extends eastwards from the eastern margin of the old sedimentary rocks forming the main ridge of the Serra de Espinhaço (Backbone Ridge) to within 50 or 60 miles of the coast, forming a belt over 100 miles wide and reaching from 13°30′ to below 22° of south latitude, a distance of over 600 miles. * * *
>
> In the State of Minas Geraes, beryl and aquamarine are also found at the following places farther south and west: Brejahuba, Esmeralda, S. Anna dos Ferros, Antonio Dias, S. Domingos da Prata, Taquarana, Espera Feliz, Bicas, etc. But perhaps the most interesting and commercially important deposits in the State are those which occur near Sant. Anna da Onça, situated about half-way between the cities of Peçanha and Figueira. Figueira is situated on the railway at the great elbow of the Rio Doce. At several places in this neighborhood large deposits have been found and are being mined. These mines have yielded some large crystals, one of which measured over 17 feet long by 40 inches across, weighing upwards of 3 tons. * * *
>
> About 30 miles below Figueira, at the tourmaline mines near the station of Lajão, there is a considerable production of beryl and aquamarine, as well as of tourmaline.
>
> Beryl is reported from various points in the environs of the city of Rio de Janeiro; and in the State of this name, from the Rio do Ouro district and from near São Goncalo, a short distance from Nictheroy, the capital of the State.
>
> In southern Bahia, the industry centers about the town of Conquista, which is quite a market for aquamarines. * * * Producing centers in this region of Bahia are Poções, Verruga, Encruzijada, and Condeuba, and much of the material from the valley of the Jequitinhonha River, in northern Minas, finds its way to Conquista. Other reported localities in Bahia are Gandú, Ituassú, Jacobina, and Bom Jesus dos Meiras. * * *

*Canada.*—It is reported that promising discoveries of beryl have been made adjacent to the Winnipeg River about 80 miles northeast of Winnipeg.[16]

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[12] Sloman, H. A., Beryllium and Its Alloys: Metal Ind. (London), vol. 44, no. 6, Feb. 9, 1934, pp. 160–2; no. 7, Feb. 16, 1934, pp. 183–6; and no. 8, Feb. 23, 1934, pp. 210–11.

[13] Chimie et Industrie, Le Béryl de l'Erythrée (The Beryl of Eritrea): Vol. 29, no. 2, February 1933, p. 83E; abstracted in Ceram. Abs., vol. 12, no. 5, May 1933, p. 203.

[14] France, Bureau d'Études Géologiques et Minières Coloniales, Les Ressources minérales de la France d'Outre-Mer: Vol. 2, Paris, 1934, pp. 37–9.

[15] Moraes, Luciano J., Beryllium Minerals in Brazil: Econ. Geol., vol. 28, no. 3, May 1933, pp. 289–92.

[16] Metal Bulletin (London), Beryllium. Manitoba Occurrences: No. 1839, Nov. 7, 1933, p. 16.

*Germany.*—Reports from Germany indicate that investigations in the laboratories of Heraeus-Vacuum Smelze, A./G., of Hanau have resulted in the successful reduction of beryllium directly from its oxide to copper or nickel alloys. This achievement gives promise of reduced production costs.[17]

*Hungary.*—Late in 1933 announcement was made that beryllium metal would be produced at an aluminum plant to be constructed on the Island of Cseped.[18]

*Mexico.*—A tract on the west side of the Cordon de la Bolsa in the Sierra de la Madera, Montezuma municipality, in the State of Sonora, was declared by the ministry to be part of the national mineral reserves for the exploitation of beryllium.[19]

## BISMUTH

In 1933, as in former years, there were two producers of bismuth in the United States but figures covering the quantity and value of the output may not be published. Aside from the marked recovery in prices the year witnessed no notable developments in the way of published articles or patent applications. Nevertheless the search for new uses was pushed vigorously and the consumption of low-melting alloys showed an encouraging increase despite the continued stagnation in many lines of manufacturing.

*Prices.*—On June 27, 1933, the price of bismuth was advanced 5 cents a pound after remaining stationary for 18 months at the record low (since 1895) price of 85 cents a pound. A few days later (on July 10) there was a 10-cent advance; this was followed by additional increments of 5 cents on July 17, 15 cents on August 31, and 10 cents on November 8. The fifth and last of these advances brought the quotation to $1.30 a pound, which is still rather low compared with the standards of former years but is high enough to raise the question as to whether or not the producers throughout the world propose henceforth to tempt new consumers with a low price or to revert to former policies of realizing a higher return per unit in a practically assured market of somewhat limited proportions.

During the first 6 months a 6d. drop in London quotations for sterling, which occurred in February, was eventually offset by the progressive depreciation of the dollar. The New York price, very nearly the same as that in London in January and much higher in February, was considerably lower than the London parity at the midyear, and subsequent advances were mainly the result of the "mark-up" of London prices and continued weakening of the dollar. Beginning with a 3d. advance in July the sterling quotation reached 5s. 6d. in November, where it remained until after the close of the year. At the average exchange rate for December the latter quotation equaled $1.40 a pound or 10 cents above the New York price, whereas the 5s. quotation in January and the 4s. 6d. price in February were equivalent to 83 and 72 cents, respectively, compared with the New York price of 85 cents a pound.

*Imports.*—Imports of bismuth and of sundry bismuth compounds are dutiable under the Tariff Act of 1930. Statistics on imports in

[17] American Metal Market, Efforts to Extend Use of Beryllium in Germany: Vol. 40, no. 229, Nov. 30, 1933, p. 5.
[18] Chemical Age (London), Hungarian Aluminum and Beryllium: Vol. 30, no. 758, Jan. 6, 1934, p. 8.
[19] Engineering and Mining Journal, Beryllium in Sonora: Vol. 134, no. 2, Feb. 1933, p. 88.

recent years are given in the following table. Additional quantities of bismuth are imported in the form of metallurgical products containing considerable lead and consequently dutiable and reported in the import records as lead bullion. In 1932 bismuth was imported from Germany, but in 1933 imports under this category were wholly from South America.

*Bismuth and "compounds, mixtures, and salts of bismuth" imported for consumption in the United States, 1929–33*

| Year | Bismuth | | Compounds, mixtures, and salts of bismuth | |
|---|---|---|---|---|
| | Pounds | Value | Pounds | Value |
| 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 |
| 1933 | 28,530 | 28,504 | 2,026 | 1,255 |

## THE INDUSTRY IN FOREIGN COUNTRIES

The Bolivian industry was well reviewed by Johnston.[20] Brief mention is made elsewhere of a reported discovery of bismuth in Mexico on the property of the Cia. Minera Los Amigos, a tin-mining company, near Encarnacion, Jalisco. Unconfirmed press reports relate to the discovery of "rich" deposits of bismuth in Namaqualand, South Africa, about 70 miles from Springbok. In South Australia some work has been done within the last year or two at the Mount McDonnell mine near Yudnamatuna and at Forest Range and Echunya; a small concentrating plant built at the old Grundy (now Golden Ridge) mine near Second Valley also was operated recently. In Queensland, Bismuth Products, Ltd., was promoted to reopen the Biggenden bismuth-gold property, operated for long periods between 1890 and 1912. In New South Wales molybdenite and bismuth mines in the Kingsgate and Deepwater districts (20 miles from Glen Innes) were worked in a small way. Despite numerous occurences, however, Australia never has been a very important factor in the world bismuth trade. Bismuth was mined in Spain from four mines at Conquista; Province of Cordoba; the principal mine, San Sixto, was worked to a depth of 75 meters.[21] In Russia the U.S.S.R. Chamber of Commerce has announced discovery of rich bismuth deposits in the Hodjent district of the Tadzhik Republic which may in time meet the total requirements of the Soviet Union.

Canada's two producers—one at Trail, British Columbia, and the other at Deloro, Ontario—reported a production, including bismuth metal and bismuth in silver-lead-bismuth bullion exported, of 78,303 pounds valued at $81,442 in 1933, a sharp increase compared with 1932 but less than in 1931 or 1929, the record year.

*China.*—China, formerly a relatively minor factor in bismuth production, has attained considerable importance in recent years. As late as 1925 the output of bismuth ore was around 60 tons annually,

[20] Johnston, T. L., The Bolivian Bismuth Industry: Min. and Met., vol. 14, no. 320, August 1933, pp. 333–338.

[21] Heriot, E. Mackay, Rarer Metals Found in Spain: Min. Jour. (London), vol. 184, no. 5140, Feb. 24, 1934, p. 121.

divided about equally between Kwang-Si and Kwang-Tung with insignificant amounts from Hunan. By 1928, however, the output was apparently five times as great, and even in 1931, the latest year for which official figures are available, the output was 131 metric tons. In 1928 the output of crude ore containing bismuth and tungsten totaled 3,122,801 metric tons, and the recovery of bismuth carbonate (crude?) from southeastern China was 314 metric tons, of which 120 tons came from Kwang-Si, 95 tons from Kiang-Si, 80 tons from Kwang-Tung, and 19 tons from Hunan. In view of the rapid rise of China as a source of bismuth the following abstract of a recent French description [22] of the deposits is timely:

*Kwang-Si.*—Two similar deposits about 6 kilometers apart occur in the region about 30 kilometers southwest of Ping-Yang-Hsien. The ore contains sulphides and oxides of bismuth, wolframite, and molybdenite associated with pyrite as stringers and veins in granite. Bismuth and tungsten ores are produced in about equal amounts, the former ranging in bismuth content from 41 to 55 percent in the case of sulphide ore to 51 to 62 percent in the case of oxide ore. At Hui-lo there was another operation, but it was closed when the price of bismuth declined.

*Hunan and Kwangtung.*—Three deposits in the mountains near Nan-An were furnishing a total of about 4 tons of ore daily. The native miners, from southern Hunan, work in groups of 4 or 5, each group getting out a "minimum" of 10 kilograms of ore a day. The ore, containing variable proportions of bismuth and molybdenum, is reduced by hand sorting to about 10 percent of the original volume and forwarded to Nan-An for further treatment. The deposits have long been known and have been mentioned by missionaries but were not worked intensively until the market improved some years ago. The ore is complex, containing both oxides and sulphides of bismuth, molybdenite, pyrite, and also graphite and biotite. It occurs in series of parallel veins up to 500 meters in length and ranging in width from a few centimeters to 2 meters.

*Kiangsi.*—The production from this Province is derived exclusively from the vicinity of Ping-Yang.

*Germany.*—The German industry is discussed in a report from the American Consul General at Frankfurt-am-Main,[23] from which the following notes are abstracted:

Despite the developing depression, German exports of bismuth salts expanded notably in 1930, rising to 99.7 metric tons as against 86.1 tons in 1929. Since 1930, however, the trade contracted to 59.2 tons in 1931 and 53.3 tons in 1932. Due to price declines, the value of the shipments dropped off even more markedly. The best markets are the less highly industrialized countries in southern Europe and overseas; exports to Western European countries have dropped off quite substantially in recent years.

Nearly all Germany's output of bismuth ore occurs in the mountain range known as the "Erzgebirge" in Saxony. The ore is complex and as the bismuth content is only around 5 percent and as the nickel and cobalt contents are no longer profitable, the drop in prices has handicapped the Saxon mines. Compared with 217 tons (containing 5 percent bismuth) in 1913, these mines furnished a steadily declining output from 155 tons in 1926 to only 48 tons in 1929; in 1931, however, there was a great upward spurt to 119 tons.

## CADMIUM

Marked improvement in automobile production and a sharp upturn in domestic output of slab zinc were accompanied by a phenomenal increase in cadmium sales and production in 1933, but the price of the metal evinced no tendency to rise from the all-time low level of the previous 2 years. Cadmium was produced in 1933 in the United States by 5 companies; and cadmium compounds—mainly sulphide, oxide, and lithopone—were manufactured by 5 companies (including 1 new

[22] Kuklops, M., La Chine: Mines carrières, vol. 12, no. 131, September 1933, p. 4.
[23] Redecker, Sydney B. (U.S. consul, Frankfurt-am-Main, Germany), Notes on German Chemical Industry: Mar. 29, 1933, pp. 12-15 (Bureau of Mines Foreign Files, no. 11132).

producer of cadmium sulphide). The domestic output of metal totaled 2,276,933 pounds compared with 799,501 pounds in 1932 and a record of 2,777,762 pounds in 1930. The cadmium content of compounds produced in this country in 1933 was 401,400 pounds, compared with 259,800 pounds in 1932 and a previous high of 433,300 pounds in 1929.

*Cadmium produced in the United States, 1929–33*

| Year | Metallic cadmium | | Cadmium compounds | |
|---|---|---|---|---|
| | Pounds | Value | Estimated cadmium content (pounds) | Value |
| 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) |
| 1933 | 2,276,933 | (1) | 401,400 | (1) |

[1] Producers' value not available for 1932 and 1933. Average quoted price at New York was 55 cents a pound for both years.

*Prices.*—No change has been made in the New York quotation for cadmium since the drop from 70 to 55 cents in January 1931. The London quotation, which had fallen to 1s. 8d. by the end of 1932, continued to sag until about July 1933, after which it held steady at around 1s. 2d. The changing value of the dollar, however, obscured any significance that might attach to the apparent decline in sterling prices, which in terms of American currency represented a slight advance from below 27 cents a pound early in the year to a trifle over 27 cents during the first part of the summer and to around 30 cents in December.

*Uses.*—The meteoric rise of cadmium industrially has been based upon its wide employment as a plating metal for rustproofing; first tested as protective coating for wires for pianos and other musical instruments, it soon was adopted for motor-vehicle parts and accessories. In 1933 probably the principal new development was the commercial introduction of cadmium to the automotive trade in a new role, as a constituent element of crankshaft and other bearings. Cadmium-alloy ingots containing 1 to 2 percent nickel (U.S. Patent 1,904,175 covers 0.25 to 7 percent nickel) are now furnished for this purpose, and tests on bearings made from this material indicate that it has good frictional properties. Because of its relatively high melting point and wear resistance, it may have wide acceptance as the preferred material for bearings of high-compression-type engines. A 1.35-percent nickel-cadmium alloy casts easily, bonds readily to common backing materials, and is not easily oxidized, and its hard constituent ($NiCd_7$) does not scratch the softest steel.[24] The British Non-Ferrous Metals Research Association has recommended two new lead alloys, known as B.N.F. lead alloys, both ternary alloys containing 0.25 percent cadmium; No. 1 of these alloys also contains 0.5 percent antimony, and No. 2 contains 1.5 percent tin as the sole other addition to the lead.

[24] Swartz, C. E., and Phillips, A. J., A Comparison of Certain White-Metal Bearing Alloys, Particularly at Elevated Temperatures: Proc. Am. Soc. Testing Materials, no. 30, 1933, 10 pp. (preprint).

Originally developed for use in lead-cable sheathing, these alloys have four times the resistance of pure lead to vibration and are about one-third stronger. Some 80,000 tons of lead are used in Great Britain annually for cable sheathing alone, and a much wider market is indicated in the general building industry for water pipes and other purposes. A die-casting zinc alloy containing cadmium and copper has been proposed by John R. Freeman, Jr., of the American Brass Co. (U.S. Patent 1,914,367). A trolley-wire alloy containing cadmium and silver, a new brazing alloy for silverware, and sundry contributions to plating technique were among the year's developments.

*Technology*.—An unusual amount of attention seems to have been devoted recently to methods of recovering cadmium. Current practice has been summarized succinctly as follows: [25]

Separation of cadium from material such as ores, furnace products, or flue or baghouse dusts containing also other metals or compounds, which comprise sulphatizing it with sulphuric acid, or spent electrolyte obtained subsequently in the process, heating—e.g., from 600–800° C.—to drive off excess acid and volatile arsenic, and to render zinc insoluble, and leaching the preferably ground material with water to obtain cadmium sulphate, is further characterized by adding cadmium sulphide to precipitate impurities from the solution, which is then electrolyzed for the production of metallic cadmium. The residue from the leaching contains lead sulphate and the insoluble zinc. The impurities removed from the solution may be lead, copper, bismuth, mercury, and part of the arsenic. Prior to electrolysis, the liquor is brought to a specific gravity of 1.30, and iron removed by heating the solution oxidized with sodium chlorate and neutralized with lime. The remaining arsenic is carried down with the iron. Thallium, if present, is removed by adding sodium chromate, and excess of the latter by lead sulphate or by reduction to chromic sulphate with sodium sulphide and precipitation with caustic soda. The purified solution containing, say, 100 grams cadmium per liter is electrolyzed employing a ferrosilicon anode, and a cathode comprising cadmium sheets previously deposited on and removed from an aluminum cathode.

*Producers of cadmium or cadmium products in the United States in 1933*

| | *Location of plant* |
|---|---|
| American Smelting & Refining Co | Denver, Colo. |
| Anaconda Copper Mining Co | Great Falls, Mont. |
| Ceramic Color & Chemical Co | New Brighton, Pa. |
| Chemical & Pigment Co., Inc | Collinsville, Ill.[26] |
| Do | St. Helena, Md. |
| The Eagle-Picher Lead Co | Hillsboro, Ill.[26] |
| Grasselli Chemical Co | Cleveland, Ohio. |
| Harshaw Chemical Co | Elyria, Ohio. |
| Krebs Pigment & Color Corporation | Newport, Del.[26] |
| Do | Newark, N.J.[26] |
| Sherwin-Williams Co | Chicago, Ill. |
| Do | Coffeyville, Kans.[26] |
| Sullivan Mining Co | Kellogg, Idaho. |

*Imports*.—There were no imports of cadmium metal into the United States in 1932, but 108,861 pounds valued at $31,704 were entered for consumption in 1933. Norway, Belgium, and Germany and Netherlands (combined) each furnished about one-fourth of the imports and Canada slightly less than one-fourth, the remaining small quantity coming from the United Kingdom.

*The industry in foreign countries*.—As cadmium is a byproduct its recovery depends upon the activity of the zinc industry, as well as

[25] Chemical Industries, Cadmium Electrolytic Extraction: Vol. 33, no. 4, October 1933, p. 326.
[26] Cadmiferous residues only.

upon the extent to which cadmium-bearing residues from the major metallurgical processes are utilized. Even in the United States, by far the best market as well as the leading source of supply, probably less than one-half of the potentially recoverable cadmium contents of domestic and Mexican ores undergoing treatment in American smelters is saved, and in certain other countries there has been much less incentive to attempt to extract the element from metallurgical wastes. World-wide attention is being given to byproduct recoveries in general and to cadmium recovery in particular, and one by one new names are added to the growing list of plants that produce the metal or its compounds. Two important new sources, one in Canada and the other in Norway, were reported in the chapter of this series in Minerals Yearbook, 1932–33.

*World production of cadmium, 1929–33, by countries, in kilograms*

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

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Australia [2] | 202, 261 | 234, 510 | 201, 889 | 160, 854 | (3) |
| Belgium [4] | 2, 313 | 5, 080 | 2, 903 | 23, 300 | (3) |
| Canada | 351, 068 | 207, 101 | 146, 573 | 29, 676 | 111, 602 |
| France | 59, 000 | 72, 000 | 82, 176 | 124, 488 | (3) |
| Germany | 41, 000 | 40, 000 | 39, 300 | [5] 40, 000 | [5] 40, 000 |
| Great Britain [4] | 2, 357 | 6, 584 | 2, 171 | 3, 770 | (3) |
| Italy | (3) | (3) | 8, 000 | 6, 238 | (3) |
| Mexico | (6) | (6) | (6) | (6) | (3) |
| Norway [7] | (3) | (3) | 92, 000 | 109, 000 | (3) |
| Poland | 3, 584 | 94 | 109, 000 | 34, 602 | (3) |
| United States: | | | | | |
| Cadmium compounds [8] | 196, 541 | 143, 471 | 152, 951 | 117, 843 | 182, 071 |
| Metallic cadmium | 1, 125, 550 | 1, 259, 965 | 476, 509 | 362, 646 | 1, 032, 794 |

1 In addition to countries listed cadmium is produced in Russia, South-West Africa, and Sweden, but production figures are not available.
2 Smelted in Tasmania.
3 Data not available.
4 Exports of domestic product. Production figures not available.
5 Approximate production.
6 The Mexican Government reports the total cadmium content of material produced in Mexico as follows: 1929, 640,968 kilos; 1930, 547,742 kilos; 1931, 462,907 kilos; 1932, 86,174 kilos. This material is exported for extraction of cadmium elsewhere; therefore, to avoid duplication of figures the data are not included in this table.
7 Output of the Eitrheim plant of the Norsk Zinkkompani A/S.
8 Estimated cadmium content.

## COBALT

The United States has produced very little cobalt, and no cobalt ore has been mined in this country since 1921 except a small carload in 1931. In 1933, however, approximately 20 short tons of residues containing nearly 3 percent cobalt were recovered (but not sold) at a western electrolytic zinc plant.

Cobalt generally has been considered a relatively rare metal, and as new uses developed the usual fears were expressed as to where suitable supplies might be obtained. In mineral economics, however, orthodox theories have a perplexing way of being disproved by facts, and 1933 developments forebode further evidence that Nature is not so niggardly in her gifts as many suppose. Early in the nineteenth century the limited supply of cobalt (then mainly smalt and zaffer) came from Norway, Sweden, and Saxony and, for the Far East, from China. Later New Caledonia emerged as the chief producer. Early in the twentieth century an overwhelming surplus of the element seemed to develop as the silver-cobalt-arsenic deposits in Ontario came rapidly into production. An active search for new uses, however, soon remedied this condition and by 1926, when the Belgian Congo challenged Canada as the leading source of the metal, the demand had grown to the point where an orderly marketing policy was a practical and perhaps even a desirable means of retarding upward as well as downward price disturbances.

As Canada's contributions threaten to dwindle to rather small proportions it is of interest to record in 1933 the rise of a new British Empire source, as a byproduct or at least a coproduct of the operations of a leading Rhodesian copper producer. Another new source appears in French territory, in Morocco, which shows promise of becoming far more important than New Caledonia in this respect. The United States, a large consumer, has so far failed to develop substantial supplies, but some contend that this does not imply that commercial deposits may not be proved up, and at least two such attempts appear at the moment to warrant further investigation. Ore from two or more Latin American countries was being tested by an American ceramic concern in 1933. Russia is reported confident of developing substantial supplies, and scattered contributions keep coming from other parts of the globe. Additional supplies are potentially recoverable from pyrite cinder; several processes have been developed in Sweden, and in 1933 an American fertilizer company obtained a patent (U.S. Patent 1,922,490, Aug. 15, 1933) for obtaining cobalt from such sources. Discovery of a new mineral, julienite, with the formula $Na_2Co(SCN)_4.8H_2O$ has been announced.[27]

*Prices.*—Commercial cobalt, which contains 97 to 99 percent of the metal and 0.06 to 0.3 percent carbon, has been quoted at the nominal price of $2.50 a pound for a number of years. Discounts allowed from this base are not a matter of record, but on much business the 35-percent deduction formerly allowed was increased substantially, and the average price actually paid by large consumers undoubtedly was lower in 1933 than in many years past. Black oxide quotations (70 to 71 percent cobalt) remained nominally unchanged throughout the year at $1.35 per pound. The published price of 48 cents a pound of contained cobalt for 12- to 14-percent ore, f.o.b. Ontario mines, likewise remained unaltered following the slight reduction in July 1932. Actual transactions in cobalt ore from various sources were subject to negotiation.

At the beginning of 1933 cobalt metal was quoted in London at 7s. a pound compared with a price of 8s. in December 1932 and about 7s. 6d. throughout the greater part of that year. In May 1933 the price was cut to 5s. 6d., which was reduced further to 5s. and later to 4s. 6d. as additional offerings became available. This drop in sterling quotations, however, was balanced by the drop in the dollar, so that the British market price, expressed in American currency at the end of the year, as well as at the beginning of 1933, was approximately $1.15 per pound (in hundredweight lots). A general downward movement in sterling prices for cobalt oxides throughout 1933 canceled only part of the gain registered in the latter part of 1932. For black oxide the net result was a slight shading from 4s. 9d. to 5s. 2d. during the first quarter to 4s. 6d. to 4s. 8d. per pound in the last 4 or 5 months; for gray oxide the range

[27] Cuvelier, V., The Chemical Composition of Julienite, a New Cobalt Mineral: Naturw. Tijdschr. vol. 15, 1933, pp. 17–20.

of 5s. 4d. to 5s. 7d. quoted early in the year eventually was reduced to 4s. 9d. to 4s. 11d. per pound. Even in shillings the 1933 average was substantially above that for 1932, and in dollar equivalents the London prices of cobalt oxides instead of reflecting the downward tendency of the metal registered a visible advance.

*Uses.*—The leading outlet for cobalt metal is stellite alloys. Several of these cobalt-chrome combinations are hardened with tungsten or molybdenum, in proportions varied according to the service for which they may be designed. The principal cutting alloy, No. 3, is harder than high-speed steel at temperatures above 500° C.; at 850° C. it shows a Rockwell C hardness of 49 compared with 61 (or Brinell 600) at normal temperatures. This material is not recommended for automatic or semiautomatic machines, but if rigidly supported it may be used on mild steel and is quite efficient for milling cast iron, semisteel, malleable iron, bronze, or similar metals.[28] Cobalt has become the principal bonding agent for tungsten carbide and similar superhard cutting materials, and of more recent introduction are dispersion-hardening alloys consisting essentially of cobalt or cobalt and iron with 20 to 35 percent tungsten or molybdenum as a hardening agent; a new alloy of this type containing about 20 percent tungsten was placed on the market commercially in the United States in 1933. During the same year there was the usual crop of patents covering the use of the element in sundry other cutting mediums, magnet steels, and other alloys. Mention may be made of an oxidation-withstanding, high-electrical-resistance alloy containing 40 to 85 percent nickel, 40 to 10 percent cobalt, and (remainder) 20 to 5 percent iron with 10 to 1 percent titanium. The I.G. Farbenindustrie has patented a process for depositing an intermediate coating of cobalt or nickel under a coat of chromium. The subsequent heat treatment takes place in a neutral atmosphere and at a temperature slightly below the melting point of the intermediate metal. Such platings are said to possess great heat resistance.[29]

*Imports.*—After declining for several years imports of cobalt ore and metal rose sharply in 1933. Ore imports were larger even than in 1929 and as usual were derived mainly from Canada; Australian ore was of some importance, but only a small quantity came from Morocco. Imports of metal for consumption, although more than double those in 1932, were only one-third of those in 1929; about 75 percent came from Belgium and the remainder from Canada and Germany. Imports of oxide represented an all-time high record.

*Cobalt ore, cobalt metal, oxide, and other compounds of cobalt imported for consumption in the United States, 1930–33*

| | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value |
| Cobalt ore | 199,642 | $18,994 | 83,895 | $8,453 | 27,193 | $12,516 | 556,119 | $117,261 |
| Cobalt metal | 460,251 | 984,244 | 164,967 | 254,520 | 123,112 | 147,925 | 281,713 | 331,828 |
| Oxide | 425,881 | 769,331 | 321,891 | 391,479 | 225,896 | 220,497 | 568,057 | 413,584 |
| Linoleate | 91 | 38 | | | | | | |
| Sulphate | 33,084 | 17,564 | 23,147 | 7,595 | 51,048 | 12,040 | 51,045 | 13,225 |
| Other salts | 22,128 | 6,519 | 23,170 | 11,768 | 41,050 | 18,586 | 59,711 | 25,281 |

[28] Becker, W. A., Gordon, E. E., and Wissler, W. A., Haynes Stellite Cutting Tools: Trans. Am. Soc. Mech. Eng., vol. 53 (MSP-1, 11a), 1931, pp. 93–100; abstracted in Ceram. Abs., vol. 12, no. 3, March 1933, p. 119.

[29] Metal and Mineral Markets., German Metal Developments: Vol. 4, no. 45, Nov. 9, 1933, p. 3.

*Cobalt and cobalt ore imported into the United States, 1931–33, by countries*

[General imports]

| Country | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value |
| Australia | 23, 296 | $4, 542 | | | 76, 377 | $5, 917 |
| Belgium | 99, 198 | 159, 299 | 57, 403 | $77, 587 | 252, 990 | 315, 747 |
| Canada | 118, 872 | 83, 172 | 85, 622 | 74, 224 | 461, 663 | 85, 619 |
| Germany | 3, 016 | 5, 876 | 4, 193 | 5, 543 | 37, 687 | 39, 930 |
| Japan | | | | | 2, 400 | 62 |
| Morocco | | | | | 2, 235 | 256 |
| United Kingdom | 4, 480 | 10, 084 | 3, 087 | 3, 087 | 4, 480 | 1, 558 |
| | 248, 862 | 262, 973 | 150, 305 | 160, 441 | 837, 832 | 449, 089 |

## THE INDUSTRY IN FOREIGN COUNTRIES

Available statistics on production of cobalt in foreign countries in recent years are set forth in the following table:

*World production of cobalt, 1931–33, in metric tons*

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

| Country | Cobalt-bearing material | 1931 | | 1932 | | 1923 | |
|---|---|---|---|---|---|---|---|
| | | Gross weight | Cobalt content | Gross weight | Cobalt content | Gross weight | Cobalt content |
| Australia: Queensland | Cobaltite concentrates, etc | | | (1) | 3 | (1) | (1) |
| Belgian Congo | | (1) | [2] 370 | (1) | [2] 335 | (1) | (1) |
| Canada: Ontario | Cobalt, alloys, and chemicals | (1) | 236 | (1) | 223 | (1) | 208 |
| China: Yunnan [3] | | 250 | (1) | 250 | (1) | 250 | (1) |
| India, British: Burma [4] | Cobaliterferous nickel speiss | 3, 504 | 123 | 3, 060 | 107 | (1) | (1) |
| Morocco, French | Cobalt ore; average cobalt content estimated at 11 percent | | | 570 | 63 | 610 | 67 |
| Northern Rhodesia | Cobaltiferrous copper ore | | | | | (1) | 118 |
| Union of South Africa | Cobalt ore | 45 | 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.*—The bulk of the rather small Australian output of cobalt ore has originated in the Cloncurry district, Queensland. According to the local warden's report a parcel of 11 tons of this ore (18½ percent) shipped early in 1933 fetched about 1s. 3d. per pound of contained cobalt. It is also reported that cobalt may be a by-product of electrolytic zinc refining in Tasmania.

*Burma.*—The report of the Burma Corporation for the year ended June 30, 1933, indicates a small expansion in output of nickel-cobalt speiss.

*Canada.*—Canadian cobalt production includes the cobalt contained in ores exported and the various cobalt products sold by the Deloro Smelting & Refining Co., Ltd., the only company in Canada treating ores from the Cobalt district. The output declined only slightly in 1933 from 1932, but it is significant that there was a decline when demand was tending to improve. Apparently no more shipments were made from Werner Lake, and commercial production at Great

Bear Lake has not begun. Since 1932 prospecting has been proceeding at a point 2 miles north of Great Slave Lake and 3 miles east of Francois River. Two rather narrow veins have been opened up, and the nickel-cobalt mineralization resembles that at Cobalt, Ontario, and also that at Camsell River and Great Bear Lake, 300 miles to the northwest, but the deposit has not yet proved to carry important quantities of precious metals and is said to be too small to work for cobalt alone.

Starting with an ore containing 15.81 percent cobalt, with pyrite and sphalerite, Government laboratories succeeded in getting a 97-percent recovery of a 24.77-percent concentrate and an 85-percent recovery of a 29.5-percent product by flotation.[30]

*China.*[31]—Asbolite, containing 8 to 10 percent cobalt, is produced in northwestern Yunnan copper district north of the village of Toung-Chouan, where about 200 metric tons of the oxide are produced annually from some 16 mines. China also furnishes arsenical cobalt ores (cobaltite and smaltite).

*Morocco.*—With an initial shipment of 200 tons in 1932 Morocco was able in 1933 substantially to increase exports of arsenical ore containing an average of about 11 percent cobalt. The following analyses are said to be typical of three classes of better-grade ore from these mines:

| | Percent | | |
|---|---|---|---|
| As | 20–25 | 20–25 | 40–55 |
| Co | 12–15 | 15–20 | 12–15 |
| Ni | 4–6 | 0–0.5 | 2–4 |
| S | 0.5–1 | 0.5–1 | 0.5–2 |
| $Al_2O_3$ | 2–3 | 2–3 | 1.5–4 |
| CaO | 3–5 | 3–5 | 1.5–4 |
| MgO | 0.5 | 0.5 | 2–3 |
| $SiO_2$ | 5–10 | 5–10 | 10–25 |
| $H_2O$ | 2 | 2 | 3 |
| Fe | 2–5 | 2–5 | 2–5 |
| Cu | Traces | Traces | Traces |

According to a French report[32] exploration for cobalt has been conducted principally in an area 180 kilometers southeast of Marrakech near Bou-Azzer and El Graara along the trail from Marrakech to the Wadi Draa in Anti Atlas. The cobalt-nickel mineralization is confined mainly to granite contacts, especially those with serpentine, and is quite erratic although doubtless extensive.

*Rhodesia.*—Cobalt made its first appearance in the Northern Rhodesian mineral returns for February 1933. Throughout the first half of the year the cobalt operations were more or less experimental, and sales on a commercial scale did not begin until about September. Research covered production of electrolytic cobalt, as well as the 50/50 cobalt-iron alloy which has so far constituted the only product. The total output for 1933 is reported as 260,941 pounds, of which 85,440 pounds were produced in December and 40,230 pounds in November. Cobalt is not generally disseminated throughout the

[30] Godard, J. S., Flotation Tests on a Sample of High-Grade Cobalt Ore From Kenora Prospectors and Miners, Ltd., Toronto, Ontario: Canada Dept. Mines, Mines Branch, Rept. 728, 1933, pp. 75–6.

[31] Kuklops, M., La Chine: Mines Carrières, vol. 12, no. 131, September 1933, p. 3

[32] Glasser, M., Le Cobalt: Les Ressources Minèrales de la France d'Outre-Mer, vol. 2, Paris, 1934, pp. 370–373.

copper ore of Northern Rhodesia but appears to be confined to one ore body at the N'Kana mine of the Rhokana Corporation. This ore contains a considerably smaller percentage (about 0.5 percent?) of cobalt than the ores utilized in Katanga where the average cobalt content is probably 3 to 4 percent, but the aggregate quantity is reputed to be very great, and the annual report of the Rhokana Corporation foreshadows a substantial production and considerable revenue therefrom. The existence of a joint selling agreement with other leading producers is also confirmed in the annual report.

*U. S. S. R.* (*Russia*).—Hitherto noncommercial deposits of complex ores in the Urals, Trans-Baikal, and the Caucasus are reported to be coming into production and may afford enough cobalt to meet the growing needs of the Soviet steel industries.

## SELENIUM AND TELLURIUM

Selenium has found a variety of uses within the past decade or two and after much fruitless investigation over a long period of years even tellurium was finally put to work, so that now both these erstwhile abominations of the smelterman have become valuable servants of industry. Spectacular discoveries of new uses for both these elements were recorded in the preceding chapter of this series in Minerals Yearbook, 1932–33, and although no comparable achievements took place in 1933 it is significant that previous gains have been consolidated and that shipments of tellurium to England during 1933 by one American company exceeded the aggregate for the previous quarter century. It should not be inferred that there are no obstacles to be overcome or that bothersome difficulties no longer threaten wider utilization of these still recalcitrant members of the sulphur family, but in view of their past reputation these elements are enjoying relative prosperity. Selenium insecticides, for example, are valuable aids for combating plant enemies, notably red spiders in vineyards and citrus-fruit orchards, but a warning is sounded[33] as a result of experiments showing that selenium absorbed from the soil by plants not only may injuriously affect growth of plants but also may make them unfit for food. Wheat grown experimentally in selenium-bearing soils was fatally poisonous to animals to which it was fed. On the other hand, it has been claimed that this menace can be prevented by the proper use of sulphur. In the glass industry selenium now may be employed to produce an amber color in lead glass mixtures, preferably containing borax, under controlled oxidizing conditions.

Tellurium is even more obnoxious than selenium, and in no case can its use be recommended without apprising the prospective buyer of its dangerous properties. A research worker for a large American company recently lost the use of his eyes for 2 months following exposure to tellurium fumes.

In the International Tables for 1934 the atomic weight of selenium was changed from 79.2 to 78.96 and that of tellurium from 127.5 to 127.61.

[33] Nelson, E. M., Hurd-Karrer, A. M., and Robinson, W. O., Selenium As An Insecticide: Science, vol. 78, 1933, p. 124.

Two new occurrences of native tellurium have been described recently, one in New Mexico (northwest of Silver City)[34] and the other in Japan (Teine gold mine)[35].

Selenium and tellurium were each produced in 1933 by three companies. Sales of selenium by producers were 362,697 pounds valued at $607,382 in 1928 but declined gradually to 292,234 pounds valued at $386,255 in 1931, the latest year for which the Bureau of Mines is permitted to publish figures. Until the last year or two, sales of tellurium were quite small.

*Prices.*—New York quotations for both selenium and tellurium remained unchanged during 1933, as in 1932 and 1931. Selenium (black, powdered, 99.5 percent pure) continued to be quoted nominally at $1.80 to $2 per pound with actual wholesale transactions at around $1.75. Tellurium prices are still more or less nominal at $2 a pound.

In England the published price of tellurium ingots (minimum 14-pound lots) remained nominal at 15s. to 16s. per pound throughout 1933, irrespective of exchange fluctuations that modified the equivalent quotation expressed in American dollars from $2.50 to over $3.80 per pound. Early in the year the actual price was said to be around 10s., and business normally is transacted in England on a parity with the New York market. In September the Liverpool quotation for selenium (black, powdered), which had remained for a year or more at 7s. 8d. to 7s. 9d. per pound on a gold basis, was revised to 7s. 6d. to 7s. 8d. per pound, a sharp reduction, inasmuch as at the time the British pound was worth only $3.13 in gold dollars compared with a paper value of $4.66 in United States currency. The new price was in line with the American market in the early fall, but as sterling exchange rose above $5 it rose once more above the American equivalent.

*Tellurium-lead.*—The chapter of this series in Minerals Yearbook, 1932–33, briefly mentioned the use of tellurium as a lead-hardening agent. An alloy containing about 0.06 percent tellurium was placed on the market in Great Britain and later in the United States under the trade name "Teledium." Patent rights cover a wide range of lead-base alloys, with varying quantities of tellurium and other metals such as cadmium, antimony, and tin. Pipe made from tellurium-lead exhibits remarkable strength and resistance to bursting from freezing. The material has a fine grain structure, has high fatigue and vibration resistance, is greatly toughened by work-hardening, and has an extraordinary ability to withstand corrosion by sulphuric acid (even boiling concentrated acid, for brief periods). It is stated that, in toughened condition, the alloy may be bent double and hammered flat without cracking. The material is almost twice as strong as pure lead and has 8 to 12 times the corrosion resistance. It can be worked very much like ordinary lead, and even in adding the tellurium to the lead no real difficulty arises. Fumes occur only when the temperature is too high or the tellurium powder insufficiently mixed with the lead.[36]

*Imports.*—Domestic supplies of tellurium still potentially greatly exceed actual demand, and exports are made to Europe; although statistics are lacking, imports of tellurium may be considered insig-

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[34] Ballmer, Gerald J., Native Tellurium From Northwest of Silver City, N.Mex.: Am. Mineralogist, vol. 17, 1932, pp. 491–492.

[35] Watanabe, Manjiro, A New Occurrence of Native Tellurium in Japan: Proc. Imp. Acad. (Tokyo), vol. 27, no. 15, Aug. 10, 1933, p. 3684.

[36] Singleton, W., Discussion of Tellurium-Lead Paper: Metal Ind. (London), vol. 42, no. 11, Mar. 17 1933, pp. 300–303.

nificant or nonexistent. Imports of selenium and selenium salts in recent years have been as follows:

*Selenium and selenium salts imported for consumption in the United States, 1929–33*

| Year | Pounds | Value | Year | Pounds | Value |
|---|---|---|---|---|---|
| 1929 | 3,592 | $5,971 | 1932 | 1,914 | $2,240 |
| 1930 | 680 | 988 | 1933 | 1,755 | 2,402 |
| 1931 | 2,189 | 2,777 | | | |

*The industry in foreign countries.*—The United States is probably by far the largest producer of both tellurium and selenium, but Germany and other European smelting countries are likewise paying increasing attention to the recovery of these elements. Selenium was produced in 1931 for the first time in Canada by the Ontario Refining Co., Ltd., at Copper Cliff, Ontario. The Canadian Copper Refiners, Ltd., produced a quantity of selenium-bearing sludge which will be treated at a future date. Production in 1933 totaled 26,090 pounds valued at $53,745. No production was reported for 1932.[37]

## TANTALUM AND COLUMBIUM

In 1933 Philip S. Hoyt shipped 300 pounds of tantalum ore valued at $180 from New Mexico, and some preparations were made to produce columbite in 1934. As in former years the ore used in America for the production of tantalum was obtained from Australia. No tantalum metal was imported in 1933.

*Prices.*—No change has been made in the published quotation of $91 a kilogram for tantalum (C.P. bar or sheet) since 1930, and the British quotation of £15 a pound likewise was unaltered in 1933. The latter was substantially higher than the American price, even at the beginning of the year, and as the dollar dropped the spread increased correspondingly. The quotation for ore (60-percent concentrates) was revised downward from $1.75 to $0.75 a pound of $Ta_2O_5$ content, but this quotation is purely nominal. In the Western Australian fields (Wodgina) little or no business was done, although there was some inquiry from Germany. At present, no market for low-grade ore appears to exist at any price.

*Uses.*—Important progress was made commercially as well as technically in the employment of tantalum carbide, alone and with other carbides, in ultrahard cutting-tool materials. The Vascoloy-Ramet Corporation was formed September 1, 1933, consolidating the tantalum carbide-manufacturing divisions of two leading companies in this field. A number of different compositions are offered under the trade name of this company, and tantalum carbide or tantalum-columbium carbide mixtures are incorporated in cutting-tool mixtures produced by other manufacturers. Improved methods for tipping tools with these ultrahard materials have been patented.

Continued headway was made in 1933 in the introduction of commercially pure metal (99.9 percent) in the electrical and chemical industries. Tantalum is now available in a wide range of shapes and sizes, and among the developments of the year was improvement in

[37] Mineral Production of Canada, 1933 (Prelim. Rept.), p. 21.

drawing and spinning technique leading to production of seamless tubing; notable progress also was reported in control of grain growth through treatment of the tantalum powder, working and annealing schedules that assure fine-grain metal, and rolling and hardening technique. A metallurgical process was developed for sheet which has to be hardened and lapped, whereby a fine mat finish free from pits may be obtained by the removal of only two or three ten-thousandths inch. By a combination of unique methods of resistance and arc welding, it is now possible to fabricate large units and intricate shapes from relatively small sheets. Many of the commercial applications of tantalum are due to its remarkable resistance to chemical corrosion. However, it is one of the most satisfactory metals for thermionic valves and finds extensive use in electrolytic rectifiers. Its use in various kinds of steel has been patented, and certain of its nonferrous alloys are considered worthy of commercial investigation.

Columbium has properties remarkably similar to those of its twin metal tantalum, except for its lower melting point. Generally associated in nature with tantalum and possibly somewhat less scarce, columbium nevertheless has not hitherto found any tangible commercial applications. Mention has been made of its use in sintered carbide tools, and it has also been employed in high-speed steel of European origin but merely as an associate of or partial substitute for tantalum and not for itself. Columbium metal was offered commercially a few years ago by the Fansteel Products Co., Inc. (North Chicago, Ill.), but it has remained more or less of a laboratory curiosity. In 1933, however, Dr. F. M. Becket and associates in the Union Carbide & Carbon Research Laboratories made two important announcements relative to the discovery of remarkable effects of columbium in plain chromium and chromium-nickel steels. Tantalum is not recommended, even as a neutral accompaniment of the columbium, although under certain conditions it may yield similar results. The first paper by Becket and Franks [38] describes the softening effect of columbium in plain high-chromium steels. In amounts up to about 10 times the carbon content, columbium is very efficacious in keeping such steels soft and workable, both hot and cold; the indicated result is a much wider application of these steels, as greater softness and ductility and substantial freedom from air hardening are obtained without loss of resistance to corrosion or high-temperature oxidation.

A second paper by the same authors [39] gives the results of the introduction of columbium to steels of the 18-percent-chromium, 8-percent-nickel type. Such steels previously have been limited in their applications because of intergranular corrosion when exposed concurrently to elevated temperatures and chemical corrosion, and the effectiveness of columbium in inhibiting this defect without the sacrifice of other valuable properties opens up new fields. A number of other addition agents, including titanium which is the one generally employed for this purpose, were tested under similar conditions, but none of them afforded as satisfactory a solution of the problem. Of special interest is the protection obtained from localized failure in welds and adjacent zones. The alloying addition is made in the form

[38] Becket, F. M., and Franks, R., Titanium and Columbium in Plain High-Chromium Steels: Am. Inst. Min. and Met. Eng. Tech. Pub. 506, 1933, 14 pp.

[39] Becket, F. M., and Franks, R., Effects of Columbium in Chromium-Nickel Steels: Am. Inst. Min. and Met. Eng. Tech. Pub. 519, 1934.

of ferrocolumbium containing 50 to 60 percent columbium and of low carbon content. For steels of normal low carbon content the quantity of columbium required generally is less than 1 percent, and in certain cases less than 0.5 percent is sufficient. By adding the alloy through the slag to a thoroughly deoxidized steel just before pouring, recoveries of 80 to 90 percent of the columbium can be secured in the finished steel. Under these circumstances the cost of columbium treatment is expected to be no handicap to its extensive use to replace titanium wherever extraordinary conditions have to be met.

*Imports.*—Imports of tantalum ores into the United States, all from Australia, were 14,257 pounds valued at $20,530 ($1.44 a pound)—less than one-half those in 1932, when shipments jumped to 36,131 pounds valued at $51,033, but almost up to the previous record of 15,250 pounds in 1929. In 1931 only 6,288 pounds and in 1930 only 8,474 pounds were imported.

*World production.*—The world supply of high-grade tantalite has come mostly from the Pilbarra field in Western Australia. Occasional small lots have been shipped from British India and Africa, and a Russian expedition to the Kzyl-Kum Desert claims to have discovered tantalite there. Specimens have been reported from Argentina and elsewhere in South America. In the past there has been no demand for columbite high in columbium, but with such demand impending new developments in British Africa are counted upon, as the supply of byproduct columbium from fields prospected for tantalum is deemed inadequate and unduly costly.

## TITANIUM

The concentrating plant of the American Rutile Co., for many years the principal producer of titanium minerals in the United States, was not operated in 1933, but shipments were continued from stock at a normal rate. The Southern Mineral Products Co. resumed operations and made shipments of ilmenite concentrates and phosphate, but its pigment production was still on a more or less experimental basis. Both these enterprises are in Virginia. The Bureau of Mines has no information as to any production of titanium ores in other States. The deposits in Arkansas continued to receive attention, but no production or shipments were reported and considerable ore previously produced remained unsold. Actual figures of domestic production cannot be published without revealing individual operations, but it is common knowledge that the output is of the order of several hundred tons of rutile and a thousand tons or more of ilmenite annually. A good description of the Virginia deposits with a discussion of their economic possibilities was published by Ryan.[40]

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 makers of titanium pigments. For several years the former company has been considering an eastern location, as its present factory is in St. Louis, Mo.; property at Spotswood, N.J., was purchased in 1933, but it is reported that it probably will not be utilized for this purpose and that the company's new plant on the eastern seaboard will be built in the near future at some other site. Statistics of titanium-pigment production are not available and import statistics for ilmenite, due partly to the variety of such pigments pro-

[40] Ryan, C. W., The Ilmenite-Apatite Deposits of West-Central Virginia: Econ. Geol., vol. 28, no. 3, May 1933, pp. 266–75.

duced, afford only a rough index of the state of the industry; however, despite the continued decline in building construction, sales of titanium pigments in 1933 undoubtedly were larger than ever before. At the opening of a new plant at Luton, England, early in the year it was stated that the output of titanium pigments in the United States already had reached 75,000 tons annually compared with 5,000 tons in the British Isles.

Ferrotitanium and other titanium alloys are now produced by the Vanadium Corporation of America at both Bridgeville, Pa. (low-carbon) and Niagara Falls, N.Y. (ferrocarbon grades), as well as by the two older producers, the Titanium Alloy Manufacturing Co. at Niagara Falls, N.Y., and the Metal & Thermit Corporation at Jersey City, N.J. A moderately large increase in consumption has occurred during the last year or two, but sales data may not be given without revealing confidential information.

*Prices.*—The steady decline in prices of titanium pigments has proceeded at a slower pace since about 1931, and by the end of 1933 the schedule for calcium- and barium-base pigments had become firm at 6 cents a pound in carlots (minimum 20 tons) or 6¼ cents a pound for less than carload shipments, in bags. For titanium dioxide the quotation was cut sharply, contracts being made after the midyear on the following schedule: Bags, carlots (minimum 20 tons), 17 cents a pound; 5-ton lots, 17½ cents a pound; 1-ton lots, 18 cents a pound; and lots under 1 ton, 18½ cents a pound. Under each of the foregoing categories, one-fourth cent a pound extra was charged for packing in barrels instead of bags. The standard titanium-calcium pigment contains 30 percent titanium dioxide precipitated upon and coalesced with calcium sulphate, and the titanium-barium pigment contains 25 percent titanium dioxide precipitated upon a blanc fixe base. A leading brand of titanated lithopone contains 15 percent titanium dioxide.

No change was made in the contract price of $137.50 a short ton for ferrocarbon-titanium (the original titanium alloy containing 15 to 18 percent titanium and 6 to 8 percent carbon), freight allowed east of the Mississippi River and north of Baltimore or equivalent deduction for shipments outside of this territory; on less than ton lots the quotation was 7½ cents a pound. On standard low-carbon grade the price was 20 cents a pound in ton lots or more, 25 cents on smaller shipments, and 30 cents for material milled through 100-mesh. Aluminum-reduced, low-carbon ferrotitanium was offered in less than ton lots at 32 cents a pound, and metallic titanium (96 to 98 percent) was priced at $6 to $7 a pound, according to quantity. The London quotation of ferrocarbon-titanium was reduced to 6¾ d. a pound in June 1933, and shortly thereafter the price of carbide-free ferrotitanium (23 to 25 percent titanium) was dropped from 10 d. to 9 d. a pound; no subsequent revisions were reported.

Ilmenite (45 to 52 percent $TiO_2$) prices remained nominally at $10 to $12 a long ton despite the rise in sterling and rupee exchange.

*Uses.*—Titanium pigments, in addition to their growing use in paints and allied industries, find increased employment in the paper, rayon, rubber, ceramic, and glass industries. In 1933 one of the principal developments was the use of titanium dioxide in the manufacture of many kinds of paper. Fiber pie plates containing titanium are satisfactorily put through the ovens of a Canadian bakery, but titanium-loaded thin stock is of greater practical importance due to the demand for light-weight paper of extraordinary opacity for air-mail use. The hiding power of titanium pigments also is utilized to advantage in wax wrapping papers. In the printing-ink industry, which likewise demands pigments of high-tinting strength and hiding power, titanium is being used more and more, and in the rubber industry these pigments are of great advantage in the production of white and light-colored products.

Metallurgical uses for titanium have until quite recently been confined almost exclusively to deoxidation and scavenging of molten metals. The strong affinity of the element for oxygen and other impurities made it difficult to obtain enough residual titanium in solid steel to show characteristic alloy effects, and partly, at least, for this reason it is only within the last 5 years that the element has been used commercially as a true alloying agent in steel or other structural alloys. Two important effects of alloyed titanium, as revealed by recent research in both Germany and the United States, are age-hardening (following suitable heat treatment) and carbide control. The latter has prime commercial importance, as has been shown already by a generally improved demand for titanium alloys. Titanium additions appear to lock up the carbon in certain alloy steels so as to prevent it from combining with other elements and consequently robbing the adjacent matrix of one or more essential constituents. British and German patent applications cover the employment of titanium in "stabilized 18 and 8" rustless steels to inhibit intergranular corrosion. From the Union Carbide & Carbon Research Laboratories comes evidence [41] that marked benefits similar to those imparted by columbium are obtained by the addition of titanium in definitely limited proportions (in a ratio of 5 to 7 times the percentage of carbon) to plain high-chromium steels. Instead of the hardening effect resulting normally from the presence of chromium and carbon, steels so treated are characterized by the facility with which they may be hot-worked, their relative freedom from air-hardening, and their ductility and softness in the as-rolled condition. Titanium-nickel steels are being used, and in the nonferrous field titanium additions have been shown to be valuable in the case of several simple and complex alloys; in copper alloys, titanium produces age-hardening and in aluminum alloys it refines grain size, increases strength, and promotes soundness. Titanium carbide, generally mixed with molybdenum or tungsten carbide, now is employed by several firms in superhard cutting materials. Titanium is also one of the ingredients of certain electron-emitting materials.

*Imports.*—For the third consecutive year imports of ilmenite set a new record, amounting to 38,610 long tons in 1933 valued at $196,211 compared with 33,491 tons in 1932 valued at $231,652 and 29,857 tons in 1931 valued at $144,951. In all 3 years the imports were from British India, but it will be noted that the average value per ton (as reported) moved contrary to the value of the dollar; it rose sharply from $4.85 in 1931 to $6.92 in 1932 at a time when the exchange value of the rupee dropped, and it dropped sharply to $5.08 in 1933 when the value of the rupee rose in terms of depreciating American currency.

Imports of rutile were only slightly smaller than the extraordinary imports in 1932; they totaled 157,638 pounds valued at $3,737 in 1933 compared with 176,393 pounds valued at $4,508 in 1932 and 2,000

[41] Becket, F. M., and Franks, R., Titanium and Columbium in Plain High-Chromium Steels: Am. Inst. Min. and Met. Eng. Tech. Pub. 506, 1933, 14 pp.

pounds valued at $189 in 1931. Formerly Norway was the sole source of imports of this mineral, but now Brazil furnishes the bulk of the foreign rutile used in this country and the rest, although possibly still of Norwegian origin, is shipped from Germany.

Imports of ferrotitanium and other titanium alloys, mostly from Italy and Great Britain, are insignificant, amounting to only 6,776 pounds valued at $1,292 in 1933.

## THE INDUSTRY IN FOREIGN COUNTRIES

*Africa* (*French West*).[42]—Black sands along the coast between Rufisque and the mouth of the Saloum were discovered in 1900, and in 1912 an attempt was made to exploit them. In 1923 production began again and continued until 1931 when the rising output of British India and the general effects of the depression resulted in a second shut-down. The sands are gathered at low tide and spread on a concrete floor to dry in the sun. The sand, being larger than the ilmenite, is largely eliminated on shaking screens which yield a product containing 44.3 percent $TiO_2$, 14.2 percent $SiO_2$, and 12.4 percent $ZrO_2$. Magnetic treatment eliminates most of the remaining silica and zirconia and brings the titania up to 52 percent. Ilmenite has recently been found in situ in Dahomey where it occurs in veins with amphibole asbestos. Rutile likewise has been found in French West Africa, in gneissoid formations in Upper-Dahomey, and in the crystalline schists of the Ivory Coast.

*Australia.*—The first large shipment of ilmenite, 120 long tons, which was recovered from the extensive alluvial deposits at Frazers River, King Island, Tasmania, was made by the Titanium Products, Ltd., to their plant at Brooklyn, Victoria, for the manufacture of titanium white.[43] Preliminary work on these deposits was done by the Government.

*British India.*—The main source of world supply of titanium minerals is the ilmenite output from the extensive beach sands of Travancore which in 1932 furnished 50,053 long tons of ilmenite, 491 tons of zircon, and 654 tons of monazite. In 1930 the output of ilmenite from this State was 28,776 tons valued at £32,993, and in 1931 it was 36,166 tons valued at £41,991. In 1933 it was reported that a concession had been granted to F. X. Pereira & Sons to work three mines in Travancore for ilmenite and associated minerals.[44]

*Italy.*—A Societa Montecatini subsidiary has operated a large plant for the manufacture of titanium white at Bovisa (Milan) since March 1927. The yearly capacity is given as 1,800 metric tons, of which two-thirds is exported to various European countries.[45] Ilmenite has to be imported although consideration has been given to utilizing black sands of the Tyrrhenian coast which contain magnetite and about 2 percent $TiO_2$.

*Japan.*—With the aid of a proposed Government subsidy, two concerns—the Shai Industrial Chemical Co. and the Dai-Nippon Artificial Fertilizer Co.—have decided to manufacture titanium white. Hitherto titanium pigments have been imported, the total imports being about 300,000 yen annually.[46]

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[42] Blondel, F., Le Titane: Les Ressources Minèrales de la France d'Outre-Mer, vol. 2, Paris, 1934, pp. 381–6.
[43] Bureau of Foreign and Domestic Commerce, World Trade Notes on Chemicals and Allied Products: Vol. 7, no. 43, Oct. 23, 1933, p. 14.
[44] Metal Bulletin (London), Titanium: No. 1809, July 21, 1933, p. 15.
[45] de Bartholomaeis, E., Le Blanc de titane: Chim. et Ind., vol. 29, no. 3, Paris, March 1933, pp. 746–7.
[46] Bureau of Foreign and Domestic Commerce, World Trade Notes on Chemicals and Allied Products: Vol. 7, no. 52, Dec. 25, 1933, p. 5.

*Norway.*—In 1932 A/S Titania produced 13,481 metric tons of titaniferous iron ore; rutile was produced by two firms, but the total output was only 30 tons. Experiments still continue with a view to utilizing titanium- and vanadium-bearing magnetites, possibly along the lines proposed for Russian ore of similar character.

*U.S.S.R.* (*Russia*).—As part of the Soviet Government plan for exploiting rare elements the trust "Lakokraska" arranged for the construction of a titanium-white plant. Apparently this project is linked with the proposals to utilize the large deposits of titanium-bearing magnetites in the Urals. Using coke impregnated with salt (which is introduced during the coking process) and an iron ore containing 16 percent $TiO_2$ and 0.65 percent $V_2O_5$, it was possible to produce in a regular blast furnace a high-grade pig iron containing 0.80 percent vanadium and a slag containing 42 percent $TiO_2$, the latter being suitable for conversion into pigment. Even at full capacity, however, the new titanium-pigment department of the Yaroslavl white-lead plant is expected to produce only 30 tons monthly.

*United Kingdom.*—On May 10, 1933, the Parliamentary Secretary of Trade, Dr. E. Leslie Burgin, officially opened at Luton a new titanium-pigment plant in the presence of some 200 guests, including a number of distinguished members of the chemical industry and leaders in finance and municipal politics. The new factory is the only one of its kind in England. It adjoins the chemical works (blanc fixe, hydrogen peroxide, etc.) of B. Laporte, Ltd., who recently acquired control of National Titanium Pigments, Ltd.; the latter had previously operated a pilot plant at Barking, now closed. The Laporte concern had long been a shareholder in Titanium, Ltd., of Canada. The raw material for the English operations will be ilmenite from Travancore. The British Titan Products Co., a subsidiary of Imperial Chemical Industries, which originally was reported to be interested in the Luton venture, is subsequently reported to have acquired a 7-acre site between Stockton-on-Tees and Haverton Hill, County Durham, where it proposes to erect a titanium-pigment factory.

*World production of titanium minerals, 1932–33*

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

| Mineral and country | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Ore produced | Content of $TiO_2$ | Value [1] | Ore produced | Content of $TiO_2$ | Value [1] |
| | *Metric tons* | *Percent* | | *Metric tons* | *Percent* | |
| Ilmenite: | | | | | | |
| Australia: Tasmania | | | | 122 | (2) | (2) |
| Brazil [3] | 35 | (2) | $1,004 | (2) | (2) | (2) |
| Egypt | 487 | (2) | (2) | (2) | (2) | (2) |
| India (Travancore) | 50,856 | 54 | 203,822 | (2) | (2) | (2) |
| Norway | 13,481 | 45 | 72,736 | 23,200 | (2) | (2) |
| Portugal | 766 | 50 | 2,447 | (2) | (2) | (2) |
| Senegal [3] | | | | [4] 310 | 47 | (2) |
| United States | (5) | (5) | (5) | (5) | (5) | (5) |
| Rutile: | | | | | | |
| Norway [6] | 30 | 90–93 | 5,941 | (2) | (2) | (2) |
| United States | (5) | (5) | (5) | (5) | (5) | (5) |

1 Values as officially reported converted to United States currency at the annual average rate of exchange as published by the Federal Reserve Board.
2 Data not available.
3 Exports.
4 Exports during first 11 months of year; complete data not yet available.
5 Bureau of Mines not at liberty to publish figures.
6 Concentrates.

## ZIRCONIUM

No production of zirconium minerals in the United States has been reported to the Bureau of Mines since 1927, when operations at Pablo Beach, Fla., yielded 3,646 short tons.

The most recent development, and virtually the only one of importance, was the placing on the market of sintered zirconium, which is quoted nominally at $1 a pound. In large lots, however, it may be obtained for about 75 cents. It is described as a supercleanser in the manufacture of nonferrous alloys. Among other advantages, it has a high heat of combination, thus increasing the fluidity of the metal.

*Prices.*—Quotations for zirconium products in 1933 virtually were unchanged from 1932. Zircon ore, 55 percent $ZrO_2$, has remained stationary for several years at $40 to $45 a short ton f.o.b. Atlantic seaboard in 30-ton lots, and, as in previous years, crude granular zircon was quoted at $70 per ton f.o.b. Suspension Bridge, N.Y. 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 "Zirkonalba" (high-grade precipitated $ZrO_2$) at 80 cents to $1.10 a pound were likewise quoted at the same level as in former years. Prices for the lower grades of zirconium dioxide have declined from 50 cents per pound in 1931 to 38 to 43 cents in 1932 and the first half of 1933 and 25 cents per pound in the latter half. The price of zirconium-ferrosilicon was reduced further from $97.50 to $105 per long ton to $94.50 to $102. Silicon-zirconium (35 to 40 percent zirconium, 47 to 52 percent silicon) was quoted at 13 to 15 cents a pound throughout the year and zirconium-metal powder in 100-pound lots at $6 per pound.

*Uses.*—An excellent review of the uses of zirconium has been prepared by Gordon H. Chambers,[47] in which he classifies commercial uses according to: (1) Metallurgical applications for the powdered metal and (2) fields in which the relatively low ignition temperature (210° to 275°) and high heat of combustion of zirconium are utilized. Of leading importance is the employment of zirconium metal powder in ammunition primers. Smokeless flashlight power, containing approximately 13½ percent magnesium, 58 percent barium nitrate, and 28½ percent finely divided zirconium metal, which a few years ago appeared as an important development in the commercial progress of zirconium, has been superseded to a considerable extent by the photoflash lamp. Zirconium also is employed in photoflash lamps but in very much smaller percentages. Electric blasting caps, pyrotechnics, torpedoes, firecrackers, and zirconium getters for vacuum lamps offer potential outlets for additional quantities of the metal. Zirconium-alloy additions continue to be of interest in the steel industry, and numerous contributions to the patent literature have been noted. Zirconium shares in the general interest in metallic carbides and is being used by several manufactures of sintered tungsten carbide tools.

*Imports.*—Consumption of zirconium in the United States is indicated roughly by the imports of ore (mainly from Brazil). A recovery

[47] Chambers, Gordon H., Zirconium: Metals and Alloys, vol. 4, no. 12, December 1933, pp. 199–201. Reprinted, Foote-Prints, vol. 6, no. 2, December 1933, pp. 20–28.

is shown for 1933, although the average declared value per short ton dropped to $18.66 in 1933 compared with over $32 in 1931 and 1932 and over $26 in 1929 and 1930. No imports of ferro-alloys of zirconium were reported for 1932 or 1933, and in 1933 only one small lot of zirconium metal powder was imported from Germany.

*Zirconium ores and alloys imported for consumption in the United States, 1929–33*

| Year | Zirconium ores | | Ferrozirconium, zirconium, and zirconium ferrosilicon | |
|---|---|---|---|---|
| | Pounds | Value | Pounds | Value |
| 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 | ---------- | ---------- |
| 1933 | 568,581 | 5,306 | ---------- | ---------- |

*The industry in foreign countries.*—In British India the production of zircon in 1932 did not rise with the increased output of ilmenite, only 491 long tons being produced at Travancore compared with 846 tons in 1931. The output from Madagascar is still insignificant, only about 2 tons being reported for 11 months of 1933 and only 3.3 tons for the year 1932. Brazil continues to be the main source of zirconium oxide ores, which are chiefly in demand. According to a recent review [48] of the mineral resources of the British Protectorate of Nyasaland, zircon as well as corundum will be worked in Tambani Hill, Mwanza area, as opportunity affords.

[48] Rhodesian Mining Journal, Mineral Resources of Nyasaland: Vol. 8, no. 81, February 1934, p. 97.

# NICKEL

By C. E. Julihn

## SUMMARY OUTLINE



In 1933 the world output of nickel was approximately 49,000 tons, of which the United States produced 126 tons as a byproduct of copper refining. It also recovered 1,650 tons of secondary nickel. Net imports of nickel into the United States amounted to about 19,000 tons.

These figures reflect the fact that this country has no nickel mines or known ore deposits that promise much future production, although some nickel occurs in ores of southeastern Missouri, Colorado, Oregon, southern California, and Alaska. Thus the United States virtually depends upon foreign production of nickel for its supply. Usually this country imports more than half of the world output.

*Summary of statistics for nickel in the United States, 1924–33*

| | 1924–28 average | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| Production: | | | | | | |
| At copper refineries [1] short tons | 434 | 340 | 308 | 373 | 195 | 126 |
| From secondary sources short tons | 3,094 | 4,350 | 2,900 | 2,070 | 1,450 | 1,650 |
| Value of imports for consumption [2] | $9,365,528 | $19,416,259 | $12,878,827 | $7,613,834 | $4,694,430 | $10,762,417 |
| Value of exports [2] | $1,525,409 | $2,795,351 | $2,429,964 | $1,411,816 | $1,361,472 | $1,394,316 |
| Price per pound [3] cents | 36.6 | 35 | 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.

Since the uses of nickel are so numerous and important that it is almost indispensable to industry as now established, its situation closely parallels that of tin. The United States is the chief consumer of both metals, although it produces neither metal in important amounts and does not have important known resources of their ores. For this reason the foreign resources and facilities for the production of nickel are as important in the domestic nickel situation as domestic consumption.

The strategic aspect of nickel must also be recognized. It is recalled that when the German submarine *Deutschland* accomplished its perilous trip to Baltimore, while this country was still neutral, supplies of nickel were eagerly sought as cargo because of pressing military needs for the metal in Germany. Fortunately the possession

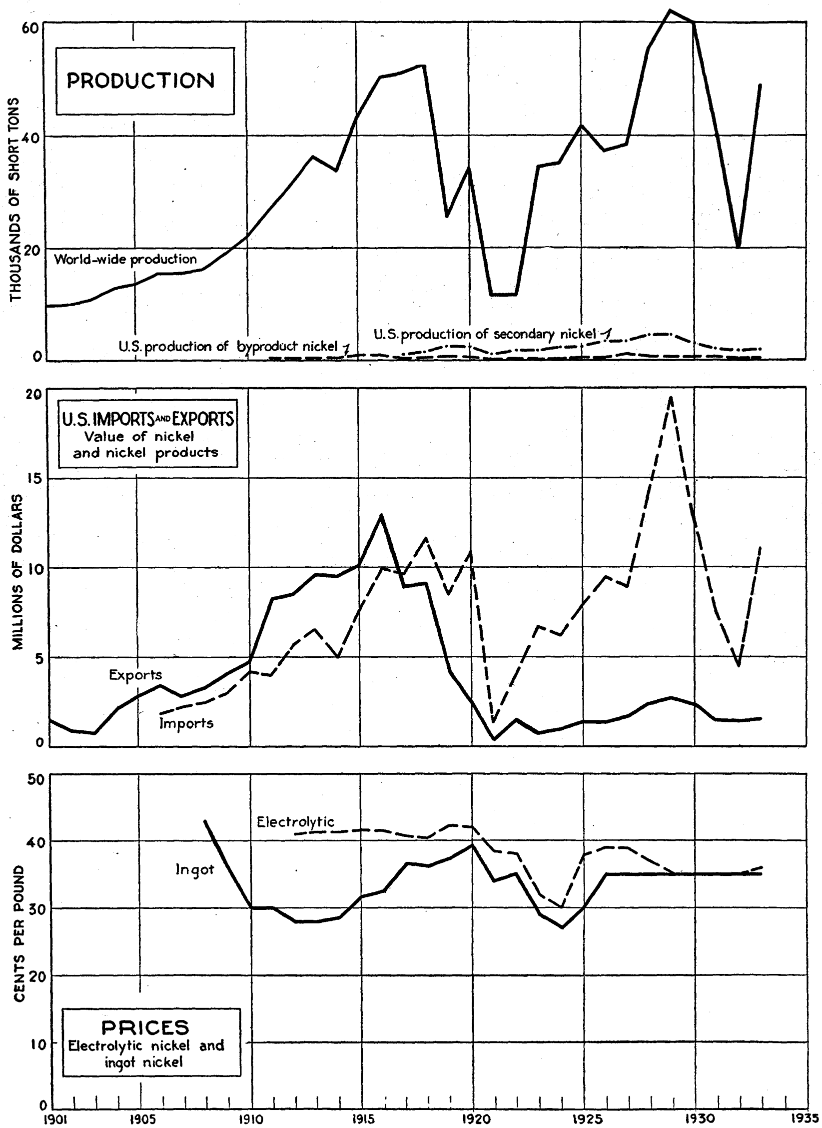


FIGURE 24.—Outstanding trends in the nickel industry, 1901–1933.

by Canada of the most important nickel deposits in the world minimizes the danger of interruption to the flow of nickel into this country.

*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.

*Quoted prices [1] for nickel at New York, in cents per pound, 1924–33*

| | Electrolytic | Ingot | Shot |
|---|---|---|---|
| 1924–28, average | 36.6 | 32.4 | 33.2 |
| 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 |
| 1933 | 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.

## PRODUCTION

Of the 49,000 tons of nickel produced in 1933, 86 percent was supplied by Canada and 9 percent by New Caledonia. Usually Norway, India, and, in a few recent years, Greece produce a small quantity, comparable to the output of the United States.

In effect, Canada is preeminent not only in production but also in possession of reserves of nickel ore, as the nickel reserves of Canada, in the Sudbury district of Ontario, are large enough to meet all probable world requirements for many decades. The reserves of New Caledonia are far more limited as well as more uncertain.

Production by countries in recent years was as follows:

*World production of nickel ore (content of ore), 1924–33, by countries, in short tons*

| Country | 1924–28 (average) | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| Australia | 19 | 95 | 132 | ------- | ------- | 10 |
| Canada | 36,438 | 55,138 | 51,884 | 32,833 | 15,184 | 42,293 |
| Greece | 157 | 284 | ------- | 715 | 1,000 | [1] 640 |
| India | 250 | 930 | 1,065 | 900 | 840 | [1] 800 |
| New Caledonia | [2] 4,072 | [3] 4,816 | [3] 5,376 | [3] 4,256 | [3] 2,912 | [1] 4,500 |
| Norway | 127 | 483 | 965 | 586 | 1,074 | 860 |
| United States [4] | 434 | 340 | 308 | 373 | 195 | 126 |
| Total | 41,500 | 62,100 | 59,800 | 39,600 | 21,000 | 49,200 |

[1] Estimate.
[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.*—The International Nickel Co. of Canada, Ltd., is the chief producer of nickel in the world, as well as in Canada. The company represents a consolidation of the International Nickel Co., Inc., and the Mond Nickel Co., Ltd. Its ore reserves are estimated at nearly 205,000,000 tons, of which the average grade is not stated. Presumably the total nickel content is enormous, as it would exceed 4,000,000 tons if reckoned at 2 percent. The ratio of nickel to copper in this ore is approximately 2 to 1.

In 1933 the company produced 1,336,040 tons of ore, including nearly a million tons from the Frood mine, while the balance came from the Creighton mine. Most of the ore was smelted at Copper Cliff, Ontario, and the balance at Coniston, Ontario.

The Port Colborne refinery, in Ontario, refined 20,748 tons of nickel in cathodes and oxide, while 10,380 tons were refined at the Clydach refinery in Wales. The combined refinery production of 31,128 tons attributed to the two refineries is exclusive of the company's production of rolled nickel, Monel metal, and other nickel alloys made by its Huntington (W.Va.) works and by other works in England and Scotland. The nickel content of such products sold in 1933 exceeded 6,500 tons. Total nickel production by the company in 1933 is estimated at 37,622 tons, or 76 percent of world production.

The other producer of Canada is Falconbridge Nickel Mines, Ltd., which also reduces its ore to matte at a smelter near the mines at Falconbridge, Ontario. The matte is exported to a refining plant owned by the company at Kristiansand, Norway. The mine and reduction plants of this company, which started underground work in 1928, are being developed rapidly. It now reports proven ore reserves of nearly 3,000,000 tons, containing 2.23 percent nickel and 0.93 percent copper, or about 65,000 tons of nickel.

In 1933 the output of its smelter was 4,671 tons of nickel and that of its refinery 4,594 tons of nickel, including 860 tons refined for a Norwegian company, but at the end of the year the rate of refining had reached 6,000 tons of nickel and 3,000 tons of copper annually.

*New Caledonia.*—The deposits of New Caledonia are now operated by the Sociètè Calèdonickel, in which are joined the Sociètè Le Nickel and La Sociètè Caledonia. Their consolidation resulted in a general reorganization of operations by which mining was discontinued in the Thio district but maintained in that of N'goye. Smelting operations have been confined to the Noumea smelter, those at Thio and Yatè being discontinued. The matte produced is shipped to France and Belgium for refining. The future outlook for these operations is obscure, but it seems unlikely that their importance will increase.

*Norway.*—Presumably the 860 tons of Norway nickel, refined by Falconbridge, will constitute the production of that country. It was derived chiefly from the Hosangar mine.

*Greece.*—Recently Greece has contributed annually about 700 tons of nickel, presumably derived from Locris and Boetia deposits controlled by the Locris Nickel Co.

*Burma.*—The nickel from India, amounting to about 800 tons a year, is derived from a speiss made by the Burma Corporation, Ltd., at Namtu in the Northern Shan States. It contains copper, silver, and cobalt, as well as nickel. The speiss is shipped to Hamburg for treatment.

*United States.*—New nickel is produced in the United States merely as a byproduct of copper refining. In 1928 production was 522 tons, but it has declined with the curtailment of copper production and of the refining of foreign ores, from which some of the nickel was derived. Nickel contained in anodes dissolves and fouls the electrolyte, but it does not deposit on the cathode. When the electrolyte contains about 1 percent of nickel it is treated for precipitation of the nickel as a salt.

*Nickel content of nickel salts and metallic nickel produced in the United States as a byproduct in the electrolytic refining of copper, 1924–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| Average 1924–28 | 434 | $240,340 | 1931 | 373 | $202,406 |
| 1929 | 340 | 297,273 | 1932 | 195 | 88,515 |
| 1930 | 308 | 213,803 | 1933 | 126 | 62,913 |

Secondary nickel is recovered by the United States in substantial quantities. In 1928 recovery was 4,500 tons, compared with 1,650 tons in 1933. It was reported that in 1933 the supply of scrap nickel was depleted and that little of it is now to be had.

*Secondary nickel recovered as metal and in nonferrous alloys and salts in the United States, 1924–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| Average, 1924–28 | 3,094 | $2,058,300 | 1931 | 2,070 | $1,449,000 |
| 1929 | 4,350 | 3,045,000 | 1932 | 1,450 | 1,015,000 |
| 1930 | 2,900 | 2,030,000 | 1933 | 1,650 | 1,155,000 |

## IMPORTS AND EXPORTS

In 1933 the value of nickel imports increased 129 percent, exceeding their average value in the 5-year period 1924–28.

*Value of nickel imported into and exported from the United States, 1924–33*

| 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, 1924–28 | $9,237,261 | $128,267 | $9,365,528 | $662,076 | $617,585 | $245,748 | (1) | $1,525,409 |
| 1929 | 19,098,105 | 318,154 | 19,416,259 | 1,115,568 | 1,347,391 | 325,992 | (1) | 2 2,795,351 |
| 1930 | 12,750,721 | 128,106 | 12,878,827 | 1,207,612 | 923,547 | 243,528 | (1) | 2 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 |
| 1933 | 10,746,721 | 15,696 | 10,762,417 | 546,878 | 504,760 | 57,645 | 285,033 | 1,394,316 |

1 Not separately recorded.
2 Includes nickel salts valued at $6,400 in 1929 and $55,277 in 1930; not separately recorded for other years.

The value of nickel exports in 1933 gained only slightly over that for the previous year.

*Nickel imported for consumption in the United States, 1931–33, by classes*

| Class | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value |
| Unmanufactured: | | | | | | |
| Nickel ore and matte | 11,629,709 | $1,530,557 | 5,917,770 | $775,438 | 19,220,399 | $2,522,682 |
| Nickel alloys, pigs, bars, etc | 23,633,754 | 5,987,610 | 15,023,813 | 3,764,803 | 31,621,203 | 7,850,443 |
| Nickel oxide | 304,991 | 47,522 | 687,597 | 120,248 | 2,019,155 | 373,596 |
| Nickel silver or German silver | 100 | 135 | | | | |
| Manufactured: | | | | | | |
| Nickel silver or German silver in sheets, strips, and rods | 10,111 | 5,247 | 2,193 | 1,743 | | |
| All other manufactures of nickel | (1) | 42,763 | (1) | 32,198 | (1) | 15,696 |
| | | 7,613,834 | | 4,694,430 | | 10,762,417 |

1 Quantity not recorded.

*Nickel exported from the United States, 1931–33, by classes*

| Class | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value |
| Nickel; Monel metal and other alloys | 1,776,917 | $648,026 | 2,059,352 | $635,399 | 1,509,301 | $546,878 |
| Manufactures | (1) | 438,333 | (1) | 432,173 | (1) | 504,760 |
| Nickel-chrome electric resistance wire | 175,707 | 253,107 | 229,596 | 250,681 | 262,743 | 285,033 |
| Nickel silver or German silver in bars, rods, or sheets | 409,847 | 72,350 | 237,128 | 43,219 | 330,176 | 57,645 |

1 Quantity not recorded.

## USES AND CONSUMPTION

World consumption of nickel recovered sharply in 1933, increasing 68 percent to approximately 48,000 tons from a low of about 28,500 tons in the previous year. The United States contributed substantially to this increase, as shown by the large gain in imports. The consumption of new nickel in the United States was approximately 19,000 tons.

The great and rapidly expanding importance of nickel in recent years is due not only to a multiplicity of valuable minor uses, such as nickel plating, but also, more notably, to its use as what may be termed a "complimentary" metal to iron. Preeminent among the metals for their abundance, cheapness, and strength, iron and its steel alloys are benefited in many ways by addition of nickel to them.

A recent estimate indicates that 42 percent of nickel consumption is used for this purpose. It includes 30 percent used in structural nickel steel, through a wide range of compositions, from steels containing only a fraction of a percent of nickel to those having a very high content of nickel to meet special requirements in costly machines, such as automobiles. Another 4 percent of nickel is consumed in corrosion-resistant steels; 4 percent in nickel cast iron; 2 percent in nickel-steel castings; and 2 percent in iron-nickel alloys in which temperature effects are of importance, such as "Invar" and "Permalloy."

Its use in varying amounts thus makes possible a wide range of properties in iron and steel and a variety of new materials to meet varying requirements of design. Although similar effects may be obtained by the use of other metals as alloys, they are generally less abundant and more costly.

The next largest use of nickel is that in which it is alloyed with copper to make metal of the Monel type. This accounts for 31 percent of nickel consumption.

Nickel plating consumes 7 percent, malleable nickel 6 percent, nickel silver 5 percent, and heat-resisting or electrical alloys 5 percent. The balance of 4 percent is used for nickel catalyzers, storage batteries, coinage, and a variety of minor alloys having special uses.

Some types of uses are as follows:

### IRON-NICKEL

*Heat-resistant steels, 7 to 35 percent nickel.*—Oil refineries; ceramic, glass, and metal industries; power plants; and high-temperature chemical processes.

*Corrosion-resistant steels, 7 to 35 percent nickel.*—Cooking utensils, marine fittings, turbine blades, cables, building trim, and hardware fittings.

*Nickel steels, one half to 7 percent nickel.*—Automobile, aircraft, motorcycle, locomotive, and car parts; mining and excavating tools and machines; ordnance, and turbines.

*Nickel-steel castings, 1 to 4 percent nickel.*—Locomotive frames, track work, ore and rock crushers, mill rolls, and high-pressure valves.

*Corrosion-resistant cast irons, 12 to 20 percent nickel.*—Diesel engines, valves, oil refineries, mines having acid waters, rolls for glass, and equipment for handling sugar.

*Chilled cast iron, 4 to 5 percent nickel.*—Crusher jaws, rolls, ore and coal carriers, and pumping with abrasives in the liquid.

*Nickel cast iron, one-half to 3 percent nickel.*—Cut gears and cams, resistance grids, machine tools, glass molds, forming dies, frames, and other parts of machines.

*Nickel cast iron, 5 percent nickel.*—Car-heating grids, subway car-resistance control.

*Nickel cast iron, 10 to 15 percent nickel.*—Nonmagnetic, high-resistance, electrical-machinery castings.

*Highly magnetic alloys, 45 to 80 percent nickel.*—Radio transformers, telephone and telegraph relays, current transformers, and sheathing of submarine cable.

*Nonmagnetic alloys, 10 to 25 percent nickel.*—Transformer, motor, and generator parts.

*Low-expansion alloys, 35 to 45 percent nickel.*—Thermostatic metals, exact dimension rods, surveying tapes, wire glass, struts in auto-engine pistons, and electric-light bulbs.

### COPPER NICKEL

*Monel metal, 68 percent nickel.*—Chemical manufacturing, dye handling, metal pickling, canning, packing and dispensing, marine shafting, propellers, condensing tubes, and laundry, hospital, and kitchen equipment.

*Nickel silver, 10 to 30 percent nickel.*—Base for silver-plated ware, filled-gold jewelry, coinage, and hardware.

*Nickel bronzes, one-half to 5 percent nickel.*—Bearings, valve castings, and steam-packing metal.

*Copper-nickel alloys, 15 to 50 percent nickel.*—Bullet jackets, condenser tubes, electric resistance wire, corrosion-resistant castings.

### CHROMIUM NICKEL

*Electrical-resistance alloys, up to 85 percent nickel.*—Heater, pyrometer, and rheostat wire.

*Heat-resistant alloys, 35 to 85 percent nickel.*—Electric furnace heater elements and other parts, and tubes and retorts in chemical, glass, and ceramics industries.

### ALUMINUM NICKEL

*Two percent nickel.*—Pistons and cylinder heads for internal-combustion engines, crank cases.

ALUMINUM-ZINC-NICKEL

*One-half to 5 percent nickel.*—Die-cast parts for meters and other light machinery.

There are also numerous, but less important, alloys of nickel with other metals for special purposes, such as spark-plug wire, 96 percent nickel and 4 percent manganese; nickel-cobalt-titanium, 78 percent nickel, for rectifier tubes; nickel-molybdenum-iron alloy, 60 percent nickel, for resistance to hydrochloric and other acids; white gold, 15 percent nickel, for eyeglasses and jewelry; rose gold, 5 to 6 percent nickel; and green gold, 1 to 2 percent nickel.

# ORE CONCENTRATION

By T. H. Miller

SUMMARY OUTLINE



Final figures on total ore treated, flotation reagents consumed, and other milling data for 1933 are not yet available, but preliminary reviews indicate that the totals will not differ greatly from the 1932 data in the following tables. The total quantity of nonferrous ore treated was lower due to continued curtailment of output at the copper concentrators, but this loss was offset partly by increases in ore treated at gold and silver mills.

*Total nonferrous ore produced in the United States in 1932, by classes of ore and methods of treatment, in dry tons*

| Method of treatment | Copper ore | Copper-lead ore | Lead ore | Lead-zinc ore | Zinc ore | Gold and silver ore | Total ore |
|---|---|---|---|---|---|---|---|
| Straight flotation concentration | 8, 956, 121 | 165, 490 | 35, 816 | 1, 141, 646 | 194, 396 | 97, 706 | 10, 591, 175 |
| Combined gravity and flotation concentration | 2, 022, 346 | | 4, 315, 740 | 1, 909, 402 | 1, 105, 993 | 202, 488 | 9, 555, 969 |
| Straight gravity concentration | 15 | | 3, 157 | 24, 500 | 11, 900 | 12, 088 | 51, 660 |
| Total ore concentrated | 10, 978, 482 | 165, 490 | 4, 354, 713 | 3, 075, 548 | 1, 312, 289 | 312, 282 | 20, 198, 804 |
| Direct smelting | 752, 527 | 1, 616 | 99, 155 | 1, 216 | 715 | 225, 612 | 1, 080, 841 |
| Amalgamation or cyanidation | | | | | | 3, 619, 718 | 3, 619, 718 |
| Miscellaneous methods | 581, 207 | | | 260, 600 | 580, 509 | | 1, 422, 316 |
| Total ore, all methods: 1932 | 12, 312, 216 | 167, 106 | 4, 453, 868 | 3, 337, 364 | 1, 893, 513 | 4, 157, 612 | 26, 321, 679 |
| 1931 | 34, 447, 480 | 203, 334 | 6, 043, 169 | 6, 023, 825 | 3, 912, 958 | 4, 134, 076 | 54, 764, 842 |

No marked changes are indicated in consumption of flotation reagents. Reagent changes were reported at two copper concentrators and at several gold and silver mills, but the general trends were the same as in 1932. The following table giving total consumption of reagents in 1932 may be considered as showing the approximate consumption in 1933.

*Consumption of reagents in the treatment of all ores in 1932*

[141 plants treating 16,124,007 tons of ore]

| Reagent | Plants using | Ore treated (tons) | Consumption of reagents (pounds) | | |
|---|---|---|---|---|---|
| | | | Total, 1932 | Per ton | |
| | | | | 1932 | 1931 |
| I. Frothers: | | | | | |
| Pine oils | 115 | 11, 335, 507 | 1, 189, 077 | 0. 105 | 0. 123 |
| Cresylic acid | 63 | 7, 207, 153 | 1, 187, 931 | . 165 | . 165 |
| Total frothers | 141 | 16, 124, 007 | 2, 377, 008 | . 147 | . 153 |
| II. Collectors: | | | | | |
| Distillation products: | | | | | |
| Coal-tar creosotes | 26 | 2, 215, 300 | 421, 548 | . 190 | . 186 |
| Wood-tar creosotes | 2 | 19, 576 | 700 | . 036 | . 052 |
| Petroleum products | 1 | 1, 417, 810 | 1, 374 | . 001 | . 103 |
| Blast-furnace oils | 1 | 615, 285 | 75, 330 | . 122 | . 080 |
| Total distillation products | 29 | 4, 250, 595 | 498, 952 | . 117 | . 126 |
| Synthetic products: | | | | | |
| Ethyl xanthates | 97 | 8, 437, 200 | 716, 827 | . 085 | . 111 |
| Butyl xanthates | 5 | 2, 002, 957 | 172, 311 | . 086 | . 052 |
| Amyl xanthates | 35 | 3, 416, 021 | 119, 722 | . 035 | . 028 |
| Xanthate derivatives | 7 | 3, 162, 664 | 36, 269 | . 011 | . 011 |
| Dicresol-dithiophosphoric acid | 51 | 3, 795, 723 | 164, 005 | . 043 | . 110 |
| Sodium dicresol-dithiophosphate | 28 | 2, 060, 262 | 90, 738 | . 044 | . 035 |
| Sodium diethyl-dithiophosphate | 1 | 3, 169, 411 | 40, 424 | . 013 | . 013 |
| Thiocarbanilide | 2 | 157, 152 | 14, 353 | . 091 | . 061 |
| Total synthetic products | 140 | 15, 972, 124 | 1, 354, 649 | . 085 | . 100 |
| Total collectors | 141 | 16, 124, 007 | 1, 853, 601 | . 115 | . 119 |
| III. Acids and alkalies: | | | | | |
| Acids: Sulphuric acid | 8 | 1, 668, 602 | 1, 201, 871 | . 072 | 21. 342 |
| Alkalies: | | | | | |
| Sodium carbonate | 44 | 1, 191, 506 | 666, 040 | . 559 | . 586 |
| Sodium hydroxide | 4 | 142, 611 | 55, 800 | . 391 | . 057 |
| Lime | 44 | 12, 684, 084 | 44, 547, 277 | 3. 512 | 3. 859 |
| Total alkalies | 80 | 13, 177, 669 | 45, 269, 117 | 3. 435 | 3. 852 |
| IV. Other inorganic reagents: | | | | | |
| Sulphidizing: Sodium sulphide | 17 | 2, 378, 074 | 444, 110 | . 187 | . 723 |
| Activating: Copper sulphate | 59 | 3, 066, 100 | 2, 066, 572 | . 674 | . 593 |
| Depressing: | | | | | |
| Cyanides | 21 | 6, 301, 387 | 207, 980 | . 033 | . 050 |
| Sodium sulphite | 2 | 312, 097 | 340, 959 | 1. 092 | 1. 158 |
| Sodium silicate | 10 | 318, 720 | 98, 838 | . 310 | . 862 |
| Zinc sulphate | 18 | 2, 180, 114 | 815, 530 | . 374 | . 290 |
| Sodium bichromate | 1 | 42, 617 | 8, 766 | . 206 | . 350 |
| Total depressing | 34 | 6, 798, 608 | 1, 472, 073 | . 217 | . 166 |
| Miscellaneous: | | | | | |
| Sodium chloride | 1 | 33, 423 | 35, 750 | 1. 070 | 1. 243 |
| Starch | 2 | 58, 245 | 49, 380 | . 848 | . 252 |
| Chlorine | 1 | 34, 366 | 28, 350 | . 825 | ------- |
| Total reagents | 141 | 16, 124, 007 | 54, 797, 832 | 3. 399 | 3. 979 |

In 1933, as in 1932, most of the changes and improvements in ore-dressing practice were reported at plants treating gold ores. Nearly all new plant construction during the year was at properties of this class. Several new plants were built, and many older plants were rebuilt. Most of the new plants placed in operation used some combination of flotation with other processes, such as amalgamation or cyanidation, but a few straight flotation plants were built.

Flow sheets in use at operating gold mills represent a wide variety of processes, and no general type seems to be indicated. The advisability of removing free gold at the earliest possible stage is recognized in many of these flow sheets. The removal of free gold during the grinding and classification steps is gaining wider application. The equipment used for this operation ranges from simple riffles in the grinding-mill discharge launders to very complicated classification-amalgamation-concentration arrangements. In almost all cases the ball-mill or tube-mill discharge is diverted to some special treatment before advancing to the circulating classifier. The purpose of this is the same in all cases—to remove gold from the grinding circuit. It prevents the building-up or cycling of gold in these machines and has the added advantage of equalizing the gold content of the classifier overflow even on ores of highly variable gold content.

The development of single-cell flotation machines for this work has resulted in a wide demand for equipment of this type. The process has the advantage of simplicity and does not cause a loss in material elevation in the grinding circuit. At least one unit-cell design provides a hydraulic-classifier cone in the bottom of the cell which allows the removel of coarse, nonfloating gold. One large Canadian mill using cells of this type reports a recovery of 70 percent of the total gold in the mill feed at this point.

Concentrates produced at mills treating gold ores continue to be treated by a variety of processes, including amalgamation, cyanidation, and direct smelting. In general, the trend in development of flow sheets for the treatment of gold ores seems to be toward a combination of flotation with other processes rather than the adoption of straight flotation. A wide variety of flotation reagents continue to be used on ore of this type. The use of higher alcoholic xanthates and xanthate derivatives as the chief collecting reagent still gains in favor. Lime has been shown repeatedly to be a depressor of gold, and the undesirability of using this reagent in gold circuits adds to the problem of slime dispersion and alkalinity control.

In the copper-flotation field no major developments took place during 1933. Metallurgical results were improved slightly, but no important changes in methods were reported. One large copper mill partly replaced its flotation machines with new machines recently developed and made slight changes in reagent combinations. A second plant planned to adopt a middling regrinding flow sheet and produced iron concentrates for acid manufacture.

Progress was noted in the laboratory treatment of copper-zinc ores. A new process was announced whereby the sphalerite would be floated away from copper minerals depressed by a complex salt using aerofloat as a collector. The use of xanthate in the second circuit removes the coating from the copper minerals and causes them to float.

# PART III. NONMETALS

## COAL

By H. O. Rogers and F. G. Tryon[1]

### SUMMARY OUTLINE



For the coal industry 1933 was a year of portentous developments. It began with the morale of the industry at low ebb. Conditions had never been more discouraging, and the situation grew progressively more acute as the country drifted toward the financial crisis that culminated in the Nation-wide bank holiday early in March. With confidence restored after the reopening of the sound banks, the country witnessed one of the most spectacular examples of industrial recovery in our economic history. In the short space of 4 months, from March to July, the Federal Reserve Board's index of industrial activity rose from 60 to 96, a gain of 60 percent. This remarkable revival, however, was due partly to short-lived, temporary forces. Speculation in inventories in anticipation of increased prices accounted for a large part of the advance. As a result, about midsummer a reaction set in that canceled approximately two-thirds of the March-to-July recovery before it was checked. The year ended, however, with nearly all the standard measurements of industrial activity once more

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

pointing upward. Compared with 1932, the level of industrial activity in 1933 as a whole gained 18.8 percent.

Apart from the improvement in the general business situation, the most important development of the year was the passage of the National Recovery Act. Indeed, from the viewpoint of the coal trade, this had even greater significance. The post-war boom had demonstrated effectively that much more than a high level of industrial activity was needed to bring prosperity to coal mining. In no other industry, with the possible exception of agriculture, has the classical concept of unrestricted competition as the automatic and beneficent regulator of prices and wage rates shown more serious defects. Because of this, the coal industry stands to gain more from control of wages and price cutting, made possible by the recovery act, than almost any other branch of industrial activity. It is, of course, much too early to appraise adequately the effect of the National Recovery Administration on the coal industry. The code for bituminous mining did not become effective until October 2, and conflicting interests still prevent the adoption of a satisfactory code for the Pennsylvania anthracite industry. Yet, even from this short-range view, it is clear that the events of the past year are charged with potentialities that promise to influence the coal industry for years to come.

Coal mining is a business of many thousands of competing units. Not counting wagon mines and country coal banks, bituminous coal was produced in 1932 by 5,427 mines of commercial size. As this book goes to press many of the mines have not yet reported their operations for 1933. The following analysis is therefore based on preliminary figures which are subject to revision. Details will be published later when all of the final returns have been received.

*Salient statistics of the coal industry, 1932–33* [1]

[All tonnage figures represent net tons of 2,000 pounds]

| | Bituminous coal | | | Pennsylvania anthracite | | |
|---|---|---|---|---|---|---|
| | 1932 | 1933 [1] | Percent of change in 1933 | 1932 | 1933 [1] | Percent of change in 1933 |
| Production ........ net tons | 309,709,872 | 327,940,000 | +5.9 | 49,855,221 | 49,399,000 | −0.9 |
| Value at mines | $406,677,000 | $445,998,000 | +9.7 | $222,375,000 | $213,400,000 | −4.0 |
| Average value per ton | $1.31 | $1.36 | +3.8 | $4.46 | $4.32 | −3.2 |
| Average retail price [2] | $7.71 | $7.65 | −.8 | [3] $13.91 | [3] $13.18 | −5.2 |
| Stocks on hand: [4] | | | | | | |
| Jan. 1 ........ net tons | 35,500,000 | 29,666,000 | −16.4 | 3,073,074 | 1,732,216 | −43.6 |
| Dec. 31 ........ do | 29,666,000 | 32,840,000 | +10.7 | 1,732,216 | 1,106,085 | −36.1 |
| Exports ........ do | 8,814,047 | 9,036,947 | +2.5 | 1,303,355 | 1,034,563 | −20.6 |
| Imports ........ do | 186,909 | 197,269 | +5.5 | 607,097 | 456,252 | −24.8 |
| Consumption (calculated) ........ do | 306,917,000 | 315,947,000 | +2.9 | 50,500,000 | 49,447,000 | −2.1 |
| Number of men employed | 406,380 | 409,000 | +.7 | 121,243 | [5] 102,469 | −15.5 |

[1] Figures for 1933 are in most instances preliminary and subject to revision.
[2] Compiled by Bureau of Labor Statistics, U.S. Department of Labor.
[3] Represents average retail price of stove coal only.
[4] Figures for bituminous coal represent consumers' stocks; for anthracite, producers' stocks.
[5] Pennsylvania Department of Mines.

# BITUMINOUS COAL

## THE MARKET IN 1933

*Production.*—In the bituminous branch of the industry the trend in 1933 was generally upward, with output, consumption, prices, and employment showing moderate gains compared with 1932. Over the year as a whole, the output of soft coal amounted to 327,940,000 tons, an increase of 18,230,000 tons, or 5.9 percent, compared with 1932. The increase was less than that recorded by some other industries, such as pig iron, steel, and automobiles, but it must be remembered that even during the worst of the depression coal never fell as low as the industries that produce capital goods. Coal is steadied by the demands of industries producing consumers' goods, by the railroads, and especially by the consumption of household fuel. The homes of the Nation ordinarily absorb 15 to 20 percent of the output of bituminous coal. In 1933 this important market again was curtailed by abnormally warm weather, although the temperatures probably were not as excessively warm as in the preceding year. Continued unemployment and the drastically reduced purchasing power of a large segment of the working population likewise restricted the consumption of house coal.

Despite the increase over 1932, bituminous production in 1933 was still abnormally low compared with that in other recent years. It was 14.2 percent less than in 1931, 29.9 percent less than in 1930, and 38.7 percent less than in 1929. In fact, except for 1932, production in 1933 was less than for any year since 1905.

*Monthly output.*—In the first quarter of the year the market was extremely dull. As the year opened, industrial activity again was hovering close to the low point of the depression, the short-lived rally that began in the late summer of 1932 having long since subsided. Conditions grew progressively worse as the financial crisis which culminated in the national banking moratorium approached. With the closing of the banks activity of basic industry slowed almost to a standstill. At the same time the weather in the densely populated eastern sections of the country was unusually mild. In view of these factors, it is small wonder that production of bituminous coal during the first 3 months of the year averaged only 1,022,000 tons per working day. Compared with the output in the corresponding period in 1932, this is a decrease of 11.7 percent and, in fact, is substantially below the normal midsummer level. (See fig. 25.)

With the reopening of the banks, most barometers of business activity advanced vigorously. Coal mining, however, was slow to respond. Production of soft coal continued to decline for fully 6 weeks after the upturn appeared in most other industries, largely because consumers, still doubtful about the future, hesitated to make forward commitments and drew on stock piles for their immediate requirements. It was not until late in April that the coal industry began to feel the effects of the improved business situation.

By May 1, orders reflecting the accelerated pace of business activity were arriving at the mines in sufficient volume to lift production above the 1932 level. Beginning at 7.5 percent above the corresponding week of the preceding year, production rose steadily and during the closing days of May was 32.5 percent ahead of the 1932 rate. As the recovery program of the new administration unfolded, production was stimulated further. Throughout June and the early part of July evidence of the usual seasonal slackening in the rate of industrial activity was entirely lacking, and the output of soft coal rose rapidly. The expansion of business was retarded abruptly about the middle of July, but bituminous-coal production continued to forge ahead, rising to a peak of 33,910,000 tons in August. This was an increase of 15 percent over the July production and, in fact, was the largest output for any month since October 1931.

In the closing months of the year production receded moderately from the August peak. The growing impatience of the miners over failure to reach an agreement on a code for the industry resulted in wide-spread strikes which seriously curtailed production in September. In the 2 succeeding months, after the labor difficulties had been settled by adoption of the code, production advanced once more.

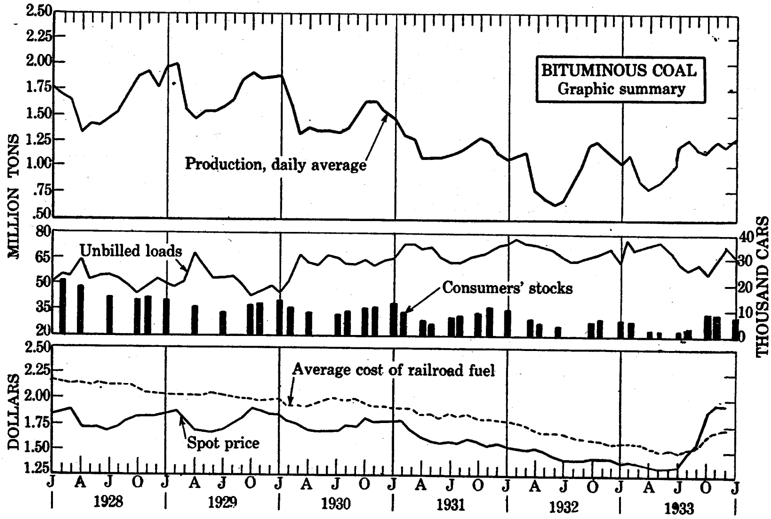


FIGURE 25.—Current trends of production, stocks, and prices of bituminous coal, 1928–33.

However, continued contraction of industrial activity combined with relatively mild temperatures in important consuming regions held output below the August peak, and in December the rate of production was back again to the September level.

*Commercial stocks.*—Unlike many other branches of industry, the bituminous-coal market was not influenced greatly by speculation in inventories during 1933. For the most part, the improvement in demand corresponded closely to the increase in industrial requirements; and, in spite of mounting prices during the last half of the year, there were few signs of abnormal purchasing for storage. It is true that in August and September the eastern railroads laid in heavy stocks, but this was due largely to the apprehension that the labor difficulties might seriously interrupt production. With resumption of mining in the troubled zones, following the signing of the Bituminous-Coal Code, railroad stocks were sharply reduced.

In other respects the trend of commercial stocks during 1933 followed the usual seasonal pattern. From 29,666,000 tons on

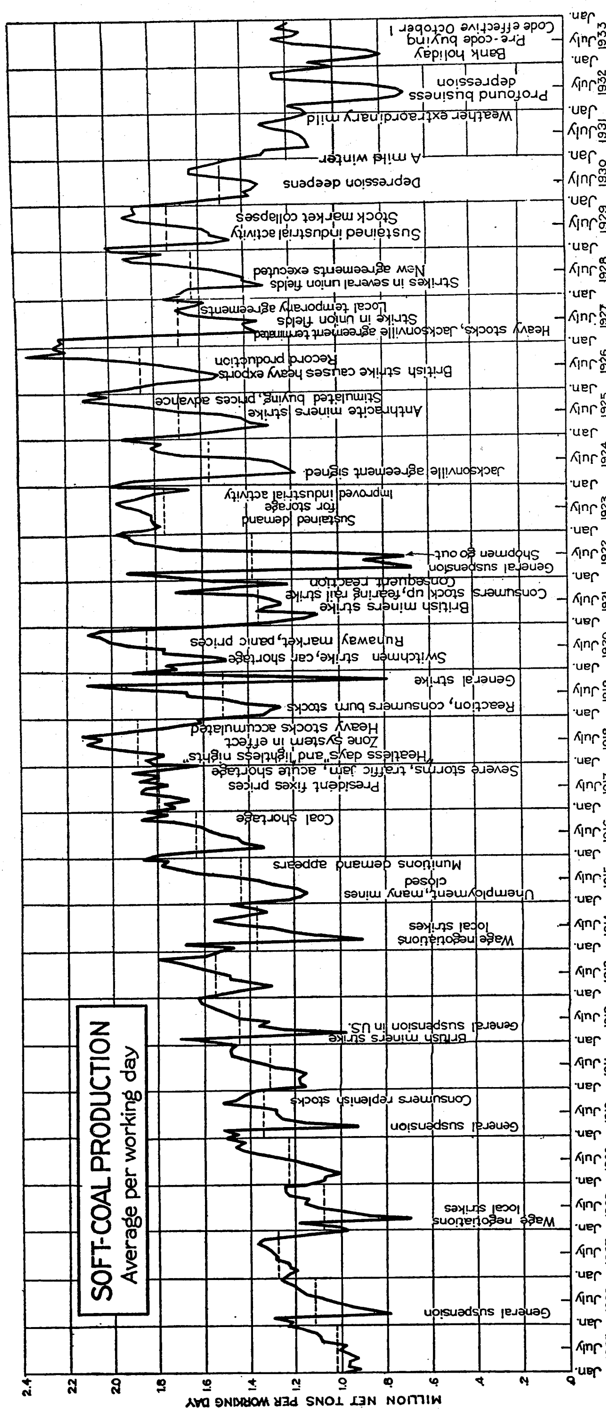


FIGURE 26.—Average production of bituminous coal per working day in each month, 1905–33.

January 1, reserves in the hands of commercial consumers and retail dealers declined to 21,722,000 tons on June 1, a reduction of 7,944,000 tons in 5 months. During the following 4 months consumers added to their reserves, as they ordinarily do upon the approach of the heating season, but the additions to stock piles, except those of the railroads, during this period were not abnormal. At the close of the year the total commercial reserves stood at 32,840,000 tons. Although this is a net increase of 3,174,000 tons over the stocks on hand at the beginning of the year, it should be pointed out that the stocks on January 1, 1933, were lower than at any corresponding date since 1920, following the great strike of 1919.

All classes of industrial consumers added to their stock piles in 1933. The most conspicuous increase occurred at byproduct coke ovens, whose stocks at the end of the year were 38.3 percent more than at the beginning. Substantial additions were also reported by steel works, electric public utilities, and class I steam railroads. More moderate increases are shown in stocks at coal-gas retorts, cement

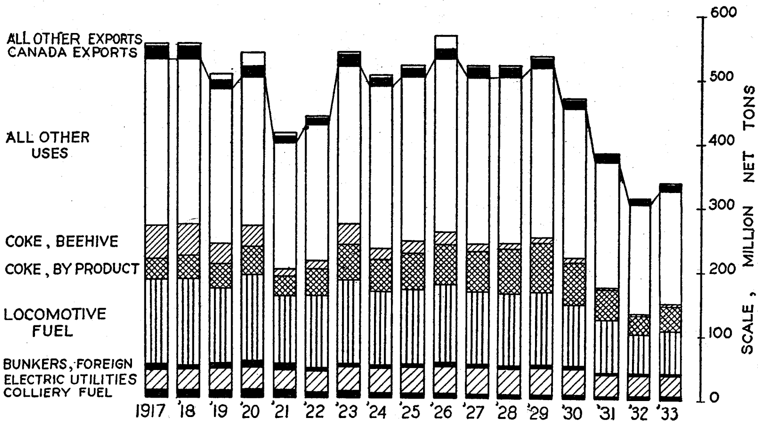


FIGURE 27.—Tonnage of bituminous coal absorbed by the principal branches of consumption, 1917–33.

mills, and miscellaneous industrial plants. On the other hand, stocks in the yards of the retail dealers at the end of 1933 were somewhat less than at the beginning of the year; likewise, there was a small reduction in the stocks of soft coal on the commercial docks of Lakes Superior and Michigan.

The number of unbilled loads—cars loaded with coal for which the railroads had received no billing instructions from the shipper—remained comparatively high throughout the year. On January 1, 1934, the number of unbilled loads awaiting shipment totaled 1,533,000 tons compared with 1,494,000 tons on the corresponding date of 1933.

*Increase in consumption.*—Allowing for imports, exports, and changes in commercial stocks, the total consumption of coal in the United States during the year was 315,947,000 tons, an increase of 9,030,000 tons (2.9 percent) over 1932. The increase in consumption, therefore, was somewhat less than that in production, a difference accounted for by the increase in commercial stocks.

Lack of complete information for earlier years makes a detailed analysis of consumption by principal uses in 1933 impossible. For certain of the more important consumers, however, the record is complete. Consumption of coking coal, for example, increased sharply, the total consumption at both byproduct and beehive ovens during the year amounting to 39,981,000 tons, a gain of 25.3 percent compared with the 31,917,000 tons consumed in 1932. The increased requirements of the coke ovens reflect the spectacular upturn in the iron and steel industry during the year. In addition to the increased consumption of metallurgical coke, however, gas- and steam-coal consumption by the steel mills also rose abruptly, amounting to 10,009,000 tons, a gain of approximately 50 percent compared with 1932. A substantial increase of approximately 15 percent is indicated in consumption of soft coal by the general manufacturing plants in 1933. These gains were partly counterbalanced by losses in other directions. A small decline was reported in the consumption of locomotive coal by the class I steam railways; the tonnage of bunker coal supplied to ships in foreign trade likewise fell off moderately, while, in spite of the increased production of electricity in 1933, there was no significant change in the consumption of bituminous coal by the electric public utilities. Household consumption, as indicated by retail deliveries, likewise showed no marked improvement.

*Upturn of prices.*—One outstanding event of the year was the abrupt reversal in the trend of prices. During the early months of 1933 bituminous-coal prices sagged to new lows. The bottom was reached about midyear, when quotations on most grades were lower than at any time since the war. Thereafter the trend was vigorously upward.

Trade-journal quotations indicate that the trend of spot prices, f.o.b. mines, was generally downward during the first half of the year. Toward the end of June the decline was halted, and marked firmness developed in the market. In July, for the first time in years, bituminous prices displayed a buoyant tendency which was followed by a violent upward surge in succeeding weeks when it became clear that wage rates in many of the important producing fields would be raised materially by the recovery program. At the end of the year the mine price of soft coal not only was more than 50 percent above the low point of May and early June but also was higher than at any time since 1927.

Wholesale prices followed much the same course as spot prices, except that the changes were neither as abrupt nor as violent. According to the Bureau of Labor Statistics, the index of bituminous wholesale prices rose from a low of 78.1 for April to a high of 90.7 for November. For 1933 as a whole the index averaged 82.8 compared with 82.0 for the previous year.

One of the most reliable indicators of the price trend of bituminous coal is the cost of locomotive fuel, which is reported monthly to the Interstate Commerce Commission by the class I carriers. This series of reports is especially valuable as it reflects contract as well as spot prices. In 1933 the cost of railroad coal declined steadily until July, when the average, excluding direct freight charges, stood at $1.50 per ton. The trend was reversed in the last half of the year, and by December the average cost for all roads was $1.73 per ton, an advance of 15 percent in 6 months. This increase not only wiped out the declines of the first 6 months, but also brought the cost back to the level of March 1932. Nevertheless, the average for the year as a whole was still below that of the previous year, being $1.57 per ton as against $1.66.

According to the Bureau of Labor Statistics, retail prices also increased sharply during the latter part of 1933. After sagging to $7.17 per ton in May, the average retail price of grades commonly sold for household purposes rose to $8.18 in November and December. The average for the year was $7.65 against $7.71 in 1932.

The average sales realization on all soft coal produced during 1933 was $1.36. This is a preliminary figure based on incomplete returns and subject to revision on receipt of final data. In comparison with the previous year, this represents an increase of 3.8 percent but is still 23.6 percent less than in 1929.

*Statistical summary of monthly developments in the bituminous coal industry in 1933*

[All tonnage figures represent thousands of net tons]

| | 1933 | | | | | | | | | | | | | 1932 total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January | February | March | April | May | June | July | August | September | October | November | December | Total | |
| Production, including mine fuel and local sales: | | | | | | | | | | | | | | |
| Monthly total | 27,060 | 27,134 | 23,685 | 19,523 | 22,488 | 25,320 | 29,482 | 33,910 | 29,500 | 29,656 | 30,582 | 29,600 | 327,940 | 309,710 |
| Average per working day | 1,070 | 1,135 | 877 | 790 | 852 | 974 | 1,179 | 1,256 | 1,175 | 1,141 | 1,233 | 1,184 | 1,071 | 1,007 |
| Distribution: | | | | | | | | | | | | | | |
| Rail movement (including railway fuel)— | | | | | | | | | | | | | | |
| From Appalachians north of Alabama— | | | | | | | | | | | | | | |
| To tidewater | 2,537 | 2,280 | 2,174 | 1,934 | 1,930 | 2,034 | 2,314 | 2,350 | 2,372 | 2,378 | 2,307 | 2,516 | 27,126 | 26,777 |
| To New England | 509 | 427 | 420 | 327 | 292 | 261 | 397 | 419 | 443 | 343 | 455 | 531 | 4,824 | 4,713 |
| To Lake Erie | 10 | 29 | 289 | 1,741 | 3,012 | 4,076 | 5,023 | 4,870 | 4,327 | 3,384 | 2,896 | 110 | 29,767 | 23,685 |
| West-bound commercial | 5,649 | 6,242 | 4,637 | 3,267 | 3,282 | 3,977 | 5,031 | 5,428 | 4,822 | 4,912 | 4,939 | 5,762 | 57,948 | 54,358 |
| East and south-bound, local and railway fuel (all rail) | 7,209 | 6,702 | 6,688 | 5,050 | 6,212 | 6,727 | 7,281 | 9,934 | 7,144 | 7,136 | 7,908 | 7,744 | 85,735 | 81,896 |
| From Alabama field | 702 | 638 | 584 | 559 | 610 | 641 | 773 | 881 | 825 | 720 | 691 | 796 | 8,420 | 7,577 |
| From interior fields | 5,846 | 6,179 | 5,192 | 3,464 | 3,453 | 3,472 | 4,022 | 4,970 | 4,985 | 6,235 | 6,117 | 6,573 | 60,508 | 60,897 |
| From far western fields | 1,632 | 1,730 | 1,113 | 907 | 952 | 764 | 822 | 1,148 | 1,562 | 1,912 | 1,790 | 1,762 | 16,094 | 16,706 |
| Lake dock receipts | 5 | 14 | 14 | 202 | 1,270 | 1,623 | 2,031 | 1,736 | 1,691 | 1,144 | 1,314 | 25 | 11,069 | 9,609 |
| Lake dock deliveries | 1,092 | 1,256 | 887 | 703 | 668 | 613 | 725 | 926 | 959 | 1,149 | 1,138 | 1,274 | 11,390 | 11,468 |
| New England tide receipts (preliminary) | 1,155 | 1,013 | 979 | 712 | 859 | 799 | 877 | 946 | 918 | 973 | 955 | 1,011 | 11,197 | 10,477 |
| Exports to Canada and Mexico | 350 | 322 | 304 | 443 | 742 | 873 | 1,047 | 1,009 | 1,076 | 869 | 1,100 | 467 | 8,602 | 8,429 |
| Exports to Caribbean region | 16 | 14 | 1 | 31 | 49 | 20 | 20 | 20 | 15 | 7 | 12 | 17 | 222 | 239 |
| Exports "overseas" | 10 | 13 | 16 | 13 | 19 | 11 | 34 | 39 | 2 | 32 | 9 | 18 | 216 | 146 |
| Imports | 23 | 24 | 10 | 16 | 8 | 12 | 9 | 9 | 15 | 28 | 23 | 20 | 197 | 187 |
| Industrial consumption by— | | | | | | | | | | | | | | |
| Railroads (class I only) | 6,134 | 5,802 | 5,841 | 5,353 | 5,479 | 5,354 | 5,833 | 5,993 | 5,981 | 6,555 | 6,479 | 6,524 | 71,328 | (1) |
| Electric-power utilities | 2,325 | 2,183 | 2,163 | 1,973 | 2,093 | 2,362 | 2,653 | 2,742 | 2,556 | 2,679 | 2,589 | 2,696 | 29,014 | (1) |
| Byproduct coke ovens | 2,580 | 2,371 | 2,408 | 2,395 | 2,780 | 3,251 | 4,057 | 4,235 | 3,927 | 3,734 | 3,391 | 3,554 | 38,683 | 30,887 |
| Beehive coke ovens | 128 | 132 | 146 | 74 | 74 | 78 | 107 | 111 | 93 | 70 | 145 | 140 | 1,298 | 1,030 |
| Steel works and rolling mills | 666 | 682 | 619 | 648 | 820 | 919 | 1,026 | 1,007 | 884 | 904 | 859 | 975 | 10,009 | (1) |
| Coal-gas retorts | 223 | 205 | 218 | 196 | 199 | 185 | 187 | 189 | 195 | 197 | 195 | 209 | 2,398 | (1) |
| Cement mills | 148 | 141 | 165 | 191 | 273 | 373 | 426 | 393 | 244 | 187 | 167 | 124 | 2,832 | (1) |
| Other industrials | 7,085 | 6,900 | 6,950 | 6,080 | 6,150 | 5,900 | 5,950 | 6,130 | 5,891 | 6,557 | 7,193 | 7,339 | 78,125 | (1) |
| Bunker coal, foreign | 66 | 70 | 65 | 73 | 116 | 101 | 109 | 111 | 137 | 150 | 156 | 102 | 1,256 | 1,350 |
| Coal-mine fuel | 258 | 258 | 226 | 164 | 187 | 212 | 247 | 285 | 247 | 249 | 257 | 266 | 2,856 | 2,781 |

[1] Comparable figures for 1932 not available.

*Statistical summary of monthly developments in the bituminous coal industry in 1933*—Continued

| | 1933 | | | | | | | | | | | | | 1932 total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January | February | March | April | May | June | July | August | September | October | November | December | Total | |
| **Stocks at end of period shown:** | | | | | | | | | | | | | | |
| Railroads (class I only) | 4, 693 | 4, 292 | 4, 151 | 3, 811 | 3, 714 | 3, 609 | 4, 041 | 5, 529 | 5, 937 | 5, 014 | 4, 933 | 5, 096 | 5, 096 | 4, 619 |
| Electric-power utilities | 4, 330 | 4, 547 | 4, 578 | 4, 446 | 4, 392 | 4, 405 | 4, 458 | 4, 710 | 4, 923 | 5, 137 | 5, 213 | 5, 320 | 5, 320 | 4, 455 |
| Byproduct coke ovens | 4, 051 | 3, 679 | 3, 104 | 2, 921 | 2, 971 | 3, 338 | 3, 949 | 5, 465 | 5, 797 | 5, 643 | 6, 129 | 6, 061 | 6, 061 | 4, 382 |
| Steel works and rolling mills | 851 | 745 | 733 | 707 | 676 | 705 | 811 | 1, 153 | 1, 217 | 1, 175 | 1, 085 | 1, 025 | 1, 025 | 807 |
| Coal-gas retorts | 473 | 455 | 441 | 399 | 377 | 398 | 450 | 463 | 459 | 447 | 489 | 484 | 484 | 477 |
| Cement mills | 221 | 209 | 187 | 203 | 227 | 217 | 266 | 262 | 281 | 274 | 250 | 249 | 249 | 228 |
| Other industrials | 7, 100 | 6, 300 | 5, 600 | 5, 240 | 5, 220 | 5, 300 | 5, 840 | 6, 800 | 7, 881 | 8, 117 | 8, 344 | 7, 585 | 7, 585 | 7, 130 |
| Total commercial stocks | 29, 046 | 26, 288 | 23, 843 | 22, 486 | 21, 722 | 22, 472 | 24, 815 | 30, 582 | 34, 095 | 33, 907 | 34, 143 | 32, 840 | 32, 840 | 29, 666 |
| Stocks on Lake docks | 5, 720 | 4, 491 | 3, 628 | 3, 169 | 3, 774 | 4, 785 | 6, 093 | 6, 899 | 7, 655 | 7, 650 | 7, 828 | 6, 579 | 6, 579 | 6, 793 |
| Unbilled loads | 1, 933 | 1, 734 | 1, 814 | 1, 852 | 1, 682 | 1, 466 | 1, 304 | 1, 399 | 1, 207 | 1, 476 | 1, 746 | 1, 533 | 1, 533 | 1, 494 |
| **Trend of prices:** [2] | | | | | | | | | | | | | | |
| Average cost of railroad fuel, excluding freight charges | $1. 55 | $1. 56 | $1. 55 | $1. 53 | $1. 51 | $1. 52 | $1. 50 | $1. 52 | $1. 55 | $1. 66 | $1. 70 | $1. 73 | $1. 57 | $1. 66 |
| Average retail price, 38 cities | $7. 46 | $7. 44 | $7. 43 | $7. 37 | $7. 17 | $7. 18 | $7. 64 | $7. 77 | $7. 94 | $8. 08 | $8. 18 | $8. 18 | $7. 65 | $7. 71 |
| Index of wholesale prices | 79. 8 | 79. 4 | 79. 3 | 78. 1 | 78. 3 | 78. 3 | 81. 0 | 83. 6 | 84. 7 | 89. 8 | 90. 7 | 90. 6 | 82. 8 | 82. 0 |
| **Labor conditions:** [3] | | | | | | | | | | | | | | |
| Index of employment | 69. 8 | 69. 3 | 67. 6 | 63. 7 | 61. 2 | 61. 3 | 63. 2 | 68. 6 | 71. 8 | 68. 0 | 74. 8 | 75. 4 | 67. 9 | 67. 4 |
| Index of pay-roll totals | 36. 1 | 37. 2 | 30. 7 | 26. 6 | 26. 9 | 29. 2 | 33. 6 | 43. 3 | 44. 1 | 44. 1 | 50. 7 | 50. 8 | 37. 8 | 35. 6 |

Average per net ton.

[3] Bureau of Labor Statistics, index numbers, 1929 average=100.0.

*Distribution trends.*—The movement of bituminous coal, reflecting in part the increased consumption and in part the flow into storage, increased in virtually all directions in 1933. The movement through the major channels of distribution is traced graphically in figure 28.

Perhaps the most striking feature shown in figure 28 is the marked revival in lake trade during 1933. Throughout 1932 the trade had been in the doldrums due to the general business depression and heavy stock accumulations at the head of the Lakes in consequence of a succession of exceptionally mild winters. In 1932 receipts at the lower lake ports were barely a third of the normal volume. By contrast, the trade was brisk from the opening of the navigation season in 1933 until late in the summer. There was a steep tapering off in the fall, when the normal flow was interrupted by an epidemic of suspensions in many of the important producing fields. Notwithstanding this handicap the total movement for the year increased 25.7 percent, amounting to 29,767,000 tons compared with 23,685,000 tons in 1932.

More modest gains are shown in shipments in other directions. The east- and south-bound movement from the Appalachian region,

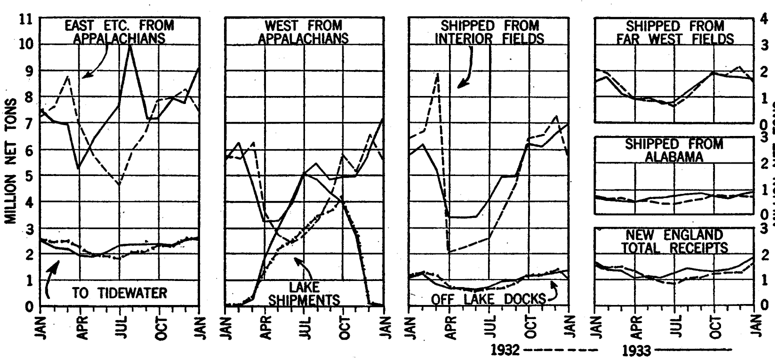


FIGURE 28.—Monthly movement of bituminous coal in the major channels of distribution, 1932–33.

for example, which revealed an enormous increase over 1932 at midyear, finished 1933 with a net gain of only 4.7 percent because of lower shipments in the first and last quarters. Similarly, in westbound shipments from the Appalachian fields, the substantial bulge in the late spring, summer, and early fall was largely offset by the quietness in the other months, and the net increase for 1933 as a whole was a shade under 7 percent. A gain of 11.1 percent over 1932 was reported in shipments from the Alabama fields. There were also moderate increases in the New England and tidewater trade, but shipments from the interior and far-western fields and movement off the lake docks declined slightly.

*Export trade.*—Some signs of revival also were apparent in the export trade. The total exports of bituminous coal during the year were 9,036,947 tons, an increase of 222,902 tons (2.5 percent) over 1932. In spite of this gain the bituminous export trade was still far short of normal, being scarcely half of the 1929 volume and 43 percent below the 1930 level.

Of the total exports in 1933, 8,598,807 tons (95 percent) were shipped to Canada. Canada always has been the principal foreign market for American coal. (See fig. 29.) Although the Dominion has extensive resources of coal and lignite the deposits occur chiefly in the coastal regions or western plains, remote from the densely populated sections of the central Provinces. Consequently, 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 3 years, however, shipments to Canada have been curtailed sharply and in 1932 amounted to only 8,426,886 tons. Although exports to Canada in 1933 were 2 percent higher than in 1932, they were still almost 39 percent below the 1925–30 average.

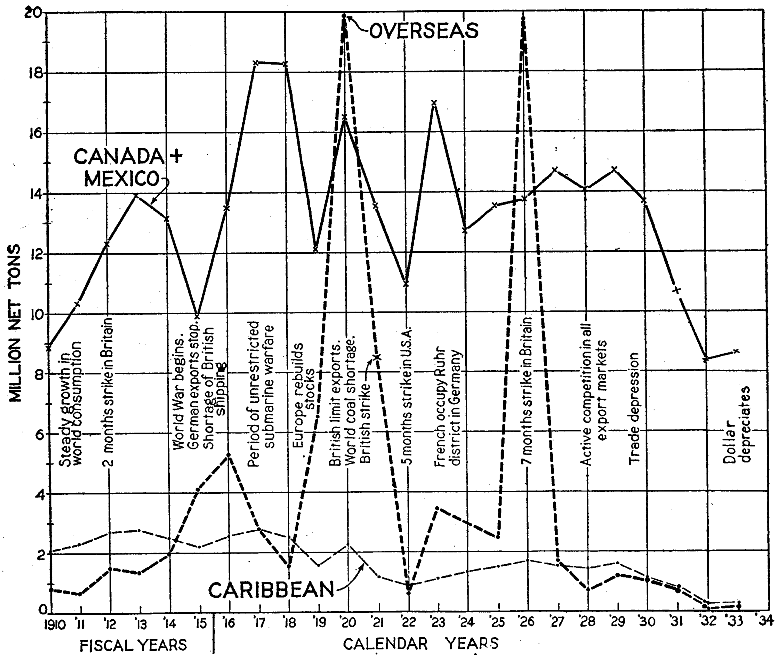


FIGURE 29.—Twenty-four years' exports of bituminous coal to (1) Canada and Mexico, (2) the Caribbean, and (3) "overseas" destinations. Exports to Canada (including also the small shipments to Mexico) have been relatively stable, except for the changes in general business conditions, and closely parallel the domestic 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 have declined greatly during the depression.

Most of the loss in shipments to Canada can be attributed to the world-wide industrial depression, but a number of other factors have contributed. Among these may be mentioned the 50-percent increase in the Canadian tariff on soft coal in 1932 and the efforts of the Dominion Government to stimulate the output of Canadian mines by subvention grants. During the past year the Dominion Government placed a dumping duty on bituminous coal from England. This was done primarily to help Canadian producers, but it may also be a slight stimulus to shipments from the United States. On the other hand, it seems likely that the recovery program, by raising production costs, will make it still more difficult for American coal to compete in foreign markets.

Aside from the Canadian market, exports of bituminous coal from the United States have never been of great significance, except when strikes or other interruptions have disturbed the normal flow of coal in international trade. A comparatively small tonnage is shipped regularly to the Caribbean region (West Indies and Central America, including the Bahamas, the Virgin Islands, and Panama), where American exporters have had a natural advantage in distance over British and German shippers. Although not a large market, the Caribbean region as a whole absorbed somewhat more than 2,000,000 tons annually before the war. The market has since been reduced because of increased use of fuel oil, and it has been curtailed still further by the depression. In 1933 exports to the Caribbean countries amounted to 221,854 tons, a decrease of 7.1 percent compared with 1932. The decline was due chiefly to lower exports to Cuba, where political disturbances reduced requirements from 158,699 tons in 1932 to 118,647 tons in 1933. Shipments to the West Indies, particularly British possessions, also fell off during the year, but increased shipments were reported for many of the other Caribbean destinations, which largely offset the losses in exports to Cuba and the British West Indies.

Although exports to the Caribbean declined, there was a substantial rise in shipments overseas. The increase was accounted for chiefly by heavier exports to several important South American countries. In 1933 exports to Argentina totaled 48,662 tons as against 13,153 tons in 1932; exports to Brazil rose from 82,122 tons to 94,442 tons, while exports to Uruguay amounted to 26,984 tons compared with 7,267 tons in 1932. The total overseas exports during the year were 215,315 tons, an increase of 47.1 percent over the previous year.

*Imports.*—Imports of bituminous coal have seldom been a material factor in the domestic coal market. The small tonnage imported consists chiefly of coal from Vancouver Island and the Crows Nest Pass field in British Columbia, received in Washington, Montana, and Idaho. There is also a small movement of coal into New England from Nova Scotia. Except in years when strikes or other interruptions have caused a shortage, however, the tonnage imported has never been large. For the 6-year period, 1924 to 1929, inclusive, imports averaged about 500,000 tons. Since 1929 the imported tonnage has been greatly reduced, amounting to 206,000 tons in 1931 and only 187,000 tons in 1932. Imports in 1933 totaled 197,000 tons, an increase of 5.3 percent over 1932, but still considerably short of the normal volume.

*Employment and earnings.*—Notwithstanding the improvement in market conditions, employment in the soft-coal industry increased little or none. Spurred by the fierce competitive struggle that has raged in the industry for the past decade, the operators have turned to improved technique and more efficient management to gain a temporary advantage over their competitors. As a result, the increased output in 1933 was obtained without a corresponding gain in the number of workers employed.

Pending final returns from the operators, the best guide to the trend of employment in the coal-mining industry 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. Taking the average for 1929 as 100, the index of the number of men on the pay rolls of the mines canvassed stood at 69.8 in January 1933. In May the index fell to 61.3, but it recovered to 75.4 in December with the winter increase in demand. For the year as a whole the index of the number of workers on pay rolls averaged 67.9 as against 67.4 in the previous year. Thus, employment in the bituminous-mining industry in 1933 was still nearly a third short of the 1929 level.

Although there was little material change in the number of workers employed in the industry the earnings of the miners who were fortunate enough still to have jobs were 6.2 percent higher than in 1932. For 1933 as a whole the pay-roll index averaged 37.8 compared with 35.6 for 1932. This rise reflects in part steadier working time and in part the increased wages that became effective in the last quarter of the year after adoption of the code. In spite of the increase during 1933 the wage bill of the bituminous-coal industry was still 62.2 percent less than in 1929.

Bureau of Labor Statistics' indexes of employment and pay-roll totals in soft-coal mining follow:

| Index of— | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Number on pay rolls | 100 | 93.4 | 83.2 | 67.4 | 67.9 |
| Sum paid in wages | 100 | 81.3 | 57.5 | 35.6 | 37.8 |

## PRODUCTION BY STATES AND FIELDS

In the bituminous industry as a whole, production in 1933 increased 5.9 percent compared with 1932. The increase, however, was by no means general, and while some fields experienced a marked revival others remained in the grip of acute depression. The following table gives the production by States. The 1933 figures are preliminary and subject to revision.

Among the principal beneficiaries of the recovery were West Virginia, Pennsylvania, Ohio, Illinois, Virginia, Alabama, and Maryland. Ohio shows the largest gain, with a rise of 43.5 percent over 1932. This increase is explained partly by the fact that in 1932 production in Ohio was curtailed seriously by labor disturbances, but the recovery of business was also a factor of importance. Shipments from the northern and eastern Ohio fields to industrial centers along Lake Erie, for example, advanced 62.5 percent, while the revival of the lake trade resulted in a gain of 65.9 percent in the movement from the same fields to the lower lake ports.

Reflecting the marked improvement of industrial conditions in the South, coal production in the fields adjacent to this area also increased substantially. Compared with the previous year, production in Alabama in 1933 advanced 11.7 percent, and a gain of 9.1 percent is shown for Virginia. Pennsylvania and West Virginia shared about equally in the recovery, as production for both States advanced approximately 6 percent. The showing of Pennsylvania undoubtedly would have been much more favorable if output had not been curtailed by strikes in the late summer and early fall. In Illinois production increased 7.9 percent, but in view of the serious labor difficulties that restricted production in many of the Illinois fields in 1932 the record for 1933 did not meet expectations. Small increases also are shown for Indiana, Kentucky, Montana, and Tennessee.

The gains in these States were partly offset by declines in other fields. West of the Mississippi, except in Montana, the decline was general, the largest losses being reported for the lower Mississippi Valley fields of Iowa, Kansas, and Missouri. In New Mexico, Utah, and Washington, production was about 8 percent less than in 1932, while in Wyoming, Colorado, Arkansas, Oklahoma, Texas, and North Dakota the decrease ranged from 4.2 to 6.9 percent. Production in Michigan in 1933 was 23.8 percent less than in 1932.

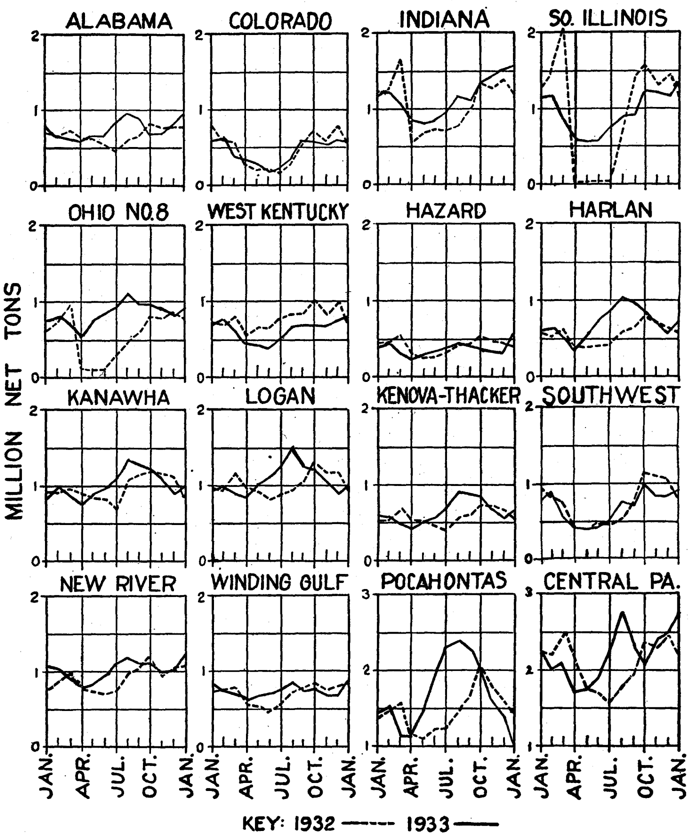


FIGURE 30.—Monthly production of bituminous coal in selected fields, 1932–33.

*Monthly trend of production by fields.*—The trend of production, month by month in the principal fields, is shown in figure 30. All the diagrams in this illustration have been plotted on the same scale, except that in certain of the largest districts, such as the Pocahontas and central Pennsylvania, it was necessary to start at the bottom with 1,000,000 tons instead of with zero. The diagram for Pocahontas includes the output of Tug River.

Among the outstanding features of the year was the sudden pick-up in the second and third quarters of the year. During this period nearly all the important fields made substantial gains compared with the same periods in 1932.

*Decline compared with 1929.*—Although production for the country as a whole was 5.9 percent higher than in 1932, all important producing States show sharp declines compared with 1929. The effects of the depression have been felt most severely in the Arkansas and Oklahoma fields, where production in 1933 was barely a third of that in 1929. Declines of more than 50 percent are shown for Michigan, New Mexico, and Alabama, and of more than 40 percent for many other States. North Dakota, with a decrease of 11.4 percent, apparently has been affected least by the depression.

*Comparison of bituminous coal produced 1930–33, by States*

| State | Production (net tons) | | | | Percent of change | |
|---|---|---|---|---|---|---|
| | 1929 | 1931 | 1932 | 1933 (preliminary) | 1929–33 | 1932–33 |
| Alabama | 17, 943, 923 | 11, 998, 781 | 7, 856, 939 | 8, 775, 000 | −51. 1 | +11. 7 |
| Arkansas and Oklahoma | 5, 469, 188 | 3, 061, 949 | 2, 288, 937 | 2, 170, 000 | −60. 0 | −5. 2 |
| Colorado | 9, 920, 741 | 6, 604, 369 | 5, 598, 721 | 5, 211, 000 | −47. 5 | −6. 9 |
| Illinois | 60, 657, 641 | 44, 303, 295 | 33, 474, 553 | 36, 110, 000 | −40. 5 | +7. 9 |
| Indiana | 18, 344, 358 | 14, 295, 165 | 13, 323, 573 | 13, 500, 000 | −26. 4 | +1. 3 |
| Iowa | 4, 241, 069 | 3, 388, 355 | 3, 862, 435 | 3, 230, 000 | −23. 8 | −16. 4 |
| Kansas and Missouri | 7, 006, 282 | 5, 607, 367 | 6, 022, 483 | 5, 390, 000 | −23. 1 | −10. 5 |
| Kentucky | 60, 462, 600 | 39, 963, 621 | 35, 299, 582 | 35, 530, 000 | −41. 2 | +. 7 |
| Maryland | 2, 649, 114 | 2, 005, 773 | 1, 428, 937 | 1, 500, 000 | −43. 4 | +5. 0 |
| Michigan | 804, 869 | 359, 403 | 446, 149 | 340, 000 | −57. 8 | −23. 8 |
| Montana | 3, 407, 526 | 2, 378, 052 | 2, 125, 225 | 2, 130, 000 | −37. 5 | +. 2 |
| New Mexico | 2, 622, 769 | 1, 552, 822 | 1, 263, 386 | 1, 160, 000 | −55. 8 | −8. 2 |
| North Dakota | 1, 862, 130 | 1, 519, 307 | 1, 739, 658 | 1, 650, 000 | −11. 4 | −5. 2 |
| Ohio | 23, 689, 477 | 20, 410, 995 | 13, 909, 451 | 19, 960, 000 | −15. 7 | +43. 5 |
| Pennsylvania | 143, 516, 241 | 97, 658, 698 | 74, 775, 862 | 79, 770, 000 | −44. 4 | +6. 7 |
| Tennessee | 5, 405, 464 | 4, 721, 548 | 3, 537, 882 | 3, 570, 000 | −34. 0 | +. 9 |
| Texas | 1, 100, 668 | 716, 020 | 636, 590 | 610, 000 | −44. 6 | −4. 2 |
| Utah | 5, 160, 521 | 3, 350, 044 | 2, 852, 127 | 2, 610, 000 | −49. 4 | −8. 5 |
| Virginia | 12, 748, 306 | 9, 698, 680 | 7, 692, 180 | 8, 390, 000 | −34. 2 | +9. 1 |
| Washington | 2, 521, 327 | 1, 846, 461 | 1, 591, 426 | 1, 460, 000 | −42. 1 | −8. 3 |
| West Virginia | 138, 518, 855 | 101, 473, 172 | 85, 608, 735 | 90, 770, 000 | −34. 5 | +6. 0 |
| Wyoming | 6, 704, 790 | 4, 993, 686 | 4, 170, 963 | 3, 985, 000 | −40. 6 | −4. 5 |
| Other States | 230, 734 | 181, 833 | 204, 078 | 119, 000 | −48. 4 | −41. 7 |
| Total United States | 534, 988, 593 | 382, 089, 396 | 309, 709, 872 | 327, 940, 000 | −38. 7 | +5. 9 |

## TREND OF MINE CAPACITY

The ultimate effect of the bituminous-coal code defies accurate prediction, yet already its adoption has had certain clearly defined repercussions. Especially significant has been the effect on the productive capacity of the industry.

The capacity of mines active each year since 1899 is shown in figure 31. The curve of "full-time capacity" represents what the mines in operation could do with the equipment and labor employed if they produced for 308 days at the same rate at which they actually did produce on the days they were operating. Coal is loaded 308 or more days each year, and many individual mines work as much as 308 days. It is not feasible, however, for all mines to attain so high a figure because of unavoidable losses of time through break-downs, falls of roof, and failure of the power supply and because of the seasonal character of the market. For these reasons the more conservative figure of 280 days is also shown, a figure suggested some years ago by the coal committee of the American Institute of Mining and Metallurgical Engineers.

*Expansion prior to 1923.*—Capacity was increasing rapidly in the period prior to the World War. The rate of growth was greatly accelerated by the high price level from 1916 to the early part of 1923. The growth was especially rapid just after the war, when additional labor was readily obtainable at the high wages then prevailing, and thousands of new mines were opened. The peak was reached in 1923, when the mines in operation had an annual capacity at 308 days of 970,000,000 tons.

*Period of liquidation.*—So great an excess above the needs of the market made liquidation inevitable, and since 1923 the industry has been involved in a continous process of deflation, forcing heavy financial loss and sharp reduction in wages. Between 1923 and 1932, the latest year for which complete figures are available, the net reduction

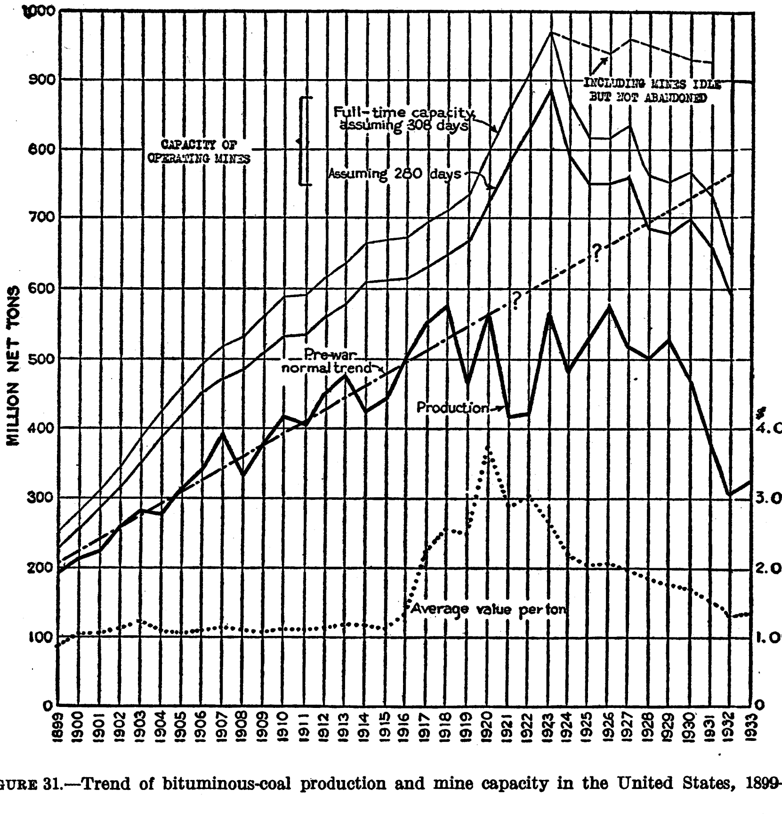


FIGURE 31.—Trend of bituminous-coal production and mine capacity in the United States, 1899–1933

in the number of operating mines—commercial mines, not wagon mines—was 3,904 and the net reduction of operating capacity, 317,000,000 tons. In 1932 alone, 215 mines with an annual capacity of 83,000,000 tons shut down. Actually, the number of commercial mines that were shut down between 1923 and 1932 was over 3,904, because meanwhile other new mines have been opened. By the same reasoning, the capacity of the shut-down mines was greater than 317,000,000 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 3,904 mines and 317,000,000 tons are merely the net reduction to the end of 1932.

*Capacity in 1933.*—Complete figures for 1933 are not yet available, but it is reasonably certain that the low prices and restricted market that characterized the early months of the year resulted in further liquidation of mine capacity. With the higher prices prevailing since adoption of the code, many marginal mines that were forced out of business between 1923 and 1932 have been reopened. Just how many resumed operation during the year will not be known until the canvass has been completed, but indications are that the number has been considerable. In the northern Appalachian region it is reported that several hundred mines were reopened in the closing quarter of 1933.

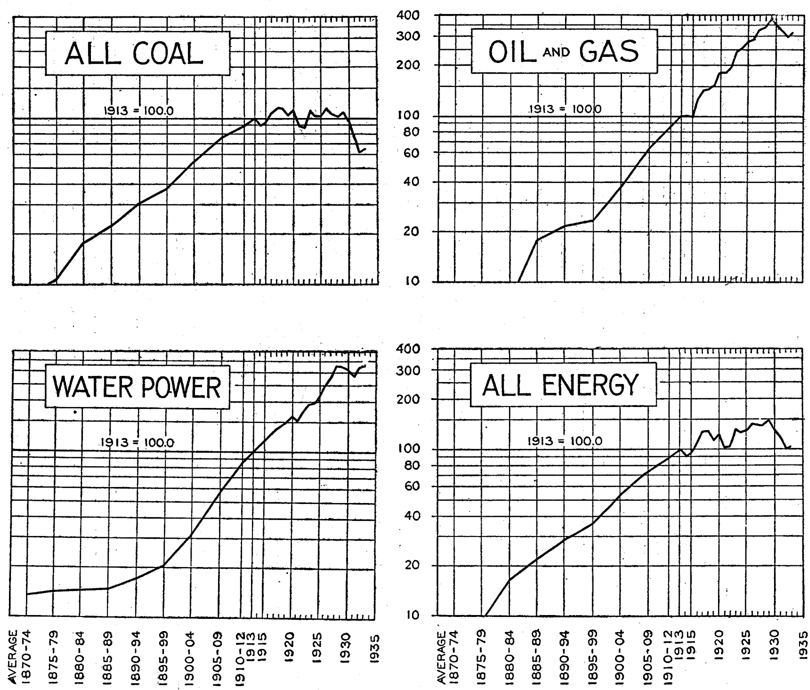


FIGURE 32.—Relative rate of growth of annual supply of coal, oil and gas, and water power in the United States, 1870–1933

## COMPETITION OF OTHER SOURCES OF POWER

A major cause in the post-war change in coal demand has been the competition of other sources of energy. Although production of coal has remained almost stationary since 1918, production of oil, gas, and water power made enormous forward strides during the decade ended with 1929. (See fig. 32.) Since 1929 coal's competitors have felt the depression, but not to the same degree.

*Fuel oil.*—Although the production of bituminous coal increased 5.9 percent compared with 1932, production of crude petroleum increased 14.5 percent. Fuel-oil output increased 6.5 percent—less than crude, but somewhat more 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 1,743,831,132 gallons in 1932 and 1,695,297,762 gallons in 1933, a decrease of 2.8 percent. Coal consumed for locomotive use in the same period declined 0.2 percent. Fuel oil supplied for bunkers to ships in foreign trade declined from 20,239,957 barrels in 1932 to 15,528,112 barrels in 1933, a decrease of 23.3 percent. Bunker coal, on the other hand, declined only 2.6 percent. Electric central stations used 24.7 percent more fuel oil in 1933 than in the previous year but only 0.9 percent more coal, the reported consumption of oil being 9,940,000 barrels compared with 7,967,000 barrels in 1932.

*Natural gas.*—Complete statistics of natural-gas production in 1933 are not available, but certain indications point to a slight decline. Consumption of natural gas by electric public utilities dropped from 107,875,000,000 cubic feet to 102,601,000,000 cubic feet, a decrease of 4.9 percent.

According to the American Gas Association, sales of natural gas to household consumers, to commercial establishments, and for miscellaneous purposes also fell in 1933, but an increase was reported in sales to industrial consumers.

*Hydroelectricity.*—Production of electricity by water power in 1933 broke all previous records, amounting to 34,727,000,000 kilowatt-hours as against 34,696,000,000 kilowatt-hours in 1928, the previous high record. Compared with 1932 the output of hydroelectricity in 1933 gained 1.8 percent, but the relative proportion of hydropower to the total sales of electricity by the public-utility companies during the year was slightly lower than in 1932, being 40.7 percent as against 41.0 percent in 1932.

*Total consumption of energy.*—The total supply of energy from all sources in 1933, including imports of crude oil, is reckoned as 19,054 trillion B.t.u. Compared with the previous year, this is an increase of 5.7 percent, but it is still 28.2 percent below the high mark of 26,534 trillion B.t.u. established in 1929. The trend of total energy supply is shown graphically in the lower diagram of figure 32.

It is significant, also, to compare the energy consumption in 1933 with that of still earlier years. In terms of raw fuels it was 2.6 percent higher than in 1921, the year of the last preceding acute depression, and 6.8 percent more than 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 improved efficiency of utilization. If it were possible to make any accurate allowance for changes in fuel efficiency, the energy consumption of 1933 would appear larger than it does.

The total energy supply of 19,054 trillion B.t.u. in 1933 was derived as follows:

| | Trillion B.t.u. | Percent |
|---|---|---|
| Anthracite | 1,344 | 7.1 |
| Bituminous coal | 8,592 | 45.1 |
| American oil [1] | 5,393 | 28.3 |
| Imported oil [1] | 203 | 1.1 |
| Natural gas, total production | 1,591 | 8.3 |
| Water power, fuel equivalent | 1,931 | 10.1 |
| | 19,054 | 100.0 |

[1] Total crude produced.

The figures are expressed in British thermal units 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 32. 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, if gasoline was not cheap and abundant, automotive

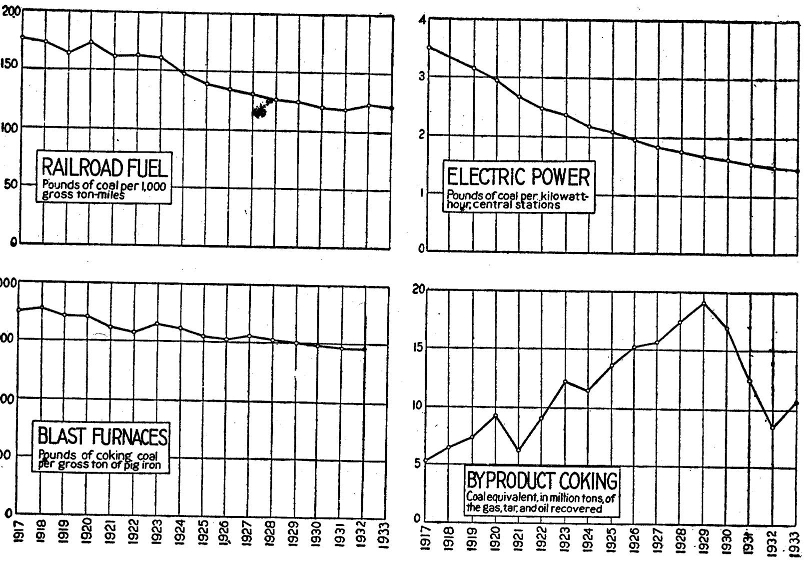


FIGURE 33.—Trends in fuel efficiency in the United States, 1917–33.

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

Not only did the pressure of competitive fuels continue unabated in 1933, but the coal market was also restricted by further progress in fuel efficiency. Figure 33 illustrates the economies effected during the past year by four of the most important industrial consumers.

*Railroad fuel.*—In 1932 a conspicuous feature of the fuel-economy movement was the slight upturn in the unit consumption of coal by the railroads, a development that reversed a trend of 10 years' standing. In freight service the average consumption per 1,000 gross ton-miles in 1932 was 123 pounds, an increase of 3.4 percent over the previous year. At the same time, consumption in passenger service advanced from 14.5 pounds per passenger-train car-mile to 14.9 pounds.

In 1933 the downward trend of consumption per unit in freight service was resumed, and for the year as a whole the average was 121 pounds. This, however, still leaves consumption 2 pounds per 1,000 gross ton-miles higher than in 1931, when the low point was reached. On the other hand, consumption in passenger service again advanced, standing at 15.2 pounds per passenger-train car-mile, an increase of 0.3 pound over 1932 and 0.7 pound over 1931.

*Electric public utilities.*—In power generation at electric central stations economies continued in 1933 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, pounds* |
|---|---|
| 1917 to 1922 | 0. 97 |
| 1922 to 1927 | . 66 |
| 1927 to 1932 | . 34 |

For 1933 the average was 1.47 pounds per kilowatt-hour against 1.50 pounds in 1932 and represents a saving of 0.03 pound during the year. A decade ago, however, the saving was running about 0.20 pound a year. The influence of the depression on the average efficiency of the electric utilities has been mixed. At a given station, lowering 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 33 shows slowing down in the rate of saving.

*Blast furnaces.*—Indications are that a resistance point has also been reached in the iron and steel industry. In 1932, the latest year for which figures are available, statistics show that the average consumption of coking coal per gross ton of pig iron was 2,933 pounds, compared with 2,923 pounds in 1931.

The trend of coal saving since the war in the iron and steel industry, shown by the net reduction in pounds of coking coal required per ton of pig iron, follows:

| | *Net reduction, pounds* |
|---|---|
| 1917 to 1921 | 287 |
| 1921 to 1926 | 188 |
| 1926 to 1931 | 126 |

## PROGRESS OF MECHANIZATION

Despite the difficult conditions surrounding the coal industry during most of 1933, the tonnage of bituminous coal produced by mechanized mining increased 5.6 percent over the preceding year.

In general, conditions in 1933 did not stimulate the use of machinery. During the first half of the year declining prices and wage rates tended to discourage mechanization. In some instances machines were deliberately laid by in an effort to spread employment. In the early months, especially, the typical coal company had no money to buy new equipment and was often forced to defer repairs even at the cost of leaving the machine idle. The higher level of wages and prices brought about by the code, although favorable to mechanization in the long run, came too late in the year to have much effect on the purchase of new machines during 1933. Manufacturers, however, reported a revival of demand for repair parts in the closing months of the year.

Under these circumstances, an increase in mechanized output proves that mechanical loading is now firmly established in the coal fields of the United States. The total tonnage mined mechanically increased from 35,817,000 tons in 1932 to 37,820,000 in 1933. For the industry as a whole, 1 ton out of 8 is now won by mechanical loading.

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. The data cover only operations underground and do not include coal loaded by power shovels in strip pits, which amounted to nearly 20,000,000 tons in 1932. The figures are preliminary, and the Bureau will appreciate advice as to omissions, if any are noted.

Figure 34 gives the tonnage of bituminous coal loaded mechanically, by types of machines, for the past 8 years.

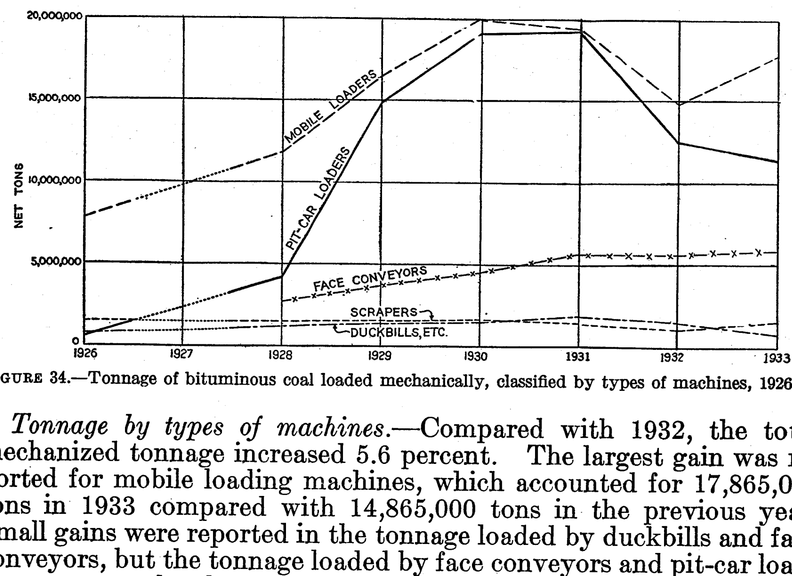


FIGURE 34.—Tonnage of bituminous coal loaded mechanically, classified by types of machines, 1926–33.

*Tonnage by types of machines.*—Compared with 1932, the total mechanized tonnage increased 5.6 percent. The largest gain was reported for mobile loading machines, which accounted for 17,865,000 tons in 1933 compared with 14,865,000 tons in the previous year. Small gains were reported in the tonnage loaded by duckbills and face conveyors, but the tonnage loaded by face conveyors and pit-car loaders was somewhat less than in 1932.

Of the total tonnage loaded mechanically in 1933, 47.2 percent was accounted for by mobile loading machines, 30.2 percent by pit-car loaders, 2.6 percent by scraper loaders, and 20.0 percent by conveyor loaders, including duckbills.

*Mechanization by States.*—Illinois continued to lead in the tonnage mined mechanically with Pennsylvania second, Indiana third, and Wyoming fourth.

It is not feasible to show each type of machine used in each State, for that would involve disclosure of individual operations, but the following table breaks down the total into two major types. The first column shows the total loaded without hand-shoveling, that is, by mobile loading machines, scrapers, and duckbills. Illinois, with

10,351,000 tons, is far in the lead; second place is held by Indiana and third by Wyoming. The second column covers the machines that require hand-shoveling; that is, pit-car loaders and other hand-loaded face conveyors. In this group, also, Illinois is far in the lead, with 6,771,000 tons. Pennsylvania is second, Alabama is third, and Indiana fourth.

*Coal produced by loading machines, pit-car loaders, and other hand-loaded conveyors in 1933, by States, in short tons*

| State | Loaded by machine | Handled on pit-car loaders and other hand-loaded conveyors | Total produced by mechanized mining |
|---|---|---|---|
| Illinois | 10,351,000 | 6,771,000 | 17,122,000 |
| Pennsylvania | 1,380,000 | 5,302,000 | 6,682,000 |
| Indiana | 3,146,000 | 1,076,000 | 4,222,000 |
| Wyoming | 2,364,000 | 606,000 | 2,970,000 |
| Alabama | 176,000 | 1,213,000 | 1,389,000 |
| West Virginia and Virginia | 401,000 | 764,000 | 1,165,000 |
| Montana | 914,000 | 173,000 | 1,087,000 |
| Ohio | (1) | (1) | 1,029,000 |
| Kentucky | 60,000 | 730,000 | 790,000 |
| Utah | (1) | (1) | 551,000 |
| Other States [2] | 163,000 | 650,000 | 813,000 |
| | 20,511,000 | 17,309,000 | 37,820,000 |

[1] Separation figures not available for publication but included in total.
[2] Washington, Arkansas, Maryland, Missouri, Colorado, Tennessee, New Mexico, Michigan, and Iowa.

*Percentage of total output mechanized.*—The fairest test of the progress of mechanization is the percentage of the total deep-mined output of the State produced by mechanized mining. Judged by this standard, the fields of the Rocky Mountains and the Middle West lead in the proportion mechanized. First place in 1933 was attained by Montana, where 80.8 percent of the deep-mined tonnage was won by mechanized mining as against 76.3 percent the year before. Next in rank came Wyoming with 76.0 percent, Illinois with 58.9 percent, Indiana with 51.9 percent, and Utah with 21.1 percent. Alabama with 15.9 percent led the Eastern and Southern States.

*Number of machines in use.*—Some new machines were sold for use in bituminous-coal mines in 1933, despite the depression. The number employed, however, declined due to retirements, a tendency to defer repairs, and in some cases a desire to spread employment. Compared with 1932 the number of mechanical loaders in use—mobile machines, scrapers, and duckbills—decreased from 835 to 748. The number of pit-car loaders in use decreased from 3,112 to 2,453. The number of mines using hand-loaded face conveyors decreased from 136 to 114.

## PENNSYLVANIA ANTHRACITE

### THE MARKET IN 1933

*Production.*—In contrast with the improvement shown by the bituminous coal-mining industry, most of the barometers of the Pennsylvania anthracite industry dropped to new lows in 1933. The total production of hard coal for the year, according to preliminary figures, was 49,399,000 net tons. Compared with the previous year this represents a decrease of 0.9 percent, and with the exception of the strike year of 1902 is the smallest output for any year since the early nineties. About the only favorable aspect of the past year's developments is the fact that the rate of decline, which has continued at an accelerated pace since 1926, slowed down.

As the year opened production of hard coal was hovering close to the low point of the depression. For January the output totaled only 3,807,000 tons. Except for the summer of 1932 and for months when the mines were closed because of strikes, this was the lowest touched at any time since the beginning of the record of monthly production. In the 2 succeeding months somewhat more seasonable weather conditions in the hard-coal consuming area mildly stimulated demand, but production again relapsed as the heating season came to an end. In both April and May production was only a fraction higher than in June 1932, when the rate averaged less than 100,000 tons per working

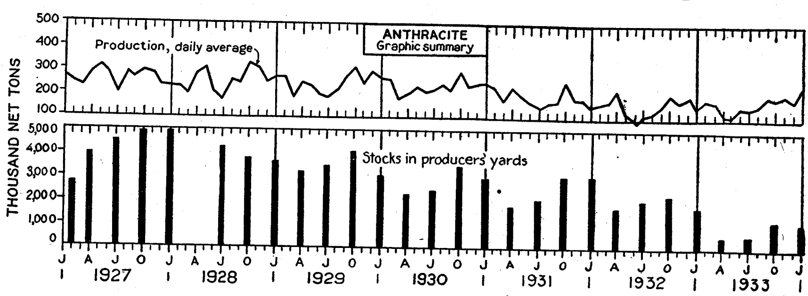


FIGURE 35.—Current trends of production and stocks of Pennsylvania anthracite, 1927–33.

day. Demand picked up moderately during the early summer, and by August production had risen to 4,396,000 tons. This level was closely adhered to throughout the remainder of the year, with production fluctuating between 4,993,000 tons for September and 4,424,000 tons for December.

The causes for the unsatisfactory showing of the hard-coal industry in 1933 are readily discernible. As in 1931 and 1932, an important restricting influence was the abnormally mild weather which extended over almost the entire anthracite-consuming territory throughout a large part of the heating season. Moreover, the general industrial revival had little material effect on hard-coal mining as all but a small part of the anthracite production is used for heating purposes. Meanwhile, with earnings still sharply reduced, consumers continued to utilize cheaper substitute fuels. On the other hand, some consumers were deserting anthracite for costlier but more convenient fuels. Accordingly, the hard-coal industry is being squeezed from both sides.

*Statistical summary of monthly developments in the Pennsylvania anthracite industry in 1933*

[All tonnage figures represent thousands of net tons]

| | 1933 | | | | | | | | | | | | | 1932 total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January | February | March | April | May | June | July | August | September | October | November | December | Total | |
| Production, including mine fuel, local sales, and dredge coal: | | | | | | | | | | | | | | |
| Monthly total | 3,807 | 4,275 | 4,519 | 2,891 | 2,967 | 3,928 | 3,677 | 4,396 | 4,993 | 4,711 | 4,811 | 4,424 | 49,399 | 49,855 |
| Average per working day | 152.3 | 181.9 | 167.4 | 120.5 | 114.1 | 151.1 | 147.1 | 162.8 | 199.7 | 188.4 | 200.5 | 177.0 | 163.6 | 163.7 |
| Shipments, breakers and washeries only:[1] Monthly total, all sizes | 3,326 | 3,782 | 3,866 | 2,461 | 2,508 | 3,512 | 3,212 | 3,942 | 4,222 | 4,147 | 4,098 | 4,012 | 43,088 | 43,849 |
| Distribution: | | | | | | | | | | | | | | |
| Lake loadings | | | | 7 | 26 | 77 | 82 | 73 | 46 | 93 | 22 | | 426 | 294 |
| Receipts at Duluth-Superior | | | | | 7 | 22 | 17 | 21 | 25 | 34 | 9 | | 135 | 66 |
| Shipments from Lake docks | 34 | 42 | 18 | 17 | 29 | 79 | 40 | 87 | 43 | 64 | 44 | 44 | 541 | 512 |
| New England receipts— | | | | | | | | | | | | | | |
| By tide | 163 | 155 | 120 | 108 | 117 | 144 | 175 | 130 | 141 | 171 | 119 | 147 | 1,690 | 1,659 |
| By rail | 275 | 291 | 289 | 191 | 183 | 238 | 224 | 422 | 397 | 358 | 387 | 307 | 3,562 | 3,980 |
| Exports | 75 | 89 | 67 | 42 | 35 | 93 | 114 | 111 | 140 | 95 | 93 | 80 | 1,034 | 1,303 |
| Imports | 59 | 62 | 41 | 31 | 22 | 25 | 14 | 37 | 37 | 61 | 20 | 48 | 457 | 607 |
| Industrial consumption by— | | | | | | | | | | | | | | |
| Railroads (class I only) | 149 | 138 | 141 | 122 | 112 | 104 | 107 | 107 | 108 | 130 | 135 | 160 | 1,513 | (2) |
| Electric-power utilities | 116 | 110 | 121 | 102 | 101 | 117 | 127 | 134 | 121 | 145 | 139 | 135 | 1,468 | (2) |
| Stocks at end of period shown: | | | | | | | | | | | | | | |
| Railroads (class I only) | 162 | 157 | 157 | 143 | 145 | 172 | 163 | 157 | 162 | 153 | 155 | 156 | 156 | 165 |
| Electric-power utilities | 1,161 | 1,152 | 1,126 | 1,148 | 1,123 | 1,063 | 1,250 | 1,265 | 1,285 | 1,322 | 1,349 | 1,323 | 1,323 | 1,189 |
| Stocks on Lake docks | 355 | 313 | 296 | 286 | 274 | 261 | 304 | 295 | 295 | 319 | 300 | 257 | 257 | 389 |
| Retail stocks, 163 representative dealers | 367 | (2) | 254 | 264 | (2) | 346 | 379 | (2) | 497 | 490 | 497 | 461 | 461 | 422 |
| Producers' stocks | 1,239 | 792 | 511 | 457 | 435 | 533 | 736 | 977 | 1,267 | 1,351 | 1,293 | 1,106 | 1,106 | 1,732 |
| Prices at mines, average per net ton:[3] [4] | | | | | | | | | | | | | | |
| Company stove | $7.25 | $7.25 | $7.25 | $7.25 | $6.25 | $6.25 | $6.50 | $6.75 | $7.25 | $7.25 | $7.25 | $7.25 | $6.98 | $7.06 |
| Independent stove | $7.25 | $7.25 | $7.25 | $7.25 | $6.25 | $6.25 | $6.50 | $6.75 | $7.25 | $7.25 | $7.25 | $7.25 | $6.98 | $6.93 |
| Company buckwheat No. 1 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 |
| Independent buckwheat No. 1 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 | $3.25 |
| Retail prices (average 25 cities):[3] [5] | | | | | | | | | | | | | | |
| Stove | $13.82 | $13.75 | $13.70 | $13.22 | $12.44 | $12.18 | $12.47 | $12.85 | $13.33 | $13.44 | $13.46 | $13.45 | $13.18 | $13.91 |
| Chestnut | $13.61 | $13.53 | $13.48 | $13.00 | $12.25 | $12.00 | $12.26 | $12.65 | $13.12 | $13.23 | $13.26 | $13.24 | $12.97 | $13.74 |
| Labor conditions:[6] | | | | | | | | | | | | | | |
| Men on pay rolls at 159 mines | 52.5 | 58.7 | 54.6 | 51.6 | 43.2 | 39.5 | 43.8 | 47.7 | 56.8 | 56.9 | 61.0 | 54.5 | 51.7 | 62.5 |
| Index of pay-roll totals | 43.2 | 56.8 | 48.8 | 37.4 | 30.0 | 34.3 | 38.2 | 46.6 | 60.7 | 61.6 | 47.8 | 44.3 | 45.8 | 53.7 |

[1] As reported by the Anthracite Bureau of Information.
[2] Comparable figures for 1932 not available.
[3] Average per net ton.
[4] Quoted by trade journals in New York market.
[5] Bureau of Labor Statistics, white ash, sidewalk delivery.
[6] Bureau of Labor Statistics, index numbers—1929 average=100.0.

*Weather conditions.*—Abnormally warm weather was again a dominating factor influencing the hard-coal market in 1933. Considering the season, the weather throughout the anthracite-consuming territory during the first quarter of the year was especially mild. In January the temperatures in the northeastern section of the country ranged from 8° to 12° above normal. Somewhat more normal temperatures prevailed in February over most of the country; but in the northeast, where the bulk of the anthracite is consumed, mild weather persisted, although the departure from normal was not quite as pronounced as in the preceding month. March also was a month of relatively mild temperatures in most of the hard-coal territory.

In the fall when the new heating season began, weather conditions were considerably more favorable for the coal trade. The temperatures throughout the northeast during both October and November averaged somewhat below normal. December likewise was subnormal along the northern fringe of the hard-coal territory, but in spite of the more favorable weather conditions in the closing quarter of 1933 the temperatures for the year as a whole were distinctly higher than normal in all sections of the North Atlantic coast area, and consumption of anthracite was restricted on this account.

*Trend of stocks.*—The year, however, was not entirely devoid of encouraging features. One favorable aspect of the anthracite market was the further pronounced liquidation of above-ground stocks. Not only were producers' stocks reduced sharply, but substantial declines likewise were reported in stocks in the hands of the lake-dock operators and in unbilled loads.

Unlike the bituminous trade, stocks in the hands of the mine operators are an important element in the above-ground reserves of hard coal. On January 1, 1933, the stocks of anthracite at producers' storage yards stood at 1,732,000 tons. In the succeeding 5 months approximately three-fourths of this tonnage was used to meet current market requirements, and by June 1 only 435,000 tons were on hand. During the summer and early fall operators built up reserves, and by November 1 a total of 1,351,000 tons had been accumulated, but 245,000 tons of this were withdrawn during the next 2 months, and the total quantity on hand at the beginning of the new year amounted to 1,106,000 tons. This represents a reduction of 36.1 percent compared with the quantity in the producers' yards 12 months before.

An almost parallel decline is shown in stocks on the upper lake docks. At the beginning of the year stocks of hard coal in the hands of the commercial dock operators stood at 389,000 tons. During the first 6 months of the year they were reduced by 128,000 tons and on July 1 totaled 261,000 tons. With the approach of the heating season moderate additions were made to reserves, but the year ended with stocks standing at 257,000 tons (33.3 percent less than on Jan. 1).

Complete figures on retail stocks of anthracite are not available, but a canvass of a selected group of dealers believed to be representative of the trade as a whole indicates that retailers' stocks were increased by about 9 percent during the year.

The available information on industrial stocks of hard coal shows a mixed picture of gains and losses. Railroad stocks declined from 165,000 tons on January 1 to 156,000 tons on December 31. On the other hand, stocks of anthracite at electric public utilities increased from 1,189,000 tons to 1,323,000 tons, a gain of 11.3 percent.

*Decline in consumption.*—As the drafts on reserves went to increase consumption the decline in the quantity consumed was somewhat less than appears from the record of production alone. Allowing for imports, exports, and withdrawals from producers' storage yards, the apparent consumption in 1933 was 49,447,000 tons, a decrease of 2.1 percent from the previous year. If allowance is made for changes in unbilled loads, stocks on the lake docks, and stocks in the hands of the important industrial consumers, the record is still more favorable, the total consumption being 50,126,200 tons.

*Movement through major distribution channels.*—Another encouraging aspect of the anthracite-market situation was the marked improvement in the lake trade. Compared with the previous year, loadings of hard coal at the lower Lake Erie ports in 1933 increased 44.6 percent. Receipts at Duluth-Superior were more than double those of the previous year, while shipments from the lake docks advanced 5.7 percent.

In other areas the record is much less favorable. A 1.9-percent increase in New England tidewater receipts was overshadowed by a 10.5-percent decrease in receipts by rail. Detailed distribution statistics are not available for the Middle Atlantic States, which comprise the most important hard-coal market, but it is evident from the record of breaker shipments that there was some contraction.

*Continued shrinkage of exports.*—While the domestic market held up fairly well, exports in 1933 again fell off sharply. The total exports for the year amounted to 1,034,000 tons, a decrease of 269,000 tons (20.6 percent) compared with 1932.

As in the previous year, the major factor in the shrinkage of anthracite exports was the further contraction of the Canadian market. Canada always has been the principal and virtually the only foreign market for American hard coal. Small tonnages are shipped regularly to certain Caribbean markets, but this movement is insignificant compared with the Canadian trade. Formerly the United States supplied virtually all the anthracite used in Canada. Since 1929, however, American shippers have experienced increasingly keen competition from British anthracite. During this interval Canadian imports of anthracite from Great Britain have more than doubled, while there has been a corresponding reduction in imports from the Pennsylvania fields. In 1933 this trend continued; while imports of American hard coal declined 15 percent, imports from Great Britain increased from 1,399,086 tons to 1,605,776 tons.

*Imports remain at high levels.*—In spite of the excise tax of $2 per net ton levied on foreign coal in the summer of 1932, imports of anthracite during 1933 remained relatively high. The total imports of hard coal amounted to 457,000 tons. Although this represents a decrease of 24.8 percent, compared with 1932, it is still about three times as much as the quantity imported in 1927 when there were no restrictions on importations.

Of the total imports in 1933, more than 50 percent (229,151 tons) came from Soviet Russia and 200,291 tons (about 44 percent) from Great Britain. The remainder came from the Netherlands, Germany, China, and French Indo-China.

*Inroads of competitive fuels.*—Largely because of the high price levels prevailing in recent years, anthracite has been especially vulnerable to competition from substitute fuels. As a result there has been a decided drop in the consumption of Pennsylvania hard coal, while consumption of substitute fuels has increased conspicuously. This has been particularly true of fuels in the lower-price range, but some increase has occurred in the use of the more expensive substitutes as well.

At present coke appears to be offering the most serious competition. The past few years have witnessed a spectacular increase in the use of coke for household purposes. In 1933, for the sixth successive year, sales of coke to household consumers broke all previous records, amounting to 10,491,037 tons. Compared with the previous year this is a gain of 11 percent and is nearly 40 percent more than in 1929. Of the total domestic sales during 1933, 10,215,360 tons were byproduct coke and 275,677 tons beehive. In 1932 sales of byproduct coke to householders totaled 9,422,343 tons and sales of beehive coke 207,857 tons. Since the coke industry is concentrated mainly in the northeastern section of the country, it is clear that the domestic market for coke has been developed largely at the expense of Pennsylvania anthracite.

Although far less important, fuel briquets likewise compete directly with anthracite in the domestic fuel market. Production of briquets declined sharply from 1929 to 1932, but in 1933 the industry recovered somewhat. The total output for the year was 530,430 tons, an increase of 11.3 percent compared with the 470,604 tons produced in 1932.

On the other hand, sales of both natural and manufactured gas for domestic purposes declined in 1933. According to the American Gas Association, total domestic sales of natural gas during the year were 8.2 percent less than in 1932, while sales of manufactured gas dropped 6.3 percent. Notwithstanding this loss, sales of natural gas for domestic purposes were still 10.8 percent higher than in 1929, and sales of manufactured gas were within 13.2 percent of the 1929 level. By contrast the production of anthracite in 1933 was almost 28 percent less than in 1929.

Sales of fuel and distillate oils for househeating increased from 5,021,000 barrels in 1924 to 24,659,000 in 1931. Since 1931 no detailed analysis of consumption of fuel oil has been made, but indications are that there has been no significant shrinkage in domestic demand. This view is substantiated by the record of production which shows that, while the output of gas oil and fuel oil declined in 1932, the loss was largely wiped out in 1933 when the output rose to within 7 percent of the 1931 total. Further evidence is found in the continued heavy sales of oil burners. In 1933 shipments of domestic oil burners to points in the United States totaled 51,336, as against 58,445 in 1932.

*Stabilization of prices.*—Generally, the prices of anthracite in 1933 averaged somewhat less than in the preceding year, but the general undertone of the hard-coal price structure was appreciably steadier. In 1932, it will be recalled, the industry avoided a serious price war by only the narrowest margin. From the beginning of the 1931–32 heating season until late in February 1932 the mine price of the prepared sizes produced by the independent companies ranged from 40 to 50 cents a ton lower than for similar grades produced by the old-line companies. Late in February, however, the old-line companies retaliated with a horizontal cut of $1 per ton on all domestic sizes. This, in turn, resulted in a further slash in the price of independent coal. It was not until the beginning of the 1932–33 heating season that prices again were stabilized.

As a result of this experience, prices remained firm throughout 1933, but because of the higher levels in the early weeks of 1932 average prices for 1933 as a whole show small declines. Thus a preliminary estimate, based on returns from the larger companies, indicates that the average value of breaker and washery shipments was $4.59 per ton in 1933 as against $4.74 in 1932.

The lower mine price was reflected in a reduced price to consumers. The average retail price of stove coal in 25 representative cities in 1933, according to the Bureau of Labor Statistics, was $13.18 per ton compared with $13.91 in 1932. Similarly, the average retail price of chestnut dropped from $13.74 per ton to $12.97.

*Labor conditions.*—The employment situation in the anthracite region remained critical throughout 1933 and was, in fact, more acute

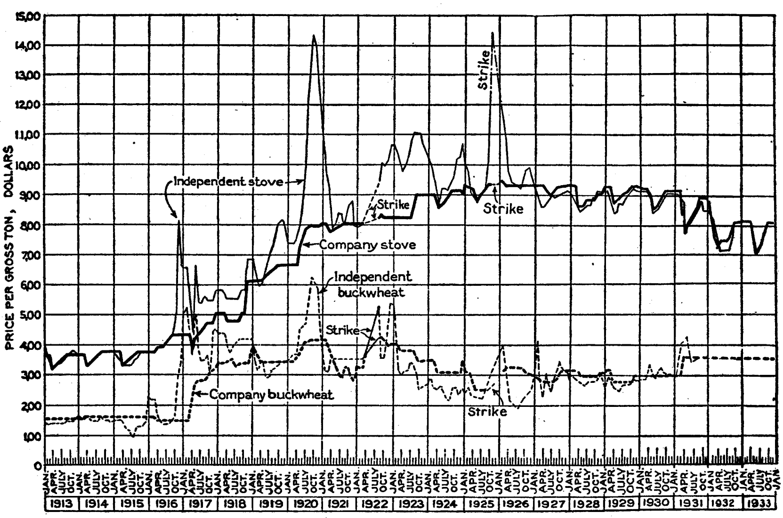


FIGURE 36.—Monthly prices of Pennsylvania anthracite, f.o.b. mine, as quoted by the trade journals, 1913–33. Prices are averages of the range, as quoted on the New York market.

in some aspects than in the previous year. Thousands of miners were idle, and the earnings of those fortunate enough still to hold jobs were curtailed drastically by reduced working time. It is true that the operators as well as the miners have felt the pinch of hard times, but the reduction in numbers employed has proceeded more rapidly than the contraction of the demand for coal. According to the Pennsylvania Department of Mines only 102,469 workers were employed by the anthracite industry in 1933. Compared with the number employed in the previous year this is a decrease of 15.5 percent. Production, as has been noted previously, declined only 0.9 percent.

Protest against prevailing conditions found expression in 1933 in a number of strikes and disturbances of major proportions. Early in the year a rumor that the Philadelphia Coal & Iron Co. intended closing its Piney Knot Colliery at Pottsville aroused a storm of protest by the miners, who feared that this might lead to other shutdowns in the region. For several years the question of equalization of working time between collieries has been a disturbing factor in the industry, and in 1933 it led to recurring disputes. The most serious labor disturbances during the year, however, occured after the organization of a new union, the Anthracite Mine Workers of Pennsylvania. With dissatisfaction at high pitch the membership of the insurgent union grew rapidly, and in the late summer it tested its strength by attempting to close down the mines of the Penn Anthracite Mining Co. in protest against the discharge of 15 miners. This was followed on November 6, after several attempts had been made to obtain the intervention of the National Labor Board, by a serious strike which involved 25,000 to 35,000 workers and closed down virtually all operations in Luzerne County and some of the mines in Lackawanna County. The strike was ended on November 13, after the National Labor Board had agreed to appoint a fact-finding committee to investigate the grievances of the workers. Other strikes during the year involved the operations of the Lehigh Navigation Coal Co. in the Panther Creek Valley field and were called as a result of disagreements concerning wage rates.

The move to reduce the wage rates of the hard-coal miners, which was initiated by the operators in 1932, ended unsuccessfully. Neither the conference of operators and miners nor the two arbitrators who were appointed to decide the question could agree, and at the request of the Secretary of Labor the question was dropped. All the major labor problems confronting the industry in recent years have thus been carried over into 1934.

## WORLD PRODUCTION

Preliminary statistics of coal production in the leading countries of the world indicate that the industrial recovery of 1933 was not confined to the United States but was international in scope and was reflected in the coal output of many of the important coal-producing countries. The total world production for the year is estimated at 1,154,000,000 metric tons, an increase of 30,000,000 tons (2.7 percent) compared with 1932. Of the total 1933 output 982,000,000 tons (about 85 percent) was bituminous coal and anthracite, and 172,000,000 tons was lignite. Compared with 1932 the output of bituminous coal and anthracite increased 2.8 percent and the output of lignite 1.8 percent. (See fig. 37.) The following table shows production by countries and is based upon information from such official sources as are available at present, supplemented by trade reports.

Apart from the United States, where the total output of both bituminous coal and anthracite was 4.9 percent higher than in 1932, the increased production in 1933 was accounted for chiefly by Belgium, Soviet Russia, Germany, and Australia. The most substantial gain is reported for Belgium, where the output advanced from 21,424,000 tons in 1932 to 25,278,000 tons in 1933, a rise of 18.0 percent. Production in Russia rose to 59,200,000 tons, an increase of 10.8 percent over 1932. Germany and Australia show gains of 4.1 percent and 3.9 percent, respectively. Small increases also are shown for Canada, France, the Saar, and South Africa.

These gains were partly offset by declines in other countries. In Spain, for example, continued political unrest was largely responsible for the sharp drop of 16.4 percent in coal production. Elsewhere, however, the losses were much less severe. In Great Britain, in 1933, production came within 0.9 percent of the 1932 level and, while the decreases were somewhat greater for the Netherlands, Czecho-

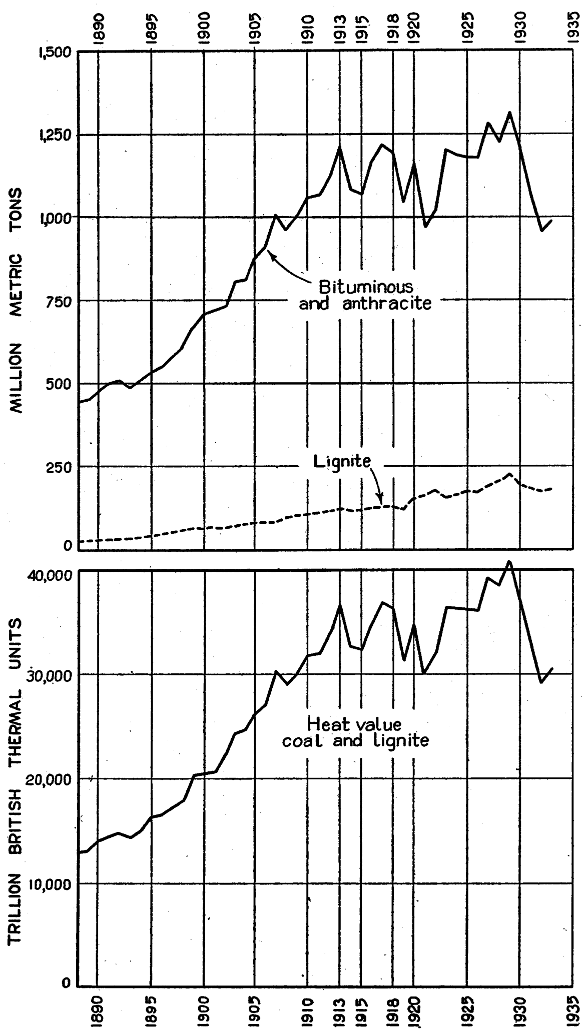


FIGURE 37.—World production of coal and lignite, 1888–1933.

slovakia, Poland, and Hungary, they were much less pronounced than in 1932.

In spite of the improvement during 1933, coal production in nearly all the leading producing countries was still far short of normal. The following tabulation shows the percentage of decrease (or increase) in the output of the principal countries from 1929 to 1933.

| | Percent of change since 1929 |
|---|---|
| United States, bituminous and anthracite | −38.4 |
| Canada, coal | −37.1 |
| Poland | −41.0 |
| Germany: | |
| Coal | −32.7 |
| Lignite | −27.3 |
| Union of South Africa | −17.7 |
| Japan | −22.5 |
| Belgium | −6.2 |
| India | −15.9 |
| Great Britain | −19.7 |
| France | −12.8 |
| Netherlands | +8.6 |
| Russia in Europe | +62.7 |

Production has been affected most seriously in Poland, where the decline in tonnage produced from 1929 to 1933 was 41 percent. In the United States production, counting both anthracite and bituminous, has decreased 38 percent. Sharp declines also are shown for most of the other countries, but in the Netherlands and Soviet Russia production has increased. The spectacular increase in production in Russia (62.7 percent over 1929) is explained largely by the recent rapid growth of industry in that country and the consequent rise in coal requirements.

*Coal produced in principal countries of the world in calendar years 1931, 1932, and 1933, in thousands of metric tons* [1]

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

| Country | 1931 | 1932 | 1933 |
|---|---|---|---|
| North America: | | | |
| Canada: | | | |
| Coal | 8,466 | 7,507 | 7,722 |
| Lignite | 2,640 | 3,142 | 3,052 |
| United States: | | | |
| Anthracite | 54,109 | 45,228 | 44,814 |
| Bituminous and lignite | 346,624 | 280,963 | 297,501 |
| Other countries | 927 | 692 | (2) |
| South America | 1,849 | 1,825 | (2) |
| Europe: | | | |
| Belgium | 27,042 | 21,424 | 25,278 |
| Czechoslovakia: | | | |
| Coal | 13,103 | 10,961 | 10,640 |
| Lignite | 17,932 | 15,858 | 15,125 |
| France: | | | |
| Coal | 50,011 | 46,266 | 47,941 (coal and lignite) |
| Lignite | 1,035 | 991 | |
| Germany: [3] | | | |
| Coal | 118,640 | 104,741 | 109,921 |
| Lignite | 133,311 | 122,647 | 126,796 |
| Saar [4] | 11,367 | 10,438 | 10,564 |
| Hungary: | | | |
| Coal | 776 | 895 | 840 |
| Lignite | 6,111 | 5,931 | 5,619 |
| Netherlands: | | | |
| Coal | 12,901 | 12,756 | 12,574 |
| Lignite | 122 | 124 | (2) |
| Poland: | | | |
| Coal | 38,265 | 28,835 | 27,300 |
| Lignite | 41 | 33 | (2) |
| Russia: | | | |
| Coal and Lignite | 50,400 | 53,600 | [5] 59,200 |
| Europe—Continued | | | |
| Spain: | | | |
| Coal | 7,186 | 6,854 | [5] 5,730 |
| Lignite | 353 | 336 | [5] 284 |
| United Kingdom: | | | |
| Great Britain | 222,981 | 212,083 | 210,309 |
| Other countries | 13,251 | 13,076 | (2) |
| Asia: | | | |
| China | 27,682 | 28,000 | (2) |
| India, British | 22,065 | 20,477 | [6] 20,000 |
| Japan (including Taiwan and Karafuto): | | | |
| Coal | 29,876 | 28,100 | (2) (coal, lignite, and other countries) |
| Lignite | 118 | 112 | |
| Other countries | 14,325 | 16,150 | |
| Africa: | | | |
| Southern Rhodesia | 587 | 438 | 484 |
| Union of South Africa | 10,881 | 9,921 | 10,714 |
| Other countries | 456 | 366 | (2) |
| Oceania: | | | |
| Australia: | | | |
| New South Wales | 6,536 | 6,893 | 7,160 |
| Other States | 4,230 | 4,450 | (2) (Other States through other countries) |
| New Zealand: | | | |
| Coal | 995 | 943 | |
| Lignite | 1,197 | 928 | |
| Other countries | --------- | --------- | |
| Total | 1,258,000 | 1,124,000 | 1,154,000 |

[1] 1 metric ton equivalent to 2,204.6 pounds.
[2] Estimate included in total.
[3] Exclusive of mines in the Saar under French control.
[4] Mines under French control.
[5] Estimated on the basis of 9 months' figures.
[6] Approximate production.

# COKE AND BYPRODUCTS

By W. H. Young and H. L. Bennit

## SUMMARY OUTLINE



The coke industry participated in the general business recovery during 1933. Production of both beehive and byproduct coke totaled 27,555,378 net tons in 1933 compared with 21,788,730 net tons in 1932, an increase of 26.5 percent. However, production in 1933 represents a decrease of 17.7 percent from 1931 and 54 percent from 1929, the peak year of coke production in the United States. The annual output for the 10-year period 1923–32 averaged 47,640,607 tons (72.9 percent greater than that in 1933).

Most of the increase in 1933 was accounted for by increased activity in the metallurgical industries. The output of pig iron in 1933 was 52.1 percent greater than in 1932; coke production increased 26.5 percent.

Coke production was marked by a decline in the daily rate from the first of the year through April; a sharp improvement in the iron and steel industries resulted in a rapid increase in output during the next 4 months, after which it declined slightly. (See fig. 38.) The daily average of beehive and byproduct production was 60,800 tons in January, 97,000 tons in August, and 82,800 tons in December.

Byproduct ovens contributed 96.8 percent of the total production, virtually the same proportion as in 1932. The output of these plants rose to 26,678,136 tons, an increase of 5,541,294 (26.2 percent) from 1932. However, increases at "furnace" plants (those affiliated with blast furnaces) were much greater than at merchant plants. (See table 9 and fig. 41.) Furnace plants produced 16,144,168 tons, an increase of 4,769,797 tons (41.9 percent) from 1932. Production at merchant plants was 10,533,968 tons, an increase of 771,497 tons (7.9 percent). The difference in the rates of increase 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 experienced considerably more activity than the industry as a whole. Total deliveries of byproduct coke to blast furnaces (interplant transfers and sales) increased from 8,766,116 tons in 1932 to 13,110,485 tons in 1933 (49.6 percent).

The activity of beehive ovens increased even more in proportion than that of byproduct plants. Production amounted to 877,242 tons in 1933, an increase of 34.6 percent from that in 1932.

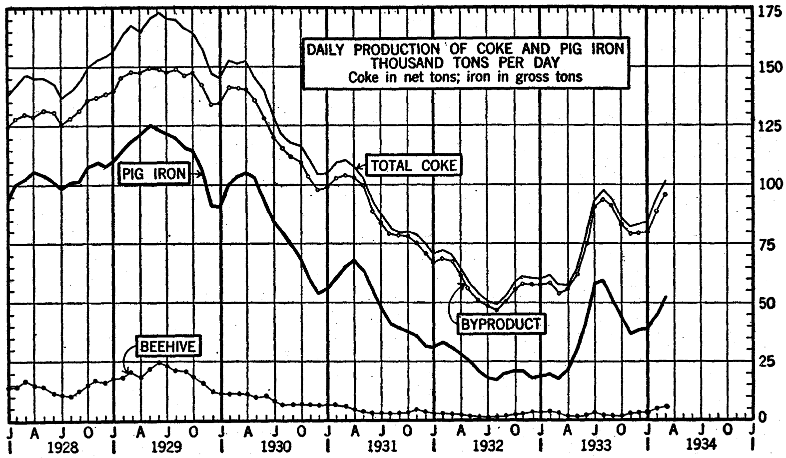


FIGURE 38.—Average daily production of beehive and byproduct coke and of pig iron, by months, 1928–34.

Of particular significance is the growing demand for coke for domestic use. Throughout the depression sales of domestic coke increased each year to 10,491,037 tons in 1933, an increase of 8.9 percent over 1932. (See table 2 and fig. 42.)

## STATISTICAL SUMMARY

TABLE 1.—*Salient statistics of the coke industry in 1933*

| | Byproduct | Beehive | Total |
|---|---|---|---|
| Coke produced: | | | |
| At merchant plants: | | | |
| Quantity ... net tons | 10, 533, 968 | ---------- | 10, 533, 968 |
| Value | $57, 132, 796 | ---------- | $57, 132, 796 |
| At furnace plants: | | | |
| Quantity ... net tons | 16, 144, 168 | ---------- | 16, 144, 168 |
| Value | $63, 179, 528 | ---------- | $63, 179, 528 |
| Total: | | | |
| Quantity ... net tons | 26, 678, 136 | 877, 242 | 27, 555, 378 |
| Value | $120, 312, 324 | $2, 531, 703 | $122, 844, 027 |
| Screenings or breeze produced: | | | |
| Quantity ... net tons | 2, 533, 381 | 45, 932 | 2, 579, 313 |
| Value | $5, 054, 641 | $74, 717 | $5, 129, 358 |
| Coal charged into ovens: | | | |
| Quantity ... net tons | 38, 680, 937 | 1, 408, 181 | 40, 089, 118 |
| Value | $130, 891, 297 | $1, 861, 616 | $132, 752, 913 |
| Average value per ton | $3. 38 | $1. 32 | $3. 31 |
| Average yield in percent of coal charged: | | | |
| Coke | 68. 97 | 62. 30 | 68. 74 |
| Breeze (at plants actually recovering) | 6. 55 | 5. 20 | 6. 52 |
| Ovens: | | | |
| In existence Jan. 1 | 13, 053 | 19, 440 | 32, 493 |
| In existence Dec. 31 | 13, 053 | 16, 410 | 29, 463 |
| Dismantled during year | ---------- | 2, 733 | 2, 733 |
| In course of construction Dec. 31 | ---------- | ---------- | ---------- |
| Daily capacity of ovens Dec. 31 ... net tons | 172, 741 | (1) | (1) |

[1] Data not available.

TABLE 1.—*Salient statistics of the coke industry in 1933*—Continued

| | Byproduct | Beehive | Total |
|---|---|---|---|
| Coke used by operator: | | | |
| In blast furnaces: | | | |
| Quantity net tons | 11,882,920 | | 11,882,920 |
| Value | $46,611,428 | | $46,611,428 |
| For other purposes: | | | |
| Quantity net tons | 1,559,907 | 253 | 1,560,160 |
| Value | $7,781,000 | $514 | $7,781,514 |
| Disposition of coke: | | | |
| Sold for furnace use to affiliated corporations: | | | |
| Quantity net tons | 638,094 | 44,270 | 682,364 |
| Value | $2,101,647 | $286,118 | $2,387,765 |
| Merchant sales of furnace coke: | | | |
| Quantity net tons | 589,471 | 115,653 | 705,124 |
| Value | $2,355,781 | $274,420 | $2,630,201 |
| Sold for foundry use: | | | |
| Quantity net tons | 833,633 | 171,252 | 1,004,885 |
| Value | $4,452,635 | $559,634 | $5,012,269 |
| Sold for domestic use: | | | |
| Quantity net tons | 10,215,360 | 275,677 | 10,491,037 |
| Value | $52,280,220 | $673,028 | $52,953,248 |
| Sold for manufacture of water gas: | | | |
| Quantity net tons | 554,170 | 81,951 | 636,121 |
| Value | $3,224,422 | $181,292 | $3,405,714 |
| Sold for industrial and other use: | | | |
| Quantity net tons | 996,098 | 162,552 | 1,158,650 |
| Value | $4,620,775 | $491,983 | $5,112,758 |
| Disposition of screenings or breeze: | | | |
| Used by operator: | | | |
| For raising steam: | | | |
| Quantity net tons | 1,640,046 | 736 | 1,640,782 |
| Value | $3,185,981 | $785 | $3,186,766 |
| To make producer or water gas: | | | |
| Quantity net tons | 84,757 | | 84,757 |
| Value | $313,959 | | $313,959 |
| Other purposes: | | | |
| Quantity net tons | 212,502 | 130 | 212,632 |
| Value | $391,939 | $369 | $392,308 |
| Sold: | | | |
| Quantity net tons | 625,530 | 28,724 | 654,254 |
| Value | $1,231,490 | $46,961 | $1,278,451 |
| Average receipts per ton sold: | | | |
| Furnace coke (merchant sales) | $4.00 | $2.37 | $3.73 |
| Foundry coke | $5.34 | $3.27 | $4.99 |
| Domestic coke | $5.12 | $2.44 | $5.05 |
| For manufacture of water gas | $5.82 | $2.21 | $5.35 |
| Other industrial coke | $4.64 | $3.03 | $4.41 |
| Screenings or breeze | $1.97 | $1.63 | $1.95 |
| Stocks on hand on Jan. 1, 1934: | | | |
| Furnace net tons | 919,583 | 5,216 | 924,799 |
| Foundry do | 64,552 | 10,979 | 75,531 |
| Domestic and other do | 1,835,743 | 29,187 | 1,864,930 |
| Breeze do | 438,795 | 1,042 | 439,837 |
| Imports do | | | 160,873 |
| Exports do | | | 637,819 |
| Calculated consumption do | | | 27,738,000 |
| Byproducts produced: | | | |
| Gas M cubic feet | 431,291,780 | | 431,291,780 |
| Wasted percent | 1.7 | | 1.7 |
| Burned in coking process do | 34.3 | | 34.3 |
| Surplus sold or used do | 64.0 | | 64.0 |
| Tar gallons | 363,298,586 | | 363,298,586 |
| Ammonium sulphate or equivalent pounds | 840,585,150 | | 840,585,150 |
| Crude light oil gallons | 96,632,316 | | 96,632,316 |
| Yield of byproducts per ton of coal: | | | |
| Gas M cubic feet | 11.15 | | 11.15 |
| Tar gallons | 9.39 | | 9.39 |
| Ammonium sulphate or equivalent pounds | 22.18 | | 22.18 |
| Crude light oil gallons | 2.79 | | 2.79 |
| Value of byproducts sold: | | | |
| Gas (surplus) | $55,997,694 | | $55,997,694 |
| Tar: | | | |
| Sold | $8,980,956 | | $8,980,956 |
| Used by producer | $4,525,044 | | $4,525,044 |
| Ammonium sulphate or equivalent | $7,188,652 | | $7,188,652 |
| Crude light oil and derivatives | $12,306,227 | | $12,306,227 |
| Other byproducts [2] | $654,825 | | $654,825 |
| Total value of coke, breeze, and byproducts [3] | $215,020,363 | $2,606,420 | $217,626,783 |

[2] Includes naphthalene and tar derivatives.
[3] Includes value of tar used by the coke plants.

TABLE 2.—*Statistical trends of the coke industry, 1923 and 1930–33*

| | 1923 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Coke produced: | | | | | |
| Beehive ... net tons | 19,379,870 | 2,776,316 | 1,128,337 | 651,888 | 877,242 |
| Byproduct ... do | 37,597,664 | 45,195,705 | 32,355,549 | 21,136,842 | 26,678,136 |
| Total ... do | 56,977,534 | 47,972,021 | 33,483,886 | 21,788,730 | 27,555,378 |
| Percent of total from byproduct ovens | 66.0 | 94.2 | 96.6 | 97.0 | 96.8 |
| Disposition of coke (beehive and byproduct): | | | | | |
| Furnace coke (including all coke used by producer) ... net tons | 47,774,408 | 34,524,554 | 20,608,175 | 10,524,496 | 14,830,568 |
| Foundry coke ... do | 3,600,719 | 2,127,715 | 1,357,276 | 1,054,771 | 1,004,885 |
| Other industrial (including water gas) net tons | 2,283,888 | 2,030,103 | 1,838,566 | 1,295,290 | 1,794,771 |
| Domestic coke ... do | 2,733,414 | 8,027,823 | 8,495,317 | 9,630,200 | 10,491,037 |
| Number of ovens in existence: | | | | | |
| Beehive | 62,349 | 23,907 | 21,588 | 19,440 | 16,410 |
| Byproduct | 11,156 | 12,831 | 13,108 | 13,053 | 13,053 |
| Number of new byproduct ovens under construction at end of year | 629 | 276 | --- | --- | --- |
| Cost of coal charged, byproduct ovens, average per ton | $4.76 | $3.48 | $3.55 | $3.55 | $3.38 |
| Prices of coke: | | | | | |
| Average spot price of Connellsville furnace coke f.o.b. ovens | $5.33 | $2.56 | $2.43 | $2.04 | $2.41 |
| Average realization on byproduct coke sold: | | | | | |
| Furnace coke (merchant sales) | $6.74 | $4.95 | $5.59 | $4.22 | $4.00 |
| Foundry coke | $10.54 | $6.57 | $6.11 | $5.65 | $5.34 |
| Other industrial (including water gas) | $9.06 | $5.88 | $5.72 | $5.26 | $5.06 |
| Domestic | $9.05 | $6.03 | $5.73 | $5.21 | $5.12 |
| Yield of byproducts per ton of coal charged: | | | | | |
| Tar ... gallons | 8.1 | 9.20 | 9.62 | 9.84 | 9.39 |
| Ammonium sulphate or equivalent pounds | 21.2 | 23.47 | 24.33 | 23.06 | 22.18 |
| Light oil ... gallons | 2.7 | 3.06 | 3.03 | 2.94 | 2.79 |
| Surplus gas sold or used ... M cubic feet | 5.9 | 6.75 | 7.02 | 7.47 | 7.14 |
| Average gross receipts of byproducts per ton of coke produced: | | | | | |
| Tar sold or used | $0.51 | $0.656 | $0.637 | $0.577 | $0.506 |
| Ammonia and its compounds | $0.84 | $0.502 | $0.441 | $0.305 | $0.269 |
| Light oil and its derivatives | $0.51 | $0.527 | $0.447 | $0.445 | $0.461 |
| Surplus gas sold or used | $1.37 | $1.754 | $2.084 | $2.596 | $2.099 |
| Total byproducts, including breeze | $3.48 | $3.708 | $3.863 | $4.182 | $3.549 |

*Scope of report.*—The urgent need for economy in public expenditure impels the Bureau of Mines to confine this report to presenting, through selected tables, the essential facts of the statistical record for the year. The present report omits numerous derivative figures, such as average yields and prices, as the reader who needs such data can make his own calculations if he is supplied with the primary record. If not readily found, any derivative figures carried in earlier reports will be furnished by the Bureau upon application.

The report covers only coke made by high-temperature carbonization of coal in beehive and byproduct ovens. However, byproduct coke produced by city gas companies is included. Adaptation of the byproduct coke oven 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. With respect to ownership and accounting, these installations are part of the gas utility system, and the Bureau of the Census therefore groups them within the manufactured-gas industry under the title "The Gas and Coke Industries." In other respects, however, these installations form part of the byproduct coke industry, and they are so included in the statistics of the Bureau of Mines. The differences in classification are followed advisedly by the Bureau of the Census and

Bureau of Mines after consultation with leaders of the gas and coke industries, and the two offices have collaborated in the collection and analysis of the statistics. (See table 51.)

Coke is also made by other processes not included in this report, among them the following: About 2,000,000 tons of gas-house coke are made by the high-temperature carbonization of coal in types of equipment other than coke ovens, chiefly in horizontal retorts. Statistics of gas-house coke are given in Coke and Byproducts in 1930, page 495. Petroleum coke is a byproduct of petroleum refining; production in 1933 amounted to 1,576,000 tons. Much experimental

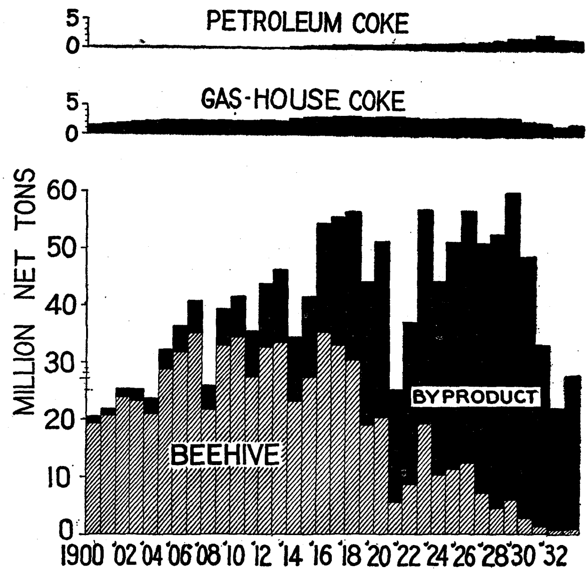


FIGURE 39.—Production of petroleum coke, gas-house coke, and beehive and byproduct coke in the United States, 1900–33. No figures on production of petroleum coke are available before 1914, when the production was 213,777 tons.

work has been done in the field of low-temperature carbonization of coal, but the commercial feasibility of the process has not been demonstrated in the United States. The manufacture of coke from coal-tar pitch, on the other hand, is established on a commercial basis, but the tonnage produced is small. None of these kinds of coke are covered in this report. Gas-house coke, petroleum coke, and low-temperature coke are not adapted for blast furnace and foundry uses, which consume the great bulk of all the coke produced, and the production of coal-tar-pitch coke is so small as to have little importance. Practically, therefore, the coke trade is concerned with beehive and byproduct-oven coke (fig. 39).

TABLE 3.—*Summary of coke produced, value, number of ovens, coal charged, and average yield, by States, in 1933*

[Exclusive of screenings or breeze]

| State | Byproduct | | | | | | | Beehive | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plants in existence | Ovens in existence [1] | Coal used (net tons) | Yield of coke from coal (percent) | Coke produced (net tons) | Value of coke at ovens | | Ovens in existence [1] | Coal used (net tons) | Yield of coke from coal (percent) | Coke produced (net tons) | Value of coke at ovens | | Coke produced (net tons) | Value of coke at ovens |
| | | | | | | Total | Per ton | | | | | Total | Per ton | | |
| Alabama | 8 | 1,248 | 2,420,945 | 68.94 | 1,668,975 | $3,885,858 | $2.33 | | | | | | | 1,668,975 | $3,885,858 |
| Colorado | 1 | 151 | 210,791 | 66.28 | 139,722 | ([2]) | ([2]) | 378 | 54,478 | 64.54 | 35,161 | ([2]) | ([2]) | 174,883 | ([2]) |
| Connecticut | 1 | 61 | ([3]) | ([3]) | ([3]) | ([3]) | ([3]) | | | | | | | ([3]) | ([3]) |
| Illinois | 8 | 950 | 2,242,506 | 66.93 | 1,501,020 | 7,379,561 | 4.92 | | | | | | | 1,501,020 | 7,379,561 |
| Indiana | 6 | 1,550 | 2,945,174 | 70.93 | 2,089,100 | 12,031,285 | 5.76 | | | | | | | 2,089,100 | 12,031,285 |
| Kentucky | 1 | 108 | ([3]) | ([3]) | ([3]) | ([3]) | ([3]) | | | | | | | ([3]) | ([3]) |
| Maryland | 1 | 361 | 971,981 | 72.25 | 702,227 | ([2]) | ([2]) | | | | | | | 702,227 | ([2]) |
| Massachusetts | 3 | 430 | 1,483,004 | 68.80 | 1,020,255 | 5,935,219 | 5.82 | | | | | | | 1,020,255 | 5,935,219 |
| Michigan | 9 | 674 | 3,345,881 | 69.97 | 2,341,081 | 9,911,010 | 4.23 | | | | | | | 2,341,081 | 9,911,010 |
| Minnesota | 3 | 196 | 604,364 | 68.18 | 412,037 | 2,919,602 | 7.09 | | | | | | | 412,037 | 2,919,602 |
| Missouri | 1 | 64 | ([3]) | ([3]) | ([3]) | ([3]) | ([3]) | | | | | | | ([3]) | ([3]) |
| New Jersey | 2 | 202 | 1,188,665 | 70.26 | 835,125 | ([2]) | ([2]) | | | | | | | 835,125 | ([2]) |
| New York | 9 | 1,024 | 4,961,647 | 69.06 | 3,426,529 | 19,232,209 | 5.61 | | | | | | | 3,426,529 | 19,232,209 |
| Ohio | 15 | 1,834 | 5,228,134 | 70.33 | 3,676,727 | 14,540,301 | 3.95 | | | | | | | 3,676,727 | 14,540,301 |
| Oklahoma | | | | | | | | 100 | | | | | | | |
| Pennsylvania | 13 | 3,478 | 9,180,700 | 67.21 | 6,170,240 | 24,045,292 | 3.90 | 11,388 | 1,052,491 | 63.68 | 670,179 | $1,685,947 | $2.52 | 6,840,419 | 25,731,239 |
| Rhode Island | 1 | 65 | ([3]) | ([3]) | ([3]) | ([3]) | ([3]) | | | | | | | ([3]) | ([3]) |
| Tennessee | 1 | 24 | 100,816 | 70.91 | 71,484 | 252,339 | 3.53 | 430 | 23,591 | 48.09 | 11,346 | 23,485 | 2.07 | 82,830 | 275,824 |
| Utah | 1 | 56 | 124,100 | 53.94 | 66,945 | ([2]) | ([2]) | 819 | 21,916 | 46.34 | 10,156 | ([2]) | ([2]) | 77,101 | ([2]) |
| Virginia | | | | | | | | 1,599 | 121,077 | 58.22 | 70,493 | 243,475 | 3.45 | 70,493 | 243,475 |
| Washington | 1 | 20 | 56,818 | 56.00 | 31,817 | 141,267 | 4.44 | 80 | 622 | 60.93 | 379 | 2,903 | 7.66 | 32,196 | 144,170 |
| West Virginia | 4 | 362 | 1,580,429 | 67.96 | 1,074,002 | 2,170,183 | 2.02 | 1,616 | 134,006 | 59.35 | 79,528 | 256,706 | 3.23 | 1,153,530 | 2,426,889 |
| Wisconsin | 2 | 195 | ([3]) | ([3]) | ([3]) | ([3]) | ([3]) | | | | | | | ([3]) | ([3]) |
| Combined States | | | 2,034,982 | 71.30 | 1,450,850 | 8,635,585 | 5.95 | | | | | | | 1,450,850 | 8,635,585 |
| Undistributed | | | | | | 9,232,613 | 5.29 | | | | | 319,187 | 7.04 | | 9,551,800 |
| | 91 | 13,053 | 38,680,937 | 68.97 | 26,678,136 | 120,312,324 | 4.51 | 16,410 | 1,408,181 | 62.30 | 877,242 | 2,531,703 | 2.89 | 27,555,378 | 122,844,027 |

[1] No new ovens were put into operation during the year, and no new ovens were under construction at the end of 1933.
[2] Included under "Undistributed."
[3] Included under "Combined States."

The standard unit of measurement in the coke industry is the short or net ton of 2,000 pounds and, unless otherwise specified, is the unit employed throughout this chapter.

*Prices.*—The average value for all grades of byproduct coke was $4.51 in 1933 compared with $4.85 in 1932. Average receipts for sale of coke show declines as follows: Domestic coke declined from $5.21 to $5.12; foundry coke from $5.65 to $5.34; and furnace coke from $4.22 to $4. These decreases reflect the further decline in the cost of coking coal. The average cost of all coal consumed in byproduct plants was $3.38 per ton in 1933 compared with $3.55 in 1932.

*Production by furnace and nonfurnace plants.*—During the decade closing with 1929 the relative output of furnace and nonfurnace byproduct plants was rather constant, averaging 76 percent for furnace and 24 percent for nonfurnace plants. Beginning with 1930 the nonfurnace plants contributed a larger and larger proportion of the total production, and by 1932 they made 46.2 percent of the total. The failure of furnace plants to maintain their relative position reflects the decline in pig-iron output, whereas the nonfurnace plants suffered less because of the greater stability of the nonmetallurgical coke markets. With the increased output of pig iron in 1933 the ratios changed, and the furnace plants accounted for 60.5 percent of the total. (See table 9 and fig. 40.)

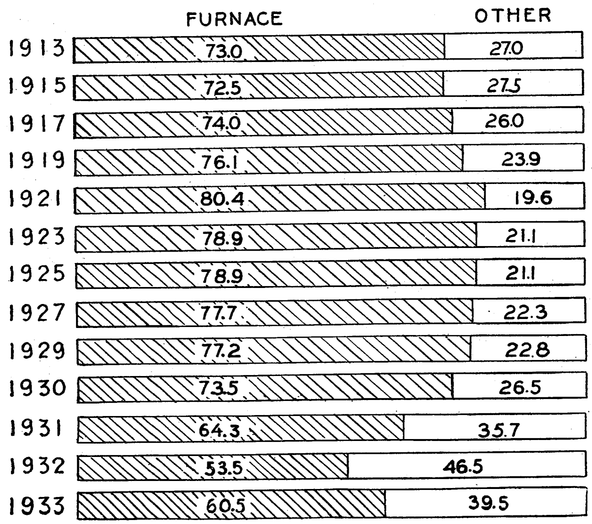


FIGURE 40.—Output of byproduct coke by furnace plants and by all other plants, 1913–33. Figures in bars represent percentage of the total produced during year.

*Production by States.*—The States showing the greatest increases in 1933 were naturally the important pig-iron-producing States—Alabama, Indiana, Ohio, and Pennsylvania.

*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 27,738,027 tons in 1933 compared with 22,176,708 tons in 1932 and 58,352,535 tons in 1929. Disposition of sales of coke, by uses, is shown in table 1.

*Stocks of coke.*—Stocks of coke declined markedly in 1933. Byproduct coke stocks on hand at producers' plants amounted to 3,498,262 tons on January 1 and 2,819,878 tons on December 31, a decrease of 19.4 percent. (See table 32 and fig. 43.)

*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 percent to 16.2, with an average of 14.8 percent for the period 1923 to 1930. In 1933 the proportion fell slightly below the normal for coke making. Coke ovens consumed 40,089,100 tons (only 12.2 percent) of the total output of bituminous coal. Of this quantity 38,680,900 tons were used in byproduct ovens. West Virginia heads the list of States in the supply of byproduct coking coal with 42.1 percent of the total; Pennsylvania (37.6 percent), Kentucky (10.9 percent), and Alabama (6.3 percent) follow in the order shown. (See tables 22 and 23.)

The average cost per net ton of coal charged into byproduct-coke ovens declined from $3.55 in 1932 to $3.38 in 1933.

*Coke-oven byproducts.*—This discussion is confined to the products of coal obtained in the high-temperature byproduct ovens. The production of byproducts reflected an adjustment in operations due to changing market for the several products. The recovery of gas, tar, ammonium sulphate or equivalent, and crude light oil per ton of coal charged in byproduct ovens in 1933 declined compared with 1932. (See table 2 and fig. 45.) However, the total production of these byproducts increased in 1933 over 1932, particularly that of coke-oven gas. (See fig. 46.) In value the byproducts represent a total almost equal to that of byproduct coke itself; in 1933 their combined value per ton of coke produced was $3.55 compared with $4.51 for the coke. In 1913 the value of byproducts was only 27 percent of the total gross value of all products per ton of coke produced. In 1933 their value had risen to 44 percent. (See table 2 and fig. 44.)

The average gross value of the byproducts per ton of coke produced decreased from $4.18 in 1932 to $3.55 in 1933; however, this decrease was due largely to the decrease in the average realization for gas from $2.60 to $2.10 per ton of coke produced. The average realization for ammonium sulphate fell to the extremely low level of 27 cents per ton of coke produced. The continued decline in the receipts for ammonium sulphate reflects the depressed condition of agriculture. According to the National Fertilizer Association the consumption of all fertilizers in 1933 declined approximately 40 percent from that in 1930.

*Prices of byproducts.*—The price of ammonium sulphate with few exceptions has declined each year over a long period. As quoted by Steel[1] this decline was arrested, the average for 1933 being $1.17 per 100 pounds, f.o.b. producers' works, compared with $1.12 in 1932. The price was $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 production of synthetic nitrogen.

The prices of coal-tar products have remained more stable than those of ammonia. According to Steel[2] the averages for benzol (90 per-

[1] Steel, vol. 94, 1934.
[2] See footnote 1.

cent) increased slightly over 1932. The average was 21.6 cents per gallon as against 20 cents in 1932 and 19.5 cents in 1931. Solvent naphtha held the quotation of 26 cents per gallon throughout the year compared with 26 cents in 1932 and 27.5 cents in 1930. Toluol remained at 30 cents throughout the year, the same as in 1932, 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 1933 rose to 6 cents.

## COKE AND COKE BREEZE

### MONTHLY AND WEEKLY PRODUCTION

TABLE 4.—*Byproduct, beehive, and total coke produced in the United States, 1930–33 by months, and average per day, in net tons*

| Month | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Total | Daily average | Total | Daily average | Total | Daily average | Total | Daily average |
| Byproduct: | | | | | | | | |
| January | 4,167,100 | 134,400 | 3,082,700 | 99,400 | 2,097,200 | 67,600 | 1,782,700 | 57,500 |
| February | 3,977,200 | 142,100 | 2,889,000 | 103,200 | 1,992,300 | 68,700 | 1,636,600 | 58,500 |
| March | 4,361,400 | 140,700 | 3,246,300 | 104,700 | 2,085,100 | 67,200 | 1,663,000 | 53,600 |
| April | 4,216,800 | 140,600 | 3,136,900 | 104,600 | 1,881,200 | 62,800 | 1,651,900 | 55,100 |
| May | 4,234,800 | 136,600 | 3,116,000 | 100,500 | 1,740,200 | 56,100 | 1,914,900 | 61,700 |
| June | 3,927,500 | 130,900 | 2,706,900 | 90,200 | 1,535,100 | 51,200 | 2,236,600 | 74,600 |
| July | 3,746,700 | 120,900 | 2,560,900 | 82,600 | 1,521,000 | 49,000 | 2,793,200 | 90,100 |
| August | 3,611,100 | 116,500 | 2,435,400 | 78,600 | 1,472,300 | 47,500 | 2,920,200 | 94,200 |
| September | 3,376,100 | 112,600 | 2,303,100 | 76,800 | 1,542,400 | 51,400 | 2,707,900 | 90,300 |
| October | 3,407,800 | 109,900 | 2,381,800 | 76,800 | 1,736,100 | 56,000 | 2,579,000 | 83,200 |
| November | 3,114,000 | 103,800 | 2,269,400 | 75,600 | 1,749,000 | 58,300 | 2,341,100 | 78,000 |
| December | 3,055,200 | 98,600 | 2,227,200 | 71,800 | 1,784,900 | 57,600 | 2,451,000 | 79,000 |
| | 45,195,700 | 123,900 | 32,355,600 | 88,600 | 21,136,800 | 57,800 | 26,678,100 | 73,100 |
| Beehive: | | | | | | | | |
| January | 318,000 | 11,800 | 144,400 | 5,300 | 73,700 | 2,800 | 86,700 | 3,300 |
| February | 279,000 | 11,600 | 144,300 | 6,000 | 72,300 | 2,900 | 89,100 | 3,700 |
| March | 288,700 | 11,100 | 132,100 | 5,100 | 73,500 | 2,700 | 98,700 | 3,700 |
| April | 299,600 | 11,500 | 96,200 | 3,700 | 47,400 | 1,800 | 49,800 | 2,000 |
| May | 270,100 | 10,000 | 83,200 | 3,200 | 38,400 | 1,500 | 50,200 | 1,900 |
| June | 259,800 | 10,400 | 77,300 | 3,000 | 34,800 | 1,300 | 53,100 | 2,000 |
| July | 213,100 | 8,200 | 67,200 | 2,600 | 32,800 | 1,300 | 72,700 | 2,900 |
| August | 168,300 | 6,500 | 61,600 | 2,400 | 34,800 | 1,300 | 74,600 | 2,800 |
| September | 166,900 | 6,400 | 68,900 | 2,700 | 39,400 | 1,500 | 62,800 | 2,400 |
| October | 176,600 | 6,600 | 93,400 | 3,500 | 57,000 | 2,200 | 47,200 | 1,800 |
| November | 166,300 | 6,700 | 87,100 | 3,500 | 68,400 | 2,600 | 97,800 | 3,800 |
| December | 169,900 | 6,500 | 72,600 | 2,800 | 79,400 | 3,100 | 94,500 | 3,800 |
| | 2,776,300 | 8,900 | 1,128,300 | 3,600 | 651,900 | 2,100 | 877,200 | 2,800 |
| Total coke: | | | | | | | | |
| January | 4,485,100 | 146,200 | 3,227,100 | 104,700 | 2,170,900 | 70,400 | 1,869,400 | 60,800 |
| February | 4,256,200 | 153,700 | 3,033,300 | 109,200 | 2,064,600 | 71,600 | 1,725,700 | 62,200 |
| March | 4,650,100 | 151,800 | 3,378,400 | 109,800 | 2,158,600 | 69,900 | 1,761,700 | 57,300 |
| April | 4,516,400 | 152,100 | 3,233,100 | 108,300 | 1,928,600 | 64,600 | 1,701,700 | 57,100 |
| May | 4,504,900 | 146,600 | 3,199,200 | 103,700 | 1,778,600 | 57,600 | 1,965,100 | 63,600 |
| June | 4,187,300 | 141,300 | 2,784,200 | 93,200 | 1,569,900 | 52,500 | 2,289,700 | 76,600 |
| July | 3,959,800 | 129,100 | 2,628,100 | 85,200 | 1,553,800 | 50,300 | 2,865,900 | 93,000 |
| August | 3,779,400 | 123,000 | 2,497,000 | 81,000 | 1,507,100 | 48,800 | 2,994,800 | 97,000 |
| September | 3,543,000 | 119,000 | 2,372,000 | 79,500 | 1,581,800 | 52,900 | 2,770,700 | 92,700 |
| October | 3,584,400 | 116,500 | 2,475,200 | 80,300 | 1,793,100 | 58,200 | 2,626,200 | 85,000 |
| November | 3,280,300 | 110,500 | 2,356,500 | 79,100 | 1,817,400 | 60,900 | 2,438,900 | 81,800 |
| December | 3,225,100 | 105,100 | 2,299,800 | 74,600 | 1,864,300 | 60,700 | 2,545,500 | 82,800 |
| | 47,972,000 | 132,800 | 33,483,900 | 92,200 | 21,788,700 | 59,900 | 27,555,300 | 75,900 |

TABLE 5.—*Coke shipped from the Connellsville and Lower Connellsville districts, Pennsylvania, 1928, 1929, and 1931–33, by months, in net tons*[1]

| Month | 1928 | 1929 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| January | 221,200 | 292,842 | 88,110 | 43,600 | 46,900 |
| February | 222,550 | 270,314 | 84,620 | 38,300 | 47,600 |
| March | 299,400 | 338,624 | 70,820 | 33,600 | 51,300 |
| April | 261,000 | 324,140 | 41,773 | 19,900 | 29,800 |
| May | 218,060 | 457,792 | 35,937 | 15,200 | 27,200 |
| June | 185,570 | 440,028 | 33,760 | 10,500 | 32,300 |
| July | 130,380 | 450,395 | 33,487 | 10,800 | 39,800 |
| August | 137,560 | 419,595 | 32,056 | 13,400 | 30,200 |
| September | 145,660 | 337,974 | 32,227 | 14,900 | 14,800 |
| October | 260,470 | 281,206 | 43,870 | 26,100 | 8,900 |
| November | 269,010 | 207,520 | 44,413 | 35,600 | 51,400 |
| December | 254,090 | 160,330 | 35,890 | 41,100 | 56,200 |
| | 2,604,950 | 3,980,760 | [2] 576,963 | 303,000 | 436,400 |

[1] From the Connellsville Courier. Since 1928 the weekly shipments as reported by the Courier have been prorated on a monthly basis by the Bureau of Mines.
[2] Total revised to 573,730. The Daily Courier, Jan. 12, 1933.

TABLE 6.—*Beehive coke produced in the United States in 1933, by weeks*

[Estimated from railroad shipments]

| Week ended— | Net tons | Week ended— | Net tons | Week ended— | Net tons |
|---|---|---|---|---|---|
| Jan. 7 | 19,100 | May 13 | 11,800 | Sept. 16 | 17,900 |
| Jan. 14 | 22,500 | May 20 | 11,000 | Sept. 23 | 10,500 |
| Jan. 21 | 17,800 | May 27 | 9,500 | Sept. 30 | 7,900 |
| Jan. 28 | 20,600 | June 3 | 11,400 | Oct. 7 | 7,200 |
| Feb. 4 | 18,600 | June 10 | 11,200 | Oct. 14 | 8,300 |
| Feb. 11 | 20,400 | June 17 | 13,100 | Oct. 21 | 11,200 |
| Feb. 18 | 25,500 | June 24 | 11,300 | Oct. 28 | 13,900 |
| Feb. 25 | 23,500 | July 1 | 13,900 | Nov. 4 | 20,700 |
| Mar. 4 | 23,000 | July 8 | 14,000 | Nov. 11 | 20,200 |
| Mar. 11 | 20,800 | July 15 | 15,800 | Nov. 18 | 22,900 |
| Mar. 18 | 22,200 | July 22 | 18,900 | Nov. 25 | 25,100 |
| Mar. 25 | 21,500 | July 29 | 17,500 | Dec. 2 | 24,200 |
| Apr. 1 | 22,600 | Aug. 5 | 14,300 | Dec. 9 | 21,400 |
| Apr. 8 | 12,700 | Aug. 12 | 14,000 | Dec. 16 | 22,400 |
| Apr. 15 | 10,300 | Aug. 19 | 18,800 | Dec. 23 | 22,200 |
| Apr. 22 | 12,200 | Aug. 26 | 18,000 | Dec. 30 | 20,600 |
| Apr. 29 | 10,700 | Sept. 2 | 20,100 | | |
| May 6 | 12,100 | Sept. 9 | 19,900 | Total | 877,200 |

TABLE 7.—*Byproduct coke produced in the United States in 1933, by months and by States, in net tons*

[Based on reports from all producers]

| State | January | February | March | April | May | June | July |
|---|---|---|---|---|---|---|---|
| Alabama | 89,000 | 89,200 | 91,000 | 95,000 | 99,500 | 108,400 | 187,200 |
| Colorado | 1,100 | 10,200 | 11,800 | 14,900 | 6,000 | 1,000 | 2,200 |
| Illinois | 136,700 | 123,200 | 130,200 | 116,800 | 118,800 | 111,500 | 112,000 |
| Indiana | 106,600 | 97,000 | 93,300 | 90,500 | 135,800 | 190,100 | 273,500 |
| Maryland | 42,300 | 39,400 | 44,700 | 43,800 | 47,800 | 62,700 | 84,100 |
| Massachusetts | 82,800 | 71,600 | 76,100 | 80,500 | 94,300 | 85,700 | 79,500 |
| Michigan | 207,100 | 170,300 | 177,900 | 169,300 | 179,000 | 194,000 | 210,200 |
| Minnesota | 33,400 | 33,600 | 35,800 | 34,400 | 35,700 | 30,400 | 29,500 |
| New Jersey | 69,700 | 63,800 | 69,500 | 68,200 | 67,900 | 66,100 | 68,000 |
| New York | 287,700 | 256,900 | 259,000 | 220,400 | 234,700 | 232,100 | 291,000 |
| Ohio | 211,600 | 211,600 | 186,000 | 213,400 | 291,500 | 359,300 | 437,700 |
| Pennsylvania | 320,700 | 297,800 | 309,400 | 323,300 | 391,500 | 578,600 | 773,000 |
| Tennessee | 6,300 | 5,700 | 5,500 | 5,900 | 5,900 | 5,800 | 6,100 |
| Utah | 6,700 | 6,500 | 4,900 | 4,200 | 4,500 | 5,000 | 5,600 |
| Washington | 2,700 | 2,400 | 2,300 | 2,700 | 2,800 | 2,900 | 2,700 |
| West Virginia | 71,700 | 64,100 | 62,000 | 68,300 | 95,800 | 102,600 | 125,000 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 106,600 | 93,300 | 103,600 | 100,300 | 103,400 | 100,400 | 105,900 |
| Total | 1,782,700 | 1,636,600 | 1,663,000 | 1,651,900 | 1,914,900 | 2,236,600 | 2,793,200 |
| At merchant plants | 885,900 | 791,500 | 837,800 | 798,600 | 832,500 | 810,100 | 835,900 |
| At furnace plants | 896,800 | 845,100 | 825,200 | 853,300 | 1,082,400 | 1,426,500 | 1,957,300 |

TABLE 7.—*Byproduct coke produced in the United States in 1933, by months and by States, in net tons*—Continued

| State | August | September | October | November | December | Total |
|---|---|---|---|---|---|---|
| Alabama | 193, 600 | 187, 600 | 164, 700 | 148, 200 | 215, 600 | 1, 669, 000 |
| Colorado | 19, 500 | 20, 800 | 20, 400 | 17, 100 | 14, 700 | 139, 700 |
| Illinois | 116, 600 | 118, 200 | 135, 500 | 138, 300 | 143, 200 | 1, 501, 000 |
| Indiana | 279, 200 | 238, 200 | 246, 900 | 177, 700 | 160, 300 | 2, 089, 100 |
| Maryland | 90, 200 | 80, 900 | 57, 300 | 50, 100 | 58, 900 | 702, 200 |
| Massachusetts | 76, 500 | 89, 600 | 95, 900 | 95, 100 | 92, 700 | 1, 020, 300 |
| Michigan | 213, 700 | 195, 100 | 218, 900 | 206, 700 | 198, 900 | 2, 341, 100 |
| Minnesota | 33, 300 | 34, 400 | 37, 000 | 36, 600 | 37, 900 | 412, 000 |
| New Jersey | 71, 300 | 70, 000 | 74, 800 | 71, 600 | 74, 200 | 835, 100 |
| New York | 322, 200 | 328, 200 | 333, 300 | 332, 600 | 328, 400 | 3, 426, 500 |
| Ohio | 450, 100 | 378, 800 | 353, 000 | 270, 400 | 313, 300 | 3, 676, 700 |
| Pennsylvania | 779, 000 | 702, 200 | 594, 300 | 535, 900 | 564, 500 | 6, 170, 200 |
| Tennessee | 6, 100 | 6, 000 | 6, 100 | 5, 900 | 6, 200 | 71, 500 |
| Utah | 5, 300 | 5, 700 | 6, 100 | 5, 800 | 6, 600 | 66, 900 |
| Washington | 2, 900 | 2, 800 | 2, 600 | 2, 600 | 2, 400 | 31, 800 |
| West Virginia | 116, 400 | 100, 100 | 77, 100 | 95, 600 | 95, 300 | 1, 074, 000 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 144, 300 | 149, 300 | 155, 100 | 150, 900 | 137, 900 | 1, 451, 000 |
| Total | 2, 920, 200 | 2, 707, 900 | 2, 579, 000 | 2, 341, 100 | 2, 451, 000 | 26, 678, 100 |
| At merchant plants | 901, 900 | 931, 400 | 987, 500 | 963, 300 | 957, 600 | 10, 534, 000 |
| At furnace plants | 2, 018, 300 | 1, 776, 500 | 1, 591, 500 | 1, 377, 800 | 1, 493, 400 | 16, 144, 100 |

TABLE 8.—*Beehive coke produced in the United States in 1933, by months and by States, in net tons*

[Based on railroad shipments]

| State | January | February | March | April | May | June | July |
|---|---|---|---|---|---|---|---|
| Colorado | 2, 500 | 2, 800 | 2, 400 | 1, 800 | 1, 700 | 1, 600 | 2, 300 |
| Pennsylvania | 73, 100 | 76, 100 | 85, 300 | 40, 400 | 36, 700 | 38, 900 | 55, 300 |
| Tennessee | 1, 000 | 200 | 500 | 100 | 500 | 1, 500 | 700 |
| Utah | 600 | 300 | 400 | 400 | 500 | 300 | 200 |
| Virginia | 3, 600 | 5, 400 | 4, 900 | 3, 100 | 5, 800 | 5, 300 | 7, 000 |
| Washington [1] | 100 | | | 100 | | | 100 |
| West Virginia | 5, 800 | 4, 300 | 5, 200 | 3, 900 | 5, 000 | 5, 500 | 7, 100 |
| Total | 86, 700 | 89, 100 | 98, 700 | 49, 800 | 50, 200 | 53, 100 | 72, 700 |

| State | August | September | October | November | December | Total |
|---|---|---|---|---|---|---|
| Colorado | 2, 900 | 4, 800 | 4, 800 | 4, 000 | 3, 600 | 35, 200 |
| Pennsylvania | 52, 500 | 38, 200 | 23, 900 | 75, 100 | 74, 700 | 670, 200 |
| Tennessee | 1, 600 | 1, 800 | 1, 000 | 700 | 1, 700 | 11, 300 |
| Utah | 1, 100 | 1, 400 | 2, 200 | 1, 600 | 1, 100 | 10, 100 |
| Virginia | 7, 100 | 7, 200 | 6, 500 | 6, 600 | 8, 000 | 70, 500 |
| Washington [1] | | | 100 | | | 400 |
| West Virginia | 9, 400 | 9, 400 | 8, 700 | 9, 800 | 5, 400 | 79, 500 |
| Total | 74, 600 | 62, 800 | 47, 200 | 97, 800 | 94, 500 | 877, 200 |

[1] Distribution by months partly estimated.

## PRODUCTION BY FURNACE AND NONFURNACE PLANTS

TABLE 9.—*Number and production of byproduct coke plants connected with iron furnaces and of other byproduct plants, 1913, 1918, and 1931–33*

| Year | Number of active plants | | Coke produced (net tons) | | Percent of production | |
|---|---|---|---|---|---|---|
| | Furnace plants | Other plants | Furnace plants | Other plants | Furnace plants | Other plants |
| 1913 | 20 | 16 | 9, 277, 832 | 3, 436, 868 | 73. 0 | 27. 0 |
| 1918 | 36 | 24 | 19, 220, 342 | 6, 777, 238 | 73. 9 | 26. 1 |
| 1931 | 46 | 42 | 20, 817. 240 | 11, 538, 309 | 64. 3 | 35. 7 |
| 1932 | 44 | 44 | 11, 374, 371 | 9, 762, 471 | 53. 8 | 46. 2 |
| 1933 | 42 | 43 | 16, 144, 168 | 10, 533, 968 | 60. 5 | 39. 5 |

TABLE 10.—*Monthly and average daily production of byproduct coke by plants associated with iron furnaces and by all other plants, 1931–33, in net tons*

| Month | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Furnace plants | Other plants | Furnace plants | Other plants | Furnace plants | Other plants |
| Monthly production: | | | | | | |
| January | 2,052,400 | 1,030,300 | 1,210,000 | 887,200 | 896,800 | 885,900 |
| February | 1,956,300 | 932,700 | 1,185,100 | 807,200 | 845,100 | 791,500 |
| March | 2,234,700 | 1,011,600 | 1,253,700 | 831,400 | 825,200 | 837,800 |
| April | 2,188,200 | 948,700 | 1,090,700 | 790,500 | 853,300 | 798,600 |
| May | 2,158,300 | 957,700 | 952,700 | 787,500 | 1,082,400 | 832,500 |
| June | 1,776,100 | 930,800 | 786,100 | 749,000 | 1,426,500 | 810,100 |
| July | 1,615,500 | 945,400 | 751,300 | 769,700 | 1,957,300 | 835,900 |
| August | 1,445,800 | 989,600 | 707,700 | 764,600 | 2,018,300 | 901,900 |
| September | 1,369,800 | 933,300 | 764,800 | 777,600 | 1,776,500 | 931,400 |
| October | 1,393,300 | 988,500 | 877,000 | 859,100 | 1,591,500 | 987,500 |
| November | 1,338,700 | 930,700 | 903,500 | 845,500 | 1,377,800 | 963,300 |
| December | 1,288,200 | 939,000 | 891,700 | 893,200 | 1,493,400 | 957,600 |
| | 20,817,300 | 11,538,300 | 11,374,300 | 9,762,500 | 16,144,100 | 10,534,000 |
| Average daily production: | | | | | | |
| January | 66,200 | 33,200 | 39,000 | 28,600 | 28,900 | 28,600 |
| February | 69,900 | 33,300 | 40,900 | 27,800 | 30,200 | 28,300 |
| March | 72,100 | 32,600 | 40,400 | 26,800 | 26,600 | 27,000 |
| April | 72,900 | 31,600 | 36,400 | 26,400 | 28,500 | 26,600 |
| May | 69,600 | 30,900 | 30,700 | 25,400 | 34,900 | 26,800 |
| June | 59,200 | 31,000 | 26,200 | 25,000 | 47,600 | 27,000 |
| July | 52,100 | 30,500 | 24,200 | 24,800 | 63,100 | 27,000 |
| August | 46,600 | 31,900 | 22,800 | 24,700 | 65,100 | 29,100 |
| September | 45,700 | 31,100 | 25,500 | 25,900 | 59,200 | 31,100 |
| October | 44,900 | 31,900 | 28,300 | 27,700 | 51,300 | 31,900 |
| November | 44,600 | 31,000 | 30,100 | 28,200 | 45,900 | 32,100 |
| December | 41,600 | 30,300 | 28,800 | 28,800 | 48,100 | 30,900 |
| Average | 57,000 | 31,600 | 31,100 | 26,700 | 44,200 | 28,900 |

## PRODUCTION BY STATES AND DISTRICTS

TABLE 11.—*Byproduct and beehive coke produced, by States, 1918 and 1930–33, in net tons*

| State | 1918 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Byproduct: | | | | | |
| Alabama | 2,634,451 | 3,986,920 | 2,943,143 | 1,400,597 | 1,668,975 |
| Colorado | 230,663 | 379,070 | 225,760 | 92,384 | 139,722 |
| Connecticut | | (1) | (1) | (1) | (1) |
| Illinois | 2,285,610 | 3,576,577 | 2,478,984 | 1,428,334 | 1,501,020 |
| Indiana | 3,898,215 | 4,984,620 | 2,757,135 | 1,435,405 | 2,089,100 |
| Kentucky | 517,749 | (1) | (1) | (1) | (1) |
| Maryland | 474,368 | 1,169,016 | 817,995 | 499,502 | 702,227 |
| Massachusetts | 556,397 | 862,663 | 1,150,270 | 987,106 | 1,020,255 |
| Michigan | (1) | 2,603,815 | 2,436,630 | 2,165,109 | 2,341,081 |
| Minnesota | 784,065 | 641,205 | 440,489 | 385,699 | 412,037 |
| Missouri | (1) | (1) | (1) | (1) | (1) |
| New Jersey | 682,148 | 918,814 | 930,912 | 805,720 | 835,125 |
| New York | 1,069,587 | 3,849,563 | 3,578,311 | 3,130,078 | 3,426,529 |
| Ohio | 5,226,334 | 6,163,324 | 3,932,939 | 2,346,686 | 3,676,727 |
| Pennsylvania | 4,586,981 | 12,529,255 | 7,524,722 | 4,037,810 | 6,170,240 |
| Rhode Island | | (1) | (1) | (1) | (1) |
| Tennessee | 124,469 | 100,439 | 83,439 | 72,529 | 71,484 |
| Utah | | 225,361 | 146,788 | 103,862 | 66,945 |
| Washington | 30,129 | 36,221 | 30,104 | 32,610 | 31,817 |
| West Virginia | 603,393 | 1,479,431 | 1,265,039 | 902,872 | 1,074,002 |
| Wisconsin | (1) | (1) | (1) | (1) | (1) |
| Combined States | 2,293,021 | 1,689,411 | 1,612,889 | 1,310,539 | 1,450,850 |
| | 25,997,580 | 45,195,705 | 32,355,549 | 21,136,842 | 26,678,136 |

[1] Included under "Combined States."

TABLE 11.—*Byproduct and beehive coke produced, by States, 1918 and 1930–33, in net tons*—Continued

| State | 1918 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Beehive: | | | | | |
| Alabama | 1,717,721 | | | | |
| Colorado | 758,784 | 79,373 | (1) | 23,560 | 35,161 |
| Georgia | 22,048 | | | | |
| Kentucky | 301,036 | | | | |
| New Mexico | 597,072 | | | | |
| Ohio | 138,909 | | | | |
| Oklahoma | (1) | | | | |
| Pennsylvania | 22,136,664 | 2,011,324 | 855,527 | 506,377 | 670,179 |
| Tennessee | 302,637 | 25,473 | 17,074 | 10,954 | 11,346 |
| Utah | (1) | 6,508 | (1) | 5,511 | 10,156 |
| Virginia | 1,234,256 | 219,656 | 99,305 | 56,143 | 70,493 |
| Washington | 93,659 | 12,252 | 582 | 736 | 379 |
| West Virginia | 2,716,613 | 421,730 | 113,627 | 48,607 | 79,528 |
| Combined States | 461,393 | | 42,222 | | |
| | 30,480,792 | 2,776,316 | 1,128,337 | 651,888 | 877,242 |
| Grand total | 56,478,372 | 47,972,021 | 33,483,886 | 21,788,730 | 27,555,378 |

[1] Included under "Combined States."

TABLE 12.—*Byproduct and beehive coke produced in Pennsylvania in 1933, by districts*

[Number of plants and ovens includes those idle during the year; no ovens were under construction in 1933]

| District | Plants | Ovens | Coal used (net tons) | Yield of coke from coal (percent) | Coke produced (net tons) | Value of coke at ovens | |
|---|---|---|---|---|---|---|---|
| | | | | | | Total | Per ton |
| Byproduct: | | | | | | | |
| Eastern Pennsylvania [1] | 6 | 864 | 1,917,597 | 69.38 | 1,330,405 | $7,088,804 | $5.33 |
| Western Pennsylvania [2] | 7 | 2,614 | 7,263,103 | 66.64 | 4,839,835 | 16,956,488 | 3.50 |
| | 13 | 3,478 | 9,180,700 | 67.21 | 6,170,240 | 24,045,292 | 3.90 |
| Beehive: | | | | | | | |
| Allegheny Mountain and Allegheny Valley | 3 | 434 | 39,804 | 58.98 | 23,477 | 75,222 | 3.20 |
| Connellsville | 21 | 4,541 | 191,044 | 66.12 | 126,313 | 318,376 | 2.52 |
| Lower Connellsville | 22 | 3,913 | 525,285 | 62.97 | 330,752 | 749,316 | 2.27 |
| Upper Connellsville | 6 | 874 | 216,702 | 64.57 | 139,933 | 369,341 | 2.64 |
| Pittsburgh [3] and other districts [4] | 7 | 1,626 | 79,656 | 62.40 | 49,704 | 173,692 | 3.49 |
| | 59 | 11,388 | 1,052,491 | 63.68 | 670,179 | 1,685,947 | 2.52 |
| Grand total | 72 | 14,866 | 10,233,191 | 66.85 | 6,840,419 | 25,731,239 | 3.76 |

[1] Includes plants at Bethlehem, Chester, Lebanon, Philadelphia, Steelton, and Swedeland.
[2] Includes plants at Aliquippa, Clairton, Erie, Johnstown, Midland, Neville Island, and Pittsburgh.
[3] There was no production in the Pittsburgh district during 1933.
[4] Includes Bedford, Huntingdon, and parts of Indiana and Westmoreland Counties.

TABLE 13.—*Byproduct coke produced in Ohio in 1933, by districts*

| District | Plants | Ovens | Coal used (net tons) | Yield of coke from coal (percent) | Coke produced (net tons) | Value of coke at ovens | |
|---|---|---|---|---|---|---|---|
| | | | | | | Total | Per ton |
| Canton, Cleveland, and Massillon | 5 | 595 | 1,335,401 | 69.22 | 924,413 | $3,095,284 | $3.35 |
| Youngstown | 3 | 594 | 1,099,910 | 68.24 | 750,569 | 3,412,386 | 4.55 |
| Other districts [1] | 7 | 645 | 2,792,823 | 71.67 | 2,001,745 | 8,032,631 | 4.01 |
| | 15 | 1,834 | 5,228,134 | 70.33 | 3,676,727 | 14,540,301 | 3.95 |

[1] Includes plants at Hamilton, Ironton, Lorain, Painesville, Portsmouth, Toledo, and Warren.

## NUMBER AND TYPE OF OVENS

TABLE 14.—*Coke ovens completed and abandoned in 1933 and total number in existence at end of year, by States*

| State | Plants in existence Dec. 31 | Ovens [1] | | |
|---|---|---|---|---|
| | | Abandoned during year | In existence Dec. 31 | |
| | | | Number | Capacity per day (net tons of coke) |
| Byproduct: | | | | |
| Alabama | 8 | | 1,248 | 13,995 |
| Colorado | 1 | | 151 | 2,233 |
| Connecticut | 1 | | 61 | (2) |
| Illinois | 8 | | 950 | 13,377 |
| Indiana | 6 | | 1,550 | 21,746 |
| Kentucky | 1 | | 108 | (2) |
| Maryland | 1 | | 361 | 5,088 |
| Massachusetts | 3 | | 430 | 4,488 |
| Michigan | 9 | | 674 | 7,882 |
| Minnesota | 3 | | 196 | 2,597 |
| Missouri | 1 | | 64 | (2) |
| New Jersey | 2 | | 202 | 2,490 |
| New York | 9 | | 1,024 | 14,896 |
| Ohio | 15 | | 1,834 | 25,398 |
| Pennsylvania | 13 | | 3,478 | 46,311 |
| Rhode Island | 1 | | 65 | (2) |
| Tennessee | 1 | | 24 | 360 |
| Utah | 1 | | 56 | 1,015 |
| Washington | 1 | | 20 | 101 |
| West Virginia | 4 | | 362 | 4,996 |
| Wisconsin | 2 | | 195 | (2) |
| Undistributed | | | | 5,768 |
| Total byproduct | 91 | | [3] 13,053 | [3] 172,741 |
| At merchant plants | 44 | | 3,607 | 43,069 |
| At furnace plants | 47 | | 9,446 | 129,672 |
| Beehive: | | | | |
| Colorado | 2 | | 378 | (4) |
| Oklahoma | 1 | | 100 | (4) |
| Pennsylvania | 59 | 2,675 | 11,388 | (4) |
| Tennessee | 3 | | 430 | (4) |
| Utah | 1 | | 819 | (4) |
| Virginia | 8 | | 1,599 | (4) |
| Washington | 1 | | 80 | (4) |
| West Virginia | 14 | 58 | 1,616 | (4) |
| Total beehive | 89 | 2,733 | 16,410 | (4) |

[1] No new ovens were put into operation during the year, and no new ovens were under construction at the end of 1933.
[2] Included under "Undistributed."
[3] Includes 220 ovens, with a capacity of 3,540 tons per day, completed but not put into operation.
[4] Data not available.

TABLE 15.—*Byproduct ovens of each type at end of 1933, by States*

| State | Koppers | Semet-Solvay | Wilputte | United Otto [1] | Cambria-Belgian | Roberts [2] | American Foundation | Klönne | All others [3] | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 768 | 420 | 60 | | | | | | | 1,248 |
| Colorado | 151 | | | | | | | | | 151 |
| Connecticut | 61 | | | | | | | | | 61 |
| Illinois | 662 | 120 | 88 | | | 80 | | | | 950 |
| Indiana | 1,269 | 161 | 120 | | | | | | | 1,550 |
| Kentucky | | 108 | | | | | | | | 108 |
| Maryland | 361 | | | | | | | | | 361 |
| Massachusetts | 175 | | 55 | 200 | | | | | | 430 |
| Michigan | 131 | 336 | 120 | | | | | | 87 | 674 |
| Minnesota | 196 | | | | | | | | | 196 |
| Missouri | 56 | | | | | | | | 8 | 64 |
| New Jersey | 202 | | | | | | | | | 202 |
| New York | 743 | 226 | | | | | 55 | | | 1,024 |
| Ohio | 1,541 | 293 | | | | | | | | 1,834 |
| Pennsylvania | 3,018 | 218 | 97 | | 120 | 25 | | | | 3,478 |
| Rhode Island | 65 | | | | | | | | | 65 |
| Tennessee | | 24 | | | | | | | | 24 |
| Utah | 56 | | | | | | | | | 56 |
| Washington | | | | | | | | 20 | | 20 |
| West Virginia | 316 | | 46 | | | | | | | 362 |
| Wisconsin | 115 | 80 | | | | | | | | 195 |
| Total | 9,886 | 1,986 | 586 | 200 | 120 | 105 | 55 | 20 | 95 | 13,053 |
| At merchant plants | 1,911 | 1,080 | 221 | 200 | | 25 | 55 | 20 | 95 | 3,607 |
| At furnace plants | 7,975 | 906 | 365 | | 120 | 80 | | | | 9,446 |

[1] Includes the Otto-Hoffman type.
[2] Includes the Robert-Morrissey type.
[3] Includes 8 Piette, 27 Parker-Russell, and 60 Improved Equipment Co. ovens.

## CAPACITY OF BYPRODUCT OVENS

TABLE 16.—*Estimated annual potential production of coke and coal required for charge of byproduct coke ovens in the United States, 1931–33, when operated at different percentages of maximum capacity, in millions of net tons*

| Percent of maximum capacity | Ovens completed Dec. 31 [1] | | | | | |
|---|---|---|---|---|---|---|
| | 1931 | | 1932 | | 1933 | |
| | Coke | Coal [2] | Coke | Coal [2] | Coke | Coal [2] |
| 100 | 63.5 | 90.7 | 62.8 | 89.7 | 63.1 | 90.1 |
| 90 | 57.2 | 81.6 | 56.5 | 80.7 | 56.8 | 81.1 |
| 85 | 54.0 | 77.1 | 53.4 | 76.2 | 53.6 | 76.6 |
| 75 | 47.6 | 68.0 | 47.1 | 67.3 | 47.3 | 67.6 |
| 50 | 31.8 | 45.4 | 31.4 | 44.9 | 31.6 | 45.1 |

[1] No ovens under construction at end of 1931, 1932, or 1933.
[2] Coal for charge estimated on basis of 70-percent yield in coke.

TABLE 17.—*Relation (percent) of production to maximum capacity at byproduct coke plants, 1928–33, by months*

| Month | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | Month | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 80.4 | 88.6 | 82.8 | 59.2 | 39.0 | 33.6 | August | 82.8 | 93.6 | 69.2 | 46.8 | 27.4 | 55.0 |
| February | 82.2 | 91.3 | 87.5 | 61.5 | 39.6 | 34.1 | September | 84.3 | 91.9 | 66.7 | 45.7 | 29.7 | 52.7 |
| March | 83.2 | 93.0 | 86.6 | 62.4 | 38.8 | 31.3 | October | 86.3 | 92.3 | 64.9 | 45.8 | 32.3 | 48.6 |
| April | 82.6 | 92.8 | 85.7 | 62.3 | 36.2 | 32.2 | November | 86.8 | 89.0 | 60.5 | 45.0 | 33.6 | 45.6 |
| May | 83.5 | 94.0 | 82.7 | 59.9 | 32.4 | 36.1 | December | 87.8 | 83.1 | 57.5 | 42.7 | 33.2 | 46.2 |
| June | 83.2 | 93.9 | 79.2 | 53.7 | 29.5 | 43.5 | | | | | | | |
| July | 81.0 | 93.0 | 72.3 | 49.2 | 28.3 | 52.6 | The year | 83.7 | 91.4 | 73.5 | 52.8 | 33.6 | 42.7 |

## QUANTITY AND COST OF COAL CHARGED

TABLE 18.—*Coal consumed in coke ovens, 1931–33, by months, in net tons*

[For figures, 1912–30, inclusive, see Coke and Byproducts in 1928, pp. 731–733, and Coke and Byproducts in 1930, p. 514]

| Month | 1931 | | | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Byproduct | Beehive | Total | Byproduct | Beehive | Total | Byproduct | Beehive | Total |
| January | 4, 457, 400 | 226, 500 | 4, 683, 900 | 3, 065, 300 | 116, 400 | 3, 181, 700 | 2, 580, 000 | 139, 100 | 2, 719, 100 |
| February | 4, 179, 700 | 226, 200 | 4, 405, 900 | 2, 913, 500 | 114, 100 | 3, 027, 600 | 2, 370, 700 | 142, 700 | 2, 513, 400 |
| March | 4, 692, 700 | 207, 000 | 4, 899, 700 | 3, 052, 500 | 116, 100 | 3, 168, 600 | 2, 407, 800 | 158, 400 | 2, 566, 200 |
| April | 4, 529, 400 | 150, 500 | 4, 679, 900 | 2, 749, 700 | 74, 900 | 2, 824, 600 | 2, 395, 000 | 79, 800 | 2, 474, 800 |
| May | 4, 496, 600 | 130, 100 | 4, 626, 700 | 2, 542, 700 | 60, 700 | 2, 603, 400 | 2, 780, 100 | 80, 300 | 2, 860, 400 |
| June | 3, 904, 800 | 120, 900 | 4, 025, 700 | 2, 241, 500 | 55, 000 | 2, 296, 500 | 3, 250, 400 | 85, 000 | 3, 335, 400 |
| July | 3, 688, 500 | 105, 200 | 3, 793, 700 | 2, 219, 300 | 51, 800 | 2, 271, 100 | 4, 057, 100 | 116, 100 | 4, 173, 200 |
| August | 3, 536, 100 | 96, 200 | 3, 632, 300 | 2, 147, 200 | 55, 000 | 2, 202, 200 | 4, 234, 800 | 119, 900 | 4, 354, 700 |
| September | 3, 349, 900 | 107, 800 | 3, 457, 700 | 2, 254, 400 | 62, 200 | 2, 316, 600 | 3, 926, 400 | 101, 000 | 4, 027, 400 |
| October | 3, 468, 300 | 146, 300 | 3, 614, 600 | 2, 537, 800 | 90, 000 | 2, 627, 800 | 3, 734, 200 | 76, 400 | 3, 810, 600 |
| November | 3, 303, 900 | 136, 400 | 3, 440, 300 | 2, 556, 500 | 108, 000 | 2, 664, 500 | 3, 390, 600 | 157, 500 | 3, 548, 100 |
| December | 3, 239, 000 | 113, 700 | 3, 352, 700 | 2, 606, 800 | 125, 400 | 2, 732, 200 | 3, 553, 800 | 152, 000 | 3, 705, 800 |
| | 46, 846, 300 | 1, 766, 800 | 48, 613, 100 | 30, 887, 200 | 1, 029, 600 | 31, 916, 800 | 38, 680, 900 | 1, 408, 200 | 40, 089, 100 |

TABLE 19.—*Total quantity and value at ovens of coal used in manufacture of coke, by States, in 1933*

| State | Coal used (net tons) | Cost of coal | | Coal per ton of coke | |
|---|---|---|---|---|---|
| | | Total | Per ton of coal | Net tons | Cost |
| Byproduct plants: | | | | | |
| Alabama | 2, 420, 945 | $4, 380, 720 | $1. 81 | 1. 45 | $2. 62 |
| Colorado | 210, 791 | (1) | (1) | 1. 51 | |
| Illinois | 2, 242, 506 | 9, 004, 508 | 4. 02 | 1. 49 | 5. 99 |
| Indiana | 2, 945, 174 | 12, 338, 754 | 4. 19 | 1. 41 | 5. 91 |
| Maryland | 971, 981 | (1) | (1) | 1. 38 | |
| Massachusetts | 1, 483, 004 | 6, 436, 688 | 4. 34 | 1. 45 | 6. 29 |
| Michigan | 3, 345, 881 | 12, 277, 727 | 3. 67 | 1. 43 | 5. 25 |
| Minnesota | 604, 364 | 2, 833, 655 | 4. 69 | 1. 47 | 6. 89 |
| New Jersey | 1, 188, 665 | (1) | (1) | 1. 42 | |
| New York | 4, 961, 647 | 19, 844, 407 | 4. 00 | 1. 45 | 5. 80 |
| Ohio | 5, 228, 134 | 16, 225, 464 | 3. 10 | 1. 42 | 4. 40 |
| Pennsylvania | 9, 180, 700 | 26, 077, 185 | 2. 84 | 1. 49 | 4. 23 |
| Tennessee | 100, 816 | 294, 383 | 2. 92 | 1. 41 | 4. 12 |
| Utah | 124, 100 | (1) | (1) | 1. 85 | |
| Washington | 56, 818 | 256, 153 | 4. 51 | 1. 79 | 8. 07 |
| West Virginia | 1, 580, 429 | 2, 806, 914 | 1. 78 | 1. 47 | 2. 62 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 2, 034, 982 | 8, 221, 023 | 4. 04 | 1. 40 | 5. 66 |
| Undistributed | | 9, 893, 716 | 3. 96 | | |
| Total byproduct | 38, 680, 937 | 130, 891, 297 | 3. 38 | 1. 45 | 4. 90 |
| At merchant plants | 15, 079, 953 | 59, 889, 453 | 3. 97 | 1. 43 | 5. 68 |
| At furnace plants | 23, 600, 984 | 71, 001, 844 | 3. 01 | 1. 46 | 4. 39 |
| Beehive plants: | | | | | |
| Colorado and Utah | 76, 394 | 184, 043 | 2. 41 | 1. 69 | 4. 07 |
| Pennsylvania | 1, 052, 491 | 1, 292, 347 | 1. 23 | 1. 57 | 1. 93 |
| Tennessee | 23, 591 | 18, 114 | . 77 | 2. 08 | 1. 60 |
| Virginia | 121, 077 | 163, 709 | 1. 35 | 1. 72 | 2. 32 |
| Washington | 622 | 2, 799 | 4. 50 | 1. 64 | 7. 38 |
| West Virginia | 134, 006 | 200, 604 | 1. 50 | 1. 69 | 2. 54 |
| Total beehive | 1, 408, 181 | 1, 861, 616 | 1. 32 | 1. 61 | 2. 13 |

[1] Included under "Undistributed."

TABLE 20.—*Average cost per net ton of coal charged into byproduct coke ovens, by States, 1929–33*

| State | 1929 | 1930 | 1931 | 1932 | 1933 | State | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | $2.49 | $2.39 | $2.19 | $1.95 | $1.81 | Pennsylvania | $2.73 | $2.69 | $2.77 | $2.86 | $2.84 |
| Illinois | 4.29 | 4.32 | 4.33 | 4.17 | 4.02 | Tennessee | 3.02 | 3.02 | 2.97 | 2.96 | 2.92 |
| Indiana | 4.61 | 4.52 | 4.42 | 4.25 | 4.19 | Washington | 5.26 | 5.21 | 5.12 | 4.61 | 4.51 |
| Massachusetts | 4.70 | 4.61 | 4.65 | 4.49 | 4.34 | West Virginia | 2.41 | 2.18 | 1.98 | 1.76 | 1.78 |
| Michigan | 4.29 | 3.96 | 4.22 | 3.92 | 3.67 | | | | | | |
| Minnesota | 5.04 | 4.97 | 5.19 | 5.14 | 4.69 | United States average | 3.50 | 3.48 | 3.55 | 3.55 | 3.38 |
| New York | 4.22 | 4.18 | 4.26 | 4.17 | 4.00 | Cost of coal per ton of | | | | | |
| Ohio | 3.31 | 3.48 | 3.40 | 3.20 | 3.10 | coke | 5.04 | 5.05 | 5.15 | 5.18 | 4.90 |

## PREPARATION AND SOURCE OF COAL CHARGED

TABLE 21.—*Washed and unwashed coal used in the manufacture of byproduct and beehive coke, by States in which used, in 1933, in net tons*

| State | Washed | Unwashed | Total |
|---|---|---|---|
| Byproduct ovens: | | | |
| Alabama | 2,420,914 | 31 | 2,420,945 |
| Colorado | 210,791 | | 210,791 |
| Illinois | 189,466 | 2,053,040 | 2,242,506 |
| Indiana | | 2,945,174 | 2,945,174 |
| Maryland | | 971,981 | 971,981 |
| Massachusetts | | 1,483,004 | 1,483,004 |
| Michigan | | 3,345,881 | 3,345,881 |
| Minnesota | | 604,364 | 604,364 |
| New Jersey | 23,000 | 1,165,665 | 1,188,665 |
| New York | 1,168,443 | 3,793,204 | 4,961,647 |
| Ohio | 360,951 | 4,867,183 | 5,228,134 |
| Pennsylvania | 3,801,303 | 5,379,397 | 9,180,700 |
| Tennessee | 100,816 | | 100,816 |
| Utah | | 124,100 | 124,100 |
| Washington | 56,818 | | 56,818 |
| West Virginia | | 1,580,429 | 1,580,429 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | | 2,034,982 | 2,034,982 |
| Total byproduct | 8,332,502 | 30,348,435 | 38,680,937 |
| At merchant plants | 1,304,756 | 13,775,197 | 15,079,953 |
| At furnace plants | 7,027,746 | 16,573,238 | 23,600,984 |
| Beehive ovens: | | | |
| Colorado | 54,478 | | 54,478 |
| Pennsylvania | 128,665 | 923,826 | 1,052,491 |
| Tennessee | 23,591 | | 23,591 |
| Utah | | 21,916 | 21,916 |
| Virginia | | 121,077 | 121,077 |
| Washington | 622 | | 622 |
| West Virginia | | 134,006 | 134,006 |
| Total beehive | 207,356 | 1,200,825 | 1,408,181 |

TABLE 22.—*Coal used in manufacture of byproduct coke in 1933, by fields of origin, in net tons*

[Based upon detailed reports from each coke plant. The difference between these totals and those shown in tables 3, 19, etc., is due to change in stock, loss of weight in handling, and the fact that these sometimes represent purchases during the year rather than actual consumption]

| State and district where coal was produced | Total used | States where coal was consumed—in order of importance |
|---|---|---|
| Alabama | 2,493,214 | Alabama. |
| Colorado: | | |
| Trinidad | 192,255 | Colorado. |
| Crested Butte and Walsen districts | 45,953 | Do. |
| Illinois: Southern | 318 | Illinois. |
| Kentucky: | | |
| Western Kentucky | 8,106 | Do. |
| Eastern Kentucky: | | |
| Elkhorn | 1,192,750 | Michigan, New York, Missouri, Illinois, Minnesota, Ohio, Pennsylvania, Indiana. |
| Harlan | 1,463,530 | Indiana, Illinois, Michigan, Minnesota, Ohio, Pennsylvania. |
| Kenova-Thacker [1] | 658,392 | Indiana, Wisconsin, Michigan, Pennsylvania. |
| Pond Creek | 1,017,186 | Michigan, Ohio, Connecticut. |
| Miscellaneous | 46,598 | New York. |
| Pennsylvania: | | |
| Central Pennsylvania, high volatile. | 221,763 | Do. |
| Central Pennsylvania, low volatile | 565,593 | Pennsylvania, New York. |
| Connellsville | 5,908,983 | Pennsylvania, Ohio, West Virginia, Illinois. |
| Freeport | 889,160 | West Virginia, New York, Ohio, Indiana. |
| Pittsburgh | 6,502,848 | Pennsylvania, New York, Ohio, Michigan, Minnesota, West Virginia, Illinois, Wisconsin, Indiana, New Jersey. |
| Somerset | 258,539 | Pennsylvania, Ohio, West Virginia. |
| Westmoreland | 673,156 | Maryland, Pennsylvania, New York. |
| Tennessee | 90,407 | Tennessee. |
| Utah: Carbon County | 124,100 | Utah. |
| Virginia: [2] Wise, Lee, and Dickenson Counties. | 598,849 | New York, New Jersey, Massachusetts. |
| Washington: Pierce County | 58,193 | Washington. |
| West Virginia: | | |
| Northern | 1,903,750 | Ohio, Pennsylvania, Maryland, New Jersey, Massachusetts. |
| Kanawha and Logan | 7,170,764 | Ohio, Massachusetts, Illinois, New York, Pennsylvania, Michigan, Wisconsin, Indiana, New Jersey, Connecticut, Rhode Island, West Virginia, Kentucky, Minnesota, Missouri. |
| New River and Winding Gulf | 1,854,301 | Massachusetts, New York, New Jersey, Illinois, Rhode Island, Connecticut, Ohio, Missouri, Minnesota, Pennsylvania. |
| Pocahontas [2] | 5,469,977 | Indiana, Ohio, Michigan, New York, Pennsylvania, Illinois, Maryland, Wisconsin, Minnesota, Connecticut, Kentucky, West Virginia, Tennessee, Alabama, Massachusetts. |
| Miscellaneous | 46,598 | New York. |
| | 39,455,283 | |

[1] Coal from the extension of the Thacker field in Mingo County, W.Va., is included under Kentucky (Thacker).

[2] Coal from the extension of the Pocahontas field in Tazewell County, Va., is included under West Virginia (Pocahontas).

TABLE 23.—*Source of coal used in the manufacture of byproduct coke in 1933, by States where consumed, separating merchant and furnace plants*

[Based upon detailed reports from each coke plant. The difference between these totals and those shown in tables 3, 19, etc., is due to change in stock, loss of weight in handling, and the fact that these sometimes represent purchases during the year rather than actual consumption]

| State where coal was used | Coal produced in— | | | | |
|---|---|---|---|---|---|
| | Alabama | Colorado | Illinois | Kentucky | Pennsylvania |
| Alabama: | | | | | |
| Merchant plants | 500,522 | | | | |
| Furnace plants | 1,992,692 | | | | |
| Total | 2,493,214 | | | | |
| Colorado: Furnace plants | | 238,208 | | | |
| Illinois: | | | | | |
| Merchant plants | | | | (1) | 161,572 |
| Furnace plants | | | 318 | 434,362 | 115,374 |
| Total | | | 318 | [2] 434,362 | 276,946 |
| Indiana: | | | | | |
| Furnace plants | | | | 1,223,551 | 33,029 |
| Total | | | | 1,223,551 | 33,029 |
| Maryland: Furnace plants | | | | | 304,425 |
| Michigan: | | | | | |
| Merchant plants | | | | 429,384 | 701,242 |
| Furnace plants | | | | 1,114,134 | |
| Total | | | | 1,543,518 | 701,242 |
| Minnesota: | | | | | |
| Merchant plants | | | | 85,500 | 151,171 |
| Furnace plants | | | | 83,925 | 41,692 |
| Total | | | | 169,425 | 192,863 |
| New Jersey: Merchant plants | | | | | 23,000 |
| New York: | | | | | |
| Merchant plants | | | | 232,034 | 1,586,915 |
| Furnace plants | | | | 143,547 | 953,411 |
| Total | | | | 375,581 | 2,540,326 |
| Ohio: | | | | | |
| Merchant plants | | | | (1) | |
| Furnace plants | | | | 206,645 | 2,156,036 |
| Total | | | | [2] 206,645 | 2,156,036 |
| Pennsylvania: | | | | | |
| Merchant plants | | | | | 117,621 |
| Furnace plants | | | | 69,014 | 7,331,860 |
| Total | | | | 69,014 | 7,449,481 |
| West Virginia: Furnace plants | | | | | 1,133,086 |
| Total | | | | | 1,133,086 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin: Merchant plants | | | | 221,508 | 27,525 |
| Undistributed: | | | | | |
| Merchant plants | | | | 64,202 | |
| Total | | | | 64,202 | |
| Grand total | 2,493,214 | 238,208 | 318 | 4,307,806 | 14,837,959 |
| Merchant plants | 500,522 | | | 1,032,628 | 2,769,046 |
| Furnace plants | 1,992,692 | 238,208 | 318 | 3,275,178 | 12,068,913 |

[1] Included under "Undistributed."
[2] Excludes items included under "Undistributed."

TABLE 23.—*Source of coal used in the manufacture of byproduct coke in 1933, by States where consumed, separating merchant and furnace plants*—Continued

| State where coal was used | Coal produced in— | | | | | Total |
|---|---|---|---|---|---|---|
| | Tennessee | Utah | Virginia | Washington | West Virginia | |
| Alabama: | | | | | | |
| Merchant plants | | | | | (1) | [2] 500,522 |
| Furnace plants | | | | | | 1,992,692 |
| Total | | | | | (1) | [2] 2,493,214 |
| Colorado: Furnace plants | | | | | | 238,208 |
| Illinois: | | | | | | |
| Merchant plants | | | | | 1,241,589 | [2] 1,403,161 |
| Furnace plants | | | | | 309,786 | 859,840 |
| Total | | | | | 1,551,375 | [2] 2,263,001 |
| Indiana: | | | | | | |
| Merchant plants | | | | | 559,896 | 559,896 |
| Furnace plants | | | | | 1,128,698 | 2,385,278 |
| Total | | | | | 1,688,594 | 2,945,174 |
| Maryland: Furnace plants | | | | | 667,556 | 971,981 |
| Massachusetts: Merchant plants | | | 39,703 | | 1,443,303 | 1,483,006 |
| Michigan: | | | | | | |
| Merchant plants | | | | | 930,265 | 2,060,891 |
| Furnace plants | | | | | (1) | [2] 1,114,134 |
| Total | | | | | [2] 930,265 | [2] 3,175,025 |
| Minnesota: | | | | | | |
| Merchant plants | | | | | 186,424 | 423,095 |
| Furnace plants | | | | | 55,652 | 181,269 |
| Total | | | | | 242,076 | 604,364 |
| New Jersey: Merchant plants | | | 245,023 | | 961,822 | 1,229,845 |
| New York: | | | | | | |
| Merchant plants | | | 314,123 | | 1,266,664 | 3,399,736 |
| Furnace plants | | | | | 464,962 | 1,561,920 |
| Total | | | 314,123 | | 1,731,626 | 4,961,656 |
| Ohio: | | | | | | |
| Merchant plants | | | 109,463 | | 545,612 | [2] 655,075 |
| Furnace plants | | | | | 2,189,282 | 4,551,963 |
| Total | | | 109,463 | | 2,734,894 | [2] 5,207,038 |
| Pennsylvania: | | | | | | |
| Merchant plants | | | | | 633,915 | 751,536 |
| Furnace plants | | | | | 1,104,487 | 8,505,361 |
| Total | | | | | 1,738,402 | 9,256,897 |
| Tennessee: Merchant plants | 90,407 | | | | 21,260 | 111,667 |
| Utah: Furnace plants | | 124,100 | | | | 124,100 |
| Washington: Merchant plants | | | | 58,193 | | 58,193 |
| West Virginia: | | | | | | |
| Merchant plants | | | | | 425,696 | 425,696 |
| Furnace plants | | | | | 25,185 | 1,158,271 |
| Total | | | | | 450,881 | 1,583,967 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin: Merchant plants | | | | | 1,897,784 | 2,146,817 |

[1] Included under "Undistributed."
[2] Excludes items included under "Undistributed."

TABLE 23.—*Source of coal used in the manufacture of byproduct coke in 1933 by States where consumed, separating merchant and furnace plants*—Continued

| State where coal was used | Coal produced in— | | | | | Total |
|---|---|---|---|---|---|---|
| | Tennessee | Utah | Virginia | Washington | West Virginia | |
| Undistributed: | | | | | | |
| Merchant plants | ---------- | ---------- | ---------- | ---------- | } 536,928 | 601,130 |
| Furnace plants | ---------- | ---------- | ---------- | ---------- | | |
| Total | ---------- | ---------- | ---------- | ---------- | 536,928 | 601,130 |
| Grand total | 90,407 | 124,100 | 708,312 | 58,193 | 16,596,766 | 39,455,283 |
| Merchant plants | 90,407 | ---------- | 708,312 | 58,193 | 10,122,265 | 15,281,373 |
| Furnace plants | ---------- | 124,100 | ---------- | ---------- | 6,474,501 | 24,173,910 |

## YIELD OF COKE PER TON OF COAL

TABLE 24.—*Percentage yield of coke from coal in byproduct and beehive ovens, by States, 1930–33*

| State | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Byproduct | Beehive | Byproduct | Beehive | Byproduct | Beehive | Byproduct | Beehive |
| Alabama | 70.93 | ---------- | 70.55 | ---------- | 69.14 | ---------- | 68.94 | ---------- |
| Colorado | 68.59 | 64.98 | 68.65 | (1) | 68.19 | 65.20 | 66.28 | 64.54 |
| Illinois | 69.52 | ---------- | 68.02 | ---------- | 66.05 | ---------- | 66.93 | ---------- |
| Indiana | 72.24 | ---------- | 70.89 | ---------- | 69.28 | ---------- | 70.93 | ---------- |
| Maryland | 71.77 | ---------- | 73.78 | ---------- | 73.22 | ---------- | 72.25 | ---------- |
| Massachusetts | 69.90 | ---------- | 71.73 | ---------- | 70.17 | ---------- | 68.80 | ---------- |
| Michigan | 70.55 | ---------- | 70.55 | ---------- | 70.03 | ---------- | 69.97 | ---------- |
| Minnesota | 68.38 | ---------- | 67.54 | ---------- | 67.73 | ---------- | 68.18 | ---------- |
| New Jersey | 71.95 | ---------- | 70.80 | ---------- | 69.21 | ---------- | 70.26 | ---------- |
| New York | 69.16 | ---------- | 69.67 | ---------- | 69.56 | ---------- | 69.06 | ---------- |
| Ohio | 67.71 | ---------- | 67.95 | ---------- | 68.26 | ---------- | 70.33 | ---------- |
| Pennsylvania | 66.73 | 66.63 | 66.88 | 65.31 | 66.03 | 65.11 | 67.21 | 63.68 |
| Tennessee | 72.94 | 53.66 | 72.38 | 50.33 | 71.75 | 49.08 | 70.91 | 48.09 |
| Utah | 54.39 | 58.66 | 54.33 | (1) | 54.53 | 42.08 | 53.94 | 46.34 |
| Virginia | ---------- | 60.86 | ---------- | 60.32 | ---------- | 58.80 | ---------- | 58.22 |
| Washington | 60.53 | 76.92 | 54.01 | 60.82 | 56.54 | 61.03 | 56.00 | 60.93 |
| West Virginia | 69.73 | 59.56 | 69.44 | 59.56 | 67.35 | 58.13 | 67.96 | 59.35 |
| United States average | 68.98 | 64.80 | 69.07 | 63.86 | 68.43 | 63.31 | 68.97 | 62.30 |

[1] Not at liberty to publish data.

## COKE BREEZE

TABLE 25.—*Coke breeze recovered at coke plants, by States, in 1933*

| State | Yield per ton of coal (percent) | Produced | | Used by producer: For steam raising | | Used by producer: For other purposes, including water gas | | Sold | | On hand Dec. 31 (net tons) | Wasted (net tons) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Net tons | Value | Net tons | Value | Net tons | Value | Net tons | Value | | |
| Byproduct ovens: | | | | | | | | | | | |
| Alabama | 4.71 | 113,906 | $117,583 | 75,569 | $79,238 | 5,647 | $8,422 | 24,770 | $22,416 | 22,573 | 9,270 |
| Colorado | 5.67 | 11,942 | (1) | 11,942 | (1) | | | | | | |
| Illinois | 8.68 | 194,738 | 437,810 | 140,435 | 343,754 | 32,338 | 52,988 | 45,821 | 106,402 | 45,284 | |
| Indiana | 6.32 | 186,261 | 466,620 | 123,531 | 287,985 | 35,324 | 82,685 | 29,995 | 99,787 | 8,931 | |
| Maryland | 5.99 | 58,208 | (1) | 15,204 | (1) | 11,012 | (1) | 24,935 | (1) | 20,674 | |
| Massachusetts | 7.89 | 116,995 | 215,813 | 3,772 | 12,367 | 5,101 | 15,302 | 107,961 | 187,422 | 1,425 | 200 |
| Michigan | 6.89 | 230,580 | 472,524 | 119,964 | 286,632 | 268 | 901 | 67,397 | 102,357 | 173,944 | |
| Minnesota | 7.85 | 47,453 | 109,198 | 38,380 | 83,957 | 645 | 1,901 | 21,124 | 56,217 | 7,876 | |
| New Jersey | 5.94 | 70,638 | (1) | 47,988 | (1) | | | 23,206 | (1) | 264 | |
| New York | 6.47 | 320,845 | 862,035 | 156,551 | 382,117 | 95,018 | 319,102 | 75,428 | 158,441 | 43,605 | |
| Ohio | 5.77 | 301,623 | 546,643 | 227,519 | 424,717 | 19,958 | 32,332 | 65,091 | 114,217 | 54,310 | 2,921 |
| Pennsylvania | 6.73 | 618,172 | 1,006,017 | 462,651 | 748,466 | 84,218 | 166,119 | 54,840 | 90,398 | 16,065 | |
| Tennessee | 2.81 | 2,836 | 4,793 | 5,114 | 7,671 | | | 908 | 2,497 | 693 | |
| Utah | 11.43 | 14,185 | (1) | 22,124 | (1) | 2,969 | (1) | 28,248 | (1) | 2,418 | |
| Washington | 9.00 | 5,111 | 19,984 | 5,016 | 19,635 | | | | | | |
| West Virginia | 4.83 | 76,380 | 69,497 | 72,688 | 66,728 | 4,761 | 4,428 | 11,003 | 8,252 | 15,735 | |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 8.03 | 163,508 | 404,031 | 111,598 | 275,025 | | | 44,803 | 112,185 | 24,998 | |
| Undistributed | | | 322,093 | | 167,689 | | 21,718 | | 170,899 | | |
| Total | 6.55 | 2,533,381 | 5,054,641 | 1,640,046 | 3,185,981 | 29 , 2 | 705,898 | 625,530 | 1,231,490 | 438,795 | 12,391 |
| At merchant plants | 7.22 | 1,088,158 | 2,540,004 | 607,118 | 1,486,218 | 117,372 | 344,821 | 377,865 | 759,215 | 257,407 | 2,775 |
| At furnace plants | 6.12 | 1,445,223 | 2,514,637 | 1,032,928 | 1,699,763 | 179,887 | 361,077 | 247,665 | 472,275 | 181,388 | 9,616 |
| Beehive ovens: | | | | | | | | | | | |
| Colorado | [2] 1.11 | 606 | (1) | | | | | 606 | (1) | | |
| Pennsylvania | [2] 6.56 | 41,562 | 66,010 | 713 | 713 | | | 25,022 | 39,535 | 1,022 | 13,228 |
| Tennessee | [2] 1.98 | 468 | 762 | | | | | | | | 468 |
| Utah | [2] 2.28 | 500 | (1) | | | | | 500 | (1) | | |
| Virginia | [2] 2.10 | 1,382 | 3,510 | 23 | 72 | 130 | 369 | 1,230 | 3,069 | 20 | |
| West Virginia | [2] 1.68 | 1,414 | 2,597 | | | | | 1,366 | 2,519 | | |
| Undistributed | | | 1,838 | | | | | | 1,838 | | |
| Total | [2] 5.20 | 45,932 | 74,717 | 736 | 785 | 130 | 369 | 28,724 | 46,961 | 1,042 | [3] 13,696 |

[1] Included under "Undistributed."
[2] Yield computed by dividing the production of the breeze at the few plants reporting by the quantity of coal charged at these plants.
[3] As reported; quantity produced but not used was undoubtedly greater. See Mineral Resources, 1922, pt. II, pp. 726–727.

## CONSUMPTION OF COKE

TABLE 26.—*Quantity of coke consumed in manufacture of pig iron and for other purposes, 1913, 1918, and 1931–33, in net tons*

| Year | Total production of coke | Imports | Exports | Net changes in stocks | Indicated United States consumption [1] | Consumed by iron furnaces [2] | | Remainder consumed in other ways | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Quantity | Percent | Quantity | Percent |
| 1913 | 46,299,530 | 101,212 | 987,395 | (3) | 45,413,347 | 37,192,287 | 81.9 | 8,221,060 | 18.1 |
| 1918 | 56,478,372 | 30,168 | 1,687,824 | (3) | 54,820,716 | 45,703,594 | 83.4 | 9,117,122 | 16.6 |
| 1931 | 33,483,886 | 103,563 | 754,302 | +1,127,825 | 31,705,322 | 18,352,522 | 57.9 | 13,352,800 | 42.1 |
| 1932 | 21,788,730 | 117,275 | 630,151 | −900,854 | 22,176,708 | 8,627,488 | 38.9 | 13,549,220 | 61.1 |
| 1933 | 27,555,378 | 160,873 | 637,819 | −659,595 | 27,738,027 | 13,024,556 | 47.0 | 14,713,471 | 53.0 |

[1] Production plus imports minus exports, plus or minus the decrease or increase, respectively, of the net changes in stocks.
[2] From Annual Report of American Iron and Steel Institute. Figures include coke consumed in the manufacture of ferro-alloys.
[3] Data not available.

TABLE 27.—*Pounds of coke and of coking coal consumed per gross ton of pig iron made in the United States, 1913, 1918, and 1931–33*

| Year | Pounds of coke per gross ton of pig iron and ferro-alloys [1] | Percent yield of coke from coal | Calculated pounds coking coal per gross ton of pig iron and ferro-alloys | Year | Pounds of coke per gross ton of pig iron and ferro-alloys [1] | Percent yield of coke from coal | Calculated pounds coking coal per gross ton of pig iron and ferro-alloys |
|---|---|---|---|---|---|---|---|
| 1913 | 2,433.3 | 66.9 | 3,637.2 | 1932 | 1,988.1 | 68.3 | 2,910.8 |
| 1918 | 2,375.2 | 66.4 | 3,577.1 | 1933 | 1,975.6 | 68.7 | 2,875.7 |
| 1931 | 2,015.1 | 68.9 | 2,923.2 | | | | |

[1] From Annual Statistical Report of American Iron and Steel Institute, 1933, p. 17. Beginning in 1926 the institute began to show the consumption per ton of pig iron only, excluding the furnaces making ferro-alloys. The results were 1,981.0 in 1931, 1,954.1 in 1932 and 1,935.7 in 1933.

## FURNACE, FOUNDRY, AND OTHER COKE

TABLE 28.—*Byproduct coke produced and sold or used by producer, by States, in 1933*

[Exclusive of screenings or breeze]

| State | Produced | | Used by producer in blast furnace, etc.[1] | | Sold | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Furnace [2] | | Foundry | | Domestic use | | Industrial and other use (including water gas) [4] | | Total | |
| | Net tons | Value | Net tons | Value | Net tons | Value | Net tons | Value | Net tons | Value | Net tons | Value | Net tons | Value |
| Alabama | 1,668,975 | $3,885,858 | 1,143,357 | $2,523,363 | 3,601 | $5,370 | 209,620 | $655,683 | 354,839 | $780,483 | 19,085 | $35,149 | 587,145 | $1,476,685 |
| Colorado | 139,722 | (3) | 120,706 | (3) | 2,609 | (3) | 21,445 | (3) | 211 | (3) | --- | --- | 24,265 | (3) |
| Illinois | 1,501,020 | 7,379,561 | 291,884 | 1,474,518 | --- | --- | 67,794 | 451,131 | 998,310 | 4,851,076 | 53,308 | 245,457 | 1,119,412 | 5,547,664 |
| Indiana | 2,089,100 | 12,031,285 | 1,719,706 | 10,264,795 | 2,768 | 18,186 | 69,654 | 446,304 | 341,017 | 1,509,674 | 20,525 | 91,634 | 433,964 | 2,065,798 |
| Maryland | 702,227 | (3) | 607,700 | (3) | --- | --- | --- | --- | 62 | (3) | 85,255 | (3) | 85,317 | (3) |
| Massachusetts | 1,020,255 | 5,935,219 | 67,263 | 370,602 | --- | --- | 27,923 | 159,774 | 906,620 | 5,270,016 | 46,800 | 303,319 | 981,343 | 5,733,109 |
| Michigan | 2,341,081 | 9,911,010 | 203,856 | 834,856 | (3) | (3) | (3) | (3) | 1,830,036 | 7,771,131 | (3) | (3) | 2,140,906 | 9,104,870 |
| Minnesota | 412,037 | 2,919,602 | 2,930 | 9,426 | --- | --- | (3) | (3) | 457,904 | 3,195,637 | (3) | (3) | 460,611 | 3,216,967 |
| New Jersey | 835,125 | (3) | 77,509 | (3) | --- | --- | 22,395 | (3) | 547,406 | (3) | 222,915 | (3) | 792,716 | (3) |
| New York | 3,426,529 | 19,232,209 | 744,596 | 4,329,650 | (3) | (3) | (3) | (3) | 1,836,371 | 11,068,507 | 507,201 | 2,912,309 | 2,784,856 | 15,640,118 |
| Ohio | 3,676,727 | 14,540,301 | 2,653,241 | 10,766,912 | 123,030 | 357,810 | 145,915 | 739,214 | 738,342 | 2,703,640 | 163,850 | 669,829 | 1,171,137 | 4,470,493 |
| Pennsylvania | 6,170,240 | 24,045,292 | 4,803,609 | 17,542,385 | 441,962 | 1,596,535 | 75,872 | 509,766 | 794,274 | 4,209,313 | 137,355 | 683,466 | 1,449,463 | 6,999,080 |
| Tennessee | 71,484 | 252,339 | 19,643 | 68,751 | --- | --- | 15,002 | 67,509 | 31,940 | 121,372 | 17,290 | 38,038 | 64,232 | 226,919 |
| Utah | 66,945 | (3) | 43,770 | (3) | 19,417 | (3) | --- | --- | --- | --- | 1,665 | (3) | 21,082 | (3) |
| Washington | 31,817 | 141,267 | 18,051 | 53,218 | --- | --- | 411 | 2,635 | 13,294 | 85,186 | --- | --- | 13,705 | 87,821 |
| West Virginia | 1,074,002 | 2,170,183 | 784,910 | 1,561,627 | --- | --- | (3) | (3) | 265,285 | 643,181 | (3) | (3) | 365,019 | 805,428 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 1,450,850 | 8,635,585 | 140,096 | 704,991 | 9,988 | 50,630 | 110,578 | 771,857 | 1,099,449 | 6,681,015 | 111,638 | 636,055 | 1,331,653 | 8,139,557 |
| Undistributed | --- | 9,232,613 | --- | 3,887,334 | 624,190 | 2,428,897 | 67,024 | 648,762 | --- | 3,389,989 | 163,381 | 2,229,941 | --- | 5,520,971 |
| Total | 26,678,136 | 120,312,324 | 13,442,827 | 54,392,428 | 1,227,565 | 4,457,428 | 833,633 | 4,452,635 | 10,215,360 | 52,280,220 | 1,550,268 | 7,845,197 | 13,826,826 | 69,035,480 |
| At merchant plants | 10,533,968 | 57,132,796 | 1,199,736 | 6,420,361 | 332,984 | 1,541,931 | 574,616 | 3,297,251 | 7,595,108 | 41,728,979 | 1,235,740 | 6,490,792 | 9,738,448 | 53,058,953 |
| At furnace plants | 16,144,168 | 63,179,528 | 12,243,091 | 47,972,067 | 894,581 | 2,915,497 | 259,017 | 1,155,384 | 2,620,252 | 10,551,241 | 314,528 | 1,354,405 | 4,088,378 | 15,976,527 |

[1] Totals include 1,559,907 tons, valued at $7,781,000, used for other purposes than in blast furnaces.
[2] Totals include 638,094 tons, valued at $2,101,647, sold to affiliated corporations, and 589,471 tons, valued at $2,355,781, reported as merchant sales.
[3] Included under "Undistributed."
[4] Totals include 554,170 tons, valued at $3,224,422, sold for manufacture of water gas.

TABLE 29.—*Beehive coke produced and sold or used by producer, by States, in 1933*

[Exclusive of screenings or breeze

| State | Produced | | Used by producer[1] | | Sold | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Furnace[2] | | Foundry | |
| | Net tons | Value | Net tons | Value | Net tons | Value | Net tons | Value |
| Colorado and Utah | 45,317 | $319,187 | | | 34,862 | $255,542 | | |
| Pennsylvania | 670,179 | 1,685,947 | 253 | $514 | 104,391 | 252,157 | 113,397 | $345,471 |
| Tennessee | 11,346 | 23,485 | | | 10,457 | 20,618 | 978 | 3,936 |
| Virginia | 70,493 | 243,475 | | | 737 | 1,843 | 18,707 | 71,786 |
| Washington | 379 | 2,903 | | | | | 319 | 2,420 |
| West Virginia | 79,528 | 256,706 | | | 9,476 | 30,378 | 37,851 | 136,021 |
| Total | 877,242 | 2,531,703 | 253 | 514 | 159,923 | 560,538 | 171,252 | 559,634 |

| State | Sold | | | | | |
|---|---|---|---|---|---|---|
| | Domestic use | | Industrial and other use (including water gas)[3] | | Total | |
| | Net tons | Value | Net tons | Value | Net tons | Value |
| Colorado and Utah | 5,179 | $25,661 | 4,977 | $34,389 | 45,018 | $315,592 |
| Pennsylvania | 245,835 | 582,066 | 181,371 | 445,555 | 644,994 | 1,625,249 |
| Tennessee | 37 | 100 | | | 11,472 | 24,654 |
| Virginia | 35 | 130 | 51,696 | 172,113 | 71,175 | 245,872 |
| Washington | 60 | 483 | | | 379 | 2,903 |
| West Virginia | 24,531 | 64,588 | 6,459 | 21,218 | 78,317 | 252,205 |
| Total | 275,677 | 673,028 | 244,503 | 673,275 | 851,355 | 2,466,475 |

[1] No beehive coke was used by the producer in blast furnaces in 1933.
[2] Totals include 44,270 tons, valued at $286,118, sold to affiliated corporations, and 115,653 tons, valued at $274,420, reported as merchant sales.
[3] Totals include 81,951 tons, valued at $181,292, sold for manufacture of water gas.

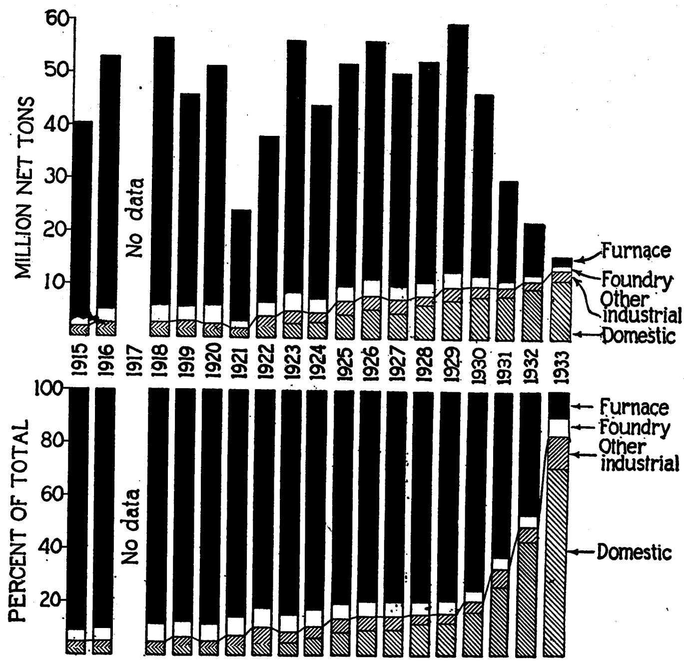


FIGURE 41.—Byproduct and beehive coke sold for furnace, foundry, other industrial, and domestic use, 1915–33. Figures for furnace coke include all coke used by the producer and not sold. The data represent the disposition made of the total production, including the exports, except that in 1915 and 1916 the exports are not included.

## DOMESTIC COKE

TABLE 30.—*Total supplies of fuels commonly used for domestic purposes in the United States, 1924 and 1930–33*

[Wherever available the figures represent the quantity actually consumed for domestic heating or for heating offices, apartments, hotels, schools, hospitals, etc. Where such figures are not available but where the fuel is known to be used chiefly for domestic purposes the total production (or imports) is shown in order to indicate the trend of growth]

| | 1924 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| *Solid fuels (net tons)* | | | | | |
| Pennsylvania anthracite production: | | | | | |
| Shipments of domestic sizes | 56, 576, 296 | 42, 508, 088 | 35, 437, 946 | 29, 096, 962 | 28, 849, 000 |
| Shipments of buckwheat no. 1 [1] | 9, 510, 508 | 8, 570, 032 | 7, 956, 978 | 6, 735, 313 | 6, 669, 000 |
| Shipments of smaller steam sizes | 11, 160, 695 | 10, 123, 937 | 9, 240, 931 | 8, 029, 388 | 8, 003, 000 |
| Local sales | 3, 043, 939 | 3, 144, 434 | 2, 901, 117 | 2, 810, 337 | 2, 766, 000 |
| Total, commercial production | 80, 291, 438 | 64, 346, 491 | 55, 536, 972 | 46, 672, 000 | [2] 46, 287, 000 |
| Anthracite exported | 4, 017, 785 | 2, 551, 659 | 1, 778, 308 | 1, 303, 355 | 1, 034, 563 |
| Anthracite imported, chiefly from United Kingdom and Russia | 117, 951 | 674, 812 | 637, 951 | 607, 097 | 456, 252 |
| Fuel briquets produced | 580, 470 | 1, 028, 865 | 698, 316 | 470, 604 | 530, 430 |
| Fuel briquets imported | 38 | 73, 418 | 60, 950 | 80, 288 | 42, 395 |
| Byproduct coke sold for domestic use | 2, 812, 771 | 7, 886, 432 | 8, 376, 652 | 9, 422, 343 | 10, 215, 360 |
| Beehive coke sold for domestic use | 139, 886 | 141, 391 | 118, 665 | 207, 857 | 275, 677 |
| Coke imported | 82, 833 | 132, 674 | 103, 563 | 117, 275 | 160, 873 |
| Gas-house coke sold | [2] 1, 400, 000 | [2] 1, 300, 000 | 1, 273, 000 | [2] 1, 250, 000 | [2] 1, 275, 000 |
| Petroleum coke produced [3] | 761, 100 | 1, 940, 000 | 2, 032, 000 | 1, 789, 000 | 1, 576, 000 |
| Anthracite and semianthracite produced outside of Pennsylvania | 704, 513 | 708, 221 | 507, 140 | 454, 028 | [2] 337, 983 |
| Bituminous coal for domestic use | (4) | (4) | (4) | (4) | (4) |
| *Oil (barrels)* [5] | | | | | |
| Oil used for heating houses | [2] 5, 021, 000 | 25, 771, 000 | 24, 659, 000 | (6) | (6) |
| Oil used for heating offices, hotels, apartments, schools, hospitals, and buildings other than houses | (6) | 17, 508, 000 | 15, 731, 000 | (6) | (6) |
| *Gas (million cubic feet)* | | | | | |
| Natural gas consumed for domestic use [7] | 285, 152 | 376, 407 | 380, 897 | 385, 887 | (6) |
| Manufactured gas sold for domestic purposes | (6) | (6) | [8] 260, 520 | (6) | (6) |

[1] A considerable part of the buckwheat no. 1 is used for domestic purposes.
[2] Partly estimated.
[3] How much petroleum coke was used for house fuel before 1928 is not known. For that year 235,000 tons were reported to have been consumed for domestic heating, according to E. B. Swanson in Economic Paper 9, Bureau of Mines.
[4] Between 56,000,000 and 77,000,000 tons a year.
[5] Based on surveys by E. B. Swanson, Bureau of Mines.
[6] Data not available.
[7] Includes heating of apartments and commercial buildings.
[8] From Census of Manufactures.

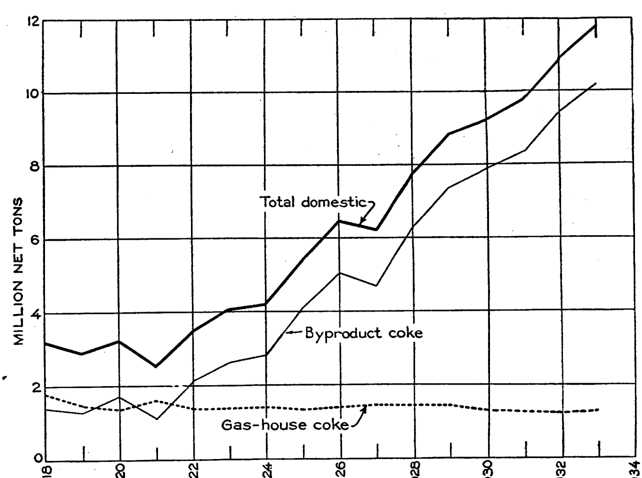


FIGURE 42.—Growth of sales of domestic coke, byproduct coke, and gas-house coke, 1918–33.

## STOCKS OF COKE

TABLE 31.—*Stocks of furnace, foundry, and domestic coke and of breeze on Jan. 1, 1934, by States, in net tons*

[Based on complete reports from all producers]

| State | Furnace | Foundry | Domestic and other | Total coke | Breeze |
|---|---|---|---|---|---|
| Byproduct plants: | | | | | |
| Alabama | [1] 409, 240 | (1) | 110, 264 | 519, 504 | 22, 573 |
| Colorado | 2, 049 | 216 | 490 | 2, 755 | ---------- |
| Illinois | 164, 995 | 12, 527 | 224, 044 | 401, 566 | 45, 284 |
| Indiana | 7, 421 | 215 | 76, 126 | 83, 762 | 8, 931 |
| Maryland | 12, 320 | ---------- | ---------- | 12, 320 | 20, 674 |
| Massachusetts | ---------- | 65 | 192, 319 | 192, 384 | 1, 425 |
| Michigan | 1, 246 | 3, 070 | 104, 864 | 109, 180 | 173, 944 |
| Minnesota | ---------- | ---------- | 93, 714 | 93, 714 | 7, 876 |
| New Jersey | ---------- | ---------- | 107, 244 | 107, 244 | 264 |
| New York | [1] 11, 141 | (1) | 210, 933 | 222, 074 | 43, 605 |
| Ohio | 24, 637 | 678 | 132, 151 | 157, 466 | 54, 310 |
| Pennsylvania | 221, 356 | 1, 232 | 313, 859 | 536, 447 | 16, 065 |
| Tennessee | 40, 550 | 31 | 14, 503 | 55, 084 | 693 |
| Utah | 5, 855 | ---------- | 7, 946 | 13, 801 | 2, 418 |
| Washington | ---------- | ---------- | 7, 019 | 7, 019 | ---------- |
| West Virginia | 33, 321 | ---------- | 22, 465 | 55, 786 | 15, 735 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | ---------- | 31, 970 | 217, 802 | 249, 772 | 24, 998 |
| Total byproduct | [1] 934, 131 | [1] 50, 004 | 1, 835, 743 | 2, 819, 878 | 438, 795 |
| At merchant plants | 43, 365 | 48, 448 | 1, 373, 447 | 1, 465, 260 | 257, 407 |
| At furnace plants | 876, 218 | 16, 104 | 462, 296 | 1, 354, 618 | 181, 388 |
| Beehive plants: | | | | | |
| Colorado | 375 | ---------- | ---------- | 375 | ---------- |
| Pennsylvania | 1, 305 | 5, 337 | 28, 617 | 35, 259 | 1, 022 |
| Tennessee | 537 | 212 | ---------- | 749 | ---------- |
| Utah | ---------- | 1, 486 | ---------- | 1, 486 | ---------- |
| Virginia | 832 | 249 | ---------- | 1, 081 | 20 |
| West Virginia | 2, 167 | 3, 695 | 570 | 6, 432 | ---------- |
| Total beehive | 5, 216 | 10, 979 | 29, 187 | 45, 382 | 1, 042 |

[1] A small amount of foundry coke is included with furnace.

TABLE 32.—*Summary of total stocks of coke on hand at all byproduct and beehive plants at first of year, 1929–34*

| | Jan. 1, 1929 | Jan. 1, 1930 | Jan. 1, 1931 | Jan. 1, 1932 | Jan. 1, 1933 | Jan. 1, 1934 |
|---|---|---|---|---|---|---|
| Byproduct plants: | | | | | | |
| Furnace | 750, 318 | 931, 654 | 1, 106, 996 | 1, 376, 902 | 1, 360, 660 | 919, 583 |
| Foundry | 24, 426 | 26, 943 | 230, 766 | 268, 149 | 152, 222 | 64, 552 |
| Domestic and other | 1, 018, 205 | 1, 256, 612 | 1, 916, 526 | 2, 734, 219 | 1, 985, 380 | 1, 835, 743 |
| | 1, 792, 949 | 2, 215, 209 | 3, 254, 288 | 4, 379, 270 | 3, 498, 262 | 2, 819, 878 |
| Beehive plants: | | | | | | |
| Furnace | 38, 446 | 30, 131 | 31, 691 | 25, 239 | 12, 067 | 5, 216 |
| Foundry | 8, 020 | 7, 929 | 6, 061 | 8, 513 | 7, 138 | 10, 979 |
| Domestic and other | 8, 511 | 7, 656 | 5, 844 | 12, 687 | 7, 388 | 29, 187 |
| | 54, 977 | 45, 716 | 43, 596 | 46, 439 | 26, 593 | 45, 382 |
| Total: | | | | | | |
| Furnace | 788, 764 | 961, 785 | 1, 138, 687 | 1, 402, 141 | 1, 372, 727 | 924, 799 |
| Foundry | 32, 446 | 34, 872 | 236, 827 | 276, 662 | 159, 360 | 75, 531 |
| Domestic and other | 1, 026, 716 | 1, 264, 268 | 1, 922, 370 | 2, 746, 906 | 1, 992, 768 | 1, 864, 930 |
| | 1, 847, 926 | 2, 260, 925 | 3, 297, 884 | 4, 425, 709 | 3, 524, 855 | 2, 865, 260 |

TABLE 33.—*Total stocks of coke on hand at all furnace and nonfurnace byproduct plants on first of each month, 1932 and 1933*

[Includes furnace, foundry, and domestic, but not breeze]

| Date | Furnace plants | | Other plants | | Total | |
|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | 1932 | 1933 |
| Jan. 1 | 1,923,784 | 1,626,074 | 2,455,486 | 1,872,188 | 4,379,270 | 3,498,262 |
| Feb. 1 | 1,886,119 | 1,601,062 | 2,292,775 | 1,707,169 | 4,178,894 | 3,308,231 |
| Mar. 1 | 1,864,765 | 1,482,514 | 1,974,310 | 1,348,734 | 3,839,075 | 2,831,248 |
| Apr. 1 | 1,826,056 | 1,487,113 | 1,647,094 | 1,215,792 | 3,473,150 | 2,702,905 |
| May 1 | 1,858,651 | 1,524,951 | 1,707,524 | 1,322,204 | 3,566,175 | 2,847,155 |
| June 1 | 1,905,998 | 1,573,756 | 1,709,316 | 1,401,416 | 3,615,314 | 2,975,172 |
| July 1 | 1,990,983 | 1,523,177 | 1,750,996 | 1,423,691 | 3,741,979 | 2,946,868 |
| Aug. 1 | 1,975,517 | 1,464,155 | 1,999,117 | 1,487,051 | 3,974,634 | 2,951,206 |
| Sept. 1 | 2,032,752 | 1,431,939 | 2,187,881 | 1,590,245 | 4,220,633 | 3,022,184 |
| Oct. 1 | 1,964,326 | 1,432,195 | 2,258,739 | 1,647,428 | 4,223,065 | 3,079,623 |
| Nov. 1 | 1,892,951 | 1,383,377 | 2,135,289 | 1,669,957 | 4,028,240 | 3,053,334 |
| Dec. 1 | 1,784,479 | 1,376,845 | 2,072,743 | 1,665,986 | 3,857,222 | 3,042,831 |

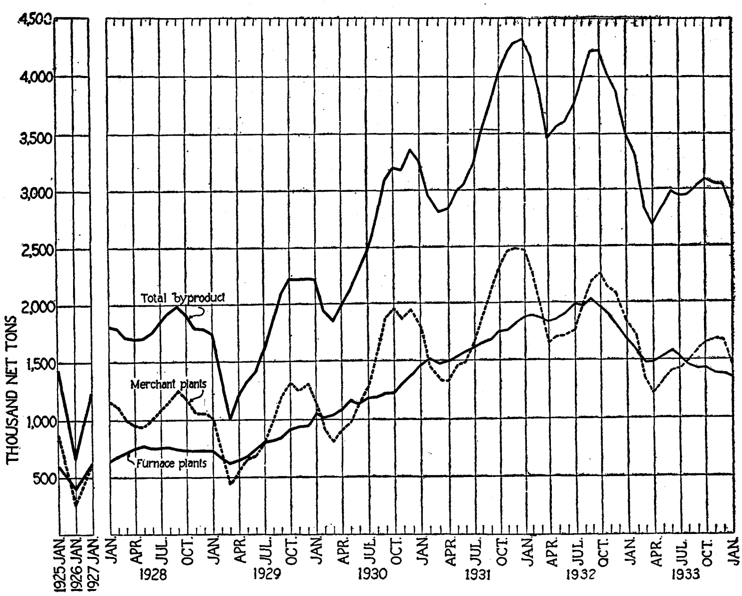


FIGURE 43.—Total stocks of byproduct coke at producers' plants on the first of each month. The diagram represents stocks at all byproduct plants.

## VALUE AND PRICE

TABLE 34.—*Average receipts per net ton for coke sold, by States, in 1933*

| State | Byproduct | | | | Beehive | | | |
|---|---|---|---|---|---|---|---|---|
| | Furnace [1] | Foundry | Domestic | Other industrial including water gas | Furnace [1] | Foundry | Domestic | Other industrial including water gas |
| Alabama | $1.49 | $3.13 | $2.20 | $1.84 | | | | |
| Colorado and Utah | 6.53 | 3.66 | 2.91 | 7.00 | $7.33 | | $4.96 | $6.91 |
| Illinois | | 6.65 | 4.86 | 4.60 | | | | |
| Indiana | 6.57 | 6.41 | 4.43 | 4.46 | | | | |
| Maryland and New Jersey | | 6.08 | 6.19 | 5.71 | | | | |
| Massachusetts | | 5.72 | 5.81 | 6.48 | | | | |
| Michigan | (2) | (2) | 4.25 | (2) | | | | |
| Minnesota | | (2) | 6.98 | (2) | | | | |
| New York | (2) | (2) | 6.03 | 5.74 | | | | |
| Ohio | 2.91 | 5.07 | 3.66 | 4.09 | | | | |
| Pennsylvania | 3.61 | 6.72 | 5.30 | 4.98 | 2.42 | $3.05 | 2.37 | 2.46 |
| Tennessee | | 4.50 | 3.80 | 2.20 | 1.97 | 4.03 | 2.70 | |
| Virginia | | | | | 2.50 | 3.84 | 3.71 | 3.33 |
| Washington | | 6.41 | 6.41 | | | 7.59 | 8.05 | |
| West Virginia | | (2) | 2.42 | (2) | 3.21 | 3.59 | 2.63 | 3.29 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 5.07 | 6.98 | 6.08 | 5.70 | | | | |
| Undistributed | 3.66 | 6.47 | | 2.80 | | | | |
| Average | 3.63 | 5.34 | 5.12 | 5.06 | 3.51 | 3.27 | 2.44 | 2.75 |
| At merchant plants | 4.63 | 5.74 | 5.49 | 5.25 | (3) | (3) | (3) | (3) |
| At furnace plants | 3.26 | 4.46 | 4.03 | 4.31 | (3) | (3) | (3) | (3) |

[1] Includes coke sold to affiliated corporations and merchant sales.
[2] Included under "Undistributed."
[3] Not available.

TABLE 35.—*Average monthly prices per net ton at ovens of spot or prompt Connellsville furnace and foundry coke, 1929–33* [1]

| Month | Furnace coke | | | | | Foundry coke | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1929 | 1930 | 1931 | 1932 | 1933 | 1929 | 1930 | 1931 | 1932 | 1933 |
| January | $2.75 | $2.55 | $2.50 | $2.25 | $1.75 | $3.75 | $3.50 | $3.50 | $3.50 | $2.50 |
| February | 2.90 | 2.60 | 2.50 | 2.25 | 1.75 | 3.75 | 3.50 | 3.50 | 3.50 | 2.50 |
| March | 2.98 | 2.60 | 2.50 | 2.25 | 1.75 | 3.75 | 3.50 | 3.50 | 3.50 | 2.50 |
| April | 2.78 | 2.60 | 2.50 | 2.25 | 1.75 | 3.75 | 3.50 | 3.50 | 3.50 | 2.50 |
| May | 2.75 | 2.53 | 2.45 | 2.20 | 1.75 | 3.75 | 3.50 | 3.50 | 3.10 | 2.50 |
| June | 2.75 | 2.50 | 2.40 | 2.00 | 1.81 | 3.75 | 3.50 | 3.50 | 3.00 | 2.56 |
| July | 2.75 | 2.50 | 2.40 | 2.00 | 2.31 | 3.75 | 3.50 | 3.50 | 3.00 | 2.94 |
| August | 2.73 | 2.58 | 2.40 | 2.00 | 2.55 | 3.75 | 3.50 | 3.50 | 2.90 | 3.15 |
| September | 2.65 | 2.60 | 2.40 | 2.00 | 2.50 | 3.75 | 3.50 | 3.50 | 2.75 | 3.25 |
| October | 2.65 | 2.60 | 2.40 | 1.81 | 3.50 | 3.75 | 3.50 | 3.50 | 2.75 | 4.05 |
| November | 2.65 | 2.53 | 2.40 | 1.75 | 3.75 | 3.75 | 3.50 | 3.50 | 2.75 | 4.25 |
| December | 2.64 | 2.50 | 2.34 | 1.75 | 3.75 | 3.75 | 3.50 | 3.25 | 2.69 | 4.25 |
| Average | 2.75 | 2.56 | 2.43 | 2.04 | 2.41 | 3.75 | 3.50 | 3.48 | 3.08 | 3.08 |

[1] Iron Age, Jan. 4, 1934.

TABLE 36.—*Average monthly prices of byproduct foundry coke, in 10 markets, as quoted by Steel*

| | January | February | March | April | May | June | July | August | September | October | November | December | Average for year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ashland, Ky. (at ovens):[1] | | | | | | | | | | | | | |
| 1931 | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 |
| 1932 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.00 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.96 |
| 1933 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.80 | 5.00 | 5.50 | 5.50 | 5.50 | 5.60 | 4.91 |
| Birmingham, Ala. (at ovens): | | | | | | | | | | | | | |
| 1931 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 4.75 | 5.00 |
| 1932 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.25 | 4.50 | 4.50 | 4.50 | 4.15 | 4.00 | 4.41 |
| 1933 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.40 | 4.50 | 4.75 | 4.85 | 4.85 | 4.28 |
| Buffalo, N.Y. (at ovens): | | | | | | | | | | | | | |
| 1931 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| 1932 | 8.00 | 8.00 | 7.60 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.59 |
| 1933 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 |
| Chicago, Ill. (at ovens): | | | | | | | | | | | | | |
| 1931 | 8.00 | 8.00 | 8.00 | 8.00 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 7.67 |
| 1932 | 7.50 | 7.50 | 7.50 | 7.50 | 7.30 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.19 |
| 1933 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.15 | 7.50 | 7.50 | 8.00 | 8.00 | 8.00 | 8.00 | 7.43 |
| Detroit, Mich. (at ovens): | | | | | | | | | | | | | |
| 1931 | 8.50 | 8.50 | 8.50 | 8.50 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| 1932 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| 1933 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| Indianapolis, Ind. (delivered at consumers' works): | | | | | | | | | | | | | |
| 1931 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 |
| 1932 | 8.30 | 8.30 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.15 | 7.75 | 7.75 | 8.17 |
| 1933 | 7.75 | 7.75 | 7.75 | 7.75 | 7.75 | 7.75 | 8.05 | 8.25 | 8.75 | 8.75 | 8.75 | 8.75 | 8.15 |
| Newark, N.J. (delivered at consumers' works): | | | | | | | | | | | | | |
| 1931 | 9.00 | 9.00 | 9.00 | 9.00 | 9.00 | 8.70 | 8.70 | 8.70 | 8.70 | 8.70 | 8.70 | 8.70 | 8.83 |
| 1932 | 8.76 | 8.76 | 8.76 | 8.76 | 8.23 | 8.21 | 8.21 | 8.21 | 8.21 | 8.21 | 8.21 | 8.21 | 8.40 |
| 1933 | 8.21 | 8.21 | 8.21 | 8.21 | 8.21 | 8.21 | 8.21 | 8.21 | 8.51 | 8.71 | 8.71 | 8.71 | 8.36 |
| New England (delivered at consumers' works): | | | | | | | | | | | | | |
| 1931 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 10.50 | 10.50 | 10.50 | 10.50 | 10.50 | 10.50 | 10.50 | 10.71 |
| 1932 | 10.50 | 10.50 | 10.50 | 10.50 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.17 |
| 1933 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.30 | 10.50 | 10.50 | 10.50 | 10.15 |
| Portsmouth, Ohio (at ovens):[1] | | | | | | | | | | | | | |
| 1931 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 |
| 1932 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.00 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.96 |
| 1933 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.80 | 5.00 | 5.50 | 5.50 | 5.50 | 5.60 | 4.91 |
| St. Louis, Mo. (at ovens): | | | | | | | | | | | | | |
| 1931 | 9.00 | 9.00 | 9.00 | 9.00 | 9.00 | 8.60 | 8.50 | 8.50 | 8.50 | 8.50 | 8.50 | 8.50 | 8.72 |
| 1932 | 8.50 | 8.50 | 8.50 | 8.50 | 8.50 | 7.95 | 7.75 | 7.75 | 7.75 | 7.75 | 7.75 | 7.75 | 8.08 |
| 1933 | 7.75 | 7.75 | 7.75 | 7.75 | 7.75 | 7.75 | 7.75 | 7.75 | 8.15 | 8.50 | 8.75 | 9.00 | 8.03 |

[1] Prices at ovens, Ashland and Portsmouth, quoted on Connellsville ovens basis.

## SHIPMENTS BY RAIL AND WATER

TABLE 37.—*Beehive coke loaded for shipment on originating railroads in the United States in 1933, by routes, as reported by coke producers* [1]

| Route | State | Quantity (net tons) | | Percent of total |
|---|---|---|---|---|
| | | By States | Total | |
| Railroads: | | | | |
| Baltimore & Ohio | Pennsylvania<br>West Virginia | 42,719<br>32,234 | 74,953 | 8.5 |
| Buffalo, Rochester & Pittsburgh | Pennsylvania | 21,645 | 21,645 | 2.5 |
| Chesapeake & Ohio | West Virginia | 46,153 | 46,153 | 5.3 |
| Denver & Rio Grande Western | Colorado<br>Utah | 35,767<br>10,156 | 45,923 | 5.3 |
| Huntingdon & Broad Top | Pennsylvania | 7,870 | 7,870 | .9 |
| Interstate | Virginia | 49,015 | 49,015 | 5.6 |
| Ligonier Valley | Pennsylvania | 92,989 | 92,989 | 10.6 |
| Monongahela | do | 289,585 | 289,585 | 33.1 |
| Nashville, Chattanooga & St. Louis | Tennessee | 3,472 | 3,472 | .4 |
| Norfolk & Western | Virginia | 23,463 | 23,463 | 2.7 |
| Northern Pacific | Washington | 319 | 319 | (2) |
| Pennsylvania | Pennsylvania | 199,882 | 199,882 | 22.8 |
| Pittsburgh & Lake Erie | do | 12,422 | 12,422 | 1.4 |
| Southern | Tennesses | 8,000 | 8,000 | .9 |
| Total railroad shipments | | 875,691 | 875,691 | 100.0 |

[1] There were no shipments of beehive coke over waterways during 1933.
[2] Less than 0.1 percent.

## EXPORTS AND IMPORTS [1]

TABLE 38.—*Coke exported from the United States, 1931–33, by customs districts*

| District | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Net tons | Value | Net tons | Value | Net tons | Value |
| Alaska | | | | | 1 | $6 |
| Arizona | 128 | $989 | | | 52 | 310 |
| Buffalo | 218, 193 | 1, 373, 823 | 134, 823 | $681, 190 | 119, 360 | 600, 916 |
| Chicago | | | 27, 079 | 87, 975 | 33, 104 | 107, 590 |
| Dakota | 10, 622 | 66, 033 | 4, 404 | 25, 019 | 7, 386 | 41, 093 |
| Duluth-Superior | 1, 729 | 11, 298 | 1, 643 | 11, 323 | 1, 569 | 10, 107 |
| El Paso | 2 | 23 | 4 | 77 | 7 | 104 |
| Florida | 3, 513 | 34, 168 | 1, 015 | 9, 866 | 1, 101 | 7, 635 |
| Galveston | 8, 833 | 62, 889 | | | | |
| Maine and New Hampshire | 1, 247 | 8, 978 | 125 | 752 | 35 | 236 |
| Maryland | 1, 135 | 8, 508 | | | 144 | 1, 539 |
| Michigan | 392, 979 | 1, 887, 501 | 370, 643 | 1, 587, 668 | 444, 110 | 1, 875, 641 |
| Mobile | 5, 881 | 55, 065 | 2, 240 | 31, 000 | 1, 816 | 4, 858 |
| New Orleans | 15, 455 | 84, 472 | 9, 530 | 42, 623 | 1, 388 | 8, 782 |
| New York | 300 | 5, 392 | 155 | 2, 315 | 250 | 3, 563 |
| Ohio | 78, 103 | 370, 339 | 76, 216 | 294, 061 | 22, 514 | 98, 445 |
| Philadelphia | 196 | 3, 127 | 2 | 24 | 6 | 60 |
| Puerto Rico | 6 | 150 | 36 | 520 | 21 | 216 |
| Sabine | 1, 120 | 8, 000 | | | 2, 240 | 21, 400 |
| St. Lawrence | 4, 626 | 31, 416 | 612 | 4, 511 | 319 | 1, 790 |
| San Antonio | | | 21 | 103 | 483 | 2, 730 |
| San Diego | 233 | 2, 547 | 363 | 3, 169 | 157 | 1, 619 |
| San Francisco | 28 | 482 | 9 | 152 | 346 | 2, 863 |
| Vermont | 3, 576 | 26, 975 | 84 | 573 | 27 | 175 |
| Virginia | 2, 615 | 22, 253 | 1, 147 | 8, 028 | 231 | 1, 409 |
| Washington | 357 | 3, 952 | | | 1, 152 | 4, 034 |
| Wisconsin | 3, 425 | 16, 588 | | | | |
| Total | 754, 302 | 4, 084, 968 | 630, 151 | 2, 790, 949 | 637, 819 | 2, 797, 121 |

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

TABLE 39.—*Coke exported from the United States, 1931–33, by countries of destination*

| Destination | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Net tons | Value | Net tons | Value | Net tons | Value |
| North America: | | | | | | |
| Bermudas | 1 | $20 | 12 | $184 | 13 | $178 |
| Canada | 722, 571 | 3, 851, 280 | 615, 629 | 2, 693, 072 | 631, 820 | 2, 761, 433 |
| Central America: | | | | | | |
| Costa Rica | 20 | 341 | 7 | 116 | 8 | 94 |
| Guatemala | 37 | 558 | 36 | 381 | 18 | 224 |
| Honduras | 75 | 860 | 31 | 429 | 44 | 629 |
| Nicaragua | 54 | 890 | 23 | 395 | 74 | 1, 221 |
| Panama | 218 | 4, 958 | 329 | 3, 983 | 224 | 1, 085 |
| Salvador | 29 | 438 | 11 | 95 | 17 | 215 |
| Mexico | 576 | 5, 014 | 424 | 3, 645 | 828 | 6, 261 |
| West Indies: | | | | | | |
| British: | | | | | | |
| Jamaica | 4 | 72 | | | | |
| Trinidad and Tobago | 361 | 3, 123 | | | | |
| Other | 8 | 88 | 9 | 48 | 2 | 29 |
| Cuba | 20, 163 | 98, 028 | 9, 421 | 40, 458 | 3, 561 | 13, 332 |
| Dominican Republic | 17 | 368 | 42 | 662 | 50 | 746 |
| Haiti | 4 | 75 | 9 | 123 | 10 | 178 |
| French West Indies | | | | | 200 | 1, 210 |
| Netherland | | | 3 | 34 | | |
| South America: | | | | | | |
| Brazil | 22 | 350 | | | | |
| Chile | 11 | 104 | | | | |
| Colombia | 27 | 499 | 74 | 1, 055 | 59 | 755 |
| Ecuador | 27 | 267 | 25 | 361 | 22 | 280 |
| Venezuela | 8 | 103 | 7 | 105 | 17 | 187 |
| Europe: | | | | | | |
| Belgium | | | | | 78 | 1, 040 |
| France | 1, 254 | 22, 400 | 2, 296 | 31, 775 | | |
| Germany | 1, 680 | 18, 000 | | | | |
| Italy | 3, 718 | 39, 098 | 1, 763 | 14, 028 | 359 | 4, 676 |
| Netherlands | 2, 296 | 29, 500 | | | 4 | 19 |
| Norway | 1, 120 | 8, 512 | | | | |
| United Kingdom | | | | | 90 | 865 |
| Asia: | | | | | | |
| Philippine Islands | | | | | 321 | 2, 464 |
| Other Asia | 1 | 22 | | | | |
| Total | 754, 302 | 4, 084, 968 | 630, 151 | 2, 790, 949 | 637, 819 | 2, 797, 121 |

TABLE 40.—*Coke imported into the United States, 1931–33, by customs districts*

| District | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Net tons | Value | Net tons | Value | Net tons | Value |
| Buffalo | 13,745 | $242,477 | | | | |
| Hawaii | 682 | 7,135 | 224 | $1,068 | 400 | $3,480 |
| Los Angeles | 24,449 | 114,790 | 14,391 | 43,461 | 15,820 | 36,904 |
| Massachusetts | 16,757 | 70,183 | 79,186 | 256,623 | 101,096 | 318,569 |
| Maine and New Hampshire | 2,642 | 17,141 | 672 | 3,086 | 2 | 16 |
| Michigan | 1,174 | 20,059 | | | | |
| Montana and Idaho | 9,847 | 73,498 | | | | |
| New York | 12,690 | 46,427 | 2,517 | 9,160 | 7,393 | 25,861 |
| Oregon | 2,234 | 10,996 | 1,255 | 3,133 | 2,107 | 5,123 |
| Rhode Island | | | | | 8,182 | 25,547 |
| St. Lawrence | 35 | 237 | | | | |
| San Antonio | 88 | 729 | | | | |
| San Francisco | 15,538 | 68,983 | 16,304 | 46,017 | 21,774 | 58,273 |
| Vermont | 27 | 179 | | | | |
| Washington | 3,655 | 18,184 | 2,726 | 7,340 | 4,099 | 9,949 |
| Total | 103,563 | 691,018 | 117,275 | 369,888 | 160,873 | 483,722 |

TABLE 41.—*Coke imported into the United States, 1931–33, by countries of origin*

| Country | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Net tons | Value | Net tons | Value | Net tons | Value |
| Belgium | 4,540 | $23,680 | 17,930 | $59,246 | 9,544 | $19,292 |
| Canada | 25,394 | 340,165 | | | | |
| Germany | 22,768 | 98,111 | 16,660 | 70,363 | 44,133 | 117,786 |
| Japan | 1 | 7 | | | 7 | 31 |
| Mexico | 88 | 729 | | | 777 | 2,464 |
| Netherlands | 6,316 | 33,217 | 8,386 | 27,677 | | |
| United Kingdom | 44,456 | 195,109 | 74,299 | 212,602 | 106,412 | 344,149 |
| Total | 103,563 | 691,018 | 117,275 | 369,888 | 160,873 | 483,722 |

## WORLD PRODUCTION

TABLE 42.—*Coke produced in principal countries, 1929–33, in metric tons* [1]

[Compiled by M. T. Latus, of the Bureau of Mines]

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Australia: | | | | | |
| New South Wales | 471,813 | 373,675 | 221,000 | 362,217 | (2) |
| Queensland | 4,144 | 3,499 | 2,317 | 1,963 | (2) |
| Belgium | 6,192,960 | 5,551,560 | 5,129,960 | 4,682,860 | (2) |
| Bulgaria | | | | 566 | (2) |
| Canada | 1,986,532 | 1,716,091 | 1,256,010 | 1,074,895 | 1,228,246 |
| China (exports) | 13,467 | 10,557 | 8,130 | (2) | (2) |
| Chosen | (3) | (3) | 154,918 | (3) | (2) |
| Czechoslovakia | 3,170,629 | 2,714,670 | 2,046,371 | 1,277,810 | 1,258,900 |
| France | 9,080,127 | 9,271,140 | 7,940,000 | 5,868,000 | (2) |
| Germany [4] | 39,421,033 | 32,699,520 | 23,189,836 | 19,545,920 | 20,713,502 |
| Saar | 2,423,000 | 2,560,000 | 1,941,000 | 1,685,000 | (2) |
| Great Britain [5] | 13,637,421 | 11,698,821 | 8,606,664 | 8,616,303 | (2) |
| Hungary | 2,092 | (3) | 2,184 | (3) | (2) |
| India, British [6] | 843,504 | 821,020 | 792,174 | (3) | (2) |
| Indo-China | 637 | 6,000 | 1,000 | 2,150 | (2) |
| Italy | 791,607 | 813,325 | 740,266 | 714,141 | (2) |
| Japan: | | | | | |
| Manufactured coke | (3) | (3) | (3) | (3) | (2) |
| Natural coke | (3) | (3) | 180,751 | (3) | (2) |
| Mexico | 493,777 | 505,505 | 350,201 | 255,595 | (2) |
| Netherlands | 2,402,566 | 2,599,403 | 2,739,343 | 2,519,656 | (2) |
| Peru | 35,899 | 35,974 | 9,269 | (3) | (2) |
| Poland | 1,858,052 | 1,581,974 | 1,354,743 | 1,090,900 | (2) |
| Rhodesia, Southern | 100,001 | 77,043 | 39,866 | 25,514 | (2) |
| Spain | 768,040 | 675,546 | 503,115 | 369,352 | (2) |
| Sweden | 103,778 | 96,942 | 126,642 | 106,328 | 103,336 |
| U.S.S.R. (Russia) | (3) | (3) | (3) | (3) | (2) |
| Union of South Africa | 99,297 | 89,429 | 86,371 | 57,347 | 75,456 |
| United States | 54,325,427 | 43,519,258 | 30,375,912 | 19,766,300 | 24,997,688 |
| Total | 144,766,000 | 123,963,000 | 94,048,000 | 75,415,000 | (2) |

1 Gas-house coke is not included.
2 Data not available.
3 Estimate included in total.
4 Exclusive of the Saar, which is shown separately.
5 In Great Britain the production of gas-house coke (including breeze), not included above, is especially important and was as follows: 1929, 12,610,467 tons; 1930, 12,514,392 tons; 1931, 12,301,695 tons; 1932, 11,990,229 tons.
6 Figures represent only coke made at collieries.

# COKE-OVEN BYPRODUCTS

## SUMMARY OF BYPRODUCTS IN 1933

TABLE 43.—*Byproducts obtained from coke-oven operations in the United States in 1933* [1]

[Exclusive of screenings or breeze]

| Product | Production | Sales | | |
|---|---|---|---|---|
| | | Quantity | Value | |
| | | | Total | Average |
| Tar gallons | 363, 298, 586 | 241, 000, 100 | $8, 980, 956 | $0. 037 |
| Ammonia: | | | | |
| Sulphate pounds | 678, 558, 802 | 662, 868, 240 | 6, 028, 765 | . 009 |
| Ammonia liquor ($NH_3$ content) do | 40, 506, 587 | 40, 242, 881 | 1, 159, 887 | . 029 |
| Sulphate equivalent of all forms do | 840, 585, 150 | 823, 839, 764 | 7, 188, 652 | |
| Gas: | | | | |
| Used under boilers, etc M cubic feet | [2] 431,291, 780 | 26, 110, 163 | 2, 324, 198 | . 089 |
| Used in steel or affiliated plants do | | 94, 857, 261 | 8, 600, 316 | . 091 |
| Distributed through city mains do | | 135, 589, 195 | 41, 119, 384 | . 303 |
| Sold for industrial use do | | 19, 590, 010 | 3, 953, 796 | . 202 |
| | | 276, 146, 629 | 55, 997, 694 | . 203 |
| Light oil and derivatives: | | | | |
| Crude light oil gallons | [3] 96, 632, 316 | 7, 578, 918 | 712, 677 | . 094 |
| Benzol, crude and refined do | 17, 218, 950 | 17, 584, 517 | 3, 038, 060 | . 173 |
| Motor benzol do | 40, 224, 022 | 38, 654, 902 | 4, 379, 737 | . 113 |
| Toluol, crude and refined do | 11, 539, 107 | 11, 541, 990 | 3, 123, 738 | . 271 |
| Solvent naphtha do | 2, 717, 254 | 2, 570, 981 | 449, 968 | . 175 |
| Xylol do | 2, 101, 377 | 2, 271, 658 | 521, 775 | . 230 |
| Other light-oil products do | 3, 713, 934 | 1, 393, 302 | 80, 272 | . 058 |
| | [4] 77, 514, 644 | 81, 596, 268 | 12, 306, 227 | . 151 |
| Naphthalene, crude and refined pounds | 6, 618, 073 | 6, 523, 204 | 67, 472 | . 010 |
| Tar derivatives: | | | | |
| Creosote oil, distillate as such gallons | 4, 559, 419 | 3, 659, 950 | 271, 069 | . 074 |
| Creosote oil in coal-tar solution do | 866, 012 | 487, 651 | 34, 355 | . 070 |
| Pitch of tar net tons | 109, 165 | 1, 340 | 9, 048 | 6. 752 |
| Other tar derivatives | | | 170, 774 | |
| Phenol gallons | 158, 268 | 149, 082 | 27, 042 | . 181 |
| Other products [5] | | | 75, 065 | |
| Value of all byproducts sold | | | [6] 85, 128, 354 | |

[1] Includes products of tar distillation conducted by coke-oven operators under same corporate name except, however, phenol and other tar acids produced at Clairton, Pa.
[2] Includes gas wasted and gas used for heating retorts.
[3] Refined on the premises to make the derived products shown, 92,895,870 gallons.
[4] Total gallons of derived products.
[5] Ammonia thiocyanate, carbolate, cyanogen, insecticides, pyridine oil, sodium prussiate, sulphur, and vented vapors.
[6] Exclusive of the value of breeze production, which in 1933 amounted to $5,054,641.

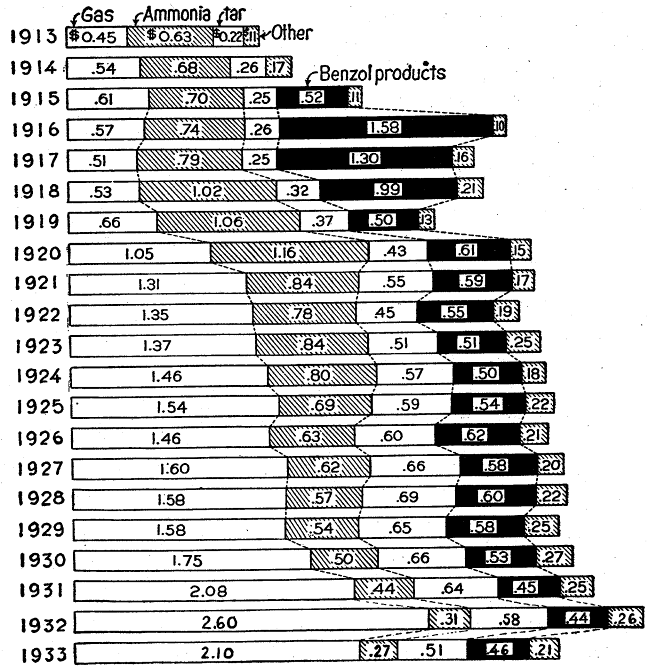


FIGURE 44.—Gross value of the several byproducts per ton of byproduct coke produced, 1913–33.

TABLE 44.—*Coal equivalent of byproducts of byproduct coking, 1913, 1914, 1918, and 1931–33*

| Year | Quantity of byproducts | | | | Rough equivalent in heating value (billion B.t.u.) | | | | | Coal equivalent | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | Coke breeze (thousand net tons) | Surplus gas (billion cubic feet) | Tar produced (thousand gallons) | Light oil produced (thousand gallons) | Coke breeze (1×20) | Surplus gas (2×550) | Tar (3×0.150) | Light oil (4×0.130) | Total (5+6+7+8) | Net tons (9÷0.0262) | Percent this forms of coal made into coke |
| 1913 | 735 | 64 | 115,145 | 3,000 | 14,700 | 35,200 | 17,272 | 390 | 67,562 | 2,600,000 | 3.8 |
| 1914 | 667 | 61 | 109,901 | 8,464 | 13,340 | 33,550 | 16,485 | 1,100 | 64,475 | 2,461,000 | 4.8 |
| 1918 | 1,999 | 158 | 263,299 | 87,562 | 39,980 | 86,900 | 39,495 | 11,383 | 177,758 | 6,785,000 | 8.0 |
| 1931 | 3,126 | 329 | 450,856 | 122,529 | 62,520 | 180,950 | 67,628 | 15,929 | 327,027 | 12,482,000 | 25.7 |
| 1932 | 2,119 | 231 | 303,812 | 73,763 | 42,380 | 127,050 | 45,572 | 9,589 | 224,591 | 8,572,000 | 26.9 |
| 1933 | 2,533 | 276 | 363,299 | 96,632 | 50,660 | 151,800 | 54,495 | 12,562 | 269,517 | 10,287,000 | 25.7 |

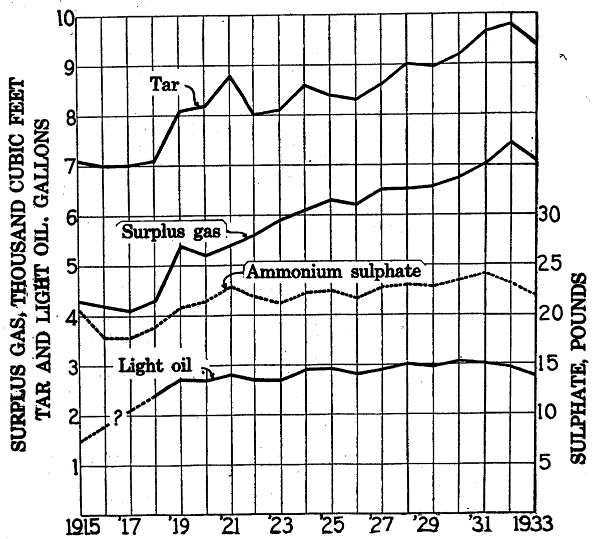


FIGURE 45.—Average yield of principal byproducts per net ton of coal carbonized in byproduct coke ovens, 1915–33. Figures for light oil represent average at plants recovering light oil.

## COKE-OVEN GAS

TABLE 45.—*Coke-oven gas produced and sold in the United States in 1933, by States*

| State | Number of active plants | Produced (M cubic feet) | Used in heating ovens (M cubic feet) | Surplus sold or used | | | Wasted (M cubic feet) |
|---|---|---|---|---|---|---|---|
| | | | | M cubic feet | Value | | |
| | | | | | Total | Average | |
| Alabama | 6 | 26,565,051 | 12,071,402 | 13,321,283 | $1,062,281 | $0.080 | 1,172,366 |
| Colorado | 1 | 2,611,958 | 1,703,316 | 895,667 | (1) | (1) | 12,975 |
| Illinois | 7 | 23,319,372 | 5,929,811 | 17,322,850 | 4,013,161 | .232 | 66,711 |
| Indiana | 6 | 31,748,533 | 14,907,416 | 16,535,484 | 4,184,720 | .253 | 305,633 |
| Maryland | 1 | 10,330,205 | 3,007,600 | 7,322,605 | (1) | (1) | ---------- |
| Massachusetts | 3 | 18,366,777 | 5,185,448 | 13,079,608 | 3,807.358 | .291 | 101,721 |
| Michigan | 9 | 39,861,583 | 13,926,619 | 25,839,187 | 5,123,895 | .198 | 95,777 |
| Minnesota | 2 | 6,700,276 | 2,593,075 | 4,048,329 | 1,519,504 | .375 | 58,872 |
| New Jersey | 2 | 14,560,084 | 2,791,331 | 11,768,753 | (1) | (1) | ---------- |
| New York | 9 | 55,137,436 | 10,832,518 | 42,448,566 | 13,766,405 | .324 | 1,856,352 |
| Ohio | 14 | 55,286,671 | 23,180,478 | 31,602,663 | 3,717,666 | .118 | 503,530 |
| Pennsylvania | 12 | 103,011,775 | 40,825,405 | 59,234,395 | 8,286,026 | .140 | 2,951,975 |
| Tennessee | 1 | 953,100 | 428,799 | 524,301 | 133,989 | .256 | ---------- |
| Utah | 1 | 1,542,562 | 814,402 | 728,160 | (1) | (1) | ---------- |
| Washington | 1 | 653,941 | ---------- | 577,160 | 158,933 | .275 | 76,781 |
| West Virginia | 4 | 17,238,549 | 5,291,618 | 11,923,588 | 1,062,581 | .089 | 23,343 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 6 | 23,403,907 | 4,293,890 | 18,974,030 | 5,764,230 | .304 | 135,987 |
| Undistributed | ------- | ---------- | ---------- | ---------- | 3,396,945 | .164 | ---------- |
| Total | 85 | 431,291,780 | 147,783,128 | 276,146,629 | 55,997,694 | .203 | 7,362,023 |
| At merchant plants | 43 | 173,349,354 | 40,476,277 | 129,709,907 | 38,456,246 | .296 | 3,163,170 |
| At furnace plants | 42 | 257,942,426 | 107,306,851 | 146,436,722 | 17,541,448 | .120 | 4,198,853 |

1 Included under "Undistributed."

TABLE 46.—*Disposition of surplus coke-oven gas in the United States in 1933, by States*

| State | Used by producer | | | | | |
|---|---|---|---|---|---|---|
| | Under boilers | | | In steel or other affiliated plants | | |
| | M cubic feet | Value: Total | Value: Average | M cubic feet | Value: Total | Value: Average |
| Alabama | 3,424,016 | $180,424 | $0.053 | 6,741,559 | $442,473 | $0.066 |
| Colorado | | | | 895,667 | (1) | (1) |
| Illinois | 1,057,318 | (1) | (1) | 128,186 | 31,198 | .243 |
| Indiana | 322,272 | 22,019 | .068 | 10,590,085 | 1,291,429 | .122 |
| Maryland | | | | 3,261,921 | (1) | (1) |
| Michigan | 10,740,211 | 1,409,806 | .131 | | | |
| Minnesota | 44,507 | 2,610 | .059 | | | |
| New York | 1,716,129 | 99,494 | .058 | 6,581,365 | 625,486 | .095 |
| Ohio | 3,542,553 | 263,356 | .074 | 19,915,905 | 1,941,857 | .098 |
| Pennsylvania | 3,300,890 | 191,237 | .058 | 37,850,011 | 3,210,347 | .085 |
| Tennessee | 119,390 | 4,417 | .037 | | | |
| Utah | 289,180 | (1) | (1) | 27,120 | (1) | (1) |
| Washington | | | | 2,746 | 1,922 | .700 |
| West Virginia | 1,355,638 | 45,642 | .034 | 8,859,880 | 724,997 | .082 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 198,059 | 20,270 | .102 | 2,816 | 735 | .261 |
| Undistributed | | 84,923 | .063 | | 329,872 | .079 |
| Total | 26,110,163 | 2,324,198 | .089 | 94,857,261 | 8,600,316 | .091 |
| At merchant plants | 7,510,287 | 451,579 | .060 | 970,332 | 91,159 | .094 |
| At furnace plants | 18,599,876 | 1,872,619 | .101 | 93,886,929 | 8,509,157 | .091 |

| State | Sold | | | | | |
|---|---|---|---|---|---|---|
| | Distributed through city mains | | | Sold for industrial purposes | | |
| | M cubic feet | Value: Total | Value: Average | M cubic feet | Value: Total | Value: Average |
| Alabama | 3,093,443 | $430,633 | $0.139 | 62,265 | $8,751 | $0.141 |
| Illinois | 16,137,346 | 3,913,237 | .242 | | | |
| Indiana | 5,007,441 | 2,756,024 | .550 | 615,686 | 115,248 | .187 |
| Maryland | 4,060,684 | (1) | (1) | | | |
| Massachusetts | 13,025,670 | 3,792,037 | .291 | 53,938 | 15,321 | .284 |
| Michigan | 14,814,701 | 3,634,436 | .245 | 284,275 | 79,653 | .280 |
| Minnesota | 4,003,822 | 1,516,894 | .379 | | | |
| New Jersey | 3,082,214 | (1) | (1) | 8,686,539 | (1) | (1) |
| New York | 32,925,985 | 12,786,342 | .388 | 1,225,087 | 255,083 | .208 |
| Ohio | 5,856,794 | 1,260,060 | .215 | 2,287,411 | 252,393 | .110 |
| Pennsylvania | 14,963,846 | 4,277,620 | .286 | 3,119,648 | 606,822 | .195 |
| Tennessee | 404,911 | 129,572 | .320 | | | |
| Utah | 340,138 | (1) | (1) | 71,722 | (1) | (1) |
| Washington | 373,369 | 102,057 | .273 | 201,045 | 54,954 | .273 |
| West Virginia | | | | 1,708,070 | 291,942 | .171 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 17,498,831 | 5,569,778 | .318 | 1,274,324 | 173,447 | .136 |
| Undistributed | | 950,694 | .127 | | 2,100,182 | .240 |
| Total | 135,589,195 | 41,119,384 | .303 | 19,590,010 | 3,953,796 | .202 |
| At merchant plants | 105,574,968 | 34,716,582 | .329 | 15,654,320 | 3,196,926 | .204 |
| At furnace plants | 30,014,227 | 6,402,802 | .213 | 3,935,690 | 756,870 | .192 |

[1] Included under "Undistributed."

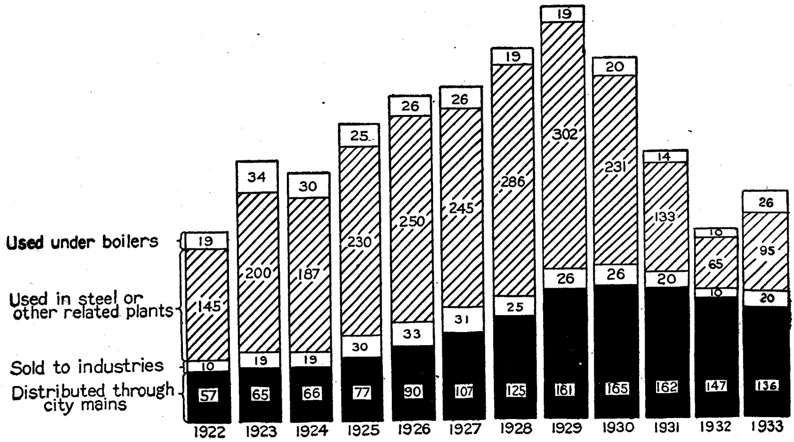


FIGURE 46.—Disposition of surplus coke-oven gas, 1922–33. Gas used in heating ovens or wasted, not included. Figures in bars represent billions of cubic feet.

## TAR

TABLE 47.—*Coke-oven tar produced and sold in the United States in 1933, by States* [1]

| State | Total produced (gallons) | Yield of tar (gallons) per ton of coal coked | Sold | | | | |
|---|---|---|---|---|---|---|---|
| | | | For use as fuel (gallons)[2] | For refining into tar products (gallons) | Total sold (gallons) | Value | |
| | | | | | | Total | Average |
| Alabama | 23,832,583 | 9.84 | 11,954,883 | 4,022,802 | 15,977,685 | $589,983 | $0.037 |
| Colorado | 2,362,013 | 11.21 | | 1,243 | 1,243 | (3) | (3) |
| Illinois | 20,974,414 | 9.35 | 1,066,816 | 20,895,325 | 21,962,141 | 808,594 | .037 |
| Indiana | 19,922,241 | 6.76 | 562,866 | 11,194,080 | 11,756,946 | 413,564 | .035 |
| Maryland | 7,804,938 | 8.03 | | 8,462,488 | 8,462,488 | (3) | (3) |
| Massachusetts | 13,583,361 | 9.16 | 904,856 | 12,545,189 | 13,450,045 | 706,220 | .053 |
| Michigan | 28,435,757 | 8.50 | 2,846,511 | 18,498,986 | 21,345,497 | 549,068 | .026 |
| Minnesota | 4,957,037 | 8.20 | | 4,997,786 | 4,997,786 | 244,648 | .049 |
| New Jersey | 9,966,993 | 8.39 | 9,710,656 | | 9,710,656 | (3) | (3) |
| New York | 50,029,401 | 10.08 | 11,733,980 | 36,977,489 | 48,711,469 | 1,838,643 | .038 |
| Ohio | 47,446,516 | 9.08 | 2,675,323 | 24,930,603 | 27,605,926 | 1,040,834 | .038 |
| Pennsylvania | 96,238,465 | 10.48 | 7,338,165 | 20,672,694 | 28,010,859 | 952,743 | .034 |
| Tennessee | 680,531 | 6.75 | | 648,836 | 648,836 | 37,957 | .059 |
| Utah | 1,436,634 | 11.58 | | 1,466,571 | 1,466,571 | (3) | (3) |
| Washington | 410,698 | 7.23 | 26,405 | | 26,405 | 660 | .025 |
| West Virginia | 18,735,641 | 11.85 | 2,655,027 | 8,338,535 | 10,993,562 | 338,534 | .031 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 16,481,363 | 8.10 | 2,515,075 | 13,356,910 | 15,871,985 | 622,075 | .039 |
| Undistributed | | | | | | 837,433 | .043 |
| Total | 363,298,586 | 9.39 | 53,990,563 | 187,009,537 | 241,000,100 | 8,980,956 | .037 |
| At merchant plants | 138,016,862 | 9.15 | 27,402,780 | 109,736,833 | 137,139,613 | 5,210,590 | .038 |
| At furnace plants | 225,281,724 | 9.54 | 26,587,783 | 77,272,704 | 103,860,487 | 3,770,366 | .036 |

1 This table excludes the quantity of tar "refined at plant", which in 1933 was 28,540,374 gallons.
2 Includes 13,275,513 gallons sold to affiliated corporations and 40,715,050 gallons sold to other purchasers.
3 Included under "Undistributed."

TABLE 47.—*Coke-oven tar produced and sold in the United States in 1933, by States*—Continued

| State | Used by producer (gallons) | | | On hand Dec. 31 (gallons) |
|---|---|---|---|---|
| | As fuel under boilers | In open-hearth or affiliated plants | Otherwise | |
| Alabama | 5,357 | (3) | 99,675 | 3,834,558 |
| Colorado | | 90,083 | 39,981 | 394,828 |
| Illinois | | 28,023 | | 2,153,012 |
| Indiana | | 6,664,980 | 240,713 | 4,124,710 |
| Maryland | | 14,755 | | 749,233 |
| Massachusetts | | | | 2,180,440 |
| Michigan | (3) | (3) | | 2,431,760 |
| Minnesota | | | | 212,758 |
| New Jersey | | | | 862,737 |
| New York | | | 1,755 | 5,887,932 |
| Ohio | (3) | 19,668,880 | | 3,178,580 |
| Pennsylvania | (3) | 65,940,843 | 51,740 | 8,868,807 |
| Tennessee | | | | 79,503 |
| Utah | | 450 | | 85,524 |
| Washington | 306,202 | | 82,443 | 19,242 |
| West Virginia | | 7,557,084 | | 832,915 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | | | 911 | 1,601,227 |
| Undistributed | 6,604,404 | 7,492,999 | | |
| Total | 6,915,963 | [4]107,458,097 | 517,218 | 37,497,766 |
| At merchant plants | 369,716 | | 85,109 | 12,010,531 |
| At furnace plants | 6,546,247 | [4]107,458,097 | 432,109 | 25,487,235 |

[3] Included under "Undistributed."
[4] Includes a certain quantity of pitch of tar derived from the item "refined at plant" and mixed with virgin tar for use as fuel.

## AMMONIA

TABLE 48.—*Ammonia produced at coke-oven plants in 1933, by States, in pounds*

| State | Number of active plants | Sulphate equivalent of all forms | | Produced as— | |
|---|---|---|---|---|---|
| | | Total | Per ton of coal coked | Sulphate | Liquor ($NH_3$ content) |
| Alabama | 6 | 65,219,475 | 26.94 | 65,219,475 | |
| Colorado | 1 | 4,968,556 | 23.57 | 4,968,556 | |
| Illinois | 7 | 51,964,781 | 23.17 | (1) | (1) |
| Indiana | 6 | 53,102,395 | 18.03 | 46,881,791 | 1,555;151 |
| Maryland | 1 | 22,545,545 | 23.20 | 22,545,545 | |
| Massachusetts | 3 | 33,639,772 | 22.68 | (1) | (1) |
| Michigan | 9 | 74,827,716 | 22.36 | 29,348,340 | 11,369,844 |
| New Jersey | 2 | 24,019,392 | 20.21 | 24,019,392 | |
| New York | 9 | 109,176,567 | 22.00 | 81,439,307 | 6,934,315 |
| Ohio | 14 | 115,235,270 | 22.04 | 81,305,406 | 8,482,466 |
| Pennsylvania | 12 | 208,416,276 | 22.70 | 197,013,068 | 2,850,802 |
| Tennessee | 1 | 2,274,969 | 22.57 | 2,274,969 | |
| Utah | 1 | 3,023,860 | 24.37 | 3,023,860 | |
| West Virginia | 3 | 34,157,180 | 24.50 | 34,157,180 | |
| Connecticut, Kentucky, Minnesota, Missouri, and Wisconsin | 5 | 38,013,396 | 18.05 | 17,737,320 | 5,069,019 |
| Undistributed | | | | 68,624,593 | 4,244,990 |
| Total | 80 | 840,585,150 | 22.18 | 678,558,802 | 40,506,587 |
| At merchant plants | 39 | 314,569,315 | 21.72 | 182,751,195 | 32,954,530 |
| At furnace plants | 41 | 526,015,835 | 22.46 | 495,807,607 | 7,552,057 |

[1] Included under "Undistributed."

## LIGHT OIL AND ITS DERIVATIVES

TABLE 49.—*Crude light oil produced at coke-oven plants in the United States in 1933, by States, in gallons* [1]

| State | Number of active plants | Produced | | Refined on premises | Total derived products obtained from refining operations |
|---|---|---|---|---|---|
| | | Total | Per ton of coal coked | | |
| Alabama | 5 | 6,834,053 | 2.85 | 6,798,183 | 5,511,464 |
| Colorado | 1 | 687,470 | 3.26 | 686,994 | 512,761 |
| Illinois | 5 | 5,147,286 | 2.54 | 1,623,264 | 1,332,224 |
| Indiana | 4 | 6,905,757 | 2.81 | 7,439,679 | 6,105,961 |
| Maryland | 1 | 3,159,000 | 3.25 | 3,159,000 | 2,670,103 |
| Michigan | 3 | 7,623,678 | 2.51 | 4,095,388 | 3,454,772 |
| New York | 8 | 9,894,931 | 2.33 | 16,012,504 | 13,579,785 |
| Ohio | 14 | 15,913,502 | 3.04 | 13,929,243 | 10,832,630 |
| Pennsylvania | 10 | 27,173,676 | 3.22 | 26,702,381 | 23,047,247 |
| Tennessee | 1 | 250,939 | 2.49 | 250,311 | 190,576 |
| Utah | 1 | 480,570 | 3.87 | 477,870 | 358,480 |
| West Virginia | 3 | 4,534,818 | 3.25 | 4,506,823 | 3,840,252 |
| Kentucky, Massachusetts, Minnesota, Missouri, New Jersey, and Wisconsin | 7 | 8,026,636 | 2.01 | 7,214,230 | 6,078,389 |
| Total | 63 | 96,632,316 | 2.79 | 92,895,870 | 77,514,644 |
| At merchant plants | 24 | 25,113,548 | 2.21 | 22,349,012 | 18,781,312 |
| At furnace plants | 39 | 71,518,768 | 3.08 | 70,546,858 | 58,733,332 |

[1] In addition to the quantity refined on the premises a few plants reported the sale of crude light oil. The total quantity sold in 1933 was 7,578,918 gallons, valued at $712,677 or 9.4 cents per gallon.

## NAPHTHALENE

TABLE 50.—*Naphthalene sold by byproduct coke operators, 1918 and 1930–33*

| Year | Quantity (pounds) | | | Value | Average receipts per pound (cents) | | Receipts per ton of coke (cents) |
|---|---|---|---|---|---|---|---|
| | Crude | Refined | Total | | Crude | Refined | |
| 1918 | 10,403,758 | 5,486,689 | 15,890,447 | $650,229 | 2.8 | 6.6 | 2.5 |
| 1930 | [1] 13,028,904 | | 13,028,904 | 161,264 | [1] 1.2 | | .4 |
| 1931 | [1] 7,360,309 | | 7,360,309 | 78,946 | [1] 1.1 | | .2 |
| 1932 | [1] 3,714,604 | | 3,714,604 | 33,323 | [1] 0.9 | | .2 |
| 1933 | [1] 6,523,204 | | 6,523,204 | 67,472 | [1] 1.0 | | .3 |

[1] Crude and refined not separated.

## BYPRODUCT COKE OVENS OWNED BY CITY GAS COMPANIES, INCLUDED BY BUREAU OF THE CENSUS IN MANUFACTURED-GAS INDUSTRY

TABLE 51.—*Production of coke, breeze, gas, and byproducts at byproduct coke plants owned by city gas companies (public utilities) and included by Bureau of the Census in manufactured-gas industry, and at all other byproduct coke plants, 1932 and 1933.*

| Product | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Plants not owned by city gas companies | Plants owned by city gas companies (public utilities) [1] | Total | Plants not owned by city gas companies | Plants owned by city gas companies (public utilities) [1] | Total |
| Number of active plants | 65 | 23 | 88 | 62 | 23 | 85 |
| Coke: | | | | | | |
| Production ... net tons | 18, 001, 111 | 3, 135, 731 | 21, 136, 842 | 23, 557, 115 | 3, 121, 021 | 26, 678, 136 |
| Value | $83, 195, 531 | $19, 339, 795 | $102, 535, 326 | $101, 901, 297 | $18, 411, 027 | $120, 312, 324 |
| Average value | $4. 62 | $6. 17 | $4. 85 | $4. 33 | $5. 90 | $4. 51 |
| Screenings or breeze: | | | | | | |
| Production ... net tons | 1, 801, 969 | 316, 885 | 2, 118, 854 | 2, 164, 889 | 368, 492 | 2, 533, 381 |
| Sales ... do | 584, 150 | 24, 376 | 608, 526 | 588, 811 | 36, 719 | 625, 530 |
| Value | $1, 335, 512 | $62, 115 | $1, 397, 627 | $1, 138, 844 | $92, 646 | $1, 231, 490 |
| Average value | $2. 29 | $2. 55 | $2. 30 | $1. 93 | $2. 52 | $1. 97 |
| Coal charged into ovens: | | | | | | |
| Quantity ... net tons | 26, 276, 482 | 4, 610, 699 | 30, 887, 181 | 33, 982, 120 | 4, 698, 817 | 38, 680, 937 |
| Coke: | | | | | | |
| Used by producer: | | | | | | |
| Quantity ... net tons | 8, 741, 986 | 857, 240 | 9, 599, 226 | 12, 795, 295 | 647, 532 | 13, 442, 827 |
| Value | $36, 751, 535 | $5, 686, 095 | $42, 437, 630 | $50, 560, 918 | $3, 831, 510 | $54, 392, 428 |
| Sales: | | | | | | |
| Quantity ... net tons | 9, 841, 514 | 2, 408, 670 | 12, 250, 184 | 11, 142, 719 | 2, 684, 107 | 13, 826, 826 |
| Value | $49, 360, 469 | $14, 318, 004 | $63, 678, 473 | $53, 212, 402 | $15, 823, 078 | $69, 035, 480 |
| Byproducts: | | | | | | |
| Gas: | | | | | | |
| Production ... M cubic feet | 291, 887, 464 | 55, 598, 434 | 347, 485, 898 | 375, 122, 227 | 56, 169, 553 | 431, 291, 780 |
| Sales of surplus: | | | | | | |
| Used under boilers: | | | | | | |
| Quantity ... M cubic feet | 9, 520, 121 | 34, 164 | 9, 554, 285 | 26, 065, 573 | 44, 590 | 26, 110, 163 |
| Value | $529, 677 | $11, 829 | $541, 506 | $2, 313, 309 | $10, 889 | $2, 324, 198 |
| Used in steel or affiliated plants: | | | | | | |
| Quantity ... M cubic feet | 64, 886, 051 | 18, 378 | 64, 904, 429 | 94, 838, 582 | 18, 679 | 94, 857, 261 |
| Value | $7, 238, 504 | $10, 445 | $7, 248, 949 | $8, 589, 689 | $10, 627 | $8, 600, 316 |
| Distributed through city mains: | | | | | | |
| Quantity ... M cubic feet | 97, 340, 574 | 49, 364, 996 | 146, 705, 570 | 86, 979, 213 | 48, 609, 982 | 135, 589, 195 |
| Value | $25, 329, 812 | $19, 944, 270 | $45, 274, 082 | $22, 632, 484 | $18, 486, 900 | $41, 119, 384 |
| Sold for industrial use: | | | | | | |
| Quantity ... M cubic feet | 8, 756, 042 | 955, 950 | 9, 711, 992 | 18, 298, 079 | 1, 291, 931 | 19, 590, 010 |
| Value | $1, 477, 696 | $333, 806 | $1, 811, 502 | $3, 548, 312 | $405, 484 | $3, 953, 796 |
| Tar: | | | | | | |
| Production ... gallons | 255, 882, 512 | 47, 929, 534 | 303, 812, 046 | 315, 117, 675 | 48, 180, 911 | 363, 298, 586 |
| Sales: | | | | | | |
| Quantity ... do | 174, 061, 553 | 48, 243, 666 | 222, 305, 219 | 194, 775, 329 | 46, 224, 771 | 241, 000, 100 |
| Value | $6, 865, 288 | $2, 065, 355 | $8, 930, 643 | $7, 152, 129 | $1, 828, 827 | $8, 980, 956 |
| Average value | $0. 039 | $0. 043 | $0. 040 | $0. 037 | $0. 040 | $0. 037 |
| Ammonia: | | | | | | |
| Production ($NH_3$ equivalent of all forms) ... pounds | 154, 206, 054 | 23, 847, 811 | 178, 053, 865 | 188, 706, 272 | 21, 440, 016 | 210, 146, 288 |
| Liquor ($NH_3$ content): | | | | | | |
| Production ... pounds | 30, 524, 808 | 3, 719, 274 | 34, 244, 082 | 36, 395, 407 | 4, 111, 180 | 40, 506, 587 |
| Sales ... do | 30, 686, 943 | 3, 778, 952 | 34, 465, 895 | 36, 210, 271 | 4, 032, 610 | 40, 242, 881 |
| Value | $1, 006, 205 | $65, 797 | $1, 072, 002 | $1, 087, 970 | $71, 917 | $1, 159, 887 |
| Sulphate: | | | | | | |
| Production ... pounds | 494, 724, 983 | 80, 514, 149 | 575, 239, 132 | 609, 243, 459 | 69, 315, 343 | 678, 558, 802 |
| Sales ... do | 521, 682, 220 | 84, 939, 953 | 606, 622, 173 | 589, 762, 574 | 73, 105, 666 | 662, 868, 240 |
| Value | $4, 638, 736 | $727, 683 | $5, 366, 419 | $5, 357, 139 | $671, 626 | $6, 028, 765 |
| Crude light oil: | | | | | | |
| Production ... gallons | 70, 448, 237 | 3, 314, 929 | 73, 763, 166 | 92, 881, 822 | 3, 750, 494 | 96, 632, 316 |
| Sales ... do | 3, 233, 505 | 2, 419, 121 | 5, 652, 626 | 4, 698, 063 | 2, 880, 855 | 7, 578, 918 |
| Value | $284, 080 | $206, 243 | $490, 323 | $449, 730 | $262, 947 | $712, 677 |
| Light-oil derivatives: | | | | | | |
| Production ... gallons | 58, 231, 506 | 658, 536 | 58, 890, 042 | 76, 865, 911 | 648, 733 | 77, 514, 644 |
| Sales ... do | 56, 873, 635 | 626, 938 | 57, 500, 573 | 73, 396, 294 | 621, 056 | 74, 017, 350 |
| Value | $8, 797, 626 | $116, 188 | $8, 913, 814 | $11, 482, 755 | $110, 795 | $11, 593, 550 |
| Naphthalene, crude and refined: | | | | | | |
| Production ... pounds | 4, 616, 992 | 15, 274 | 4, 632, 266 | 6, 603, 139 | 14, 934 | 6, 618, 073 |
| Sales ... do | 3, 699, 330 | 15, 274 | 3, 714, 604 | 6, 508, 270 | 14, 934 | 6, 523, 204 |
| Value | $33, 247 | $76 | $33, 323 | $67, 397 | $75 | $67, 472 |
| All other products, value | $695, 609 | $30, 020 | $725, 629 | $580, 608 | $6, 745 | $587, 353 |

[1] Includes all byproduct ovens built by city gas companies, some of which are operated in conjunction with coal-, oil-, and water-gas plants. Does not include independent byproduct plants which may sell as to public utility companies for distribution.

# RECENT DEVELOPMENTS IN COAL PREPARATION AND UTILIZATION

By A. C. Fieldner

## SUMMARY OUTLINE



In the Minerals Yearbook for 1932–33 [1] the writer presented the background that led up to the new developments in coal utilization. A reading of the previous discussion is necessary to provide the perspective for the following account of new developments in 1933, which also includes a brief review of the present status of the more important developments described in last year's report.

## CLASSIFICATION AND PROPERTIES OF COAL

*Classification.*—After several years of fact finding and research, the Sectional Committee on the Classification of Coal of the American Society for Testing Materials, functioning under the rules of the American Standards Association, has recommended tentative specifications [2] for the classification of coals according to rank [3] and grade. This agreement of the committee is timely in view of the urgent need of authoritative and uniform standards for classification under the coal codes and by regional selling agencies.

The classification by rank is based on the composition and physical properties of the coal, with emphasis on the properties that vary in the progressive alteration of coal in the natural series from lignite to anthracite. The classification by grade depends primarily on the amount and nature of the impurities and is determined by the calor-

[1] Fieldner, A. C., Recent Developments in Coal Utilization; Minerals Yearbook, 1932–33, Bureau of Mines, pp. 433–450.

[2] Fieldner, A. C., Report of the Sectional Committee on the Classification of Coals; Proc. Am. Soc. Test. Mat., vol. 34, 1934. (In press.) Rose, H. J., Coal Classification; Ind. and Eng. Chem., vol. 26, 1934, pp. 140–143.

[3] Selvig, W. A., Ode, W. H., and Fieldner, A. C., Classification of Coals of the United States According to Fixed Carbon and B.t.u.; Am. Inst. Min. and Met. Eng. Tech. Pub. 527, 1934, 11 pp.; Trans., vol. 108, Coal Division, pp. 188–197.

ific value, amount of ash and sulphur, and ash-softening temperature of the coal as sold. Size-stability and caking properties will be included as soon as standard methods for their determination are agreed upon.

During 1933 a number of important papers were published dealing with technical aspects of coal classification. Gauger, Barrett, and Williams [4] determined the ash-forming minerals in a number of coals, and Thiessen [5] calculated the minerals in coal from ash analyses. Thiessen [6] and Herzog [7] presented data on simplified ash-correction formulas. The Illinois Geological Survey [8] published some results from an intensive study of the calorific value of Illinois coals, with particular reference to the regional values of the different beds referred to a unit coal basis—that is, free from moisture and mineral matter.

The growing interest in the composition of coal ash has been recognized by the British Fuel Research Station. Recently it published a description of chemical methods for ash analysis.[9] Now the application of spectrographic methods [10] to the examination of ash for minor constituents and for rare elements is being studied. These may be of importance to users because of their possible catalytic effect upon the reactions of coal hydrogenation. Appreciable quantities of germanium and traces of boron, chromium, lithium, molybdenum, manganese, lead, tin, vanadium, zinc, and possibly gallium have been found in coal ashes.

The Research Council of Alberta has shown that appreciable oxidation [11] takes place during the air-drying of low-rank coals and that the oven-humidity influences the slacking indices of coal as determined by the accelerated test.[12] Both the Canada Department of Mines [13] and the United States Bureau of Mines [14] have continued their studies of simple methods for measuring the caking properties of coals and have published tentative procedures for these tests.

*Grindability.*—Heywood,[15] working with British coals, finds that the relative resistances to grinding of different types of coal, in order of their increasing resistance, are: Fusain, 0.47; vitrain, 1.00; clarain

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[4] Gauger, A. W., Barrett, E. P., and Williams, F. J., Mineral Matter in Coal: Trans. Am. Inst. Minn. and Met. Eng., vol. 108, Coal Division, 1934, pp. 226–236.

[5] Thiessen, Gilbert, The Ash-to-Mineral-Matter Correction in Coal Analysis—A Study Based Upon Coal Ash Analyses; Am. Inst. Min. and Met. Eng. Contrib. 68, 1934, 12 pp.

[6] Thiessen, Gilbert, A Proposed Simplification of the Parr Unit Coal Formula: Fuel, vol. 12, 1933, pp. 403–411.

[7] Herzog, E. S., Application of Ash-Correction Formulas to Alabama Coals: Fuel, vol. 12, 1933, pp. 112–117.

[8] McCabe, L. C., Mitchell, D. R., and Cady, G. H., A Preliminary Report on Unit Coal-Specific-Gravity Curves of Illinois Coals: Trans. Am. Inst. Min. and Met. Eng., vol. 108, Coal Division, 1934, pp. 222–223. Cady, G. M., and Rees, O. W., Unit Coal as a Basis of Coal Standardization as Applied to Illinois Coals: Trans. Am. Inst. Min. and Met. Eng., vol. 108, Coal Division, 1934, pp. 224–225.

[9] King, J. G., and Crossley, H. E., Methods for the Quantitative Analysis of Coal Ash: Dept. Sci. and Ind. Research, Fuel Research, Physical and Chemical Survey of the National Coal Resources, no. 28, H.M.S. Office, London, 1933, 20 pp.

[10] Report of the Fuel Research Board, Dept. Sci. and Ind. Research, H.M.S. Office, London, 1933, p. 34.

[11] Stansfield, E., Lang, W. A., and Gilbart, K. C., Oxidation of Coal and its Relation to the Analysis of Coal: Am. Inst. Minn. and Met. Eng. Contrib. 69, 1934, 10 pp; Trans., vol. 108, 1934, pp. 243–254.

[12] Stansfield, E., and Gilbart, K. C., Effect of Oven-Humidity on Accelerated Weathering Tests of Coal: Am. Inst. Min. and Met. Eng. Tech. Pub. 543, 1934, 8 pp; Trans., vol. 108, 1934, pp. 237–242.

[13] Swartzman, E., Burrough, E. J., and Strong, R. A., A Laboratory Test on Coals for Predicting the Physical Properties of the Resultant Byproduct Coke: Canada Dept. Mines, Mines Branch, Rept. 737–2, 1933, 24 pp. (Advance Section of Investigation of Fuels and Fuel Testing, 1932.) Gilmore, R. E., Connell, G. P., and Nichols, J. H. H., Agglomerating and Agglutinating Tests for Classifying Weakly Caking Coals: Trans. Am. Inst. Min. and Met. Eng., vol. 108, Coal Division, 1934, pp. 255–266. Burrough, E. J., Swartzman, E., and Strong, R. A., Classification of Coals Using Specific Volatile Index: Canada Dept. Mines, Mines Branch, Rept. 725–2, 1933. (Advance Section of Investigations of Fuels and Fuel Testing, 1930–31, pp. 36–50.)

[14] Selvig, W. A., Beattie, B. B., and Clelland, J. B., Agglutinating-Value Test for Coal: Proc. Am. Soc. Test. Mat., vol. 33, pt. II, 1933, pp. 741–760. Barkley, J. F., and Burdick, L. R., Caking Action of Coal on Stokers: Power Plant Eng., vol. 38, 1934, pp. 132–134.

[15] Heywood, H., Characteristics of Pulverized Fuel: Jour. Inst. Fuel, vol. 6, 1933, pp. 241–248.

and durain, 2.18. However, he finds that the hardness and toughness of the coal pulverized has but little effect on "characteristic curves" in which the relative diameters of the particles are plotted against the amounts of residue remaining on the sieve.

Two modifications [16] of the ball-mill method for determining the grindability of coal have been proposed, and enough progress has been made in correlating[17] laboratory "grindability" tests with actual pulverizer performance to permit practical use of these tests. The equally important test for friability or size-stability has been studied. Yancey and Zane[18] conclude that the drop or shatter test is best adapted for showing the breakage occurring in handling the larger sizes of coal in loading and unloading cars but that the tumbler test is the method most generally suitable for estimating the relative friability of different coals because it combines the shattering due to impact and the attrition due to rubbing together of pieces of coal.

*Sampling.*—Issuance of British Standard Specification for the Sampling of Large and Run-of-Mine Coal[19] in August 1933 calls attention to the valuable work of Grumell and Dunningham[20] in making a new study of the principles of coal sampling and in reviewing the classical work of Bailey [21] upon which the present American methods for coal sampling are based. They confirm the necessity for strict observance of the quantities of coal required according to Bailey's "size-weight" theory for each step in the size reduction of gross samples but present a new theory based upon the variability or "average error" of coal consignments. Their data tend to show that the "average error" is a characteristic of commercial coals and increases with increasing ash content. In general, the British methods [22] permit the taking of smaller gross samples, especially in the larger sizes of coal, than does the method of the American Society for Testing Materials, which is a general method applicable to all grades and sizes of coal.

Mott and Wheeler[23] investigated the commercial sampling of coke. They found that more care was required to obtain a correct sample with respect to moisture than with respect to ash. They give a formula for calculating the number of increments necessary from different parts of the consignment to insure a water content within 1 percent of its true value.

*Plastic properties.*—A large number of papers has been published during the year on methods for determining the upper and lower

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[16] Baltzer, C. E., and Hudson, H. P., A Method for Rating the Grindability or Pulverizability of Coal, Developed by the Fuel Research Laboratories (F.R.L.), Department of Mines, Canada: Canada Dept. Mines, Mines Branch, Rept. 737-1, 1933, 17 pp. (Advance Section of Investigations of Fuels and Fuel Testing, 1932.) Yancey, H. F., Furse, O. L., and Blackburn, R. A., Estimation of the Grindability of Coal: Trans. Am. Inst. Min. and Met. Eng., vol. 108., Coal Division, 1934, pp. 267–294.

[17] Hardgrove, R. M., The Relation Between Pulverizing Capacity, Power, and Grindability: Paper Presented at the Semiannual Meeting of Am. Soc. Mech. Eng., Chicago, June 27, 1933; abstract in Power, vol. 77, 1933, p. 342. Frisch, Martin, and Holder, G. C., Correlation of Grindability with Actual Pulverizer Performance: Combustion, vol. 4, no.12; vol. 5, no. 1, 1933, pp. 29–34.

[18] Yancey, H. F., and Zane, R. E., Comparison of Methods for Determining the Friability of Coal: Rept. of Investigations 3215, Bureau of Mines, 1933, 24 pp.

[19] British Standards Institution, British Standard Specification for the Sampling of Large and Run-of-Mine Coal: No. 502, London, 1933, 39 pp.

[20] Grumell, E. S., and Dunningham, A. C., Report on the Sampling of Small Fuel up to 3 Inches; Embodying Some General Principles of Sampling: British Eng. Standards Assoc., no. 403, 53 pp. London, 1930. Grumell, E. S., and King, J. G., The Sampling of Coal and Coke: Proc. Internat. Assoc. Test. Mat., 1931, pp. 317–348; Jour. Inst. Fuel, vol. 6, 1933, pp. 143–159.

[21] Bailey, E. G., Accuracy in Sampling Coal: Ind. and Eng. Chem., vol. 1, 1909, pp. 161–178.

[22] British Standard Specification for the Sampling and Analysis of Coal for Export, British Eng. Standards Assoc., no. 404, 1930, 34 pp. London, 2s. net. British Standard Specification for the Sampling and Analysis of Coal for Inland Purposes: British Eng. Standards Assoc., no. 420, London, 1931, 44 pp.

[23] Mott, R. A., and Wheeler, R. V., The Commercial Sampling and Analysis of Coke: Coll. Guard., vol. 147, 1933, pp. 869–871, 912–916.

temperatures of the plastic stage of coals and the degree of plasticity attained. Bunte[24] and associates of the Gas Institute of Karlsruhe, Germany, have developed an electric furnace and apparatus for determining simultaneously the plastic range and plasticity by the Foxwell nitrogen-flow method, swelling index, and rate of gas evolution.

Pieters, Koopmans, and Hovers[25] have devised a novel type of plastometer, which measures the resistance offered by the compressed charge of pulverized and heated coal to the horizontal movement of a vertical needle.

Gieseler,[26] after study of previous methods, offers a different type of apparatus, with which he measures the plasticity by determining the velocity of rotation of a stirrer shaft immersed in the closely confined charge of pulverized coal. The shaft is driven by a constant force, and the apparatus is standardized with oils of known viscosity.

Arnu,[27] using a modification of the dilatometer method of Audibert and Delmas, showed that even mild oxidation or weathering greatly reduced the swelling properties of certain coals and suggested the use of this test for selecting coal or mixtures of coal for the production of metallurgical coke.

Ping,[28] using the Layng-Hathorne nitrogen-flow method, determined the plastic range of 17 Chinese coals and found that $\frac{\text{pressure difference}}{\text{plastic range}}$ arranged the coals in order of their coking ability.

Mott and coworkers of the Department of Fuel Technology of Sheffield University have continued their studies of the mechanism of coke formation. They developed a form of dilatometer known as the Sheffield laboratory coking apparatus,[29] in which a column of 60-mesh coal is heated gradually and allowed to expand against a loaded plunger. They found that swelling of single particles of bright and dull coals began at approximately the same temperatures as contraction of the column of particles of the same coal subjected to a load of 100 grams and, in case of bright coals, ended at approximately the temperature of final expansion.[30] At the temperature where the column began to contract under load, designated as the softening point, the individual particles began to soften and fill the voids. As long as the gas could escape between voids the column did not expand, but when the softening proceeded to the point where the single particles coalesced to fill the voids the coal column began to expand owing to the force of the evolved gases.[31] The upper temperature limit of plasticity was marked by a sudden release of gases owing to the formation of a rigid coke structure; this limit varied with the degree of freedom for the coal to expand, being raised from about 400° to 500° C. when the coal was heated under conditions not permitting any expansion or free escape of gas.[32]

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[24] Bunte, K., Brückner, H., and Ludewig, W., Experimental Arrangement for Determining the Behavior of Coal During Softening and Coke Formation: Glückauf, vol. 69, 1933, pp. 765–770.
[25] Pieters, H. A. J., Koopmans, H., and Hovers, J. W. T., Some Characteristics of a Coalification Series: Fuel, vol. 13, 1934, pp. 82–86.
[26] Gieseler, K., Measurement of the Plastic Properties of Heated Coal: Glückauf, vol. 70, 1934, pp. 178–183.
[27] Arnu, M. C., La Fusion de la houille: Rev. ind. min., no. 296, Apr. 15, 1933, pp. 155–173.
[28] Ping, K., The Plastic Range of Coking Coals in China: Geol. Surv. China Bull. 21, 1933, pp. 45–56.
[29] Davies, R. G., and Mott, R. A., The Sheffield Laboratory Coking Test: Fuel, vol. 12, 1933, pp. 294–303.
[30] Burdekin, L., and Mott, R. A., The Temperature Range of Swelling of Single Coal Particles: Fuel, vol. 12, 1933, pp. 232–235.
[31] Davies, R. G., and Mott., R. A., The Softening and Swelling of Coal in Relation to Plasticity: Fuel, vol. 12, 1933, pp. 330–340.
[32] Davies, R. G., and Mott, R. A., The Plasticity of Coal: Fuel, vol. 12, 1933, pp. 371–382.

The range between the softening or initial contraction temperature and the initial expansion temperature is termed the stage of primary plasticity, and the range over which the coal swells is called the stage of secondary plasticity. It was found that the temperature of initial oil evolution coincided with that of initial gas evolution and that these phenomena occurred at about the initial contraction or softening temperature as determined in the Sheffield Laboratory dilatometer test.[33]

Mott [34] believes that the development of plasticity in a coal and consequently its coking properties are conditioned by the wettability of the solid residue by the oils formed on heating the coal. Oxidizing the surfaces of coal particles decreases the wettability and consequently destroys the plasticity and coking power. Foxwell [35] agrees that wettability is an important factor but believes that the action of expanding gases in forcing fluid matter to the surfaces of particles and in swelling the pieces of coal so as to put the charge under pressure also is necessary to the formation of a strong, coherent coke.

*Chemical constitution and utilization.*—Lowry, of the Coal Research Laboratory, Carnegie Institute of Technology, on the basis of a critical review of published data, concludes that the coal molecule has resulted from condensation and polymerization of polynuclear six-membered carbon ring compounds [36] and suggests that this structure becomes more and more condensed as coal passes through the various ranks —peat, lignite, bituminous coal, and anthracite. The aromatics found in coal tar result primarily from dehydrogenation and decarboxylation of depolymerized nuclei present in the original coal.[37] He points out the need for additional work on the fundamental chemistry of coal and its reactions in order that it may be utilized to better advantage.[38]

An excellent review of the nature and occurrence of lignite and the progress made in its utilization has been published by Lavine.[39]

## PREPARATION OF COAL

*General features.*—In 1933 continued progress was made in the preparation of coal for the market, though at a somewhat reduced pace. Development was confined principally to the improvement of existing facilities or the installation of new equipment for sizing and/or cleaning small coal, to meet the demand partly occasioned by the increased use of automatic stokers for heating homes and other small buildings.

The capacity of screening and hand-picking methods installed or contracted for during the year was reported to be about 6,770 tons per hour and that for mechanical cleaning equipment about 5,575 tons per hour.[40] This survey showed that new major preparation facilities were installed at 63 plants during the year and that 31 of these included units for the mechanical cleaning of all or some portion

[33] Allison, J. P., and Mott, R. A., The Influence of Oil on Coke Formation: Fuel, vol. 12. 1933, pp. 258–268.
[34] Mott, R. A., The Formation of Coke: Fuel, vol. 12, 1933, pp. 412–418.
[35] Foxwell, G. E., The Mechanism of Coke Formation: Gas Jour. (London), vol. 201, 1933, p. 813; vol. 202, 1933, pp. 41, 100.
[36] Lowry, H. H., The Chemical: Coal: Ind. and Eng. Chem., vol. 26, 1934, pp. 133–139.
[37] Lowry, H. H., Thermal Decomposition of the "Coal Hydrocarbon": Ind and Eng. Chem., vol. 26, 1934, pp. 320–324.
[38] Lowry, H. H., Some Aspects of Coal Utilization: Trans. Am. Inst. Chem. Eng., vol. 30, 1933. (In press.)
[39] Lavine, Irvin, Progress in Low-Rank Coals: Ind. and Eng. Chem., vol. 26, 1934, pp. 154–164.
[40] Coal Age, Preparation at Bituminous-Coal Operations Reflects Changing Market Demands: Vol. 39, 1934, pp. 60–62.

of the product. All modern types of coal washing and cleaning equipment were represented. The new jig installations are mostly of the Baum type, in which air pressure instead of a piston is used to produce mobility in the jig bed. So far as is known, the first use of the photoelectric cell for controlling the discharge of refuse from a jig bed has been made at one of the mines of the Union Collieries Co., at Renton, Pa.

The apparent trend toward the increased use of the smaller sizes of coal has caused further attention to be given to dedusting methods, better cleaning methods, and improved methods for crushing coal with a minimum production of dust. Curiously enough, this trend toward small coal appears at a time when the introduction of new methods of mining—such as the coal saw, compressed air and carbon dioxide, and new methods of blasting—tend toward increasing the percentage of lump coal produced.

Two new dry-cleaning shaking tables were developed during the year; one employs both reciprocation and flow of air to produce mobility in the separation bed,[41] and the other utilizes reciprocation without air to separate 2 to 1¼-inch nut coal in a bed of 5/16- to 0-inch coal.[41] [42] The former device was developed at the Battelle Memorial Institute, Columbus, Ohio, and the latter has been installed at the No. 18 mine of the Peabody Coal Co., West Frankfort, Ill., to handle a size formerly hand-picked.

The Southern Experiment Station of the Bureau of Mines, in cooperation with the University of Alabama, has continued washability studies of southern coals.[43] The University of Illinois has published a study of the washing characteristics of Illinois coals.[44]

*Flotation.*—Little progress was made in the United States in the increased use of froth flotation for cleaning fine coal sludges, although the Pittsburgh Coal Co. continued the flotation plants at its mines. In Europe about 60 coal flotation plants have been installed; Germany and Spain have over 20 and England 6, with a combined capacity of about 3,000,000 tons per year.[45] A summary of the present status of coal flotation was published during the year by the Bureau of Mines.[46] In England the Fuel Research Station [47] continued its study of the Elmore vacuum system of flotation for cleaning fine coal, largely because of the ease of draining the clean coal produced. Coal up to ⅛-inch size is handled by this process with no frothing reagent.

The Fuel Research Station also continued its investigation of the baffling of conical sludge tanks to improve settling of sludge and clarification of washery water. Tanks with two types of baffles gave 27- and 43-percent increase in settling capacity over the same tank without baffles.

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[41] See footnote 40, p. 631.
[42] Morrow, J. B., Progress in the Coal Industry; Coal Preparation: Min. and Met., vol. 15, 1934, p. 57.
[43] Gandrud, B. W., Richardson, A. C., and Payne, W. G., Washability Studies of the Blue Creek Bed at the Connellsville Mine, Connellsville, Ala.: Rept. of Investigations 3200, Bureau of Mines, 1933, 10 pp. Richardson, A. C., and Carrington, W. H., Washability Studies of the Mary Lee Bed, at the Powhatan Mine, Powhatan, Ala.: Rept. of Investigations 3204, Bureau of Mines, 1933, 15 pp. Richardson, A. C., and Gandrud, B. W., Washability Studies of Coal from the Mary Lee Bed at the Bankhead Mine, Bankhead, Ala.: Rept. of Investigations 3206, Bureau of Mines, 1933, 9 pp. Richardson, A. C., and Gandrud, B. W., The Cleaning of Fine Coal from the Mary Lee Bed at the Porter Mine: Rept. of Investigations 3209, Bureau of Mines, 1933, 8 pp.
[44] Mitchell, D. R., The Possible Production of Low Ash and Sulphur Coal in Illinois as Shown by Float-and-Sink Tests: Univ. of Illinois-Eng. Exp. Sta. Bull. 258, 1933, 44 pp.
[45] Mayer, Erwin W., Why and When to Use Flotation Process: Coal Age, vol. 38, 1933, pp. 333–334.
[46] Yancey, H. F., and Taylor, J. A., Flotation Processes for Cleaning Fine Coal: Information Circ. 6714, Bureau of Mines, 1933, 31 pp.
[47] Report of the Fuel Research Board, Dept. Sci. and Ind. Research, H.M.S. Office, London, 1932, pp. 23–25.

German investigators [48] found that fusain could be floated effectively from dust and slimes of certain Ruhr and British coals; with certain others no selective flotation was obtained.

A British patent [49] has been issued for the separation of resins from finely powdered coal in two stages of flotation. Ammonium hydroxide, turpentine, pine oil, or cresol is the frothing agent in the first stage; and potassium alum, with additional ammonium hydroxide, is used in the second stage.

*Dedusting.*—The practice of removing some portion of the finer sizes from the feed to a washing or cleaning plant, or from a product for some special market, increased during the year. In Illinois two mines installed or modified equipment for dedusting buckwheat coal marketed as stoker fuel. Ten-mesh vibrating screens operating in combination with air aspiration for removal of material through 48-mesh are used at one of the plants and vibrating screens alone at the other.

Although screening fine coal from the feed to washing or cleaning plants has been a common practice,[50] the removal of the finest sizes pneumatically has not progressed in the United States as rapidly as in Europe.[51] The disposal of the dust so produced is a major problem. An excellent review [52] of the various systems employed in England and the methods of utilizing the dust has been issued by the Utilization of Coal Committee of the Institution of Mining Engineers.

*Prevention of breakage.*—An improved device for minimizing the breakage of coal during the loading of ships was announced in England.[53] It consists of a telescopic tube that maintains a continuous unbroken column of coal to the point of discharge. Breakage of the column due to the collapse of the heap of coal or other sudden movements is said to be impossible. Such a device may prove useful for purposes other than ship loading.

*Dust-prevention treatment and dyeing.*—Continued interest has been shown in the preparation of dustless coal and coke. Calcium chloride, oils, and various other materials are sprayed on domestic fuels, either at the mine or coal yard, to prevent dusting.[54]

The necessity of providing a quantitative method for measuring dustiness of coal and coke has been recognized by the Koppers

[48] Kühlwein, F. L., Separation of Fusain by Selective Coal Flotation: Glückauf, vol. 70, 1934, pp. 245–252

[49] Skerrett, H. N., Process for the Extraction of Resin from Coal: British Patent 357733, Oct. 1, 1931.

[50] Yancey, H. F., and Fraser, T., Coal-Washing Investigations; Methods and Tests: Bull. 300, Bureau of Mines, 1929, pp. 203–206.

[51] Futers, T. Campbell, A New Dedusting Plant: Coll. Guard., vol. 147, 1933, pp. 335–336. Holmes, C. W. H., The Dedusting of Coal: Coll. Guard., vol. 147, 1933, pp. 197–200. Hebley, Henry F., The Dedusting of Coal: Am. Inst. Min. and Met. Eng. Contrib. 43, 1933, 39 pp.; Trans., vol. 108, 1934, pp. 88–127; abstracted in Coal Age, as What Has Dedusting to Offer Coal Operators in Preparation and Sales Advantages: vol. 38, 1933, pp. 263–265. Appleyard, K. C., Dedusting Coal: Coal Age, vol. 38, 1933, pp. 54–55, 89–91. Report of the Fuel Research Board: Dept. Sci. and Ind. Research, H. M. S. Office, London, 1933, pp. 49–51. Chapman, W. R., Recent Progress in Coal-Cleaning Practice in Great Britain: Proc. 3d Internat. Conf. on Bituminous Coal, Carnegie Inst. Technol., vol. 2, 1931, pp. 742–758. Rosin, P., and Rammler, E., Aspirators and Their Investigation: Gluckauf, vol. 68, 1932, pp. 529–537.

[52] Institution of Mining Engineers, Utilization of Coal Committee, The Dedusting of Coal: Mem. 13, 1934, 4 pp.

[53] Futers, T. Campbell, The Morison-Leonard Anti Coal Breaker for Loading Ships: Coll. Guard., vol. 147, Dec. 15, 1933, pp. 1112–1114. Morison, Alan Mushet, and Leonard, Wilfred John, Apparatus for Discharging Coal and Other Materials: United States Patent 1951703, Mar. 20, 1934.

[54] Wallace, Frederick J. (to Robeson Process Co.), Preserving Coal: United States Patent 1910975, May 23, 1933 (uses a dilute solution of black-strap molasses). Odell, B. F. J., Method of Producing a Prepared Fuel: United States Patent 1922391, Aug. 15, 1933 (uses an oil-water emulsion). Spencer, Geo. P., Process of Treating Coal and Coke: United States Patent 1916539, July 4, 1933 (uses an aqueous lignosulphuric acid solution, with coloring matter if desired). Standard Oil Development Co., Process and Product for Treating Solid Fuels in a Way to Reduce Their Tendency to Produce Dust: French Patent 746567, March 14, 1933 (uses an aqueous solution of sodium sulphonate or other sulphonic compound derived from petroleum). Fife, Harvey R., Method of Treating Coal: United States Patent 1912697, June 6, 1933 (uses paraffin wax).

Research Laboratory. Their method, after use over a period of years, was published in 1933.[55]

Processes have been proposed for improving the ignitability of coke by coating it with a film of coal dust, using tar as an adhesive[56]; also for giving it a distinctive appearance by quenching it in water containing coloring materials or even electroplating the coke with copper or nickel.[57]

*Flocculation of slurries.*—Improvement in the clarification of washery water and increased rate of settling of solids have been obtained at several washeries in the United States through the use of lime as a flocculating agent. In Belgium further development in the use of frozen starch grains for this purpose has been made by M. R. A. Henry, managing director of a large colliery.[58] This process, or a modification of it, has been examined by several coal companies in the United States. In this process lime, starch, and caustic soda solutions are added to slurry water in the proportion of 9 ounces of lime, ¼ ounce of starch, and ½ ounce of caustic soda per ton of slurry water.

An anthracite colliery in Wales found ammonium and calcium hydroxides very satisfactory for clarifying washery water and preventing the adsorption of clay on the surface of the finer commercial sizes below 1 inch.[59] In Germany the use of colloids instead of electrolytes is favored. Protective colloids, particularly those of vegetable origin, such as swollen potato starch, were found to increase the settling rate greatly.[60] Successful, practical results were obtained in five Ruhr washeries.[61] Five to thirty grams of starch were added to each cubic meter of slurry per 100 grams of solids in the slurry. The larger amounts of starch were required for high-volatile low-rank coals; the smaller amounts for medium- or low-volatile coking coals. The clarified water contained less than 1 gram of solids per cubic meter.

Studies at the British Fuel Research Station show that the best treatment varies with the local condition at each washery.[62]

## BRIQUETTING

The Illinois State Geological Survey has made briquets satisfactory with respect to hardness and friability from certain Illinois bituminous coals without the addition of binding materials.[63] One-tenth of a pound of coal, crushed to pass a ¼-inch to ⅜-inch screen and preheated 10 minutes at 300° C. in an oven, was briquetted by the impact of a 500-pound weight dropped 4½ feet. No information on the commercial success of the experimental Apfelbeck press for briquetting German bituminous coals without binder, referred to in last year's

[55] Powell, A. R., and Russell, C. C., Method for Determining the Dustiness of Coal and Coke: Ind. and Eng. Chem., Anal. Ed., vol. 5, 1933, pp. 340–341.

[56] Hodsman, H. J., Coke for Open Fires: Gas Jour. (London), vol. 201, 1933, p. 737.

[57] Sperr, F. W., Jr. (to Koppers Co.), Coke Treatment: United States Patent 1928214, Sept. 26, 1933.

[58] Gifford, R. D., The Clarification of Colliery Waste Water: Coll. Guard, vol. 148, 1934, p. 350.

[59] Samuel, J. O., The Flocculation of Washery Water: Coll. Guard., vol. 145, 1932, pp. 939–941, 985–987.

[60] Petersen, W., and Gregor, F., The Clarification of Coal Washery Slimes: Glückauf, vol. 68, 1932, pp. 621–630.

[61] Peterson, W., Works Experiments on the Clarification of Slurries from Bituminous-Coal Washeries: Glückauf, vol. 70, 1934, pp. 125–131.

[62] The Institution of Mining Engineers, Utilization of Coal Committee, Slurries: Mem. 14, March 1934, 3 pp.

[63] Piersol, R. J., Briquetting Illinois Coals without a Binder by Compression and Impact: Illinois State Geol. Surv., Rept. of Investigations 31, 1933, 70 pp.

report, has been published, but the Coppee Co. is working on a similar process in France and Belgium.[64]

## COMBUSTION

One of the outstanding papers of the year on underfeed combustion was contributed by the Pittsburgh Experiment Station of the United States Bureau of Mines. It showed that the rate of ignition is much more important in underfeed burning than it is in overfeed fuel beds and that it fixes limits to the outputs that can be obtained.[65]

Activity is continuing in the development and installation of automatic domestic stokers. Domestic pulverized-coal burners are being tried out in Ohio, and the Anthracite Institute's "heat machine" was exhibited at the Century of Progress. The Philadelphia & Reading Coal & Iron Co. has developed a house-heating furnace for anthracite which automatically feeds the fuel from a storage bin and removes the ash to a receiver. It also provides hot water and may be combined with air-conditioning equipment for cooling the house in the summer. A commercial machine of this type has provided the world's first coal refrigerator in a Pottsville (Pa.) meat-storage warehouse.

*Colloidal fuel.*—No continuous practical use of oil-coal mixtures has been made since the trip of the Cunard liner *Scythia* across the Atlantic nearly 2 years ago. Patents [66] issued to this company indicate that they used a mixture of 180-mesh coal with a hydrocarbon oil having a fixed-carbon content of at least 5 percent without a stabilizer.

The British Fuel Research Station found that a suspension of 40 percent coal dust in a Persian fuel oil that had been converted to a dilute gel by the addition of 0.5 percent sodium stearate showed no appreciable separation after standing for 5 months at atmospheric temperature, whereas without the stabilizer the mixture began to separate after 20 days.[67] Benthin obtained stable mixtures of pulverized lignite and oil using stabilizers of 1.5 percent soap or creosote oil and small amounts of alkali soaps.[68] From 70 to 80 percent thermal efficiencies have been reported in tests on stationary boiler furnaces.[69] Several interesting reviews of the subject have appeared within the year.[70]

*Coal-dust engines.*—The fuel economy obtained by the direct combustion of coal dust in the cylinders of internal-combustion engines continues to attract discussion. It is reported that a Government committee of experts is looking into the subject in Germany.[71]

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[64] Colliery Guardian, A New Method of Upgrading Slack Coal: Vol. 148, 1934, pp. 352–353.

[65] Nicholls, P., and Eilers, M. G., The Principles of Underfeed Combustion and the Effect of Preheated Air on Overfeed and Underfeed Fuel Beds: Combustion, vol. 4, no. 12; vol. 5, no. 1, 1933, pp. 15–28; Trans. Am. Soc. Mech. Eng., vol. 56, 1934, pp. 321–336.

[66] Adam, R. A., Holmes, F. C. V., and Perrins, A. W., The Cunard Steam Ship Co., Ltd., Improved Dispersion of Coal in Oil: British Patent 396,432, Aug. 2, 1933.

[67] Wigginton, R., Oil-Coal Fuels: Fuel, vol. 12, 1933, pp. 291–292; Suspension of Coal in Oil: Report of the Fuel Research Board, Dept. Sci. and Ind. Research, H. M. S. Office (London), 1933, pp. 115-116.

[68] Benthin, G., Flow Coal from Lignite: Ztschr. angew. Chem., vol. 46, 1933, pp. 742–744.

[69] Schultes, W., Combustion Experiments with Flow Coal: Glückauf, vol. 68, 1932, p. 1198; German Trials with Coal Oil Fuel: Steam Eng., vol. 2, no. 5, 1933, p. 203; A New High Pressure Steam Generator: Eng. and Boiler House Rev., vol. 46, 1933, pp. 511–512.

[70] Brownlie, David, Colloidal Fuel; A Survey of the Present Position: Steam Eng., vol. 3, 1934, pp. 183–184. Tollemache, H. D., Pulverized Coal and Colloidal Fuel: Proc. South Wales Inst. Eng., vol. 49, 1933, pp. 163–198.

[71] Maercks, J., The Use of Pulverized Fuel in Diesel Engines: Glückauf, vol. 69, 1933, pp. 1016–1023; Coll. Guard., vol. 148, 1934, p. 259. Martin, W. H., Comparative Costs of Rupa Coal-Dust Engine, Diesel Engine, and Coal-Fired Steam Power; Internal Combust. Eng., vol. 1, 1934, pp. 137–138; Marine News, vol. 20, no. 7, 1933, pp. 67–70; abs. in Mech. Eng., vol. 56, 1934, p. 170.

## COMPLETE GASIFICATION

*Oxygen enrichment.*—Oxygen enrichment again is being tested for the production of producer gas. At the Tegel works in Berlin, Germany, a gas plant of commercial size has been operated under atmospheric pressure on brown-coal briquets and oxygen saturated with water vapor at 91° C. The Lurgi Gesellschaft has operated a test plant continuously for several months. At a gas pressure of 20 atmospheres 184 pounds of fuel per hour per square foot cross-section of shaft was gasified. The fuel column was 10 feet high. It is claimed that the advantages of the process more than outweigh the cost of the oxygen at a price of 5¾ d. per cubic foot.[72]

## HIGH-TEMPERATURE CARBONIZATION

The present low ebb in the construction of new coke ovens has not favored new developments of design. However, an interesting new idea is the "Still" process recently described by Dean.[73] The Still oven is provided with 10 or 12 gas-collecting pipes inserted into the middle of the charge from the top of the oven at equidistant intervals. Suction on these pipes maintains a pressure slightly below atmospheric. The gases and vapors evolved in the plastic layer are drawn through the uncoked coal instead of passing outward through the hot coke to the oven walls. Decomposition of liquid products is minimized, and the yields and quality of light oil and tar are said to be improved considerably. Results from commercial plants at Wolfsbank and Achenbach, Westphalia, Germany, indicate 30- to 40-percent increase in benzol, 10- to 20-percent increase in tar, and 15- to 25-percent reduction in ammonia.

The increasing demand for benzol in Germany has stimulated efforts to increase yields by decreasing decomposition of light oils in the hot space above the oven charge. Thau [74] describes two modifications of ovens in which collecting channels built into the tops of the ovens facilitate the rapid removal of benzol vapors from the hot space above the charge. Decomposition is reduced, and the yields of benzol are said to be increased 8 to 10 percent.

The Pittsburgh Experiment Station of the United States Bureau of Mines has continued at a restricted rate its studies of the gas-, coke-, and byproduct-making properties of American coals. Splint-coal bands from the Elkhorn bed in western Kentucky gave a higher yield and a stronger coke than was obtained from bright coal bands in the same seam. However, the yield of tar from the bright coal was greater than from the splint. The yield and quality of the gas from the two types of coal was nearly the same.[75]

*Properties of coke.*—The Midland [76] and Northern [77] Coke Research Committees of England have continued active work on blending coals and determining the properties of the coke produced in small experimental ovens.[78] The Northern Committee has designed a new

[72] Drawe,—Gasification with Oxygen: Gas Jour., vol. 203, 1933, p. 95.
[73] Dean, H., The "Still" Process: Fuel, vol. 13, 1934, pp. 112–115.
[74] Thau, A., Increasing Benzol Yields from Coke Ovens: Brennstoff-Chem., vol. 15, 1934, pp. 41–45.
[75] Fieldner, A. C., Davis, J. D., Reynolds, D. A., and Holmes, C. R., High-Temperature Carbonizing Properties of Coal: Ind. and Eng. Chem., vol. 26, 1934, pp. 301–303.
[76] Midland Coke Research Committee, Report of Progress during 1933: Fuel, vol. 13, pp. 51–54.
[77] Annual Report of the Northern Coke Research Committee, Solving Problems by Cooperation: Gas World, Coking Sec., vol. 99, 1933, pp. 75–76.
[78] Mott, R. A., The Evaluation and Blending of Coals for Coke Making: Fuel, vol. 12, 1933, pp. 13–25.

apparatus [79] for the laboratory determination of combustibility in air of small samples of 10–20 mesh coke. The measure of combustibility is the minimum air current through the apparatus in cubic feet per minute that will maintain combustion in the sample for 20 minutes or more after it has been ignited by means of an electrical heater under standardized conditions.

Other investigators have continued their efforts to find chemical substances that can be added to the coal before coking to increase the combustibility or lower the ignition temperature of the resultant coke. Experiments at Leeds University [80] show that sodium carbonate lowers the ignition temperature of cokes prepared above 600° C. but has no effect on those made below 600°. Sodium carbonate, calcium carbonate, or iron oxide increased the reactivities of the cokes. Similar results were obtained by German investigators.[81] White and Fox,[82] of the University of Michigan, found that less than 10 percent of a sodium compound, such as sodium carbonate, mixed with carbonaceous fuel in a gas generator substantially decreased the amount of carbon dioxide in the producer gas and permitted a reduction of the operating temperature to about 925° C.[83]

*Light-oil recovery.*—The activated-carbon light-oil recovery plant at Beckton, England, the largest in the world, is producing 3,000,000 imperial gallons of benzol annually, or 3. imperial gallons per long ton of coal coked.[84] The extraction efficiency is usually over 92 percent. The average over-all steam consumption has been 36.6 pounds per gallon, and the average rate of carbon replacement, 7.1 pounds per 1,000 pounds of benzol. Virtually all the organic sulphur is removed.

Parallel tests of oil absorption and activated carbon processes at Frankfurt-am-Main, Germany, showed higher recoveries and greater removal of organic sulphur compounds, hydrocyanic acid, naphthalene, and other undesirable impurities [85] by the activated-carbon process. Activated charcoal also is being used in Germany for the removal of phenols from crude gas liquors but does not appear as promising as the tricresyl phosphate process developed by I. G. Farbenindustrie. Tricresyl phosphate has 8 times the solvent power of benzene for phenol and 30 times the solvent power for the higher tar acids.[86]

The direct recovery of commercial fractions of tar at coke ovens, using the sensible heat of the oven gases, has made further growth in Great Britain, where this process has been installed at several plants for the production of standard road tars.[87]

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79 Blayden, H. E., Noble, W., and Riley, H. L., A Simple Laboratory Method for the Assessment of the Combustible Nature of Coke: Gas World, vol. 100, 1934, pp. 106–110.

80 Parker, A., Kerr, H., and Marson, C. B., Influence of Various Factors on the Ignition Temperature, Reactivities, and Structure of Coke: Trans. Inst. Gas Eng., vol. 78, 1928–29, pp. 240–248; vol. 79, 1929–30, pp. 50–103, 143–55.

81 Neumann, B., and van Ahlen, A., Influencing Reactivity of Pure Coke by the Addition of Certain Inorganic Substances likely to Occur in the Ash: Brennstoff Chem., vol. 15, 1934, pp. 61–64.

82 White, A.H., and Fox, D. A., Producer-Gas Process using Sodium Carbonate: United States Patent 1948085, Feb. 20, 1934.

83 Weiss, C. B., and White, A. H., Influence of Sodium Carbonate upon the Producer-Gas Reaction: Ind. and Eng. Chem., vol. 26, 1934, pp. 83–87.

84 Hollings, H., and Hay, S., The Recovery of Benzole by Active Carbon: The Gas World, vol. 100, 1934, pp. 189–193; Chem. and Ind., vol. 53, 1934, pp. 143–55.

85 Engelhardt, A., and Rüping, H., Improving the Purity of Manufactured Gas by Recovering Light Oils with Active Carbon: Gas u. Wasserfach, vol. 76, 1933, pp. 478–84; abstracted in Gas Jour., as Recovering Benzole with Activated Carbon, vol. 203, 1933, p. 154.

86 Tupholme, C. H. S., Tricresyl Phosphate as Solvent for Phenol Recovery from Gas-plant Effluents: Ind. and Eng. Chem., vol. 25, 1933, pp. 303–304.

87 Cooke, F., Progress in the Direct Recovery of Standard Road Tars and Other Tar constituents from Vertical Retort, Coke Oven, and Other Producing Plants: Gas World, Coking Sec., vol. 98, 1933, pp. 50–56; abs. in Ind. and Eng. Chem., News Ed., vol. 12, 1934, p. 16.

*Gum deposits.*—No entirely satisfactory method has yet been put into practice to eliminate completely the formation of gums in manufactured-gas distribution lines. Research over the last decade has shown that the sources of these gums are unsaturated hydrocarbons, such as styrene, indene, etc., which, in the presence of small amounts of oxygen and even smaller concentrations of nitric oxide, oxidize and polymerize to form gums or resins, which plug up pilot lights and make meters run slow.[88] In order more readily to study the effect of small percentages of nitric oxide in gases, Fulweiler developed an apparatus in which oxygen and gas are mixed in equal proportions by volume, and the $NO_2$ thus formed is determined colorimetrically.[89]

*Sulphur recovery processes.*—The substitution of ammonia from the weak ammonia liquor for soda in the Thylox process for gas purification at Racine, Wis., has made it possible to dispose of the sulphur as a profitable byproduct.[90]

In England the decline in the returns from ammonia stimulated Imperial Chemical Industries, Ltd., to the development of the "Auto" process, which simultaneously removes hydrogen sulphide, hydrogen cyanide, and over half of the ammonia from coke-oven gas.[91] The process depends on the reduction and oxidation of iron ammonium ferrocyanide, which is formed by scrubbing the gas initially with a solution of ferrous sulphate. Free sulphur is recovered by flotation. The total costs, estimated on the basis of an experimental plant, are reported as about 0.41 d. per 1,000 cubic feet of gas.

Recent German developments in dry purification, using towers and extracting the sulphur at the plant, are reported to have economic advantages over wet-purification methods.[92] Of special interest in this connection is the Raffloer dry purification process described by Thau.[93] Specially prepared iron hydroxide is formed into strong porous balls about five-eighths to seven-eighths of an inch in diameter. These balls are packed into cylindrical towers, thus permitting high gas velocities with very low back pressure. The sulphur-saturated balls are removed from the towers, the sulphur leached out and recovered for the market, and the regenerated balls returned to the towers. An experimental plant is located at the Concordia colliery near Oberhausen on the Rhine.

*Gas as motor fuel.*—The use of compressed gas as motor fuel continues to receive active support from the manufactured-gas companies in England.[94] Several gas filling stations have been established, and certain bus and trucking lines are using gas for demonstration or

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[88] Brown, R. L., Gum- and Resin-Forming Constituents in Artificial Gas: Proc. Am. Gas Assoc. Monthly, vol. 4, 1922, pp. 435–436; Gummy Deposits in Gas Meters: Proc. Am. Gas Assoc., vol. 6, 1924, pp. 1353–1411; Some General Considerations of the Gummy Meter Problems in the Gas Industry: Am. Gas Assoc. Monthly, vol. 5, 1923, pp. 309–316. Ward, A. L., Jordan, C. W., and Fulweiler, W. H., Gum Deposits in Gas-Distribution Systems: I, Liquid-Phase Gum: Ind. and Eng. Chem., vol. 24, 1932, pp. 969–977; 1238–1247; vol. 25, 1933, pp. 1224–1234.

[89] Fulweiler, W. H., The Gum Problem; Recent Developments: Proc. Am. Gas Assoc., 1933, pp. 829–846.

[90] McBride, R. S., Making Sulphur in City Gas a Profitable Byproduct: Chem. and Met. Eng., vol. 40, 1933, pp. 398–401. Denig, Fred, Gas-Purification and Ammonium-Sulphate Manufacture: Proc. Am. Gas Assoc., 1933, pp. 903–912; New Ideas on Gas Purification and Sulphate Manufacture: Gas Age Record, vol. 71, 1933, pp. 593–596, 604. Denig, Fred, and Powell, A. R., Liquid Purification of Gas and Some Recent Developments: Proc. Am. Gas Assoc., 1933, pp. 913–925.

[91] Smith, Frank F., and Pryde, D. R., A Wet Process for the Removal of Hydrogen Sulphide from Coke-Oven Gas: Gas World, Coking Sec., vol. 100, 1934, pp. 44–46.

[92] Rettenmaier, A. R., Economics of Dry and Wet Gas Desulphurization: Glückauf, vol. 70, 1934, pp. 228–232.

[93] Thau, A., Dry Gas Purification with Sulphur Recovery: Coll. Guard., vol. 148, 1934, pp. 151–153; New Process for Gas Desulphurization: Gas u. Wasserfach, vol. 77, 1934, pp. 33–35.

[94] Walter, C. M., Town's Gas for the Running of High Speed Internal Combustion Engines: Gas World, vol. 99, 1933, pp. 87–91; Coll. Guard., vol. 147, 1933, pp. 53–55; Gas for Internal-Combustion Engines: Gas Jour., vol. 203, 1933, pp. 302–304; The Possibilities of Compressed Gas: Indust. Gas Supp.; Gas World, vol. 100, 1934, p. 22.

experimental purposes.[95] Usually the gas equipment on a bus or truck consists of 6 to 8 steel containers of gas at 3,000 pounds per square inch pressure giving a cruising range of 60 to 70 miles.

## LOW-TEMPERATURE CARBONIZATION

*Foreign developments.*—After a few years of comparative indifference increasing interest is being shown in the upgrading of low-ash, fine sizes of coal by low-temperature carbonization at the mine. The Utilization of Coal Committee of the British Institution of Mining Engineers, after consideration of the economics of the situation and assuming that a suitable technical process is available, concludes that the manufacture of a low-temperature coke of good quality from cheap small coal should prove a profitable undertaking for coal companies but that, with future growth of the industry, the profits might decrease because of the equalizing of prices of small and lump coal.[96] In general, the low-temperature plants operating at present are situated at mines and working under the conditions prescribed by the committee.

The three Coalite plants[97] of Low Temperature Carbonization, Ltd., at Barugh, near Barnsley, Doncaster, and at the South Metropolitan Gas Works in London are operating at full capacity. The Bussey plant at Glenboig near Glasgow has been started up again by another company.[98] A 50-ton capacity battery of Hird retorts is being installed at the Nostell Colliery, Ltd., near Wakefield. The retorts, of cast-iron heat-resisting metal, have a capacity of 2¼ tons of coal and operate on the intermittent, externally heated system.[99]

Although the first Illingworth plants in England failed to operate successfully owing to faulty design, these defects have been corrected in later plants erected in France and Italy. During the year the plant at Courrières has been doubled in size to give a capacity of 250 tons a day. Another 250-ton plant was started up in September 1933 at Maubeuge, and the plant in Italy is in operation.[1]

Because of the lack of home supplies of anthracite many French low-temperature processes are directed toward the production of so-called artificial anthracite made from washed bituminous fines. In several of the processes, the material is briquetted with pitch binder and recarbonized at low temperatures. Most of the processes mentioned in the 1932–33 Minerals Yearbook, as well as several new ones, are operating at various mines.[2]

The outstanding new process of the year is the Koppers mid-temperature or high-temperature (as desired) coking plant at the

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[95] Gas Age-Record, Operating Motor Vehicles with Compressed Coal Gas: A Report on Experiments Carried Out by the Newcastle-upon-Tyne and Gateshead Gas Co., England, vol. 72, 1933, pp. 503–504. The Length of England on Compressed Gas-Converted Larry's Journey: Gas World, 670-Mile Test by Whitewood Chemical Co., and New Gas Filling Stations Established: Ind. Gas. Suppl., vol. 100, 1934, p. 22; Gas Journal, Wallasey Adapts Gas for Road Vehicles: Vol. 205, 1934, p. 299.

[96] The Institution of Mining Engineers, Utilization of Coal Committee, The Economics of Low-Temperature Carbonization at Collieries: Mem. 12, 1933, 7 pp.

[97] Fuel Economist, Progress of New British Industry; Smokeless Fuel: Petrol and Fuel Oil, vol 9, December 1933, pp. 134–141.

[98] Iron and Coal Trades Review, Bussey Coal Distillation Co., Ltd.: Vol. 127, 1933, p. 1006.

[99] Chemical Age, The Hird Low-Temperature Carbonization Process: Vol. 30, 1934, pp. 246–247.

[1] Colliery Guardian, Illingworth, L. T., Plants: Vol. 148, 1934, p. 97.

[2] Colliery Guardian, Synthetic Anthracites: Vol. 146, Feb. 3, 1933, p. 209. Berthelot, Ch., The Present Technique of Low Carbonization in France and England: Génie civil, vol. 103, 1933, pp. 513–518, 543–545. Colliery Guardian, The "Thermax" Low-Temperature Carbonization Process: Vol. 147, 1933, pp. 254–255. Berthelot, Ch., Modern Methods of Carbonization at Low Temperature and of the Preparation of Synthetic Anthracite: Chim. et ind., vol. 29, 1933, pp. 18–44; Present Tendencies in Industrial Low-Temperature Carbonization of Coal: Chim. et ind., vol. 31, 1934 (in press).

Bruay mines near Bethune, France.[3] Fifty ovens produced 130,000 tons of this coke in 1933. The process resembles that of the late Professor Parr,[4] in that it is carried out in two stages, and the final carbonization is conducted at a medium temperature (700° C. inside oven wall) in existing types of high-temperature ovens.

The ovens at Bruay are of the H. Koppers hairpin type, each about 12 inches wide and 120 cubic feet capacity. The coking time is about 18 hours. The oven charge consists of a carefully mixed blend of dry-cleaned raw coal and low-temperature coke, each pulverized to particles not exceeding 1 millimeter in size. The low-temperature coke is made in rotary kilns at 475° C., after suitable roasting at 350° C. to reduce the caking properties of the coal.

Successful operation of the ovens at these lower temperatures is due to the improved heating system, which provides very uniform temperatures on all sides of the oven.

The product, called Carbolux, is discharged from the oven in massive single pieces. There is no central seam to break them in two. It is free from fissures, resistant to breakage, and almost as reactive as charcoal. The volatile matter ranges from 8 to 12 percent; the ignition temperature is 450° to 460° C. The shatter index over 1½-inch screen is 86 to 88 percent.

The fuel seems ideal for domestic use, but one wonders if a process that has a roaster and low-temperature carbonizer superimposed on an ordinary coke oven can compete with the coke oven alone making ordinary byproduct coke.

The Lecocq Co. has designed and built a full-size oven for mid-temperature carbonization at the Montrambert collieries.[5] Ten to twenty percent of coke dust is blended with the raw coal charge. The coke produced at 700° C. inside oven-wall temperature contains 4 to 6 percent volatile matter, is easily ignited, and burns well in open grates. About twice as much tar is produced as with high-temperature carbonization. The gas, after being scrubbed for light oil, has a calorific value of 750 B.t.u. per cubic foot. A battery of these ovens is being built at Montrambert and at the New Brancepeth Colliery Co., Durham, England.

The British Fuel Research Station likewise is investigating carbonization at midtemperatures (600° to 800° C.). New brick F vertical retorts are being put into operation on such a research program on various coals.[6] These retorts are 21 feet high, 6 feet 6 inches long, and 7 inches wide at the top, widening uniformly to 11 inches at the botton.

*American developments.*—During the summer of 1933 the Pittsburgh Coal Co., through a controlled subsidiary, the Pittsburgh Coal Carbonization Co., constructed a plant for the production of low-temperature coke adjacent to the Champion No. 1 cleaning plant of the coal company at Champion, Pa., about 20 miles west of Pittsburgh. The process used is a modified form of the Wisner. The coal is oxidized on rectangular multiple hearths and carbonized in a rotor 6 feet inside diameter by 84 feet long. The capacity of

[3] Koppers, Heinrich, Recent Developments in Coking Practice: Coll. Guard., vol. 147, 1933, pp. 724–728, 770–773, 825–827; Jour. Inst. Fuel, vol. 7, 1933, pp. 13–28; discussion, pp. 57–66; Gas Jour., vol. 204, 1933, pp. 267–272. Tupholme, C. H. S., Free-Burning Domestic Coke from Coke Ovens: Ind. and Eng. Chem., News Ed., vol. 11, 1933, p. 342.

[4] Parr, S. W., Low-Temperature Carbonization of Coal: Ind. and Eng. Chem., vol. 21, 1929, pp. 164–168.

[5] Cerckel, H. O. H., The Manufacture of Household Coke in Coke Ovens: Gas Jour., vol. 204, 1933, pp. 831–833.

[6] Fuel Research Board Report: Dept. Sci. and Ind. Research, H.M.S. Office (London), 1933, pp. 70–72.

this unit is 95 tons of raw coal per day, dry weight. Operation was begun on November 1 and has been continuous throughout the winter. The fuel produced is a low-temperature coke of 12 to 14 percent volatile matter. The production passing over ¾-inch square-hole trommel screen is marketed. The minus ¾-inch material is pulverized in a hammer mill and recirculated through the carbonizer. The gas produced is used in roasting and carbonizing and for the operation of a tar still. The only byproducts now produced are tar and products obtained from the distillation of this tar. The raw coal used in the process is cleaned fine coal from the Champion No. 1 cleaning plant. The coke produced is a strong, dense, and easily ignitable smokeless fuel. It is on sale in Pittsburgh, Pa., Washington, D.C., and certain other cities under the name of Disco.

The Hayes process has been operated intermittently at the mines of the Ben Franklin Coal Co., Moundsville, W.Va., to supply low-temperature char as needed for the reduction of zinc ore at a near-by smelter.

The Lurgi plant of the Lehigh Briquetting Co. near Dickenson, N.Dak., is operating at a capacity of about 80 tons of briquets per day, using 250 tons of raw lignite, including that used for power and distillation of the tar. Eight to ten gallons of tar are recovered per ton of briquets made. The tar contains 50 to 60 percent of tar acids suitable for wood preserving and disinfecting. During the first 3 months of 1934, 6,300 tons of briquets were made.

## HYDROGENATION AND LIQUEFACTION OF COAL

The commercial large-scale production of gasoline from bituminous coal is now assured in England. Fortified by a Government guaranty of continuation of the present preference in tax of 8d. per gallon for the next 4½ years, or for 9 years if the tax is reduced to 4d., Imperial Chemical Industries, Ltd., has begun erecting a commercial plant at Billingham at an estimated cost of $11,000,000. The plant is expected to produce 100,000 tons (37,000,000 United States gallons) of gasoline annually by treating 400 long tons of coal per day. Including the coal used for power, steam, and hydrogen production, the total coal consumption will be 1,000 long tons per day,[7] or 3.15 tons of moisture- and ash-free coal per ton of gasoline produced. The over-all thermal efficiency is 40 to 45 percent, and the cost at the plant (including fixed charges and depreciation), based on coal at $3.10 per ton, is estimated at 11 to 12 cents per United States gallon of gasoline.

The vertical converters of the new plant are to be double-walled, consisting of an inner electrically heated thin-walled tube, in which the reaction is carried on, and an outer thick-walled pressure-resisting tube. The space between is insulated so that the temperature of the outer tube does not exceed 150° C., above which hydrogen would weaken the tube. The working pressure is maintained on both sides of the inner tube. The most effective catalyst in the

[7] Tupholme, C. H. S., Progress in Production of Motor Spirit by Coal Hydrogenation: Ind. and Eng. Chem., News Ed., vol. 12, 1934, p. 107. Petroleum Times, Oil from Coal Plant: Vol. 31, 1934, p. 112. Ormandy, W. R., and Burns, J., Oil from Coal: Jour. Inst. Fuel, vol. 7, 1933, pp. 71–84; Coll. Guard., vol. 147, 1933, pp. 749–751. Gordon, K., The Hydrogenation of Bituminous Coal, The Billingham Process: Abstract, Coll. Guard., vol. 147, 1933, p. 156. Lessing, R., The Future for Oil-Coal Fuel, Discussion at the World Petroleum Congress, London: Chem. Age, vol. 29, 1933, pp. 128–129.

first, or liquid phase, is a tin salt; in the second, or vapor phase, molybdenum impregnated on a carrier gives best results.

The Leuna Works of the German I. G. Farbenindustrie now has a capacity of producing 350,000 tons of gasoline per year from brown coal and brown-coal tar, and additions are contemplated for the hydrogenation of bituminous coal.[8]

It is reported that the Korea Nitrogen Co. is planning to erect a plant for coal hydrogenation in Japan with the aid of a State subsidy. It is to be completed in 1935 and will have a capacity of 500,000 tons of gasoline annually.[9]

The Australian Government likewise is considering the question of financial assistance to companies wishing to engage in the manufacture of oil from coal or shale.[10]

Much research on the hydrogenation of coal and tar has been conducted in various countries during the past year. The British Fuel Research Station [11] continued its studies on the fundamentals of coal hydrogenation, particularly the effect of temperature, dispersion media, catalysts, and stirring. In the absence of a liquid medium, compounds of germanium, tin, and lead greatly increased the degree of liquefaction by increasing the speed of the reaction at lower temperatures.

Dispersion of the coal in a liquid medium and the use of catalysts increase the yield of oil. The Mines Department of Canada found metallic copper and molybdic oxide effective catalysts in reducing coke formation in the hydrogenation of low-temperature tar.[12] Blom recently rendered four noncoking South African coals strongly coking by hydrogenating them under pressure for 5 hours at 380° to 395° C.[13]

The Imperial Fuel Research Institute of Japan has published papers showing that methane is decomposed rapidly at 600° to 800°C. with an excess of steam in the presence of nickel catalysts promoted with various other oxides or with potassium carbonate.[14] Ando gives the temperature conditions, catalysts, and products obtained in the hydrogenation of phenol and the phenolic oil in low-temperature tar.[15]

Bahr and Petrick [16] found that the best yields of hydrocarbons from phenols, cresols, and naphthols were obtained at 360° to 380°C. with molybdic oxide catalysts. Mixtures of molybdic oxide with the oxides of zinc, aluminum, thallium, and chromium were investigated.

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[8] Institution of Mining Engineers (London), Utilization of Coal Committee, Summary of Progress no. 2: Dec. 31, 1933, 4 pp.

[9] Iron and Coal Trades Review, Hydrogenation in Japan: Vol. 128, 1934, p. 228.

[10] Jour. Soc. Chem. Ind., Oil from Coal: Vol. 53, 1934, p. 136.

[11] Horton, L., King, J. G., and Williams, F. A., The Progressive Action of Hydrogen on Coal: Jour. Inst. Fuel, vol. 7, 1933, pp. 85–102. Fuel Research Board, Hydrogenation of Coal Report: Dept. Sci. and Ind. Research, H.M.S. Office (London), 1933, pp. 94–103.

[12] Warren, T. E., and Williams, A. R., Report of Experimental Work on the Hydrogenation of Canadian Coal, Coal Tar, and Bitumen for the Production of Motor Fuel; I, Batch Experiments on the Hydrogenation and Cracking of Low-Temperature Coal Tar. Warren, T. E., and Bowles, K. W., II, Description of an Apparatus for Continuous Hydrogenation and Experiments on Coal Tar, Bitumen, and a Suspension of Powdered Coal in Coal Tar: Canada Dept. Mines, Mines Branch, Rept. 737–3, 1933, 31 pp.

[13] Blom, I. J. B., The Influence of Pressure-Hydrogenation upon the Coking Constituents of Coal: Jour. Chem. Met. Min. Soc. South Africa, vol. 34, 1933, pp. 1–44.

[14] Takenaka, Y., The Manufacture of Hydrogen from Waste Gas in the Hydrogenation of Coal: Jour. Fuel Soc. Japan, vol. 12, 1933, pp. 57–61.

[15] Ando, S., The Catalytic Hydrogenation of Phenols under High Pressure: Jour. Fuel Soc. Japan, vol. 12, 1933, pp. 62–68.

[16] Bahr, Th., and Petrick, A. J., The Catalytic Reduction of Tar Phenols to Benzene Hydrocarbons: Brennstoff-Chem., vol. 14, 1933, pp. 161–165, 187–193.

The effects of a large number of substances that have been examined for coal hydrogenation are reviewed in Chemical Industry for February 1934.[17]

The production of satisfactory lubricating oil by the partial hydrogenation of low-temperature tar has not been solved yet,[18] although excellent lubricants are made by hydrogenation of petroleum.

## SYNTHETIC HYDROCARBONS FROM GASES

Audibert [19] has reviewed the various processes for the production of motor fuels by the catalytic hydrogenation of carbon monoxide and by the pyrolysis of methane. The Mülheim Coal Research Institute [20] has continued studies of the reactions involved in the production of synthetic fuels and has produced lubricating oil from a high-boiling fraction (Kogasin II) of the oil obtained in gasoline synthesis, by chlorination and condensation with aluminum chloride.[21] The chemical utilization of coke-oven gases for the production of alcohols, ammonia, and solvent liquids is continuing at Bethune Mines in France.[22] At present, the production of synthetic motor fuel from gases does not have as good commercial prospects as production from coal or coal tar by hydrogenation.

## ACKNOWLEDGMENTS

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17 Tupholme, C. H. S., Catalysts for Coal Hydrogenation: Chem. Ind., vol. 34, 1934, pp. 119–120.
18 Tupholme, C. H. S., British Fuel Research Board Investigates Production of Lubricating Oil from Low-Temperature Tars; Ind. and Eng. Chem., News Ed., vol. 11, 1933, p. 163.
19 Audibert, E., Liquid Products from Coal: Rev. Ind. Min., 1933, pp. 444–468; 469–488; 501–508.
20 Fischer, F., and Pichler, H., The Effect of Carbon Monoxide and Carbon Dioxide on Hydrogenation in the Synthesis of Benzine: Brennstoff-Chem., vol. 14, 1933, pp. 306–310.
21 Fischer, F., and Koch, H., Synthesis of Lubricating Oils from Kogasin: Brennstoff-Chem., vol. 14, 1933, pp. 463–468.
22 Vallette, F., Synthetic Products Derived from Bethune Coals: Rev. Ind., Min., no. 302, 1933, p. 299.

# FUEL BRIQUETS

By W. H. Young and J. B. Clark

## SUMMARY OUTLINE



The production of fuel briquets in 1933 increased slightly over that in 1932, although with the exception of 1932 it was the lowest since 1921. According to reports courteously furnished the Bureau of Mines by the operators of briquetting plants, the total output in 1933 was 530,430 net tons valued at $3,498,280, an increase of 12.7 percent in tonnage and 1.1 percent in value from 1932.

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, 1907–33*

| Year or yearly average | Production of briquets | | | | Imports | Consumption [1] | Value of product, thousands of dollars | Number of plants in operation | Average output per plant, tons | Average value per ton f.o.b. plant | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Eastern States | Central States | Pacific Coast States | Total | | | | | | Pennsylvania | 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** | | | | | | | | | | | |
| 1929 | 325 | 788 | 99 | 1,212 | 89 | 1,301 | 9,515 | 25 | 48,497 | 6.22 | 8.13 |
| 1930 | 301 | 641 | 87 | 1,029 | 73 | 1,102 | 8,029 | 25 | 41,155 | 6.22 | 8.13 |
| 1931 | 243 | 382 | 73 | 698 | 61 | 759 | 5,261 | 27 | 25,864 | 5.90 | 8.11 |
| 1932 | 128 | 296 | 47 | 471 | 80 | 551 | 3,459 | 26 | 18,100 | 5.21 | 7.60 |
| 1933 | 155 | 318 | 57 | 530 | 42 | 572 | 3,498 | 27 | 19,646 | 4.89 | 6.71 |

[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 1933 the Central States showed the smallest proportional increase in production of briquets. Their output was 318,163 tons, 7.7 percent more than in 1932. The Pacific Coast States reported an increase of 20.4 percent. Production in the Eastern States totaled 155,469 tons, an increase of 21.6 percent from 1932.

In 1933 Wisconsin accounted for more than half the total output. Its five plants and the three plants active in Pennsylvania produced more than 61 percent of the total tonnage of the country.

Figure 47 shows the trend of production during the last 19 years.

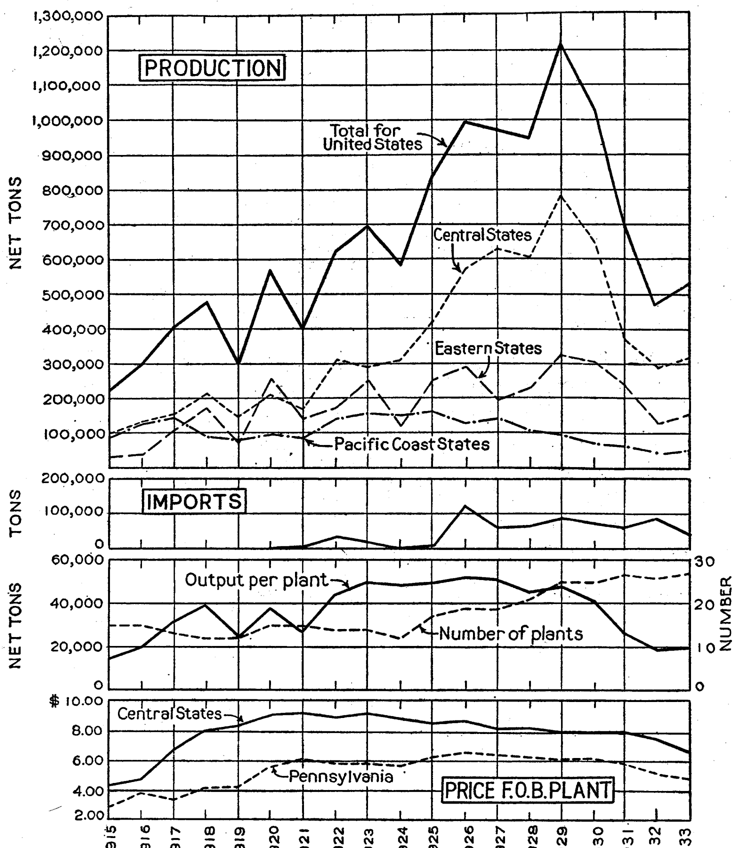


FIGURE 47.—Production and imports of fuel briquets, number of plants in operation, and average prices received f.o.b. plants, 1915–33.

*Fuel briquets produced in the United States, 1932–33*

| | Production | | | Value | | |
|---|---|---|---|---|---|---|
| | 1932 | 1933 | Increase or decrease | 1932 | 1933 | Increase or decrease |
| | *Net tons* | *Net tons* | *Percent* | | | *Percent* |
| Eastern States | 127,867 | 155,469 | +21.6 | $665,918 | $740,672 | +11.2 |
| Central States | 295,549 | 318,163 | +7.7 | 2,246,682 | 2,136,054 | −4.9 |
| Pacific Coast States | 47,188 | 56,798 | +20.4 | 546,063 | 621,554 | +13.8 |
| | 470,604 | 530,430 | +12.7 | 3,458,663 | 3,498,280 | +1.1 |

*Monthly production of fuel briquets in the United States, 1931–33, in net tons*

| Month | 1931 | 1932 | 1933 | Month | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|
| January | 102,602 | 58,380 | 42,548 | August | 41,943 | 36,287 | 52,008 |
| February | 57,764 | 45,649 | 42,682 | September | 60,552 | 44,332 | 49,844 |
| March | 40,537 | 29,848 | 20,381 | October | 76,723 | 65,695 | 76,061 |
| April | 32,590 | 14,223 | 26,252 | November | 68,104 | 55,157 | 64,421 |
| May | 82,777 | 25,433 | 37,214 | December | 70,092 | 60,341 | 74,797 |
| June | 34,905 | 16,845 | 24,079 | | | | |
| July | 29,727 | 18,414 | 20,143 | | 698,316 | 470,604 | 530,430 |

*Value.*—The total value of the briquets manufactured during 1933 was $3,498,280, an increase of $39,617 (1.1 percent) compared with 1932. The average value per net ton, f.o.b. plant, was $6.60 compared with $7.35 in 1932 and $7.53 in 1931.

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 645.

*Number and capacity of plants in operation.*—Twenty-seven plants, one more than in 1932, reported production of briquets on a commercial scale in 1933. In the 27 years from 1907 to 1933 the number of plants has more than doubled. Average production per plant in 1933 was 19,646 tons, an increase of 1,546 tons from 1932.

Although the number of plants has increased the industry has not escaped failures. From 1907 to 1933 sixty 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 645.

The total annual capacity of the 27 plants operating in 1933 was 2,851,694 net tons and the production only 530,430 net tons. The following instructions were given to the manufacturers in preparing data on capacity: "In stating capacity, please give total quantity of briquets that could actually be produced in an entire year, operating your customary number of shifts per day and allowing for unavoidable shut-downs for cleaning and repairs." The foregoing figure on capacity of plants was compiled from returns furnished on the basis of these instructions.

Five plants active in 1932 produced no briquets in 1933, but six new ones began commercial operation during the year—the Petroleum Coke Corporation, New Orleans, La.; the Superior Smokeless Coal & Mining Co., Tahona, Okla.; the Atlantic Refining Co., Philadelphia, Pa.; the C. Reiss Coal Co., Sheboygan, Wis.; the Los Angeles Briquet & By-Product Co., Los Angeles, Calif.; and the Atlas Briquet Co., Duluth, Minn.

*Briquetting plants operated in the United States in 1933*

| State | Name and address of operator | Location of plant | Date put in operation | Raw fuel used, as reported by producer |
|---|---|---|---|---|
| Eastern States: | | | | |
| Massachusetts | American Briquet Co., 1505 Philadelphia Bank Building, Philadelphia, Pa. | Charlestown. | 1929 | Anthracite. |
| Do | Staples Coal Co., 80 Federal Street, Boston, Mass. | Fall River | 1932 | Bituminous slack. |
| New Jersey | Navicoal Corporation, 1421 Chestnut Street, Philadelphia, Pa. | Keasbey | 1925 | Anthracite and bituminous slack. |
| Ohio | Receivers of Consolidation Coal Co., 811 Race Street, Cincinnai, Ohio. | Cincinnati | 1932 | Semibituminous slack. |
| Pennsylvania | American Briquet Co., 1505 Philadelphia Bank Building, Philadelphia, Pa. | Lykens | 1920 | Anthracite. |
| Do | Henriette Coal Mining Co., 15 Moore Street, New York, N.Y. | Dunlo | 1929 | Bituminous slack. |
| Do | Atlantic Refining Co., 260 South Broad Street, Philadelphia, Pa. | Philadelphia. | 1933 | Petroleum coke. |
| West Virginia | Berwind Fuel Co. of West Virginia, 122 South Michigan Avenue, Chicago, Ill. | Berwind | 1929 | Bituminous slack. |
| Do | Raleigh-Wyoming Mining Co., 230 South Clark Street, Chicago, Ill. | Glen Rogers | 1932 | Do. |
| Do | Winding Gulf Collieries, P.O. Box 30, Bluefield, W.Va. | Davy | 1930 | Do. |
| Central States: | | | | |
| Colorado | Acme Smokeless Fuel Co., 212 Davidson Building, Bay City, Mich. | Salida | 1931 | Anthracite culm and bituminous slack. |
| Louisiana | Petroleum Coke Corporation, 850 South Lopez Street, New Orleans, La. | New Orleans | 1933 | Petroleum coke. |
| Minnesota | Atlas Briquet Co., 200 South 1st Avenue, Duluth, Minn. | Duluth | 1933 | Anthracite and bituminous slack. |
| Missouri | Standard Briquet Fuel Co., 6700 Manchester Avenue, St. Louis, Mo. | Kansas City | 1909 | Semianthracite. |
| Nebraska | Christopherson-Renstrom Co., 31st Avenue and Sahler Street Omaha, Nebr. | Omaha | 1932 | Petroleum coke. |
| North Dakota | Lehigh Briquetting Co., 18 Edwards Block, Fargo, N.Dak. | Lehigh | 1929 | Lignite char. |
| Oklahoma | Superior Smokeless Coal & Mining Co., 20 North Wacker Drive, Chicago, Ill. | Tahona | 1933 | Bituminous slack. |
| Texas | Magnolia Petroleum Co., P.O. Box 798, Beaumont, Tex. | Beaumont | 1930 | Petroleum coke. |
| Wisconsin | Berwind Fuel Co., 122 South Michigan Avenue, Chicago, Ill. | Superior | 1912 | Bituminous slack. |
| Do | Panda Briquet Co., 1011 Foshay Tower, Minneapolis, Minn. | Ashland | 1931 | Do. |
| Do | Stott Briquet Co., First National Bank Building, St. Paul, Minn. | Superior | 1909 | Anthracite and bituminous slack. |
| Do | United Coal & Dock Co., 102 West Wells Street, Milwaukee, Wis. | Milwaukee | 1928 | Bituminous slack. |
| Do | C. Reiss Coal Co., Sheboygan, Wis. | Sheboygan | 1933 | Do. |
| Pacific Coast States: | | | | |
| California | California Fuel & Utilities, Inc., P.O. Box 735, Compton, Calif. | Dominguez | 1931 | Petroleum coke. |
| Do | Los Angeles Briquet & By-Product Co., 6623 McKinley Avenue, Los Angeles, Calif. | Los Angeles | 1933 | Do. |
| Oregon | Portland Gas & Coke Co., Public Service Building, Portland, Oreg. | Portland | 1913 | Carbon (petroleum residue) from oil gas. |
| Washington | Pacific Coast Coal Co., Smith Tower, Seattle, Wash. | Renton | 1914 | Bituminous slack. |

*Classification of briquet plants, by yearly capacity in 1933*

| Capacity per year, net tons: | Number of plants |
|---|---|
| Less than 5,000 | 3 |
| 5,000 and less than 10,000 | 1 |
| 10,000 and less than 25,000 | 10 |
| 25,000 and less than 100,000 | 6 |
| 100,000 and less than 200,000 | 1 |
| 200,000 and less than 400,000 | 4 |
| 400,000 and over | 2 |
| | 27 |

*Classification of briquet plants, by size of output, 1931–33*

| Output, net tons | Number of plants | | | Output, net tons | Number of plants | | |
|---|---|---|---|---|---|---|---|
| | 1931 | 1932 | 1933 | | 1931 | 1932 | 1933 |
| Less than 2,000 | 5 | 9 | 6 | 25,000 and less than 100,000 | 6 | 7 | 8 |
| 2,000 and less than 5,000 | 3 | 2 | 4 | 100,000 and over | 2 | | |
| 5,000 and less than 10,000 | 5 | 5 | 6 | | | | |
| 10,000 and less than 25,000 | 6 | 3 | 3 | | 27 | 26 | 27 |

*Classification of briquet plants, by number of hours operated per day during busy season, 1932–33*

| Hours per day | Number of plants | | Production, net tons | |
|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 |
| 14 to 24 hours | 13 | 14 | 259,286 | 402,905 |
| 8 to 12 hours | 13 | 12 | 211,318 | 127,525 |
| Less than 8 hours | | 1 | | |
| | 26 | 27 | 470,604 | 530,430 |

*Raw fuels.*—A total of 511,442 net tons of raw fuel of all kinds was briquetted in 1933; 31 percent of this amount was anthracite and semianthracite, 55 percent semibituminous and bituminous coal, and 14 percent semicoke, oil-gas residue, or petroleum coke.

Five plants reported that from a small part 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, 1928–33, in net tons*

| Fuel | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|
| Anthracite culm and fine sizes and semianthracite | 376,257 | 408,967 | 368,294 | 243,888 | 151,400 | 157,972 |
| Semibituminous, bituminous, and subbituminous slack | 512,806 | [1] 711,459 | [1] 569,057 | [1] 360,226 | [1] 260,050 | [1] 282,400 |
| Semicoke, oil-gas residue, and petroleum coke | 51,743 | 67,513 | 67,014 | 67,064 | 50,989 | 71,070 |
| | 940,806 | 1,187,939 | 1,004,365 | 671,178 | 462,439 | 511,442 |

[1] Includes no subbituminous coal.

In 1933 anthracite fines were used as raw material at 7 operations, either alone or in combination with other coal, and bituminous coal alone was employed at 11 plants. The following table shows the character of the raw fuel used by the 27 active plants.

*Classification of briquet plants, by kinds of raw fuel used in 1933*

| Kind of raw fuel used: | *Number of plants* |
|---|---|
| Anthracite fines | 3 |
| Mixture of anthracite or semianthracite fines and bituminous or semibituminous slack | 4 |
| Bituminous slack | 11 |
| Semibituminous fines | 1 |
| Semicoke (low-temperature coke or char) | 1 |
| Carbon residue from the manufacture of oil gas | 1 |
| Petroleum coke | 6 |
| | 27 |

*Weight and shape of briquets.*—In 1933 the Bureau of Mines again 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 1933 compared with 1932. The smaller sizes comprised by far the greater percentage of briquets produced. Briquets weighing less than 3 ounces accounted for 71.8 percent of the production in 1933 compared with 72.1 percent in 1932. In 1933, 27.4 percent of the production of briquets weighed 3 and under 5 ounces, whereas 27.6 percent was in this group in 1932. Thus, 99.2 percent of the briquets in 1933 weighed less than 5 ounces. Two plants produced briquets weighing 6 to 16 ounces. Two plants manufactured large cube-shaped briquets weighing more than 42 ounces. However, all the briquets weighing more than 5 ounces accounted for only 0.8 percent of the total production.

Pillow-shaped briquets continued to be most popular. Of the 27 producing plants, 19 made pillow-shaped briquets, 3 cylindrical, 1 ovoid, 2 cube-shaped, 1 both pillow-shaped and cylindrical, and 1 both ovoid and cylindrical.

*Classification of briquet plants, by prevailing weight of briquets manufactured, 1932–33*

| Weight of briquet, ounces | Number of plants | | Percent of production | | Weight of briquet, ounces | Number of plants | | Percent of producton | |
|---|---|---|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | | 1932 | 1933 | 1932 | 1933 |
| Less than 2 | 5 | 7 | 72.1 | 71.8 | 6 and under 10 | 1 | 1 | 0.3 | 0.8 |
| 2 and under 3 | 13 | 11 | | | 10 and under 16 | | 1 | | |
| 3 and under 4 | 3 | 3 | 27.6 | 27.4 | 42 and over (cube-shaped) | 1 | 2 | | |
| 4 and under 5 | 3 | 2 | | | | | | | |
| 5 and under 6 | (1) | (1) | ------ | ------ | | 26 | 27 | 100.0 | 100.0 |

[1] None.

*Binders and recarbonization.*—Asphaltic pitch is the binder used most often in the manufacture of briquets and was employed either alone or in combination by 24 out of the 27 plants active in 1933. Of the producers, 14 used asphaltic pitch exclusively; 1, lignite-tar pitch; 1, aspholeum; 2, asphaltic pitch and corn flour; 2, starch, asphalt, and water; 1, petroleum asphalt; 1, mixed pitches; 2, briquetting asphalt; 1, corn starch and petroleum asphalt; and 1, cement. One plant briquetting the carbon residue from the manufacture of oil gas required no binder.

The percentage of binder to raw fuel, by weight, ranged from less than 5 to more than 9. The proportion used most was 5 to 8 percent.

*Classification of briquet plants, by percentage of binder used in 1933*

| Binder used: | *Number of plants* |
|---|---|
| Using no binder (carbon residue) | 1 |
| Using: | |
| Less than 5 percent binder | 3 |
| 5 and less than 7 percent | 11 |
| 7 and less than 9 percent | 10 |
| 9 percent and over | 2 |
| | 27 |

One producer using a binder reported recarbonizing the briquets coming from the presses to drive off smoke from the binder. Two other producers reported that they partly recarbonized the briquets.

## DISTRIBUTION

In its questionnaire for 1933 the Bureau of Mines requested, as for 1930 to 1932, information on the tonnage of briquets shipped to each State. It should be noted that the commercial sales were slightly less than the total output, as a result of changes in producers' stocks.

The tonnage produced in 1933 was distributed widely, briquets being shipped into no less than 41 States, the District of Columbia, Alaska, and Canada. This distribution indicates a notable broadening of markets compared with 1928. (See chapter on Fuel Briquets in Mineral Resources, 1928, pt. 2, fig. 1, p. 5.) The following table gives the tonnage consumed in each State in 1932 and 1933. (For a map of consumption of fuel briquets by States see chapter on Fuel Briquets in Mineral Resources, 1930, pt. 2, fig. 2, p. 6.)

*Fuel briquets of domestic manufacture consumed in the United States and exported, 1932–33, in net tons*

| | 1932 | 1933 | | 1932 | 1933 |
|---|---|---|---|---|---|
| Consumed in— | | | Consumed in—Continued | | |
| Alaska | 425 | 344 | New Jersey | 6,339 | 3,917 |
| Arizona | 140 | 48 | New Mexico | 109 | 91 |
| California | 9,663 | 7,733 | New York | 5,086 | 5,724 |
| Colorado | 455 | 765 | Nevada | | 31 |
| Connecticut | 661 | 455 | North Carolina | 2,272 | 2,208 |
| Delaware | 712 | 378 | North Dakota | 43,915 | 46,746 |
| District of Columbia | 139 | 569 | Ohio | 4,188 | 6,166 |
| Florida | 183 | 122 | Oklahoma | 188 | 88 |
| Georgia | (1) | | Oregon | 31,747 | 36,061 |
| Idaho | | 81 | Pennsylvania | 7,629 | 10,703 |
| Illinois | 5,474 | 6,218 | Rhode Island | 7,610 | 5,202 |
| Indiana | 1,964 | 3,916 | South Carolina | [1] 218 | 143 |
| Iowa | 18,310 | 19,269 | South Dakota | 29,999 | 28,704 |
| Kansas | 6,262 | 4,243 | Texas | 1,300 | 3,178 |
| Louisiana | 450 | 839 | Utah | 36 | |
| Maine | 1,948 | 1,240 | Vermont | | 41 |
| Maryland | 4,074 | 3,378 | Virginia | 14,734 | 6,286 |
| Massachusetts | 42,497 | 61,831 | Washington | 11,962 | 11,444 |
| Michigan | 4,761 | 8,777 | West Virginia | 244 | 119 |
| Minnesota | 137,292 | 133,102 | Wisconsin | 65,872 | 89,131 |
| Missouri | 3,005 | 4,360 | Wyoming | 32 | 145 |
| Montana | | 99 | Miscellaneous | 140 | 2,261 |
| Nebraska | 8,245 | 8,992 | Exported to Canada | 3,053 | 1,810 |
| New Hampshire | 1,955 | 2,204 | | | |
| | | | | 485,288 | 529,162 |

[1] Georgia included with South Carolina.

## FOREIGN TRADE IN BRIQUETS [1]

Imports of fuel briquets in 1933 were 42,395 net tons, a decrease of 37,893 tons (47.2 percent) from 1932. In 1933 imports were equivalent to only 8 percent of the domestic production.

According to the customs records, 41,891 tons (98.8 percent of the total imported in 1933) were discharged at or in the vicinity of Boston and 504 tons were imported into New York.

Of the total imports 41,340 tons (97.5 percent) came from Germany and 1,055 tons from the United Kingdom.

*Briquets and other composition coals [1] for fuels imported for consumption in the United States, 1928–33*

| Year | Net tons | Value | Year | Net tons | Value |
|---|---|---|---|---|---|
| 1928 | 71,485 | $353,168 | 1931 | 60,950 | $325,189 |
| 1929 | 89,458 | 458,517 | 1932 [1] | 80,288 | 335,358 |
| 1930 | 73,418 | 399,146 | 1933 [1] | 42,395 | 126,157 |

[1] Beginning July 1, 1932—coal and coke briquets only.

*Fuel briquets imported into the United States, 1931–33, by months, in net tons*

[General imports]

| Month | 1931 | 1932 | 1933 | Month | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|
| January | 6,712 | 6,409 | 14,783 | August | 2,466 | ---------- | ---------- |
| February | 7,311 | 15,176 | 11,293 | September | 4,738 | 6,873 | ---------- |
| March | 3,360 | 7,996 | 10,797 | October | 3,475 | 5,687 | ---------- |
| April | 5,519 | 5,715 | ---------- | November | 8,959 | 6,162 | ---------- |
| May | ---------- | 11,078 | ---------- | December | 15,135 | 10,488 | ---------- |
| June | 3,275 | 4,704 | 5,522 | | | | |
| July | ---------- | ---------- | ---------- | | 60,950 | 80,288 | 42,395 |

*World production of fuel briquets, 1929–33, in metric tons*

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Algeria | 101,552 | 96,812 | 73,828 | 9,389 | (2) |
| Australia: Victoria | (2) | 184,000 | 296,000 | 325,000 | (2) |
| Austria | 420 | ---------- | ---------- | ---------- | (2) |
| Belgium | 2,018,110 | 1,875,210 | 1,850,360 | 1,320,750 | 1,384,000 |
| Czechoslovakia: | | | | | |
| Coal | 270,294 | 239,080 | 285,782 | 406,574 | 396,840 |
| Lignite | 256,111 | 180,718 | 209,435 | 202,003 | 199,653 |
| France | 6,670,000 | 6,810,000 | 7,185,830 | 7,550,000 | (2) |
| Germany: [3] | | | | | |
| Coal | 6,059,195 | 5,176,628 | 5,186,566 | 4,375,512 | 4,523,463 |
| Lignite | 42,136,834 | 33,988,162 | 32,422,214 | 29,752,172 | 30,146,091 |
| Saar | ---------- | ---------- | 1,178 | 6,939 | (2) |
| Great Britain | 1,394,898 | 1,149,114 | 883,498 | 923,048 | (2) |
| Hungary: | | | | | |
| Coal } Lignite } | 109,570 | 176,265 | 188,219 | 414,435 | (2) |
| Indo-China | 113,225 | 144,000 | 134,000 | 97,406 | (2) |
| Italy | 6,716 | 2,002 | 2,450 | 2,414 | (2) |
| Netherlands: | | | | | |
| Coal | 958,186 | 945,939 | 1,212,621 | 1,170,930 | (2) |
| Lignite | 54,498 | 48,868 | 40,892 | 44,025 | (2) |
| Netherland East Indies | 64,099 | 52,292 | 17,418 | 6,967 | (2) |
| Poland | 354,783 | 234,123 | 300,999 | 222,246 | (2) |
| Spain | 921,906 | 929,736 | 914,117 | 785,703 | (2) |
| United States | 1,099,879 | 933,366 | 633,498 | 426,923 | 481,195 |
| Venezuela | 1,691 | 524 | (2) | 555 | (2) |
| Yugoslavia | 51,477 | 32,413 | 41,083 | (2) | (2) |
| | 62,643,444 | 53,199,252 | 51,879,988 | 48,042,991 | (2) |

[1] In addition to the countries listed briquets are produced in Canada and New Caledonia, but data of output are not available.
[2] Data not available.
[3] Exclusive of the Saar.

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

# CRUDE PETROLEUM AND PETROLEUM PRODUCTS

By G. R. Hopkins

SUMMARY OUTLINE



Nineteen thirty-three was characterized by outstanding events in the petroleum industry. The early oil pioneers probably witnessed more exciting times than occurred in 1933, but from the standpoint of events of national interest no year has surpassed it. The year opened rather inauspiciously, with the general statistical position favorable, but in a few months production in east Texas became virtually uncontrolled and prices fell to low levels in comparison with those experienced during 1931. According to some observers the fate of the entire proration program, so laboriously built up since 1928, hung in the balance during May 1933, when production in the east Texas field, including several hundred thousand barrels of "hot" oil, was above the 1,000,000-barrel mark. Improvement was noted in June, when some producers closed in their wells in preference to selling at the low prices. However, conditions on July 1 were far from satisfactory, and the agitation for Federal aid in stopping the flow of "hot" oil increased to such an extent that on July 11 the President issued an order prohibiting interstate movements of "hot" oil. Further Federal aid was rendered the industry when the code was placed in effect early in September and dollar crude became a reality. Refined-oil prices in 1933 moved in sympathy with crude prices, although they weakened toward the end of the year when it became apparent that the contemplated price-fixing program would not be placed in effect and when the production of crude oil and motor fuel continued to exceed their respective allowables.

From the standpoint of consumption, 1933 showed a material improvement over 1932. The domestic demand for all oils declined from 1929 through 1932 and increased in 1933, hence January 1, 1933 is now generally regarded as the turning point for the oil industry in the depression. The domestic demand for all oils in 1933 was 865,447,000 barrels, or about 30,000,000 barrels (4 percent) above 1932. The gain of 30,000,000 barrels in domestic demand comprised the following approximate increases in consumption of products:

Motor fuel, 4,000,000 barrels; kerosene, 5,000,000 barrels; gas oil and fuel oil, 13,000,000 barrels; still gas, 4,000,000 barrels; losses, 4,000,000 barrels.

Imports of both crude petroleum and refined oils continued to decline, reflecting the cooperation of the importing companies in the proration program. Imports of crude in 1933 totaled 32,773,000 barrels (27 percent less than in 1932), whereas imports of refined oils were 13,498,000 barrels (55 percent below the 1932 level). Under the code imports were restricted to the average of the last 6 months of 1932.

Field activity and prospecting were greatly curtailed in the first half of the year by the depressed prices, so that during June only 387 wells were completed. The improvement in prices in July, August, and September stimulated field work so that during October 1,037 oil wells were brought in, or nearly three times as many as in June. However, total oil-well completions for the year (8,068) were 23 percent below 1932.

*Salient statistics on the supply and demand of all oils, 1932–33*

[Thousands of barrels of 42 gallons]

| | 1932 | | 1933 [1] | |
|---|---|---|---|---|
| | Total | Daily average | Total | Daily average |
| New supply: | | | | |
| Domestic production: | | | | |
| Crude petroleum | 785, 159 | 2, 145 | 898, 874 | 2, 463 |
| Natural gasoline | 36, 281 | 99 | 33, 610 | 92 |
| Benzol | 1, 031 | 3 | 1, 473 | 4 |
| Total production | 822, 471 | 2, 247 | 933, 957 | 2, 559 |
| Imports: | | | | |
| Crude petroleum | 44, 682 | 122 | 32, 773 | 90 |
| Refined products | 29, 812 | 82 | 13, 498 | 37 |
| Total new supply, all oils | 896, 965 | 2, 451 | 980, 228 | 2, 686 |
| Change in stocks, all oils | −41, 792 | −114 | +8, 256 | +23 |
| Demand: | | | | |
| Total demand, all oils | 938, 757 | 2, 565 | 971, 972 | 2, 663 |
| Exports: | | | | |
| Crude petroleum | 27, 393 | 75 | 36, 703 | 101 |
| Refined products | 75, 882 | 207 | 69, 822 | 191 |
| Domestic demand: | | | | |
| Motor fuel | 373, 900 | 1, 022 | 378, 143 | 1, 036 |
| Kerosene | 33, 221 | 91 | 38, 440 | 105 |
| Gas oil and fuel oil | 308, 157 | 842 | 321, 395 | 880 |
| Lubricants | 16, 614 | 45 | 17, 066 | 47 |
| Wax | 945 | 3 | 1, 260 | 3 |
| Coke | 9, 592 | 26 | 10, 091 | 28 |
| Asphalt | 12, 652 | 35 | 11, 260 | 31 |
| Road oil | 6, 648 | 18 | 6, 095 | 17 |
| Still gas (production) | 40, 905 | 112 | 45, 212 | 124 |
| Miscellaneous | 1, 978 | 5 | 1, 443 | 4 |
| Losses and crude used as fuel | 30, 870 | 84 | 35, 042 | 96 |
| Total domestic demand | 835, 482 | 2, 283 | 865, 447 | 2, 371 |
| Stocks (end of year): | | | | |
| Crude petroleum | 339, 715 | | 355, 394 | |
| Natural gasoline | 3, 203 | | 3, 186 | |
| Refined products | 247, 188 | | 242, 873 | |
| Total stocks, all oils | [2] 590, 106 | | [2] 601, 453 | |
| Days' supply | 230 | | 226 | |

[1] Subject to revision.
[2] Total stocks Dec. 31, 1932, and Dec. 31, 1933, are not comparable, principally because certain revisions made Aug. 31, 1933, have not yet been carried back to Jan. 1, 1933.

It is difficult to state whether the producer or the refiner fared the worse in 1933. When crude prices declined so drastically in the spring months there is no doubt that some refiners profited from the lower costs of their raw materials. On the other hand, refined oil prices did not show as much improvement in the middle of the year as crude prices and in the last quarter of the year weakened materially whereas crude prices remained unchanged. The refining industry was favored with increased demand for most of its products, but in the case of motor fuel this favorable factor was nullified by the depressing effects of burdensome stocks. The demand for kerosene increased materially, but prices failed to improve. The statistics of gas oil and fuel oil, lubricants, and wax were favorable; that is, the demand increased and stocks declined. Although data on refinery values for 1933 are lacking, it is evident that the increased monetary return from the sale of these three products during the last 6 months of 1933 partly compensated for the failure of the gasoline revenue to hold up.

Exports of crude reached a new high level, reacting to the increase in refinery capacity abroad, as well as to the fact that foreign buyers took advantage of the bargain prices. However, the advantage gained through increased exports of crude was lost by reason of the fact that the refined products made from this crude displaced a part of the refined-oil exports.

Graphic data covering supply, demand, and prices are given in figures 48 and 49.

## FEDERAL REGULATION

Because of the important part played by the Government in the regulation of the petroleum industry in 1933, it is appropriate to present here a brief chronological description of the orders and regulations prescribed by Federal agencies.

The apparent inability of the State governments of Oklahoma and Texas to curb the production of hot oil in the Oklahoma City and east Texas fields increased the agitation for Federal action to such an extent that on July 11 the President issued an Executive order prohibiting the interstate or export movement of crude petroleum and its products unlawfully produced or withdrawn from storage. A later order (July 14) designated the Secretary of the Interior as the enforcement agency. This order proved an aid to the industry as the movement of five or six hundred tank cars of hot oil from the east Texas field virtually ceased, and market conditions were greatly improved.

While efforts were being made to curb overproduction in east Texas, the industry was engaged in formulating a code in accordance with provisions of the National Industrial Recovery Act. The code was completed after a series of public hearings in Washington during the latter part of July and the first part of August and was approved by the President on August 19, 1933. It was later modified by the President on September 13, 1933.

The code is divided into seven articles. The most important section of Article I—General—permits the formation of agreements between competitors subject to approval of the President. Article II—Hours and Wages—specifies maximum and minimum hours and wages. Article III—Production—empowers the President to limit

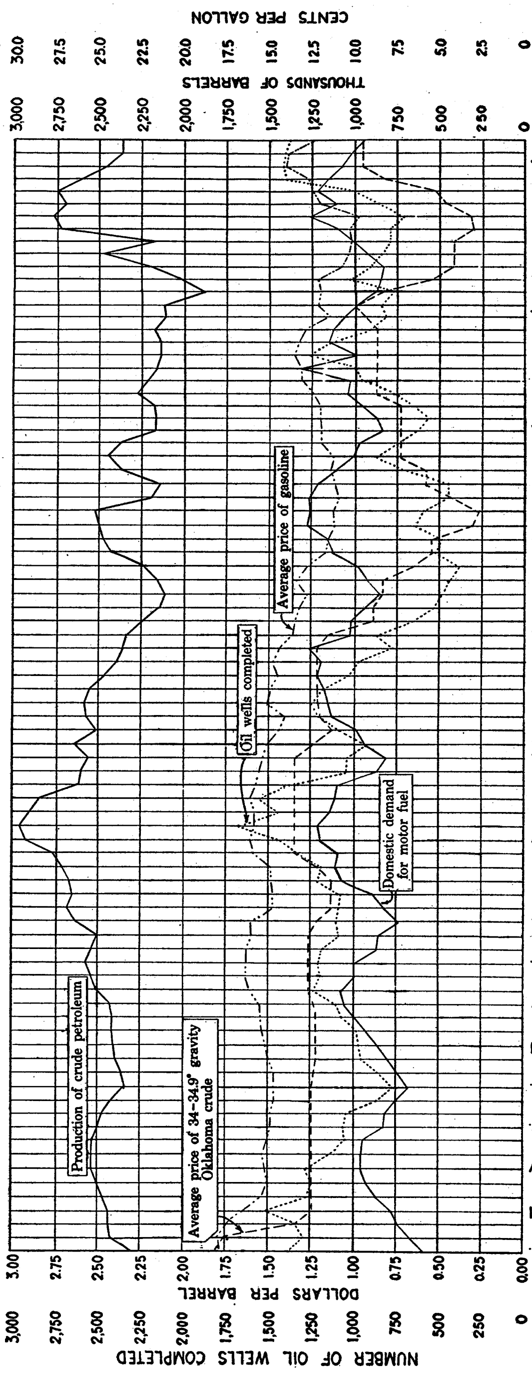


FIGURE 48.—Daily average production of crude petroleum, daily average domestic demand for motor fuel, total number of oil wells completed, average price per barrel of a selected grade of Oklahoma crude petroleum, and average tank-wagon price per gallon (excluding tax) of gasoline at 50 cities in the United States, 1927–33, by months.

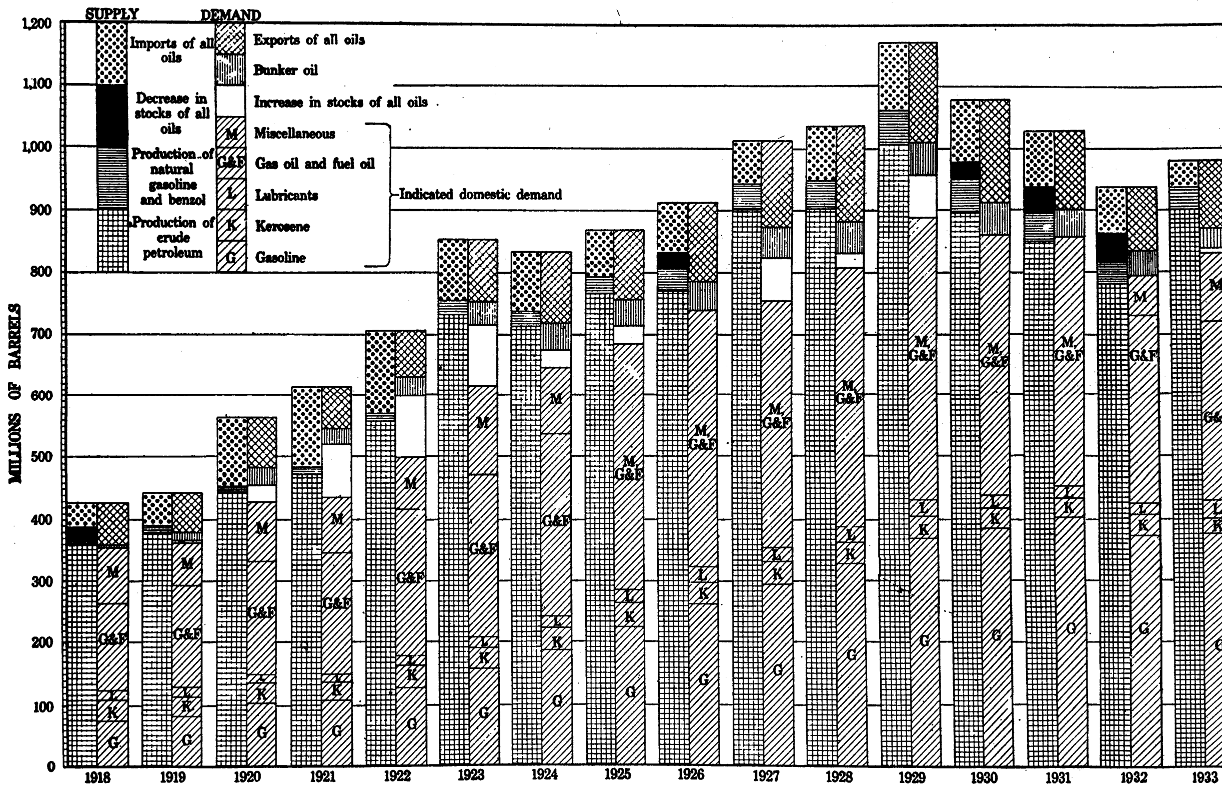


FIGURE 49.—Supply and demand of all oils, 1918–33.

imports and withdrawals from storage, establishes a Federal agency to allocate crude production according to consumer demand in the various States, establishes a schedule of crude prices, delegates power to the President to fix refined prices at his own discretion, and provides that all new fields be developed according to a plan approved by the President. Article IV—Refining—provides for the equitable distribution of gasoline business among refiners, permits withdrawals of crude from storage in special cases, but prohibits the hoarding of gasoline. Article V—Marketing—outlines a number of provisions designed to correct unfair practices in the marketing of petroleum products. Article VI—Transportation—provides investigations of transportation practices and rates as a basis for recommendations to the President. Article VII—Organization—provides that the administrative machinery shall consist of a Planning and Coordination Committee of 15 members to represent the industry and a Federal agency, designated by the President, to represent the Government. On August 28, 1933, the President designated the Secretary of the Interior to be Administrator and the Department of the Interior to be the Federal agency.

On September 2 the Administrator issued an order outlining the first daily crude-oil allowables as follows: Arkansas, 29,000; California, 480,000; Kansas, 111,000; Louisiana, 70,000; Texas, 975,200; Oklahoma, 540,000; New Mexico, 41,400; Rocky Mountain States, 38,900; Appalachian States, 94,200; and Michigan, 30,000; total, 2,409,700. These allowables were effective as of 7 a.m. September 8, 1933. This order specified that no withdrawals from storage be made without approval of the Planning and Coordination Committee and upon order of the Administrator and that imports be limited to an amount not exceeding the average of the last 6 months of 1932. By a later order the allowable for Arkansas was revised to 33,000 barrels, making the total 2,413,700 barrels.

On September 15 the Administrator established the Petroleum Administrative Board of six members to advise and assist him relative to the code.

On September 28 new allowables effective October 1 were issued. The daily crude production required to balance consumer demand was found to be 2,338,500 barrels, a reduction of 3 percent from September. This reduction reflected principally the seasonal decline in gasoline consumption.

On October 1 the Administrator issued an order prescribing the statistical reports which should be made to the Bureau of Mines. On October 13 a Labor Policy Board was created. On October 17 a full schedule of minimum prices for crude petroleum and its principal products was issued to become effective December 1. These schedules were recommended to the Administrator by the Planning and Coordination Committee.

On October 19 the Administrator issued an order directing the Petroleum Administrative Board to prescribe proper ratios between gasoline inventories and sales for each district. The Planning and Coordination Committee was authorized to recommend to all refiners the refinery crude runs necessary to maintain these ratios. On November 20 the allowables for December were issued. The total specified was 2,210,000 barrels, or 5 percent below the allowable of

2,338,500 barrels used in both October and November. On November 23 the ratios of sales to stocks as mentioned in the order of October 19 were announced.

During the last half of October and all of November a great mass of data both for and against the price-fixing program first announced in the order of October 17, was forwarded to Washington. The major portion of the evidence was against the proposal, hence the effective date for price fixing was postponed from December 1 to January 1, allowing more time to present another plan. This substitute plan was drawn up by industry representatives on December 7 and, in brief, provided for the establishment of a National Petroleum Agency to stabilize the gasoline market by disposing of surplus gasoline (pooling agreement) and by correcting marketing abuses, particularly as regards margins (marketing agreement). These so-called "pooling and marketing agreements" were being studied by the Administration and the Petroleum Administrative Board as the year closed.

During December the Administrator ordered a survey of the cost of crude oil production and issued regulations for orderly development of oil pools. On December 20 the allowables for the first quarter of 1934 were announced, together with recommendations covering gasoline stock levels for January 31, 1934. The total daily allowable production specified for the first quarter of the year was 2,183,000 barrels, the lowest figure issued up to that time.

Under the code the State allowables were recommended to the States as the best operating schedule to meet the consumer demand, but the distribution of the State total among the various fields was left to the State regulatory bodies. A number of fields consistently exceeded their allowables, so that during the part of 1933 that the plan was in effect (Sept. 8 to Dec. 31) the production for the United States was generally considerably above the Administrator's total and seldom below it. Thus during most of September the actual production was at least 100,000 barrels above the allowable, during October the excess increased to about 200,000 barrels, but during most of November the production was under the allowable. In December production continued at about the same level as in November, but the allowable was lowered materially and the daily excess production for the month was at least 100,000 barrels.

## CRUDE PETROLEUM

*General review.*—The decline in crude production which began just after 1929 was interrupted in 1933 when the output was 14 percent higher than in 1932. Imports in 1933 totaled 32,773,000 barrels, or about 12,000,000 barrels less than in 1932.

The total demand for crude petroleum in 1933 was 918,538,000 barrels, an increase of 58,218,000 barrels (7 percent) over 1932. Of the total demand, 861,254,000 barrels (94 percent) represented refinery consumption, 36,703,000 barrels (4 percent) were exported, and 20,581,000 barrels (2 percent) represented losses and fuel used in the raw state. The increase in demand, while material, was not enough to utilize all of the gain in output, with the result that stocks of crude increased 13,109,000 barrels, whereas in 1932, 30,479,000 barrels were withdrawn from storage.

69174—34——43

*Supply and demand for crude petroleum, 1932–33*

[Thousands of barrels of 42 gallons]

| | 1932 | 1933 |
|---|---|---|
| Production | 785, 159 | 898, 874 |
| Imports | 44, 682 | 32, 773 |
| crease in stocks | 30, 479 | |
| Total new supply plus decrease in stocks | 860, 320 | 931, 647 |
| Runs to stills: | | |
| Domestic | 777, 696 | 825, 786 |
| Foreign | 42, 301 | 35, 468 |
| Total runs to stills | 819, 997 | 861, 254 |
| Exports | 27, 393 | 36, 703 |
| Increase in stocks | | 13, 109 |
| Losses and crude used as fuel | 12, 930 | 20, 581 |
| Total demand plus increase in stocks | 860, 320 | 931, 647 |

## PRICES AND VALUES

Final data on the value of crude petroleum produced in 1933 are not available, but it is estimated that the total was about $540,000,000, an average of $0.60 per barrel. These data indicate material declines in values from 1932, the total being the lowest recorded since 1917 and the average the lowest since 1893.

In general, crude-oil prices were higher at the end of the year than at the beginning, the decline in average value (from 87 cents in 1932 to 60 cents in 1933) being due to the fact that the heaviest increases came quite late in the year.

The average price of 34°–34.9° gravity crude in Oklahoma–Kansas is generally close to the average for all grades, hence the trend of that grade in 1933 may be taken as typical of the general trend of crude prices. The price of 34°–34.9° was reduced in December 1932, and at the beginning of the new year was 65 cents per barrel. It was generally recognized at that time that the stability of crude prices in all districts east of California depended on the effectiveness of curtailment in the East Texas field. Despite the efforts of the State authorities to keep the production in East Texas within reasonable limits of demand the output rose rapidly, reaching a peak of about 1,000,000 barrels in May. As the production rose the price moved in inverse ratio, so that by April 24 the quotation for East Texas oil was 10 cents per barrel, with reports of considerable moving for as low as 5 cents. Other markets were correspondingly weakened; for example, a representative Pennsylvania-grade price declined to 97 cents, the lowest since May 1901, and the price of a representative grade of West Texas crude fell to 20 cents at about the same time. Beginning with June, production in East Texas declined steadily until December and crude prices generally showed a corresponding improvement. Thus the posted price of 34°–34.9° gravity Oklahoma-Kansas crude moved to 40 cents on June 19, to 50 cents on July 8, to 60 cents on August 25, and to 70 cents, 85 cents, and 96 cents on September 6, 8, and 29, respectively. A large part of the net increase of 71 cents should be credited to the stabilizing influence of the oil code; in fact, most of the increases were posted after the issuance of the President's order, prohibiting the interstate movement of "hot oil" on July 12 and after the formulation of the code.

The price trends of representative grades of crude petroleum over a period of years are shown graphically in figure 50.

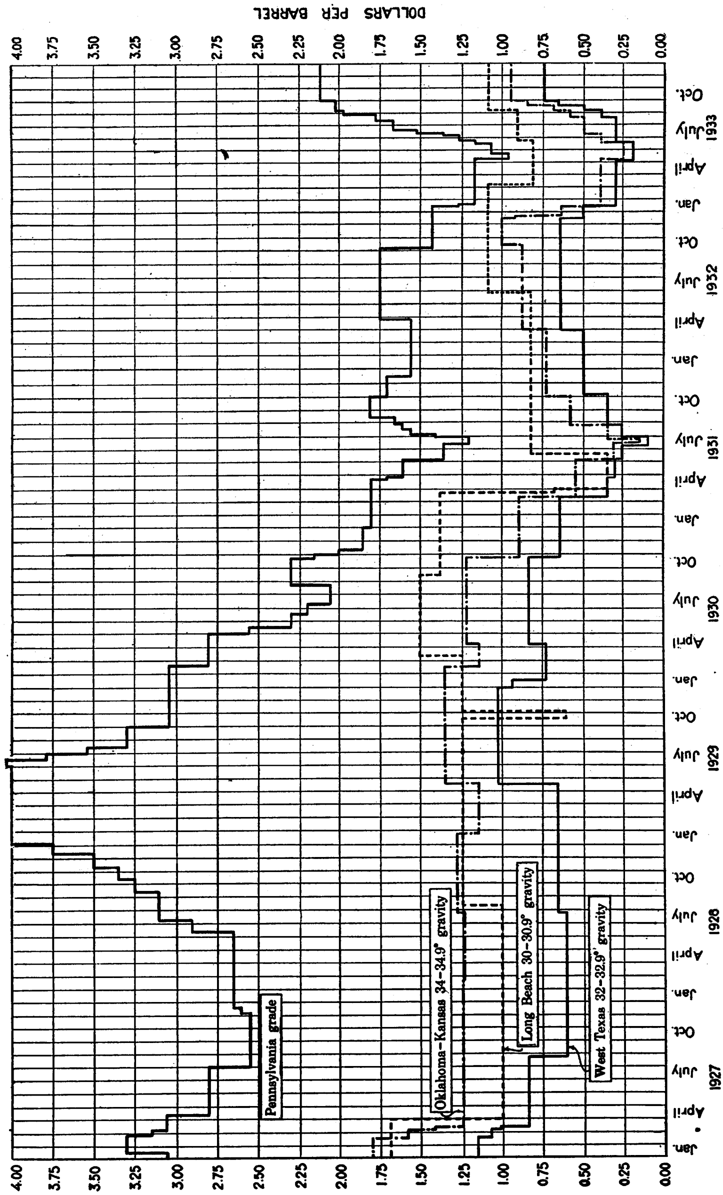


FIGURE 50.—Posted prices of selected grades of crude petroleum, 1927–33, by months.

## STOCKS

The general trend of crude stocks during 1933 was upward, reflecting the material increase in production. Because of the fact that a new form for the reporting of crude stocks was used following the formation of the Petroleum Administrative Board the data now available for crude stocks as of January 1 and December 31, 1933, are not comparable. However, after due allowance is made for this lack of strict comparability it is reasonably certain that crude stocks increased approximately 13,000,000 barrels in 1933, reaching a total of 355,394,000 barrels on December 31. The general trend of stocks was upward during the first 7 months of the year, although in April a shut-down in the East Texas field caused material withdrawals from stocks. The trend of crude stocks over the last 5 months of the year was downward, reflecting the curtailment of production to conform to the Administrator's recommendations.

Stocks of foreign crude held in the United States declined materially, amounting to only 3,055,000 barrels at the close of the year compared with 6,604,000 barrels on January 1. Stocks on the leases changed but slightly, stocks in California declined 2,372,000 barrels, hence the net increase of 13,000,000 barrels was recorded entirely in refinery and tank-farm stocks of domestic crude held east of California. The largest increase recorded in crude stocks in 1933 was in refinery stocks; however, this gain was somewhat artificial, as a large proportion of the increase represented tank-farm stocks reclassified as refinery stocks.

## CONSUMPTION AT REFINERIES

Crude runs to stills in 1933 totaled 861,254,000 barrels (5 percent higher than in 1932). Of this total, 35,468,000 barrels (4 percent) was foreign crude and 825,786,000 barrels (96 percent) domestic crude. These data indicate a continued decline in the relative proportion of foreign oil refined.

All the refinery districts except Appalachian and California processed more crude in 1933 than in 1932. The most important changes in the relative proportions of total crude runs refined in the various districts occurred in California, which lost 2 percent, and Texas, which gained 2 percent.

*Crude runs to stills, 1931–33, by districts*

| District | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Thousands of barrels | Percent of total | Thousands of barrels | Percent of total | Thousands of barrels | Percent of total |
| East Coast | 168,790 | 19 | 162,534 | 20 | 166,932 | 19 |
| Appalachian | 36,372 | 4 | 34,136 | 4 | 33,567 | 4 |
| Indiana, Illinois, Kentucky, etc | 115,442 | 13 | 106,758 | 13 | 117,073 | 14 |
| Oklahoma, Kansas, and Missouri | 105,050 | 12 | 87,170 | 11 | 96,541 | 11 |
| Texas Inland | 61,696 | 7 | 49,435 | 6 | 57,454 | 7 |
| Texas Gulf Coast | 155,660 | 17 | 147,143 | 18 | 160,691 | 19 |
| Louisiana Gulf Coast | 40,022 | 5 | 35,853 | 4 | 39,034 | 4 |
| Arkansas and Louisiana Inland | 19,889 | 2 | 18,297 | 2 | 18,485 | 2 |
| Rocky Mountain | 18,679 | 2 | 13,934 | 2 | 14,209 | 2 |
| California | 173,008 | 19 | 164,737 | 20 | 157,268 | 18 |
| Total | 894,608 | 100 | 819,997 | 100 | 861,254 | 100 |

## DISTRIBUTION BY STATES

Detailed information as to receipts of crude at refineries became available for the first time in September 1933, when a new questionnaire (A–943) was first used by the Petroleum Administrative Board. In the absence of complete information for 1933 generalized data based on reports for the last 4 months of 1933 or specific data for December 1933, taken from the table on page 666, will be used in this discussion.

*Arkansas.*—Production of crude petroleum in Arkansas during the latter part of 1933 averaged about 30,000 barrels; daily receipts from East Texas were several thousand barrels. Of this new supply about 20,000 barrels were refined daily within the State and the remainder shipped to Louisiana and Texas. Shipments of crude to other States exceed receipts from outside sources by 4 to 1, hence the State is self-sufficient as regards crude requirements.

*California.*—California is the only self-contained refining State; in other words, it is the only one that does not ship to or receive crude oil from other States. No appreciable quantity of crude oil has ever been shipped into California from other States; furthermore, the recent scattered cargoes shipped from California to Eastern States has been heavy crude classified as fuel oil and used in asphalt manufacture. In December 1933 California produced 14,726,000 barrels, refined 13,274,000 barrels, exported a little over 1,000,000 barrels, and burned and lost 720,000 barrels.

*Colorado.*—Colorado is virtually self-sufficient as regards crude-oil requirements, as receipts from Wyoming about balance tank-car shipments to Utah. The several refineries in the State utilize 2,000 to 3,000 barrels of crude daily.

*Georgia, South Carolina, and Virginia.*—These States have no production, hence their refinery requirements are supplied from outside sources. In December 1933 approximately one-fourth of the crude receipts consisted of foreign crude; the rest came from Texas.

*Illinois.*—Illinois has been a producer for many years, but its present output is only sufficient to care for about one-sixth of its refinery requirements. Runs to stills at refineries in Illinois average approximately 80,000 barrels daily, of which roughly two-thirds comes from Oklahoma.

*Indiana.*—There are only a few refineries in Indiana, but they are all of more than average size, hence the State is a leader in refining. Production within the State is negligible. Nearly 150,000 barrels of crude oil are refined daily in Indiana, two-thirds coming from Oklahoma and most of the remainder from Kansas and Texas.

*Kansas and Missouri.*—Production in Kansas exceeds consumption, and deliveries of crude to other States, particularly Illinois and Indiana, amount to about 35,000 barrels daily. Companies with refineries in Kansas and production in Oklahoma ship about 20,000 barrels daily from Oklahoma to Kansas. Production in Kansas has been averaging around 110,000 barrels daily, whereas runs to stills have averaged about 95,000 barrels daily. Production in Missouri is very small, but about 12,000 barrels of Mid-Continent crude are refined daily in the State.

*Kentucky and Tennessee.*—Production in Kentucky averages around 13,000 daily, but this is insufficient to meet refinery demands, and 7,000 barrels of Mid-Continent crude are brought in daily. Receipts from and shipments to other States are comparatively small. The distribution of crude in Tennessee is of negligible importance.

*Louisiana.*—Louisiana is an important producing State, but its output does not cover the requirements of the five large refineries in the Gulf district. Production averages 70,000 barrels daily, of which slightly more than half is shipped out of the State. Receipts from other States, particularly receipts of East Texas crude, total about 100,000 barrels daily. Several thousand barrels of foreign crude are refined monthly in Louisiana in asphalt manufacture.

*Maryland.*—Maryland, like Georgia, has no production, the requirements of the few plants there being filled by receipts of oil from Texas and New Mexico and by several thousand barrels daily of imports.

*Massachusetts and Rhode Island.*—The refinery requirements of these two States, normally about 40,000 barrels daily, are mainly supplied by receipts from Texas.

*Michigan.*—The production in Michigan of between 25,000 and 30,000 barrels daily is roughly double crude runs, yet more Oklahoma crude is refined in the State than Michigan crude. This condition is due mainly to the fact that the largest refining company has no production within the State but is supplied by an affiliate in the Mid-Continent district.

*Montana.*—Receipts into Montana from Wyoming virtually balance exports from the State, hence runs to stills and production approximately balance at about 6,000 barrels daily.

*New Jersey.*—New Jersey has no production, but it ranks fourth in runs to stills. The refinery requirements of about 170,000 barrels daily are met by receipts from Texas amounting to approximately 100,000 barrels daily, imports of about 40,000 barrels daily, and less important receipts from Louisiana, New Mexico, New York, Oklahoma, Pennsylvania, and West Virginia. The receipts from New York, Pennsylvania, and West Virginia, which are by pipe line and consist of Pennsylvania-grade crude, average about 9,000 barrels daily.

*New Mexico.*—The handful of small refineries in New Mexico consume about 3,000 barrels of crude daily; virtually all the remainder of the production, which exceeds 40,000 barrels daily, is shipped to Texas, where a large part is transshipped to the Atlantic seaboard.

*New York.*—Production is less than one-third the refinery requirements of about 35,000 barrels daily, the balance being supplied principally by receipts from Texas and Oklahoma.

*Ohio.*—Like most of the central States, Ohio produces only a small fraction of its refinery requirements, the balance being supplied chiefly by receipts from Oklahoma, Michigan, and Texas. Shipments of Michigan and Texas crudes into Ohio made appreciable gains in 1933, following increases in production in both States.

*Oklahoma.*—Oklahoma is one of the chief sources of supply for other States, refining only 25 to 30 percent of its production. Shipments are made to a dozen other States, but the most important single interstate movement is to Indiana. About 80,000 barrels daily move southward into Texas and Arkansas, but a large percentage of this is eventually refined on the Atlantic seaboard. The rapid increase in production in the East Texas field in the spring of 1933 temporarily deprived Oklahoma of some of its markets; but most of these, particularly those to the north and northeast, were regained later in the year.

*Pennsylvania.*—The production in Pennsylvania of about 30,000 barrels daily supplies the majority of the refineries in western Pennsylvania. The six large refineries near Philadelphia receive crude from

Louisiana, New Mexico, Oklahoma, and Texas by boat, and from New York, Ohio, and West Virginia by pipe line, as well as imports of about 27,000 barrels daily. The largest single receipt is from Texas; this averages about 143,000 barrels daily.

*Texas.*—Texas is the leading refining State, but a large proportion of its production is shipped to other States. The daily average balance for December 1933 was about as follows, in barrels: Production, 946,000; imports, 4,000; receipts from other States, 118,000; runs to stills, 612,000; exports, 29,000; shipped to Atlantic seaboard, 312,000; other interstate shipments, fuel, losses, change in stocks, 115,000.

*Utah.*—There are only two refineries in Utah of material importance; these receive about 5,000 or 6,000 barrels of crude daily by tank car from Colorado, New Mexico, Texas, and Wyoming.

*West Virginia.*—Production in West Virginia of about 11,000 barrels daily normally exceeds refinery runs, the difference being roughly equivalent to the excess of shipments to New Jersey, New York, Ohio, and Pennsylvania over and above receipts from Ohio and Oklahoma.

*Wyoming.*—Production in Wyoming has been averaging about 30,000 barrels daily, while daily average runs to stills approximate 20,000 barrels. The excess supply is usually accounted for by shipments to Colorado, Montana, and Utah.

*Distribution of crude petroleum in December 1933, by States*

[Thousands of barrels of 42 gallons]

| State | Production | Imports | Receipts from other States | | Runs to stills | Exports [1] | Deliveries to other States | | Fuel and losses | Change in stocks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quantity | State | | | Quantity | State | | |
| Arkansas | 942 | | 112 | Tex. | 610 | | 437 | La., Tex. | 166 | −159 |
| California | 14,726 | | | | 13,274 | 1,055 | | | 720 | −323 |
| Colorado | 77 | | 48 | Wyo. | 63 | | 19 | Utah | 6 | +37 |
| Georgia | | 67 | 174 | Tex. | [2] 169 | | | | [2] 2 | [2] +233 |
| Illinois | 378 | | 2,199 | Ind., Kans., Ky., La., Mich., N. Mex., Okla., Tex. | 2,379 | 16 | | | −182 | +364 |
| Indiana | 69 | | 4,414 | Kans., La., N.Mex., Okla., Tex. | 4,281 | | 10 | Ill., Ky. | −173 | +365 |
| Kansas | 3,470 | | 599 | Okla., Tex. | 2,722 | 20 | 1,102 | Ill., Ind., Mo., Okla. | 203 | +22 |
| Kentucky and Tennessee | 385 | | 213 | Ind., Okla. | 469 | | 46 | Ill. | | +83 |
| Louisiana | 2,126 | 129 | [3] 3,112 | Ark., Tex. | [3] 4,201 | | 1,228 | Ill., Ind., N.J., Pa., Tex. | 533 | [3] −585 |
| Maryland | | 74 | 894 | N.Mex., Tex. | 891 | | | | 5 | +72 |
| Massachusetts | | | [4] 1,353 | do | [4] 1,277 | | | | 2 | +134 |
| Michigan | 945 | | 252 | Okla. | 505 | 9 | 425 | Ill., Ohio | 128 | +130 |
| Missouri | | | 358 | Kans., Okla. | 360 | | | | [5] −12 | [5] +10 |
| Montana | 199 | | 58 | Wyo. | 165 | 45 | | | 44 | +3 |
| New Jersey | | 1,314 | 3,512 | La., N.Mex., N.Y., Okla., Pa., Tex., W.Va. | 4,998 | | | | −29 | −143 |
| New Mexico | 1,277 | | 22 | Tex. | 96 | | 1,504 | Ill., Ind., Md., Mass., N.J., Pa., Tex., Utah. | −308 | +7 |
| New York | 298 | 344 | 515 | Okla., Pa., Tex. | 1,189 | | 11 | N.J., Pa. | 52 | −95 |
| Ohio | 334 | | 1,723 | Mich., Okla., Tex., W.Va. | 1,941 | | 79 | Pa., W.Va. | −44 | +81 |
| Oklahoma | 15,208 | | 247 | Kans., Tex. | 3,901 | 657 | 9,866 | Ill., Ind., Kans., Ky., Mich., Mo., N.J., N.Y., Ohio, Pa., Tex., W.Va. | 939 | +92 |
| Pennsylvania | 1,077 | 842 | 5,131 | La., N.Mex., N.Y., Ohio, Okla., Tex., W.Va. | 7,000 | | 251 | N.J., N.Y. | −253 | +52 |
| Rhode Island | | 60 | (4) | | (4) | | | | (4) | (4) |
| South Carolina | | 102 | | | (2) | | | | (2) | (2) |
| Texas | 29,324 | 127 | 3,668 | Ark., La., N.Mex., Okla. | 18,983 | 907 | 13,608 | Ala., Ark., Ga., Ill., Ind., Kans., La., Md., Mass., N.J., N.Mex., N.Y., Ohio, Okla., Pa., R.I., Utah. | 399 | −778 |
| Utah | | | 148 | Colo., N.Mex., Tex., Wyo. | 192 | | | | | −44 |
| Virginia | | 61 | | | (2) | | | | (2) | (2) |
| West Virginia | 326 | | 125 | Ohio, Okla. | 197 | | 113 | N.J., Ohio, Pa. | 26 | +115 |
| Wyoming | 899 | | | | [6] 577 | | 188 | Colo., Mont., Utah | 27 | +107 |
| | 72,060 | 3,120 | 28,887 | | 70,440 | 2,709 | 28,887 | | 2,251 | −220 |

[1] Includes shipments to Alaska, Hawaii, and Puerto Rico.
[2] Georgia includes South Carolina and Virginia.
[3] Louisiana includes Alabama and Mississippi.
[4] Massachusetts includes Rhode Island.
[5] Missouri includes Iowa.
[6] Wyoming includes Nebraska and South Dakota.

**PRODUCTION BY STATES**

The fluctuations of domestic crude production in 1933 were much more pronounced than in 1932, the variation in daily average production by months in 1933 being from 2,064,000 barrels in January to a peak of 2,762,000 in June, a range of about 700,000 barrels, whereas in 1932 the range was hardly more than half that amount. Production increased rapidly during the first half of 1933, except in April, when the East Texas field, which caused most of the increase, was shut down for about 3 weeks. Production remained at a comparatively high level during the third quarter of the year but declined in the last quarter following adoption of the code.

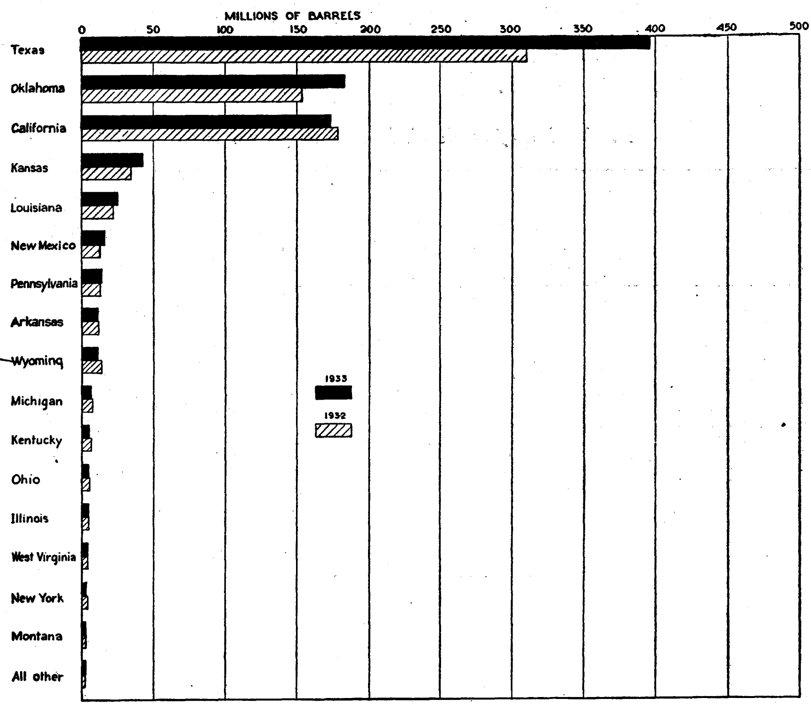


FIGURE 51.—Production of crude petroleum, 1932–33, by States.

Production in Texas increased 27 percent in 1933 to a total of 396,453,000 barrels. This was more than double the output of Oklahoma, the second ranking producing State. The output of Oklahoma increased substantially in 1933.

California showed a small decrease, with the result that the latter fell from second to third place among the producing States. Other changes in rank among the leading producing States in 1933 affected New Mexico, which rose from seventh to sixth; Pennsylvania, which rose from eighth to seventh; Arkansas, which rose from ninth to eighth; and Wyoming, which fell from sixth to ninth.

The relative importance of the various States in crude production is shown graphically in figure 51.

Production continued to decline in most of the major producing districts, only Lima-Indiana-Michigan, Gulf Coast, Oklahoma-

Kansas, and East Texas showing increases in 1933 over 1932. The gain in the Lima-Indiana-Illinois district was due entirely to developments in Michigan, that in the Gulf Coast district principally to the gain in output at Conroe, and that in Oklahoma-Kansas to increased production at Oklahoma City. In 1933, 5 percent of the output was produced in the Eastern and Central States (east of the Mississippi); 66 percent in the greater midcontinent district, including East Texas; 8 percent in the Gulf Coast; 2 percent in the Rocky Mountain; and 19 percent in California. These data, compared with 1932, indicate chiefly an increase in the relative importance of the midcontinent.

The production of Pennsylvania-grade crude oil increased in Pennsylvania; but this gain was more than outweighed by declines in New York, Ohio, and West Virginia, with the result that the total output of this grade of oil declined from 21,520,000 barrels in 1932 to 21,214,000 in 1933.

*Production of crude oil in leading fields, 1933*

| Field | Production in 1933 | Approximate increase or decrease compared with 1932 |
|---|---|---|
| | *Barrels* | *Barrels* |
| East Texas, Tex | 199,298,000 | +22,151,000 |
| Oklahoma City, Okla | 68,461,000 | +34,654,000 |
| Seminole, Okla | 41,220,000 | −1,691,000 |
| Long Beach, Calif | 24,797,000 | −2,639,000 |
| Kettleman Hills, Calif | 21,627,000 | −334,000 |
| Conroe, Tex | 21,000,000 | +18,370,000 |
| Yates, Tex | 20,774,000 | −2,943,000 |
| Santa Fe Springs, Calif | 18,271,000 | −4,266,000 |
| Van, Tex | 17,077,000 | −134,000 |
| Bradford, Pa.-N.Y | 12,367,000 | +38,000 |
| Hobbs, N.Mex | 11,520,000 | +283,000 |
| Salt Creek, Wyo | 7,000,000 | −1,006,000 |
| All other | 435,462,000 | +51,232,000 |
| | 898,874,000 | +113,715,000 |

*Arkansas.*—The production of crude petroleum in Arkansas continued to decline, although at a somewhat reduced rate. The production in 1933 was 11,608,000 barrels, a decline of 443,000 barrels (4 percent) from 1932. The output of the Smackover field in 1933 was about 8,800,000 barrels, or 76 percent of the total.

Drilling continued at a low ebb in Arkansas and exploratory work was practically nil. Only 6 oil wells were completed during the year out of a total of 48 completions. Most of the new production was found in the Miller County pool, the newest field in the State.

*California.*—Although the number of oil wells completed in California in 1933 was considerably above the 1932 level, production declined for the fourth successive year. The total output, according to monthly data of the American Petroleum Institute, was 173,085,000 barrels compared with 178,128,000 barrels in 1932. The proration record of the State in 1933 was similar to that of 1932, with the majority of the operators striving to reduce production to the allowable but being prevented from doing this by a small minority. The result was that the daily average production fluctuated between about 10,000 and 70,000 barrels in excess of the allowable.

The crude price increases of June 1932 were wiped out in the spring of 1933, following the collapse of the price structure east of California and the failure to reduce production to the allowable. The price improved slightly in June and even more in September; however, the latter increase was primarily an aftermath of the code and not the result of improved economic conditions.

No new fields were discovered in California in 1933, but some important extensions and deep sands were found. The most important of the new discoveries, at least from a geological standpoint, was the finding of production in the Puente (Miocene) formation at about 7,000 feet in the Montebello field. This well was interesting, chiefly because it indicated good possibilities of finding production in the same formation in other fields of the Los Angeles Basin, particularly Santa Fe Springs.

The outstanding extension to proven areas was made at Huntington Beach, where operators discovered that good completions could be obtained by deflecting their wells under the tidelands. This practice, usually referred to as whipstocking, was the subject of considerable controversy, and the companies involved were sued by the State to stop further drilling and for the payment of royalties. The new development in the Huntington Beach townsite area resulted in an increase in output of the field from 8,016,000 barrels in 1932 to 13,100,000 barrels in 1933. There were 51 oil wells completed in the Huntington Beach field in 1933, compared with only 1 in 1932. Drilling increased at Kettleman Hills in 1933, but the output was well-curtailed so that the total production in 1933—21,627,000 barrels—was slightly below that of 1932. Of the 1933 total about 150,000 barrels came from the middle dome which, after a number of disappointments, gave promise of becoming a substantial producer. The north dome at Kettleman Hills was the scene of the year's deep-drilling record, a well there reaching nearly 11,000 feet. This well, while not commercial, indicated the presence of oil in the Eocene formations underlying the Temblor. Long Beach retained its rank as the leading producing field in California, although its output declined from 27,436,000 barrels in 1932 to 24,825,000 barrels in 1933. The most interesting of the new fields in California was Round Mountain, which though discovered in 1930, did not yield oil in commercial quantities until 1933.

*Colorado.*—Production in Colorado in 1933 totaled 947,000 barrels—17 percent below 1932. This material decrease resulted from natural decline of the settled areas and from the failure to find much new production until just before the close of the year. Only 3 oil wells were completed in the State in 1933, but 1 of these, completed in December, was good for an initial production of 1,100 barrels. This well proved an important extension in the Iles Dome field of Moffat County. The only other discovery of importance in Colorado in 1933 was the finding of deep production in a well on the Rangely dome at about 6,300 feet. This well, while not commercial, proved the presence of oil in the Pennsylvanian formation in the western part of the State. An important test in northeast Colorado near Buckingham looked promising for a time but was finally completed as a gasser.

*Illinois.*—The production of crude petroleum in Illinois in 1933 totaled 4,227,000 barrels, compared with 4,673,000 barrels in 1932. In view of price conditions the incentive for drilling in Illinois in 1933 was virtually nonexistent, and only four oil wells were completed in 1933, compared with 12 in the previous year. Increased interest in improved recovery methods was shown in Illinois in 1933, and several repressuring and water-flood projects were initiated.

*Indiana.*—Production in Indiana in 1933 totaled 728,000 barrels, the lowest annual output since 1893. The producing areas in the northeastern corner of the State yielded only 7,000 barrels in 1933, indicating virtual exhaustion of that once famous part of the Lima district. The material decline in output in Indiana occurred despite the fact that 52 oil wells were brought in. Regardless of the apparent lack of success attending drilling in Indiana in recent years an increase in leasing was reported early in 1934.

*Kansas.*—Production in Kansas increased 20 percent in 1933 and reached a total of 41,942,000 barrels. Except for 1918 and 1929 this was the highest annual total ever recorded. The average output of the State was approximately 90,000 barrels daily on January 1 but increased to over 130,000 barrels daily in midsummer. From September until the end of the year the output was influenced by code allowables and fluctuated between 100,000 and 120,000 barrels daily over most of the period.

The Ritz-Canton field of McPherson County was again the leading producing area, its production totaling about 6,600,000 barrels compared with nearly 5,000,000 barrels in 1932. The Voshell field, also in McPherson County, continued to decline and was supplanted in second place by Harvey County, of which the Hollow Pool is the chief producing field. Other areas that showed important increases in production in 1933 were the Nikkell pool of McPherson County and the various pools of Rice County.

In 1933, as in most recent years, Kansas was an active area from the standpoint of exploratory work. Much of this consisted of geophysical surveys along the Abilene arch in the central part of the State, a type of wildcatting resorted to in the almost complete absence of surface indications which has yielded good results.

Several new pools were discovered in Kansas in 1933, the most important being the Brandenstein and Thode pools of Rice County and the Gates pool of Stafford County. These were all one-well fields; that is, the discovery well was the only producer at the close of the year.

Of more importance from the standpoint of production were the extensions and deeper sands found in such recently developed fields as Hollow, Harvey County; Chase Townsite, Rice County; and Nikkell, McPherson County. In all, 87 oil wells were completed in the Hollow pool in 1933, and from the standpoint of total daily initial production the pool led all others in the State. McPherson County, with 116 oil wells completed in 1933, was the most active area. Although completions were 32 fewer in Kansas in 1933 than in 1932 the percentage of dry holes and gas wells declined materially, and the number of oil wells completed rose from 363 in 1932 to 389 in 1933.

As much of the production in Kansas comes from lime formations it constitutes a favorable territory for acid revivifications, and in 1933 cases were recorded where production was increased as much as 300 percent following treatment with 1,000 gallons or less of acid.

*Kentucky.*—Production in Kentucky declined from 6,287,000 barrels in 1932 to 4,605,000 in 1933 or 27 percent. This was the largest percentage decline recorded in the production of any State for the year. The explanation of this material decline in Kentucky is the same as in the other Central States—low prices, slack demand, and curtailed drilling. Eighty-three oil wells were completed in Kentucky in 1933, the equivalent of only about 30 percent of the successful completions in 1932. In 1933, as in 1932, most of the drilling was concentrated in Davies, Ohio, Hancock, and McLean Counties.

*Louisiana.*—Production in Louisiana was 24,636,000 barrels in 1933, the highest annual total since 1923. The material gain in output in 1933 resulted solely from developments in the coastal fields, as production of the northern fields continued to decline.

There were nearly as many oil wells completed in north Louisiana in 1933 as in 1932 (102 in 1933, 112 in 1932), but the total initial production was only about half as large in 1933 as in 1932. Virtually all of the fields in northern Louisiana declined in output in 1933, the most notable exception being the Converse field, discovered in 1932. Nearly 30 oil wells were completed in the Converse field in 1933 at about 2,000 feet. The Zwolle field continued to be the leading field in northern Louisiana, both from the standpoint of production and drilling activity. About 150 wells were completed at Zwolle in 1933, but more than half of these were dry holes. This high ratio of failures indicates the erratic nature of the production at Zwolle, where the oil is found in crevices in a chalk formation.

The apparent lack of success which has attended exploratory work in northern Louisiana in recent years was no deterrent to wildcatters in 1933, and many geophysical surveys and deep tests were made. A number of deep tests were drilled to the Trinity formation, but the results generally were disappointing.

Production in the majority of the coastal fields of Louisiana declined in 1933, but these losses were more than offset by increased production in the Iowa, Port Barre, and Lake Barre fields. The Iowa field in particular showed a material gain in output and proved itself one of the largest fields discovered in Louisiana in many years.

Wildcatters continued active in the coastal district of Louisiana, but the number of discoveries fell below the average. The salt dome discovered at Darrow in 1932 was proved for oil and extensions in the older fields constituted the most important findings of the years in the district.

*Michigan.*—The year 1933 was a record breaker for oil production in Michigan, a State which until a few years ago was given little consideration as a future important producer. The production in 1933 totaled 7,851,000 barrels, a new record and an increase of 14 percent over 1932. A total of 218 oil wells was completed in Michigan in 1933; this was nearly double the 1932 figure, but considerably short of the peak reached during the height of the Muskegon boom in 1929. Most of the drilling in 1933 was concentrated in Midland and Isabella Counties or, more specifically, in the Porter, Yost, and Vernon pools in those counties. The average size of the completions in Michigan continued high, one being rated as a 20,000-barrel well.

The stimulation of production by acid treatment continued to be an integral part of production methods in Michigan; in fact, the State was used somewhat as an experimental plant to test several possible improvements in the process.

*Mississippi.*—Drilling in Mississippi in 1933 was mainly confined to gas wells, although a number of wildcats were drilled for oil. There were 42 completions recorded in the State in 1933, but only one or two of these were completed as oil wells. The several producing wells on the south side of the Jackson gas field were shut in virtually all of the year, and no commercial production was reported. Core drilling, supplemented by considerable geophysical work, was carried on in the southwest tier of counties.

*Missouri.*—There are between 50 and 100 producing oil wells in western Missouri just south of Kansas City. The total production of these wells in 1933 was approximately 12,000 barrels, or slightly more than in 1932.

*Montana.*—As was predicted a year ago, the most important event of the year in Montana was the development of the Cut Bank field as a substantial producer. Originally a gas field, Cut Bank was first proved for oil in 1932. In 1933, 35 oil wells were drilled in the field, and the proven territory extended to cover an area which, though now nearly 10 miles long and 3 miles wide, probably will be considerably extended on all sides. Although the production of the Cut Bank field increased from a few thousand barrels in 1932 to about 260,000 barrels in 1933, the output of the State as a whole declined from 2,457,000 barrels in 1932 to 2,122,000 in 1933. This decrease resulted from the continued decline in production in the older fields, although Kevin-Sunburst, the most important producing area, held up remarkably well. More oil wells were completed in Montana in 1933 than in 1932, but the total initial production declined more than 50 percent, as the usual number of large producers were not completed in the Dry Creek field.

*New York.*—Production in New York in 1933 totaled 3,174,000 barrels—10 percent below 1932. This decline, the largest recorded in many years, resulted primarily from unsatisfactory price conditions.

*New Mexico.*—The allowable of the Hobbs field, the principal producing area of the State, was increased materially in the spring of 1933, with the result that the total output rose from 12,455,000 barrels in 1932 to 14,074,000 in 1933. Of the total in 1933, about 11,520,000 barrels (82 percent) was produced at Hobbs, 360,000 barrels (3 percent) in the light-oil fields in the northwest corner of the State, and the remainder, 2,194,000 barrels, at Jal, Artesia, and other pools in the southeastern corner of the State.

Drilling in New Mexico in 1933 was on about a par with 1932 in number of completions, but the average initial production was lower, reflecting approaching maturity at Hobbs, which was defined on several sides by dry holes. The majority of the fields in the southeast corner of the State were extended during 1933, but the light-oil fields of San Juan County were inactive.

*Ohio.*—Production in Ohio in 1933 totaled 4,264,000 barrels, of which the pools of the central and southeastern parts of the State, producing mainly Pennsylvania-grade crude oil, accounted for 3,238,000 barrels (76 percent), and the Lima field in the northwestern part of the State for 1,026,000 barrels (24 percent). The output of that part of the Lima field which lies in Ohio declined only 4 percent in 1933, although several hundred wells were reported abandoned in that district. Drilling declined materially in the central and southeastern parts of the State, and in the absence of any important discoveries the output in these areas registered another material decrease. Increased interest was manifested in the development of Devonian shale wells in southeastern Ohio. A dry hole was drilled in Washington County to nearly 8,000 feet; this was said to be the deepest test ever drilled in Ohio.

*Oklahoma.*—Production in Oklahoma in 1933 scored a "comeback", and the total for the year—181,506,000 barrels—was 28,262,000 barrels (18 percent) above 1932 and slightly higher than in 1931. At the beginning of 1933 production averaged approximately 400,000 barrels, reached a peak of just over 600,000 barrels in midsummer, then declined to about 500,000 barrels at the end of the year. Daily average production was lowest in April as the result of a 16-day shutdown of the Oklahoma City field.

The increased output of the Oklahoma City field was responsible for the gain of the State as a whole in 1933; in fact, the Oklahoma City field increased its production by nearly 35,000,000 barrels over 1932, but the output of the other fields declined more than 6,000,000 barrrels. The Seminole field, the only other producing district of major importance, showed a well-sustained output in 1933 and declined from 42,911,000 barrels in 1932 to 41,220,000 in 1933, or only 4 percent.

Although the total number of completions declined in Oklahoma in 1933 the number of oil wells completed rose from 643 in 1932 to 668 in 1933. However, the average size of the completions in 1933 was less than half that in 1932, due largely to the fact that fewer large wells were completed at Oklahoma City. The most active counties in drilling in 1933 were Creek, Oklahoma, Okmulgee, Osage, and Seminole.

Exploratory work was moderately successful in 1933, although no large fields were discovered. The new pools opened were Sasakwa townsite and Keokuk Falls, in the Seminole district; Crescent, in Logan County; West Chandler, in Lincoln County; Olive, in Creek County; and Fitts in Pontotoc County. Of these the Crescent pool appeared to have the best prospect of developing into a major pool. The Fitts discovery was interesting, as it was the first production ever found in the area. Discoveries of 1932 which were developed into important producing areas in 1933 were the Lucien field of Noble County and the West Holdenville field of Hughes County. The settled areas of central and eastern Oklahoma experienced a revival of activity, and many wells were cleaned out and put on production following the price increases of September.

*Pennsylvania.*—The similarity between the trend of production in New York and Pennsylvania, as the result of the fact that the Bradford-Allegany field is the most important producting area in each State, was interrupted in 1933 when production in Pennsylvania increased but that in New York declined. The output in Pennsylvania totaled 12,639,000 barrels, which, except for 1930, represents the largest annual total recorded since 1900. Of the total production in 1933 the Bradford field yielded 9,193,000 barrels (73 percent) and the rest of the State 3,446,000 barrels (27 percent). Compared with 1932 these data indicate a gain in the relative importance of the Bradford field as a producer.

Drilling increased in the Bradford field in 1933, and 836 oil wells were brought in compared with 624 in 1932. However, the increased production in Pennsylvania in 1933 resulted primarily from further opening of wells on water flood.

Despite a flurry of excitement following discoveries in an old pool in Washington County the producing fields of Pennsylvania outside of the Bradford district passed a quiet year. Although prices improved materially over the low point of 1932 they remained too low to encourage the reconditioning of old wells, a factor of more importance to production than the drilling of new wells.

*Tennessee.*—The production in Tennessee totaled 6,000 barrels in 1933 compared with 5,000 in 1932. Virtually all of the production in Tennessee comes from Clay, Morgan, Pickett, and Scott Counties.

*Texas.*—Total production in Texas in 1933 rose to a new record of 396,453,000 barrels, the first instance in which the daily output of a State has averaged more than 1,000,000 barrels. The gain in output in Texas in 1933 was due chiefly to developments in two major fields, East Texas and Conroe; in fact, production in the other fields of the State declined.

Texas is divided into seven districts, Panhandle, north Texas, east Texas, central Texas, west Texas, southwest Texas, and Gulf Coast Texas, which will be discussed in that order.

Production in the five producing counties of the Texas Panhandle continued its steady decline and totaled about 16,700,000 barrels compared with 18,263,000 barrels in 1932. This decrease occurred despite the fact that the number of oil wells completed rose from 110 in 1932 to 152 in 1933, and many old wells were deepened or acidized; however, the total output in 1933 did not represent the full ability of the Panhandle to produce, as proration was in effect at all times and the allowable was always less than one-third of the rated potential.

Most of the drilling was carried on in Gray County, which yielded nearly two-thirds of the total output. The average size of the completions in Gray County was considerably lower than in 1932; in fact, the total initial production for the district as a whole was below that of 1932, when fewer wells were drilled. No important new fields or extensions were discovered in the Texas Panhandle in 1933.

Production in north Texas, including those parts of Texas commonly referred to as north Texas, north central, and west central Texas, totaled approximately 26,000,000 barrels in 1933 or about 600,000 barrels less than in 1932. The decrease would have been much larger if prices had not improved in midyear, as many wells which were abandoned in the first half of the year were brought back on production in the latter half. Another fact instrumental in maintaining production in this "stripper" area was a material gain in the total initial production of the completed oil wells. There were 524 wells completed in north Texas in 1933, which, because of more fortunate locations and the use of acid, had a daily average initial production of about 84 barrels, compared with an average initial of 60 barrels for the 492 successful completions in 1932. Most of the drilling was confined to Archer and Young Counties.

Several new discoveries were made in north Texas in 1933, the most important being completion of a large well in western Foard County at a depth of around 3,500 feet. The discovery that the Gunsight limestone formation just south of Archer City would yield good wells following acid treatment stimulated interest in the area and about 100 wells were completed there in 1933.

The east Texas field proper, in Cherokee, Gregg, Rusk, Smith, and Upshur Counties, continued to be the center of interest for the oil industry in the United States and also in the world. All units of the industry, no matter how small or how remotely situated from the east Texas field, felt the powerful influence which that field has over the economic well-being of the petroleum industry. Although the areal extent of the field was not increased as much as in former years drilling on inside locations continued at a high rate, and at the close of 1933 there were about 11,700 producing wells compared with about 9,500 at the beginning of the year.

According to preliminary data the production of the east Texas field during 1933 totaled 199,298,000 barrels, an increase of 77,849,000 barrels (64 percent) over 1932. The final figure of east Texas production will probably be several million barrels higher than the preliminary total. The general trend of production in the east Texas field during 1933 was upward from the beginning of the year until a peak of about 1,000,000 barrels daily was established in May, after which production declined to about 450,000 barrels daily on December 31. April was a low month in production but that was due to a shut-down lasting from April 6 to 24. In 1933, as in prior years, the question of prorating the east Texas field was important, and several new methods were tried. At the beginning of the year the method in force was based on an allowance for each well, with consideration given to bottom-hole pressures. A later proposal gave weight to such factors as sand—thickness, permeability, porosity, and saturation—but that method, while probably laudable from an engineering standpoint, was not sustained in court, and an alternative plan based on the potentials of key wells was substituted. It is interesting to note that the total potential of all the wells, as established by tests of the key wells amounted to the imposing but comparatively meaningless total of about 125,000,000 barrels daily.

There were 2,463 completions recorded in the east Texas field proper in 1933, or 3,178 less than in 1932. Of the completions in 1933, 2,407 (98 percent) were oil wells, which, as has always been the case in east Texas, represent an unusually high average. The average daily initial production of the oil wells completed in east Texas in 1933 was 2,020 barrels, which, as might be expected in a field several years old, was considerably below the average initial in 1932.

In the spring of the year, when daily average production in the east Texas field was hovering around the 1,000,000-barrel mark, the average bottom-hole pressure declined about 4 pounds daily, but the reduction in allowable improved operating conditions to such an extent that pressures were being built up as the year closed. One of the many beneficial results of the increase in pressures was a marked decline in the rate at which wells were put on the pump; in fact, in some parts of the field pumping wells began to flow.

Production in the other fields of the general east Texas district, including the important field at Van, Boggy Creek, and small pools in Panola and Nacogdoches Counties, showed a small decline in 1933.

Wildcatting continued active over the area, the efforts in the northern half being devoted to locating another Van, in the southern half to finding another Conroe along the "Conroe trend." These efforts produced one field, Long Lake, which for a time looked promising but which had failed to demonstrate its ability to produce consistently by the close of the year. The Nacatoch sand, which lies above the Woodbine at Van, has been known for some time to be oil-bearing, but it was not until 1933 that several wells were drilled, proving that it extended over a considerable area.

The fields of the central Texas district, including principally those along the Balcones fault zone, declined materially in output in 1933, as no outstanding discovery was made to compensate for the declines at Darst Creek and Salt Flat. Production in the Mexia-Powell area held up well, considering the age of the fields and the fact that no important producers have been completed in several years.

Wildcatters continued active in the southern end of the Balcones fault zone—that is, in the Luling area—and several new pools were discovered. Of these the Hilbig pool west of the town of Bastrop appeared the most important. There were about 10 oil wells completed in the serpentine at Hilbig in 1933, and the total output for the year was about 225,000 barrels. An extension to the Pettus field was discovered, nevertheless its production declined to about two-thirds the 1932 level.

Drilling in west Texas increased materially in 1933, and 237 oil wells were completed compared with 152 in 1932. The completions of 1933 were of a larger average size than those of 1932, and the total initial output in 1933 was approximately twice that of 1932. However, the effect of the increased drilling did not prevent another decline in the output of the district, which totaled about 55,000,000 barrels compared with 63,335,000 in 1932.

Ward County led in drilling activity in west Texas in 1933, and the Grand Falls and O'Brien fields of that county were about the only ones in the district to show increased production over 1932. The Yates field, Pecos County, continued to be the largest single factor in production in west Texas, although its output declined in 1933 for the fourth successive year. The total output at Yates in 1933 was about 20,800,000 barrels, about 3,000,000 barrels less than in 1932 and 21,100,000 below the peak production of 1929.

Only a few new productive spots were discovered in west Texas in 1933, although a number of deep tests were drilled in Crockett and other counties. Several new deep producers were completed in the Ordovician pay in the Big Lake field but did not compensate for the rather rapid decline of the older deep wells in that field. The output of that well-known field accordingly declined from 8,265,000 barrels in 1932 to about 6,800,000 in 1933.

Production in southwest Texas, including principally the fields in Webb, Zapata, Starr, Jim Hogg, and Duval Counties, continued to increase and in 1933 totaled about 7,600,000 barrels compared with 6,421,000 barrels in 1932. The output of this often underrated district has gained steadily since 1926, a growth due mainly to a number of factors, such as comparatively shallow depth of the wells and the relative lack of proration restrictions.

Drilling in southwest Texas showed a material gain, as 951 wells were completed in 1933 compared with 624 in 1932. Most of the drilling was centered in the North Government Wells pool of Duval County. About a dozen new pools were discovered in southwest Texas in 1933, and although some of these will never be more than gas fields, several bore promise of producing substantial quantities of oil in 1934.

Production in the Texas Gulf coast district increased materially in 1933, when the total output was 60,300,000 barrels compared with 41,850,000 in 1932. The total in 1933 did not quite equal the peak (61,066,000 barrels) reached in 1930; however, there was virtually no proration in the district in 1930, whereas in 1933 production was curtailed to well below the potential.

Drilling increased materially in the Texas Gulf coast in 1933 and reached a level comparable with 1929, when Refugio was being intensively developed. There were 1,030 oil wells completed in the district in 1933, a new high record and an increase of 154 percent over the preceding year. More than half of these oil wells were completed at Conroe, with Thompson and Greta the next most active fields.

Under generally successful proration the Conroe field yielded about 21,000,000 barrels in 1933 or about 18,400,000 barrels more than in 1932. As the increase in the total production of the district was approximately 18,500,000 barrels, it follows that the production of the other fields remained virtually stationary. About 15,000 acres were proven for production at Conroe, which, taken in conjunction with such factors as sand thickness and saturation, labeled it the second largest field east of California.

The Barbers Hill field continued active and registered a moderate increase in production in 1933; the same was true of the Rabb Ridge or Thompson field. The most important new production in the Texas Gulf coast district in 1933 was that from Greta, which in about 6 months yielded about 1,200,000 barrels.

For a number of years, the Texas Gulf coast has been a fertile field for the wildcatter, but leasing and exploratory work became even more intensified after Conroe proved so prolific. Some counties have been almost entirely leased with individual tracts bordering each other.

The most important of the new discoveries in the Texas Gulf coast district in 1933 were Greta, Tomball, and Louise. Of these only Greta came up to expectations. The discovery of the Tomball field near Conroe was the signal for a frenzied leasing program; however, the field proved a disappointment, having plenty of structure but little sand. Several wildcats were drilled on the Louise structure in Wharton County without deciding the question as to whether the field will be just another gas field. The Cleveland field of Liberty County, a late season discovery, bids fair to prove important, as geologically it bears some similarity to the Conroe field. The usual number of extensions to proven fields were made in 1933, those of particular interest being at Barbers Hill and Hull.

*Utah.*—No oil discoveries were made in Utah in 1933, and the State continued to be a negligible factor in production. The total output in 1933 was about 2,000 barrels, nearly all of which came from the Virgin field of Washington County.

*West Virginia.*—Considering the fact that West Virginia is one of the oldest producing States, unusually successful results attended drilling in that State in 1933. The 76 oil wells completed in 1933 had an average initial output of 93 barrels or about 10 times the average size of all completions in the Eastern States. The outstanding development was the drilling of several large wells in the Lost Run pool of Ritchie County.

*Wyoming.*—Production in Wyoming continued to decline as little new production was found to compensate for the decline of the settled fields.

The total production in 1933 was 11,196,000 barrels, of which the Salt Creek field yielded 7,000,000 barrels (63 percent). Virtually all of the fields of Wyoming declined in 1933, two of the notable exceptions being Poison Spider and Oregon Basin. Both of these fields produce heavy oil, and their increased production in 1933 probably resulted from efforts to increase the fuel oil and road oil markets for the heavy, black-oil fields of the State.

Drilling fell to a low ebb in Wyoming in 1933, and no new fields were discovered. Most of the new production was found in Weston County or, more speciffically, in a newly discovered extension of the Osage field.

## WELLS

Data on the number of producing wells at the close of 1933 are not available, but it is estimated that the total will not be far from 330,000. This estimate considers the number of oil wells completed during 1933 (8,068) and allows for the fact that the number of wells reconditioned in the last half of the year as the result of the improvement in prices more than offset the number abandoned during the first half.

After increasing sharply in 1932 drilling declined in 1933 to the lowest point in many years; only 12,312 wells were completed in 1933 compared with 15,040 in 1932 and with an all-time peak of 33,911 in 1920. Of the completions in 1933, 8,068 (65 percent) were oil wells, 932 (8 percent) were gas wells, and 3,312 (27 percent) dry holes. The percentage of oil wells continued relatively high in 1933 because a large proportion of them were completed on inside locations in the East Texas field, where only a few dry holes have been drilled. In general, drilling fell off during the first half of the year, reached a low point in June, but picked up thereafter on the advent of better prices.

The East Texas field proper was the leading field in drilling in 1933, with Bradford-Allegany second. The newer fields actively developed in 1933 were Conroe, where 586 oil wells were completed in 1933; Greta, with 87 oil wells; Midland, with 171; and Thompson (Rabb Ridge), with 91.

The total number of wells completed, divided as between oil wells, gas wells, and dry holes, is shown graphically in figure 52.

*Drilling activity in leading districts, 1932–33*

| District | State | Completions [1] 1932 | Completions [1] 1933 | District | State | Completions [1] 1932 | Completions [1] 1933 |
|---|---|---|---|---|---|---|---|
| Archer County | Texas | 302 | 346 | Gray County | Texas | 94 | 128 |
| Bradford-Allegany | Pennsylvania-New York. | 624 | 929 | Greta | do | | 94 |
| | | | | McPherson County | Kansas | 151 | 142 |
| | | | | Midland County | Michigan | 125 | 190 |
| Conroe | Texas | 100 | 615 | Oklahoma County | Oklahoma | 136 | 70 |
| Creek County | Oklahoma | 219 | 187 | Sabine Parish | Louisiana | 251 | 189 |
| East Texas | Texas | 5,760 | 1,459 | Thompson | Texas | 60 | 97 |
| Glacier County | Montana | 10 | 44 | Ward | do | 59 | 104 |
| Government Wells | Texas | 110 | 217 | Young County | do | 261 | 285 |

[1] Totals for oil wells, gas wells, and dry holes.

## WORLD PRODUCTION

Official figures as to the world production of crude petroleum are not yet available, but several estimates have been prepared by outside authorities. The average of these estimates indicates that the

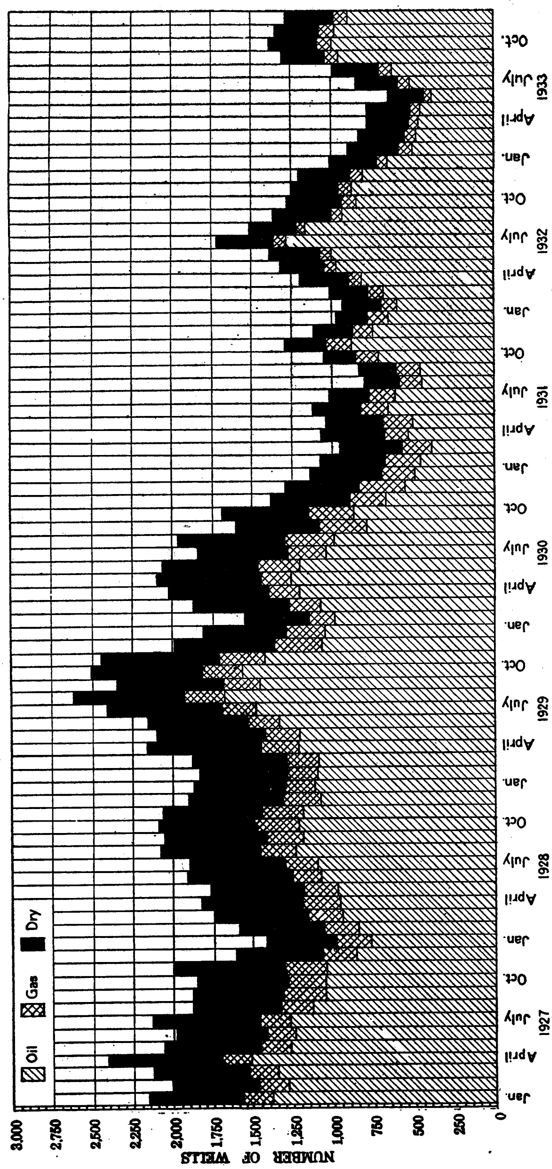


FIGURE 52.—Wells drilled, 1927–33, by months.

total production of crude petroleum in the world in 1933 was just over 1,400,000,000 barrels, or nearly 100,000,000 barrels more than in 1932. All of the increase in 1933 came from the United States; in fact, the output of the other producing countries declined about 10,000,000 barrels. The ratio of production in the United States to the world total has declined in recent years, but in 1933 the increased output raised it to 63.6 percent from 59.9 percent in 1932.

Production in the Union of Soviet Socialist Republics, the second-ranking producing country, showed another small decline in 1933, but the output in Venezuela, which ranks third, remained virtually stationary. Production in Rumania declined several million barrels below the peak of 1932. The majority of the other countries showed little change in output in 1933, except that a decline of about 3 million barrels in Colombia was compensated by an increase of about the same amount in Peru.

## IMPORTS AND EXPORTS

Exports of crude petroleum exceeded imports in 1933 for the first time since 1911. The gain in relative importance of exports compared with imports resulted both from a material gain in exports and a substantial decline in imports. Imports totaled 32,773,000 barrels, a decrease of 11,909,000 barrels (27 percent) from 1932. This decline resulted largely from the fact that the tariff imposed in June 1932 affected all of 1933 but only the last 6 months of 1932. Receipts from Venezuela continued to comprise the major portion of the imports, although the proportionate share of that country showed only a small increase. Exports of crude were stimulated by various factors, the most important of which was the growth of refinery capacity in Canada and Europe. Canada continued to be the chief customer for American crude, taking 54 percent of the total exports in 1933. The export trade with certain European countries increased rapidly in 1933; for example, exports to Germany were only 17 barrels in 1932 but rose to 676,000 in 1933, and exports to France increased from 3,404,000 barrels in 1932 to 9,143,000 in 1933.

## REFINED PRODUCTS

*General review.*—No change in the relative importance of the major petroleum products occurred in 1933. Gasoline and fuel oils continued to rank first and second, respectively, in both volume and value; kerosene was third in quantity but ranked fourth in value. The volumetric relationship of the principal refined products is set forth in the following table of percentage yields:

| | 1932 | 1933 |
|---|---|---|
| Gasoline | 44. 7 | 43. 7 |
| Kerosene | 5. 3 | 5. 7 |
| Gas oil and distillate fuels | 8. 5 | 9. 2 |
| Residual fuel oil | 27. 5 | 27. 4 |
| Lubricants | 2. 7 | 2. 8 |

Data on the values of refined products are compiled every 2 years by the Bureau of the Census. The latest report of that Bureau shows that the aggregate refinery value of refined products in 1931 was $1,511,597,675, 43 percent below 1929. The value of the gasoline fraction was $847,035,611, more than 50 percent of the total; fuel oils were valued at $265,719,924; lubricating oils at $196,190,766; kerosene at $72,146,477.

*Analysis of production and consumption of petroleum products in 1933*

[Thousands of barrels of 42 gallons]

| Product | Production | Imports | Exports | Changes in stocks | Domestic demand |
|---|---|---|---|---|---|
| Motor fuel: | | | | | |
| Gasoline | 376,623 | 12 | 29,186 | +984 | 378,143 |
| Natural gasoline | 30,188 | | | −17 | |
| Benzol | 1,473 | | | | |
| Total motor fuel | 408,284 | 12 | 29,186 | +967 | 378,143 |
| Kerosene | 48,921 | | 8,960 | +1,521 | 38,440 |
| Gas oil and fuel oil | 315,455 | 13,217 | 20,369 | −7,551 | [1] 321,395 |
| Lubricants | 23,805 | | 8,218 | −1,479 | 17,066 |
| Wax | 1,677 | 132 | 887 | −338 | 1,260 |
| Coke | 7,900 | | 956 | −3,147 | 10,091 |
| Asphalt | 12,212 | 118 | 1,189 | −119 | 11,260 |
| Road oil | 6,363 | | | +268 | 6,095 |
| Still gas | 45,212 | | | | 45,212 |
| Miscellaneous oils | 1,413 | 19 | 57 | −68 | 1,443 |
| Unfinished oils (net) | 5,082 | | | +4,917 | [2] 165 |
| Refinery losses | 16,591 | | | | 16,591 |
| Natural gasoline losses | 3,422 | | | | 3,422 |
| | 896,337 | 13,498 | 69,822 | −5,029 | 850,583 |

[1] Includes 5,687,000 barrels net transfers.
[2] Fire loss in California.

## MOTOR FUEL

Motor fuel is a broad term used in refinery statistics of the Bureau of Mines to cover the entire output of engine fuels. Some kerosene is used as fuel for engines, and small amounts of alcohols may be so used, but for all practical purposes the total production of motor fuels may be considered to represent the output of gasoline at refineries plus the quantity of natural gasoline distributed directly to the trade, plus the production of benzol at byproduct-coke plants. As a matter of fact, all of the benzol production is not used in motor-fuel blends, and the duplication in this respect partly balances omission of the kerosene used for engine fuels.

The number of automobiles in use declined from about 21,431,000 on January 1, 1933, to about 20,398,000 on December 31, 1933. However, this decrease in the number of consuming units apparently was more than offset by a gain in the average unit consumption, as the indicated domestic demand for motor fuel increased from 373,900,000 barrels in 1932 to 378,143,000 in 1933. Despite this gain the domestic demand fell considerably short of the record of 403,418,000 barrels established in 1931. The somewhat unexpected increase in domestic demand for motor fuel in 1933 was more than offset by a decline in exports, and the total demand for motor fuel decreased from 409,338,000 barrels in 1932 to 407,329,000 in 1933.

The total production of motor fuel in 1933—408,284,000 barrels—comprised the production of 195,961,000 barrels of straight-run gasoline, 180,662,000 barrels of cracked gasoline, 25,326,000 barrels of natural gasoline blended, 1,473,000 barrels of benzol, and 4,862,000 barrels of natural gasoline sold as motor fuel without blending. Compared with 1932 these data indicate chiefly further gain in the relative proportion of cracked gasoline. The proportion of natural gasoline included in motor-fuel production continued to decline, amounting to 7 percent in 1933 compared with 8 percent in 1932. This decrease was due chiefly to a decline in output of natural gasoline rather than to the desire of refiners to discontinue using natural gasoline; in fact, introduction of the so-called "Q" gasoline stimulated the consumption of natural gasoline in certain districts. Details as to the production and consumption of natural gasoline are given in the chapter on

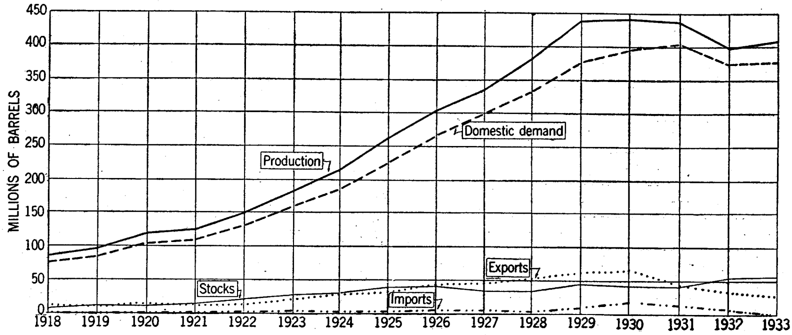


FIGURE 53.—Trends in production, domestic demand, exports, imports, and stocks of motor fuel, 1918–33.

Natural Gasoline, and the principal statistics on motor fuel are shown in figure 53.

*Production, stocks, deliveries, and days' supply of motor fuel, 1932–33*

[Thousands of barrels of 42 gallons]

| District | Production | | Stocks, Dec. 31 | | Daily average deliveries | | Days' supply | |
|---|---|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | 1932 | 1933 | 1932 | 1933 |
| East Coast | 67,848 | 67,908 | 13,643 | 15,462 | 185 | 182 | 74 | 85 |
| Appalachian | 18,343 | 19,160 | 2,188 | 2,562 | 50 | 51 | 44 | 50 |
| Indiana, Illinois, Kentucky, etc. | 60,390 | 63,221 | 6,869 | 7,945 | 165 | 170 | 42 | 47 |
| Oklahoma, Kansas, and Missouri | 55,283 | 58,194 | 4,996 | 6,420 | 151 | 156 | 33 | 41 |
| Texas Inland | 32,551 | 35,236 | 1,904 | 2,025 | 90 | 96 | 21 | 21 |
| Texas Gulf Coast | 64,685 | 68,367 | 6,141 | 4,786 | 177 | 192 | 35 | 25 |
| Louisiana Gulf Coast | 15,039 | 14,267 | 1,416 | 1,631 | 41 | 39 | 35 | 42 |
| Arkansas and Louisiana Inland | 8,972 | 9,133 | 360 | 439 | 25 | 25 | 14 | 18 |
| Rocky Mountain | 8,265 | 8,532 | 1,218 | 1,000 | 24 | 24 | 51 | 42 |
| California | 68,336 | 64,266 | 15,070 | 13,156 | 188 | 181 | 80 | 73 |
| | 399,712 | 408,284 | 53,805 | 55,426 | 1,096 | 1,116 | 48 | 50 |

The percentage yield of gasoline declined from 44.7 percent in 1932 to 43.7 in 1933, marking the first decrease in gasoline recovery recorded since comprehensive statistics were compiled. The failure of refiners to obtain as high a gasoline yield in 1933 as they did in 1932 should not be construed as an indication that the ultimate in yields has been reached, because reliable authorities estimate that a maximum average gasoline yield of 70 percent is possible with modern equipment. The real reason was that much of the excess crude production passed into the hands of refiners who were financially unable to store it and hence had to run it to stills. These refiners, also unable to store gasoline, cut just deep enough into the crude to satisfy their demands for gasoline. The average yields over the last 6 months of the year were higher than for the first half year, reflecting a closer balance between crude oil production and gasoline demand. The majority of the refining districts showed a decline in the percentage yield of gasoline in 1933, the Appalachian, Arkansas and Inland

Louisiana, and Rocky Mountain districts being the only ones showing an increase. The average yield of the Indiana-Illinois-Kentucky district declined from 56.2 percent in 1932 to 53.6 percent in 1933, nevertheless the latter continued to be the highest yield of any district.

Refinery prices of gasoline again moved sympathetically with crude; each had a downward trend until May and June, and a sharp upturn from June to September, followed by a period of relative

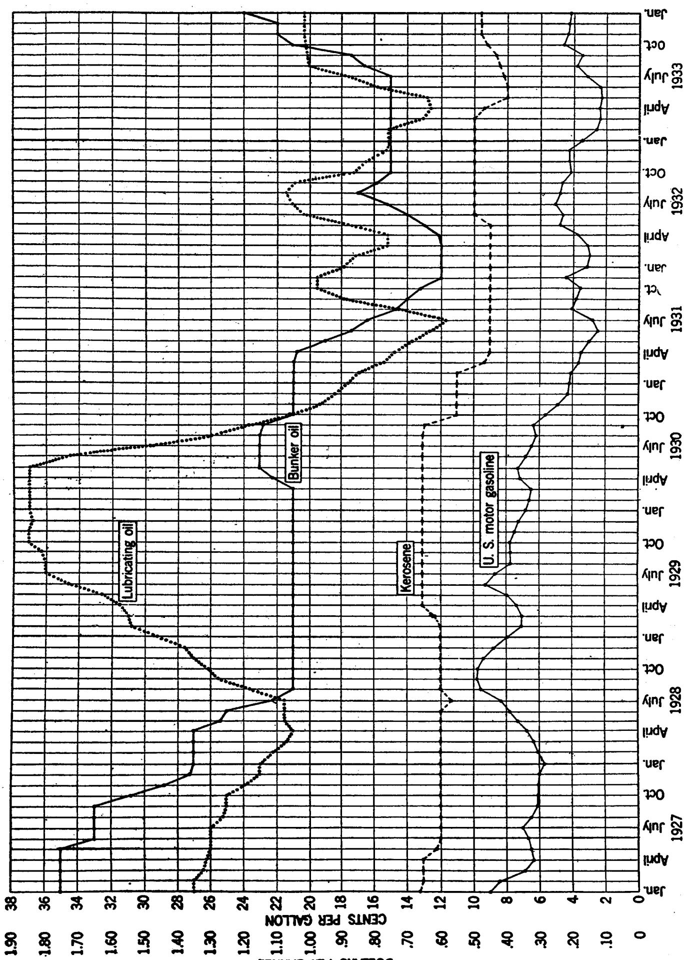


FIGURE 54.—Trends in prices of refined petroleum products, 1927–33, by months: Refinery price per gallon of United States motor gasoline, group 3; tank-wagon price per gallon of kerosene at Chicago; refinery price per barrel of grade C bunker oil at New York; refinery price per gallon of 150–160 viscosity at 210° bright stock in Oklahoma.

stability. The low point in the price of group 3 United States motor gasoline of below 57 octane was reached in May, when the average was just above 2 cents per gallon. This price virtually doubled following the posting of higher crude prices in midsummer and showed further strength in October, following stabilization of crude production and the apparent imminence of price-fixing.

The refinery price of a representative grade of gasoline is shown in figure 54.

The general trend of tank-wagon and refinery prices for gasoline in 1933 was the same, except that in December tank-wagon prices showed a marked weakness not noticeable in refined prices. The average tank-wagon price at 50 cities in the United States in 1933 was 11.54 cents per gallon, or 0.91 cent less than the average in 1932. State gasoline taxes showed little change during the year, only one State (Oregon) increasing its tax. The Federal tax was 1½ cents per gallon throughout the year, but the ½ cent was dropped January 1, 1934. The extreme range of service-station prices in 1933, including all taxes in the same 50 cities mentioned above, was from 9.9 cents per gallon in Newark to 24.5 cents in Boise and Spokane.

Stocks of motor fuel, including gasoline stocks at refineries and bulk terminals and in pipe lines, and stocks of natural gasoline totaled 55,426,000 barrels on December 31, 1933, compared with 53,805,000 on hand at the beginning of the year. During 1933, particularly during the last 4 months of the year, considerable effort was devoted to devising plans to reduce gasoline stocks, and the fact that stocks showed a net gain for the year, following a reduction in 1932 when less attention was paid to them, was generally disappointing and had much to do with the failure of gasoline prices to hold up to the theoretical ratio of 16 for a barrel of crude to 1 for a gallon of gasoline. Gasoline stocks in most districts increased in 1933, the two most notable exceptions being California and Texas Gulf. In terms of days' supply, the East Coast held the largest stocks of gasoline on December 31, 1933, having wrested this questionable honor from California during the year. The stocks in these two districts are relatively large, primarily because of the necessity of having large supplies on hand for export; furthermore, because of a variation in statistical methods, a higher proportion of the total gasoline in storage is reported in these two districts than for the interior districts.

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 1933, totaled 15,440,919,000 gallons (367,641,000 barrels) which represents a slight decrease compared with 1932. Of the three States, New York, California, and Pennsylvania, which have an annual gasoline consumption of over 1,000,000,000 gallons, only Pennsylvania showed an increase in 1933. The States making the largest percentage increases in gasoline consumption in 1933 were Mississippi, South Carolina, and Arkansas; those with the greatest declines were Nevada, South Dakota, and Vermont.

The relative rank of the States in gasoline consumption is shown in figure 55.

Imports of gasoline in 1933 had negligible importance, as the duty imposed in June 1932 was too high to permit such operations. Exports of motor fuel continued to decline, amounting to 29,186,000 barrels compared with 35,438,000 in 1932 and with a peak of 65,575,000 in 1930.

Total gasoline deliveries by pipe line continued to increase, amounting to 38,196,000 barrels compared with 29,573,000 in 1932. This gain, while material, did not compare with the increase recorded in 1932 over 1931, as the major portion of the construction had been completed by the first of 1933. However, in 1933, 1 or 2 systems were completed, and some branch lines were constructed, raising the total mileage of gasoline pipe lines from 3,662 on January 1 to 3,835 on December 31.

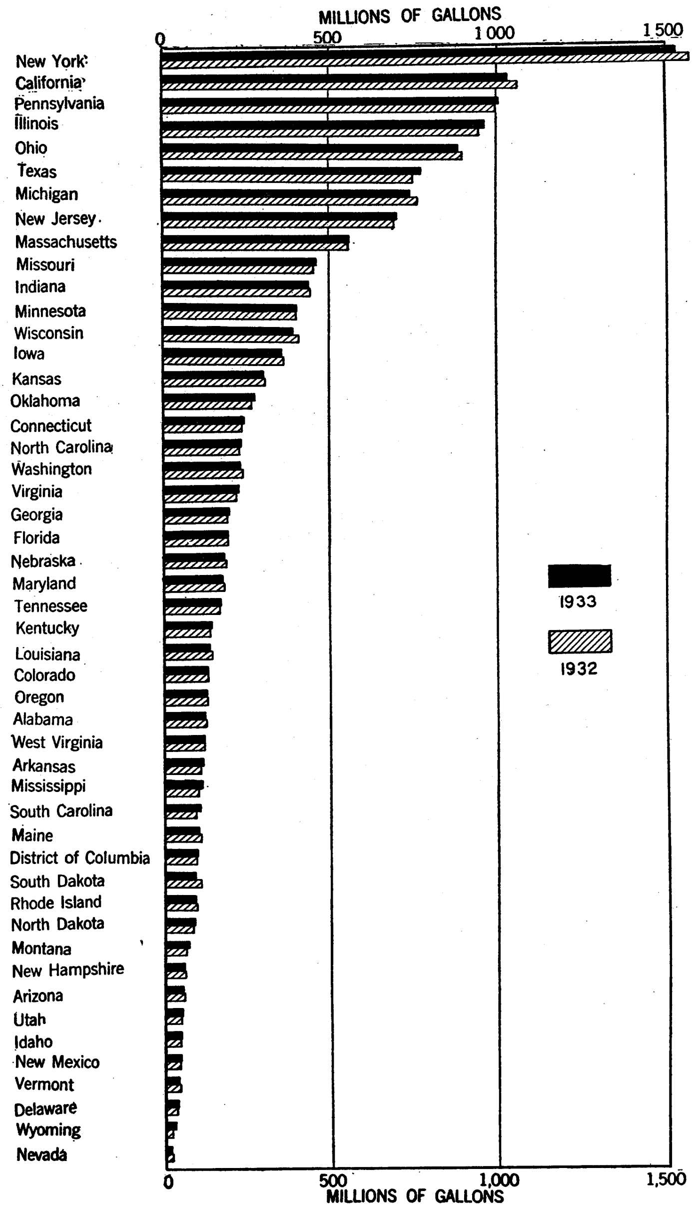


FIGURE 55.—Gasoline consumption, 1932–33, by States.

## KEROSENE

The statistics of kerosene for 1933 indicate continued growth in importance of this product, which in the early days of the industry was the only refined product but which was relegated to a position of minor importance following rapid increases in number of automobiles and electric lights. The indicated domestic demand for kerosene in 1933 was 38,440,000 barrels, which was not only 16 percent above1932 but which, with one exception (1925) represented the highest annual demand recorded since the first refinery statistics were issued by the Bureau in 1918. The increase in kerosene consumption in recent years probably is due to a gain in the use in domestic heaters; for example, the consumption of range oil, a kerosene used in ranges for heating and cooking, increased about 2,300,000 barrels (50 percent) in 1933 over 1932.

No imports of kerosene were recorded in 1933; exports continued to decline, amounting to 8,960,000,000 barrels compared with 11,044,000 barrels in 1932. Stocks, which had declined steadily, increased from about 5,000,000 barrels on January 1 to about 6,500,000 on December 31.

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 7,641,000 barrels in 1933. The total for the same 14 States for 1932 was 7,703,000 barrels, indicating a decrease of 0.8 percent in demand. The consumption in Nebraska in 1933 was 638,000 barrels (29 percent less than in 1932). This may have been due to a change in the method of reporting; in any event the 13 States, exclusive of Nebraska, increased kerosene consumption 3 percent in 1933 over 1932. Consumption in Michigan increased materially in 1933, and that State became second only to Missouri in the 14 States.

Although the statistical position of kerosene was somewhat improved in 1933, this betterment had no particular influence on prices, which continued to follow the general trend of those for crude, gasoline, and fuel oil. In other words the law of supply and demand has little control over kerosene prices, as the supply can be quickly adjusted to demand. A representative tank-wagon price of kerosene declined from 10 cents per gallon as of January 1 to 8 cents in the spring but recovered to 9.5 cents by the close of the year. The trend of this price is shown in figure 54.

## GAS OIL AND FUEL OIL

Larger crude runs to stills and a small gain in average yield in 1933 over 1932 increased the production of gas oil and fuel oil from 294,750,000 barrels in 1932 to 315,455,000 in 1933. Of the latter quantity, 79,060,000 barrels (25 percent) were gas oil and distillate fuels and 236,395,000 barrels (75 percent) residual fuel oil.

The consumption of the lighter fuel oils for domestic heating increased materially in 1933, this being the chief reason for an increased production of gas oil and distillate fuel oils from 69,467,000 barrels in 1932 to 79,060,000 in 1933. Stocks of gas oil and distillate fuels increased about 2,500,000 barrels in 1933; however, the total on hand December 31, 1933 (16,612,000 barrels), was relatively small in terms of days' supply.

The percentage yield of residual fuel oil continued to decline, but this factor was more than overbalanced by the increase in crude runs to stills and the production rose to 236,395,000 barrels from 225,283,000 in 1932.

Imports of gas oil and fuel oil were restricted somewhat because of the tax imposed in June 1932 and totaled 13,217,000 barrels compared with 21,286,000 barrels in 1932. In 1933 slightly more than half of the imports were imported into bonded warehouses, whereas in 1932 nearly all of the imports were "for domestic use." Therefore, as far as consumption within the United States is concerned, imports of gas oil and fuel oil declined drastically in 1933. Exports of gas oil and fuel oil, which had been declining steadily, increased slightly in 1933; the total in 1933 was 20,369,000 barrels; in 1932, 19,994,000 barrels.

The indicated domestic demand for gas oil and fuel oil in 1933 totaled 321,395,000 barrels, an increase of slightly more than 13,000,000 barrels over 1932. It is estimated that this increase was divided about half-and-half between gas oil and distillate fuels and residual fuel oil. The consumption of furnace oil is believed to have increased substantially in 1933. The use of diesel oil, a special type of gas oil, by trucks increased rapidly in 1933, and while this class of consumption is still small quantitatively it probably had some relation to the brisk gas-oil market which prevailed most of the year. The consumption of fuel oil by railroads probably declined slightly in 1933, this statement being based on the fact that consumption by class I railroads declined from 41,520,000 barrels in 1932 to 40,364,000 in 1933. The use of fuel oil by public-utility power plants increased approximately 2,000,000 barrels (23 percent) in 1933 over 1932, and the domestic demand for gas oil and fuel oil, for all purposes except railroads and public-utility power plants, increased about 12,500,000 barrels during the same period.

Stocks of gas oil and fuel oil, which grew to unwieldly proportions prior to 1930, have declined in recent years. In 1933 the total withdrawal was about 7,500,000 barrels, or from 129,881,000 barrels at the end of 1930 to 122,287,000 on December 31, 1933. The bulk of gas-oil and fuel-oil stocks consists of heavy residual fuel oil in storage in California; the California stocks were reduced 7,107,000 barrels in 1933, and if the heavy shipments through the Panama Canal, which began in October 1933 are maintained, will be reduced very materially in 1934.

Fuel-oil prices, which for the first half of 1933 were relatively low, were greatly stimulated by curtailment of crude production and imports and by the increased demand. For example, the price of a representative grade of bunker oil was steady at 75 cents per barrel until August 1933, when the influence of increased crude prices first became evident, and the price rose to $1.30 per barrel by the end of the year.

## LUBRICANTS

The production and consumption of lubricating oils, which had declined to low levels in 1932, increased in 1933 due to a pick-up in industrial activity and to a gain in the average mileage of motor vehicles. The production in 1933 totaled 23,805,000 barrels compared with 22,433,000 in 1932. The yield of lubricants showed a slight increase, amounting to 2.8 percent of crude runs in 1933 compared with 2.7 in 1932.

The indicated domestic demand for lubricants in 1933 was at its lowest point in January but rose rapidly until midyear. The total for the peak month, June, was 1,646,000 barrels, or nearly double that of 859,000 barrels for January. The total indicated domestic demand for 1933 was 17,066,000 barrels, or 3 percent above 1932. Exports, which had been declining, registered an encouraging advance and totaled 8,218,000 barrels in 1933 compared with 6,851,000 barrels in 1932. Imports of lubricating oils in 1933 were negligible. Stocks of lubricants were influenced by the increased demand and declined from 8,465,000 barrels on hand January 1 to 6,896,000 barrels on December 31.

Prices of lubricating oils followed the general trend of all petroleum prices, declining in the first quarter, increasing sharply in the second and third quarters, but remaining stationary in the last quarter. The effect of the overproduction of crude oil in the late spring months apparently was overbalanced by the stimulation of increased demand, because prices of most grades of lubricating oils increased in May and June when crude production was close to its peak. As shown in figure 54, the price of a representative grade of lubricating oil was 15 cents on January 1, declined to 11.75 cents by the middle of April, but increased more than 50 percent in the next 3 months.

## WAX

Trade in paraffin wax recovered swiftly from the slump of 1932, and a new high record for demand was established in 1933. Even imports, carrying a relatively high duty of 1 cent per pound, increased to nearly the record level of 1931.

The production of wax increased concomitantly with the output of its sister product, lubricants, and totaled 469,560,000 pounds in 1933 compared with 458,920,000 pounds in 1932. Approximately half of the 1933 figure was produced in the East Coast district, indicating further concentration of wax manufacture in that district.

The total demand for wax reached a new high figure of 601,210,000 pounds in 1933. Of this amount 353,272,000 pounds (59 percent) represented domestic demand, and 247,938,000 pounds (41 percent) were exported. These data indicate a further gain in the relative importance of domestic consumption.

Stocks of paraffin wax move in cycles of 1 or 2 years during which increases or decreases of 100 to 200 percent are often recorded. In 1933 the trend was downward, and stocks declined from 163,628,000 pounds on January 1 to a new low point of 68,833,000 on December 31. The December stocks comprised 42,397,000 pounds of crude scale wax and 26,436,000 of refined wax, indicating that the major portion of the withdrawal in 1933 affected crude scale stocks.

Wax prices are generally quite sensitive to changes in stocks, and the material reduction in stocks in 1933, in conjunction with the increase in lubricating-oil prices, improved prices materially. This betterment was typified by the trend of a representative price of crude scale wax, which was about 2 cents per pound on January 1, declined slightly in the spring months, but rose to just above 4 cents per pound before the end of the year.

## COKE

The production of petroleum coke continued to decline and amounted to only 1,576,000 short tons in 1933 compared with 1,788,800 short tons in 1932 and with the peak output of 2,032,000 short tons in 1931. This decrease in production resulted primarily from changes in refinery technique, chief of which was the use of cracking methods, involving a minimum of coking in tubes and reaction chambers.

The indicated domestic demand for petroleum coke registered another material gain, the total for 1933 of 1,991,300 short tons being 6 percent above 1932. This increase undoubtedly reflected the gain in popularity for domestic use in certain districts, particularly in the Northeastern States. Shipments of coke by tanker from Gulf ports to the Atlantic seaboard in 1933 were reported as heavy, a report which would appear to be confirmed by the fact that stocks in the Texas and Louisiana Gulf coast districts declined 58 percent during the year. Stocks of coke held in the other refining districts were also reduced in 1933, the total for the United States declining, from 1,330,200 short tons on January 1, 1933, to 727,400 short tons on December 31.

## ASPHALT AND ROAD OIL

The statistics of petroleum asphalts for 1933 were similar to those of 1932, in that production and consumption declined and stocks decreased further. The production of road oil also declined in 1933. Details of these two commodities may be found in the chapter on Asphalt and Related Bitumens.

## STILL GAS

Increased cracking and a further expansion in gas-recovery systems were reflected in an increase of 11 percent in the production of still gas in 1933. Production totaled 170,845,278,000 cubic feet, which on a liquid basis was equivalent to 45,212,000 barrels.

Although data as to the consumption of still gas for 1933 are lacking it is reasonably certain that its use as refinery fuel increased in approximately the same ratio as production.

## IMPORTS, EXPORTS, AND SHIPMENTS THROUGH PANAMA CANAL

*Imports.*—Imports of petroleum products in 1933 continued to be influenced by the duties and excise taxes which went into effect on June 21, 1932. Receipts of fuel oil, chiefly from the Netherland West Indies, declined materially and amounted to only 13,217,000 barrels compared with 21,286,000 in 1932. Of the imports of fuel oil in 1933, 6,155,000 barrels were imported for domestic use, 6,116,000 imported under bond to supply vessels, 741,000 barrels added to stocks in bonded warehouses, and 205,000 barrels withdrawn from bonded warehouses for consumption in the United States or exported. Imports of gasoline, kerosene, and lubricating oils declined to insignificance. Imports of paraffin wax, chiefly from the Netherland East Indies and British India, were even larger in the last 6 months of 1933 than in the first 6 months of 1932.

*Exports.*—Exports of petroleum products and shipments of these products to Alaska, Hawaii, and Puerto Rico decreased 8 percent (from 75,882,000 barrels in 1932 to 69,822,000 in 1933).

*Exports of petroleum products and shipments to Alaska, Hawaii, and Puerto Rico, 1932–33*

| | 1932 | 1933 |
|---|---|---|
| Motor fuel ........ thousands of barrels.. | 35,438 | 29,186 |
| Kerosene ........ do.... | 11,044 | 8,960 |
| Gas oil and fuel oil ........ do.... | 19,994 | 20,369 |
| Lubricants ........ do.... | 6,851 | 8,218 |
| Paraffin wax ........ thousands of pounds.. | 235,304 | 247,938 |
| Petroleum coke ........ thousands of short tons.. | 89.4 | 187.5 |
| Petroleum asphalt ........ do.... | 220.5 | 215.5 |
| Mineral spirits ........ thousands of barrels.. | 46 | 57 |

Exports and shipments of motor fuel declined 18 percent, or from 35,438,000 barrels in 1932 to 29,186,000 in 1933. Of the latter figure, 1,657,000 barrels consisted of natural gasoline and 201,000 of benzol. Less motor fuel was sold to the United Kingdom, Belgium, Germany, the Netherlands, Sweden, Australia, New Zealand, and Cuba in 1933 than in 1932. On the other hand, exports of motor fuel to France, the Irish Free State, Spain, the Netherland West Indies, Argentina, Brazil, the Philippine Islands, and the Union of South Africa increased.

Exports of kerosene to northern and western Europe, to British India, China, and Japan, and to Australia and New Zealand decreased materially in 1933. On the contrary, exports of gas oil and fuel oil to northern and western Europe (except Germany and Denmark), to the Netherland West Indies and Panama, to Chile, China, Japan, the Philippine Islands, and to New Zealand were larger in 1933 than in 1932.

Increased sales of paraffin wax to northern and Mediterranean Europe were largely counterbalanced by a sharp decline in exports to the United Kingdom, and smaller decreases to Germany, the Irish Free State, and France. Exports of paraffin wax to North American countries (except Canada), to South America, and to Asia (except British India) were larger in 1933 than in 1932.

*Shipments through the Panama Canal.*—Shipments of petroleum products from California through the Panama Canal to Atlantic and Gulf ports of the United States increased from 12,036,000 barrels in 1932 to 21,020,000 in 1933. As imports of fuel oil into Atlantic coast ports decreased, shipments of fuel oil from California to the Atlantic coast rose from 277,000 barrels in 1932 to 5,119,000 in 1933. At the same time shipments of gasoline (including natural gasoline) from California to the east coast increased from 8,911,000 barrels in 1932 to 11,460,000 in 1933; of kerosene from 570,000 barrels in 1932 to 1,732,000 in 1933; and of gas oil and Diesel oil from 2,063,000 barrels in 1932 to 2,450,000 in 1933.

# THE CHEMISTRY AND REFINING OF PETROLEUM

By H. P. Rue and H. M. Smith

SUMMARY OUTLINE



Petroleum chemistry and improvement of technique in the petroleum refining industry have progressed during the year partly because of economic conditions. In order for refiners to meet the demand for quality products it has been necessary to conduct extensive technical research programs to determine how a better product can be manufactured cheaper than it has been done previously. Equipment and processes that were thought perfect a few years ago are now obsolescent.

The days of operating a petroleum refinery by rule-of-thumb methods are passed, and the industry now recognizes the value of research. The public generally does not have a very clear conception of the true value of such work, but it is more or less critical of the quality of the petroleum products it uses. Improvement in the quality of products demands a comprehensive understanding of the characteristics of the raw material, the finished products, and constant development in methods of manufacture. Utilization of crude petroleum can never be completely accomplished without this continuous development.

An attempt is made in the following paragraphs to give a brief résumé of the outstanding developments in the fields of chemistry and refining of petroleum for the year 1933.

## CHEMISTRY OF PETROLEUM

An intelligible survey of the advances in petroleum chemistry is made most easily by considering individually the progress recorded for crude oil and the major products manufactured from it.



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## CRUDE OIL

*Classification.*—The Bureau of Mines has been active in the study and classification of crude petroleum. Since 1920 the Bureau has analyzed approximately 2,000 crude oils from all parts of the world. Two additions to the series of papers reporting these analyses concern the crude oils produced in the Oklahoma City [1] and East Texas fields.[2] Further reports on crude oils from several sections of the world are being compiled and will include a classification of crude oil based on the results of the many analyses available.

Through determination of chemical and physical properties of numerous fractions from various crude oils other investigators [3] suggest that petroleum may be divided into the following classes: (1) Methane, (2) naphthene, (3) methane-naphthene, (4) aromatic, (5) methane-naphthene-aromatic, and (6) naphthene-aromatic.

*Isolation of pure compounds.*—As the number of products manufactured from petroleum increases the need for knowledge concerning the actual components of crude oil is emphasized. During the last few years an impetus has been given to this type of research work through American Petroleum Institute grants. Of particular interest in this regard are projects concerned with hydrocarbons and with nitrogen compounds. The work has been continued for the year under review with the isolation of several aliphatic, naphthenic, and aromatic hydrocarbons from an Oklahoma petroleum. [4] [5] [6] [7] A number of nitrogen bases have been isolated from California petroleum, and methods have been developed whereby such work may be extended to other oils.[8]

*Synthesis of pure hydrocarbons and sulphur derivatives.*—Some of the major advances in petroleum chemistry have resulted from the synthetic production of pure compounds and studies of their reactions. The synthesis of saturated aliphatics having 2 to 6 methyl groups as side chains [9] [10] [11] [12] and of 50 different naphthenes [13] has been accomplished.

In recent years the aliphatic olefines have been attracting considerable attention because of their possible uses in the manufacture of alcohols and other chemical compounds in conjunction with the fact

[1] Garton, E. L., Analysis of Crude Oils from the Oklahoma City Field, Oklahoma: Rept. of Investigations 3180, Bureau of Mines, 1932, 29 pp.

[2] Garton, E. L., and Thurn, R. E., Summary of Analyses of Typical Crude Oils from East Texas and Adjoining Fields: Abs. of Bureau of Mines Publications 61, February 1934, 5 pp.

[3] Sachanen, A., and Wirabianz, R., Chemische Zusammensetzung der Erdole: Erdol and Teer, vol. 9, 1933, pp. 170–172, 187–189, 220–222.

[4] Bruun, J. H., and Hicks-Bruun, M. M., 1.1-Dimethylcyclopentane and 2-Methylhexane in a mid-continent Petroleum: Bureau of Standards Jour. Res., vol. 10, 1933, pp. 465–473.

[5] Leslie, R. T., Purification of Hydrocarbons by Crystallization from Liquid Methane. Isolation of 2-Methylheptane from Petroleum: Bureau of Standards, Jour. Res., vol. 10, 1933, pp. 609–618.

[6] White, J. D., and Rose, F. W., Jr., Isolation of Ethylbenzene from an Oklahoma Petroleum: Bureau of Standards, Jour. Res., vol. 10, 1933, pp. 639–645.

[7] Mair, B. J., and Schicktanz, S. T., The Isolation of Mesitylene, Pseudocumene, and Hemimellitene from an Oklahoma Petroleum: Bureau of Standards, Jour Res., vol. 11, 1933, pp. 665–680.

[8] Perrin, T. S., and Bailey, J. R., Nitrogen Compounds in Petroleum Distillates. IV.—Isolation of 2.4.8-Trimethylquinoline Among the Kero Bases: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 4136–4140; Biggs, B. S., and Bailey, J. R., V.—The Use of Sulphur Dioxide in the Separation of Petroleum Bases, pp. 4141–4142; Lake, G. R., and Bailey, J. R., VI.—The Occurrence of 2.8-Dimethylquinoline in Kerosene Distillate of California Petroleum, pp. 4143–4145; Armendt, B. F., and Bailey, J. R., VII.—New Reactions of the Naphthenic Base $C_{16}H_{25}N$. A New Naphthenic Base $C_{13}H_{21}$ N, pp. 4145–4149.

[9] Whitmore, F. C., Stehman, C. J., and Herndon, J. M., Hexamethylethane: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 3807–3809.

[10] Whitmore, F. C., and Fleming, G. H., Preparation of Tetramethylethane: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 3803–3806.

[11] Laughlin, K. C., and Whitmore, F. C. The Trimethylpentanes: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 2607–2608.

[12] Whitmore, F. C., and Homeyer, A. H., Preparation and Dehydration of 4.4-Dimethyl-pentanol-2: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 4194–4196.

[13] Signaigo, F. K., and Cramer, P. L., The Preparation of Mono- and Di-alkylcyclohexanes: Jour. Aml. Chem. Soc., vol. 55, 1933, pp. 3326–3332.

that they are produced in large quantities by the cracking of petroleum. Further, their properties as regards antiknock value and as potential sources of gum have increased their importance. Methods for synthesizing these hydrocarbons and their properties are important.[14 15 16 17 18 19]

Knowledge concerning the reactions of pure sulphur compounds, especially toward chemicals used for refining gasoline, have been very helpful in improving treating processes. A discussion on the synthesis and reactions of the thiophanes[20] is an example.

A definite relationship between structure and properties exists[21] and may be used to predict the physical constants of an unknown hydrocarbon, to test the validity of an assigned structure, and to detect errors in constants already recorded. These uses have definite value in the study of petroleum.

## NATURAL GAS AND REFINERY GASES

Within recent years it has become evident that natural gas and refinery gases are great potential sources of useful chemicals. These compounds include not only motor fuels but solvents, intermediates for resins, and lubricating oils. Using as a basis the gaseous paraffin and olefine hydrocarbons available in 1929, it is estimated that the potential yield of benzol produced by pyrolysis would be of the order of 4,750,000 tons per year.[22] If these gaseous paraffins were dehydrogenated to olefines and the olefines polymerized to liquid hydrocarbons a potential yield of 17,750,000 tons per year is indicated. The production of natural gas and refinery gases in 1933 can only be estimated, but the trends of the past few years point toward an increase, especially of gases from cracking stills.

*Saturated compounds.*—The production of liquid products suitable for motor fuel is the chief end of this research and may be approached by two methods: (1) Direct pyrolysis to give liquids and (2) pyrolysis to give gaseous olefines and subsequent polymerization and condensation of the olefines to liquid products. In the first method the chief factors influencing results are temperature, time of contact, pressure, and tube material. Within certain limits temperature and time of contact are reciprocal functions; that is, higher temperature may be compensated by shorter time of contact so that approximately the same yield of similar products is obtained.

The use of mild pyrolysis to form olefines and their subsequent polymerization to motor fuel gives still better yields. This process is preferable in several ways, since (1) temperatures required are lower,

[14] Whitmore, F. C., and Laughlin, K. C., The Dehydration of Tertiary Alcohols Containing a Neopentyl System. II. Methyl Isopropyl-tert-butylcarbinol, Methyldi-tert-butylcarbinol, and Methylethylneopentyl-carbinol: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 3732–3738.

[15] Whitmore, F. C., and Stahyl, E. E., The Common Basis of Intramolecular Rearrangement. II. The Dehydration of Di-tert-butylcarbinol and the Conversion of the Resulting Nonenes to Trimethylethylene and Isobutylene: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 4153–4157.

[16] Whitmore, F. C., and Homeyer, A. H., Preparation and Reactions of 4.4-Dimethyl Pentene-1: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 4555–4559.

[17] Whitmore, F. C., and Meunier, P. L., Studies on the Rearrangement of Tertiary Butylmethyl Carbinol. II. Dehydration: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 3721–3722.

[18] Soday, F. J., and Boord, C. E., Synthesis in the Olefine Series. IV. The Heptenes: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 3293–3302.

[19] Schurman, I., and Boord, C. E., Synthesis in the Olefine Series. V. Completing the Survey of the Hexenes and Including Certain Heptenes and Octenes: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 4930–4935.

[20] Bost, R. A., and Conn, M. W., Successful Syntheses of Thiophanes. Will Aid in Study of Objectionable Sulphur Compounds: Oil and Gas Jour., vol. 32, no. 3, 1933, p. 17.

[21] Boord, E. E., The Relationship of Physical Constants to Structures for Petroleum Hydrocarbons: Presented before Pet. Div. of Am. Chem. Soc., Washington, D.C., 1933.

[22] Dunstan, A. E., Hague, E. N., and Wheeler, R. V., The Thermal Treatment of Gaseous Hydrocarbons: nd. and Eng. Chem., vol. 26, 1934, pp. 307–320.

(2) pressure is an advantage, reducing plant size, (3) high yields are possible, (4) carbon deposits are negligible, (5) tar production is virtually nil, and (6) hydrogen dilution has little influence. The converse of these facts is to a large extent true for straight pyrolysis.

Some of the more theoretical aspects of pyrolysis, including the very important subject of reaction mechanism as well as the influence of time, temperature, and pressure, have been the object of considerable discussion.[23] A theory involving "free radicals" used in conjunction with chain reactions makes possible prediction of results with considerable accuracy.[24] Also no evidence has been found that the C–C chain breaks at a specific point to the exclusion of others.[25] Equilibrium constants and free energies for the dehydrogenation of several paraffins have been determined, using chromium oxide gel as a catalyst.[26] Chain reaction mechanism and velocity constants for the pyrolysis of simple paraffins also have been reported.[27] [28] [29]

The beneficial results of baffled alloy tubes nickel-free and with more than 20 percent chromium has been demonstrated.[30] The Bureau of Mines has studied production of acetylene by the pyrolysis of a methane-carbon dioxide mixture [31] and has reviewed the formation of acetylene by the pyrolysis of methane, ethane, ethylene, gasoline, and petroleum.[32]

An investigation [33] of the production of olefines from propane and butanes showed that the highest yields of olefines and aromatics with negligible yields of carbon and hydrogen were obtained at high temperatures with short contact time. The only commercial material that withstood these temperatures favorably and had no adverse catalytic effect was nichrome. Bureau of Mines studies of the decomposition of methane by a heated carbon filament indicated that the earliest product that can be isolated is ethane.[34] Kassel, of the Bureau, has explained the production of ethane and other products by an equation based on successive dehydrogenation steps following the ethane synthesis.[35]

*Unsaturated compounds.*—Considerable study has been given the polymerization reactions of the olefines. Floridin polymerizes propylene,[36] producing a high octane-number liquid in the boiling range

[23] Frey, F. E., Pyrolysis of Saturated Hydrocarbons: Ind. and Eng. Chem., vol. 26, 1934, pp. 198–203.

[24] Rice, F. O., Thermal Decomposition of Organic Compounds. III. Calculations of Products Formed from Paraffin Hydrocarbons: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 3035–3040.

[25] Hurd, C. D., The Pyrolysis of n-Butane at Low Decomposition Temperatures: Jour. Am. Chem. Soc., vol. 55, 1933, p. 5016.

[26] Frey, F. E., and Huppke, W. F., Equilibrium Dehydrogenation of Ethane, Propane, and the Butanes: Ind. and Eng. Chem., vol. 25, 1933, p. 54.

[27] Frey, F. E., and Hepp, H. T., Thermal Decomposites of Simple Paraffins: Ind. and Eng. Chem., vol. 25, 1933, p. 441.

[28] Marek, L. F., and Newhous, M., Thermal Decomposition of Isobutane into Primary Products: Ind. and Eng. Chem., vol. 25, 1933, pp. 516–519.

[29] Pease, R. N., and Morton, L. M., Kinetics of Dissociation of Typical Hydrocarbon Vapors: Jour. Am. Chem. Soc., vol. 55, 1933, pp. 3190–3200.

[30] Cambron, A., and Bayley, C. H., Pyrolysis of Lower Paraffins. III. Production of Olefines in Baffled Metal Tubes: Canadian Jour. Res., vol. 9, 1933, pp. 583–590; IV. The Conversion of Gaseous Paraffins to Aromatic Hydrocarbons in Baffled Quartz Tubes: Vol. 9, 1933, pp. 591–602.

[31] Storch, H. H., and Golden, P. L., Synthesis of Acetylene by Pyrolysis of Methane: Ind. and Eng. Chem., vol. 25, 1933, p. 768.

[32] Storch, H. H., Acetylene Formation in Thermal Decomposition of Hydrocarbons: Ind. and Eng. Chem., vol. 26, 1934, pp. 56–60.

[33] Podbielniak, W. D., Semicommercial Cracking Gas Using Nichrome Tubes and High Temperatures Combined with Short Heating Periods: Presented before petrol. div., Am. Chem. Soc., Chicago, 1933.

[34] Storch, H. H., The Thermal Decomposition of Methane by a Carbon Filament: Jour. Am. Chem. Soc., vol. 54, 1932, pp. 4188–4198.

[35] Kassel, L. S., The Thermal Decomposition of Methane: Jour. Am. Chem. Soc., vol. 54, 1932, pp. 3949–3961.

[36] Gayer, F. H., The Catalytic Polymerization of Propylene: Ind. and Eng. Chem., vol. 25, 1933, p. 1122.

of gasoline. Ethylene[37] under pressure of 50 atmospheres starts to polymerize at 325° to 340° C., and a 63–73 weight percent yield of oil is possible at 300° C., using an autoclave.

The pyrolytic reactions of simple unsaturated hydrocarbons shows that the order of thermal stability is ethylene, propylene, isobutylene, and 2- and 1-pentane.[38] Polymerization at different temperatures causes different products, and reactions are not as simple as usually implied.

## GASOLINE

Approximately 180,000,000 barrels of gasoline were produced by cracking in 1933, or about half the total gasoline manufactured from petroleum. As the major chemical problems of detonation and gums are largely caused or controlled by cracking, it is natural that these fields should record the most study. A third problem, that of sulphur compounds, continues to receive considerable attention.

*Detonation.*—The detonation problem, which is essentially a problem of hydrocarbon oxidation, progressed through study of the oxidation mechanism of hydrocarbons and the determination of the antiknock qualities of individual hydrocarbons.

The mechanism of gaseous ignition, although not distinctly related to gasoline, helps to formulate oxidation or combustion theory. Ethane, propane, and butane[39] prior to ignition decompose to the corresponding olefines, which appear to oxidize to an aldehyde before ignition. In this connection spectrographic data of gases in an engine just before knock showed formaldehyde to be present[40] with a variety of fuels. The oxidation of hexane, cyclohexane, and cyclohexene[41] in the vapor phase at 1 atmosphere pressure with hydrocarbon-oxygen ratios of 4 to 1 indicated peroxide formation was prominent at temperatures of active oxidation but disappeared completely at higher temperatures. The presence of a double bond appears to cause much more resistance to oxidation than cyclization. When mixtures of a hydrocarbon with air or oxygen at constant volume[42] are heated pressure changes follow the gas laws for a time and then show several inflection points where the pressure rises rapidly, separated by normal pressure increases. The number of points equal the number of carbon atoms in the hydrocarbons.

Detonation characteristics of 69 naphthene hydrocarbons[43] indicate that (1) antiknock value increases with size of ring, (2) for the same number of carbon atoms ring compounds have a higher value than n-paraffin, (3) increased length of largest unbranched chain causes decrease in value, (4) the most compact space arrangement of side chains gives largest value for isomers, and (5) removal of hydrogen in general causes an increase of antiknock value.

Considerable work has been done in England to determine the blending octane number of pure hydrocarbons. This is an index of

[37] Egoff, G., and Schaad, R. E., Polymerization and Explosive Decomposition of Ethylene under Pressure: Jour. Inst. Petrol. Technol., vol. 19, 1933, pp. 800–811.

[38] Hurd, C. D., Pyrolysis of Unsaturated Hydrocarbons: Ind. and Eng. Chem., vol. 26, 1934, pp. 50–55.

[39] Nayler, C. A., and Wheeler, R. V., Ignition of Gases. VIII: Ignition by a Heated Surface. (a) Mixtures of Ethane, Propane, or Butane with Air: (b) Mixtures of Ethylene, Propylene, or Butylene with Air: Jour. Chem. Soc. 1933, pp. 1240–1247.

[40] Rassweiler, G. M., and Withrow, L., Spectrographic Detection of Formaldehyde in an Engine Prior to Knock: Ind. and Eng. Chem., vol. 25, 1933, pp. 1359–1366.

[41] Estradere, Oxidation of Some Hydrocarbons: Ann. Comb. Liq., vol. 8, 1933, pp. 484–486.

[42] Akita, M., Combustion of Light Hydrocarbons at Constant Volume: Jour. Soc. Chem. Ind., Japan, vol. 36, 1933, p. 436 B.

[43] Lovell, W. G., Campbell, J. M., and Boyd, T. A., Knocking Characteristics of Naphthene Hydrocarbons: Ind. and Eng. Chem., vol. 25, 1933, pp. 1107–1110.

the change in the octane number of a given reference fuel exerted by individual hydrocarbons.[44]

The results indicate that the curve representing concentration of hydrocarbon in a blend and the octane number is not influenced by the reference fuel but is determined by the series to which the hydrocarbon belongs. The knocking tendency of 48 pure compounds, including some alcohols,[45] has been determined. The results of road performance indicate that a closer correlation between actual car tests and laboratory tests is necessary before international standards can be agreed upon. Further, the determination of detonation values of aviation and compression-ignition engine fuels are still in the formulative stage.

*Gums.*—The increased use of vapor-phase cracking has intensified studies on gums and gum-forming compounds. The literature is crowded with "new" tests for potential and preformed gums, and although a tentative standard method for preformed gums has been listed by the American Society for Testing Materials[46] the determination of potential gum is still the source of much controversy. Numerous methods for potential gum determinations involve ultraviolet rays,[47] stannic chloride,[48] air incubation,[49] and oxidation with oxygen under pressure.[50]

From the strictly chemical viewpoint the actual compounds responsible for gums are of more interest. Tests made by adding individual hydrocarbons to straight-run paraffin gasoline[51] indicate that aliphatic and cyclic diolefines, or mono-olefines attached to a benzene ring give the largest amounts of gums. Gum formation seems to be associated with oxidation, and inhibitors appear to prolong the induction period prior to oxidation but do not change the rate of reaction at the end of the induction time.

Tests on several series of gasolines[52] in which peroxides varied over a wide range of concentrations showed that peroxide formation is the first evidence of gasoline deterioration, that perodixation starts slowly but proceeds rapidly at the end of an induction period, and that gums increase and octane numbers decrease with increase in peroxide. Inhibitors are of value only with low peroxide content. Gasoline made by cracking solar oil at 600° C.[53] formed appreciable amounts of gums in those fractions whose boiling range include the boiling point of conjugated diolefines. Somewhat similar results were found by the Bureau of Mines a few years ago.[54]

[44] Garner, F. H., Evans, E. B., Sprake, C. H., Broom, W. E. J., Proc. World Petrol. Cong., London, July 1933, sec. vol. E., pp. 170-180.

[45] Schmidt, A. W., Zusammenhange zwischen chemischen Aufbau und Kloppfestigheit von Kraftstoffen: Proc. World Petrol. Cong., London, July 1933, sec. vol. E, pp. 181-185.

[46] American Society for Testing Materials, Tentative Method of Test for Gum Content of Gasoline: Designation, D381-34T.

[47] Freund, M., The Possibility of the Determination of Potential Gum in Gasoline by Ultraviolet Rays: Proc. World Petrol. Cong., London, July 1933, pp. 108-112.

[48] Kogerman, P. N., A New Method for the Determination of Preformed and Potential Gums in Cracked Gasoline: Proc. World Petrol. Cong., London, July 1933, pp. 113-115.

[49] Mardles, E. W. J., Estimation of Potential Gums: Proc. World Petrol. Cong., London, July 1933, pp. 116-121.

[50] Thomas, W. H., The Estimation of the Potential Gum Content of Cracked Gasoline: Proc. World Petrol. Cong., London, July 1933, pp. 122-128.

[51] Flood, D. T., Hladky, J. W., and Edgar, G., Chemical Nature of Gum-forming Constituents in Gasoline: Ind. and Eng. Chem., vol. 25, 1933, pp. 1234-1240.

[52] Morrell, J. C., Dryer, C. G., Lowry, C. D., and Egloff, G., Peroxides and their Effects in Gasoline: Presented before petrol. div., Am. Chem. Soc., Washington, D.C., 1933.

[53] Martin, S. M., Jr., Green, W. S., and Lowy, A., Distribution of Gum-forming Constituents in Cracked Gasoline: Ind. and Eng. Chem., vol. 25, 1933, pp. 381-386.

[54] Rue, H. P., and Espach, R. H., Refining of Light Petroleum Distillates: Bull. 333, Bureau of Mines, 1930, 111 pp.

*Sulphur compounds.*—The action of several reagents on trimethylene sulphide, ethyl sulphide, and thiophene dissolved in naphtha has been studied.[55] Trimethylene sulphide and ethyl sulphide gave stable derivatives in certain instances, and thiophene did not react. Studies of the thermal behavior of n-butyl sulphides in 0.5 molal solution in benzene [56] show that it is stable at 400° C. and undergoes moderate decomposition at 500° C. Up to 515° C. the products are largely hydrogen sulphide and mercaptans, and in the presence of large amounts of these compounds sulphur and thiophene are formed. The thermal decomposition of ethyl mercaptan and sulphide has also been investigated in the gaseous phase.[57] These have been found to be first-order reactions producing ethylene and hydrogen sulphide.

## LUBRICATING OILS

In recent years some progress has been made toward dividing lubricating oils into two or more groups or classes depending chiefly on such properties as viscosity and specific gravity differentials. Viscous oils are studied and evaluated for the most part through determination of physical properties; very little work has as yet been done in systematically correlating these properties with chemical facts, chiefly owing to lack of the latter.

*Separation and classification.*—An impetus has been given the separation of lubricant oils into groups by the recent widespread use of solvents. The solvent method generally used is based on the fact that certain parts of the oil are more soluble in many common organic solvents than other parts having properties characteristic of Pennsylvania oils. A more or less artificial grouping has been set up by the use of indices based on the temperature-viscosity relations or on the specific gravity-viscosity relations. Two general groups are formed. One, relative to the other, is characterized by low specific gravity, small viscosity change with temperature, low carbon residue, good resistance to sludging and oxidation, and in some instances reduction in sulphur, steam-emulsion number, and color.

The viscosity-temperature function or the slope of the viscosity-temperature curve has been proposed as an index of an oil.[58] Complete analyses of oils from three sources [59] according to all the usual means of evaluating lubricants indicated that for oils having the same viscosity at 50° C. the volatility, slope of viscosity-temperature curve, and generally oxidation sludge increased with the specific gravity, but carbon residue decreased. The viscosity-specific gravity constant was the only index figure that remained constant for each member of a group of oil prepared from the same crude oil.

Seemingly, one of the trends is increased production of synthetic lubricants. Oils which are stated to compare favorably with Ameri-

[55] Bost, R. W., and Conn, M. W., Behavior of Trimethylene Sulphide in Heptane and Naphtha Solutions: Ind. and Eng. Chem., vol. 25, 1933, p. 526.

[56] Malisoff, W. M., and Mahr, E. M., Thermal Behavior of Sulphur Compounds in Hydrocarbon Solvents. II. Normal Butyl Sulphide in Benzene Solution: Ind. and Eng. Chem., vol. 25, 1933, pp. 780–783.

[57] Trenner, N. R., and Taylor, H. A., The Thermal Decomposition of Ethyl Mercaptan and Ethyl Sulphide: Jour. Chem. Phys., vol. 1, 1933, pp. 77–88.

[58] Umstatter, H., The Slope of the Viscosity-Temperature Function as an Important Characteristic of Lubricating Oils: Petrol. Ztschr., vol. 29, no. 31, 1933, pp. 1–3.

[59] Freund, M., and Thamm, S., Untersuchung und Beurteilung von Motorenschmierolen: Petrol. Ztschr., vol. 29, 1933, no. 40, p. 1; no. 41, p. 1.

can petroleum oils have been obtained [60] from gases containing 20 to 33 percent of olefines. Condensation experiments with kerosene [61] gave promising results by halogenation and subsequent removal of the halogen and by condensation with acetylene or acetylene and hydrogen. A number of aromatic and aliphatic hydrocarbons have been synthesized [62] and viscosity-temperature curves determined where possible.

*Oxidation.*—The oxidation of mineral oils appears to be the object of considerable attention. It concerns a variety of fields, such as color reversion of lubricating oils, effect on lubricity of oils, and sludge formation. Color reversion [63] of oil in the dark is due to polymerization and condensation and in the light, to oxidation. Inhibitors seem to be more effective in preventing color reversion caused by oxidation than by polymerization. The role oxidation plays in lubricating bearings has been studied [64] under conditions that permitted the bearing to be heated and the oil recirculated and blown with hot air. By this method the seizing temperature of an oil could be determined; the data show that as the oil becomes oxidized its seizing temperature increases.

Apparently there is need for a reliable method of determining the oxidizability of oils if the number of methods proposed annually is a criterion. The Bureau of Mines has developed a test in connection with its study of California lubricants which will be published in 1934. Other tests include one [65] in which the oil is oxidized in the presence of a catalyst and those [66] [67] that employ air under different conditions of temperature and applications. The acceleration or deceleration of oxidation caused by different substances [68] shows that organic compounds, although effective below 150° F., are of little use at higher temperatures; whereas of the inorganic materials only tin and lead in several forms showed any inhibitory action.

*Lubricant testing.*—As usual, a number of machines designed to test the lubricant properties of oils or "oiliness" have been developed, but the most interesting and significant development along this line concerns the so-called "extreme-pressure" lubricants. Modern cars and hypoid and worm gears with their high pressures and wiping action exerted by the driving pinion or worms on the driven member of the assembly demand a new type of lubricant. This lubricant must have, among other characteristics, a high load-carrying capacity, stability under operating conditions, and minimum abrasive or wearing action and corrosive effects. Several machines have been developed, but the outstanding ones appear to be the Timken tester [69] and the appa-

[60] Petrov, A. D., Antzuz, L. I., and Pozhiltzeva, E. N., Synthetic Lubricating Oils from Gaseous Olefin Hydrocarbons, Refiner and Nat. Gaso. Manuf. vol. 12, 1933, p. 292.

[61] Ciochina, L., New Condensation Experiments upon the Hydrocarbons in Illuminating Oils: Petrol, Ztschr., vol. 29, 1933, no. 33, pp. 1–8.

[62] Lerer, M., Synthesis of Hydrocarbons of High Molecular Weight: Ann. Comb. Liq., vol. 8, 1933, pp. 681–733.

[63] Bowen, A. R., Refining of a Burma Crude Oil with Special Regard to the Color-Reversion Characteristics of the Lubricating-Oil Distillate: Jour. Inst. Petrol. Technol., vol. 19, 1933, pp. 364–375.

[64] King, R. O., The Beneficial Effects of Oxidation on the Lubricating Properties of Oil: Proc. Roy. Soc. A, vol. 139, 1933, pp. 447–459.

[65] Evers, F., and Schmidt, R., Die Ermittlung der Lebensdaur von Erdolen nach dem Oxydatorverfahren: Proc. World Petrol. Cong., London, July 1933, sec. vol. F, pp. 444–447.

[66] Garner, F. H., Kelly, C. I., and Taylor, J. L., The British Air Ministry Oxidation Test for Lubricating Oils: Proc. World Petrol. Cong., London, July 1933, sec. vol. F, pp. 448–457.

[67] Barnard, D. B., Barnard, E. R., Rogers, T. H., Shoemaker, B. H., and Wilkin, R. E., Effect of Sludge on Engine-Oil Performance: Nat. Petrol. News, Sept. 3, 1933, p. 27.

[68] Evans, E. A., The Oxidation of Lubricating Oils: Proc. World Petrol. Cong., London, July 1933, sec. vol. F., pp. 460–461.

[69] Frame, A. P., and Graham, A. K., Evaluation of Extreme-Pressure Lubricants by Use of Timken Laboratory Apparatus: Oil and Gas Jour., vol. 31, no. 33, 1933, pp. 14–16.

ratus developed by the Bureau of Standards.[70] The latter machine, on the basis of present tests, appears to rate the lubricants with reasonable agreement to service performance. Factors found to be significant are speed of rubbing, lubricant temperature, and rate of loading.

*Viscosity.*—The most interesting trend in viscometry is the recommendation by many technologists for a common international viscosity unit based on the C.G.S. system. Several interesting viscometers have been developed, notably a pipette type [71] and a falling-ball type [72] capable of an accuracy of 0.5 percent over a range of 0.01 to 500,000 centipoises.

## BYPRODUCTS

The production of organic compounds from petroleum is the subject of ever increasing research. Aside from the products possible by cracking and polymerization mentioned previously, oxidation, sulphonation, and halogenation offer possibilities of producing alcohols, esters, and other useful solvents and intermediates. During the period under review several interesting developments have been reported.

The production of fatty acids and thence to the synthesis of foods is a possibility. Paraffin hydrocarbons have been oxidized [73] in 20 percent sulphuric acid by electrolysis of the acid in the presence of certain sulphates. Several organic acids have been prepared [74] by catalytic oxidation with air or oxygen.

Mercaptans and disulphides from spent caustic soda [75] may be converted by oxidation into chemicals suitable for plasticizers, detergents, and solvents.

The study of sulphonic acids and sulphonated oils [76] [77] as spray spreaders in insecticides indicates that apparently these substances have good spreading power and are not injurious to the plants.

The chlorination of paraffin wax [78] and the bromination [79] of saturation aliphatic hydrocarbons have been investigated. The latter process is considered a step in the manufacture of alcohols.

## REFINING OF PETROLEUM

The replacements in refinery equipment during the years 1931 and 1932 were subnormal, particularly during 1932. It has been estimated that, taken as a whole, the replacements for the entire country during 1932 were as low as 25 percent and at the most not greater than 40 percent of the normal rate based on experience in previous years. In comparison it has been reported that at the end of 1933 there were more refineries in operation in the United States than ever before in the history of the petroleum industry.

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[70] McKee, S. A., Bitner, F. G., and McKee, T. R., Apparatus for Determination of Load-Carrying Capacity of Extreme-Pressure Lubricants: Soc. Automotive Eng. Jour., vol. 33, 1933, pp. 420–408.

[71] Ubbelohde, L., Suspended Level Viscosimeter: Jour. Inst. Petrol. Technol., vol. 19, 1933, pp. 376–420.

[72] Hoppler, F., Das genauste Universolviscosimeter mit cinem Messbereich von 0.01 bis uber 500,000 centipoise: Proc. World Petrol. Cong., London, July 1933, sec. vol. F, pp. 503–507.

[73] Atanasiu, I. A., Production of Fatty Acids by Electrolytic Oxidation of Petroleum Hydrocarbons: Nat. Petrol. News, vol. 25, no. 48, 1933, p. 22.

[74] Burwell, A. W., Decomposition of Saturated Petroleum Hydrocarbons Under Oxidizing Conditions at Low Temperature: Presented before petrol. div., Am. Chem. Soc., Chicago, September 1933.

[75] Wiezevich, P. J., Turner, L. B., and Frolich, P. K., Sulphur Compounds Derived from Petroleum: Ind. and Eng. Chem., vol. 25, 1933, p. 295.

[76] Martin, H., Petroleum Product as Spray Spreaders: Jour. Soc. Chem. Ind., vol. 52, 1933, pp. 429–32 T.

[77] Green, J. H., Improvement of Spraying Oils: Oil and Gas Jour., vol. 31, no. 37, 1933, p. 8.

[78] Gardner, F. T., Chlorination of Paraffin: Ind. and Eng. Chem., vol. 25, 1933, pp. 1211–1213.

[79] Perelis, W. J., Bromination of Saturated Aliphatic Hydrocarbon Gases: Ind. and Eng. Chem., vol. 25, 1933, pp. 1160–1161.

The refinery capacity in the United States at the end of 1932 was approximately 4,000,000 barrels per day, and the demand for refined products was slightly over 2,000,000 barrels. A large part of the refinery equipment at the close of the year was obsolescent, and a considerable portion could not operate economically under present prices.

Under existing gasoline prices incident to surplus production installation of equipment to lower manufacturing cost was of prime importance. In conjunction with the factor of reducing manufacturing cost is one of improvement in quality of products. Gasoline especially was subject to this condition because of the race for "octane numbers" during the last 2 years. In fact, during the past year virtually every replacement or modernization of cracking equipment has been due primarily to the necessity for meeting competition in the quality of motor gasoline.

Another reason for refinery construction has been to provide outlets for crude oil that does not have connections with established pipe lines or that, for some reason or other, cannot be disposed of to existing plants. This condition has developed because of flush production in such fields as east Texas and Oklahoma City. Surplus production in these areas gave a new source of supply to refineries which before were using crude oils from other locations, such as fields in Kansas. As a result, new plants are being built at McPherson, Kans., and old plants are being revamped at Hutchinson, Kansas City, Chanute, and elsewhere to take care of crude oil made homeless.

## CRACKING

The chief developments in the art of cracking petroleum fractions for 1933 have pointed toward improvement of the octane number of motor gasoline. This was brought about by the increase of compression ratios in the internal-combustion engines of automobiles. During 1932 the average compression ratio of automobile engines was approximately 5.30 to 1; for 1933 the average was raised to approximately 5.54 to 1. A satisfactory motor fuel for these higher compression-ratio motors should have an octane number of about 70.

To meet the demand for increased octane number in motor fuels, particularly those running Pennsylvania-type crude oils, refiners have been installing plants for the re-forming of certain naphtha fractions. The straight-run motor gasolines from Pennsylvania-type crude oils have an octane number of about 48 to 50. The tendency of a motor to knock or ping is greater when climbing than when running on level road; since a large part of the marketing area for Pennsylvania-type crude is in the Appalachian Mountain region these refiners have had to think more about re-forming the straight-run naphtha fractions than those in other refining areas of the United States.

The increase in the demand for lubricating oils from Pennsylvania crude and prospects of further increases have presented a problem of moving the straight-run gasoline which has increased as crude run to stills was stepped up to supply the demand for Pennsylvania neutrals and bright stock. To take care of the straight-run gasoline a central re-forming plant has been proposed.

Although it has not as yet been necessary for the Pacific-coast refiners to re-form the straight-run motor fuels, it has been necessary for them to construct plants to break the viscosity of the heavy fuel oils.

In the Mid-Continent refining area plants for both re-forming the straight-run motor fuels and for breaking the viscosity of the heavy fuels have been built during 1933.

The equipment of a typical modern plant for topping, cracking, and re-forming the naphtha fractions should include: [80] 2 furnaces, 1 for light oils and 1 for heavy oils; 2 bubble towers, 1 for the crude oil and 1 for the cracked stock; reaction and flash chambers; heat exchangers; pumps; controls, and other auxiliary equipment.

The customary procedure in a unit of this type is to heat the lighter oils under higher pressures to higher temperatures than those employed for heavy oils because of the greater refractoriness of the lighter oils. Such procedure, however, is not always followed; the conditions depend on many variable factors and may be changed at the will of the operator. Flexibility is the byword for new units of which the above-mentioned is a type.

In designing modern combination units the trend has been toward those of rather large capacity; during 1933 one was constructed [81] with a daily capacity of 19,000 barrels of Mid-Continent crude. This unit operates with four men on a shift and does a complete job of topping the crude, re-forming the naphtha fraction, cracking the heavy fractions of the crude, breaking the viscosity of the heavy fuel oil, and stabilizing the finished gasoline.

## TREATING CRACKED GASOLINE

The principal developments in the treating of cracked gasoline during 1933 have been made with the aim of retaining a high octane number for the finished gasolines and of keeping them from forming undesirable gum when standing in storage. A new method of clay-treating has been put in operation in refining vapor-phase cracked gasolines.[82] By this method the material under treatment is forced through a bed of fuller's earth or clay under enough pressure to maintain the liquid phase at 500° to 600° F. The liquid after passing through the clay is flashed in a tower to separate the polymers from the gasoline.

The question of sulphur in gasoline has demanded some attention; methods of treating with sulphuric acid have been developed which give quick contact between the acid and the gasoline, and the acid sludge is separated quickly from the treated product. A method developed by the Bureau of Mines for removing free sulphur from gasoline has been described recently.[83]

In treating cracked gasolines advances have been made during the last few months in the use of antioxidants to prevent the formation

[80] National Petroleum News, Shell's Montreal Refinery Employs Dubbs Multiple Coils for Topping, Cracking: Vol. 26, no. 6, Feb. 7, 1934, p. 25.

[81] Jirasek, J. V., Combination Refining Plant (at Whiting) Unique in Modernity: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 8, August 1933, p. 333.

[82] Cooke, M. B., and Hayford, A. W., Distillate Treating Now Highly Developed and Simplified: Refiner and Natural Gasoline Manufacturer, vol. 13, no. 3, 1934, p. 83.

[83] Espach, Ralph H., Blade, O. C., and Rue, H. P., Removal of Free Sulphurs from Gasoline by Lime and Hydrogen Sulphide: Refiner and Natural Gasoline Manufacturer, vol. 13, no. 2, 1934, p. 65.

of undesirable gums [84] [85] during the storage period before the motor fuel is put into use. A large number of compounds have been studied in regard to their antioxidant properties, and a number of compounds are being used commercially as antioxidants. Some are being marketed under trade names, and their exact composition is not known; however, from the data published by different investigators certain substituted phenols are very good antioxidants, chief of which are monobenzyl-para-aminophenol and dibenzyl-para-aminophenol.

In connection with the gum problem in cracked gasolines a number of investigators during the past year have spent considerable time in studying and developing methods for determining the preformed and potential gum in motor fuels.[86] The American Society for Testing Materials studied several methods for determining the gum content of gasolines; during the latter part of the year a vote of the members of committee D-2 of the society was taken and one of the tests [87] made a tentative standard.

## KNOCK CHARACTERISTICS OF MOTOR FUELS

During the last few years there has been considerable agitation in the petroleum-refining industry concerning the knock characteristics of motor fuels. The Cooperative Fuel Research Committee, composed of representatives of the American Petroleum Institute, National Automobile Chamber of Commerce, Society of Automotive Engineers, and United States Bureau of Standards, developed a method for determining the knock characteristics of motor fuels known as the C.F.R. motor method.

After some work on correlating this method of testing with the actual performance of a motor car on the road the American Society for Testing Materials voted to accept it as a tentative method of test (A.S.T.M. Designation D357-33T).[88] By this method of testing the knock characteristics of motor fuel a standard C.F.R. engine is used and a definite procedure followed.

## LUBRICATED MOTOR FUEL

The question of top-cylinder lubrication became a live one during the year, and a number of the major refiners in the United States announced the sale of lubricating gasoline.[89] [90] [91]

In addition to the petroleum refineries offering lubricated gasoline, certain companies are marketing a lubricant which is sold to service stations. This is added to the gasoline at the motorist's request as the gasoline is put in the automobile.

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[84] Rogers, T. H., and Voorhees, Vancleveer, Gum Formation in Gasoline. II. Control of Gum Formation in Gasoline by Antioxidants: Ind. and Eng. Chem., vol. 25, no. 5, 1933, pp. 520-523.

[85] Lowry, C. D., Jr., Egloff, Gustav, Morrell, J. C., and Dryer, C. G., Inhibitors in Cracked Gasolines. II. Correlation of Inhibiting Action and Oxidation Reduction Potential: Ind. and Eng. Chem., vol. 25, 1933, pp. 804-808.

[86] Rogers, T. H., Bussies, J. L., and Ward, P. T., Gum Formation in Gasoline. I. Measurement of Gum Stability in Gasoline: Ind. and Eng Chem., vol. 25, 1933, pp. 397-403.

[87] American Society for Testing Materials, Tentative Method of Test for Gum Content of Gasoline: A.S.T.M. Designation; D381-34T.

[88] American Society for Testing Materials, Standards on Petroleum Products and Lubricants: September 1933, p. 162.

[89] National Petroleum News, Two Mid-Continent Refining Companies Selling Lubricated Gasolines: Vol. 25, no. 3, Jan. 18, 1933, p. 11.

[90] National Petroleum News, Tide Water Announces Lubricated Gasoline: Vol. 25, no. 21, May 24, 1933, p. 12.

[91] National Petroleum News, Gulf Refining Announces Lubricated Gasoline: Vol. 25, no. 22, May 31, 1933, p. 8.

### ALCOHOL AS MOTOR FUEL

To make use of the overproduction of grain in the United States and to help the farmers in distressed areas the use of alcohol blended with gasoline as motor fuel has been advocated by certain groups in the agricultural regions. In fact, the pressure from some sources has been so great that laws have been proposed which would make it compulsory to use a certain amount of alcohol for motor fuel. As yet none of these proposed legislative acts have been passed. The petroleum industry has been opposed to the use of alcohol as a motor fuel; it has been stated that gasoline is a better motor fuel than alcohol and costs less.[92]

### SPECIAL STEELS IN CRACKING EQUIPMENT

The demands for high antiknock gasoline for the modern motor, which in some instances means re-forming of certain light fractions of petroleum, and the hydrogenation process have set up pressure and temperature conditions that put limitations on plain steel in modern refinery practice.[93]

Plain carbon-steel tubes can be used in the furnace or pipe still for sweet crudes and where severe temperature and pressure conditions are not prevalent, but the alloy steels are gradually crowding the plain steel tube out of the pipe still.

Steel pressure vessels composed of several layers of steel[94] have been developed; these seem to have greater strength than a single-walled vessel. The inside layer may be a thin one of an alloy highly resistant to corrosion, while the outer layers may be made of the economical load-carrying steel. Tests on vessels of this type when carried to destruction showed that they developed the full strength of the steels and burst by tearing the plates without shattering, as is typical of thick single-walled vessels tested to failure.

The technique of spraying metal has been improved and now may be used to build up worn pump shafts and piston rods.[95] Reaction chambers have been lined with sprayed aluminum to resist sulphur corrosion and so far the work seems to be successful.

### MANUFACTURE OF LUBRICATING OIL

One outstanding development in recent years in connection with the refining of petroleum products has been that of solvent-extraction processes. The Edeleanu process, utilizing liquid sulphur dioxide, has been used widely for a number of years in the refining of kerosene to give good-quality burning oils. The Bureau of Mines a few years ago did considerable work on the fractionation of crude oil by solvents.[96]

In the last few years a number of commercial processes using selective solvents have been developed primarily for the production of high-grade lubricating oils suitable for the most exacting requirements of modern lubrication, such as aero-engine and high-speed automobile-engine lubricating oils.

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92 Killeffer, D. H., Facts about Alcohol in Motor Fuel: Ind. and Eng. Chem., new ed., Apr. 20, 1933, p. 117.

93 Newell, H. D., Alloy-Steel Tubes for Refinery Service. Refiner and Natural Gasoline Manufacturer, vol. 12, no. 4, April 1933, p. 122.

94 Jasper, T. McL., Andrus, O. E., and Larson, L. J., Meeting Some of the Problem of the Pressure Vessel Used. II. Refiner and Natural Gasoline Manufacturer, vol. 12, no. 5, May 1933, p. 174.

95 Rice, H. P., Metals Spraying in Natural Gas and Gasoline Operations: Petrol. World, Jan. 1933, p. 36.

96 Smith, H. M., A Study of the Lubricant Fractions of Cabin Creek (W.Va.) Petroleum: Tech. paper 477, Bureau of Mines, 1930, 48 pp..

## SOLVENT METHODS

*Nitrobenzene process.*—The process is carried out as follows: The charge of oil is mixed with the requisite quantity of nitrobenzene, chilled, and allowed to settle, forming two layers;[97] the lower layer contains the naphthenics in solution in the bulk of the nitrobenzene and the upper layer the solution of the paraffinics. Each layer is separated continuously and passed over steam coils in a vacuum evaporator in which all but 1 to 2 percent of the nitrobenzene is removed, and then through a vacuum stripping tower where the remainder of the nitrobenzene is removed by the application of live steam.

The temperature at which extraction is conducted has an effect on the results obtained[98] and has an important bearing on the plant design. In general, it has been found that the optimum temperature is at least 40° F. below the miscibility temperature of stock and solvent. As the temperature is lowered the difference in solubility between paraffins and naphthenes increases, tending to increase the yield of an oil of given paraffinacity per volume of stock, and the actual solubility of both decreases, tending to decrease the yield per volume of solvent. Separation by selective solvents of the most paraffinic compounds from the viscous fractions of crudes ranging from the nonasphaltic Pennsylvania to the highly asphaltic type promises not only an adequate supply of stock but a control and degree of quality hitherto not practically attainable.

*Chlorex (dichloroethyl ether) process.*—This method of extraction was used in the manufacture of lubricants during the past year; oils made by this process are now being marketed.[99] The method is carried out in the following manner: It is based on a three-stage countercurrent system of extraction. The flow sheet of the plant in operation shows that the entering stock is heated above its pour point and mixed with thrice-used chlorex before cooling to the desired extraction temperature. The raffinate from the first extraction is treated with once-used chlorex from the last contacting chamber, and raffinate from the second contacting chamber is treated with fresh chlorex. This plant has a capacity of 500 barrels of finished oil a day. Another commercial plant of about 800 barrels a day was put in operation during the last few months of the year.

It is claimed that this process opens up to refiners new possibilities for the production of high-quality lubricating oils.

*Edeleanu process.*—During the past few months this method has been revised somewhat; a mixture of liquid sulphur dioxide and benzene has been used as a solvent in the manufacture of lubricating oils.[1] Changes in design and construction of Edeleanu plants now make possible the treatment of gasolines or kerosenes with liquid sulphur dioxide and lubricating oils with sulphur dioxide and benzene in the same unit.

*Duo-Sol process.*—This method of manufacturing lubricating oils differs from the other methods in that 2 solvents are used instead of

[97] Ferris, S. W., Meyers, W. A., and Peterkin, A. G., The Nitrobenzene Process, Installation and Operating Costs: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 11, November 1913, p. 435.

[98] Ferris, S. W., and Houghton, W. F., The Nitrobenzene Process for Lubricating Oils: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 8, August 1933, p. 328.

[99] Page, J. M., Jr., Buchler, C. C., and Diggs, S. H., Production of Lubricating Oils by Extraction with Dichloroethyl Ether: Ind. and Eng. Chem., vol. 25, no. 4, April 1933, p. 418.

[1] Cottrell, O. P., Scope and Flexibility of the Edeleanu Process: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 11, November 1933, p. 432.

1.[2] The double-solvent system necessitates the installation of separate recovery units for each solvent. This adds to the initial cost of the extraction plant using this process; based on the oil charged, the unit operating cost is perhaps greater than in plants using a single solvent. It is claimed, however, that this process effects a more complete separation than is possible when a single-solvent system is used, so that higher yields of lubricants of the finest characteristics are obtained.

*Furfural process.*—This method of manufacturing oils is based on the selective solvent powers of furfural, but the actual plant operation is similar to the other plants using a single solvent.[3] The furfural used in this process must be kept free from mineral acids, caustic alkali, and ammonia and should be protected against severe oxidizing conditions.

The source of raw materials in the manufacture of furfural is agricultural wastes, such as oat hulls, straw, corn cobs, and rice hulls. Furfural compares favorably in price with virtually all of the commercially available refining solvents.

Other solvents than those mentioned have been suggested for use in the manufacture of lubricating oil. Phenol has been used for 3 years in a commercial plant; [4] crotonaldehyde and acrolein have been studied, and methods adapting them to the solvent extraction of lubricating oils have been developed.[5]

A method of refining lubricating oils has been developed in which propane is used as a solvent.[6] In this method of refining, the solvent is used to deasphaltize the lubricating fractions of extremely high molecular weight which are most difficult to distill without decomposition. The operation consists essentially in mixing the residuum with the required quantity of propane at the proper temperature until equilibrium is reached, and the two phases are separated by settling. The propane phase comprises a solution of the lubricating oil and the asphalt phase, a heavy viscous liquid containing sufficient propane to permit transfer by pumping. This process can be operated continuously with relatively simple equipment.

## DEWAXING LUBRICATING DISTILLATES

The dewaxing of lubricating distillates from which lubricating oils are made has been rather difficult; it is one of the most expensive steps in the manufacture of lubricating oils, particularly in the production of low pour-point oils.

Considerable study has been given to the use of solvents in studying paraffin wax. The Bureau of Mines worked on this problem several years ago.[7]

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[2] Tuttle, Malcolm, and Miller, Max B., Duo-Sol Process in Manufacture of Lubricating Oils: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 11, November 1933, p. 453.

[3] Manley, R. E., McCarty, B. Y., and Gross, H. H., Refining of Lubricating Oils by Solvent Extraction with Furfural: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 11, November 1933, p. 420.

[4] Stratford, R. K., Pakorny, O. S., and Huggett, J. L., Use of Phenol as a Selective Solvent in the Production of High-Grade Lubricating Oils: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 11, November 1933, p. 458.

[5] Poole, John W., and Wadsworth, J. M., Solvent Extraction and Its Application: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 11, November 1933, p. 412.

[6] Bray, Ulric B., Swift, Claude E., and Carr, Donald E., The Use of Propane in Lubricating-oil Refining: Proc. Fourteenth Ann. Meeting Am. Petrol. Inst. (Refining), vol. 14 (III), November 1933, p. 96.

[7] Wyant, L. D., and Marsh, L. G., Paraffin Wax and its Properties. Methods of Testing Wax and of Analyzing Oil-Wax Mixtures: Tech. Paper 368, Bureau of Mines, 1925, 26 pp.

A process of dewaxing distillates has been developed which involves solution of the oil in liquid propane [8] under pressure followed by adiabatic evaporation of part of the solvent providing self-refrigeration for crystallization of the wax. The remaining propane after separation of wax from the chilled solution is removed by distillation. A plant based on the principles mentioned has been built; it has a charging capacity of 55,000 gallons of wax-bearing oil daily.

The refining industry has used centrifuging methods of separating wax from petroleum wax-bearing fractions for a number of years; during the last few years experimental work has been carried on in developing a centrifuge that could be used with high specific gravity solvents. A machine has now been developed which is somewhat similar to the standard centrifuge,[9] but a special bowl has been designed which discharges the petrolatum from the center of the bowl and the bright stock from the periphery. The solvent used in dewax-petroleum fractions with this machine is trichlorethylene, in which the oil is dissolved. Because of the difference between the specific gravity of the solvent and the oil it is possible to operate the centrifuges at a much lower speed than necessary with naphtha dilution.

The solvent process of dewaxing lubricating fractions of crude petroleum, using as a solvent a mixture of benzene and acetone, has been in commercial use for a number of years.[10] During the last year new dewaxing plants which employ this solvent have been built. This process of dewaxing is carried out as follows: (1) The wax-distillate charge is mixed in the proportion of 3 or 4 to 1 with the solvent composed of approximately 35 percent acetone and 65 percent benzene; (2) the solution is chilled to the desired temperature (approximately the pour point desired of the dewaxed oil) and the wax precipitated; (3) the mixture is then forced through a filter and the wax separated from the solution; (4) the solvent is separated from the filtrate by distillation, leaving a dewaxed oil with a pour point equal to the temperature at which the filtration was conducted; and (5) the solvent is recovered from the wax by distillation, and the recovered solvent is recycled through the apparatus.

Before the development of such methods of dewaxing as mentioned above the refining industry through years of experience had adopted generally three methods of dewaxing for the production of relatively low pour-point oils from wax-bearing crudes. These methods are commonly known as (1) "pressing", (2) "cold-settling", and (3) "centrifuging." These processes have their limitations. They require that a refinery be equipped with two different processes when a complete line of lubricating oils is desired; they also have been improved little in recent years.

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[8] Bahlke, W. N., Giles, R. N., and Adams, C. E., Dewaxing Oils in Propane Solution with Self-Refrigeration: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 6, June 1933, p. 229.

[9] Pester, Carl F., Centrifuge Dewaxing with Trichlorethylene: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 16, June 1933, p. 235.

[10] Govers, Francis X., and Bryant, G. R., Solvent Dewaxing of Oils with Benzol and Acetone: Refiner and Natural Gasoline Manufacturer, vol. 12, no. 6, 1933, pp. 222–228.

# FLUID-ENERGY RELATIONS IN PRODUCTION OF PETROLEUM AND NATURAL GAS

By R. A. Cattell and H. C. Fowler

SUMMARY OUTLINE



Nature has placed a wealth of oil and gas in porous underground reservoirs. Because of the character and composition of these substances, they fill many human needs. However, their fluid and mobile characteristics have led to confusion of thought and action. Most early methods of producing petroleum were by "rule of thumb." Many practices continue on an empirical basis because needed data are nonexistent. Knowledge of the properties of petroleum fluids and the characteristics of the natural reservoirs from which they are recovered, necessary to accurate analysis of the technical problems involved in their production, is being developed rapidly, but much is yet to be learned.

The behavior of oil and gas in porous reservoir rocks, in the wells through which they reach the earth's surface, and in equipment for their transportation, storage, and processing is in accord with definite physical laws. To develop these hydrocarbon resources to his greatest benefit, man must harmonize his actions with these natural laws. Opposition brings its penalties of increased cost and diminished return. The special concern of engineers, chemists, geologists, and others whose chosen work deals with technical phases of the oil and gas industry is to gain knowledge of the physical relations that determine the behavior of oil and gas and to apply such learning toward efficient production and wise utilization of these fluid minerals.

The problems of oil and gas production are not limited to technology. They cut across the fields of economics, law, politics, and human relations. Some legal precedents that had their origin in ideas of the occurrence of oil and gas prevalent a half century ago and were based on economic situations greatly different from those of today have hampered the application of new scientific knowledge as it became available. Moreover, much thought concerning oil and gas production has been based on inaccurate conceptions of physical phenomena; and legislative bodies, courts, and the public, have been insufficiently informed as to the natural laws upon which human action should be based.

To provide for wise development of the Nation's petroleum resources in the future, students of science and technology must supply



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the essential knowledge of natural laws. With a more adequate understanding of physical relations the technologist, economist, lawyer, statesman, and student of human relations may assist each other in solving problems as they arise, and all should cooperate to inform the public concerning the basic features of the industry.

The mechanism of oil and gas production is inextricably related to the whole social economy and affects the well-being of each individual. Every person should therefore know something of its rudimentary principles, a fact now recognized by leaders of the industry. The Stabilization Forum, sponsored by the American Institute of Mining and Metallurgical Engineers, had as a keynote "The public must understand."[1] Lewis expressed a similar thought when he said, "The future course of the industry must be viewed from the outside rather than the inside point of view."[2]

This short chapter discusses some of the fundamental technical problems in oil and gas production, dealing with the nature of these problems and the methods of attacking them, rather than their final solution. Generally the treatment is in simple terms, although it is assumed that the reader is familiar with the engineering concepts of work and heat, their relation to each other, and the principles of transformation of energy.[3] Footnote references are given to more detailed and technical discussions.

Emphasis is laid on sources of energy in a petroleum reservoir system,[4] the behavior of fluids under changing conditions within the system, and the effects of transformations of energy in moving the fluids against resistance. An understanding of these fluid-energy relations is basic to the solution of many difficulties, some of which are nontechnical in character.

## CONSERVATION OF RESERVOIR ENERGY

Probably the most significant trend of thought in oil and gas production is the growing realization that a producing structure is to be looked upon not only as a reservoir of oil and gas, but also as a reservoir of energy.[5] Such energy, if properly conserved and used, will move the hydrocarbon fluids to the well and through it to the surface, delaying the time when energy must be supplied from external sources through gas or air injection, artificial water drive,[6] the pump, or other means.

It is well recognized now that effective use of the energy available from a natural petroleum reservoir will decrease the ultimate cost of recovery and increase the quantity of hydrocarbons that can be produced economically from the deposit. Engineers, executives, and others who are aware of the fluid-energy attributes of a reservoir

[1] Oil and Gas Journal, Am. Inst. Min. and Met. Eng. Stabilization Forum, 13 articles, May 11 to Sept. 21, 1933.

[2] Lewis, J. O., Property Rights, Public Interest in Oil and Gas: Am. Inst. Min. and Met. Eng. Stabilization Forum, Art. 10, Oil and Gas Jour., Aug. 10, 1933, p. 11.

[3] See any standard textbook on thermodynamics. These principles are well presented in Goodenough, G. A., Principles of Thermodynamics: New York, 1920, pp. 1-11.

[4] The system extends out and beyond the natural reservoir of oil and gas. It includes the wells and all external influences on the reservoir.

[5] Fowler, H. C., Technical Developments in Petroleum and Natural-Gas Production: Minerals Yearbook 1932-33, Bureau of Mines, 1933, pp. 497-498.

Transactions, American Institute of Mining and Metallurgical Engineers, Reservoir Energy, Its Source, Ownership and Utilization in the Production of Petroleum; A symposium led by Joseph B. Umpleby: Vol. 103, Petrol. Devel. and Technol. 1933, pp. 22-32.

[6] Nowels, K. B., Rejuvenation of Oil Fields by Natural and Artificial Water Flooding: Proc. World Petrol. Cong., 1933, vol. 1, p. 310.

understand that dissipation of energy that could have performed effective work in bringing oil from the formation to the well, and thence to the surface, is contrary to efficient operation and may represent a greater financial loss than any waste of oil or gas above ground.

In laying the basis of this discussion one must not lose sight of the scientific fact that neither matter nor energy can be destroyed. They merely change their form or location. When natural gas escapes from a wellhead into the air the gas is not destroyed, but its usefulness to serve man is lost. Likewise, when such gas expands from a higher to a lower pressure without doing useful work there is no destruction of energy, but there is a loss in the usefulness of energy[7] to serve man. When expanding gas does work against needless friction, converting mechanical energy to heat (another form of energy), there is a similar loss. Therefore, it must be remembered that terms such as "dissipation of energy" or "depletion of energy", as applied to oil and gas production, refer to loss in the usefulness of energy to do desired work in moving fluids rather than to any disappearance of energy.

Overproduction of oil may have obscured the fact that this Nation's petroleum reserves are limited. Some forget that the periodic flooding of the market is due more to an excess of wells through which oil may reach the surface than to a superabundance of the reserves. Although this Nation's petroleum resources are large they are exhaustible.

Conservation is a term that brings forth diverse opinions. The word means different things to different men. However, few will disagree with the statement of the late Joseph A. Holmes, the first Director of the Bureau of Mines, that conservation is a "wiser and more efficient use of natural resources."[8] People who accept such a definition will desire to minimize the quantity of oil to be left underground, beyond recovery by economical means, just as they will desire to avoid needless blowing of natural gas to the air, loss of oil by evaporation and accidental fires, or any other useless expenditure of assets. Those who hold to such principles also will desire to prevent waste of reservoir energy.

Moore has pointed out succinctly that "gas wasted is oil wasted"; that "water wasted is oil wasted"; and that "energy waste (is) prejudicial to all."[9] In general, any action which reduces pressure within a reservoir causes a decrease in the energy useful for moving and lifting the fluid; however, there may be a considerable decrease in usefulness of the energy merely by a change in the location of a fluid, without any substantial decrease in its pressure. For example, a given quantity of natural gas that has moved from within an oil body on the flank of a structure to a position in a gas cap on its crest may have become much less useful for moving and lifting oil, although there may have been no substantial change in the pressure to which it is subjected.

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[7] The term "usefulness" as here employed includes, but is somewhat broader than, the concept of "availability" as ordinarily used in discussions of thermodynamics.

[8] Holmes, Joseph A., A Rational Basis for the Conservation of Mineral Resources: Am. Inst. Min. Eng. Bull. 29, May 1909, p. 469.

[9] Moore, T. V., Application of the Principle of Volumetric Withdrawal to the Allocation of Production: Am. Petrol. Inst. Produc. Bull. 212, November 1933, pp. 11–14.

## FLUID-ENERGY RELATIONS IN SIMPLE ASPECT

In principle the fluid-energy relations of petroleum properties are relatively simple, but in detail they may be extremely complex. To reduce the concept to its simplest terms, consider an undrilled oil-bearing geologic structure of an ideal or "textbook" type. Its productive bed is a stratum of porous rock of substantially uniform texture, lying between two impervious strata, all arched into a dome. The strata are inclined downward, but with gradually decreasing slope, from the crest of the dome to its periphery where they are substantially horizontal. From the periphery outward the beds are inclined upward, and at some point the porous stratum crops out at the surface. Assume for this discussion that enough water has entered and is retained in the porous bed to fill its voids to the lowest point of the outcrop.

From the outcrop downward to the periphery of the dome and thence upward toward its crest to an oil-water contact the voids of the porous stratum are filled with water (generally salt water in the lower levels). Inward and upward from this oil-water contact the voids are filled with oil, which is lighter than water and therefore lies above it. This oil contains lighter hydrocarbons, of the range found in natural gas, in solution. This simple structure contains more of these lighter hydrocarbons than the oil will hold in solution at the existing pressure, so the porous stratum will not contain liquid in the higher central part of the dome. Instead, natural gas, which is much lighter than the oil, will occupy the voids of the porous bed above a gas-oil contact. Thus, the structure will contain a so-called "gas cap."

This reservoir, until punctured by the drill, may be considered, for all practical purposes, to be in a state of equilibrium. Gravity is acting on both the rocks and the fluids. It is assumed, however, for present purposes, that the porous rock supports its overburden. Under that assumption, the impervious rocks confine the fluids, but the forces they exert against the porous bed are not sufficient to alter the size and shape of the voids in which the fluids are held.

At any level in the water-filled part of the porous bed the fluid is under pressure equivalent to a head of water from the lowest point of the outcrop to that level (0.433 pound per square inch per foot of depth for fresh water), and at any level in the oil-filled part of the porous stratum the oil is under a pressure equal to that at the oil-water contact minus the pressure exerted by the head of oil from the level in question to that contact. Likewise, at any point in the gas cap the gas is under a pressure equal to that at the gas-oil contact minus the pressure due to the head of gas between that point and the gas-oil contact. In this connection, it is well to mention that although the pressure exerted by a column of gas is much less than that due to a column of liquid of the same height, it is not always negligible.

It is apparent, therefore, that in such a virgin structure the forces are in balance. The water is pressing upward at the oil-water contact; but its pressure is counterbalanced by the pressure of the gas, acting at the gas-oil contact and transmitted through the oil, plus the pressure due to the head of oil between the two contacts.

If a well is drilled into the oil-saturated part of the porous stratum and opened to a lower pressure, the forces are unbalanced. The oil surrounding the well, with lighter hydrocarbons in solution, starts to flow toward the point of lower pressure at the well bore. As the pressure on the oil is reduced some of the lighter hydrocarbons come out of solution, forming gas. This gas, in expanding toward the region of lower pressure, tends to push the fluid ahead of it toward the well, but some of the gas may bypass the oil and move into the gas cap, doing little or no useful work.

When the fluid reaches the well it consists of a mixture of oil (still saturated[10] with lighter hydrocarbons) and gas. If the pressure and other conditions are adequate the fluid moves up the well, the gaseous part tending to rise faster than the oil and to slip past it. As the fluid mixture reaches higher levels in the well, where the pressures are lower, more of the lighter hydrocarbons come out of solution joining the gas. Moreover, as this mixture rises and the pressure upon it decreases, the gaseous part expands, doing work on the fluid above it. Work of this nature is done at the expense of heat absorbed from the fluid or the surrounding formation.

The more important sources of mechanical energy may now be considered. A given quantity of the fluid has potential energy (pressure head) measurable in terms of the product of its pressure and volume. The fluid also has ability to increase its volume with reduction in pressure, principally through release from solution and subsequent expansion of the lighter hydrocarbons, converting a part of its own heat energy, or the heat energy of its surroundings, into mechanical work. The mechanical energy resulting from such expansion is not a fixed and definite quantity but depends upon the conditions under which the expansion takes place, particularly the opportunities for transfer of heat between the fluid and its surroundings and generation of heat within the fluid by friction or other effects.

Important transformations of energy involved in the movement of the fluid mixtures from the reservoir to the surface may be listed as follows: (1) A definite amount of mechanical work must be done to lift the fluid through the vertical distance from its position in the formation to the surface; (2) the fluid must be accelerated from zero velocity at its original position in the formation to the velocity at which it leaves the well head; (3) the friction in the formation, in the flow tube, and in well-head connections must be overcome; and (4) the energy represented by the pressure head (pressure times volume) at which the fluid leaves the well must be supplied. In considering friction, account must be taken of the slippage of one fluid (gas) past another (oil), in addition to frictional effects that are analogous to resistance of porous media and pipes to the flow of homogeneous fluids.

The objective in applying knowledge of fluid-energy relations is largely to move oil to the well and lift it to the surface, leaving a maximum of energy in the system available to do such work in the future. Each of the terms listed in taking stock of applicable energy and its expenditure, except the mechanical work represented by the lifting of the fluid against gravity from its original position in the sand to the surface, is subject to a measure of control through design or method of operation. Hence it is evident that the problem is one in which man may use his knowledge and ingenuity to his benefit.

[10] Distinction between saturation and supersaturation is not made in this discussion; also, for simplicity, the term "solution" is used to denote a phenomenon which essentially is one of distribution of constituents between coexisting phases, rather than solubility.

## COMPLEXITIES OF FLUID-ENERGY RELATIONS

In the foregoing the assumed conditions are simple, and the treatment is qualitative rather than quantitative. Space does not permit detailed discussion of the ramifications of conditions that affect fluid-energy relations. However, the following illustrate the variety of factors to be considered.

1. Producing structures are not ordinarily as simple as the one assumed; in fact, most of them are complicated.

2. Oil-bearing beds are variable in their porosity (the measure of their capacity to hold fluid) and their permeability (the measure of their capacity to conduct fluid).

3. Water and sand may accompany the hydrocarbon fluids in their movements.

4. The relation of water, oil, and gas and their pressures is subject to a wide variety of conditions. As fluid is withdrawn from the oil-filled or gas-filled parts of the producing bed the oil-water contact tends to rise. The rate and regularity of its movement and the extent to which such encroachment will maintain pressure in the productive parts of the porous bed depend upon the manner and rate of withdrawal of fluids, the characteristics and uniformity of the producing stratum, and the opportunities for flow of water into the porous rock. If the gas cap is tapped and drawn upon for natural-gas production, the gas-oil contact may move up-dip. However, under some conditions the gas cap may expand and the gas-oil contact move down-dip. This movement is substantially uniform or irregular, depending upon the conditions in the reservoir system.

5. The natural gas associated with the oil in the structure, as distinct from that formed by evolution of lighter hydrocarbons from the oil, may aid materially in moving and lifting the fluids.

6. The lighter hydrocarbons in a structure may be insufficient to saturate the oil. For example, experimental work in the East Texas field showed that evolution of gas from solution did not start until the pressure on the oil was reduced to 755 pounds per square inch, although the reservoir pressure was 1,390 pounds per square inch when the tests were made and had been more than 1,600 pounds. [11]

7. The flow of an oil-gas mixture in a well may be of several different types, with intermediate and transition forms. If the pressure is high enough, all the lighter hydrocarbon constituents are in solution, and the flow is that of a true liquid. If all the gas is not dissolved the oil-gas mixture may flow as a foam, the oil may be carried in the gas as a mist, slugs of oil and gas may alternate in the flow tube, or oil may be dragged up the walls of the flow tube in the form of a sleeve around a central column of gas. Differential movements of gas and oil are influenced greatly by the type of flow.

8. The release of gas from solution has harmful as well as helpful effects. As the gas is released the viscosity and surface tension of the oil are increased, rendering it more difficult to move through the

[11] Lindsly, Ben E., A Study of "Bottom-Hole" Samples of East Texas Crude Oil: Rept. of Investigations 3212, Bureau of Mines, 1933, p. 12.

sands.[12] The bubbles of gas, by the so-called "Jamin effect",[13] also may increase the resistance to flow. Recent discussion[14] as to whether the Jamin effect is as important in oil production as some have supposed indicates that this question merits further experimental study. As another factor, expansion of the gas, although resulting in mechanical work, may reduce the fluidity of the oil and cause deposition of wax by its cooling effect.

9. In general, the causes of pressure of the fluids and the sources of energy are not as free from complexity as was assumed in considering fluid-energy relations in their simplest aspect. This will be evident from the discussion that follows:

## PRESSURE AND ENERGY IN THE RESERVOIR

A summation of causes of pressure within the producing beds given by Mills and Wells[15] in 1919 seems as pertinent today as when written. These authors said:

> It seems probable that hydrostatic pressure, deep-seated thermal conditions, the long continued formation of natural gas, and the resistance to fluid movements through the strata all enter into the causes for "rock pressure."

In this quotation the term "rock pressure" has the meaning that has long been given it in the oil and gas industry, although when used in that sense it is, at best, a misnomer. In accordance with the trend toward more exact terminology in oil and gas production, expressions such as "reservoir pressure" and "pressure in the sand" now are commonly used. In view of recent interest in the possible effect of the weight of overlying strata on pressure and available energy,[16] it would be well to confine the term "rock pressure" to its original geophysical definition, that is, the pressure exerted by the overburden of rock above any point,[17] which generally is greater than the pressure of the fluids in the reservoir.

In considering causes of pressure within a reservoir, heads of fluids undoubtedly are of primary importance; but possible effects of weight and subsidence of overlying strata, crystallization, diastrophism (deformation of the earth's crust), chemical precipitation, molecular rearrangements, and the like, should not be disregarded. Likewise in considering sources of useful energy, although the pressure head of the fluid (pressure times volume) and the conversion of heat to mechanical work by expansion of fluids (principally through expansion of the gaseous part) are of first-rank importance, it should not be assumed that these are the only sources of energy. For example, capillarity always should be taken into account, and in the later life of a field direct action of gravity on the oil near a well may be a primary factor causing its flow into the bore.

[12] Beecher, C. E., and Parkhurst, I. P., Effect of Dissolved Gas Upon Viscosity and Surface Tension of Crude Oil: Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol. 1926, pp. 51–69.

Dow, D. B., and Calkins, L. P., Solubility and Effects of Natural Gas and Air in Crude Oils: Rept. of Investigations 2732, Bureau of Mines, February 1926, 13 pp.

[13] Miller, H. C., Function of Natural Gas in the Production of Oil: Rept. of the Bureau of Mines in cooperation with the Am. Petrol. Inst., 1929, pp. 12, 71, and 228–231.

Herold, Stanley C., Analytical Principles of the Production of Oil, Gas, and Water from Wells: Stanford Univ. Press, 1928, pp. 410–418.

Gardescu, Ionel I., Behavior of Gas Bubbles in Capillary Space: Trans. Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol. 1930, pp. 351–370.

[14] Discussion between Versluys, J., and Wright, Randall, Jamin Effect in Oil Production: Bull. Am. Assoc. Petrol. Geol., vol. 18, no. 4, April 1934, pp. 547–549; also papers referred to in that discussion.

[15] Mills, R. van A., and Wells, R. C., The Evaporation and Concentration of Waters Associated with Petroleum and Natural Gas: U.S. Geol. Survey Bull. 693, 1919, p. 29.

[16] Umpleby, Joseph B., Efficient Utilization of Reservoir Energy: Paper presented before Am. Inst. Min. and Met. Eng., New York meeting, February 1934, printed in Oil Weekly, Mar. 5, 1934, p. 22.

[17] Heroy, Wm. B., Rock Pressure: Bull. Am. Assoc. Petrol. Geol., April 1928, p. 355.

## APPLICATIONS OF FLUID-ENERGY RELATIONS

Rigid quantitative analysis of the flow even from a simple "textbook" structure is impossible with present data. With more complicated conditions the difficulties are increased. However, marked advance has been made toward mathematical solution of the flow in certain types of wells.[18] Fluid movements in the reservoir also have been the subject of recent constructive thought,[19] but to date that field is barely scratched. Probably flow in some reservoir rocks and in certain types of wells cannot be reduced to mathematical analysis. Even in that event, however, much that is new can be learned of the magnitude, importance, and relative influence of the various factors. Knowledge gained through studies directed toward such ends can be used in many practical ways. The following are cited as illustrations:

*Equitable allocation of production.*—With "control" a predominating note in the whole social economy and with the petroleum industry in the "proration period", much attention is being given to allocation of production. Recently a committee of the American Petroleum Institute issued a progress report on the engineering factors involved.[20] The advance which has been made in the work of that committee would have been impossible without the research directed toward better understanding of fluid-energy relations carried on by the Bureau of Mines and others. The report shows need for much additional research of similar character. It is self-evident that equity in allocation of production hinges on an understanding not only of the distribution and characteristics of the fluids within the reservoir but also of the energy that may be used to move them to the surface.

*Estimation of the capacities of wells to produce oil and gas (well potentials).*—The estimation of the capacities of wells to produce oil and gas is closely related to equitable allocation. Productivity of wells is an important factor in any scheme of proration. The rate at which oil and gas may be delivered from a well depends upon the ability of these fluids to reach the bore from the adjacent sand and upon the facilities for lifting them to the surface. The movement of the fluids against frictional resistance and gravity requires energy. Obviously, understanding of flow from wells and development of a

[18] Versluys, J., Mathematical Development of the Theory of Flowing Oil Wells: Trans. Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol. 1930, pp. 192–208; Some Principles Governing the Choice of Length and Diameter of Tubing in Oil Wells: Trans. Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol. 1931, pp. 279–295.

Moore, T. V., and Wilde, H. D., Jr., Experimental Measurement of Slippage in Flow Through Vertical Pipes: Trans. Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol. 1931, pp. 296–319.

Moore, T. V., and Schilthuis, R. J., Calculation of Pressure Drops in Flowing Wells: Trans. Am. Inst. Min. and Met. Eng., vol. 103, Petrol. Devel. and Technol. 1933, pp. 170–190.

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: Bureau of Mines Rept. of Investigations 3211, 1933; also published in Am. Petrol. Inst. Produc. Bull. 211, May 1933, pp. 53–69.

May, John Cecil, and Laird, Albert, The Efficiency of Flowing Wells: Jour. Inst. Petrol. Technol. (London), March 1934, pp. 214–247.

[19] Versluys, J., Sources of Energy Involved in Propagation of Oil Towards a Well: Proc. World Petrol. Cong., 1933, vol. 1, p. 446; Principles Governing the Location of Wells with Respect to the Structure: Proc. World Petrol. Cong., 1933, vol. 1, p. 289.

Hurst, W., Unsteady Flow of Fluids in Oil Reservoirs: Physics, vol. 5, no. 1, 1934.

Wyckoff, R. D., Botset, H. G., and Muskat, M., The Mechanics of Porous Flow Applied to Water-Flooding Problems: Trans. Am. Inst. Min. and Met. Eng., vol. 103, Petrol. Devel. and Technol. 1933, pp. 219–249.

Nowels, K. B., Mechanics of Water Movement in Natural and Artificial Flooding of Oil Sands: Trans. Am. Inst. Min. and Met. Eng., vol. 103, Petrol. Devel. and Technol. 1933, pp. 192–218.

Wilde, H. D., Jr., and Lahee, F. H., Simple Principles of Efficient Oil-Field Development: Bull. Am. Assoc. Petrol. Geol., vol. 17, no. 8, August 1933, pp. 981–1002.

[20] American Petroleum Institute, Essential Engineering Factors in the Allocation of Production—Progress Report of the Topical Committee on Allocation of Production: Produc. Bull. 212, November 1933, pp. 4–21.

rational system for determination and comparison of their capacities hinge upon knowledge of fluid and energy relations underground.

*Estimation of reserves.*—When capital is to be invested in any prospective or producing field it is important to know the quantity of oil that may be recovered, and it is of almost equal importance to know the rate at which the oil may be produced during each of the various stages of the field's life.[21] The Nation needs similar information with respect to its petroleum resources as a whole.

Future recovery and rate of production depend not only upon the quantities of the various hydrocarbons underground but also upon the energy available, and that required, to deliver them to the surface.

*Methods of control and operation of wells.*—The study of fluid-energy relations includes consideration of the mechanics and thermo-dynamics of flow in wells. Until these are understood the operator lacks fundamentals upon which to select his equipment and methods of operation for minimizing waste of reservoir energy and thus reducing waste of oil and gas.

*Optimum spacing of wells.*—Well spacing, without its human complications, is a problem in fluid mechanics, and if the natural laws are understood more thoroughly some of the difficulties that arise from human relations will be less troublesome to solve. The problem of efficient well spacing dates back to the time men began to realize that oil and gas generally are contained in closed structures of porous rock and not in caverns or underground streams. The subject was treated several years ago by engineers of the Bureau of Mines,[22] who recognized the importance of reservoir energy and interference between wells. Their work marks an epoch because it based estimation of values in the petroleum industry on facts that previously had not gained general recognition. However, in applying their work today, one should remember that it was based on conditions prior to the "proration period."

Cutler presented the tentative rule that:

> The ultimate productions for wells of equal size in the same pool, where there is interference (shown by a difference in the production decline curves for different spacing), seems approximately to vary directly as the square roots of the areas drained by the wells.

In reference thereto he said:

> This (tentative) rule seems to rest on the fundamental mechanical law that the energy required to move a fluid (either liquid or gas) through a pipe, or analogous conductor, is proportional to the distance.[23]

If all recoverable oil in a reservoir is to be produced at the maximum rate of withdrawal (open-flow conditions), depending almost entirely for energy upon the propulsive power of gas under pressure, the rule given by Cutler may seem to argue for close spacing. However, if permeability of the sand and other elements of fluid-energy relations are taken into account, a spacing of wells wider than that in many fields apparently would have given at least equal recovery during the

[21] Brace, O. L., Factors Governing Estimates of Recoverable Oil Reserves in Sand Fields: Bull. Am. Assoc. Petrol. Geol., vol. 18, no. 3, March 1934, pp. 343-357.

[22] Beal, C. H., The Decline and Ultimate Production of Oil Wells, with Notes on the Valuation of Oil Properties: Bull. 177, Bureau of Mines, 1919, pp. 13, 43, 70, 105, 122, 130, 161, 204.

Beal, C. H., and Lewis, J. O., Some Principles Governing the Production of Oil Wells: Bull. 194, Bureau of Mines, 1921, pp. 18–19, 25–34, 51.

Cutler, W. W., Jr., Estimation of Underground Oil Reserves by Oil-Well Production Curves: Bull. 228, Bureau of Mines, 1924, pp. 85–90, 105–107.

[23] Cutler, W. W., Jr., Estimation of Underground Oil Reserves by Oil-Well Production Curves: Bull. 228, Bureau of Mines, 1924, p. 89.

present "proration period" and would have resulted in more efficient use of reservoir energy and lower costs of production.[24]

Notwithstanding the constructive thought that has been given the problem, few engineers feel qualified to state the optimum well spacing for any given area. The answer depends on more accurate knowledge than is available today concerning relations of fluid and energy within the reservoir.[25]

*Control of movement of gas, oil, and water within a structure.*—Irregular encroachment of water up-dip from the original oil-water contact is to be minimized because the advancing water may trap oil and leave it beyond recovery by any ordinary means. Likewise invasion by oil of the part of a structure that was occupied originally by gas is to be avoided, because only part of the oil that enters a "gas cap" can be recovered.[26] As mentioned, migration of the lighter hydrocarbons from a position within the oil body to one in the gas cap may result in a loss in usefulness of energy without substantial reduction in pressure.

Such undesirable movements of fluids can be minimized by appropriate campaigns of development and operation, determinable only from knowledge of fluid-energy relations within the reservoir.

*Selection of most effective means of stimulating recovery.*—The underlying principles in the use of energy are the same whether the energy is a natural attribute of the reservoir or is supplied from external sources. Added knowledge of fluid-energy relations will be helpful, therefore, in selecting and applying means of stimulation, such as water drive or gas injection.

In the foregoing discussion of applications of knowledge concerning fluid-energy relations illustrative problems have been discussed under captions for convenience. However, they are closely interrelated. All involve transformations of energy and flow of fluids. Furthermore, in all of them useful work is measured in terms of valuable substance delivered at the surface, and needless expenditures of energy are to be looked upon as waste.

Such problems must be considered in the light of the present and future situation. For example, a question now confronting engineers is how to evaluate the productivity and ultimate recovery of a property under controlled operation. The production-decline curves of the form applicable in the earlier period must be reinterpreted and modified to meet a new set of conditions.

## STUDIES OF FLUID-ENERGY RELATIONS

Many individuals and organizations have contributed to present knowledge of fluid-energy relations. The following discussion is based largely on the work of the Bureau of Mines, which has a coordinated program of further research along these lines. Several references are given to contributions by others, but limitation of space

[24] Moore, T. V., Schilthuis, R. J., and Hurst, William, The Determination of Permeability from Field Data: Amer. Petrol. Inst. Produc. Bull. 211, May 1933, pp. 4–14.

[25] Wood, Fred E., A First Approximation of Comparative Ultimate Yields of Oil with Varied Well Spacing: Am. Petrol. Inst. Produc. Bull. 211, May 1933, pp. 14–18.

[26] Versluys, J., Principles Governing the Location of Wells with Respect to the Structure: Proc. World Petrol. Cong., 1933, vol. 1, p. 289.

prevents mention of many that are important. Some recent contributions have had their origin in research in Persia.[27]

The importance of expansion of gas in producing oil was recognized in some of the earliest writings of the Bureau of Mines on petroleum.[28] Later, in 1917, Lewis summarized advanced technical thought of that period regarding more effective utilization of natural pressure and expressed a far-seeing appreciation of fluid-energy relations in the following statement:

> In the expansion of the gases, as the pressure is reduced (in the formations), an enormous amount of energy is released which is the principal force in driving the oil from the sand into the wells.[29]

Some years later, when considerable attention was being given to gas-oil ratios, Pierce and Lewis said:

> We have seen no consideration of the fundamental principle, which is that the oil represents the useful work done by the energy contained by the gas, measured by volume and pressure in terms of horsepower or foot-pounds of work.[30]

In their further treatment of "gas-pressure-oil" ratios, Pierce and Lewis recognized the interrelation of the flow within the reservoir and the vertical flow through the well to the surface. These may be studied separately only if sight is not lost of their definite relation as parts of a single flow system.

At that time individuals and research groups were accumulating knowledge of some of the properties and characteristics of hydrocarbon fluids in natural reservoirs, but crystallization of thought on the function of natural gas in the production of oil did not become definitely apparent until the available knowledge on the subject was brought together in one volume.[31]

In the past few years the Bureau of Mines has conducted a number of research studies dealing with oil recovery, flow of petroleum fluids, and related subjects.[32] Recently these have been coordinated more closely and directed toward the presentation of a comprehensive treatment of fluid-energy relations. Although these problems interlock, they may be discussed conveniently under the following captions:

*Pressures and temperatures in wells, and vertical flow.*—Obviously, knowledge of the pressures and temperatures in the reservoir and at different levels in wells is essential to the study of fluid-energy relations. The Bureau has developed a pressure- and temperature-recording bomb for use in wells under flowing or "shut-in" conditions. Reistle and Hayes made traverses with such a bomb of pressure and temperature gradients in wells of the East Texas field and used the data in a very practical way to solve problems relating to vertical

[27] Pym, L. A., The Measurement of Gas-Oil Ratios and Saturation Pressures and Their Interpretation; Jones, D. T., The Surface Tension and Specific Gravity of Crude Oil under Reservoir Conditions; Comins, D., Gas Saturation Pressure of Crude under Reservoir Conditions as a Factor in the Efficient Operation of Oil Fields: Papers presented before World Petrol. Cong., London, July 19–25, 1933.

[28] Huntley, L. G., Possible Causes of the Decline of Oil Wells and Suggested Methods of Prolonging Yield: Tech. Paper 51, Bureau of Mines, 1913, 32 pp.

Arnold, Ralph, and Garfias, V. R., Methods of Oil Recovery in California: Tech. Paper 70, Bureau of Mines, 1914, 57 pp.

McMurray, W. F., and Lewis, J. O., Underground Waste of Oil and Gas and Methods of Prolonging Yield: Tech. Paper 130, Bureau of Mines, 1916, 28 pp.

[29] Lewis, J. O., Methods for Increasing the Recovery from Oil Sands: Bull. 148, Bureau of Mines, 1917, p. 13.

[30] Pierce, H. R., and Lewis, James O., Principles of the Air-Gas Lift as Applied to Oil Production: Trans. Am. Inst. Min. and Met. Eng., Petroleum Devel. and Technol., 1927, p. 33.

[31] Miller, H. C., Function of Natural Gas in the Production of Oil: Report of the Bureau of Mines in cooperation with Am. Petrol. Inst., 1929, 267 pp.

[32] Fowler, H. C., Petroleum and Natural-Gas Studies of the U.S. Bureau of Mines: Information Circ. 6737, Bureau of Mines, 1933, pp. 21-36.

flow and thereby increase efficiency in use of reservoir energy.[33] However, they found it impossible to determine the energy requirements under all conditions of vertical flow and recognized the need for more exhaustive study of the flow of oil-gas mixtures through vertical pipes.

Since the Bureau's initial studies in the East Texas field were completed, similar pressure-temperature traverses of wells have been made at Oklahoma City. This later work has been extended to include studies made above-ground with equipment erected in a derrick, simulating sections of a flow string. These studies add to the knowledge of the characteristics of vertical flow of oil-gas mixtures.

*Liberation and expansion of gas from oil-well fluids.*—It has been noted that the reservoir fluid expands as it flows, thus doing mechanical work; the expansion is due largely to liberation and expansion (as a gas) of the lighter hydrocarbons. If a true average sample of the fluid from the reservoir, or a point in the well, could be brought to the surface at its reservoir temperature and pressure, then expanded by reducing the pressure, varying the temperature to maintain the same pressure-temperature relations as those obtaining during the flow, and keeping all parts of the original fluid in contact and equilibrium (incremental or flash liberation), one could determine the mechanical energy that would be made available by expansion of the fluid if there were no differential movement of its liquid and gaseous parts.

The pressure-temperature relations, in the well at least, can be determined by traverses with temperature- and pressure-recording bombs, but maintaining corresponding relations during expansion at the surface presents practical difficulties. However, approximately the same result may be reached by proper interpretation of data from isothermal expansions of the fluid at different temperatures.

Generally under flowing conditions there is differential movement of gas and oil, so the liquid may not remain in contact with the gas evolved from it. Therefore, helpful experimental data may be obtained by pressure-volume measurements during expansion of a sample when the liberated gases are not allowed to remain in contact with the oil (differential liberation). The difficulty of obtaining representative samples must be met through technique and interpretation.

In connection with the Bureau's studies of solubility of gas in oil [34] Lindsly has developed high-pressure bombs by means of which he has obtained samples of fluid from points within wells and expanded them isothermally at different temperatures, using both incremental and

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[33] 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, 30 pp.; also published in Am. Petrol. Inst. Produc. Bull. 211, pp. 53–69.

Reistle, C. E., Jr., East Texas Production: Paper presented before American Petroleum Institute, Division of Production, Oklahoma City, Okla., Feb. 15–16, 1934, published in Oil and Gas Jour., Feb. 15, 1934, p. 50, under the title, "It Is Necessary to Limit Daily Production Rate in East Texas to Get Maximum Recovery", and in Oil Weekly, Feb. 26, 1934, p. 14, under author's title.

[34] Dow, D. B., and Reistle, C. E., Jr., Absorption of Natural Gas and Air in Crude Petroleum: Min. and Met., May 1924, p. 336.

Dow, D. B., and Calkin, L. P., Solubility and Effects of Natural Gas and Air in Crude Oils: Rept. of Investigations 2732, Bureau of Mines, 1926, 13 pp.

Mills, R. van A., and Heithecker, R. E., Volumetric and A.P.I. Gravity Changes Due to the Solution of Gas in Crude Oil: Rept. of Investigations 2893, Bureau of Mines, 1928, 15 pp.

Lindsly, Ben E., Preliminary Report on an Investigation of the Bureau of Mines Regarding the Solubility of Natural Gas in Crude Oil: Trans. Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol., 1931, pp 252–278.

Lindsly, Ben E., Solubility and Liberation of Gas from Natural Oil-Gas Solutions: Tech. Paper 554, Bureau of Mines, 1933, 65 pp.

differential liberation. Important work of this kind has been done in the East Texas, Oklahoma City, and other fields. As an indication of the quantity of energy that may be transformed by expansion of the fluids, Lindsly found that 328,800 foot-pounds of work was done by 1 cubic foot of gas-saturated East Texas oil when expanded isothermally at 90° F., with flash liberation, from 638 pounds per square inch to atmospheric pressure.

This work has developed data of importance—particularly in estimation of reserves—regarding the shrinkage of oil as the lighter hydrocarbons come out of solution. For example, the reduction in volume of East Texas oil, due to liberation of gas and thermal contraction as the oil moved from the reservoir to the surface, was found to be of the order of 20 percent. The expansion of the reservoir oil (undersaturated with lighter hydrocarbons), due to reduction of pressure from 1,400 to 755 pounds per square inch, was only about 0.6 percent.[35] In some fields the shrinkage has been found to be greater than in East Texas.

*Gaging and control of gas wells.*—In the study of flow from wells two extremes may be considered. The first is an artesian water well, in which action of gas is not involved; the second is a "dry-gas" well in which there is no liquid. The oil well is intermediate in that it produces a mixture of liquid and gas.

With proper interpretation, much information derived from these two extremes can be applied in studies of flow of the fluid mixtures produced from oil wells. The Bureau, in cooperation with the natural gas department of the American Gas Association, has made an extended study of the flow from gas wells. A method has been developed for determining and comparing capacities of wells, without waste of gas to the air, and data resulting from the study have been applied in many practical ways to increase efficiency and reduce waste in natural-gas production. Preliminary reports by Pierce and Rawlins have been published,[36] and a more complete discussion by Rawlins and Schellhardt is in preparation. The marked influence of this work, observable in the progress report of the American Petroleum Institute Topical Committee on Allocation of Production,[37] is ample evidence that the principles developed in it are not limited in application to production of natural gas.

*Flow and properties of natural gas.*—The Bureau, in cooperation with the natural gas department of the American Gas Association, has made an exhaustive study of the flow of natural gas through pipe lines. Preliminary reports by Johnson and Berwald[38] concerning this work are to be followed by a more extended treatment now in preparation. The Bureau has also studied flow of gas through

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35 Lindsly, Ben E., A Study of "Bottom-Hole" Samples of East Texas Crude Oil: Report of Investigations 3212, Bureau of Mines, May 1933, 28 pp.; also published in Am. Petrol. Inst. Produc. Bull. 211, pp. 40-52.

36 Pierce, H. R., and Rawlins, E. L., The Study of a Fundamental Basis for Controlling and Gaging Natural-Gas Wells. Part 1. Computing the Pressure at the Sand in a Gas Well. Part 2. A Fundamental Relation for Gaging Gas-Well Capacities: Repts. of Investigations 2929 and 2930, Bureau of Mines, 1929, 14 and 21 pp.

37 Work cited, footnote 20.

38 Johnson, T. W., and Berwald, W. B., Flow of Natural Gas through High-Pressure Transmission Lines: Rept. of Investigations 2942, Bureau of Mines, 1929, 18 pp.

Berwald, W. B., and Johnson, T. W., Factors Influencing Flow of Natural Gas through High-Pressure Transmission Lines: Rept. of Investigations 3153, Bureau of Mines, December 1931, 27 pp.

Johnson, T. W., and Berwald, W. B., Formulas for Designing Natural-Gas Pipe-Line Systems Consisting of Parallel Lines: Rept. of Investigations 3241, Bureau of Mines, 11 pp.

small orifices and other openings,[39] the viscosity of natural gas,[40] and the deviation of natural gases from Boyle's law.[41] The latter has been applied recently in estimating gas reserves and is an important factor in the accurate analysis of many problems.[42] All of these studies have developed principles and supplied data applicable to the broad study of fluid-energy relations.

*Flow through porous media.*—Considerable progress toward a better understanding of the characteristics of reservoir rocks and flow of petroleum fluids through them has resulted from research during the past few years.[43] As a part of its oil-recovery investigations,[44] the Bureau has given attention to the theory of flow through porous media and has experimented to develop constants for use in the various equations of fluid flow. This work is now being pressed forward as an integral part of the Bureau's study of fluid-energy relations. Closely related to it is the study of characteristics of producing beds.

*Properties of oil-gas mixtures.*—With adequate knowledge of the behavior of hydrocarbon mixtures, many factors, such as the pressure-temperature-volume relations for the fluids in a given well, can be approximated without specific tests. Such knowledge will also aid in extrapolating from specific tests to obtain data that cannot be determined by direct means. In this field the physical chemist can be of great assistance to the engineer.

Several valuable contributions along these lines have been made recently by research workers in other organizations.[45] Some of the problems are analogous to those which have been dealt with in the

[39] Rawlins, E. L., Flow of Air and Gas Through Small Orifices: Oil and Gas Jour., May 10, 1928, p. 111. Rawlins, E. L., and Wosk, L. D., Leakage from High-Pressure Natural-Gas Transmission Lines: Bull. 265, Bureau of Mines, 1928, pp. 23–31.

[40] Berwald, W. B., and Johnson, T. W., Viscosity of Natural Gas: Tech. Paper 555, Bureau of Mines, 1932, 34 pp.

[41] Johnson, T. W., and Berwald, W. B., Deviation of Natural Gas from Boyle's Law: Tech. Paper 539, Bureau of Mines, 1932, 29 pp.

[42] Hill, H. B., and Rawlins, E. L., Estimate of Gas Reserves of the Oklahoma City Field, Oklahoma County, Okla.: Rept. of Investigations 3217, Bureau of Mines, in cooperation with the State of Oklahoma, 1933, 54 pp.

[43] Muskat, M., and Botset, H. G., Flow of Gas Through Porous Materials; Physics, vol. 1, no. 1, July 1931, pp. 27–47.
Fancher, G. H., Lewis, J. A., and Barnes, K. B., Some Physical Characteristics of Oil Sands: Pennsylvania State Coll. Bull., Min. Ind. Exper. Sta., Bull. 12, 1933, pp. 65–171.
Wyckoff, R. D., Botset, H. G., Muskat, M., and Reed, D. W., Measurement of Permeability of Porous Media: Bull. Am. Assoc. Petrol. Geol., vol. 18, no. 2, February 1934, pp. 161–190.

[44] Mills, R. Van A., Chalmers, Joseph, and Desmond, J. S., Oil-Recovery Investigations of the Petroleum Experiment Station of the United States Bureau of Mines: Am. Inst. Min. and Met. Eng., Tech. Pub. 144, October 1923, discussion in Trans. Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol. in 1928–29, pp. 334–342.
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Taylor, Sam S., and Smith, H. M., Summary of Experimental Data on Laboratory Oxidation of Crude Oils with Particular Reference to Air Repressuring: Rept. of Investigations 3238, Bureau of Mines, 1934, 11 pp.

[45] Lacey, W. N., Experiments on Rates of Solution of Gas in Oil: Inst. Petrol. Technol., August 1931, p. 413.
Sage, Bruce H., Measurements of Viscosities of Liquids Saturated with Gases at High Pressures: Jour. Ind. and Eng. Chem., vol. 23, August 1931, p. 900.
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Lacey, W. N., Pressure-Density-Temperature Relations for the Methane-Propane System: Proc. California Natural Gasoline Assoc., vol. 9, no. 1, meeting of Jan. 5, 1934.
Sage, B. H., Lacey, W. N., and Schaafsma, J. G., Phase Equilibria in Hydrocarbon Systems: Ind. Eng. Chem., vol. 26, 1934, pp. 103 and 214.

Bureau's helium activities[46]—which are now conducted as a part of its Petroleum and Natural-Gas Division—although they involve different ranges of fluids and temperatures.

The Bureau of Mines has recognized the importance of physics and physical chemistry in studying pressure-volume relations and phase equilibria, the effect of dissolved lighter hydrocarbons on fluidity and other characteristics of the oil in the sands and wells, the viscosity of oil-gas mixtures, and similar problems. Therefore men specialized in these fields of research are coordinating their work with that of the Bureau's engineers in the study of fluid-energy relations.

## SUMMARY

Increased understanding of fluid-energy relations in petroleum deposits and in wells is needed to aid in solving many difficulties of the oil and gas industry. From an engineering standpoint, production of oil is a problem in flow of fluids, involving transformations of energy. Efficient use of the energy available from a natural petroleum reservoir will reduce costs of production and increase ultimate recovery.

The basic features of such fluid-energy relations are relatively simple, but the details are complex. Research has been in progress on many of the factors involved, but most of them still require intensive study. Further research is planned and will be correlated to bring each contribution of knowledge into its proper relation to others, in order that a broad view of the general problem may be obtained. With comprehensive knowledge of conditions underground and of the mechanics of flow through producing beds and up the well, the producer of oil and gas will be able to work more nearly in harmony with natural laws.

[46] Stewart, Andrew, About Helium: Information Circ. 6745, Bureau of Mines, 1933, 46 pp.

# NATURAL GAS

By E. B. Swanson and H. J. Struth [1]



Marketed production of natural gas in the United States in 1933 is estimated at approximately 1,480,000,000,000 cubic feet, having an aggregate value at points of consumption of about $375,000,000. Compared with the output of natural gas in 1932 this represents a drop of about 5 percent. It is noteworthy that the decline in natural-gas production in 1933 was considerably less than those in 1931 and 1932. Compared with actual production recorded for 1932 the decline

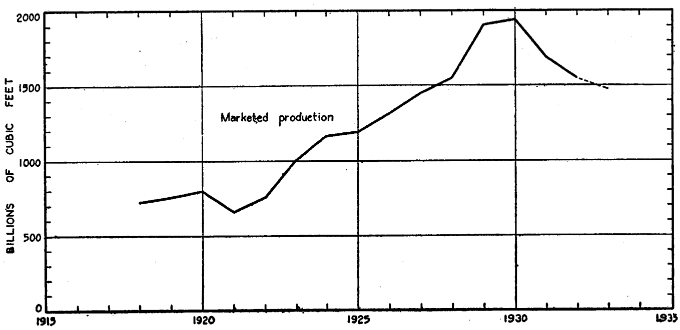


FIGURE 56.—Marketed production of natural gas, 1918–33. The figure for 1933 is subject to revision.

in 1933 was 76,000,000,000 cubic feet, whereas in 1932 the decrease from the preceding year was 130,000,000,000 cubic feet and in 1931 the drop from 1930 was 257,000,000,000 cubic feet. It is apparent, therefore, that the natural-gas industry showed some signs of recovery in 1933, primarily due to increased consumption of natural gas for industrial purposes. Figure 56 portrays the steady upward trend of natural-gas production to a peak in 1930 when the total output was 1,943,421,000,000 cubic feet. The figure also shows the tendency of the production curve to "flatten out."

[1] Technical adviser, Production and Refining Division, Petroleum Administrative Board.

Natural gas treated for the manufacture of natural gasoline apparently totaled about 1,384,000,000,000 cubic feet. Carbon-black plants consumed 186,781,000,000 cubic feet. Public-utility power plants consumed 102,601,000,000 cubic feet. Petroleum refineries apparently consumed as fuel about 70,600,000,000 cubic feet. The use of natural gas for fuel in oil- and gas-field operation is estimated to total about 450,000,000,000 cubic feet. Consumption of natural gas for all other industrial purposes probably aggregated 300,000,000,000 cubic feet.

Field developments in the natural-gas industry in 1933 showed a further decline. Total gas wells completed, as reported by annual statistics prepared by the Oil and Gas Journal, amounted to 932. This compares with 1,027 wells completed in 1932; 1,985 in 1931; 2,866 in 1930; and 2,870 in 1929.

The decline in development of new sources of natural-gas production coincided with a similar decline in development of oil production. However, a number of important gas-producing areas were opened to development in 1933, particularly in the Texas Gulf coast, east Texas, and Oklahoma fields. With posted prices of crude petroleum at an extremely low level during 1933 field developments in both oil and natural gas were retarded to lower levels than had been recorded in many years.

An encouraging upturn was indicated in industrial consumption of natural gas during 1933. An increase of about 19,000,000,000 cubic feet apparently was recorded in the consumption of natural gas for carbon-black manufacture during the year as compared with 1932. Increased processing of oil by refineries undoubtedly augmented the consumptionof natural gas in 1933 perhaps 3,000,000,000 cubic feet. At the same time, the preliminary figures disclose that the quantity of natural gas consumed by electric public-utility power plants declined somewhat more than 5,000,000,000 cubic feet. Although complete information was not available concerning the utilization of natural gas for domestic and commercial uses, it is believed that final figures will probably reveal a slight upturn over 1932.

Although efforts to reduce the waste of natural gas undoubtedly were continued in 1933 the industry was confronted with a serious problem in the Texas Panhandle, where legislation which permitted stripping of "sour" natural gas for the recovery of gasoline resulted in an unusually large quantity of gas being blown into the atmosphere. A report from Claude C. Brown, chief engineer of the California Railroad Commission, indicates that natural-gas wastage also increased in California during 1933, although declines had been recorded during several prior years. Explanation of the increase in gas wastage in California shows that it was influenced by tideland drilling in the Huntington Beach field.

Following are detailed reports of natural-gas developments for the various gas-producing States in 1933, as revealed by information from authoritative sources.

## RECENT NATURAL-GAS DEVELOPMENTS

*Arkansas.*—There were no new natural-gas developments in Arkansas in 1933. Only one test well was drilled. This well in the western part of the State in the center of SW¼ SW¼ sec. 6, T. 5 N., R. 17 W., Conway County, was drilled to 2,504 feet and temporarily abandoned. Drilling probably will be resumed.

No gas wells have been drilled in the southern part of the State, and the gas which has been produced and has been available for use in the coastal fields has almost disappeared. Cheap gas, however, is much in demand there for field operations.

*California.*—According to an annual summary of natural-gas developments in California for 1933, prepared by Calude C. Brown, chief engineer, California Railroad Commission, net production totaled 270,059,500,000 cubic feet. The report shows that wastage of natural gas increased after February 1933, resulting in a maximum waste during November of 1,713,300,000 cubic feet compared with 459,000,000 cubic feet in February. This was due primarily to the tideland drilling in the Huntington Beach field. Recorded wastege of natural gas in California for the entire year aggregated 12,183,600,000 cubic feet. This represented 4.52 percent of the total production.

Sales to utilities and others in 1933 were 157,206,600,000 cubic feet—58.21 percent of the total production. Other uses of natural gas were for field fuel, 38,381,100,000 cubic feet; refinery fuel, 4,995,000,000 cubic feet; repressuring and storage, 6,204,800,000 cubic feet; and gasoline-plant fuel and shrinkage, 51,088,400,000 cubic feet.

*Colorado.*—Field developments in Colorado during 1933 were retarded to a considerable extent. No new gas-producing areas of any consequence were reported during the year. Total production was probably slightly less than in 1932.

*Illinois.*—No gas wells supplying gas for commercial or industrial use outside of oil-producing leases were drilled in Illinois in 1933, according to Alfred H. Bell, geologist and head of the Oil and Gas Division, Illinois State Geological Survey. One well in the Jacksonville area, Morgan County, had an estimated initial open flow of 250,000 cubic feet per day. The producing horizon is a sandstone in Lower Pennsylvania strata, and the total depth of the well was 335 feet. This well has been capped and has not been connected to a pipe line. Two farm wells in this area, drilled in 1933 to depths of 306 and 315 feet, respectively, yielded enough gas for one house each from the above producing horizon.

In the Southeastern Illinois oil field, in which more than 90 percent of the natural gas of the State is produced, a gas well was drilled in Montgomery Township, Crawford County, to a depth of 898 feet. It had a closed pressure of 250 pounds. The producing horizon is the Robinson sand, of Pennsylvanian age. The gas is being used for power on adjacent leases.

*Indiana.*—There was less activity in the oil and gas industry of Indiana in 1933 than in previous years, according to W. N. Logan and Paul F. Simpson, of the Indiana Department of Conservation. The only oil development of any consequence was in Perry and Vanderburgh Counties in southwestern Indiana, while a few gas wells were brought in in Jay County in northeastern Indiana. Well completions in 1933 included 38 gas wells.

The shallow gas field in northern Knox County was extended north and east by several completions, and late in the year oil was found in commercial quantities. Two disappointing gas tests were made in the old Lyons field in Greene County, but from existing information the locations seemed poorly advised. Only small flows of gas were obtained in the Devonian limestone at about 1,800 feet.

The Francisco gas field in Gibson County was practically delineated to the east and south. Competitive property-line drilling, coupled with competitive production of gas, has practically ruined the field. Coning and rapid water encroachment have resulted in abandonment of many wells. Deepening of two wells to a horizon in the St. Louis limestone showed both oil and gas in paying quantities.

The Alford gas field in Pike County has been extended north and west, until at present it exceeds 3 miles in length. Production here comes largely from the brown sand of lower Chester age at about 1,100 feet in depth. Deeper drilling recently has shown encouraging results.

*Kansas.*—Of outstanding importance in Kansas natural-gas developments for 1933 was the Hollow pool in Harvey County, according to Kenneth K. Landes, assistant State geologist. This oil and gas pool was discovered in 1931 but was the scene of active drilling in 1933. In March this pool was extended to the north with the bringing in of a combination oil and gas well, showing an initial daily production of 1,000 barrels of oil and 10,000,000 cubic feet of gas. At the same time the Nikkell pool, which extends from northwestern Harvey County into southern McPherson County, and the Ritz-Canton field in McPherson County continued to be scenes of active drilling. These pools produced large quantities of gas in addition to oil.

Completion of a pipe line to the Otis Gas field in Rush County furnished a market outlet from that area. Due to lack of market outlets, there were no new developments in the gas field of Stevens County and adjacent counties in southwestern Kansas. This is rated the second largest gas field in the United States.

Records of the State Geological Survey of Kansas show that 31 gas wells were completed during the year, having an initial daily gas production of 357,289,000 cubic feet. This was a considerable decline from the initial production reported for 1932, although the number of wells completed was increased by one. Numerous oil wells completed in Kansas during 1933 were productive of natural gas.

*Kentucky.*—There has been little change in gas production in Kentucky during 1933, which possibly was a little less than that in 1932 (between 26 and 27 billion feet, according to Arthur C. McFarlan, State geologist).

The bulk of the production comes from eastern Kentucky. About 71 percent of the total comes from the black shale of Floyd County and vicinity, apparently not restricted to any one horizon. The "Corniferous", including undoubtedly beds of Silurian age, 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. The "Big Lime", of Knox County and vicinity, and the Maxon sand, of Pikeville and vicinity, produced respectively about 7 and 6 percent of the total. Other producing sands include the "Salt Sand" (Pennsylvanian), 4 percent; the "Wier" (Waverly) of Magoffin, Johnson, and Lawrence Counties, 2 percent; the "Big Injun" (Waverly), 1 percent; and a small amount from the Berea. Western Kentucky produced perhaps a quarter billion feet, the producing sands in order of importance being the

Sebree (Caseyville), Barlowe, Jett (Chester), a gas horizon in the base of the Ohio shale, and an unimportant amount from the Trenton.

*Louisiana.*—Natural-gas production in Louisiana during 1933 totaled 193,202,645,000 cubic feet, according to Dr. J. A. Shaw, director, Minerals Division, Louisiana Department of Conservation. This was slightly less than the production reported for 1932. The Monroe gas field continued to be the largest producing area in the State, showing a total output in 1933 of 113,424,295,000 cubic feet. The Richland gas field produced 56,449,103,000 cubic feet.

The carbon-black industry of Louisiana was the largest industrial consumer of natural gas, using in 1933 a total of 40,865,000,000 cubic feet. A survey of the Monroe field as of October 20, 1933 showed that this area had an open-flow capacity of 4,823,220,000 cubic feet. A similar survey of the Richland field indicated an open flow of 1,787,475,000 cubic feet. The combined open-flow capacity of the Northeast Louisiana gas field as of October 20, 1933 was reported at 6,738,865,000 cubic feet.

*Michigan.*—Natural-gas production in Michigan was reported for 1933 at 1,697,628,000 cubic feet, according to F. R. Frye, petroleum engineer, Michigan Department of Conservation. This compares with 1,405,880,000 cubic feet reported in 1932.

The most important natural-gas development in Michigan was the discovery of a new gas field about 7 miles southeast of Big Rapids, Mecosta County. Four wells were drilled with open flows ranging from 4,000,000 to 27,500,000 cubic feet daily.

In August and September 1933 natural gas was turned into the lines of Saginaw and Bay City and other small communities formerly serviced by artificial gas. At the close of the year 21 cities and towns and 27 townships had natural-gas service, and there were 60 producing gas wells—20 in the Muskegon field, 17 in Broomfield, 8 in Vernon, 7 in Clare, 4 in Austin, and 4 in Ashley.

Development statistics show that 10 gas wells were completed in Michigan during 1933; 6 producing gas wells were completed in Isabella County and 4 in Mecosta County. The combined open flow of these wells is rated at 57,129,000 cubic feet.

*Mississippi.*—Natural-gas production in Mississippi during 1933 aggregated 9,557,962,000 cubic feet, according to George C. Swearingen, Mississippi State oil and gas supervisor, compared with 9,847,907,000 cubic feet in 1932. The Jackson field contributed 9,375,972,000 cubic feet, while the Amory field, with three wells, produced 181,990,000 cubic feet.

The Jackson area comprises 6,697 acres and is reported to have an open-flow capacity of 4,164,781,000 cubic feet. At the end of 1933 this field had 124 producing gas wells, whereas the total number of wells drilled on the Jackson structure was 169.

*Missouri.*—The development of gas in the comparatively shallow sands and, in some instances, black shales of the Des Moines group of Pennsylvanian age in western Missouri has continued during 1933, according to H. A. Buehler, State geologist.

The Hammon pool north of Plattsburg in sec. 18, T. 55 N., R. 31 W. and sec. 13, T. 55 N., R. 32 W., Clinton County, was opened to production, and 13 wells were completed. The initial production of the largest well was reported to be 2,332,000 cubic feet.

A new gas pool also was opened in sec. 3, 4, 9, and 10, T. 47 N., R. 33 W., Jackson County. Four wells were completed in 1933, the largest having an initial production of 1,000,000 cubic feet.

In the same county extensions of pools were also reported in the Independence area, and two wells were completed in the limits of Kansas City at a depth of 700 feet. Production was found in a sand in the lower part of the Cherokee formation which has heretofore been nonproductive in this area.

In Cass County the Shaler area, in sec. 27 and 34, T. 44 N., R. 33 W., was marked by several extensions, the largest of the new wells having a reported initial production of 300,000 cubic feet.

*Montana.*—No new gas fields were discovered in Montana during 1933, according to Dr. Eugene S. Perry, on the staff of the Montana School of Mines. Four additional wells were drilled in the Cut Bank gas field, and gas was encountered in several wells drilled in the Cut Bank oil field, incident to the drilling of oil wells. Gas was found in the Dry Creek field in an upper horizon, incident to drilling for oil in that field.

No new gas pipe lines have been built, and no new extensions of importance to existing gas pipes have been made.

The fields producing and marketing natural gas in Montana are as follows: Kevin-Sunburst, Cut Bank, Sweetgrass Hills, Bowes (Havre), Bowdoin-Saco, Dry Creek, Hardin, Baker-Glendive. Red Coulee or Border field (closed), and Lake Basin (closed). Several isolated wells yielding gas have been drilled elsewhere, the most important of which is near Devon, about 20 miles east of Shelby.

*New Mexico.*—Wildcatting in New Mexico in 1933 was at low ebb., according to E. H. Wells, State geologist, and no important new gas fields were discovered. The Jal field in Lea County, only a few miles from the southeastern corner of the State, continued to be the largest producer. This gas is found in the Carlsbad (Permian) formation at depths of 3,200 to 3,400 feet, and several wells have a daily potential of 50,000,000 to 90,000,000 cubic feet. It is associated with considerable oil in part of the field, and both oil and gas were produced commercially from a number of wells. Most of the production, however, was from regular gas wells. Prior to 1933 the gas was piped to El Paso, Tex.; Deming, N.Mex.; Douglas, Bisbee, and Warren, Ariz.; and Cananea, Mexico. In 1933 pipe lines were extended to Tucson and Phoenix, Ariz., and a branch line was constructed to the refinery of the United States Potash Co. near Carlsbad, N.Mex.

In the Hobbs field, Lea County, the most important oil field in the State, the oil is associated with large quantities of gas, but the gas is conserved as much as possible. Most of the gas produced in flowing the wells was treated at plants in the field and the natural gasoline content saved. Some of the gas from this field was utilized locally and at Lovington, Lea County.

In the Artesia-Jackson-Maljamar area, Eddy County, two small gas wells were brought in during the year in the Leonard & Levers field. Gas from this area was utilized in Roswell, Artesia, Carlsbad, and other towns in the Pecos Valley.

There were no important gas developments in San Juan County during the year. The Kutz Canyon field and the Southern Ute dome continued to supply gas to Farmington, Albuquerque, and Santa Fe in the State and to Durango, Colo. The gas of the Kutz Canyon field occurs in the Pictured Cliffs (Cretaceous) sand at a depth of about 2,000 feet, and the largest well was rated at 4,050,000 cubic feet. At the Southern Ute dome the gas comes from the Dakota sand at depths of 2,300 to 2,500 feet. Several wells have been drilled, the largest having a potential of 70,000,000 cubic feet a day.

*New York.*—The search for new sources of natural-gas supply was active in 1933, according to D. H. Newland, State geologist, although exploration of the Oriskany sandstone in the southern tier of counties no longer claimed chief attention. After the Wayne-Dundee field was brought in during 1930, the area south and west in Schuyler, Steuben, and Allegany Counties, which holds continuation of the structures found in that district, was for a time given precedence by well drillers, but no discovery comparable to the first one has been reported so far. In the town of Greenwood, Steuben County, a structure has been partly proved by three wells, of which two gave a fairly large yield from the Oriskany and the third showed salt water only. Three additional wells are planned to test the importance of the find. The locality is some 10 or 12 miles south of Hornell, a convenient market for the output. The Rathbone field, west of Corning in Steuben County, continued to produce from shallow wells in the Chemung beds, but little interest in new drilling was apparent. Reports show 28 wells in the field, of which 25 are listed as producers with 1 well yielding small amounts of amber oil.

In Allegany County, town of Allen, the Oriskany horizon has been explored by six holes, each about 3,000 feet deep. The best well is said to have tested 1,500,000 cubic feet, with a rock pressure of 1,300 pounds and 3 to 4 barrels of oil. Two of the holes were dry. In the Scio fields, Allegany County, a deep test found the Oriskany sandstone at 4,098 feet and was abandoned at 4,103 feet.

Deep tests are in progress in Cattaraugus County near the Pennsylvania State line. Two wells are now down below 4,000 feet.

The new Geneva field, at the foot of Seneca Lake just north of the city of Geneva, attracted much interest because of the number of producing wells brought in and the large indicated flows of some of the wells when first opened. The discovery well was completed in August 1932; altogether 55 have been reported as completed to date, and 5 more are in progress. The number of producers listed is 32, with individual flows as high as 20,000,000 cubic feet. The gas comes from the Niagara or Lockport dolomite, a new horizon for New York State but one that is known to be gas-bearing in Ontario. A few wells were drilled to the Medina below without additional results, and one test 4 miles north of the field went into the Trenton at 4,000 feet, also dry. The average depth of the Lockport here is 900 to 1,000 feet. The estimated daily flow of the wells, based on unit rock pressure, exceeds 125,000,000 cubic feet. It would appear that the field may be overdeveloped, considering the relative depth and spacing of the wells, but as no service connections have been made the final test is yet to come.

At Clyde, Wayne County, 12 miles northeast of the Geneva field, seven wells were put down which explored successively the Lockport, Medina, and Trenton formations. The first test came in with a flow estimated at over 3,000,000 cubic feet at a depth of 2,730 feet, in the Trenton. The flow fell off notably when other wells were drilled in the vicinity. Of the seven holes two were listed as dry, and the others may be classed as small producers.

Outside the more favored territory for gas exploration were the tests made in Montgomery, Oneida, and Lewis Counties bordering the Adirondack pre-Cambrian region. Only small showings resulted from the tests, but the well drilled at Oneida Valley, Oneida County, proved of unusual geological interest in that the whole Paleozoic section from the Clinton sandstone down through the Potsdam was penetrated, also about 375 feet of pre-Cambrian formations. The latter consisted of quartzite, schist, and crystalline limestone, representative of the Grenville series, not reported heretofore in any similar tests outside of the Adirondacks. All other holes that have penetrated below the Potsdam were reported as bottomed in granite. The Grenville series was encountered at about 2,420 feet and drilled into for 375 feet, the total depth being reported as 2,795 feet. Some gas was found in the Trenton and a further small supply in the pre-Cambrian, according to the driller's statement. The presence of natural gas in the Adirondack crystalline limestone (Grenville series) was first noted some years ago in the zinc mines at Edwards, St. Lawrence County.

*Ohio.*—Natural-gas developments during the past year in Ohio consisted chiefly of extending the boundaries of known fields, according to R. E. Lanborn, assistant geologist, Geological Survey of Ohio. The most concentrated activity has occurred in Stark County, where the Canton pool has been extended nearly to the eastern edge of Plain Township, and the limits in this direction apparently have not been reached as yet. The gas is obtained from the Clinton sand at depths ranging from 4,300 to 4,500 feet. The initial production of wells ranges from a few hundred thousand to 7,000,000 cubic feet per day and the rock pressures from 1,200 to 1,400 pounds. Substantial additional production has also been obtained from the Clinton sand in Lorain, Median, and Muskingum Counties. Exploratory wells have been drilled east of the producing areas to the Clinton horizon in Portage, Columbiana, and Carroll Counties.

No new shale-gas fields have been discovered. Some additions have been made to shale-gas production in Rome and Union Townships, Lawrence County, but the northern limits of this field are not known to have been reached. Minor extensions worthy of mention have been made in fields producing from the Berea and shallower sands in Belmont, Columbiana, and Meigs Counties.

*Oklahoma.*—On the basis of natural-gasoline production recorded for Oklahoma during 1933 it is estimated that the total output of natural gas for the State during the year was 240,000,000,000 cubic feet, which compares with an actual production in 1932 of 255,000,000,000 cubic feet—a decline of about 15,000,000,000 cubic feet.

Fewer wells were completed in 1933. Reported well completions aggregated 72 as against 106 in 1932. Although development of natural gas was retarded in Oklahoma to some extent in 1933, it is significant to note that a number of new pools augmented the State supply.

Southern Pontotoc County was opened to commercial gas development in 1933. Several large gas wells were completed in this area toward the end of the year.

The Oklahoma City pool continued to furnish a number of spectacular gas wells during the year, although drilling was retarded considerably in that area. Estimates made by engineers of the United States

Bureau of Mines showed that the Oklahoma City field contains a reserve of perhaps 95,000,000,000 cubic feet of natural gas.

Among the important pools producing both oil and gas under development in 1933 were the Crescent in Logan County, Keokuk Falls in Northern Seminole County, West Chandler in Lincoln County, West Holdenville in Hughes County, and the Tatums in southern Oklahoma.

The West Holdenville pool was reported to have 24 producing gas wells at the close of the year showing a combined open-flow gas volume of 425,000,000 cubic feet. The Tatums pool was extended 3 miles in the latter part of the year by a well reported to have an initial production of 30,000,000 cubic feet.

*Pennsylvania.*—Northern Pennsylvania continued to be the center of exploratory activity in 1933, although operations were decidedly curtailed, according to S. H. Cathcart, of the Pennsylvania Geological Survey. Gas was found in the Oriskany sand at two additional localities in Potter County, and it is not improbable that these finds may lead to the development of new fields.

In northern Potter County the Moran well, 4,879 feet deep, found the Oriskany sand at −2,788 feet and had an initial open-flow volume of 8,000,000 cubic feet at 1,950 pounds rock pressure. The well flowed much salt water with the gas. This well is on the Smethport anticline but is not definitely known to produce from a closed structure. No attempt has been made to produce the well or to prospect the locality further.

In southern Potter County two wells have been completed on a dome on the Marshlands anticline. These wells are 6,425 and 6,023 feet deep and have Oriskany sand at −4,344 and −4,396 feet, respectively. Both wells are small, the maximum yield being about 250,000 cubic feet.

At Hebron field, Potter County, 10 wells were completed in 1933; 5 were successful and 5 failed. In addition, 2 wells south of the axis were abandoned above the sand. Initial volumes ranged from 12 to 33 million and initial rock pressure from 2,005 to 2,120 pounds per square inch. Total initial volume for the 5 wells is 86,500,000; of the dry holes, 1 encountered salt water and 3 on the southwest end of Hebron dome about 5½ miles from the nearest producing well found the sand to be absent, confirming the results of a well drilled on that part of the structure in 1932.

The outstanding field development of the year was the result of two wells drilled in the anticline about 6 miles northeast of the proven area. One found salt water at −3,521 feet; the other, 1,200 feet northwest, is a 13,000,000 cubic-foot well at −3,030 feet. This find may represent a separate pool. The two wells are on opposite sides of a fault that at the main pool is suggested by surface data and excessive depth of the Oriskany in wells drilled south of the axis of the fold.

The total number of completions in this field on December 31, 1933, was 19, of which 12 were productive and had an aggregate initial volume of 168,000,000 cubic feet a day. The probable productive area of the field cannot yet be estimated. An area of about 6 square miles, in which effective closure is about 150 feet, has been proven; the extent of the capable sand to the southwest and of connection with the producing well 6 miles northeast has yet to be demonstrated.

In 1933 pipe-line facilities of the field were increased by completion of a 10-inch line connecting with a 20-inch line from Tioga field to Syracuse, N.Y., and by an 8-inch line connecting the field with a gathering system.

Only 5 wells were drilled in Tioga field during the year; 2 were successful and 3 dry. The gas wells had initial volumes of 3,360,000 and 25,000,000 cubic feet at 1,460 and 1,440 pounds rock pressure; the dry holes were marginal wells, of which two produced salt water. The total number of gas wells in the field on December 31, 1933, was 43, and the aggregate daily initial volume of the wells was about 648 million cubic feet. The field is about half drilled.

Tioga field is on a faulted structure. Basing subdivision upon response of rock pressure to gas withdrawal, the field is known to consist of three pools, closure in which is 100, 285, and 320 feet. The sand averages about 45 feet in thickness and has an average porosity of about 9 percent. The proven area is about 7,000 acres, and the original content of the sand is estimated to have been about 62 billion cubic feet. On September 1, 1933, about 10 billion cubic feet had been withdrawn.

Exploration was limited to Tioga, Potter, McKean, and Cameron Counties. One well on the Charleston dome, Wellsboro anticline, Tioga County, found 44 feet of capable sand in structurally high position but was dry. In Potter County, a well on Sweden Valley dome, Harrison anticline, found the Oriskany sand absent; another on Ulysses dome on the same anticline found 10 feet of fine, tight sand. In McKean County, one well was drilling on Hamlin dome, Smethport anticline, and two wells were drilling on Knapp Creek dome, Bradford anticline, just across the New York State line. Two wells were drilling on Shippen dome, Harrison anticline, in Cameron County.

Gas in the Oriskany sand appears to be closely related to structurally high areas. In the Plateau region of northern Pennsylvania, from McKean and Elk Counties east to the Delaware River, there are about 1,000 miles of anticline on which are recognized 35 domes suitable for gas accumulation. By December 31, 1933, 4 of these domes had proven productive, 11 wells that may have been satisfactory, tests on 8 other domes were unsuccessful, and 3 wells were drilling on 2 additional domes.

*South Dakota.*—There were no new natural-gas developments in South Dakota during 1933, according to E. P. Rothrock, State geologist. The small production for farm and town consumption continued but no new gas wells were brought in. The only towns supplied with natural gas produced within the State are Pierre and Fort Pierre.

*Tennessee.*—There were no new natural-gas developments in Tennessee during 1933, according to Walter F. Pond, State geologist. The small fields at McMinnville and Cookeville are still producing, also the Sunbright area. There has been no more development in the Harpeth Valley area in Dickson County. The pool discovered in 1932 on Long Branch in eastern Macon County has not been drilled farther although there is considerable interest in it. The Smithland field in Lincoln County, from which gas was piped into Fayetteville, has dropped off to such an extent that butane gas was installed. The pressure in this field seems to be building up a little, and may be reexamined and redrilled.

*Texas.*—Estimates of natural-gas production for Texas during 1933 indicate an aggregate output of about 446,000,000,000 cubic feet, representing a decline of possibly 11,000,000,000 cubic feet from 1932.

Well completions numbered approximately 140 in 1933 for all producing areas of the State compared with 167 in 1932. Gas-well completions were recorded principally in the Gulf coast area, which accounted for 26, of which 10 were brought in in the new Tomball area and 6 in the Conroe field. The southwest Texas area contributed 52 gas wells, while the east Texas area recorded 4 gas-well completions. Incidentally, the east Texas completions showed a considerable decline from 1932, when 13 gas wells were completed.

A number of important gas-producing areas were brought into commercial production during 1933, particularly in the Gulf coast area. These included such fields as Tomball, Livingston, Louise, Pledger, Greta, O'Conner-McFadden, and Raisin.

Field developments in the Tomball area indicated that approximately 10,000 acres might be highly productive of natural gas.

The Ariola field also showed possibilities of being highly productive of gas through a blow-out encountered in a well drilling at a depth of about 4,200 feet. This well was reported to have made 25,000,000 cubic feet daily while out of control.

The Long Lake area particularly attracted development in 1933 due to the discovery of natural gas in shallow wells. Estimates indicate the possibility of 4,000 to 5,000 acres in this area being highly productive of natural gas.

Preponderance of gas similar to that at Long Lake was also indicated in 1933 by oil developments in Leon County, where geologists estimated a possible productive area embracing about 15,000 acres.

The southwest Texas area continued to show a potential gas supply far in excess of market requirements. Drilling was slowed down considerably in this area during 1933. Gas production at both Bethany and Waskom declined from the 1932 output, while drilling in these fields was held at a minimum.

The waste of natural gas in the Texas Panhandle reached alarming proportions during 1933 and caused wide-spread appeals for action by the State legislature to nullify the gas-stripping law. Estimates compiled by leading independent agencies in the State, as well as records obtained by the Texas Railroad Commission, showed that the waste of natural gas in the Panhandle increased by leaps and bounds during 1933; in fact, by the end of 1933 it was indicated that gas waste in this area had attained a total volume of a billion cubic feet daily. In view of the fact that the Panhandle gas area is probably one of the largest reserves of gas in the United States the blowing of natural gas into the air incident to the manufacture of natural gasoline was shown to be shortening the productive life of this area to an alarming degree.

*Utah.*—Field developments in Utah during 1933 were retarded to a considerable extent. No new gas-producing areas of any consequence were reported during the year. Total production was probably slightly less than in 1932.

*Washington.*—The only commercial development of natural gas in Washington is in the area known as Rattlesnake Hills in Benton County, where 15 commercial wells are located, according to R. B. Newbern, T. A. Rogers, and M. S. Hurwirtz, in cooperation with the Washington Division of Geology. All but one of these wells produce gas from two levels, the lower one some 200 to 250 feet below the upper. On account of low pressure gas is piped to a compressor plant and thence distributed to seven towns in the Yakima Valley between Toppenish and Prosser.

The total measured production for 1933 was 108,000,000 cubic feet, an increase of nearly 3,000,000 cubic feet over the 1932 production, representing an average daily production of some 297,000 cubic feet. For both years additional amounts, unmetered, were utilized for lease operations, compressors, and minor uses.

The low pressure of the gas in these wells continues to be a surprising feature. The maximum pressure recorded (32 ounces) has not been met for at least many months, and the present pressure appears to lie from zero to below zero. Variation of this amount and character seems to bear no relation to the pumping operations.

This field lies in the midst of the vast plateau of Columbia River lavas. It is frankly considered a freak field, because production is from flows of basalt and igneous rock. Although this area obviously is superficially unfavorable for the development of oil or gas, the known occurrence of natural gas has stimulated structural and stratigraphic investigations, both by private and public agencies. Close cooperation is maintained between the private operators and the investigators in the Division of Geology, and accurate delineation of structures may be possible in the relatively near future.

Great interest attached to the present deepening of one of the producing wells in an attempt to locate the true source bed of the gas, which is thought to lie below the igneous rocks. This well is at present at a depth of 1,870 feet. In view of the widely divergent hypotheses held as to the source and origin of the gas, completion of this test will add materially to data already available.

The test, which is being conducted at Union Gap, just south of Yakima, is below 3,000 feet but is now idle. This is an attempt to test a well-defined structure which shows in the Columbia basalt at the surface. Showings of gas in the hole indicate the possibility of commercial production.

The occurrence of natural gas is also considered a possibility in the lower Wenatchee Valley. A test is under way in the Wenatchee Heights district; the well is now below the 900-foot level. This test has been located on the basis of careful geologic work which demonstrated the presence of promising structures. The petroliferous content of the rocks is indicated by the presence of several natural-oil seeps, and the hope is entertained that the test may show the presence of either oil or gas.

In addition to these and other tests in eastern Washington, equally important investigations are under way west of the Cascade Mountains. One of the most promising, on the basis of present showings, is the well at Forks in western Clallam County. Here a test, now reported well below 2,300 feet, is being carried deeper in the expectation of testing conclusively the possible gas production of the sands of any Tertiary zones that may be present. A large amount of work has been undertaken in the Olympic Peninsula in the past few years, and the presence of a thick series of Tertiary marine sediments in the marginal belt surrounding the central core of the Olympic Mountains may be proved.

Within the past year a shallow gas zone has been roughly outlined in western Whatcom County in the immediate vicinity of Bellingham. Here, at a depth of approximately 170 feet, gas has been found in a number of tests. Pressures up to 50 pounds have been reported, and the potential yield has been variously estimated, but no extensive measurement for long-continued flow has been made. Although it is not demonstrated that this shallow gas has great commercial importance, its significance in connection with the possibility of deeper gas or oil is obvious. Detailed structural studies now underway are expected to yield reliable information as to locations for deep tests.

To summarize the numerous tests now in progress in carefully located sites mark an advance in the examination of the State for its commercial gas resources. There is as yet no basis for any statement of potential production, but evidence is accumulating continually that seems to warrant belief in the ultimate discovery of important gas resources.

*West Virginia.*—Well completions for the year totaled 309, including 181 gas wells averaging about 550,000 cubic feet each of daily initial production, 74 oil wells averaging nearly 115 barrels each of daily initial production, and 54 dry holes, according to Reitz C. Tucker, assistant geologist, West Virginia Geological Survey. The gas wells ranged in size from 60,000 to 7,700,000 cubic feet daily, while the oil wells ranged in size from 1 to 1,600 barrels daily. Drilling depths ranged from 522 to 5,398 feet.

The large initial oil production was from 31 wells completed in the Lost Run oil pool of Ritchie County, the discovery well being completed early in March 1933. The wells averaged about 255 barrels initial production. Depths in this pool range from about 1,750 to a little over 2,000 feet. The production is from the Big Injun sand.

The largest gas well in the State in 1933 was completed early in August in Guyandot district, Cabell County, with an initial daily production of 7,700,000 cubic feet from the Brown shale at a depth of 2,807 feet.

Production apparently increased considerably in 1933 owing to the severe weather experienced in the State. Plenty of gas was available to supply all demands.

*Wyoming.*—Field developments in Wyoming during 1933 were retarded considerably. According to information obtained from Pierre LaFleiche, mineral supervisor of the State of Wyoming, the chief gas development from a discovery area during 1933 was on Government land in the Allen Lake structure, Carbon County. It is stated that a new gas line is being laid from Allen Lake to Rock Creek, and from there the gas is being transported from the old Illinois oil pipe line to Laramie.

Several "sweet" gas wells were completed in South Baxter Basin, adding to the supply available for a line running to Salt Lake City. A gas well was drilled 2 miles south of the town of Douglas in Converse County, obtaining a flow of some 600,000 cubic feet from a depth of 121 feet, with a rock pressure of 24 pounds. This gas is coming from the base of the White River formation.

Although information on the total production of natural gas in Wyoming during 1933 was not available final figures probably will show a slightly lower output than in 1932.

# NATURAL GASOLINE

By G. B. SHEA

SUMMARY OUTLINE



Production of natural gasoline declined in 1933 for the fourth consecutive year, but the rate of decline was greatly retarded. Refinery consumption was the lowest since 1925, as vapor-recovery gasoline from cracking and reforming operations continued to make inroads on the refiners' need for natural gasoline. An encouraging development, however, that has marked a definite check in the rapid expansion of cracking and reforming was the licensing of the use of ethyl fluid in regular station gasoline. In the short time that it has been operative, the increasing use of ethyl fluid to increase antiknock properties in lieu of cracking has exerted a favorable influence on refinery purchases of natural gasoline to obtain volatility.

There was a notable reduction in exports and sales to jobbers during the year. Unsettled conditions in the motor-fuel market during the first half of the year tended to discourage jobber purchases of natural gasoline, but the drop in production greater than that in refinery demand was an even greater factor in reducing the volume moved into the motor-fuel market through the jobber route. The drop in refinery consumption was only one-third of that in production, and this favorable turn of the factors of supply and demand tended to reduce the volume of distress natural gasoline which otherwise would have been forced into the motor-fuel market.

Wide fluctuations in prices, with low levels prevailing during the first half of the year, characterized 1933. Unfavorable conditions in the refinery-gasoline market during the spring months, with attendant low net returns to Mid-Continent and Gulf Coast refiners, were responsible for an abnormally low refinery demand for natural gasoline, and the price of 26–70 grade dropped to an all-time low of 1 cent per gallon in Oklahoma and Texas. In the summer and fall conditions became more stable, and prices advanced sharply under the stimulus of heavy refinery buying. The quotation for the 26–70 grade reached 5¾ cents per gallon, the highest since 1930.

The following table summarizes salient statistics of the natural-gasoline industry for 1932 and preliminary figures for 1933.

*Salient statistics of the natural-gasoline industry, 1932–33*

[Thousands of gallons]

| | 1932 | 1933 [1] | Increase (+) or decrease (−) |
|---|---|---|---|
| Production: | | | *Percent* |
| Appalachian | 60, 700 | 59, 200 | −2. 5 |
| Indiana, Illinois, Kentucky | 9, 400 | 8, 100 | −13. 8 |
| Oklahoma | 378, 600 | 359, 700 | −5. 0 |
| Kansas | 24, 800 | 22, 900 | −7. 7 |
| Texas | 371, 100 | 359, 400 | −3. 2 |
| Louisiana | 46, 200 | 38, 100 | −17. 5 |
| Arkansas | 18, 700 | 15, 000 | −19. 8 |
| Rocky Mountain | 62, 400 | 56, 200 | −9. 9 |
| California | 551, 900 | 493, 000 | −10. 7 |
| Total production | 1, 523, 800 | 1, 411, 600 | −7. 4 |
| Stocks: | | | |
| At plants Jan. 1 | 27, 070 | 18, 840 | −30. 4 |
| At plants Dec. 31 | 18, 840 | 27, 584 | +46. 4 |
| Net change | −8, 230 | +8, 744 | |
| At refineries Jan 1 | 91, 266 | 115, 416 | +26. 5 |
| At refineries Dec. 31 | 115, 416 | 106, 134 | −8. 0 |
| Net change | +24, 150 | −9, 282 | |
| Total, Jan. 1 | 118, 336 | 134, 256 | +13. 5 |
| Total, Dec. 31 | 134, 256 | 133, 718 | −0. 4 |
| Net change | +15, 920 | −538 | |
| Total supply [2] | 1, 507, 880 | 1, 412, 138 | −6. 3 |
| Distribution: | | | |
| Blended at refineries: | | | |
| East Coast | 26, 922 | 46, 578 | +73. 0 |
| Appalachian | 15, 834 | 9, 954 | −37. 1 |
| Indiana, Illinois, Kentucky | 78, 078 | 74, 970 | −4. 0 |
| Oklahoma, Kansas, Missouri | 203, 574 | 207, 816 | +2. 1 |
| Texas Inland | 136, 416 | 142, 968 | +4. 8 |
| Texas Gulf | 134, 442 | 105, 504 | −21. 5 |
| Louisiana Gulf | 35, 028 | 11, 928 | −65. 9 |
| Arkansas, Louisiana inland | 33, 768 | 17, 094 | −49. 4 |
| Rocky Mountain | 41, 622 | 34, 398 | −17. 4 |
| California | 347, 718 | 358, 428 | +3. 1 |
| Total blended at refineries | 1, 053, 402 | 1, 009, 638 | −4. 2 |
| Blended at plants [3] | 2, 043 | 5, 505 | +169. 5 |
| Run through crude-oil pipe lines in California | 52, 542 | 54, 054 | +2. 9 |
| Exports, sales to jobbers, etc | 236, 460 | 199, 217 | −15. 8 |
| Losses | 163, 433 | 143, 724 | −12. 1 |
| Total distribution | 1, 507, 880 | 1, 412, 138 | −6. 3 |

[1] Subject to revision.
[2] Production plus or minus changes in stocks.
[3] East of California.

## POSITION OF NATURAL GASOLINE IN THE MOTOR-FUEL MARKET

Wedged between the oil producer and the refiner, the natural gasoline manufacturer's position is controlled by the activities of both. The supply of raw material depends largely upon operations of the producer of crude oil, and the return on the product is determined largely by operations of the refiner.

Natural gasoline constitutes a significant part of the total motor-fuel supply, since the output finds its way into the motor-fuel market in one form or another regardless of refinery demand. Although the normal route to market is through the refinery, production not taken by refiners is moved through jobbers. With refinery consumption comprising such a large share of the total market, however, fluctuations in refinery demand are reflected promptly in marketing and price structures of natural gasoline. As the average storage capacity at natural-gasoline plants does not exceed 10 days' production, the price of natural gasoline is extremely sensitive to market demand, and curtailment in refinery demand results almost immediately in a distressed natural-gasoline market, which in turn has a detrimental effect on the motor-fuel market. Under present conditions it is difficult to retain the refinery market and maintain prices. Because of the highly seasonal demand for natural gasoline, prices rise throughout the summer and early winter and decline during the late winter and spring. Efforts are therefore being made to stabilize the natural-gasoline market by adopting a fixed ratio between gasoline production and purchases of natural gasoline.

*Production.*—All but a small part of the supply of natural gasoline depends on oil production. Consequently, the output was affected by the continued curtailment of crude-oil production in nearly all fields of the United States. Furthermore, depletion of the producing horizons has resulted in a natural decline in available gas, particularly in the older fields. These factors, together with the reduction in yield as a result of manufacturing a large percentage of lower-vapor-pressure gasoline, brought the output of natural gasoline down to 1,411,600,000 gallons in 1933, a decrease of 7.4 percent compared with 1932 and of 36.8 percent compared with peak production in 1929. Principal trends in the industry are shown graphically in figure 57.

Declines were recorded in all States except New Mexico and Pennsylvania, although substantial increases were reported in the East Texas and Oklahoma City fields and in the Huntington Beach field in California. Approximately 60 to 65 percent of the total output was produced by integrated companies, 20 percent by nonintegrated companies, and 15 to 20 percent by gas-utility companies.

The trend toward larger but fewer plants, prevalent since 1928, continued during 1933. Adverse marketing conditions in the first half of the year, however, retarded activity in new plant construction and in many instances necessitated shutting down marginal plants. The improved market in the last half of the year encouraged building of plants in some fields, and as the year closed more construction was in progress than at any time during the past 2 years. The number of new plants, however, was not large.

*Trend of stocks.*—The year opened with 134,256,000 gallons of natural gasoline in storage at refineries and plants and closed with 133,718,000 gallons, a net reduction of 538,000 gallons. Of this reserve 27,584,000 gallons were held at plants, and 106,134,000 gallons were in storage at refineries. Despite an abnormal seasonal shrinkage in demand during the spring and early summer months stocks that accumulated during that period were not burdensome. As usual, a high point was reached in late spring, and on June 1, stocks were 166,270,000 gallons. Liquidation of stocks at both plants and refineries was effected throughout the balance of the year, and December closed with refinery stocks of natural gasoline off 9,282,000 gallons, although stocks at plants were up 8,744,000 gallons for the year. Of the total supply of natural gasoline in storage in the country at the end of the year, 92,551,000 gallons (69.2 percent) were held in California.

*Prices.*—Natural-gasoline prices during the first half of 1933 were at the lowest level in the history of the industry. At the beginning of the year the quotation for the 26–70 grade stood at 2½ cents per gallon with the trend steadily downward, and on June 1 the price reached a record low of 1 cent per gallon in Oklahoma and Texas. Some sales as low as ⅞ cent per gallon were reported. About the middle of June there was a sharp reversal of trend, and prices of both

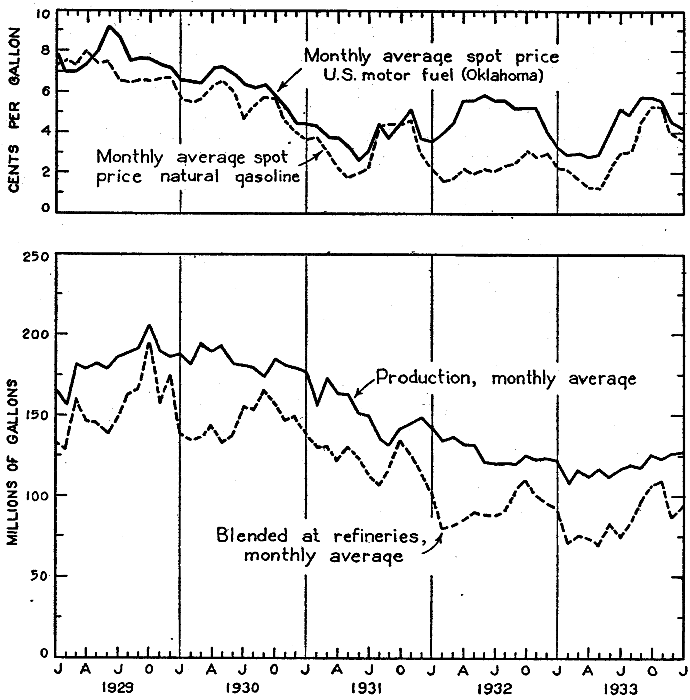


FIGURE 57.—Trends of production, blending at refineries, and prices of natural gasoline, 1929–33, by months.

natural and refinery gasoline moved up sharply due to advances in posted crude-oil schedules and increased buying of refinery gasoline by marketing companies and jobbers before the additional one-half-cent Federal tax became effective. This increased buying of refinery gasoline immediately improved the natural-gasoline market. Day-to-day advances brought the quotation for the 26–70 grade up to 3 cents per gallon at the beginning of July. Further strengthening of the market began in September under active seasonal buying of natural gasoline to meet volatility requirements of motor fuel for winter use; and the price of the 26–70 grade rose above 5 cents per gallon, touching a peak of 5¾ cents, the highest since 1930. These prices were maintained until the middle of November, when curtailment in refinery purchases resulted in a price recession. When the year closed the 26–70 grade was quoted at 3½ cents per gallon.

Based on an estimated average price of 3.8 cents per gallon the output of natural gasoline in 1933 had a sales value at plants of $53,640,000, or 8.9 percent above 1932, when the total value was $49,244,000. The average value per gallon in 1932 was 3.2 cents.

The daily average posted price of 26–70 grade in Oklahoma in 1933 was 2.926 cents, while in California the average spot price of the 75–85, 375–390 end-point grade was 5.0177 cents per gallon.

*Consumption.*—In the past few years the competition between refiners for higher-octane motor fuel has resulted in increased cracking and reforming operations; in consequence, production of lighter hydrocarbons has increased to the point where their utilization in motor fuel has in many instances replaced the refiners' former demand for natural gasoline. Contraction in refinery demand for natural gasoline in 1933, despite a 2.1-percent increase in the total output of motor fuel compared with 1932, is a reflection of this replacement. Refinery consumption for the year was 1,063,692,000 gallons, comprising 6.2 percent of the total motor-fuel production. In comparison with the year before the refinery demand of 1933 represents a decrease of 3.8 percent.

General weakness in the price structure of motor fuel due to the production of cheap crude oil in the East Texas field was a disturbing factor in the natural-gasoline market and contributed to the low volume of refinery purchases during the spring months. With refinery gasoline being offered in East Texas below the minimum cost of producing natural gasoline at Mid-Continent operations refiners in other areas were compelled to cut prices to unprofitable levels to meet the competition and found it expedient to curtail purchases of natural gasoline as a means of reducing their manufacturing costs.

Reduction in the use of natural gasoline for blending by refineries brought the natural-gasoline content in motor fuel down to 6.2 percent in 1933 compared with 6.6 percent in 1932. Decreases in percentage of natural gasoline in refinery-gasoline output were recorded in all districts except the East Coast and California. Data by districts are summarized in the following table:

*Percentage of natural gasoline in refinery gasoline, 1932–33, by districts*

| Year | East Coast | Appalachian | Indiana, Illinois, Kentucky | Oklahoma, Kansas, Missouri | Texas Inland | Texas Gulf | Louisiana Gulf | Arkansas and Louisiana Inland | Rocky Mountain | California |
|---|---|---|---|---|---|---|---|---|---|---|
| 1932 | 0.94 | 2.2 | 3.0 | 9.4 | 11.6 | 4.7 | 5.3 | 9.6 | 12.4 | 14.5 |
| 1933 | 1.6 | 1.4 | 2.8 | 9.0 | 11.0 | 3.5 | 2.0 | 4.8 | 9.9 | 15.5 |

With increased cracking and attendant production of low-boiling fractions, as a result of sustained emphasis on high octane number by refiners, the trend has continued toward the purchase of stabilized grades of natural gasoline of lower vapor pressure, particularly from 14 to 20 pounds Reid.

Bulk-station blending, whereby a saving of one freight rate is made possible, has shown an upward tendency, although it has not increased as rapidly as was indicated a year ago.

*Blended at refineries.*—The decline in the refinery demand for natural gasoline in 1933 was felt unequally in different parts of the country. Although the total national volume blended at refineries declined 3.8 percent compared with 1932, in some refinery districts the decrease exceeded 60 percent, and in others there was an increase, one district showing an increase of more than 70 percent. The table of salient statistics gives the volume of natural gasoline blended in the different refinery districts. Among districts showing heavy declines were Appalachian, Texas Gulf, Louisiana Gulf, and Arkansas and Louisiana Inland.

Greatly reduced purchases of natural gasoline by refiners along the Gulf coast brought the consumption down to 117,432,000 gallons as against 169,470,000 gallons in 1932. Of the 1933 total, 105,504,000 gallons were blended by Texas Gulf coast refiners and only 11,928,000 gallons by Louisiana coast refiners compared with 134,442,000 and 35,028,000 gallons blended in these districts in 1932, declines of 21.5 and 65.9 percent, respectively.

Although part of the shrinkage in the refinery demand for natural gasoline by Gulf coast refiners is due to increased production of light ends from cracking operations within refineries, another factor responsible for the shrinkage has been the practice of mixing natural gasoline with crude oil in the field and transporting the mixture in pipe lines or tank cars to refineries. This practice destroys the identity of the natural gasoline and reduces the volume subsequently required for blending.

Refining of East Texas crude oil, which contains a relatively high percentage of light fractions, also has cut down the volume of natural gasoline consumed at Gulf coast refineries.

The running of a high percentage of East Texas crude oil by refiners in the Arkansas-Louisiana Inland district likewise accounts for a large part of the 49.4-percent drop in the volume blended in this district.

Slight gains over 1932 were recorded in volumes blended in the Oklahoma-Kansas-Missouri, Texas Inland, and California districts; and an abnormal increase of 73 percent in consumption was recorded by refineries in the East Coast district. This increase in blending at East Coast refineries in the latter part of 1933 was probably related to the more general adoption and increased sales of "Q" or second-grade ethyl gasoline.

*Blended at plants.*—Although the quantity of natural gasoline blended at plants is small measured in terms of percentage of total output, reports of manufacturers indicate an unprecedented increase of 169.5 percent in the volume blended at plants—to 5,505,000 gallons in 1933 from 2,043,000 gallons in 1932. Comparative figures of the volumes blended at plants in the several producing States during 1932 and 1933 show that Texas, Louisiana, and Arkansas accounted for most of the increase. Of particular significance is the large increase in the volume blended at plants in Texas as a result of operations in the East Texas field. In 1933, 2,071,000 gallons were blended at plants in Texas compared with 507,000 gallons in 1932, an increase of 308 percent. Of the total volume, 1,857,000 gallons were accounted for in East Texas, leaving only 214,000 gallons blended at plants in other parts of the State.

A large increase in volume blended by manufacturers in Louisiana and Arkansas also was recorded. Compared with 209,000 gallons in 1932, 1,298,000 gallons were blended at Louisiana plants in 1933. Arkansas plants blended 45,000 and 515,000 gallons in 1932 and 1933, respectively.

The volume blended at plants in the Appalachian district in 1933—926,000 gallons—was almost double that in 1932, when 473,000 gallons were utilized in motor blends by manufacturers.

*Exports and sales to jobbers.*—Although complete figures for exports of natural gasoline are not yet available, a contraction in shipments to foreign markets during 1933 is indicated. Exports from California in 1933 totaled 45,591,672 gallons, 17 percent less than in 1932. Of the total gallonage exported, 33,796,896 gallons were shipped via the Panama Canal to foreign countries bordering the Atlantic and 11,794,776 gallons were consigned to foreign ports in the Pacific. Compared with 1932 Atlantic foreign shipments in 1933 dropped 15 percent, and consignments to Pacific foreign markets declined approximately 23 percent. More than 75 percent of the natural-gasoline exports from California went to Canada and the Netherland West Indies.

Consignments of crude oil fortified with natural gasoline, which of course loses its identity, also were shipped to foreign refineries, particularly those in countries having differential taxes in favor of their refining industries. With the tax on crude oil substantially below that on gasoline it was to the importers' advantage to obtain a mixture containing as much potential gasoline as it was practical to handle.

Available information indicates that sales to jobbers were below the 1932 figures. Unsettled conditions and general weakness in the refinery-gasoline market during the spring months resulted in extreme dullness in natural-gasoline markets. Despite the fact that prices at the plants in the Mid-Continent were only slightly higher than the posted prices of crude oil at the well, refinery and jobber buying was at a standstill. There was some shifting by manufacturers to the production of low-vapor-pressure gasoline, and grades having a vapor pressure as low as 9 pounds were quoted at prices around 2 cents a gallon. The weak market, however, offered little incentive to buy, and the low prices attracted only a small volume of business from jobbers.

## LIQUEFIED PETROLEUM GASES

Continued expansion in the liquefied-petroleum-gas industry was recorded in 1933, when 38,931,008 gallons of propane, butane, pentane, and propane-butane mixtures were marketed compared with 34,114,767 gallons in 1932, a gain of 14.1 percent. The demand for butane, which is predominantly industrial, accounts for most of the increase; deliveries of 19,056,230 gallons were made in 1933 compared with 14,661,688 gallons in 1932. Sales of butane for industrial and miscellaneous uses totaled 12,179,766 gallons in 1933 and 7,353,856 gallons in 1932, whereas domestic sales increased from 81,981 gallons in 1932 to 705,894 in 1933. The quantity of butane utilized for gas manufacture, however, declined from 7,225,851 gallons in 1932 to 6,170,570 in 1933.

The market for propane was slightly above the 1932 demand, increasing from 15,181,871 to 15,834,730 gallons. Of the total volume, 14,334,412 gallons (90 percent) went into domestic consumption. Deliveries of pentane and propane-butane mixtures were 4,040,048 gallons in 1933 compared with 3,786,677 gallons in 1932.

Substantial increases in the industrial market for liquefied petroleum gases were chiefly responsible for the increase in tank-car, tank-wagon, and pipe-line shipments from 19,717,798 gallons in 1932 to 24,515,445 in 1933. Shipment of 14,415,563 gallons in cylinders and drums was only slightly higher than 1932 deliveries.

The following information has been supplied by the American Gas Association:

At the end of 1933, liquefied petroleum gas was being delivered through mains to consumers in 137 communities in 28 States by 56 companies. Butane-air gas with heating value ranging from 520 to 600 B.t.u. per cubic foot was supplied to 91 communities in 26 States by 48 companies. A mixture of undiluted butane and propane gas with a heating value of 2,800 to 3,000 B.t.u. per cubic foot was supplied to 12 communities in California and Nevada by 5 companies. Undiluted propane gas, with a heating value of 2,550 B.t.u. per cubic foot, was supplied to 34 communities in Minnesota, North Dakota, and Wisconsin by three companies. These latter three companies distribute gas in some communities through mains from a central plant and in others use an "alley-tank" system delivering to a number of consumers on the same block from a central reservoir.

At the end of 1933, three communities in Canada were also supplied with butane-air gas. One community, Three Rivers, Quebec, was supplied from a plant located in that city, while Milltown and St. Stephen, New Brunswick, were being supplied by the Citizens Gas Co. from its plant at Calais, Maine.

## PRODUCTION BY STATES AND FIELDS

*California.*—Despite a material reduction in output California retained a substantial lead over all other States in the production of natural gasoline. The output in 1933 was 493,000,000 gallons, a decrease of 10.7 percent from 1932 and the lowest since 1926. Except for the Huntington Beach field, which recorded an increase of 56.1 percent as a result of the new tideland development, the production of natural gasoline in all fields was below that of 1932. Kettleman Hills, which has the largest actual and potential production of natural gasoline of any field in the State, produced 133,400,000 gallons in 1933 compared with 135,200,000 gallons in 1932.

The largest drop in output was reported for the Long Beach field, which produced 81,900,000 gallons in 1933 compared with 111,700,000 gallons in 1932, a loss of 26.7 percent. A decline in production of natural gasoline also was recorded in the Santa Fe Springs field, where the 1933 output of 80,700,000 gallons was 19.2 percent below that of 1932. Production of natural gasoline in the Ventura field dropped from 43,700,000 gallons in 1932 to 38,900,000 in 1933, a decline of 11 percent.

Although all California fields are under strict proration regulations which limit the supply of gas to natural-gasoline plants, the large declines in natural-gasoline production in the older fields reflect also the pronounced natural decline in gas production.

*Oklahoma.*—Production of natural gasoline in Oklahoma dropped 5.0 percent from 378,600,000 gallons in 1932 to 359,700,000 in 1933. A decline of 25.4 percent in production from plants in the Seminole area was a major factor in the sharp reduction in total output for the

State. Actual production in the Seminole area was only 97,000,000 gallons compared with 130,000,000 in 1932.

The Osage field, with an output of 41,300,000 gallons in 1933 compared with 49,000,000 gallons in 1932, likewise contributed to the decline in total production.

A study of production records reveals a continuous month-to-month natural decline in available gas supply in all areas except the Oklahoma City field. The diminishing volume of available gas and the abnormally low price paid for natural gasoline would not permit profitable operation of many small plants in these older fields.

Production of natural gasoline from the Oklahoma City field, where proration has limited the supply of gas, was well-sustained during 1933. The output of 92,500,000 gallons was 18 percent more than the volume produced in 1932.

*Texas.*—Texas produced 359,400,000 gallons of natural gasoline in 1933 compared with 371,100,000 gallons in 1932, a decline of 3.2 percent. East Texas production was 20,000,000 gallons in 1933, almost double the output of 10,400,000 gallons in 1932, but all other fields in Texas reported declines. The increase in output of approximately 10,000,000 gallons in the east Texas field was offset by a decrease of 10,000,000 gallons in the north Texas area, where production declined 33.1 percent to 20,200,000 gallons.

Production in the Panhandle was well-sustained as a result of the enactment of a gas law, which permits processing 25 percent of the potential gas supply and burning the residue for carbon-black manufacture or blowing it to the air. The output of 178,900,000 gallons in 1933 was only slightly less than the output in the preceding year.

A small drop in production was recorded at plants in the central part of the State, where 84,900,000 gallons were produced in 1933 compared with 85,900,000 gallons in 1932.

*West Virginia.*—Production of natural gasoline in West Virginia dropped 8.7 percent, from 43,773,000 gallons in 1932 to 39,963,000 in 1933.

*Other States.*—New Mexico, the only State except Pennsylvania that showed an increase in output, produced 19,147,000 gallons of natural gasoline in 1933, an increase of 9.4 percent from 1932. A decline of 20.5 percent in output of natural gasoline was recorded in Wyoming; 35,273,000 gallons were produced in 1933 compared with 44,391,000 in 1932.

# CARBON BLACK

By G. R. Hopkins and H. Backus

## SUMMARY OUTLINE



The establishment of a new record for sales and the formulation of a code under the provisions of the National Industrial Recovery Act were achievements of the carbon-black industry in 1933. Production of carbon black in 1933 was 269,325,000 pounds, 11 percent

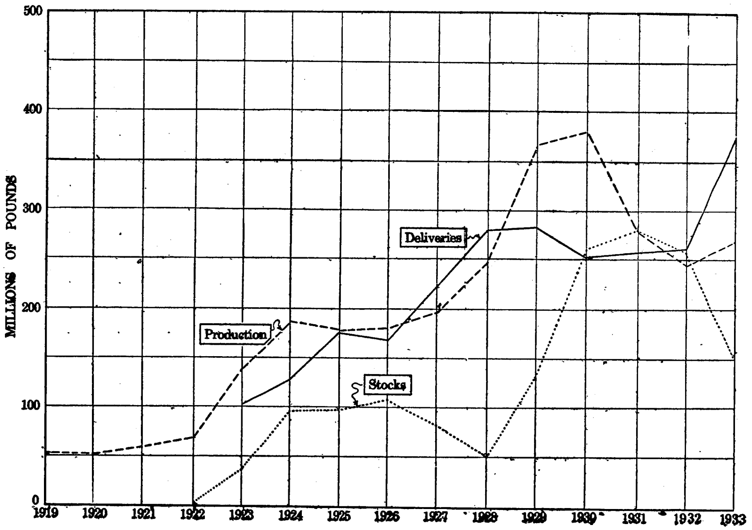


Figure 58.—Carbon-black production, stocks, and deliveries, 1919–33.

higher than in 1932, but the increase in production was relatively small compared with gains of 38 percent in domestic sales and 52 percent in exports. (See fig. 58.) However, the principal consuming industries—rubber, ink, and paint—did not show gains in activity in 1933 comparable with the increase in sales of carbon black. Therefore, part of the total sales, possibly 50,000,000 pounds, was speculative buying in anticipation of price increases. The price remained at 3 cents per pound or less throughout 1933, the average for the year being 2.77 cents, f.o.b. plants. On January 1, 1934, prices advanced to about 4 cents, partly to meet the higher wages imposed by the code but principally as an economic reward for curtailing production enough to effect a 41-percent decline in producers' stocks.

The Carbon-Black Code, submitted to the Administrator for Industrial Recovery on August 23, 1933, was revised after a public hearing November 16, 1933, and approved February 8, 1934. Briefly, the code stipulates maximum hours and minimum wages for labor, provides for coordinating production with demand, provides a control of plant capacity, and contains provisions designed to prevent violent fluctuations in prices.

*Salient statistics of carbon black made from natural gas in the United States, 1923 and 1930–33*

| | 1923 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Number of producers reporting | 47 | 33 | 26 | 24 | 24 |
| Number of plants | 69 | 69 | 58 | 50 | 50 |
| Quantity produced: | | | | | |
| By States and districts: | | | | | |
| Louisiana pounds | 101,398,881 | 96,729,000 | 57,485,000 | 42,260,000 | 54,470,000 |
| Texas: | | | | | |
| Breckenridge do | 2,633,013 | 16,905,000 | 13,332,000 | [1] 23,071,000 | [1] 24,499,000 |
| Panhandle do | | 254,844,000 | 197,546,000 | 177,369,000 | 190,356,000 |
| Total Texas do | 2,633,013 | 271,749,000 | 210,878,000 | [1] 200,440,000 | [1] 214,855,000 |
| Other States do | 34,230,754 | 11,464,000 | 12,544,000 | (1) | (1) |
| Total United States do | 138,262,648 | 379,942,000 | 280,907,000 | 242,700,000 | 269,325,000 |
| By processes: | | | | | |
| Channel process do | 116,696,891 | 350,254,000 | 255,322,000 | 224,536,000 | 234,226,000 |
| Other processes [2] do | 21,565,757 | 29,688,000 | 25,585,000 | 18,164,000 | 35,099,000 |
| Stocks held by producers Dec. 31 pounds | 38,320,814 | 259,245,000 | 280,010,000<br>[3] 281,667,000 | 257,998,000 | 151,993,000 |
| Losses do | 165,885 | 1,361,000 | 1,716,000 | 4,814,000 | 686,000 |
| Quantity sold: | | | | | |
| Domestic: | | | | | |
| To rubber companies do | (4) | 128,572,000 | 134,315,000 | 130,380,000 | 191,358,000 |
| To ink companies do | (4) | 19,220,000 | 15,184,000 | 18,341,000 | 18,539,000 |
| To paint companies do | (4) | 11,922,000 | 6,760,000 | 7,636,000 | 6,260,000 |
| For miscellaneous purposes do | (4) | 7,565,000 | 5,453,000 | 5,126,000 | 6,201,000 |
| Total domestic sold do | (4) | 167,279,000 | 161,712,000 | 161,483,000 | 222,358,000 |
| Export do | (4) | 84,260,000 | 96,714,000 | 100,072,000 | 152,286,000 |
| Total sold do | 102,210,496 | 251,539,000 | 258,426,000 | 261,555,000 | 374,644,000 |
| Value (at plants) of carbon black produced: | | | | | |
| Total | $11,692,066 | $14,852,000 | $8,621,000 | $6,664,000 | $7,449,000 |
| Average per pound cents | 8.46 | 3.91 | 3.07 | 2.75 | 2.77 |
| Estimated quantity of natural gas used M cubic feet | 109,096,000 | 266,625,000 | 195,396,000 | 168,237,000 | 186,781,000 |
| Average yield per M cubic feet pounds | 1.27 | 1.43 | 1.44 | 1.44 | 1.44 |

[1] Oklahoma and Wyoming included with Breckenridge district, Texas.
[2] 1923: Chain, disk, plate, ring, roller, "special", and thermatomic; 1930 and 1932–33: Disk, Lewis, roller, "special", and thermatomic; 1931: Disk, roller, "special", and thermatomic.
[3] For comparison with 1932.
[4] Figures not available.

## PRODUCTION BY STATES AND DISTRICTS

The carbon-black industry has migrated steadily westward, but statistics reveal that the center of production in 1933 actually moved eastward, due primarily to the fact that production in Louisiana increased 29 percent over 1932 whereas production in the Texas Panhandle increased only 7 percent. The increase in Louisiana was somewhat surprising, as production in that State had declined steadily from 1928 through 1932.

The output of carbon black in the Texas Panhandle totaled 190,356,000 pounds in 1933, 12,987,000 pounds above 1932, but 64,488,000 pounds below the peak established in 1930; it was 71 percent of the total output in the United States compared with 73 percent in 1932. Production at the 1 plant in Oklahoma and the 1 plant in Wyoming is included with the output in the Breckenridge district to avoid disclosing individual operations; as a result, it is not possible to reveal production trends in these States in 1933. However, the fact that the surplus natural-gas supply in the Breckenridge district has been diminishing would indicate that Oklahoma and Wyoming are at least maintaining their production at a rate comparable with previous years.

*Carbon black produced from natural gas in the United States in 1933, by States and by major producing districts*

| State and district | Producers reporting | Number of plants | Production | | | Quantity of natural gas used (M cubic feet) | Average yield per M cubic feet (pounds) |
|---|---|---|---|---|---|---|---|
| | | | Pounds | Value at plant | | | |
| | | | | Total | Average (cents) | | |
| Louisiana: Monroe-Richland district (Morehouse, Ouachita, and Richland Parishes) | 11 | 19 | 54,470,000 | $1,565,000 | 2.87 | 40,865,000 | 1.33 |
| Oklahoma | 1 | 1 | (1) | (1) | (1) | (1) | (1) |
| Texas: | | | | | | | |
| Breckenridge district (Eastland and Stephens Counties) | 4 | 5 | 1 24,499,000 | 1 688,000 | 1 2.81 | 1 13,186,000 | 1 1.8 |
| Panhandle district (Carson, Gray, Hutchinson, and Wheeler Counties) | 12 | 24 | 190,356,000 | 5,196,000 | 2.73 | 132,730,000 | 1.43 |
| Total Texas | 2 14 | 29 | 1 214,855,000 | 1 5,884,000 | 1 2.74 | 1 145,916,000 | 1 1.47 |
| Wyoming | 1 | 1 | (1) | (1) | (1) | (1) | (1) |
| Total United States, 1933 | 2 24 | 50 | 269,325,000 | 7,449,000 | 2.77 | 186,781,000 | 1.44 |
| 1932 | 2 24 | 50 | 242,700,000 | 6,664,000 | 2.75 | 168,237,000 | 1.44 |

1 Oklahoma and Wyoming included with Breckenridge district, Texas.
2 In counting the total number of producers, a producer operating in more than 1 State, district, or county is counted only once.

## METHODS AND YIELDS

No important changes in manufacturing technique occurred in 1933, the channel and furnace processes continuing as the chief methods employed. In 1932 the relative importance of furnace blacks declined, but in 1933 the output of this type was practically double that in 1932. On the other hand, the total production of channel blacks, although increasing in quantity from 224,536,000 to 234,226,000 pounds, declined in relative importance and represented only 87 percent of the total in 1933 compared with 93 percent in 1932.

The average yield of carbon black, which in recent years has fluctuated in an increasingly narrow range, was 1.44 pounds per thousand cubic feet of gas burned in both 1933 and 1932. In general the yield of carbon black by furnace methods is much higher than that by the channel process; consequently, the sharp increase in production of furnace blacks in 1933 must have been compensated by a small decline in yield at channel plants. The carbon-black industry ranks next to the oil industry as a consumer of natural gas; in 1933 it utilized 186,781,000,000 cubic feet (about 12 percent of the total natural gas consumed that year) compared with 168,237,000,000 cubic feet in 1932.

Although manufacturing technique showed little change in terms of yields, there was one development which may revolutionize transportation methods. Increasing quantities of black were produced in the form of small, round pellets that can be transported in bulk instead of by the more costly method of compressing in bags.

## DOMESTIC CONSUMPTION

Sales of carbon black in 1933 totaled 374,644,000 pounds, an increase of 113,089,000 pounds (43 percent) over 1932. Because of this sharp increase the 1933 total was much higher than the previous record of 283,806,000 pounds established in 1929. Of the 1933 total, 222,358,000 pounds (59 percent) represented domestic sales and 152,286,000 pounds (41 percent) foreign sales; these data indicate a further increase in the proportion exported. Of the domestic deliveries, 191,358,000 pounds (86 percent) were consigned to rubber companies, 18,539,000 pounds (8 percent) to ink companies, 6,260,000 pounds (3 percent) to paint and varnish companies, and 6,201,000 pounds (3 percent) to companies producing miscellaneous products. (See fig. 59.) These figures indicate a gain in the relative quantity consigned to rubber companies and a corresponding drop in the percentages to ink, paint, and varnish companies.

Sales of carbon black to rubber companies represent over four-fifths of total domestic sales. It is appropriate, therefore, to present a short résumé of developments in the rubber industry in 1933. The consumption of rubber—or what amounts to about the same thing, the production of automobile casings—reached such a low level in 1932 that an increase was forecast for 1933. This gain materialized, and, according to E. G. Holt, assistant chief, Leather-Rubber-Shoe Division, Bureau of Foreign and Domestic Commerce, the consumption of crude rubber in the United States increased 21 percent in 1933, or from 332,000 long tons in 1932, to 401,000 tons in 1933. The use of reclaimed rubber, which had declined sharply in 1932, also increased, reaching 85,000 long tons compared with 77,500 tons in 1932. Total rubber consumption in 1933 was 19 percent higher than in 1932, but sales of carbon black to rubber companies increased 47 percent. The fact that sales to rubber companies increased faster than the consumption of rubber may have been due to several causes, chief of which were the growth of manufacturers' stocks of carbon black and the increased use of balloon tires and casings with thicker treads, thus raising the average consumption of carbon black per tire. No data are available to prove that stocks of carbon black at rubber factories increased, but the fact that higher prices were forecast long before the code went into effect supports this contention.

According to B. M. Frost, Forest Products Division, Bureau of Foreign and Domestic Commerce, the production of newsprint declined from 1,008,588 short tons in 1932 to 946,374 tons in 1933. Exports and stocks of newsprint have minor economic importance.

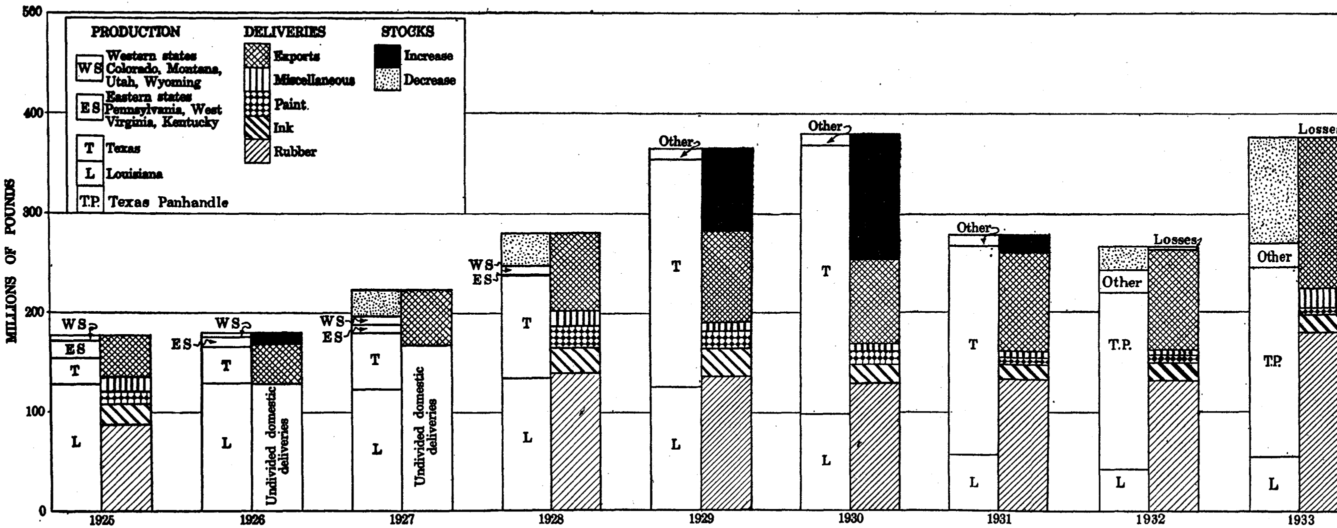


FIGURE 59.—Production and consumption of carbon black, 1925–33.

Imports of newsprint showed little change, totaling 1,793,541 short tons in 1933 compared with 1,792,130 tons in 1932. These data indicate that the consumption of newsprint in 1933 was about 2 percent less than in 1932. On the other hand, sales of carbon black to ink companies increased 1 percent, and this difference between sales and apparent consumption probably was due to speculative buying.

Sales of carbon black to paint companies, which had increased in 1932, declined 18 percent (from 7,636,000 pounds in 1932 to 6,260,000 pounds in 1933). No data are available to show a similar decrease in production of black paints and varnishes in 1933, but the pronounced pick-up in the automobile industry in the latter part of 1933 and the first part of 1934 should be reflected in a gain in sales of carbon black for paints and varnishes.

Sales of carbon black for miscellaneous purposes, such as the manufacture of carbon paper, artificial stone, typewriter ribbons, and brake bands and for use in concrete to eliminate glare, totaled 6,201,000 pounds in 1933, an increase of 21 percent over 1932. Much of this gain may have resulted from speculative buying.

Carbon-black losses declined materially in 1933, amounting to only 686,000 pounds or about one-fourth of 1 percent of the total production. This percentage is the lowest recorded since 1929 and may be accounted for principally by the absence of serious fires in 1933.

## EXPORTS [1]

Exports of carbon black increased 52 percent from 1932, rising to a new high level of 152,286,178 pounds in 1933. The average value per pound of carbon black exported continued to decline and was only 3.65 cents per pound in 1933 compared witn 4.43 cents in 1932. Because of the material increase in quantity the total value of the exports increased from $4,436,331 in 1932 to $5,552,145 in 1933; this total value, however, is much smaller than in 1928, when the quantity exported was only slightly more than half that in 1933.

The United Kingdom, with purchases of 42,603,940 pounds of carbon black from the United States in 1933, continued to be the leading customer. Exports to France increased materially, and that country retained second place well ahead of Germany. December was the leading month in carbon-black exports, probably because it was the last month before the higher prices became effective.

Of interest to exporters was the formation of an export corporation to replace that formed in 1929. The new organization was created to take better advantage of allowances under the Webb-Pomerene export laws.

Imports of "gas black and carbon black" in 1933 totaled 212,950 pounds valued at $19,845. As in former years, these imports probably were special blacks such as acetylene black rather than true carbon blacks.

[1] Figures on exports compiled by A. H. Redfield, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

*Carbon black exported from the United States, 1931-33, by countries*

| Country | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value |
| Australia | 1, 915, 738 | $97, 890 | 4, 052, 346 | $184, 713 | 5, 121, 578 | $182, 745 |
| Belgium | 2, 896, 126 | 139, 952 | 3, 351, 515 | 156, 027 | 5, 376, 058 | 192, 064 |
| Canada | 9, 825, 346 | 352, 236 | 6, 977, 194 | 224, 254 | 10, 578, 559 | 303, 115 |
| China | 1, 047, 870 | 58, 320 | 1, 328, 446 | 63, 114 | 2, 033, 162 | 75, 677 |
| France | 18, 039, 671 | 1, 005, 411 | 19, 459, 854 | 895, 177 | 32, 417, 013 | 1, 191, 920 |
| Germany | 14, 414, 348 | 771, 243 | 16, 216, 415 | 695, 446 | 20, 327, 467 | 745, 052 |
| Italy | 2, 808, 707 | 165, 458 | 3, 391, 780 | 151, 893 | 7, 196, 800 | 259, 313 |
| Japan | 6, 313, 937 | 327, 366 | 5, 997, 461 | 278, 464 | 9, 335, 065 | 377, 497 |
| Netherlands | 1, 583, 015 | 86, 051 | 2, 424, 612 | 108, 426 | 6, 690, 947 | 238, 119 |
| United Kingdom | 32, 279, 788 | 1, 763, 180 | 31, 059, 005 | 1, 392, 895 | 42, 603, 940 | 1, 589, 503 |
| Other | 5, 589, 570 | 311, 731 | 5, 813, 858 | 285, 922 | 10, 605, 589 | 397, 140 |
| | 96, 714, 116 | 5, 078, 838 | 100, 072, 486 | 4, 436, 331 | 152, 286, 178 | 5, 552, 145 |

*Carbon black exported from the United States in 1933, by months and districts*

| Month | Pounds | Value | District | Pounds | Value |
|---|---|---|---|---|---|
| January | 11, 695, 974 | $439, 022 | Galveston | 99, 123, 162 | $3, 515, 744 |
| February | 7, 612, 385 | 282, 467 | New Orleans | 33, 292, 023 | 1, 369, 926 |
| March | 9, 168, 435 | 340, 353 | Michigan | 9, 947, 853 | 280, 619 |
| April | 9, 657, 461 | 355, 975 | Los Angeles | 4, 107, 138 | 136, 076 |
| May | 6, 888, 646 | 245, 110 | San Francisco | 272, 384 | 12, 140 |
| June | 11, 095, 047 | 388, 629 | Sabine | 4, 468, 596 | 169, 466 |
| July | 14, 576, 721 | 517, 855 | New York | 426, 644 | 44, 791 |
| August | 14, 537, 649 | 537, 958 | Vermont | 481, 546 | 13, 538 |
| September | 11, 698, 644 | 412, 075 | Buffalo | 76, 073 | 5, 658 |
| October | 15, 962, 461 | 568, 774 | Dakota | 35, 058 | 1, 432 |
| November | 14, 861, 817 | 543, 401 | St. Lawrence | 29, 491 | 1, 228 |
| December | 24, 530, 938 | 920, 526 | Other | 26, 210 | 1, 527 |
| | 152, 286, 178 | 5, 552, 145 | | 152, 286, 178 | 5, 552, 145 |

## STOCKS

Stocks of carbon black held by producers were reduced drastically in 1933. The total on hand December 31, 1933, was 151,993,000 pounds, or 106,005,000 pounds (41 percent) less than at the beginning of the year. Dividing the stocks at the end of 1933 by the daily average demand during the year shows that there was about a 5-month supply on hand December 31, 1933, representing a radical change from December 31, 1932, when about a year's supply was in stock. Data on consumers' and brokers' stocks are not available, but in view of price fluctuations they probably increased substantially; if so, stocks of carbon black at the close of 1933 may not have been reduced 41 percent from 1932 but, rather, may have been transferred from producers to consumers or brokers.

## PRICES AND VALUES

The average value of carbon black at the plants advanced from 2.75 cents a pound in 1932 to 2.77 cents in 1933. This increase, although of little consequence from a revenue-producing standpoint, was important because it marked the first advance in average price since 1928. The total value increased materially, amounting to $7,449,000 compared with $6,664,000 in 1932.

The quoted prices of 2.82 cents for carbon black at Louisiana works and 2.72 cents at Texas works, which became effective July 18, 1932, remained unchanged throughout 1933. There was discussion of higher prices for carbon black during 1933, particularly after the pick-up in the rubber industry in May, June, and July, but this increase in business had little effect on prices, as most of them had been set previously by contracts. However, improved conditions in the industry and anticipation of increased costs under the code resulted in the establishement of higher prices early in 1934, and contracts for the first quarter of the new year stipulated prices of about 4 cents per pound at the plants.

*Quoted prices of various grades of carbon black, 1932–33, 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) |
|---|---|---|---|---|
| 1932: | | | | |
| Jan. 1[1] | 22.0 | 7.0 | 3.1 | 3.0 |
| Apr. 25 | | 5.75 | 2.85 | 2.75 |
| June 13 | | 5.0 | | |
| July 18 | | | 2.82 | 2.72 |
| 1933[2] | | | | |

[1] In effect as of first of year.
[2] No changes from 1932 prices.

## NUMBER AND CAPACITY OF PLANTS

Carbon black was made in 1933 by 24 producers operating 50 plants. One less plant was operated in Louisiana than in 1932, but this fact was compensated by the addition of one new operating plant in the Texas Panhandle.

The total daily capacity of the plants operated during 1933 was 1,267,825 pounds, or 22,850 pounds greater than the total daily capacity of those operated in 1932. As the average daily production of carbon black in 1933 was 737,877 pounds, the plants operated at about 58 percent of their capacity during the year compared with 53 percent in 1932.

*Number and daily capacity of carbon-black plants operated in the United States 1932–33, by counties or parishes*

| State | County or parish | Number of plants | | Total daily capacity (pounds) | |
|---|---|---|---|---|---|
| | | 1932 | 1933 | 1932 | 1933 |
| Louisiana | Morehouse | 4 | 5 | 59,850 | 69,350 |
| | Ouachita | 14 | 12 | 238,925 | 224,775 |
| | Richland | 2 | 2 | 20,000 | 20,000 |
| | | 20 | 19 | 318,775 | 314,125 |
| Oklahoma | Beckham | 1 | 1 | (1) | (1) |
| Texas | Carson | 1 | 2 | (2) | (2) |
| | Eastland | 1 | 1 | (1) | (1) |
| | Gray | 9 | 9 | 308,400 | 321,400 |
| | Hutchinson | 10 | 10 | 414,250 | 416,750 |
| | Stephens | 4 | 4 | [1] 104,550 | [1] 104,550 |
| | Wheeler | 3 | 3 | [2] 99,000 | [2] 111,000 |
| | | 28 | 29 | [1] 926,200 | [1] 953,700 |
| Wyoming | Niobrara | 1 | 1 | (1) | (1) |
| United States | | 50 | 50 | 1,244,975 | 1,267,825 |

[1] Oklahoma, Wyoming, and Eastland County, Texas, included with Stephens County, Texas.
[2] Carson County included with Wheeler County.

## PRODUCERS

The list of carbon-black producers showed fewer changes in 1933 than in many years; 24 producers were operating on December 31, 1933, compared with 22 producers at the close of 1932. Four more plants were active on December 31, 1933, than on December 31, 1932; the majority of these were plants that produced in 1932, were idle on December 31, 1932, but were again in operation at the close of 1933.

*Carbon-black producers of the United States, as of Dec. 31, 1933*

| 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 34th Street, New York, N.Y. | Ouachita | Swartz | Do. |
| Imperial Oil & Gas Products Co., 1104 Union Bank Building, Pittsburgh, Pa. | do | Sterlington | Do. |
| Keystone Carbon Co., Inc., post-office box 11, Monroe, La. | do | Monroe | Do. |
| Monroe-Louisiana Carbon Co., 45 East 42d Street, New York, N.Y. | do | Hancock | Lewis. |
| Peerless Carbon Black Co., 3003 Grant Building, Pittsburgh, Pa. | do | Bourland | "Special." |
| Southern Carbon Co., 45 East 42d Street, New York, N.Y. | Morehouse | Perryville | Channel. |
| | Ouachita | Fowler | Do. |
| | do | Swartz. | Do. |
| Texas-Louisiana Producing & Carbon Co., post-office box 181, Monroe, La. | Morehouse | Colliston | 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. |
| | do | Dewdrop | Do. |
| | Ouachita | Guthrie | Do. |
| | do | Phillips | Do. |
| | do | Swartz | Do. |
| Oklahoma: Oklahoma Carbon Industries, Inc., Sayre, Okla. | Beckham | Sayre | Do. |
| Texas: | | | |
| Cabot Carbon Co., 940 Old South Building, Boston, Mass. | Gray | Pampa | Do. |
| Cabot Co., 940 Old South Building, Boston, Mass. | Carson | Skellytown | Channel and roller. |
| Coltexo Corporation, 45 East 42d 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 (3 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 Louisiana, Inc., 460 West 34th Street, New York, N.Y. | Carson | Skellytown | Channel. |
| | Hutchinson | Borger | Do. |
| Kosmos Carbon Co. (United Carbon Co., owner), post-office box 1475, Charleston, W.Va. | do | Borger (2 plants) | Do. |
| Magnolia Petroleum Co., Dallas, Tex | Gray | Pampa | Do. |
| | Wheeler | Magic City | Do. |
| Palmer Carbon Co., 80 East Jackson Boulevard, Chicago, Ill. | Hutchinson | Borger | Do. |
| Peerless Carbon Black Co., 3003 Grant Building, Pittsburgh, Pa. | Eastland | Pioneer | "Special." |
| | Gray | Pampa | Do. |
| Texas Carbon Industries, Inc., Sayre, Okla | Stephens | Breckenridge (2 plants). | Channel. |
| Texas Elf Carbon Co., 940 Old South Building, Boston, Mass. | Gray | Pampa | Do. |
| | Stephens | Eliasville | Do. |
| Western Carbon Co., 45 East 42d Street, New York, N.Y. | Gray | Kings Mill | Do. |
| | do | Lefors | Do. |
| | do | Pampa | Do. |
| | Hutchinson | Borger | Do. |
| | Wheeler | Lela | Do. |
| | do | Magic City | Do. |
| Wyoming: J. M. Huber Co. of Louisiana, Inc., 460 West 34th Street, New York, N.Y. | Niobrara | Manville | Do. |

# HELIUM

By C. W. Seibel and H. S. Kennedy

## SUMMARY OUTLINE



Helium, an inert gaseous element, was first discovered as a constituent of the sun's atmosphere in 1868. Not until 1895 was it found on earth in a gas given off on heating the radioactive mineral cleveite. Later (1905) it was discovered to be a constituent of certain natural gases of Kansas. It is now known to be present in most of the natural gases of the United States in varying percentages.

Helium has unique properties and uses. It is colorless, odorless, tasteless, and nonpoisonous. It will not burn or explode when mixed with air and is next to the lightest gas known. Although it was a chemical curiosity when the United States entered the World War, these properties suggested to the scientist the possibility of its use as a lifting medium for balloons and airships. Pure helium has a lift of about 65 pounds per thousand cubic feet compared with a lift of about 76 pounds for hydrogen, the lightest known gas. Although hydrogen has a small advantage in that it is more buoyant, its use involves danger of fire and explosion.

Members of the Bureau of Mines suggested to the Army and Navy early in 1917 that helium might be produced in sufficient quantity for aeronautical purposes. At that time helium was selling in small quantities at the rate of $2,500 per cubic foot. It is now produced at the Bureau of Mines Amarillo helium plant in millions of cubic feet, with operating costs of less than 1 cent per cubic foot.[1]

## FIELD SURVEY AND RESEARCH

The Army and Navy adopted the suggestion of the Bureau of Mines that efforts be made to produce helium for military aeronautics and allotted funds to the Bureau for initiation of the work. The first step was to find an adequate source of supply of helium-bearing natural gas. Early analytical work in this connection was performed for the Bureau at the University of Kansas under the direction of Dr. H. P. Cady, the discoverer of helium in natural gas. Owing to

[1] For a more detailed review of the history of helium see Stewart, Andrew, About Helium: Information Circ. 6745, Bureau of Mines, 1933, 46 pp.

the emergency of war and the necessity for early production, gas coming from a field at Petrolia, Tex., and available by means of an interconnecting pipe line at Fort Worth, Tex., was selected for use in experimental plants. This decision was reached because of certain economic features, notwithstanding the realization that the remaining life of the Petrolia field would be only about 10 years.

With a process for extraction of helium proved experimentally, the Bureau in 1918 established a laboratory at Fort Worth and embarked on a field survey looking to the discovery of additional supplies of helium-bearing natural gas. Samples were collected from the larger known gas fields of the country and analyzed for their helium content. In 1921 the Bureau was allotted funds to enlarge upon the field activities and to establish a research laboratory. The purpose of this "cryogenic" (low-temperature) laboratory was to obtain fundamental information on helium and natural gas, looking to the design of more efficient plants for production and purification.

The Bureau's field work, which was the forerunner of large-scale production of helium, has been continued without interruption to the present time. Several thousand samples of gas have been analyzed, and a number of fields containing helium-bearing natural gas have been found. In general, there are few natural gases that do not contain at least a trace of helium, the percentage ranging from a trace to as high as 8 percent by volume. However, gases containing more than 1 percent are relatively uncommon, being restricted chiefly to the mid-continent region and to smaller areas in Colorado and Utah.

In the early survey the gas of Petrolia field was found to have a helium content of approximately 1 percent. Incidentally, this is thought to be a minimum content for economical extraction. After serving as a source of supply for experimental work directed by the Bureau of Mines and, following that, for a full-scale production plant erected under the jurisdiction of the Navy, Petrolia field was depleted to such an extent by 1929 that its further use for helium production was inadvisable.

Meanwhile, helium had been discovered in the gas of the Nocona field of Texas, about 22 miles from the pipe line bringing gas from the Petrolia field to the Fort Worth helium plant. However, because of the low heating value of this gas, which would have made disposal of the plant residue difficult, and because of the rapid development of the Nocona area into an oil field with excessive waste of its natural-gas content, it was thought inadvisable to connect the field with the existing pipe line. This decision has been amply justified, as the gas reserve of Nocona field has been virtually exhausted through waste and use in oil operations.

*Cliffside field.*—Shortly after the first well had been drilled (April 1920) in what is now known as the "Cliffside field", Potter County, Tex., the Bureau of Mines found that this gas contained more than 1.75 percent helium and as additional wells were drilled in that general area kept in close contact with the situation. Before the Bureau became financially interested in the Cliffside field three wells had been drilled, but virtually no gas had been removed from the area except that incident to drilling operations. Careful geologic surveys of the field, which is separate from other producing areas of the Texas Panhandle, revealed that the area of the structure probably did not exceed 50,000 acres. The land was owned by 4 interests (individuals and companies), and the gas leasehold rights were controlled by 2 companies. The field is about 15 miles from Amarillo, Tex., which offered a good opportunity for disposal of the residue gas.

Through a series of transactions extending from 1927 to 1934 the Government obtained control of the gas rights in fee in 50,000 acres covering the entire Cliffside field. The gas rights in the whole structure were bought by the Government in order that the gas might be used only to supply the demands of the Army and Navy for helium. The structure can thus be depended upon as a reserve to meet military requirements for many years. Also it was desired to maintain the comparatively high pressure of the field, which is advantageous in helium-plant operation.

There are now four producing gas wells on the structure, with a total initial open-flow of 30,000,000 cubic feet per day. These have supplied more than 55,000,000 cubic feet of helium. The wells are connected with the plant by 12 miles of 6-inch welded pipe line, also Government-owned. From May 16, 1929, when the Bureau took control of the wells, to December 31, 1933, they produced 3,328,175,000 cubic feet of natural gas. Based on the decline of rock pressure, the indicated depletion over a period of 5 years of operation is only about 2 percent.

The Government's ownership of the Cliffside structure is unique in many ways. The whole structure is under the Bureau's control so the gas can be conserved in the ground until needed. As the Government owns all rights to the gas, it is not compelled to produce gas or to drill offset wells according to contractual relations with royalty owners, as in most oil and gas fields. The Government is in a position to operate the wells according to the best engineering principles, to conserve the gas in the field, and to drill additional wells when needed, in accordance with the geologic conditions and demands for helium rather than lease requirements.

*Helium Reserve No. 1.*—In 1923 the Bureau analyzed gas developed on public land near Woodside, Utah, and found a helium content of 1.3 percent. This was a virgin field about 8 miles from a source of water and so far from any center of population as to make the gas virtually valueless for any ordinary purpose. On recommendation of the Bureau the area was withdrawn from public entry by Executive orders dated March 21, 1924, and June 28, 1926, and has been established as Helium Reserve No. 1.

*Helium Reserve No. 2.*—Later it was found that one of the richest helium-bearing natural gases in commercial quantities ever discovered, having a helium content of approximately 8 percent, had been developed on public land in Grand County, Utah. This public land was also withdrawn from entry and established as Helium Reserve No. 2 by Executive order dated June 26, 1933.

*Value of helium in gas.*—The value of a natural-gas field for helium extraction depends upon a number of factors beside the helium content of the gas. The total amount of gas in the field, the rock pressure under which the gas is confined, the type of geological structure, the fuel value of the gas, the supply of power or other fuel if the gas lacks satisfactory burning qualities, the market for residue gas not needed in plant operation, and the availability of labor, water, and transportation facilities, as well as many other factors, must be taken into account. An unusual combination of relatively high helium content with other desirable features makes the Cliffside field the best source of raw material for helium extraction that has yet been discovered.

Appreciable quantities of helium in natural gas do not ordinarily increase the value of the gas. Even in the event of helium extraction, the value of the helium is based largely on the cost of extraction, and the value of the original natural gas is not measurably increased by this element.

## GOVERNMENT PLANTS

*Experimental plants.*—Funds allotted by the Army and Navy to initiate the helium program provided for three experimental plants operated under the direction of the Bureau of Mines, each involving a different process. The processes were based on the developments of commercial concerns, interested in extraction of oxygen from air, who designed equipment and cooperated in the experimental work looking to extraction of helium. When the armistice was signed they had produced about 200,000 cubic feet of helium, some of which was on the docks at New Orleans waiting shipment to the front. The most successful of the three experimental plants was one based on the process of the Linde Air Products Co.

*Purification plants.*—Through early research in the Bureau's cryogenic laboratory information was obtained and applied in designing a helium-purification plant for the Naval Air Station at Lakehurst, N.J. Air diffuses into the envelop of any lighter-than-air ship, thus contaminating the lifting gas and decreasing the buoyancy. The purpose of the purification plants is to treat this air-contaminated lifting gas in such a way as to leave substantially pure helium. In addition to the plant at Lakehurst, the Bureau constructed a mobile unit mounted in a railroad car and a stationary plant at Scott Field, Ill., both for the Army. These three plants have given good service and saved many thousands of dollars for the military arms of the Government.

The economies demonstrated by the operation of the purification units designed by the Bureau of Mines led the Navy Department to build a purification plant at the new air base near Sunnyvale, Calif.

*Fort Worth plant.*—After the feasibility of extracting helium in large quantities had been demonstrated by the experimental plants mentioned, the Army and Navy decided to use funds at their disposal for the construction of a large plant at Fort Worth. Although this plant was being designed before the signing of the armistice, it did not begin operation until April 1921. The construction and early operation were under the cognizance of the Navy Department, but the special equipment was designed and operated by the Linde Air Products Co. Under this arrangement approximately 23,000,000 cubic feet of helium were produced. On July 1, 1925, the jurisdiction of the plant was transferred by Congressional enactment to the Bureau of Mines where it remained until depletion of the Petrolia field forced the closing of the plant in January 1929. Under the Bureau regime approximately 25,000,000 cubic feet of helium were produced at Fort Worth.

*Amarillo plant.*—As a result of the depletion of Petrolia field, the desirability of the Cliffside area, and data obtained by the research laboratory, the Bureau felt that construction of a new plant at Amarillo, Tex., was wiser than to connect Nocona field with the existing pipe line to bring its gas to Fort Worth. Accordingly, Bureau engineers designed an entirely new plant, employing a different system of helium production than that used at Fort Worth. Ground was broken in August 1928, and helium production started in April 1929. Since that time (to Dec. 31, 1933) the Amarillo plant has produced 55,569,220 cubic feet of helium, computed on the basis of the actual helium contained in the airship gas of about 98-percent purity delivered by the plant. Expenditures in plant and gas-field operation have been $645,334.14, or $11.61 per thousand cubic feet; $154,024.11 has been returned to the Treasury from sale of residue gas. Thus, the net outgo from the Treasury for operation has been only $491,310.03 or $8.84 per thousand cubic feet. The lowest average operating cost of helium produced at the Fort Worth plant in any fiscal year was $34.04 per thousand cubic feet of airship gas of about 95-percent purity. On that basis the Amarillo plant has saved the Government more than $1,400,000 during its operation; enough to pay the entire cost of the plant and about half of the investment in the gas field which, as has already been stated, is only about 2 percent depleted.

Production and operating costs at both Fort Worth and Amarillo are summarized in the following table. The superiority of the Amarillo plant with respect to economy will be noted. This plant also has the advantage of being independent of any outside operating agency. All plant equipment and the Cliffside gas field are operated by Bureau of Mines employees selected under Civil Service regulations.

The equipment now installed in the Amarillo plant can produce 2,000,000 to 3,000,000 cubic feet of airship gas of 98 percent helium purity per month. Adequate space is provided for additional equipment which could, in case of necessity, approximately double these figures. Ninety percent of the helium contained in the natural gas is recovered. The plant is self-contained; it produces its own electricity and has its own gas and water supply. The residue gas, which is a source of considerable income, is sold to a local gas company. As salaries and wages are the major item of expense and a certain minimum force is required to man the plant and gas field in any event, the unit costs are influenced markedly by changes in the volume of production, decreasing with increased output.[2]

[2] For a more complete description of the Amarillo plant see Seibel, C. W., The Government's New Helium Plant at Amarillo, Tex.: Chem. and Met. Eng., vol. 37, no. 9, September 1930, pp. 550–552; Anderson, C. C., The Government's Helium Projects in Texas: Petrol. Eng., September 1932, pp. 102–105.

*Government helium production and costs, April 1921 to December 1933*

| Period | Production[1] | Gross operating cost (expenditures in operation and maintenance) [2] | | Return from sale of residue gas | Net operating cost (gross operating cost less return from sale of residue gas) [2] | |
|---|---|---|---|---|---|---|
| | | Total | Average per M cubic feet produced | | Total | Average per M cubic feet produced |
| Fort Worth Plant: [3] | | | | | | |
| Under jurisdiction of Navy Department: | *Cubic feet* | | | | | |
| April to June 1921 | 260,520 | $126,694.05 | $486.31 | | | |
| July to December 1921 | 1,841,000 | 320,859.73 | 174.28 | | | |
| October 1922 to June 1923 [4] | 4,069,940 | 489,299.70 | 120.22 | | | |
| July 1923 to June 1924 | 8,204,665 | 636,438.38 | 77.57 | | | |
| July 1924 to June 1925 | 9,418,363 | 451,084.58 | 47.89 | | | |
| | 23,794,488 | 2,024,376.44 | 85.08 | | | |
| Under jurisdiction of Bureau of Mines: | | | | | | |
| July 1925 to June 1926 | 9,355,623 | 318,446.40 | 34.04 | | | |
| July 1926 to June 1927 | 6,330,056 | 277,384.70 | 43.82 | | | |
| July 1927 to June 1928 | 6,687,834 | 274,210.54 | 41.00 | | | |
| July 1928 to Jan. 10, 1929 | 2,638,894 | 121,440.65 | 46.02 | | | |
| | 25,012,407 | 991,482.29 | 39.64 | | | |
| Amarillo plant: [5] | | | | | | |
| Under jurisdiction of Bureau of Mines: | | | | | | |
| April to June, 1929 | 844,900 | 27,833.16 | 32.94 | $2,645.32 | $25,187.84 | $29.81 |
| July 1929 to June 1930 [6] | 9,805,600 | 140,146.75 | 14.30 | 30,445.43 | 109,701.32 | 11.19 |
| July 1930 to June 1931 | 11,362,730 | 150,190.53 | 13.22 | 32,510.24 | 117,680.29 | 10.36 |
| July 1931 to June 1932 | 15,171,680 | 148,545.26 | 9.79 | 40,862.43 | 107,682.83 | 7.10 |
| July 1932 to June 1933 | 14,749,960 | 151,165.51 | 10.25 | 37,661.70 | 113,503.81 | 7.70 |
| July to December 1933 | 3,634,350 | 27,452.93 | [7] 7.55 | 9,898.99 | 17,553.94 | [7] 4.83 |
| | 55,569,220 | 645,334.14 | 11.61 | 154,024.11 | 491,310.03 | 8.84 |

[1] Production from the Fort Worth plant represents volume of airship gas produced, which had an average helium purity of 93 to 94 percent under Navy jurisdiction and about 95 percent under Bureau of Mines jurisdiction. Production from the Amarillo plant represents actual helium in the airship gas of better than 98-percent purity produced by that plant. Therefore, the advantage of the Amarillo plant from standpoint of cost is about 5 percent greater than a direct comparison of the figures indicates.

[2] Gross operating costs for the Fort Worth plant represent expenditures in operating and maintaining the plant, including current expenditures for natural gas. The Government did not own the gas field that supplied the Fort Worth plant, so there was no return from sale of residue. Gross operating cost for the Amarillo plant represents expenditure in operating and maintaining both the plant and the Government-owned gas properties. This gross operating cost at Amarillo is a measure of the amount that must be available to the Bureau of Mines for current expenditure. Returns from sale of residue gas, in excess of its cost, must be deposited to credit of miscellaneous receipts of the Treasury and therefore are not available for expenditure by the Bureau. As the net operating cost is computed by subtracting current returns from current expenditures, it is a measure of the net withdrawal of funds from the Treasury for operation and maintenance.

[3] Costs at the Fort Worth plant are based on compilations by the Bureau of Efficiency from records of the Navy Department and the Bureau of Mines. (Report of Bureau of Efficiency in hearing on Amarillo helium plant before the Committee on Mines and Mining, House of Representatives, 71st Cong., 2d sess., p. 210.) The costs do not include depreciation or depletion, and those for period of Navy jurisdiction do not include cost of Washington administration.

[4] Plant closed in 1922 from January to September, inclusive, because of lack of funds.

[5] Compiled from Bureau of Mines records. The costs do not include depreciation or depletion.

[6] Plant shut down entire months of December 1929 and February 1930 because the Navy purchased its helium elsewhere at $34 per thousand cubic feet. Stand-by costs for these 2 months were $19,181.14.

[7] Unit costs for year 1933 abnormally low because of Government pay cuts, furlough of employees, and reduction of plant crew to the minimum required to man plant and gas field for intermittent operation. In normal times considerably higher unit costs for a like volume of production may be expected. Average costs for entire fiscal year 1934 probably will exceed those for the first 6 months.

## NONGOVERNMENTAL PRODUCTION

The only production of helium for aeronautics in privately owned plants has been at Dexter, Kans., and Thatcher, Colo. Small plants at these points have operated intermittently since October 1927. During their main operating period (October 1927 to February 1930) they produced a little more than 8,000,000 cubic feet of helium, approximately 80 percent of which was sold to the Navy Department at about $34 per thousand cubic feet. Since February 1930 the annual production from these 2 plants has been of the order of 1 million cubic feet per year, the principal use being in small, privately owned dirigibles of the nonrigid type.

## STORAGE AND TRANSPORTATION

*Storage.*—As helium is a fugacious element it is difficult to store. It may be compressed into steel cylinders under high pressure or stored in gas holders at low pressure, but the cost of such equipment for holding large volumes is excessive. The best place to store helium until needed is in its natural reservoir underground. The Government's complete control of the Cliffside gas structure makes this possible. Therefore, only enough storage capacity is provided at the Amarillo plant to give flexibility in operation and the Army and Navy air stations need only enough to provide a working reserve for current use.

*Transportation.*—The helium produced in the Amarillo plant is a little better than 98 percent pure. It is discharged under a pressure of about 2,000 pounds per square inch into special tank cars operated by the Army and Navy. The older cars have 3 large cylinders to hold the helium, but the more recent ones have 28 or 30 cylinders of much smaller diameter. The cylinders are mounted on special railroad trucks. The capacity of each of these cars is approximately 200,000 cubic feet of helium.

## FOREIGN SUPPLIES AND EXPORTS

*Foreign supplies.*—The Bureau's field surveys indicate that no other country has reserves of helium-bearing natural gas comparable to those in the United States. A small field in Canada (Ontario) contains 0.8 percent. Generally the helium content of natural gases produced in Europe is so small that extraction would be almost, if not altogether, prohibitive.

*Exports.*—Exportation of helium from the United States is prohibited, except with the approval of the President on the joint recommendation of the Secretaries of War, the Navy, and the Interior.[3] All exports to date have been in small quantities, principally for use in scientific work.

## USES AND FUTURE POSSIBILITIES

*Helium for airships and other uses.*—The new helium required for a year's operation of a ship is one to one and one-half times its volume. A hydrogen-filled ship, to reduce the hazards of explosion, would require 5 to 10 complete changes of hydrogen per year. Economies of operation therefore favor a helium-filled ship, although the initial cost of helium may be greater than that of hydrogen.

Virtually all the helium produced at the Amarillo plant is used for aeronautical purposes by the two military arms of the Government. Other uses have been proposed, namely, as an artificial vehicle for oxygen in deep-sea diving, in certain types of radio tubes, for

[3] Act approved Mar. 3, 1927 (44 Stat. 1387); also Executive order of Feb. 22, 1934, transferring the Bureau of Mines to the Department of the Interior, pursuant to the act approved Mar. 3, 1933 (Public, No. 428, 72d Cong.)

cooling electrical equipment, and for electric signs. It is also used to some extent in filling toy balloons and as an inert atmosphere in metallurgical operations.

*Future possibilities.*—The production of helium is closely allied with the operation of large lighter-than-air craft. Therefore, future development of helium as an industrial product seems to depend almost entirely upon advancement in the use of dirigibles. As helium becomes more universally available and its cost is reduced one may expect it to find new and varied applications. However, until such uses have passed the experimental stage, which is hardly true at present, the future of lighter-than-air craft will determine the future of helium production.

# ASPHALT AND RELATED BITUMENS

By A. H. Redfield

## SUMMARY OUTLINE



Sales of petroleum asphalt changed little in quantity but increased 26.5 percent in value from 1932 to 1933. Domestic demand was virtually unchanged. Exports of petroleum asphalt were 1 percent less in 1933 than in 1932; they accounted for 8.6 percent of the asphalt sold in 1932 and 8.4 percent of that sold in 1933. Imports, chiefly of lake asphalt from Trinidad and grahamite from Cuba, constituted less than 1 percent of the asphalt apparently consumed in the United States in 1932 and 1933.

Decreased construction of hard-surfaced streets and highways was reflected in a decline of 6.8 percent in the tonnage of paving asphalt sold, and of 9.2 percent in the tonnage of natural rock asphalt sold. On the other hand, increased use in the construction of low-cost bituminous types of surface, especially on secondary roads, caused sales of cut-back asphalt to increase 15.4 percent in quantity. Sales of road oil, however, were 24.5 percent less in 1933 than in 1932, partly because of the substitution of cut-back asphalt and partly because of decreased construction of highways.

A slight gain in the manufacture of prepared roofing made little change in sales of roofing asphalt and flux from 1932 to 1933.

*Salient statistics of asphalt and related bitumens in the United States, 1932–33*

| | 1932 | 1933 |
|---|---|---|
| SUPPLY | | |
| Native asphalt and related bitumens: | | |
| Produced ... short tons | 340,019 | 313,135 |
| Imported (chiefly lake asphalt) ... do | 20,474 | 21,706 |
| Petroleum asphalt (excluding road oil): | | |
| Produced at refineries from— | | |
| Domestic petroleum ... do | 1,115,547 | 1,237,386 |
| Foreign petroleum ... do | 1,359,372 | 1,218,665 |
| | 2,474,919 | 2,456,051 |
| Stocks, Jan. 1 ... do | 304,623 | 298,684 |
| Total supply ... do | 3,140,035 | 3,089,576 |

*Salient statistics of asphalt and related bitumens in the United States, 1932–33*—Continued

| | 1932 | 1933 |
|---|---|---|
| DISTRIBUTION | | |
| Native asphalt and related bitumens: | | |
| Indicated domestic demand ... short tons | 327,654 | 299,329 |
| Exports (unmanufactured) ... do | 12,365 | 13,806 |
| Petroleum asphalt (excluding road oil): | | |
| Indicated domestic demand (including lake asphalt) ... do | 2,295,326 | 2,296,046 |
| Exports ... do | 206,006 | 204,032 |
| Stocks, Dec. 31 ... do | 298,684 | 276,363 |
| Total distribution | 3,140,035 | 3,089,576 |
| VALUES | | |
| Native asphalt and related bitumens: | | |
| Sales | $1,942,943 | $1,705,310 |
| Imports (chiefly lake asphalt) | 251,402 | 278,401 |
| Exports (unmanufactured) | 448,949 | 553,892 |
| Petroleum asphalt: | | |
| Sales (excluding road oil) from— | | |
| Domestic petroleum | 8,591,564 | 10,675,280 |
| Foreign petroleum | 10,013,553 | 12,867,264 |
| Total sales | 18,605,117 | 23,542,544 |
| Exports | 3,168,138 | 2,860,964 |

## NATIVE ASPHALTS AND BITUMENS

*Bituminous rock.*—Sales of bituminous rock by producers in the United States decreased 9.2 percent in quantity and 20.5 percent in value from 1932 to 1933. They amounted to 314,039 short tons valued at $1,415,427 in 1932 and 285,070 tons valued at $1,125,164 in 1933. Producers of bituminous sandstone in Kentucky sold 91,289 tons valued at $792,643 in 1932 and 44,369 tons valued at $356,139 in 1933. Operators of quarries near Uvalde, Tex., sold 132,636 tons of asphaltic limestone valued at $312,663 in 1932 and 126,069 tons valued at $353,847 in 1933. The remaining sales were made by producers in Alabama, California, Kansas, New Mexico, and Oklahoma.

Exports of natural asphalt and bitumen, unmanufactured, increased from 12,365 short tons valued at $448,949 in 1932 to 13,806 tons valued at $553,892 in 1933. Of these exports, 80 percent in 1932 and 80.5 percent in 1933 went to Europe, chiefly to the United Kingdom, France, Germany, the Netherlands, Italy, and Belgium. Canada received 11 percent of the exports in 1932 and 8.8 percent in 1933.

*Gilsonite and wurtzilite.*—Greater demand for paints and varnishes and greater activity in the rubber industry increased the sales of gilsonite by producers in northeastern Utah from 25,955 short tons valued at $525,266 in 1932, to 28,029 tons valued at $577,716 in 1933.

Similarly, sales of wurtzilite increased from 25 short tons valued at $2,250 in 1932, to 36 tons valued at $2,430 in 1933.

## MANUFACTURED OR PETROLEUM ASPHALT

Domestic demand for petroleum asphalt remained practically unchanged—from 2,295,326 short tons in 1932 to 2,296,046 tons in 1933. Production of petroleum asphalt at refineries in the United States decreased from 2,474,919 tons in 1932 to 2,456,051 tons in 1933.

Imports, chiefly of lake asphalt and grahamite, increased slightly—from 20,474 short tons in 1932 to 21,706 tons in 1933. Exports of petroleum asphalt declined from 206,006 short tons in 1932 to 204,032 in 1933. The domestic supply was augmented by the withdrawal of 22,321 tons from stocks in 1933 compared with a reduction of 5,939 tons in stocks in 1932.

*Production, receipts, stocks, consumption, transfers and losses, and sales of asphalt (exclusive of road oil) at petroleum refineries in the United States in 1933, by districts*

| District | Production | Other petroleum products blended | Receipts from other sources | Stocks: Dec. 31, 1932 | Stocks: Dec. 31, 1933 |
|---|---|---|---|---|---|
| | *Short tons* | *Short tons* | *Short tons* | *Short tons* | *Short tons* |
| East Coast | 1,054,975 | 84,262 | 18,551 | 108,439 | 96,254 |
| Appalachian | 88,430 | 3,555 | 71 | 9,360 | 9,028 |
| Indiana-Illinois-Kentucky | 422,212 | 21,820 | 257 | 66,277 | 57,447 |
| Oklahoma-Kansas-Missouri | 66,720 | 1,303 | 154 | 4,706 | 7,170 |
| Texas: | | | | | |
| Gulf Coast | 156,149 | | | 5,963 | 7,197 |
| Rest of State | 33,651 | | 1,482 | | 2,644 |
| Total, Texas | 189,800 | | 1,482 | 5,963 | 9,841 |
| Louisiana-Arkansas: | | | | | |
| Louisiana Gulf Coast | 100,184 | 8,651 | 203 | 38,392 | 28,963 |
| Northern Louisiana and Arkansas | 81,365 | 5,022 | | 22,819 | 19,169 |
| Total Louisiana and Arkansas | 181,549 | 13,673 | 203 | 61,211 | 48,132 |
| Rocky Mountain | 3,382 | 546 | 1,686 | 3,231 | 2,525 |
| California | 312,411 | 11,413 | 31,551 | 39,497 | 45,966 |
| Grand total, 1933 | 2,319,479 | 136,572 | 53,955 | 298,684 | 276,363 |
| Total, 1932 | 2,367,428 | 107,491 | 77,126 | 304,623 | 298,684 |

| District | Consumption by companies | Transfers and losses | Sales: Quantity | Sales: Value |
|---|---|---|---|---|
| | *Short tons* | *Short tons* | *Short tons* | |
| East Coast | 3,571 | 712 | 1,165,690 | $12,183,401 |
| Appalachian | 18 | | 92,370 | 1,085,355 |
| Indiana-Illinois-Kentucky | 1,251 | 4,422 | 447,446 | 4,047,953 |
| Oklahoma-Kansas-Missouri | 29,563 | 1 | 36,149 | 351,832 |
| Texas: | | | | |
| Gulf Coast | 26,382 | 11,037 | 117,496 | 980,468 |
| Rest of State | | | 32,489 | 261,321 |
| Total, Texas | 26,382 | 11,037 | 149,985 | 1,241,789 |
| Louisiana-Arkansas: | | | | |
| Louisiana Gulf Coast | 2,254 | 24 | 116,189 | 1,120,125 |
| Northern Louisiana and Arkansas | | | 90,037 | 587,897 |
| Total, Louisiana and Arkansas | 2,254 | 24 | 206,226 | 1,708,022 |
| Rocky Mountain | 540 | 1,685 | 4,095 | 44,767 |
| California | 26,067 | | 322,839 | 2,879,425 |
| Grand total, 1933 | 89,646 | 17,881 | 2,424,800 | 23,542,544 |
| Total, 1932 | 64,236 | 84,930 | 2,408,818 | 18,605,117 |

*Production.*—Asphalt manufactured in the East Coast and Gulf Coast districts from foreign petroleum, imported chiefly from Venezuela, Colombia, and Mexico, decreased from 1,359,372 short tons in 1932 to 1,218,665 in 1933. On the other hand, asphalt manufactured from domestic petroleum increased from 1,115,547 tons in 1932 to 1,237,386 in 1933.

The total refinery output in 1933 included 136,572 short tons of other petroleum products blended with the asphalt to produce commercial varieties of the required hardness and consistency.

*Sales by uses.*—Sales of asphalt at petroleum refineries were little changed in quantity—from 2,408,818 short tons in 1932 to 2,424,800 in 1933. In value, however, they increased 26.5 percent—from $18,605,117 in 1932 to $23,542,544 in 1933.

Nearly all grades of asphalt advanced in value from 1932 to 1933. The average sales value of paving asphalt increased from $7.41 per short ton in 1932 to $9.36 in 1933. Roofing asphalt, which sold for $7.22 per ton in 1932, brought $9.68 in 1933. Cut-back asphalt, valued at $8.27 per ton in 1932, averaged $11.34 in 1933. On the other hand, the value of emulsified asphalt sold declined from $12.90 per ton in 1932 to $10.65 in 1933; and of roofing flux from $8.53 per ton in 1932 to $7.49 in 1933.

*Asphalt and asphaltic material (exclusive of road oil) sold at petroleum refineries in the United States in 1933, 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 | 355,276 | $3,082,557 | 443,331 | $4,392,294 | 798,607 | $7,474,851 |
| Roofing | 292,365 | 2,713,889 | 203,093 | 2,082,947 | 495,458 | 4,796,836 |
| Waterproofing | 55,719 | 503,684 | 48,163 | 476,765 | 103,882 | 980,449 |
| Blending with rubber | 3,067 | 35,503 | 18,544 | 207,592 | 21,611 | 243,095 |
| Briquetting | 27,003 | 302,817 | 4,087 | 42,738 | 31,090 | 345,555 |
| Mastic and mastic cake | 212 | 1,701 | 679 | 7,060 | 891 | 8,761 |
| Pipe coatings | 4,953 | 61,423 | 1,967 | 19,650 | 6,920 | 81,073 |
| Molding compounds | 2,899 | 30,496 | 6,139 | 64,827 | 9,038 | 95,323 |
| Miscellaneous uses | 30,746 | 298,137 | 38,633 | 380,605 | 69,379 | 678,742 |
| | 772,240 | 7,030,207 | 764,636 | 7,674,478 | 1,536,876 | 14,704,685 |

[1] DEFINITIONS

*Paving asphalt.*—Refined alphalt 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.
*Waterproofiing asphalt.*—Asphalt and asphaltic cement used to waterproof and damp-proof 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.

*Asphalt and asphaltic material (exclusive of road oil) sold at petroleum refineries in the United States in 1933, by varieties*—Continued

[Value f.o.b. refinery]

| | From domestic petroleum | | From foreign petroleum | | Total | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| Semisolid and liquid products of more than 200 penetration:[1] | | | | | | |
| Flux for— | | | | | | |
| Paving | 67,417 | $459,286 | 43,500 | $415,823 | 110,917 | $875,109 |
| Roofing | 124,292 | 647,924 | 82,340 | 898,890 | 206,632 | 1,546,814 |
| Waterproofing | 2,481 | 16,388 | 5,495 | 60,382 | 7,976 | 76,770 |
| Cut-back asphalts | 194,945 | 2,166,463 | 313,608 | 3,598,535 | 508,553 | 5,764,998 |
| Emulsified asphalts and fluxes | 19,439 | 220,911 | 13,864 | 129,643 | 33,303 | 350,554 |
| Paints, enamels, japans, and lacquers | 7,275 | 92,179 | 5,915 | 65,407 | 13,190 | 157,586 |
| Other liquid products | 4,618 | 41,922 | 2,735 | 24,106 | 7,353 | 66,028 |
| | 420,467 | 3,645,073 | 467,457 | 5,192,786 | 887,924 | 8,837,859 |
| Grand total, 1933 | 1,192,707 | 10,675,280 | 1,232,093 | 12,867,264 | 2,424,800 | 23,542,544 |
| Total, 1932 | 1,062,816 | 8,591,564 | 1,346,002 | 10,013,553 | 2,408,818 | 18,605,117 |

[1] See footnote 1 on page 768.

Road building and street paving consumed 60 percent of the asphalt sold in 1933, in the form of paving asphalt, paving flux, cut-back asphalt, and emulsified asphalt. Decreased construction of high-type roads and hard-paved streets caused sales of paving asphalt to decline from 856,638 short tons in 1932 to 798,607 in 1933. Sales of paving flux increased slightly. On the other hand, increased use in the construction of low-cost bituminous types of surfacing caused the sales of cut-back asphalts to increase from 440,838 tons in 1932 to 508,553 in 1933. Refinery sales of asphalts emulsified with water decreased from 44,354 tons (10,436,288 gallons) in 1932 to 33,303 tons (7,845,911 gallons) in 1933. In addition, 25,800,000 gallons of asphalt emulsions valued at $1,908,488 prepared by industrial companies from asphalts purchased from petroleum refineries were sold in 1932 and 21,149,000 gallons valued at $1,132,790 in 1933.

Of the total asphalt sold in 1933, 29 percent was used in the manufacture of prepared roofing. Although statistics compiled by the Bureau of the Census showed a slight increase in factory shipments of prepared roofing and a slight increase in the factory consumption of dry roofing felt from 1932 to 1933, refinery sales of asphalt for roofing manufacture were little changed—from 702,393 tons in 1932 to 702,090 in 1933. A marked decrease in sales of roofing asphalt was counterbalanced by an almost equal increase in sales of roofing flux.

The construction industries accounted for 5 percent of all asphalt sold by refineries in 1933, in the form of waterproofing asphalt and flux, mastic and mastic cake, pipe coatings, and paints, varnishes, and lacquers. Sales of this group of products as a whole increased from 124,952 tons in 1932 to 132,859 tons in 1933.

The shift in the uses of asphalt, which has been manifest since 1930, continued in 1933. Cut-back asphalts increased in relative importance, constituting 21 percent of all asphalts sold in 1933 compared with 18.3 percent in 1932, 15.5 percent in 1931, and 8.1 percent in

1930. On the other hand paving asphalt, which made up 42.4 percent of all asphalts sold in 1930, 39.1 percent of the sales in 1931, and 35.6 percent of the sales in 1932 constituted only 32.9 percent of the asphalt sold in 1933. Similarly, roofing asphalt declined in relative importance from 26.2 percent in 1930, 24.7 percent in 1931, and 23.6 percent in 1932 to 20.4 percent in 1933.

## DOMESTIC DEMAND

Domestic demand for petroleum asphalt (including small quantities of imported lake asphalt and grahamite) averaged 191,337 short tons per month during 1933 compared with 191,277 tons per month in 1932. The average monthly demand in 1933 was 29.2 percent below the expected demand (270,246 tons) according to the long-time trend compared with 26.6 percent below the expected demand (260,423 tons) in 1932.

During the first 3 months of 1933 the indicated domestic demand

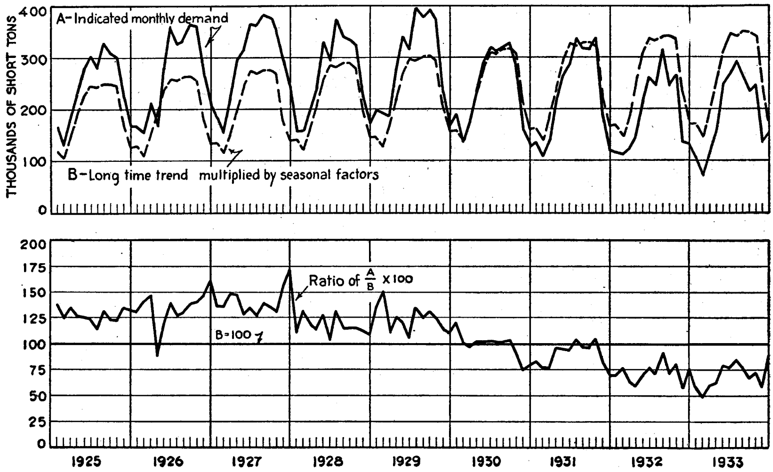


FIGURE 60.—Relation of indicated monthly demand for asphalt, 1925–33, to long-time trend, 1908–31, multiplied by seasonal factors. The long-time trend is expressed by the formula, log $Y$=1.095818+0.944148 log $X$, in which $Y$ equals the average monthly demand for petroleum and lake asphalt during each 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.

averaged 55.8 percent of the long-time trend multiplied by seasonal factors compared with 70.6 percent in the first 3 months of 1932. In the second quarter of 1933 the actual demand averaged 72.4 percent of the expected demand compared with 69.2 percent during the second quarter of 1932. From July to September 1933 the actual demand averaged 75.7 percent of the expected demand compared with 79 percent in the same months of 1932. In the last 3 months of 1933 domestic requirements of asphalt averaged 71.8 percent of the expected reqirements compared with 71 percent in the corresponding months of 1932.

*Relation of indicated asphalt demand to basic trend multiplied by seasonal factors, 1932–33*

| Month | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Trend multiplied by seasonal factors | Indicated monthly demand | Relation of indicated monthly demand to trend | Trend multiplied by seasonal factors | Indicated monthly demand | Relation of indicated monthly demand to trend |
| | *Short tons* | *Short tons* | *Percent* | *Short tons* | *Short tons* | *Percent* |
| January | 166,421 | 115,302 | 69.28 | 172,816 | 103,183 | 59.71 |
| February | 143,027 | 110,536 | 77.28 | 148,504 | 71,873 | 48.40 |
| March | 189,278 | 123,435 | 65.21 | 196,501 | 116,549 | 59.31 |
| April | 247,600 | 147,276 | 59.48 | 257,019 | 159,034 | 61.88 |
| May | 304,528 | 214,976 | 70.59 | 316,073 | 249,577 | 78.96 |
| June | 335,366 | 259,498 | 77.38 | 348,029 | 265,924 | 76.41 |
| July | 331,831 | 243,532 | 73.39 | 343,978 | 290,612 | 84.49 |
| August | 338,657 | 313,353 | 92.53 | 351,370 | 266,359 | 75.81 |
| September | 338,589 | 241,124 | 71.21 | 351,255 | 235,150 | 66.94 |
| October | 331,169 | 262,806 | 79.36 | 343,518 | 247,597 | 72.08 |
| November | 230,700 | 132,375 | 57.38 | 239,275 | 136,897 | 57.25 |
| December | 171,728 | 131,113 | 76.35 | 178,088 | 153,291 | 86.08 |
| Total | | 2,295,326 | | | 2,296,046 | |

## DISTRIBUTION BY RAIL

The tonnage of asphalt (natural, byproduct, or petroleum), terminated by class I railroads in the United States amounted to 2,407,165 short tons, a decrease of 8 percent from the 2,617,253 tons terminated in 1932, according to statistics compiled by the Interstate Commerce Commission. The greatest decreases were in terminations of asphalt by transcontinental railroads operating between Chicago and Duluth on the east and the Pacific coast on the west; by railroads serving the corn and wheat States west of the Mississippi River; and by railroads of the Great Lakes region and of New England. On the other hand, more asphalt was terminated in 1933 than in 1932 by railroads operating between New York, Philadelphia, and Baltimore on the east and Chicago, Peoria, and St. Louis on the west; and by railroads of Missouri, Arkansas, Louisiana, eastern and southern Texas, and eastern Oklahoma.

Nearly 70 percent of the asphalt (petroleum, lake, and natural rock) terminated in the United States by land carriers in 1933 was delivered to consumers in the northeastern district, lying north of the Potomac and Ohio Rivers, and east of the Mississippi and Illinois Rivers. Class I railroads terminated in this district 1,680,535 short tons of asphalt in 1932 and 1,726,803 in 1933. In the southeastern district, lying south of the Potomac and Ohio Rivers and east of the Mississippi and Pearl Rivers, railroad deliveries of asphalt increased from 272,429 tons in 1932 to 278,499 in 1933. In the southwestern district, west of the Mississippi and Pearl Rivers and south of St. Louis, Kansas City, and Amarillo, asphalt deliveries amounted to 111,868 tons in 1932 and to 167,924 in 1933. On the contrary, railroad terminations of asphalt in the north central district dropped from 311,019 tons in 1932 to 116,208 in 1933. Similarly, in the Pacific-Rocky Mountain district west of Great Falls, Cheyenne, Denver, Albuquerque, and El Paso the tonnage of asphalt terminated

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by land carriers decreased from 247,128 tons in 1932 to 188,346 in 1933.

*Supply and distribution of asphalt (petroleum, lake, and natural rock) exclusive of road oil, in the United States, by districts, 1933, in short tons*

| | North-eastern district | South-eastern district | South-western district | North Central district | Pacific-Rocky Mountain district |
|---|---|---|---|---|---|
| SOURCE | | | | | |
| Produced within district | 1,492,223 | 289,085 | 616,480 | | 361,017 |
| Imported | 11,311 | 8,647 | 1,675 | 2 | 71 |
| Received by rail from: | | | | | |
| Northeastern district | | 25,000 | 2,500 | 60,206 | |
| Southeastern district | 266,188 | | 25,000 | 24,000 | |
| Southwestern district | 26,000 | 257,615 | | 29,000 | |
| Pacific-Rocky Mountain district | | | 11,736 | 3,000 | |
| Received by water (coastwise) | 78,000 | 23,000 | 8,000 | | 10,000 |
| Withdrawn from stocks | 30,628 | | 6,737 | | |
| | 1,904,350 | 603,347 | 672,128 | 116,208 | 371,088 |
| DISTRIBUTION | | | | | |
| Shipped by rail: | | | | | |
| Within district | 1,726,803 | 278,499 | 167,924 | 116,208 | [1]188,346 |
| To Northeastern district | | 266,188 | 26,000 | | |
| To Southeastern district | 25,000 | | 257,615 | | |
| To Southwestern district | 2,500 | 25,000 | | | 11,736 |
| To North Central district | 60,206 | 24,000 | 29,000 | | 3,000 |
| Shipped by water (coastwise and intraport) | 34,214 | 3,000 | 107,000 | | 85,000 |
| Exported | 55,627 | 379 | 84,589 | | 77,243 |
| Added to stocks | | 6,281 | | | 5,763 |
| | 1,904,350 | 603,347 | 672,128 | 116,208 | 371,088 |

[1] Includes shipments by electric railroads, minor steam railroads, and motor trucks.

## FOREIGN TRADE

*Imports.*—Imports of asphalt and bitumen into the United States increased 6 percent in quantity (from 20,474 short tons in 1932 to 21,706 in 1933) and 10.7 percent in value (from $251,402 in 1932 to $278,401 in 1933). Lake asphalt imported from Trinidad amounted to 12,596 short tons in 1932 and 12,047 in 1933. Glance pitch or grahamite from Cuba increased from 7,457 tons in 1932 to 8,286 in 1933. From Germany 186 short tons of "Montan wax bitumen" were received in 1932 and 1,040 in 1933.

Of the imports in 1933, 12,200 short tons were received at Atlantic coast ports, chiefly New York, Baltimore, and Norfolk, and 8,674 at Gulf coast ports, chiefly Mobile and Galveston.

*Exports.*—Exports of petroleum asphalt decreased 1 percent in quantity (from 206,006 short tons in 1932 to 204,032 in 1933) and 9.7 percent in value (from $3,168,138 in 1932 to $2,860,964 in 1933). Compared with 1928, when exports of petroleum asphalt amounted to 492,362 short tons valued at $9,788,501, the exports in 1933 represented a decline of 58.6 percent in quantity and of 70.7 percent in value.

Coincident with the decline in quantity the export trade in petroleum asphalt underwent a marked regional shift in demand from 1928 to 1933, inclusive. Countries of northern and western Europe, which bought 264,476 tons or 53.7 percent of the petroleum asphalt exported from the United States in 1928, took only 46,911 tons or 23 percent of the exports in 1933. This decline in European demand may be attributed chiefly to the increased manufacture of asphalt by refineries in Great Britain, France, Germany, and the Netherlands. Similarly Canada, which bought 47,799 short tons of petroleum asphalt from the United States in 1928, imported only 3,498 tons in 1933, while Canadian refineries supplied 64.5 percent of the asphalt requirements of the Dominion in 1928 and 90.5 percent in 1932. On the other hand, countries of the western Pacific Basin, notably Australia, Netherland East Indies, Japan, China, Hong Kong, and New Zealand, whose share in the exports of petroleum asphalt from the United States totaled 23.5 percent in 1928, received 41.9 percent of these shipments in 1932 and 33.8 percent in 1933. Countries on the Indian Ocean, chiefly British India, British Malaya, Ceylon, and Mozambique, bought 18,404 short tons (3.7 percent of the total exports) in 1928 and 27,059 tons (13.3 percent) in 1933. Sales of petroleum asphalt to Mediterranean countries, chiefly Italy, have grown from 15,911 tons (3.2 percent of the total) in 1928 to 32,787 tons (16.1 percent) in 1933. Exports to Latin America have decreased from 21,456 tons in 1928 to 16,789 in 1933, but the share of these countries in the total exports of petroleum asphalt from the United States has increased from 4.4 percent in 1928 to 8.2 in 1933.

More than nine-tenths of the petroleum asphalt sold to foreign countries was exported through three ports. Exports from the customs district of New York increased from 36,637 short tons in 1932 to 48,522 in 1933; exports from the Sabine customs district increased from 71,563 tons in 1932 to 74,739 in 1933; but exports from San Francisco decreased from 80,039 tons in 1932 to 67,263 in 1933. Shipments over the northern border to Canada dropped from 10,846 tons in 1932 to 2,738 in 1933.

## ROAD OIL

Sales of road oil by petroleum refineries in the United States were 24.5 percent less in quantity and 13.9 percent less in value in 1933 than in 1932. At least some of the apparent decrease in demand for road oil may be explained by the substitution of cut-back asphalts for road oils, especially in the construction of low-cost bituminous types of surfacing. This is evidenced by the increase in sales of cut-back asphalts from 440,838 short tons (about 2,425,000 barrels) in 1932 to 508,553 tons (2,797,000 barrels) in 1933. Moreover, some disagreement still exists over the classification of liquid asphaltic products of petroleum by the refining companies. Some road oils, as sold, are in fact blends of residual oil and lighter petroleum distillates and are difficult to distinguish in practice from cut-back asphalts. Although specifications for liquid asphaltic products have recently been recommended to the Federal Specifications Board by the Bureau of Public Roads and the Asphalt Institute, there is yet no general agreement in practice over the definition of road oil and its application.

*Road oil sold by petroleum refineries in the United States, 1932–33, by districts*

| District | 1932 | | 1933 | |
|---|---|---|---|---|
| | Barrels | Value | Barrels | Value |
| East coast | 1,042,185 | $1,205,069 | 863,656 | $1,243,813 |
| Appalachian | 199,273 | 172,519 | 137,868 | 222,770 |
| Indiana-Illinois-Kentucky | 2,574,621 | 2,053,411 | 1,828,844 | 1,666,754 |
| Oklahoma-Kansas-Missouri | 1,058,854 | 809,584 | 661,953 | 597,792 |
| Texas: | | | | |
| Gulf coast | 90,893 | 107,617 | 165,141 | 199,619 |
| Rest of State | 196,713 | 62,960 | 61,826 | 38,691 |
| Total Texas | 287,606 | 170,577 | 226,967 | 238,310 |
| Louisiana-Arkansas: | | | | |
| Louisiana Gulf coast | 75,649 | 63,756 | 48,814 | 68,469 |
| Northern Louisiana and Arkansas | 153,117 | 61,918 | 101,241 | 63,865 |
| Total Louisiana and Arkansas | 228,766 | 125,674 | 150,055 | 132,334 |
| Rocky Mountain | 904,892 | 998,910 | 484,505 | 531,582 |
| California | 1,968,627 | 1,770,588 | 1,885,050 | 1,655,764 |
| Grand total | 8,264,824 | 7,306,332 | 6,238,898 | 6,289,119 |

By far the greater part of the road oil sold in the United States in 1932 and 1933 was made from domestic petroleum. Only 10.3 percent of the total road oil sold in 1932 and only 11.6 percent in 1933 was made from foreign crude petroleum, imported chiefly from Venezuela and Mexico. Of the road oil made from foreign crude 86.4 percent was sold by refineries of the Atlantic seaboard in 1932 and 88 percent in 1933; the rest was made in Gulf coast refineries of Louisiana and Texas.

Eighty percent of the road oil sold in 1932 and 83 percent of that sold in 1933 came from four refining districts—the east coast district, the Indiana-Illinois-Kentucky district, the Oklahoma-Kansas-Missouri district, and the California district. Road-oil sales in all four districts decreased from 1932 to 1933. The only gain in road-oil sales from 1932 to 1933 occurred in the Texas Gulf coast district.

Petroleum refineries in the United States reported the production of 5,534,455 barrels of road oil in 1933, compared with 6,879,000 in 1932. The refinery output of road oil was augmented in 1933 by 1,027,814 barrels of other petroleum products, chiefly fuel oil, transferred to road-oil stocks, compared with 1,579,590 barrels similarly transferred in 1932. Stocks of road oil and of transferred fuel and other oils, held at refineries in the United States, increased from 571,333 barrels on December 31, 1932, to 832,738 on December 31, 1933. Consumption of road-oil by refineries in their own operations, losses, and adjustments accounted for 61,966 barrels during 1933 compared with 109,670 in 1932.

Prices of road oil were generally higher in 1933 than in 1932. In the east coast district the average sales value of road oil increased from $1.156 per barrel in 1932 to $1.44 in 1933. Refineries of the Indiana-Illinois-Kentucky district sold road oil at an average price of $0.798 in 1932 and of $0.911 in 1933. Producers of the Oklahoma-Kansas-Missouri district obtained an average price of $0.765 in 1932 and of $0.903 in 1933. On the other hand, the average value of road oil sold at California refineries declined from $0.899 in 1932 to $0.878 in 1933.

# CEMENT

By H. H. Hughes and B. W. Bagley

## SUMMARY OUTLINE



Normal outlets for portland cement in 1933 were curtailed drastically by the sharp drop in concrete-pavement contract awards and the continued slump in building construction. The increase in construction-contract awards toward the end of the year, which resulted largely through the efforts of the Public Works Administration, arrived too late to prevent a decline of 20.7 percent in shipments of portland cement in 1933 compared with 1932. Salient statistics of the industry are summarized in the following table:

*Salient statistics of the cement industry in the United States, 1932–33*

| | 1932 | 1933 [1] | Percent of change in 1933 |
|---|---|---|---|
| Portland cement: | | | |
| Production ... barrels | 76, 740, 945 | 63, 373, 000 | −17. 4 |
| Shipments ... do | 80, 843, 187 | 64, 086, 000 | −20. 7 |
| Stocks at mills [2] ... do | 20, 240, 204 | 19, 541, 000 | −3. 5 |
| Capacity ... do | 271, 308, 000 | (3) | |
| Value of shipments | $82, 021, 723 | $83, 965, 000 | +2. 4 |
| Unit factory value | $1. 01 | $1. 31 | +29. 7 |
| Exports: [4] | | | |
| Barrels | 374, 581 | 680, 301 | +81. 6 |
| Total value | $802, 205 | $1, 487, 686 | +85. 4 |
| Average per barrel [5] | $2. 14 | $2. 19 | +2. 3 |
| Imports: | | | |
| Barrels | 462, 496 | 477, 784 | +3. 3 |
| Total value | $351, 033 | $400, 594 | +14. 1 |
| Business indicators: | | | |
| Capacity utilized: | | | |
| Portland cement [6] ... percent | 28. 3 | 23. 6 | −16. 6 |
| Steel [7] ... do | 20. 0 | 34. 0 | +70. 0 |
| Industrial production [8] ... index numbers | 64. 0 | 76. 0 | +18. 8 |
| Asphalt, domestic demand [9] ... short tons | 2, 295, 326 | 2, 059, 146 | −10. 3 |

[1] Subject to revision.
[2] End of year.
[3] Total capacity for 1933 not yet computed.
[4] Excludes shipments to Alaska, Hawaii, and Puerto Rico—296,562 barrels in 1932 and 265,943 barrels in 1933.
[5] Value of exports of domestic cement is actual cost at time of exportation in ports of the United States, as declared by shippers on export declarations.
[6] Output of finished cement is compared with estimated capacity of 165 plants at close of December 1932 and 163 plants at close of December 1933.
[7] Computed from statistics of American Iron and Steel Institute.
[8] Federal Reserve Board; 1923–25 average=100.
[9] Compiled by A. H. Redfield, Bureau of Mines; petroleum asphalt only.

Actual shipments of cement totaled only 64,086,000 barrels in 1933; even in 1911, the first year for which data on shipments were collected, they were more than 10,000,000 barrels higher than in 1933. Production in 1933 was 713,000 barrels less than shipments; thus stocks of finished cement decreased from 20,240,204 barrels at the end of 1932 to 19,541,000 barrels at the end of 1933. To find a period of comparable production one must go back to 1909, when the automobile industry was still in its infancy and a concrete road a curiosity.

Cement prices, however, improved in 1933. The average factory value advanced from $1.01 in 1932 to $1.31 in 1933. As a result, the total value of all cement shipped from mills in 1933 actually increased 2.4 percent from 1932, despite the drop of 20.7 percent in volume. The higher price enabled some companies to show profits for the year, even while operating at only a small fraction of their total capacity. It is estimated that the cement industry as a whole operated during 1933 at 23.6 percent of capacity.

Figure 61 shows the relation between cement shipments, value,

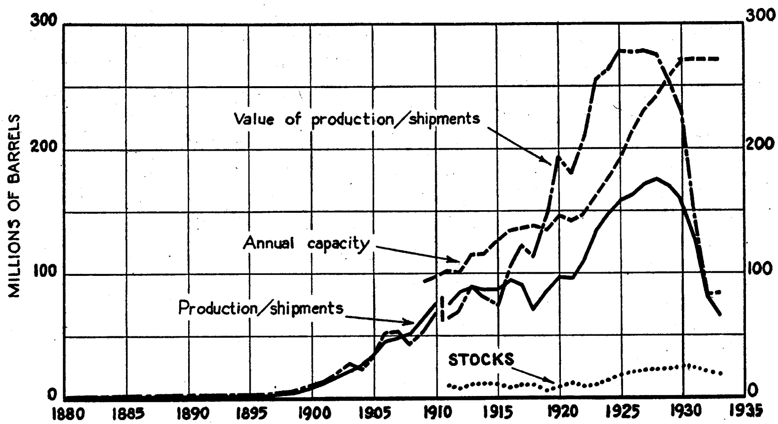


FIGURE 61.—Principal trends in the portland-cement industry, 1880–1933. The solid line represents production from 1880 to 1910 and shipments from 1911 to 1933.

capacity, and stocks from 1880 to 1933. Although 1924 marked the centennial of the discovery of portland cement, 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, leading to capacity in excess of average needs. Extensions of the curves from 1932 to 1933 reveal a further downward trend in shipments; but this is accompanied by a slight upturn in total value, no appreciable change in capacity, and reduction in stocks.

To gain a proper perspective of the cement industry it must be compared with other industries. Production of steel ingots in 1933 was 34 percent of capacity. This may seem low, but it represents an increase of about 70 percent over 1932, when steel production was only 20 percent of capacity. The indicated domestic demand for asphalt in 1933 dropped 10.3 percent from 1932. Asphalt competes directly with cement in highway construction, but large quantities also are used in the manufacture of prepared roofing.

Index numbers of the Federal Reserve Board, computed to show industrial production compared with 1923–25 as 100, stood at 76 in 1933, a net gain of 12 points, equivalent to a rise of 18.8 percent from 64, the average level of the index in 1932. The Federal Reserve Board index, of course, is weighted by industries less susceptible to fluctuating conditions than cement or steel.

Figure 62 shows the behavior of cement in comparison with the

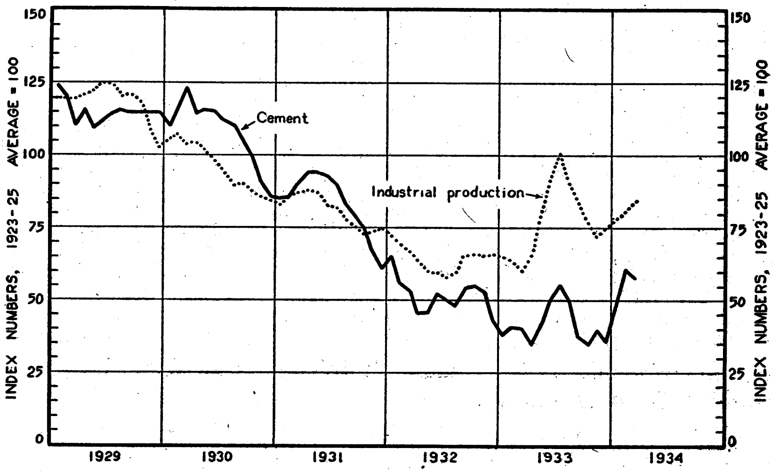


FIGURE 62.—Cement shipments compared with industrial production, 1929–34. The cement industry was relatively active through 1931 but dropped below industrial production in 1932 and 1933. The data are compiled by the Federal Reserve Board, and both indexes have been adjusted for seasonal variation.

general index of industrial production from 1929 to early in 1934. The indexes have been adjusted for seasonal variation. The position of the curves indicates that the cement industry held up well during 1930 and most of 1931 but dropped far below the general level of business in 1932 and 1933.

## ECONOMIC DEVELOPMENTS

The National Industrial Recovery Act was the strongest influence upon economic developments in the cement industry during 1933. This measure was designed "to encourage national industrial recovery, to foster fair competition, and to provide for the construction of certain useful public works." The importance of the Public Works Administration, created to carry out the last provision, is discussed in the supplement on the construction industry which accompanies this chapter.

*Code for Cement Industry.*—The Cement Institute conducted code negotiations for the cement industry. A proposed code was submitted to the Administrator July 19, 1933, but the public hearing was not scheduled until September 15. Objections to the code as proposed were voiced at the hearing, and it was not until November

27 that the code was approved by the President to be effective December 7, 1933.

*Wage and hour provisions.*—The provisions of the code as to wages and hours were summarized as follows in the Administrator's letter transmitting the code to the President:

> Hours of employment are permitted to be flexible over any half calendar year but are not permitted to be in excess of an average of more than thirty-six (36) hours per week during this period, nor more than eight (8) hours in any one day. The maximum hours of work are limited to forty-two (42) hours per week for employees other than clerical and office employees who are limited to forty (40) hours per week. Employees engaged in the work of packing and shipping are limited to ten (10) hours in any one day and thirty-six (36) hours per week averaged over any half calendar year.
>
> The following are exempted from the preceding provisions:
>
> (*a*) Employees engaged in executive, administrative, technical, and sales staff work, and employees in supervisory capacities.
>
> (*b*) Employees engaged in emergency work involving break-downs or protection of life or property.
>
> No evasion of this Code by reclassification of workers is permitted.
>
> Minimum wages are established in twelve geographical districts as defined by the Bureau of Mines. In two Southern districts a minimum hourly rate of thirty (30) cents per hour is established, in a portion of two districts a miniumm of thirty-seven (37) cents, and in a portion of one district a minimum of thirty-eight (38) cents. In all other districts a minimum of forty (40) cents is established.
>
> The above minimum rates are excepted only when the rate for the same class of work on July 15, 1929, was less than forty (40) cents per hour, in which case the hourly rate shall be not less than the hourly rate on July 15, 1929, and in no event less than thirty (30) cents per hour.
>
> No minor under the age of sixteen (16) years shall be employed, and no minor under the age of eighteen (18) years shall be employed in any hazardous occupation.

In transmitting the code, the Administrator outlined its probable economic effects as follows:

> Comparison of the production of portland cement in the years 1928 and 1932, shows a decline of 54 percent. Comparison of number or persons employed by the industry shows a decrease from 34,244 employees in 1928, to 11,941 in February 1933, or a decline in employment of 68.8 percent. It is estimated that based on employment in 1932, the adoption of the average 36-hour week as proposed in the Code will cause absorption by the industry of 5,618 additional workers and a pay-roll increase of approximately 40 percent.
>
> The approval of this Code is expected to (1) stabilize the industry and prevent economic disturbance due to price wars; (2) protect dealers and the consumer against undue monopolistic tendencies of the industry; (3) preclude the possibility of uncontrolled abuses due to the multiple basing system.

Details for organizing a code authority as the governing agency of the industry are provided in the code. Briefly, this body consists of a member from each of the 12 districts, seven chosen at large by the original 12, and three officers of The Cement Institute.

*Plan for sharing business.*—Because of the low utilization of productive facilities in many plants and the resultant increase in costs the cement industry has included in its code a plan for sharing available business. The code states that:

> The Board is hereby authorized to formulate a plan or plans, within thirty (30) days after the effective date of this Code, unless such time shall be extended by the Administrator, for the equitable allocation of available business among all members of the industry or among members of the industry operating in one or more Districts and for the control of cement inventory and to submit the same either to a meeting of all members of the industry or to meetings of members in the Districts affected, as the Board may determine, for approval, modification, or rejection.

The code provides further that "any such plan shall be based on the following principles":

(*a*) It shall be fair and its benefits shall be equitably apportioned to all plants.
(*b*) It shall give due consideration to all pertinent factors including demonstrated productive capacity based on the clinker and/or cement production performance of non-obsolete plants and equipment.
(*c*) It shall in no way reduce the total production of all plants below what is necessary amply to supply demand.
(*d*) It shall not promote monopoly or monopolistic practices or oppress small enterprises.

An extension of 90 days was granted the industry to prepare the plan for sharing available business, but even by the expiration of this period no program had been presented to the Administrator. It is difficult, of course, to arrive at a basis for production allocation which will be acceptable to all manufacturers.

Any plan for sharing business involves detailed study of capacity of existing cement mills. Some complications of this problem were summarized early in 1934.[1] Productive capacity is not the only factor to be considered, for any deficiency in storage facilities must be met by reserve capacity in anticipation of a high seasonal peak.

A discussion of capacity of the cement industry in a recent book[2] prepared by the staff of the Brookings Institution dwells at some length upon the essential differences between clinker capacity and finished-cement capacity. Kiln capacity for the industry as a whole is about 10 percent less than finished-cement capacity. The seasonal pattern of cement shipments also must be interpreted properly in considering capacity figures. During the 10 best years from 1911 to 1929 daily production for any year as a whole averaged 17 percent less than daily production for the peak month. This meant that the typical grinding mill could not be used more than 83 percent of the time over the year as a whole, even though it was used 100 percent of the time in the peak quarter. The figures of the Bureau of Mines on "rated capacity" for finished cement probably are somewhat above possible production on an annual basis, but the figure on so-called "attainable capacity", calculated by deducting the 17 percent seasonal discount, is conservative.

*Increase in capacity.*—The cement code is one of the few which contain provisions for restriction of new productive capacity. The plant under construction at the time the code was approved, however, apparently has not been affected by the restrictions, which are worded as follows:

Prior to the construction or operation of a new plant, or the increase in the productive capacity of an existing one, or the movement of all or part of such a plant from one place to another, The Cement Institute, on receipt of such information, shall promptly collect complete information concerning existing productive capacity in the area in which the proposed new plant is to be located, together with data concerning consumption of cement in that area. If these data disclose that such new plant will result in further increasing the problem of overproduction or overcapacity in such area, The Cement Institute may petition the President to prohibit the construction, or operation, of the proposed new plant or the increase in manufacturing capacities of such existing plants. The provisions hereof shall not be construed to prevent the modernization of existing plants to improve quality of product and/or operating efficiency.

The Board may study the problem of permanent excess of productive capacity in any area and may from time to time prepare and submit to the Administrator

[1] Hughes, H. H., Capacity of the Cement Industry: Rock Products, vol. 37, no. 3, March 1934, pp. 33–5.
[2] Nourse, E. G., and associates, America's Capacity to Produce: Brookings Institution, 1934, pp. 120–37.

for consideration plans for the closing down or amortization of the less economical plants.

*Cost accounting.*—The code states that—

> It shall be an unfair method of competition for any member of the industry to sell or offer to sell cement at less than his expenses of manufacture, provided, however, that any member of the industry may sell or offer to sell cement at below his own expenses to meet the competition of any other member of the industry whose price is not less than the expenses of manufacturing of such other member.

Details of determining costs are outlined in the code, and provision is made for the adoption of a uniform system of cost accounting.

*Open prices.*—Open-price provisions are an important feature of the cement code, which states that—

> Each member of the industry shall file its prices and all terms and conditions of sale with the Code Authority within 5 days after the effective date of this code and make same public by broadcast quotations to the trade, so that competitors, the trade, and the buying public may at all times have accurate information relative thereto, and no member of the industry shall deviate therefrom except in the manner hereinafter provided.

The manner of procedure on price changes is explained in detail in the code.

The practice of quoting delivered prices of cement is continued under the code, although objections were raised at the public hearing.

*Selling methods.*—In general, the code continues the long-established practice of marketing cement through dealers. Numerous exceptions are made, however, and the dealers objected to the curtailment of their activities. Representatives of contractors and concrete-products manufacturers contended that the dealer should not be entitled to commission on cement delivered direct to the job in carload lots, but the dealers protested that this was due them to compensate for their services to the manufacturers in small-lot transactions on which their handling costs might be more than their profit. Differences of opinion on this subject were not settled in a second public hearing, and the Administrator ordered the selling-methods provisions of the code suspended until such time as an agreement could be reached.

The code also lists numerous unfair trade practices, requirements for standardization of products, procedure for modification, and other miscellaneous provisions of administrative interest.

The year 1933 was distinctly a formative period for industry under the NRA. The cement code did not go into effect until December, and appraisal of its effect on the industry must be deferred until a longer period has elapsed.

## MARKETS

Concrete paving 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. Figure 63 shows the relation of cement shipments to highway and building construction since 1928. The data are plotted as index numbers, with figures for all years expressed in percentages of 1928, the peak year of cement shipments as well as concrete paving and building construction.

Building construction has declined each year since 1928, but concrete paving held up well until 1932 and 1933. Cement shipments during 1933 were 63.6 percent below those in 1928; this compares with an

81-percent slump in building contracts and a 69.5-percent decline in concrete-pavement awards relative to the 1928 peak.

Because of the close correlation between cement consumption and construction activity a detailed discussion of building and highway construction has been included in this volume. It appears as a supplement to this chapter but is equally applicable to the discussions of other building materials.

*Miscellaneous outlets for cement.*—To estimate the quantity of cement used on farms is difficult, but the index of the purchasing power of farmers is a possible indicator. In 1932, on the basis of the 1910–14 average as 100, the Bureau of Agricultural Economics computed this index at 53, whereas in 1933 it had risen to 58. This index cannot be correlated exactly with cement consumption on farms, but the increase in 1933 indicates that farmers may have been better able to make

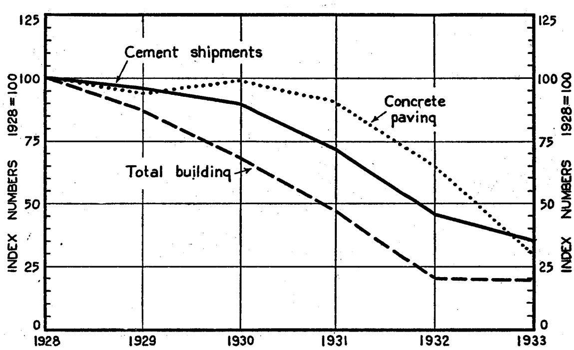


FIGURE 63.—Trends of principal markets for cement compared with cement shipments, 1928–33.

necessary repairs than in 1932. The index is still low compared with the 1928 index of 90.

No accurate estimates of concrete-products production have been made since 1930. Roughly, however, the output 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. Available information, based on the figures covering the output of face brick, common brick, and hollow tile, as well as on general statistics of construction, indicates that production in 1933 was about the same as in 1932.

Railway expenditures for cement in 1933 are not known. Total expenditures for maintenance of way and structures, however, dropped from $351,220,552 in 1932 to $322,335,022 in 1933, indicating further curtailment of construction by class I roads.

Statistics on river and harbor, sewer, reclamation, and other engineering projects are included in this chapter in the supplementary discussion of the construction industry.

## CONSUMPTION BY STATES

Although cement shipments in the United States dropped 20.7 percent in 1933 compared with 1932 the rate of decline varied considerably in different parts of the country. Consumption actually was higher in 14 States. Increases ranged from 1 percent in Virginia to 128 percent in Nevada and 137 percent in Alabama. With the exception of California, the States in which consumption increased ordinarily consume relatively small quantities of cement: Montana, Idaho, Utah, New Mexico, Arkansas, and Mississippi are typical of this group.

Consumption declined in the East and Middle West. Shipments into New York decreased 35 percent; Pennsylvania, 11 percent; Ohio, 43 percent; and Illinois, 10 percent. Shipments into States in

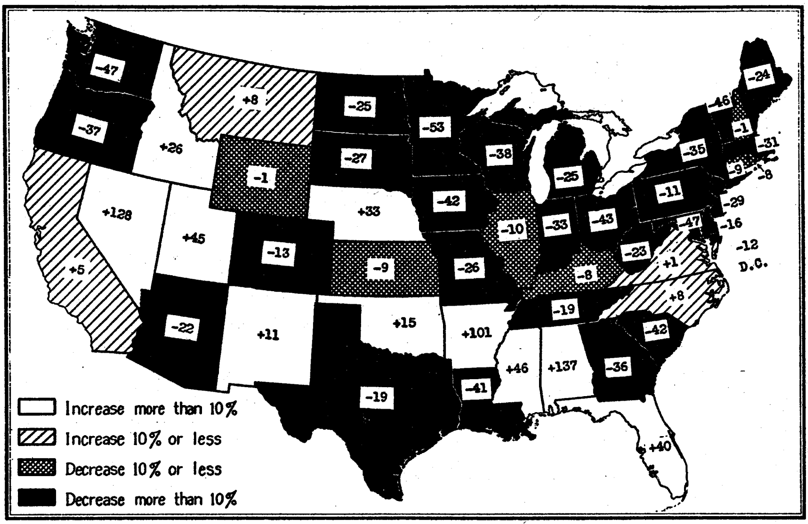


FIGURE 64.—Shipments of cement into States in 1933 compared with 1932. The figures represent percentage of change in 1933.

1933 are compared with those in 1932 in figure 64. The figures represent percentage of change for each State.

## PRICES

Prices of portland cement were relatively high during the early years of its manufacture. 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. From 1900 to 1931 cement prices were slightly lower than those of building materials generally. This comparison is based on price indexes of the Bureau of Labor Statistics computed on the basis of 1926 as 100. During the price peak of 1920 cement remained relatively low, the index number rising to only 117.2 compared with 150.1 for building materials and 154.4 for all commodities.

Figure 65 shows detailed price fluctuations since 1929. Two series of data compiled monthly by the Bureau of Labor Statistics and the average factory value of cement are plotted for comparison. The dotted curve represents the weighted index of 86 price series covering all building materials. Data for the solid curve showing monthly fluctuation in cement prices are compiled by averaging quoted prices, f.o.b. plant, at six plants in the United States. The annual average factory value of cement is compiled from reports of producers, who are requested by the Bureau of Mines to report the total selling value of their product, f.o.b. plant. Further instructions are given manufacturers to exclude the price of containers and to make proper adjustments for cash discounts allowed. To permit ready comparison, all curves are plotted as index numbers calculated as percentages of values for 1926, which are taken as 100. The year 1926 has been selected because it is used by the Bureau of Labor Statistics for calculations of all commodity price indexes.

A significant feature of the chart is that cement prices, after dropping sharply during the first few months of 1931, began to recover in 1932 and jumped even higher in 1933 and early 1934. The price index of all building materials also turned sharply upward in the latter half of 1933, but remained slightly lower than that of cement.

During 1931 and 1932 the average factory value per barrel of cement dropped below the index of current prices, indicating that extra price concessions may have been allowed. This practice apparently was discontinued in 1933, for the average factory value increased from

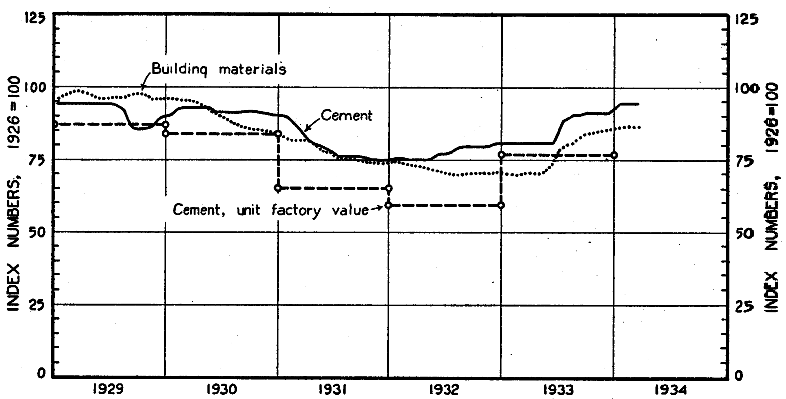


FIGURE 65.—Trends in prices of portland cement compared with a weighted price of all building materials, 1929–34. The solid curve "Cement" is plotted from index numbers compiled by the Bureau of Labor Statistics from quoted prices, f.o.b. plant. The curve "Cement, unit factory value" represents national average prices actually received by manufacturers as reported by them to the Bureau of Mines.

$1.01 a barrel in 1932 to $1.31 a barrel in 1933, paralleling the advance in prices reflected by the Bureau of Labor Statistics monthly index; however, prices remained below the 1926 level, despite the sharp rise in 1933.

## SPECIAL CEMENTS

Increased interest in special cements continued during 1933. Blank[3] has stated that sooner or later a number of cements must be developed for individual uses. This trend, however, need not result in a multitude of new products. The opinions of those in close contact with the cement industry indicate that standard specifications may be proposed for at least three types of portland cement in addition to the standard product. The first is high-early-strength portland cement, a product well known to the construction industry, for which tentative specifications already have been adopted. The second is low-heat cement, a variation of portland cement developed in connection with the construction of Boulder Dam. Numerous

[3] Blank, A. J., Some New Cements—Their Manufacture and Their Special Uses: Rock Products, vol. 36, no. 8, August 1933, pp. 54–57.

jobs now under way may require similar cement. The third is sulphate-resisting cement, a low-alumina product recommended for use in any construction which comes in contact with sea water, alkaline soils, mine drainage, or other chemically active solutions.

Production of high-early-strength portland cement in 1932 totaled 1,287,586 barrels, whereas shipments from the mills were 1,105,191 barrels valued at $1,915,215. This quantity represents returns from 19 plants, some of which reported production of high-early-strength cement for the first time in 1932. The increase in number of producing plants in recent years indicates wider interest in the material despite the decline in output. The average factory value of the product was $1.73 a barrel in 1932, $0.72 higher than the average of standard portland cement. Obviously, only cement selling at premium prices has been included in the total, and information from producing companies indicates that all the cement thus reported was manufactured to conform with the tentative specification of A.S.T.M. C74–30 T. At the end of 1933 producers were asked, for the first time, to make a preliminary report of production of special cements. These returns indicate production of about 1,072,000 barrels of high-early-strength cement in 1933 and shipments of 1,096,000 barrels valued at $2,193,000, an average of $2 a barrel. This represents a drop of less than 1 percent in barrels shipped and an increase of 16 percent in average factory value compared with 1932.

Special masonry cements, in which portland cement is a principal constituent, are becoming increasingly important. In 1932 production of this type of cement from 25 plants was 433,332 barrels, and shipments were 442,038 barrels valued at $581,255, an average value per barrel of $1.31. Preliminary returns for 1933 indicate production of about 386,000 barrels and shipments amounting to 395,000 barrels valued at $535,000, an average of $1.35 per barrel. This is a decrease of 11 percent in barrels shipped and an increase of 3 percent in average factory value compared with 1932.

The remaining special cements include so-called "oil-well" and "high-silica"[4] portland cements and those manufactured under the trade name "Super." Production of such cements totaled 413,644 barrels in 1932, and shipments were 340,494 barrels valued at $577,175, an average of $1.70 per barrel. Production in 1933, according to preliminary reports, was 807,000 barrels, and shipments were 754,000 barrels valued at $1,314,000, an average per barrel of $1.74. The quantity shipped increased 122 percent from 1932, and the average factory value advanced 2 percent. Super cement was introduced originally as a waterproofed cement. More recently, however, its high-early-strength properties have been stressed by the manufacturers, and statistics of its production might logically be included with those of the high-early-strength cements.

One company on the Pacific coast began to produce white cement during 1933. Statistics of white-cement manufacture are included in the total figures for portland cement, but the Bureau of Mines is not at liberty to publish the figures separately. Data on production of alumina cement also are not available for publication.

Shipments of natural, masonry, and puzzolan cements in 1932 were 524,844 barrels valued at $696,474. Although no comparable

[4] Kinze, R. A. Jr., Production of High-Silica Cement by Santa Cruz Portland Cement Co.: Am. Inst. Min. and Met. Eng. Contribution no. 67, February 1934, 10 pp.

figures are available for 1933 sales of these products correlate closely with activity in building construction, and it may be reasonable to assume that shipments decreased 5 to 10 percent in 1933.

## FOREIGN TRADE[5]

Despite complaints regarding importation of cement in 1933[6] imports increased 3.3 percent—from 462,496 barrels in 1932 to 477,784 barrels in 1933; the total value of imported cement increased from $351,033 to $400,594, or 14.1 percent. The tariff of $0.06 per hundredweight remained in effect during 1933.

Imports equaled 0.57 percent of shipments from domestic mills in 1932 and 0.75 percent in 1933, but the competition of even this comparatively small quantity is felt keenly in ports of entry and adjacent territory.

Exports of portland cement increased 81.6 percent—from 374,581 barrels in 1932 to 680,301 barrels in 1933, with an attendant increase in unit value from $2.14 to $2.19 a barrel. These figures exclude shipments to Alaska, Hawaii, and Puerto Rico, which dropped from 296,562 barrels in 1932 to 265,943 barrels in 1933.

## TECHNOLOGIC PROGRESS

Although code negotiations occupied the attention of the cement industry throughout the greater part of 1933, technology was not slighted. Improvements were made at several mills, and the technical research program of the Portland Cement Association was continued.

*Plant construction.*—No new plants were completed during the year, but construction was begun on the plant of the National Portland Cement Co. at Brodhead near Bethlehem, Pa. It was reported that this plant probably would be producing by the end of 1934. Meanwhile the company already has begun marketing its own brand of cement purchased from another producer.

*Fuel efficiency.*—Low production schedules during recent years have forced the cement industry to think in terms of low manufacturing costs rather than volume of output. Plants necessarily show higher costs when operating at 25 percent of capacity than at full capacity. Higher prices in 1933 eased the situation for many manufacturers, while others profited also by improvements designed to reduce costs.

Fuel is a large item in the cost of manufacturing cement. Exact fuel costs per barrel of finished cement vary considerably with individual operations, but the average for the entire industry is about $0.20 to $0.25 a barrel. As a saving of 20 percent in fuel costs means a net reduction of $0.04 to $0.05 a barrel in total costs, serious consideration by the industry of methods of increasing fuel efficiency is well worth while.

The thermal efficiency of rotary kilns is, at best, quite low.[7] Heat may be lost through escape of high-temperature flue gases, but installation of waste-heat boilers has resulted in material savings.

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

[6] Browne, M. H., Foreign Cement Threatens to Ruin American Industry: The Evening Star, Washington, D.C., Jan. 13, 1933.

[7] Catlin, A. W., Major Economies in Burning Cement Clinker in a Rotary Kiln: Pit and Quarry, vol. 25, no. 10, June 1933, pp. 25–28.

This practice is not new and warrants only passing mention in connection with 1933 developments. However, Newhouse [8] states that the use of other heat-recuperating devices at the upper end of the kiln is becoming of increasing interest. Savings in fuel costs are effected thereby, but except for waste-heat boilers such equipment tends to increase capacity, and there has been little incentive for additional productive capacity in recent years. Heat losses due to radiation from the kiln shell have not attracted much attention.

Utilization of the heat contained in the clinker as discharged from the kiln was the primary object of many improvements in 1933. At least three plants installed some type of clinker coolers during the year.[9] Rotary coolers have been in use for many years. Their essential function is to cool the hot clinker as it is discharged from the kilns, for it is generally agreed that air-quenched clinker has advantages during grinding. Heat from the clinker is dissipated into the air by the rotary cooler; not even enough is recovered to supply hot secondary air for combustion in the kilns. This continued loss of heat prompted development of coolers designed not only to cool clinker but also to supply secondary air to the kilns. Although installations of such coolers have been made in earlier years, they had just begun to prove their worth by 1933. One company reported that clinker coolers had saved more than 15 percent of its fuel bills.[10]

Robinson [11] summarized possible savings in fuel costs by stating that the average filter installations (wet-process) would reduce fuel bills 20 to 25 percent; heat exchangers and fans perhaps 5 to 10 percent; and efficient coolers about 10 percent. Increase in kiln length to 400 feet should save about 8 percent of the fuel normally consumed in a 250-foot kiln, judging by the only installation for which comparable data are available; exit-gas analyzers and improvements in coal grinding and feeding equipment might save an additional 4 percent. Although present experience demonstrates that coal consumption as low as 60 pounds per barrel of cement may be attained in wet-process kilns, caution must be observed to be sure that capital charges may not more than offset expected economies.

After 2½ years operation it was reported [12] that in one plant disk-type filters had raised potential production 16.7 percent, with an attendant decrease of 12.2 percent in fuel costs.

*Grinding economies.*—Further economies may be possible in preparing raw materials and grinding clinker. It is claimed [13] that reasonable elimination of fines from crusher feed may increase crusher capacity 25 to 30 percent.

A new type of grinding mill, comprising horizontal, superimposed sets of ball bearings riding in separate rings, was described [14] early in 1933. Exhaustive tests for a year or more indicate a saving of 25 percent in total power consumption in an average cement plant.

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[8] Newhouse, R. C., Cement Industry Uses Depression Period as Opportunity for Improvement: Pit and Quarry, vol. 26, no. 7, January 1934, pp. 35–38.

[9] Pit and Quarry, Cement, Lime, and Other Industries Look Forward to Increased Business: Vol. 26, no. 7, January 1934, pp. 46–49.

[10] Moyle, Frank, Clinker-Cooler Installation Cuts Coal Consumption Fifteen Percent: Pit and Quarry, vol. 26, no. 7, January 1934, pp. 73–74.

[11] Robinson, A. W., Possibilities of Greater Fuel Economy in Wet Process Cement Making: Pit and Quarry, vol. 25, no. 8, Apr. 1933, pp. 20–22.

[12] Sonntag, C. H., Problems Encountered in Application of Filters for Cement Slurry: Pit and Quarry, vol. 26, no. 3, September 1933, pp. 31–36.

[13] Shultz, R. S., Jr., What is Ahead for Portland Cement?: Rock Products, vol. 36, no. 8, August 1933, pp. 50–53.

[14] Rockwood, N. C., Possible Grinding Economies Would Save 25 Percent in Power Cost of Portland Cement: Rock Products, vol. 36, no. 4, April 1933, pp. 42–44.

*Wagner turbidimeter.*—Development of the Wagner turbidimeter [15] in 1933 marked a definite advance in the technique of measuring subsieve sizes of portland cement. The sample of cement to be measured is placed in a kerosene suspension. A beam of light of constant intensity passes through the suspension and actuates a photoelectric cell; the intensity is then measured with a microammeter. Speed and ease of operation are the greatest assets of the instrument; more than 50 of them were in use by cement companies early in 1934.

*Potash recovery.*—History is repeated in byproduct potash-recovery processes. During the World War, when potash was selling at premium prices, several cement companies installed equipment for its recovery from kiln gases, but virtually all of these installations were abandoned later. Interest in potash-recovery equipment has been revived. One company installed a potash-recovery unit in 1932 and improved its efficiency during 1933.

*Anhydrite as a retarder.*—In connection with the problem of utilizing anhydrite as a retarder in portland cement, a new method of studying the reactions in liquor from normally gaged cement has been evolved at the Nonmetallic Minerals Experiment Station of the Bureau of Mines. Results indicate that tricalcium silicate, a constituent of cement, and calcium sulphate, added later as a retarder, both tend to retard the set by liberating lime in the cement liquor.

*Bulk shipments.*—At least two companies during 1933 enlarged their facilities for shipping bulk cement by self-unloading boats. Additional storage silos were built near centers of consumption. Shipment of cement in bulk was encouraged further by the remodeling of additional hopper cars patterned after the bulk-cement cars developed a few years ago by one of the companies in the Lehigh district.

## SUPPLEMENT—CONSTRUCTION INDUSTRY

The portland-cement industry depends directly upon construction for its markets. Concrete in highways and structural concrete in buildings consume more than half the output of cement in an average year. The rest also enters some form of construction through miscellaneous jobs on farms, sidewalks, concrete products, railway maintenance, waterworks, bridges, and river and harbor and other large engineering projects.

Cement shares these markets with other nonmetallic building materials. Sales of dimension stone, sand and gravel, crushed stone, gypsum, lime, soapstone, slate, and asphalt reflect activity in the construction industry. This discussion of building and highway statistics therefore applies to some of the other chapters in this volume.

[15] Wagner, L. A., A Rapid Method for the Determination of the Specific Surface of Portland Cement: Proc. Am. Soc. Testing Materials, vol. 33, pt. 2, 1933.

*Summary of statistics of the construction industry in the United States, 1928 and 1932–33*

| Type of construction | 1928 | 1932 | 1933 | Percent of change in 1933 from— | |
|---|---|---|---|---|---|
| | | | | 1932 | 1928 |
| Construction contracts awarded: [1] | | | | | |
| Total value | $6,628,284,000 | $1,351,159,000 | $1,256,601,000 | −7.0 | −81.0 |
| Public works | $980,063,000 | $514,700,000 | $499,518,000 | −2.9 | −49.0 |
| Public utilities | $484,418,000 | $75,602,000 | $103,203,000 | +36.5 | −78.7 |
| Nonresidential | $2,375,490,000 | $480,790,000 | $404,564,000 | −15.9 | −83.0 |
| Residential | $2,788,318,000 | $280,069,000 | $249,314,000 | −11.0 | −91.1 |
| Residential, floor space square feet | 568,384,000 | 73,608,000 | 72,796,000 | −1.1 | −87.2 |
| Building permits issued: [2 3] | | | | | |
| Total value | $3,098,940,040 | $513,101,306 | $403,518,134 | −21.4 | −87.0 |
| Nonresidential | $1,185,219,330 | $290,678,180 | $189,081,892 | −35.0 | −84.0 |
| Residential | $1,913,720,710 | $113,149,016 | $98,814,345 | −12.7 | −94.8 |
| Alterations and repairs | (4) | $109,274,110 | $115,621,897 | +5.8 | |
| Public building contracts awarded: [2] | | | | | |
| Federal buildings [5] | (4) | $149,904,662 | $85,403,832 | −43.0 | |
| State buildings | (4) | $53,309,615 | $29,665,372 | −44.4 | |
| Non-Federal buildings, P.W.A. | (4) | (4) | [6] $23,701,467 | | |
| Engineering construction: | | | | | |
| Total contracts awarded [7] | $3,578,580,000 | $1,219,309,000 | $1,068,369,000 | −12.4 | −70.1 |
| River and harbor projects, P.W.A. | (4) | (4) | [8] $112,760,074 | | |
| Reclamation projects, P.W.A. | (4) | (4) | [8] $7,906,186 | | |
| Water and sewerage projects, P.W.A. [9] | (4) | (4) | [8] $29,912,153 | | |
| Concrete pavement contracts awarded: [10] | | | | | |
| Total square yards | 148,078,000 | 96,827,000 | 45,128,000 | −53.4 | −69.5 |
| Roads only do | 93,532,000 | 86,393,000 | 37,138,000 | −57.0 | −60.3 |
| Highway construction contracts awarded: [2] | | | | | |
| Public roads [11] | (4) | (4) | [8] $165,687,072 | | |
| Streets and roads, Federal, P.W.A. [12] | (4) | (4) | [8] $20,595,434 | | |
| Streets and roads, non-Federal, P.W.A. [12] | (4) | (4) | [6] $8,726,129 | | |
| State highways | (4) | (4) | [8] $18,726,383 | | |

[1] F. W. Dodge Corporation.
[2] Bureau of Labor Statistics.
[3] Building permit figures cover 310 cities in 1928, compared with 340 in 1932 and 1933.
[4] Comparable data not available.
[5] Includes P.W.A. contracts, October–December 1933.
[6] 3 months only, October–December 1933.
[7] Engineering News-Record.
[8] 4 months only, September–December 1933.
[9] Includes both Federal and non-Federal projects.
[10] Portland Cement Association.
[11] P.W.A. funds administered by Bureau of Public Roads.
[12] Street and road projects other than those of Bureau of Public Roads.

*Construction contracts awarded.*—Numerous indicators of construction activity are available currently, but none is complete and none gives an exact measurement of the physical volume of construction. The foregoing table and the following figures summarize the statistics that best measure the demand for cement and other building materials. In discussing these data some information has been taken from a paper by Gill [16] published early in 1933.

The F. W. Dodge Corporation has collected statistics of the construction industry for more than 40 years. Data are available since 1925 for the 37 States east of the Rocky Mountains on number of projects, value, square feet of floor space, and types of construction. Until recently total square feet of floor space of contracts awarded had been considered the best indicator of volume of construction. During 1933, however, Dodge officials announced that this series

[16] Gill, Corrington, Construction Statistics: Jour. Am. Statistical Assoc., March 1933, pp. 31–54.

would be discontinued, because the ever-increasing heavy engineering projects made it impossible to arrive at a reasonable estimate of square feet of floor space. Residential contracts are still reported in floor space as well as in value, but for other types of construction value of contracts only is available. Although the Dodge figures on contracts awarded are recognized as the most complete data available, certain limitations are apparent.

The Dodge service covers only the 37 States east of the Rocky Mountains. Correction factors ranging from 10 to 15 percent have been used arbitrarily to adjust the figures for the omission of the Rocky Mountain and Pacific Coast States, but no accurate data are available to show the exact relationship between the 37 States included in the service and the 11 omitted.

Before 1932 the data included only contracts amounting to $5,000 or more, but since that year the reports have shown all contracts, regardless of amount. Furthermore, contracts on alterations and repairs have been included only since January 1932. Dodge officials state that these revisions have not affected seriously the comparability of the data for 1932 and 1933 with those for previous years. It is evident, nevertheless, that the declines in 1932 and 1933 would have been even more pronounced had small contracts been eliminated.

The first group of data in the table summarizes Dodge figures of contracts awarded during 1933 compared with 1932 and contrasted with 1928. Total contracts awarded in 1928 were valued at more than 6.6 billion dollars. By 1933 the total value had declined 81 percent to 1.2 billion dollars and was 7 percent less than in 1932.

Figure 66 shows graphically total and residential contracts awarded from 1925 to 1934. The low levels of construction in 1932 and 1933 contrast strikingly with the levels of previous years. The rise in contracts awarded late in 1933 and in the spring of 1934 indicates the results of the public works program. Residential contracts, however, did not show a comparable advance.

Dodge statistics are subdivided into four general types of construction. Value of public works contracts awarded in 1933 dropped 49 percent from 1928; public utilities, 78.7 percent; nonresidential, 83 percent; and residential, 91.1 percent. With contracts for various types of construction ranging from about half to less than one-tenth of total contracts in 1928, it is not surprising that sales of cement and other building materials fell almost as sharply.

The public works program, starting late in 1933, failed to offset completely the low levels in the early months of the year, and total public works contracts were 2.9 percent below those in 1932. Value of nonresidential contracts dropped 15.9 percent and residential 11 percent. Public utilities contracts, however, increased 36.5 percent over 1932.

In 1928 public works construction was relatively unimportant, amounting to only 14.8 percent of the total contracts awarded. Value of residential contracts comprised the largest item, being 42.1 percent, and private nonresidential construction was a close second, with 35.8 percent. Public utilities contracts comprised 7.3 percent of the total. In 1933 these relationships were almost reversed. Value of residential contracts amounted to only 19.8 percent of the total, whereas public works led with 39.8 percent. This change compared with 1928 reflected efforts of the Federal and State Governments to buoy the construction industry during the depression. Private nonresidential contracts remained at about the same relative position, 32.2 percent, and public utilities contracts increased slightly to 8.2 percent of the total.

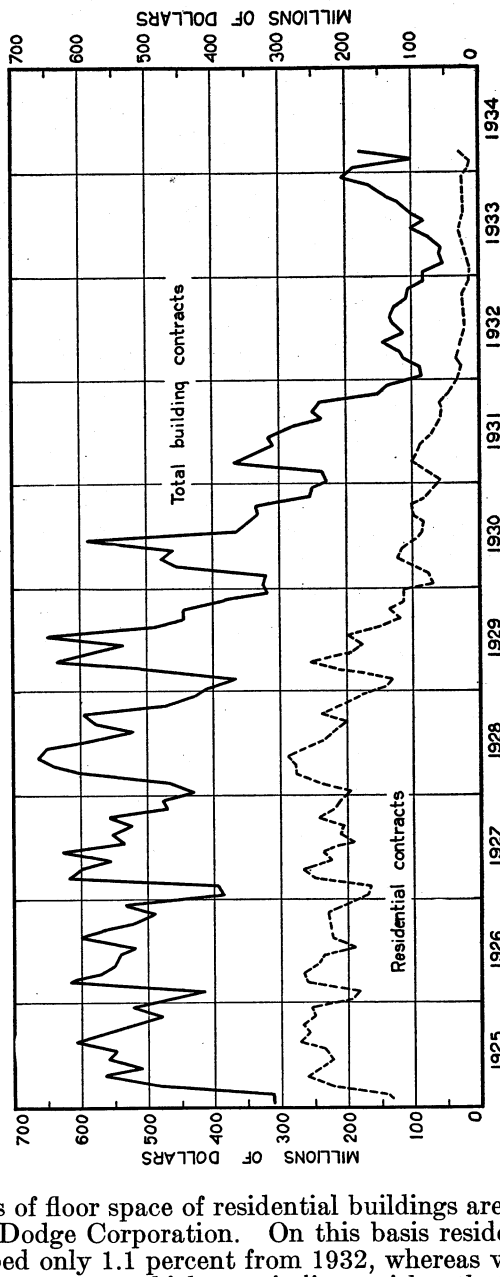


FIGURE 66.—Construction contracts awarded, 1925–34, by months. The low level of contract awards in the spring of 1933 and the subsequent upswing, due largely to the public works program, are prominent features of the past year. The continued depressed status of residential contracts in 1933 also is conspicuous. Data are from reports of the F. W. Dodge Corporation.

Statistics of floor space of residential buildings are still reported by the F. W. Dodge Corporation. On this basis residential building in 1933 dropped only 1.1 percent from 1932, whereas value of contracts decreased 11 percent, which may indicate either that costs per square foot of floor space actually were lower in 1933 than in 1932 or possibly that there was a trend toward cheaper construction in 1933. Compared with 1928 residential contracts awarded in 1933 dropped 91.1 percent in total value and 87.2 percent in square feet of floor space, indicating that the residential builder received more for his money

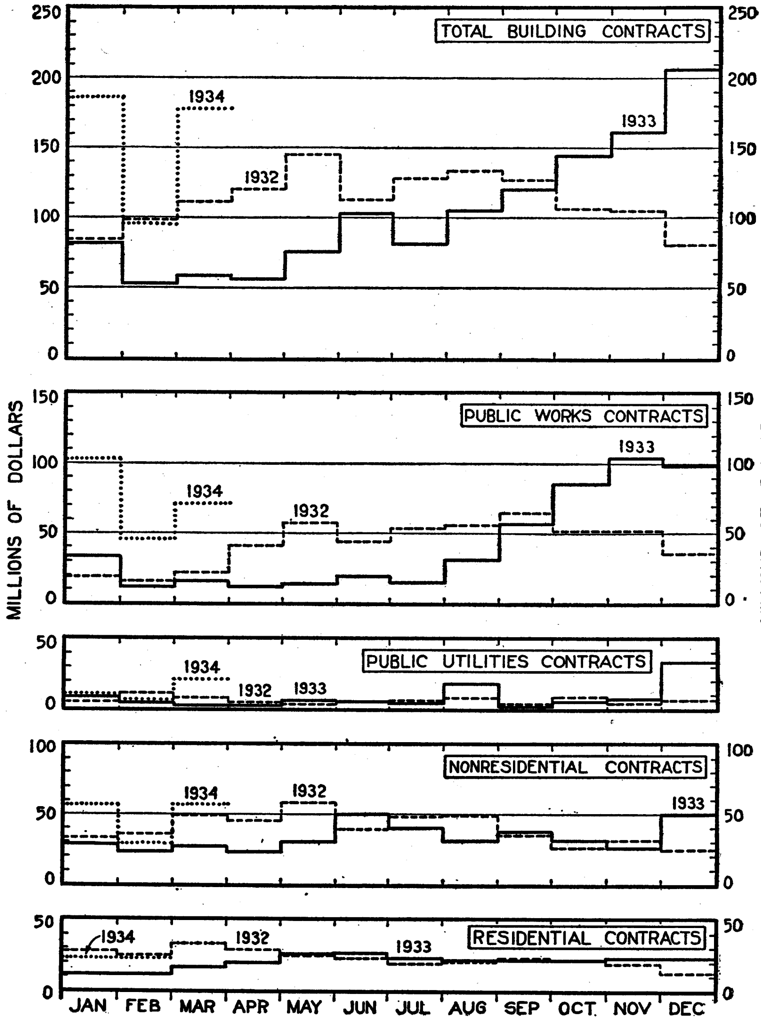


FIGURE 67.—Construction contracts awarded during 1932 and 1933, by months. Effects of the public works program are strikingly evident during the last quarter of 1933. Data are from reports of the F. W. Dodge Corporation.

in 1933 than in 1928. Comparison of building costs and building-material prices supports this conclusion.

To limit comparison to yearly contracts awarded does not show adequately the effect of the public works program that gained momentum only during the last months of the year. Figure 67, therefore, has been prepared to show in detail monthly variations in contracts awarded during 1932, 1933, and the early months of 1934.

For three-quarters of the year, total contracts in 1933 were less than in 1932, but during the last quarter, through the stimulating effects of the Public Works Administration, notable increases were recorded. Awards in December were higher than in any month since the summer of 1931.

The other curves in figure 67 reveal to what extent public works projects have been responsible for the increase in contracts awarded. Public utilities and nonresidential construction remained virtually stationary from month to month throughout 1933 until December.

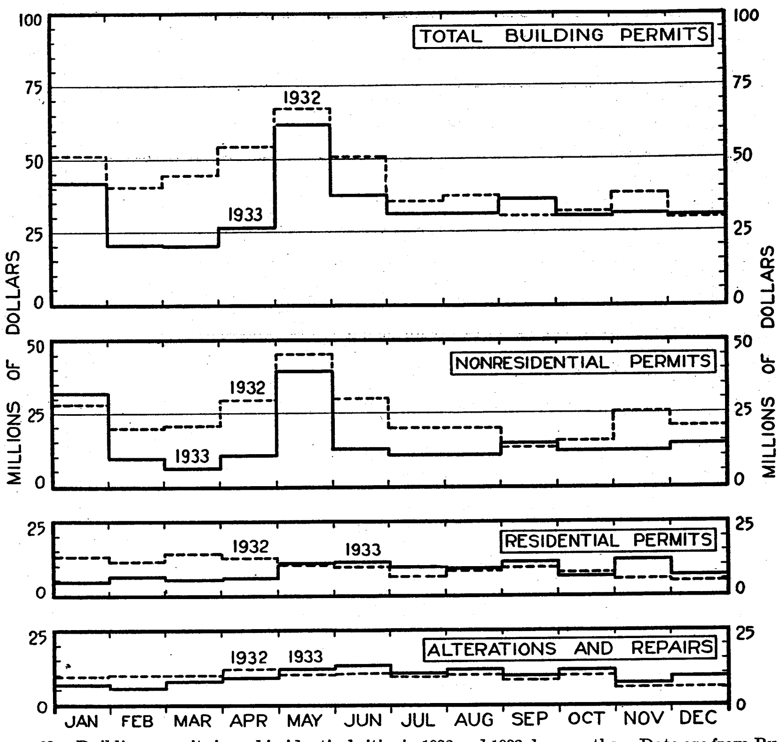


FIGURE 68.—Building permits issued in identical cities in 1932 and 1933, by months. Data are from Bureau of Labor Statistics; the number of cities is identical in corresponding months for comparisons between 1933 and 1932 but ranges from 340 to 352 from month to month in the calendar year.

This behavior characterized the residential curve throughout both 1932 and 1933.

*Building permits issued.*—Figures on building permits issued during 1933, collected by the Bureau of Labor Statistics, also show that private construction did not improve during the year. Direct comparison of permits issued in an identical group of cities reveals that the total value dropped 21.4 percent from 1932 to 1933. Nonresidential permits declined 35 percent and residential 12.7 percent, whereas permits for alterations and repairs increased 5.8 percent. The exact number of cities included in the group ranges from 340 to 352 from month to month in the calendar year, but is identical in corresponding months for comparisons between 1932 and 1933.

Exact correlation with 1928 is not possible, but similar data are available for 310 cities. Even with the discrepancy in the total number of cities compared, total permits issued in 1933 dropped 87 percent from 1928. The decline in nonresidential permits was 84 percent and in residential permits 94.8 percent.

Curves in figure 68 show the fluctuation in value of permits issued from month to month. The absence of any definite indication of improved conditions in 1933 is striking.

Comparison of permits in various cities may be misleading because building ordinances are not uniform in all cities. This factor is eliminated, however, in comparing yearly totals for all cities. New York and Boston ordinances provide for "filing plans", which procedure, for purposes of the Bureau of Labor Statistics, is assumed to be equivalent to issuing building permits. Building permits also may be a poor measure of residential construction in any community, for suburban residential sections of most metropolitan areas are not included within the city limits. Permits are not issued for many of the public works projects or for a large part of the construction work of railroads and public utilities. Moreover, the fact that a building permit has been issued is not proof that the project actually is under construction; it may be postponed indefinitely or even abandoned.

These shortcomings are not cited in criticism of building-permit statistics but to suggest factors to be considered in interpreting and using them.

*Public buildings.*—The Bureau of Labor Statistics also compiles data on contracts awarded by the State and Federal Governments. In September 1933 this service was expanded to include all P.W.A. contracts, according to type of construction.

Federal building contracts awarded in 1933 dropped 43 percent from 1932. This decline may seem severe in view of the Public Works Administration program; but, as demonstrated in figure 69, contracts for public buildings had dropped to all-time lows in the first 8 months of 1933. The influx of public works money raised the curve for the last 4 months of the year but not enough to balance the previous lean months. It must be remembered also that expenditures for public buildings represent only a small part of P.W.A. construction.

Only part of the States are covered in the figures for building contracts awarded by State governments. For those represented, however, awards during 1933 were 44.4 percent below 1932, and there was no upturn at the end of the year to parallel the P.W.A. trend.

A new series of data, established September 1933, shows contracts awarded for non-Federal buildings financed by P.W.A. funds. This type of construction amounted to more than Federal buildings in December 1933.

*Engineering construction.*—Dodge statistics and building permits primarily cover only building construction, leaving a gap between building and highway construction, in which dams, reservoirs, levees, bridges, docks, and other large engineering projects logically belong. Statistics covering this type of construction are compiled by Engineering News-Record. Contracts awarded in 1928 for engineering construction amounted to more than 3½ billion dollars; but by 1933 the total had declined 70.1 percent to only a little more than 1 billion dollars, a drop of 12.4 percent from 1932.

Figure 70 shows contract awards by months. Early months of 1933 were below 1932, but sharp increases in the last quarter of 1933 reflect P.W.A. expenditures.

Three supplementary series of related data are available as a result of the P.W.A. program. Beginning with September 1933 the Bureau of Labor Statistics each month has summarized contracts awarded for river and harbor, reclamation, and water and sewerage projects. Continuation of these series will add materially to data on construction.

*Highway construction.*—Of the nonmetallic building materials only cement, aggregates, and asphalt are used extensively in highway construction. The cement industry is particularly dependent upon concrete paving for much of its business.

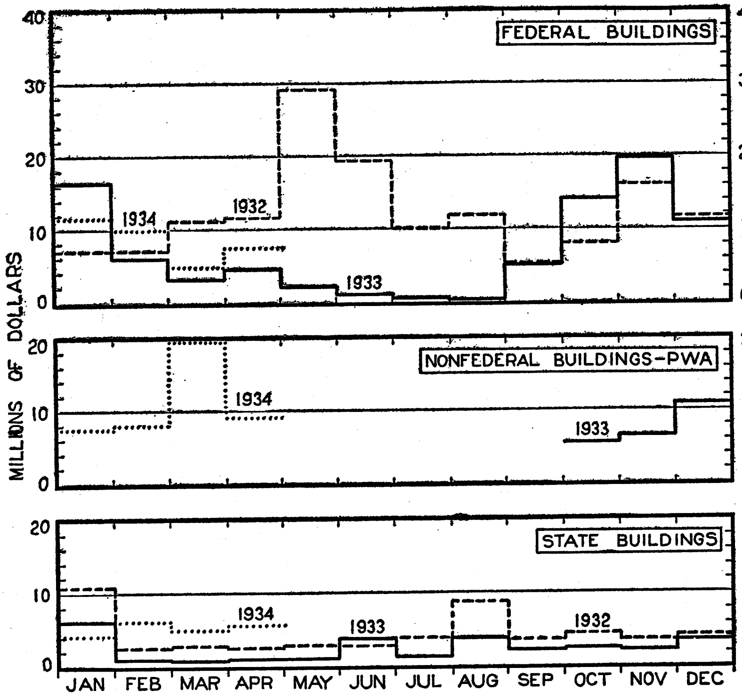


FIGURE 69.—Contracts awarded for public buildings during 1932 and 1933, by months. Federal buildings include P.W.A. and all other Federal building projects; non-Federal buildings—P.W.A. include those to be constructed by States, counties, or municipalities with P.W.A. funds; and State buildings include only those actaully financed by State governments. Data are from Bureau of Labor Statistics.

The Portland Cement Association long has recognized the importance of current statistics for concrete paving and compiles monthly reports on concrete-pavement contracts awarded. Figure 71 plots these data, along with shipments of cement, from 1925 to 1934 by months. Concrete paving held up remarkably well through 1931, slumped in 1932, and registered a further sharp drop in 1933. Total contracts awarded in 1933 declined 53.4 percent from 1932 and 69.5 percent from 1928. Contracts for concrete roads in 1933 dropped 57 percent from 1932 and 60.3 percent from 1928.

Spring "road lettings" usually are bunched in April; in April 1933, however, contracts totaling only 570,000 square yards were awarded. This yardage was the lowest ever recorded for any month and contrasts sharply with the April 1931 total of 24,671,000 square yards. Diversion of funds normally used for highways to other purposes may account for much of this decline. The failure of highway contracts to materialize in the spring of 1933 was reflected in a sharp drop in cement shipments during August, usually the peak month of the year.

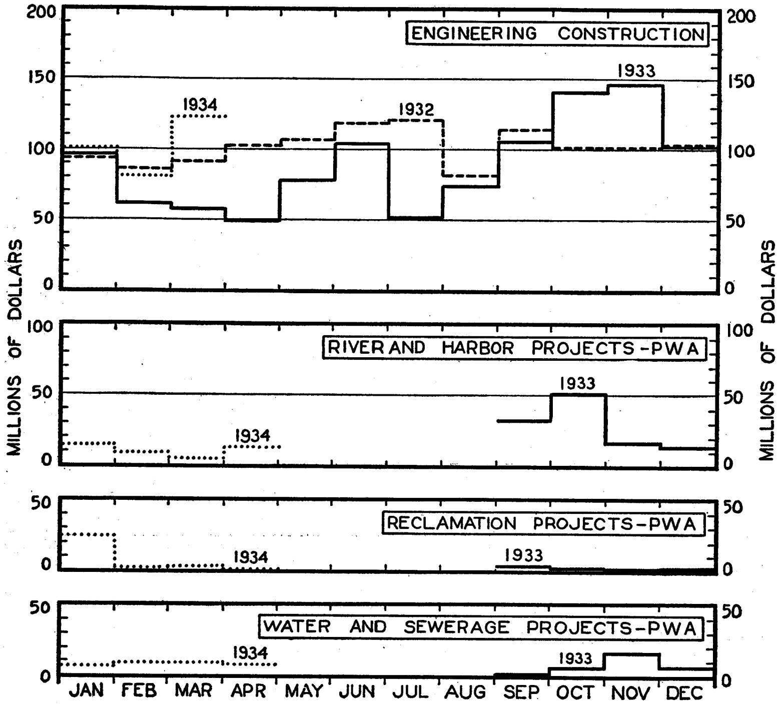


FIGURE 70.—Engineering construction contracts awarded during 1932 and 1933 by months. Data are from Engineering News-Record and Bureau of Labor Statistics.

Figure 72 shows additional details of paving-contract awards by months. It also includes four new series of highway-construction data that have been available since the P.W.A. came into existence.

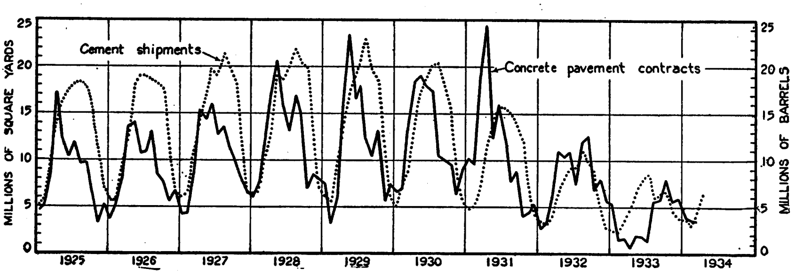


FIGURE 71.—Concrete-pavement contract awards and cement shipments, 1925–34. The contrast between awards in the spring of 1933 and in the spring of 1931 stands out sharply. Data on contracts are from the Portland Cement Association.

Contracts awarded for highway construction from funds administered by the Bureau of Public Roads comprise the first and largest item; the second includes streets and roads to be built with P.W.A. funds under the jurisdiction of other Federal agencies; and the third includes contracts awarded for non-Federal street and road projects using P.W.A. money. These data complete the statistical records of highway construction resulting from the public works program. The fourth new series shows highway contracts awarded by State governments.

In past years the States have carried most of the financial burden of highway construction, many floating large bond issues to raise funds. The present depleted condition of many State treasuries and the

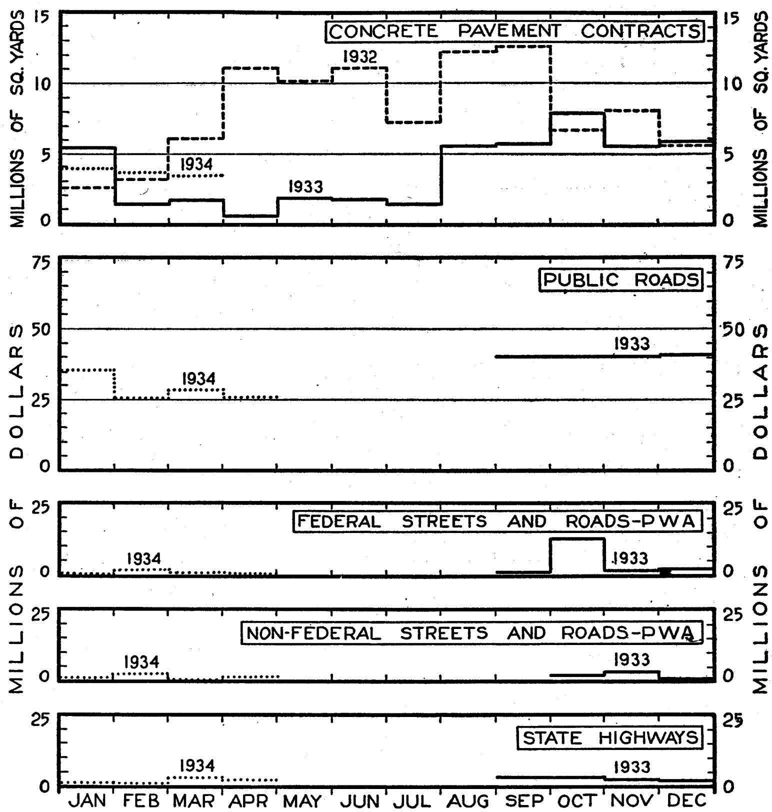


FIGURE 72.—Concrete-paving contracts awarded and other indicators of highway construction during 1932 and 1933, by months. Concrete-pavement contracts include streets and alleys as well as roads. Public roads construction includes only those projects constructed under the direction of the Bureau of Public Roads; other Federal street and road projects financed by P.W.A. funds are shown separately. Non-Federal streets and roads include projects financed by P.W.A. funds but built by States, counties, or municipalities. State highways include road projects financed by State funds. Data are from the Portland Cement Association and the Bureau of Labor Statistics.

diversion of funds to purposes other than roads has forced the Federal Government to take the initiative in continuing a highway program.

*Construction compared with industrial production.*—Building construction declined steadily from 1928 to 1933. Since 1929 this downward trend has been common to virtually all indicators of business activity. Figure 73 shows the Federal Reserve Board index of industrial production compared with index numbers of total and residential building. All figures are expressed as percentages of the 1923–25 average. It is evident that late in 1931 construction began to drop far more rapidly than industrial production and, furthermore, that construction improved little until the effects of the public works program was felt. Private construction, as reflected by the residential curve, fell even farther below industrial production and up to the spring of 1934 had shown no material advancement.

The importance of the construction industry in the industrial life of the United States is discussed in a recent article [17] which compares the value of building contracts with that of products of major industries.

The total value of building contracts awarded in 1929, the peak year for most industries although not for construction, amounted to nearly 6 billion dollars. In the same year production of motor vehicles was

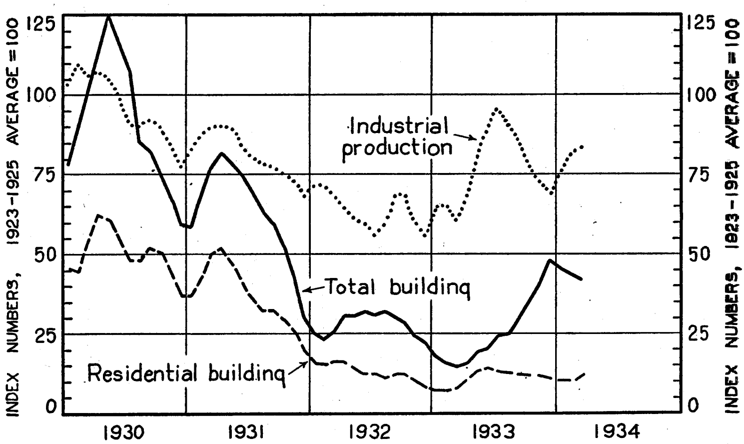


FIGURE 73.—Index of industrial production compared with total and residential building, 1930–34. Data are from Federal Reserve Board.

valued at less than 4 billions, output of the meat-packing industry at about 3.5 billions, and steel production at less than 3.5 billions. Inclusion of the States west of the Rocky Mountains and of small contracts probably would increase the total contract awards by at least 1 billion dollars. Expenditure in 1 year of the entire P.W.A. appropriation of 3.3 billion dollars for construction only would not have raised the total in 1933 to more than about two-thirds of that in 1928.

Efforts are being made to stimulate private construction so that it may regain its customary position in relation to public works. Mortgage money made available on more liberal terms may hasten the upswing in residential building.

[17] Hughes, H. H., Public Works Requirements of Rock Products: Rock Products, vol. 37, no. 1, January 1934, pp. 56–63.

# DIMENSION STONE

By Oliver Bowles and A. T. Coons

## SUMMARY OUTLINE



The industries producing natural stone in blocks or slabs used for building and other purposes experienced further declines in both value and quantity of output. According to preliminary figures the value of dimension stone sold in 1933 was $24,076,000, 21 percent below the value in 1932 and only about one-half the value of similar products sold in 1931. The quantity sold amounted to about 1,550,000 short tons, 18 percent below that in 1932 and 46 percent below that in 1931. Every variety of stone shared in the decline.

As stone is produced by a great many operators scattered over all parts of the country complete statistics for 1933 are not yet available. However, the proportion of returns already received is so high that final figures for 1933 probably will vary only slightly from preliminary figures. Figures for marble are almost complete.

The following table of salient statistics shows sales in 1932, preliminary figures of sales in 1933, and percentage of change from 1932 for each kind of stone and each principal use:

*Salient statistics of the dimension-stone industries in the United States, 1932–33*

| | 1932 | 1933 [1] | Change from 1932 |
|---|---|---|---|
| Granite: | | | |
| Building stone: | | | *Percent* |
| Rough construction ... short tons | 209,190 | 132,000 | −37 |
| Value | $341,256 | $178,000 | −48 |
| Average value per ton | $1.63 | $1.35 | −17 |
| Cut stone ... cubic feet | 1,796,640 | 1,312,000 | −27 |
| Value | $5,531,904 | $2,988,000 | −46 |
| Average value per cubic foot | $3.08 | $2.28 | −26 |
| Monumental stone ... cubic feet | 1,605,780 | 1,540,000 | −4 |
| Value | $4,574,965 | $3,834,000 | −16 |
| Average value per cubic foot | $2.85 | $2.61 | −8 |
| Rubble ... short tons | 38,850 | 40,000 | +3 |
| Value | $39,165 | $32,000 | −18 |
| Paving blocks ... number | 6,804,270 | 6,260,000 | −8 |
| Value | $563,258 | $530,000 | −6 |
| Curbing ... cubic feet | 695,160 | 563,000 | −19 |
| Value | $692,860 | $506,000 | −27 |
| Total value | $11,743,408 | $8,068,000 | −31 |
| Total quantity (approximate in short tons) | 648,420 | 512,000 | −21 |

[1] Subject to revision.

*Salient statistics of the dimension-stone industries in the United States, 1932–33*—Continued

| | 1932 | 1933 | Change from 1932 |
|---|---|---|---|
| Marble: | | | *Percent* |
| Building stone (cut stone) ... cubic feet | 1,681,850 | 1,335,000 | −21 |
| Value | $5,627,602 | $4,861,000 | −14 |
| Average value per cubic foot | $3.35 | $3.64 | +9 |
| Monumental stone ... cubic feet | 432,590 | 413,000 | −5 |
| Value | $1,669,689 | $1,305,000 | −22 |
| Average value per cubic foot | $3.86 | $3.16 | −18 |
| Total value | $7,297,291 | $6,166,000 | −16 |
| Total quantity (approximate in short tons) | 179,130 | 148,000 | −17 |
| Limestone: | | | |
| Building stone: | | | |
| Rough construction ... short tons | 50,580 | 39,000 | −23 |
| Value | $77,872 | $68,000 | −13 |
| Average value per ton | $1.54 | $1.74 | +13 |
| Cut stone, slabs, and mill blocks ... cubic feet | 6,804,500 | 5,580,000 | −18 |
| Value | $6,950,352 | $6,325,000 | −9 |
| Average value per cubic foot | $1.02 | $1.13 | +11 |
| Rubble ... short tons | 84,570 | 75,000 | −11 |
| Value | $84,308 | $96,000 | +14 |
| Total value | $7,112,532 | $6,498,000 | −9 |
| Total quantity (approximate in short tons) | 640,780 | 520,000 | −19 |
| Sandstone: | | | |
| Building stone: | | | |
| Rough construction ... short tons | 35,120 | 188,000 | +435 |
| Value | $61,435 | $320,000 | +421 |
| Average value per ton | $1.75 | $1.70 | −3 |
| Cut stone, slabs, and mill blocks ... cubic feet | 684,410 | 657,000 | −4 |
| Value | $984,672 | $760,000 | −23 |
| Average value per cubic foot | $1.44 | $1.16 | −19 |
| Rubble ... short tons | 37,720 | 6,500 | −83 |
| Value | $19,645 | $11,000 | −44 |
| Paving blocks ... number | 779,220 | 430,000 | −45 |
| Value | $56,920 | $32,000 | −44 |
| Curbing ... cubic feet | 296,080 | 136,000 | −54 |
| Value | $233,330 | $135,000 | −42 |
| Flagging ... cubic feet | 198,470 | 109,000 | −45 |
| Value | $168,220 | $148,000 | −12 |
| Total value | $1,524,222 | $1,406,000 | −8 |
| Total quantity (approximate in short tons) | 172,180 | 267,500 | +55 |
| Basalt: | | | |
| Building stone ... short tons | 5,080 | 4,500 | −11 |
| Value | $5,900 | $5,000 | −15 |
| Average value per ton | $1.16 | $1.11 | −4 |
| Rubble ... short tons | 8,240 | 7,000 | −15 |
| Value | $12,988 | $10,000 | −23 |
| Total value | $18,888 | $15,000 | −21 |
| Total quantity (approximate in short tons) | 13,320 | 11,500 | −14 |
| Miscellaneous building stone [2] ... short tons | 157,340 | 18,000 | −89 |
| Value | $603,573 | $416,000 | −31 |
| Slate [3] (approximate in short tons) | 74,490 | 73,240 | −2 |
| Value | $1,906,484 | $1,515,863 | −20 |
| Total stone, by uses: | | | |
| Building stone: | | | |
| Rough construction ... short tons | 457,310 | 381,500 | −17 |
| Value | $1,090,036 | $987,000 | −9 |
| Cut stone, slabs, and mill blocks ... cubic feet | 10,967,400 | 8,884,000 | −19 |
| Value | $19,094,530 | $14,934,000 | −22 |
| Monumental stone ... cubic feet | 2,038,370 | 1,953,000 | −4 |
| Value | $6,244,654 | $5,139,000 | −18 |
| Paving blocks ... number | 7,583,490 | 6,690,000 | −12 |
| Value | $620,178 | $562,000 | −9 |
| Curbing ... cubic feet | 991,240 | 699,000 | −29 |
| Value | $926,190 | $641,000 | −31 |
| Flagging ... cubic feet | 198,470 | 109,000 | −45 |
| Value | $168,220 | $148,000 | −12 |
| Rubble ... short tons | 169,380 | 128,500 | −24 |
| Value | $156,106 | $149,000 | −5 |
| Slate ... short tons | 74,490 | 73,240 | −2 |
| Value | $1,906,484 | $1,515,863 | −20 |
| Grand total, value | $30,206,398 | $24,075,863 | −20 |
| Grand total, quantity (approximate in short tons) | 1,885,660 | 1,550,240 | −18 |

[2] Includes soapstone, mica schist, volcanic rocks, argillite, and other varieties that cannot be classified in the principal groups.
[3] Details are given in chapter on Slate.

The term "dimension stone" is applied to blocks or slabs of natural stone that for the most part are cut to definite shapes and sizes. It includes cut, carved, sawed, and roughhewn blocks of building stone, memorial stone, paving blocks, curbing, flagging, and roofing slabs, as well as many special products such as tubs, sinks, tanks, blackboards, steps, baseboards, and floor tile. Rubble consisting of more or less irregular fragments used with mortar in building masonry walls is included. Dimension-stone products are quite distinct from crushed, broken, and pulverized stone, which consist of irregular fragments or grains sized chiefly by mechanical screening or air separation. Processes of quarrying and manufacturing, uses, and market channels of dimension stone bear no similarity to those of crushed stone. Because these two great branches of the industries differ so widely they are treated separately, and dimension stone only is discussed in this chapter; other stone products are discussed in the chapter of this volume on crushed and broken stone. Slate, complete data for which are available for 1933, also is treated in a separate chapter; however, in order that figures may be comparable from year to year, the total quantity and value of slate are included in the table of salient statistics of this chapter.

The dimension-stone industry may be divided into three main divisions on the basis of plant operation. The first group of operators quarries stone and sells the product in the form of rough blocks or slabs. The second group quarries stone and operates fabricating plants where it is cut, carved, sawed, polished, or otherwise treated. A third group comprises companies that operate finishing mills but have no quarries. They purchase raw materials in the form of rough blocks or slabs from quarry operators.

The Bureau of Mines statistical canvass covers the first and second groups, but as companies of the third group are manufacturers rather than producers, they are canvassed by the Bureau of the Census. Bureau of Mines statistics are compiled from actual tonnages sold and the actual value received when the material first enters commerce. It is evident therefore that the figures include some material sold as rough blocks and some sold as finished products.

*Uses.*—At least three-fourths of all dimension stone sold is used in some phase of building construction. The principal building products are rough blocks, sawed and cut stone, and numerous building units such as columns, spindles, wainscoting, slabs, floor tile, steps, and stair rails. They are employed both for structural purposes and as ornaments or accessories. Among stone building accessories are tubs, sinks, table tops, shelves, and window boxes. Every kind of stone represented in statistical reports is used for building purposes.

The second largest use is for memorial-stone manufacture. Products range from simple headstones and markers to more eleborate monuments and mausoleums. It may be difficult to decide whether stone used in mausoleums is to be classed as building or as memorial stone. Granite and marble are the principal stones used for monuments.

A third use is for street and sidewalk construction. The principal products so employed are paving stones, curbing, and flagging. Flagging used for steps, porches, and floors might properly be classed as building stone.

Minor uses are numerous. Novelties, statuary, lamp bases, dresser tops, garden seats, and bird baths are among the miscellaneous products which consume only a relatively small part of the total.

Granite is adapted to the greatest variety of uses of all common stones. It is used extensively for rough construction and as cut and polished stone for both interiors and exteriors of buildings; it is the principal memorial stone and is the leading raw material for manufacture of paving blocks and curbing. Flagging is the only ordinary use for which granite finds limited application.

The uses of sandstone are also diversified. It is employed as building stone for both interiors and exteriors. It is well adapted for cutting and carving, but not for polishing. Insignificant quantities are used for memorial stone, but it is employed extensively for paving block, flagstones, and curbing manufacture. Bluestone and related varieties are the most important rocks used for the manufacture of flagging.

Marble has long been a favored material for the higher types of architecture. It is employed principally for interior decoration, but is used also for exteriors. Like granite, it is well adapted for polishing, and for this reason is used widely for memorials. The uses of marble other than for buildings and memorials consume relatively small quantities.

Limestone in the form of dimension stone is used almost exclusively for building construction, both exteriors and interiors. Its easy workability adapts it well for cutting and carving, but it will not take a polish. Calcareous stones that polish well are classed with the marbles.

*Recent trends.*—Figure 74 shows trends in the major branches of the stone industry during recent years. The graph is plotted on a

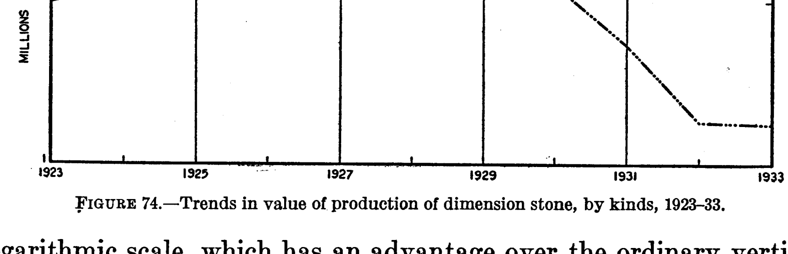


FIGURE 74.—Trends in value of production of dimension stone, by kinds, 1923–33.

logarithmic scale, which has an advantage over the ordinary vertical scale in that it indicates percentages of increases or decreases from year to year in their proper relationship, regardless of actual values involved. In value of production, granite stands first, limestone second, marble third, and sandstone fourth. Marble has suffered the smallest decline during the depression, the value of production in 1933 being 48 percent of the 1923–25 average. The value of limestone produced in 1933 was 39 percent of the 1923–25 average, that of granite 34 percent, and that of sandstone 25 percent. Although there is no apparent change in the downward trend of the curve for granite since 1931, the other curves show a much smaller percentage of decline in 1933 than in 1932—a condition that bears some promise of improvement during 1934.

*Dependence of stone on building construction.*—As a large proportion of all stone sold in block form is used in building, the stone industries are sensitive to changes in construction activity. The low level of sales of stone in 1933 is correlated closely with the sharp decline in building.

Figure 75 shows trends in dimension-stone production compared with total building construction and industrial production for a series

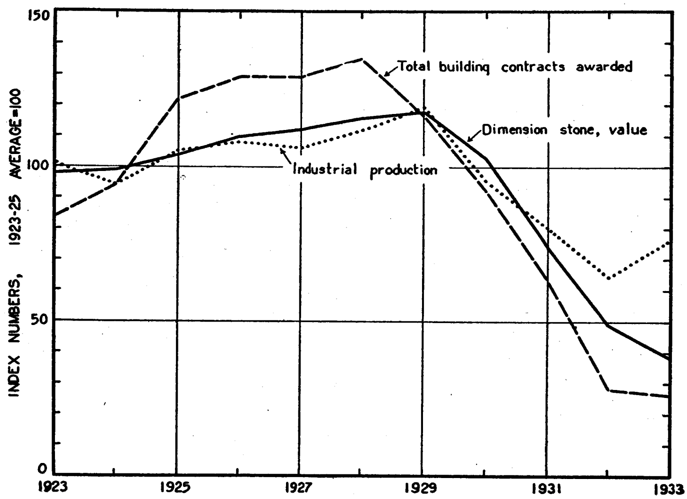


FIGURE 75.—Trends in dimension stone compared with total building construction and industrial production, 1923–33. Data on construction and industrial production are index numbers compiled by the Federal Reserve Board.

of years. To facilitate comparison of unlike quantities the figures have been reduced to percentages of the 1923–25 average.

It will be noted from the chart that sales of stone dropped rapidly after 1929 in consonance with the decline in building construction. The rise in industrial production during 1933 was not reflected in an increased demand for stone. Renewed activity in stone quarrying is to be expected only when building revives. Stone producers, therefore, are vitally interested in present and probable future activity in building construction of all kinds. For data concerning residential building, public works, public utilities, Federal and State building, and engineering construction the reader is referred to the chapter on Cement, where they are discussed in detail.

*Technical progress.*—The fabrication of stone is becoming more and more highly mechanized. Although certain hand operations are necessary, sawing, cutting, carving, turning, rubbing, and polishing are accomplished chiefly by circular or gang saws, pneumatic tools, carborundum machines, lathes, and other mechanical equipment. During recent years improvements in equipment have been developed, and many new machines have been introduced in mills devoted to fabrication of granite, marble, limestone, and sandstone. In the limestone industry hand methods of scabbling blocks are giving way to the use of pneumatic tools, and greater speed is being attained in milling by the use of wider cutting tools on planers, and improved methods of sawing. The popular "package-freight" idea has found a place in the limestone industry in the use of returnable crates by means of which cut stone is delivered to the stone setter. Wire saws are used to some extent in limestone and sandstone quarries and have found some application in the milling of sandstone.

An unusual use of a wire saw has been noted in Indiana.[1] It was employed successfully to undercut a huge mass of waste rock and thus permit its removal by blasting without danger of damage to the commercial stone lying beneath it. The chief significance of this experiment is its demonstration of the fact that wire sawing in a horizontal plane is possible and practical.

Although this chapter is devoted to the natural-stone industries, mention should be made of a possible competitor in the form of a new synthetic stone known as "rostone." It consists of finely ground clay, shale, or other alumino silicate intimately mixed with hydrated lime and enough water to form a damp mass; the latter is pressed in steel molds at 2,500 pounds pressure per square inch, dried, and autoclaved with saturated steam at low pressure for about 2 hours. A chemical reaction takes place, forming a hard, strong product. It may be used as a matrix to bind together fragments of slate, limestone, granite, or other rock and thus provide an outlet for quarry waste. The product was developed at Purdue University, Lafayette, Ind., and two exhibition houses have been built of it, one near Purdue and the other at A Century of Progress.

Other competitive materials, notably enameled steel, various forms of structural steel, and glass bricks or blocks are invading the normal building-stone markets to some extent.

During 1933 the Bureau of Mines issued several reports [2] on various phases of the dimension-stone industries.

## CODES OF FAIR COMPETITION

Under the provisions of the National Industrial Recovery Act, Codes of Fair Competition covering the major branches of the dimension-stone industry have been approved or are in process of final revision. Even those that have passed the approval stage became effective too late to exert any definite influence during 1933. It is confidently expected that adherence to codes will contribute materially to improvement in conditions throughout the industries, particularly in the field of marketing, and for this reason a brief discussion of their principal provisions is included.

*Construction industry.*—A Code of Fair Competition for the Construction Industry was submitted by the Construction League of the United States on August 7, 1933, and after settlement of various controversial points was approved by the President on January 31, 1934

[1] Newsom, J. B., and Bowles, Oliver, A New Adaptation of a Wire Saw: Eng. and Min. Jour., vol. 124, no. 12, December 1933, pp. 506–508.

[2] Bowles, Oliver, Limestone, Part II—Dimension Stone: Inf. Circ. 6756, Bureau of Mines, 1933, 16 pp. Bowles, Oliver, and Banks, D. M., Onyx Marble and Travertine: Inf. Circ. 6751, Bureau of Mines, 1933, 11 pp.
Hatmaker, Paul, Markets for Residential Stone: Inf. Circ. 6749, Bureau of Mines, 1933, 14 pp.

(code no. 244). As the field covered is extensive and diversified, the provisions deal only with general conditions. They establish certain minimum wage rates and hours of work and provide for correction of abuses in marketing known as "bid peddling." Construction planning and adjustment boards are established to adjust differences and to develop plans for the entire industry. Provisions of codes for individual branches of the building industries must harmonize with the general provisions of the Construction Industry Code.

*Limestone industry.*—A Code of Fair Competition for the Building Limestone Industry was approved November 14, 1933 (code no. 113). With certain exceptions it provides for a working week of 40 hours averaged over 3-month periods and limited to 48 hours in any week, 6 days in any week, and 8 hours in any 24 hours. Minimum wage rates are 38 cents an hour, except that in the Southern States the wage may be as low as that prevailing on July 15, 1929, provided that in no case shall less than 30 cents an hour be paid.

A national control committee of the National Limestone Industry, Associated, is given authority to administer the code. Selling below reasonable cost is designated an unfair method of competition. Member companies who sell block and sawed stone are required to publish formal price schedules and to file them with the association. They must adhere to the published prices in making sales, but provision is made for publishing new schedules which become effective 6 days after filing with the association. Those branches of the industry that both quarry and fabricate limestone are required to charge themselves the prices for block and sawed stone that they file with the association.

Because of the present excess capacity in quarries and mills, certain restrictions are placed against adding additional equipment to existing plants.

The foregoing general conditions apply to the entire building-limestone industry, but the code contains a provision permitting the establishment of supplemental regional codes. Under this provision a supplemental code, which was awaiting final approval in May 1934, has been prepared for the Indiana limestone district. It provides that copies of bids on contracts shall be filed with the code authority in such a way that the name of the bidder, the project, and the time of opening shall be fully disclosed without disclosing the amount of the bid or the particulars thereof. The bids shall not be opened by the code authority prior to the time of opening bids by the awarding authority of the project.

*Sandstone industry.*—A Code of Fair Competition for the Sandstone Industry was approved April 6, 1934 (code no. 388). It covers the quarrying and fabrication of sandstone for building purposes, curbing, flagging, grave vaults, breakwaters, pulpstones, and grindstones. Because of direct competition with the limestone industry, the working-hour and wage provisions are essentially the same in each code. Administration is in the hands of a National Control Committee of five members of the National Sandstone Association. An important feature of the code is the provision against selling below cost. According to this provision it shall be deemed an unfair trade practice for any member of the industry to sell or offer to sell any products of the industry at prices below the reasonable cost of such products. Members of the industry are required to publish prices and to adhere strictly to them. As in the Limestone Code, companies who both quarry and fabricate sandstone shall charge themselves the prices for block stone which they have filed with the Code Authority.

Various unfair trade practices are forbidden, such as collusion in preparation of bids, extending special rebates and refunds, or making misleading statements regarding products.

Operators of quarries in bluestone, and related sandstones that split easily into thin, smooth sheets used for flagging, constitute a branch of the industry having problems distinct from those of the ordinary sandstone producer. Accordingly a separate code known as the "Code of Fair Competition for the Natural Cleft-Stone Industry" was prepared for a public hearing on March 17, 1934. The proposed wages and hours of labor are adjusted to accommodate numerous small intermittent operations. Proposed marketing policies and restrictions against unfair trade practices are similar to those already approved for the sandstone industry. The proposed Code Authority shall consist of the president of the National Cleft-Stone Association, one member from each district who shall be elected by members of the association, and another member who shall represent nonmembers of the association. The two districts active at present are New York-Pennsylvania and Tennessee.

*Granite industry.*—A public hearing on a code covering the building-granite industry was held in August 1933. An important section deals with methods of filing bids on granite contracts. In general, they follow the principles adopted for the limestone industry, but conditions are more complex because granites vary greatly in color and texture, and contracts may call for certain specific varieties. Thus, some companies may bid on contracts calling for stock produced by other companies. These and other complexities have occasioned much delay in adjusting differences. As the final code may vary from the tentative proposals, discussion of provisions is inappropriate at this time.

A public hearing on a Code of Fair Competition for the Wholesale Monumental Granite Industry was held on January 2, 1933, and its approval was expected late in May 1934. It covers the quarrying, wholesale manufacture, and wholesale distribution of granite used for memorials. The code in its tentative form establishes 11 regional divisions each having a Control Committee and a Code Authority consisting of the chairmen of the 11 control committees.

The Granite Paving Block Manufacturers Association submitted a tentative code on October 30, 1933. The National Recovery Administration decided, however, that producers of granite paving blocks should be governed by the code for the crushed stone, sand and gravel, and slag industries which was approved on November 10, 1933. A discussion of the latter code appears in the chapter on sand and gravel.

*Marble industry.*—A Code of Fair Competition for the Marble Quarrying and Finishing Industry (code no. 421) was approved May 9, 1934. It covers the quarrying and fabrication of architectural marble. With certain exceptions, it provides for a 40-hour week and a minimum wage rate of 37½ cents per hour in the North and 30 cents per hour in the South. Article VI of the code enumerates trade practices that are forbiddden. Among them are inaccurate advertising, misrepresentation of competitors' goods, and giving of rebates or refunds. The code reestablishes rules for bidding on contracts that were in effect for more than 12 years before the depression.

The Code Authority consists of 7 members—2 producer members and 2 nonproducer members of the National Association of Marble Dealers; 1 member representing the Metropolitan district of the city of New York, 1 the Pacific Coast area, and 1 the nonmembers of the association.

A proposed code for the wholesale monumental-marble industry was prepared in 1933 and revised for a public hearing on January 2, 1934. It was still awaiting approval in May 1934. It covers the quarrying and fabrication of memorial marble sold to qualified retail monument dealers, jobbers, and wholesalers. The proposed Code Authority consists of five members. One represents the territory north of the Potomac and Ohio Rivers, one the territory south of these rivers, and a third, the remainder of the country. These three choose two additional members. Provisions covering hours of labor, wages, and restrictions against unfair trade practices doubtless will conform with those of the code covering architectural marble.

## FOREIGN TRADE

*Imports.*—Stone imported for consumption in the United States in 1933 was valued at $536,510, as shown in the following table. This was 30 percent below the corresponding total for 1932.

*Stone imported for consumption in the United States in 1933, by classes*

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

| Class | Quantity | Value | Class | Quantity | Value |
|---|---|---|---|---|---|
| Marble, breccia, and onyx: | | | Quartzite.........short tons.. | 48,259 | $77,950 |
| In blocks, rough, etc. cubic feet.. | 63,239 | $196,783 | Travertine stone (unmanufactured).........cubic feet.. | 13,574 | 10,133 |
| Sawed.................do.... | 243 | 689 | Stone (other): | | |
| Slabs or paving tiles superficial feet.. | 155,492 | 66,825 | Dressed.................. | .......... | 5,514 |
| All other manufactures... | .......... | 49,769 | Rough (monumental or building stone) cubic feet.. | 8,091 | 5,876 |
| Mosaic cubes of marble or onyx: Loose............... | .......... | 70 | Rough (other)............ | .......... | 15,753 |
| | .......... | 314,136 | | .......... | 27,143 |
| Granite: | | | | | |
| Dressed.......cubic feet.. | 14,126 | 62,803 | Grand total............ | .......... | 536,510 |
| Rough..............do.... | 35,560 | 44,345 | | | |
| | 49,686 | 107,148 | | | |

The countries from which imported materials were shipped are shown in the following table. The totals do not agree with those of the preceding table, which includes only materials that were actually sold to consumers, whereas the table of imports by countries (general imports) includes all materials, whether sold or held in warehouses.

*Stone imported into the United States in 1933, by classes and countries*

[General imports]

| Country | Marble, breccia, and onyx | | | Granite | | Other building or monumental stone (value) | Other stone n.e.s. (value) | Total value |
|---|---|---|---|---|---|---|---|---|
| | Rough | | Manufactures (value) | Cubic feet | Value | | | |
| | Cubic feet | Value | | | | | | |
| North America: | | | | | | | | |
| Canada | 767 | $2,437 | $2,664 | 10,463 | $12,426 | $12,537 | $80,771 | $110,835 |
| Cuba | | | 48 | | | | | 48 |
| Mexico | | | 30 | | | | | 30 |
| Total | 767 | 2,437 | 2,742 | 10,463 | 12,426 | 12,537 | 80,771 | 110,913 |
| South America: | | | | | | | | |
| Argentina | 2,935 | 54,306 | | | | | | 54,306 |
| Brazil | | | | | | | 1,000 | 1,000 |
| Total | 2,935 | 54,306 | | | | | 1,000 | 55,306 |
| Europe: | | | | | | | | |
| Austria | | | 80 | | | 4 | | 84 |
| Belgium | 4,242 | 21,975 | 12,365 | | | 119 | | 34,459 |
| Czechoslovakia | | | 133 | 1,098 | 4,894 | 5,718 | | 10,745 |
| Finland | | | | 22,664 | 55,297 | | | 55,297 |
| France | 7,877 | 9,062 | 8,290 | | | 3,768 | | 21,120 |
| Germany | 86 | 1,912 | 5,168 | 2,018 | 9,772 | 9,303 | 9 | 26,164 |
| Greece | | | 105 | | | | | 105 |
| Italy | 19,382 | 50,920 | 81,291 | | | 146,438 | | 278,649 |
| Portugal | 7,806 | 17,945 | | | | | | 17,945 |
| Rumania | | | | | | 9,953 | | 9,953 |
| U.S.S.R. | | | | | | 186 | | 186 |
| Spain | 14,062 | 21,975 | 72 | | | | | 22,047 |
| Sweden | 436 | 1,963 | | 13,190 | 23,562 | | | 25,525 |
| United Kingdom | 1,021 | 2,328 | 4,144 | 450 | 2,091 | 4,706 | 1,227 | 14,496 |
| Other Europe [1] | 10 | 37 | 8 | 31 | 68 | 986 | | 1,099 |
| Total | 54,922 | 128,117 | 111,656 | 39,451 | 95,684 | 181,181 | 1,236 | 517,874 |
| Algeria and Tunisia | 772 | 3,463 | | | | | | 3,463 |
| China | | | 704 | | | 39,417 | | 40,121 |
| Japan | | | 360 | | | 8,072 | | 8,432 |
| Other countries [2] | | | 204 | | | 656 | 250 | 1,110 |
| Grand total | 59,396 | 188,323 | 115,666 | 49,914 | 108,110 | 241,863 | 83,257 | 737,219 |

[1] Includes Denmark, Irish Free State, Latvia, Netherlands, Norway, Poland and Danzig, and Switzerland.
[2] Includes Australia, Egypt, Hong Kong, India (British), Persia, Syria, and West Indies (British).

About 55 percent (in value) of marble imports originated in Italy, although substantial supplies were obtained also from Belgium, Spain, and France. About half the foreign supplies of granite came from Finland and most of the remainder from Sweden and Canada. Relatively small quantities were shipped from Germany and Czechoslovakia. As indicated in the table, stone other than marble and granite was obtained chiefly from Italy. Probably the larger part of it was travertine, an interior building and decorative stone that has attained popularity in America.

*Exports.*—Exports of stone from the United States over a period of years are shown in the following table. The value of $326,494 for 1933 is 27 percent below the corresponding total for 1932.

*Stone [1] exported from the United States, 1929–33, by classes*

| Year | Marble in blocks, rough or dressed | | Other building or monumental stone (including cement building blocks) | | Value of other manufactures of stone (including other cement manufactures) | Total value |
|---|---|---|---|---|---|---|
| | Cubic feet | Value | Cubic feet | Value | | |
| 1929 | 98,478 | $394,654 | 825,254 | $682,632 | $1,487,993 | $2,565,279 |
| 1930 | 84,550 | 375,964 | 731,359 | 594,177 | 1,066,584 | 2,036,725 |
| 1931 | 32,443 | 141,216 | 284,050 | 209,353 | 627,771 | 978,340 |
| 1932 | 30,691 | 99,943 | 73,098 | 75,558 | 273,755 | 449,256 |
| 1933 | 11,585 | 46,031 | 29,933 | 35,588 | 244,875 | 326,494 |

[1] Figures not separately recorded for stone and for cement building blocks and for stone and for cement manufactures.

## GRANITE

*Market conditions.*—Granite sold as dimension stone in 1933 had an estimated value of about $8,068,000, or 31 percent below the total for 1932 and considerably less than half that for 1931. The tonnage sold in 1933 was about 21 percent below that in 1932. Granite used for building purposes (rough construction, cut stone, and rubble) suffered the most serious decline, the value for 1933 being 46 percent lower than in 1932. Granite is a popular stone for high-class architectural work, and the low output in 1933 does not indicate decreasing popularity but rather that granite is sharing in the unusually low market demands for all building materials.

Because of its crystalline character, attractive colors, and ability to take a high polish, granite is widely used for memorials; in fact, monumental granite exceeds building granite in both quantity and value. Memorial stone sales in 1933 dropped 4 percent in quantity and 16 percent in value below those of 1932.

The paving-block branch of the industry, which experienced a serious decline in 1932, exhibited more resistance to the downward trend in 1933 than other branches of the granite industry. Sales dropped only 8 percent in quantity and 6 percent in value compared with 1932. Sales of curbing decreased 19 percent in quantity and 27 percent in value. Detailed figures have been given in the table of salient statistics.

*Review by States.*—Granite is produced chiefly in the New England States. The deposits not only are large and numerous but also many are available to water transportation, a definite advantage because normally the large eastern cities provide extensive markets. However, granite deposits exist elsewhere, and other important centers of production are situated in the Southern, Middle Western, and Pacific Coast States.

According to preliminary figures the States producing important supplies of architectural granite, in order of value of production in 1933, were Massachusetts, Maine, New Hampshire, Wisconsin, Georgia, Minnesota, North Carolina, and Vermont. Some of the important centers of building-granite production are Westford, Weymouth, and Milford, Mass.; North Jay, Stonington, Frankfort, and North Berwick, Maine; Milford, Redstone, and Concord, N.H.;

Mellen and Waupaca, Wis.; Stone Mountain, Ga.; Rockville, Minn.; Mount Airy, N.C.; Woodbury, Vt.; and Knowles, Calif.

Vermont leads all the States by a wide margin as a producer of memorial granite. According to preliminary figures other important States, in order of value of production in 1933, were Georgia, Wisconsin, Massachusetts, Pennsylvania, and South Dakota. Minnesota usually stands second in order, but figures for this State are too incomplete to determine its rank in 1933.

The most important center of production for memorial stone is the Barre district of Vermont, where several large quarries and numerous fabricating mills are operated for production of a fine-grained gray granite. The quarry output of the Barre district in 1933 amounted to 563,570 cubic feet valued at $1,405,270. Among the more important monumental granites of other States are the medium- to coarse-grained greenish gray of Quincy and the dark bluish gray of Chester, Mass.; the medium-grained red and gray granites of St. Cloud, Minn.; the blue-gray of Elberton, Ga.; the red granites of Wausau and Montello, the red and gray of Amberg and Marinette, and the coarse-grained red and gray varieties of Waupaca, Wis.; the black granites of Pottstown and Coopersburg, Pa.; the medium-grained red of Milbank, S.Dak.; and the fine-grained gray, blue-gray, pink, and buff stones of Westerly, R.I.

Maine produces more than half the Nation's supply of granite paving blocks and smaller quantities of curbing. Other important production centers for both paving blocks and curbing are in Massachusetts, Wisconsin, Georgia, New Hampshire, and North Carolina.

## MARBLE

*Market conditions.*—Marble production in 1933 declined 17 percent in quantity and 16 percent in value compared with 1932. The output in 1933 was valued at about $6,166,000. Approximately three-fourths of it was used in buildings and one-fourth as memorial stone. Architectural marble declined 21 percent in quantity but only 14 percent in value; thus the unit value advanced about 9 percent. Monumental stone, on the other hand, decreased only 5 percent in quantity but 22 percent in value, the unit value decreasing about 18 percent. Whether this decrease was due to depressed prices or to sale of a larger proportion of low-priced material cannot be determined from data at hand.

Large Government building projects furnished the mainstay of the marble industry in 1933, but these markets have declined greatly in volume. Public works projects may sustain demand to some extent until private construction, which has been very small for some years, is resumed.

*Review by States.*—Marble has essentially the same composition as limestone but differs from it in texture. Calcite and dolomite, which are present in limestone as small grains firmly cemented together, have been recrystallized in marble, forming a semitranslucent rock which takes a high polish. Marbles are most abundant in regions where mountain folding has caused recrystallization of the original limestone. The principal commercial deposits occur in the Appalachian Mountain district of the eastern United States.

Because of its decorative value, marble is a popular architectural stone, particularly for interiors. White, red, pink, green, blue-gray, and clouded marbles are available from domestic quarries. Verd antique or serpentine marble is produced in several localities.

The six leading marble-producing States in 1933, in order of value of output, were Vermont, Georgia, Tennessee, Alabama, Missouri, and North Carolina. In quantity produced, the order was the same except that Tennessee was second and Georgia third. Colorado, Maryland, Massachusetts, California, Arkansas, New Jersey, and Arizona produced small quantities.

*Vermont.*—The great marble belt of western Vermont is the most productive region of its kind in the world. It extends from near Middlebury at the north to Danby at the south, a distance of about 80 miles. Within this area are numerous extensive openings; several are operated as underground mines. The largest quarries are at Danby, Clarendon, West Rutland, Proctor, Pittsford, and Brandon. White, bluish-gray, green, pink, and clouded marbles are produced for both architectural and memorial uses. Large finishing mills equipped with modern machinery are located at Proctor and West Rutland.

There are several important quarry districts outside the western Vermont marble belt. A reddish, siliceous marble is obtained at Swanton, verd antique at Roxbury, and Rochester, and black marble at Isle La Motte. In 1933 Vermont produced about 40 percent in value, of the total marble output of the United States.

*Georgia.*—The value of marble produced in Georgia in 1933 was about 22 percent of the total for the United States. The most productive quarries are confined to a relatively small area near Tate and Marble Hill in Pickens County. Several large, deep quarries provide coarsely crystallized white, gray, blue, pink, and clouded marbles suitable for both architectural and monumental uses. Verd antique is quarried at Hollysprings, Cherokee County. Large, well-equipped finishing mills are located at Tate and Marble Hill and at several points more remote from the quarries.

*Tennessee.*—Gray, mahogany, and pink marbles of high quality are quarried in the vicinity of Knoxville. In 1933 Tennessee produced about 21 percent in value of the total marble output of the United States. Production has dropped to less than one-fourth that recorded for 1929. The serious decline is due chiefly to the fact that Tennessee marble is used principally in interiors of buildings, a field in which market requirements have been exceedingly small.

*Alabama.*—White and clouded marbles suitable for both architectural and memorial uses are quarried near Sylacauga, southern Talladega County. Part of the product is fabricated in a large, modern mill, and the remainder is shipped as quarry blocks.

*Missouri.*—An attractive fossiliferous marble quarried in the Ozora district, Ste. Genevieve County, is used for interior decoration. Carthage, Jasper County, and Phenix, Greene County, are long-established centers for production of architectural marble.

*North Carolina.*—Dark bluish-gray, mottled, and white marbles are produced in Cherokee County. Quarries have been operated in past years at Murphy and Regal, but more recent developments are near Marble where a large finishing plant was built a few years ago.

*Other States.*—Attractive white and golden vein marbles are quarried on Yule Creek near the town of Marble in Gunnison County, Colo.

Verd antique is quarried near Cardiff, Md. A marble-finishing mill is located near the quarry, but the major part of the output is shipped as quarry blocks. White marble has been quarried and fabricated at Cockeysville, Baltimore County, for many years.

In Massachusetts white and clouded dolomitic marbles are quarried near Lee, Berkshire County, and verd antique near Westfield, Hampden County.

A gray marble suitable for exteriors of buildings is quarried near Batesville, Independence County, Ark. Several quarries have been opened recently in a black marble deposit near Batesville. A coarsely crystallized, light gray marble is quarried near Guion in Izard County.

Marbles of many varieties, including onyx, are obtainable in California, but production is small.

A dense, black marble is quarried near Harrisonburg, Va. A small mill for sawing blocks into slabs was erected in 1933.

## LIMESTONE

*Market conditions.*—The quantity of building limestone sold in 1933, approximately 520,000 short tons, was 19 percent less than in 1932. The production was valued at approximately $6,489,000, 9 percent less than in 1932. As indicated in the table of salient statistics, by far the largest item is cut stone, together with slabs and mill blocks that are fabricated later into cut-stone products. These products have a Nation-wide market range. Government building programs, which have furnished the principal market outlet for limestone during recent years, were curtailed greatly in 1933, and private construction afforded little relief. Unless public works projects provide substantial orders there is little prospect of improvement during 1934.

*Review by States.*—Indiana leads all States by a wide margin as a producer of building limestone. About 68 percent of the total tonnage sold in 1933 originated in Indiana quarries. Other States producing substantial quantities were, in order of importance, Alabama, Texas, and Minnesota. Smaller quantities were obtained in Wisconsin, Florida, Montana, Kentucky, and several other States.

*Indiana.*—The limestone industry of Indiana is centered in the territory surrounding Bedford, Lawrence County, and Bloomington, Monroe County, where buff and gray oolitic limestones occur in beds 25 to 100 feet thick. Twelve or more companies quarry stone, and most of them also operate well-equipped fabricating mills. The quarry companies also supply mill blocks and slabs to a dozen or more independent mills in the district, and large quantities of mill blocks are shipped to finishing mills in many cities.

Sales of stone for construction from the quarries of the Indiana oolitic limestone district in 1933 amounted to 4,858,660 cubic feet, valued at $4,817,822. This was a decrease of 18 percent in quantity and 12 percent in value compared with 1932 (5,927,350 cubic feet valued at $5,491,276) and followed successive decreases in quantity and value from 1930 to 1932. The figures for 1933 include 2,036,460 cubic feet of rough blocks valued at $733,804, a decrease of 31 percent in quantity and 33 percent in value; 369,230 cubic feet of sawed and semifinished stone valued at $239,229, a decrease of 65 percent in quantity and 70 percent in value; and 2,452,970 cubic feet of cut stone valued at $3,844,789, an increase of 27 percent in quantity and 7 percent in value.

Stone furnished by quarry operators to the finishing mills of the district and milled and sold by them in 1933 amounted to 1,198,430 cubic feet valued at $1,900,414, a decrease of 14.7 percent in quantity and 20 percent in value from 1932. The total sales reported by finishing plants were all of cut stone; no sales of sawed stone were reported in 1933.

Production in Indiana in 1933 is shown in more detail in the following tables.

*Limestone sold by producers in the Indiana oolitic limestone district, 1932 and 1933, by classes*

| Class | 1932 | | 1933 | |
|---|---|---|---|---|
| | Quantity | Value | Quantity | Value |
| Construction: | | | | |
| Rough blocks.......cubic feet.. | 2,932,040 | $1,096,161 | 2,036,460 | $733,804 |
| Sawed and semifinished.......do.... | 1,061,080 | 806,365 | 369,230 | 239,229 |
| Cut.......do.... | 1,934,230 | 3,588,750 | 2,452,970 | 3,844,789 |
| Total construction.......do.... | 5,927,350 | 5,491,276 | 4,858,660 | 4,817,822 |
| Approximate equivalent.......short tons.. | 429,730 | ------------ | 352,000 | ------------ |

*Indiana oolitic limestone sold by mills not operated by quarry companies in the district, 1932 and 1933, by classes* [1]

| Year | Sawed | | Cut | | Total | |
|---|---|---|---|---|---|---|
| | Cubic feet | Value | Cubic feet | Value | Cubic feet | Value |
| 1932 | 27,440 | $22,238 | 1,376,870 | $2,353,036 | 1,404,310 | $2,375,274 |
| 1933 | ------------ | ------------ | 1,198,430 | 1,900,414 | 1,198,430 | 1,900,414 |

[1] Includes stone purchased by quarry operators, milled, and resold.

*Alabama.*—Oolitic limestone is quarried near Rockwood, Franklin County. It grades in color from gray to buff and is somewhat harder than Indiana limestone. It is fabricated in a well-equipped mill the products of which are marketed in many States.

*Minnesota.*—Attractive gray, yellow, buff, and mottled dolomitic limestones are plentiful in southeastern Minnesota. Stone suitable for heavy masonry and bridge construction, as well as for building purposes, is quarried at Mankato. Buff and mottled limestones well-adapted for interior decoration are quarried between Mankato and Kasota. Architectural limestone is quarried near Winona.

*Texas.*—Oolitic limestone similar to that obtained in Indiana has been quarried extensively during recent years near Cedar Park, Williamson County. Other deposits are worked near Lueders, Jones County, and near Albany, Shackelford County, as occasion demands.

*Other States.*—Travertine of good quality occurs near Salida, Fremont County, Colo., and an attractive green sandy limestone near

Manitou, El Paso County. Production in the State was very small in 1933.

Porous limestone is quarried near Miami at Islamorada on Windly's Island, Monroe County, and at Bradenton, Manatee County, Fla.

Oolitic limestone occurring in beds 10 to 20 feet thick near Bowling Green, Warren County, Ky., has been quarried for many years. Quarry blocks are shipped to Bowling Green for manufacture into finished products.

A deposit of travertine said to resemble the Italian product has recently been opened at Gardiner, Mont., near the entrance of Yellowstone Park. A small production was reported in 1933.

A strong, hard, gray dolomite occurring in thin beds near Lannon, Waukesha County, Wis., is used to some extent for curbing and flagging, an unusual use for limestone. Stone quarried at Wauwatosa, Milwaukee County, is used for bridge construction, ashlar, sills, flagging, and rubble.

## SANDSTONE

*Market conditions.*—Sales of sandstone in 1933 amounted to about $1,406,000, a decrease of 8 percent from 1932. The total quantity sold, approximately 267,500 short tons, was 55 percent greater than in 1932. The increase was due to a large gain in rough building stone used for extensive seawall construction in Oregon. All other varieties decreased.

A fair estimate of general conditions can be gained best by considering only the varieties other than rough construction stone. On this basis the value in 1933 was 26 percent less and the tonnage 42 percent less than in 1932.

The output of cut stone, slabs, and mill blocks in 1933 decreased 4 percent in quantity and 23 percent in value compared with 1932. Paving blocks and curbing experienced the most serious decline, sales being nearly 50 percent lower than in 1932. More detailed figures are given in the table of salient statistics.

Sandstone, as the name implies, consists of sand grains firmly cemented together. The grains are of quartz, a mineral highly resistant to weathering. Because of their enduring qualities, well-cemented sandstones are used extensively under normal conditions as exterior building stone. The more attractive types are used for interior decoration. Highly colored rustic varieties have become popular for residential building. Ordinarily large quantities of sandstone are used in the building trades, but sandstone shared with granite, marble, and limestone an unusually small sales volume in 1933.

The market demands for sandstone paving blocks and curbing were surprisingly small in view of the fact that sales of similar granite products were sustained fairly well in 1933.

*Review by States.*—There was little activity in rough construction-stone production except in Oregon, where a special project increased the output of that State unusually. Ohio leads all States by a wide margin in the production of sandstone used for building. Other producing States arranged according to the value of output in 1933, were Washington, Pennsylvania, New York, Idaho, Kentucky, and South Dakota.

Paving blocks were produced chiefly in New York and curbing in Ohio. Flagging was produced principally in northern Ohio, at Crab Orchard, Tenn., and in the bluestone districts of Pennsylvania and New York.

*Ohio.*—Of the output of cut sandstone, together with slabs and blocks ultimately manufactured into cut-stone products, Ohio in 1933 produced 84 percent of the total for the entire country. The value of these products quarried in Ohio amounted to more than 70 percent of the total. The sandstone industry is centered chiefly in the territory near Amherst, Lorain County, and Berea, Cuyahoga County. Blue-gray, buff, and variegated sandstones are quarried in deep, open pits and fabricated in modern mills for exteriors and interiors of buildings and for curbing, flagging, grindstones, and pulpstones. Sandstones quarried near Empire, Jefferson County, and at Constitution and Marietta, Washington County, are applied principally to the last-named uses.

A fine-grained sandstone quarried at McDermott, Scioto County, is used for building stone, burial vaults, grindstones, and small abrasive stones. Glenmont, Holmes County, is an important center for production of the rustic types.

*Washington.*—Gray sandstone quarried at Wilkeson, Pierce County, is used as building stone and for manufacture of paving blocks and pulpstones. Buff and gray sandstones quarried at Tenino, Thurston County, are used for building purposes in several western States.

*Pennsylvania.*—Sandstones recently produced in Pennsylvania consist chiefly of the variety known as bluestone, which appears plentifully in Pike, Susquehanna, and Wyoming Counties. It is used principally for flagging, curbing, and building stone.

*New York.*—Sandstone quarried near Albion and at other points in Orleans County is employed chiefly for paving-block manufacture, a use for which it is well adapted. Bluestone, similar to that produced in Pennsylvania, occurs in several counties bordering the Hudson and Delaware Rivers. Small quantities were quarried in 1933.

*Idaho.*—Buff and gray sandstones obtained in Ada County are used for local building and are shipped to construction centers in nearby States.

*Kentucky.*—A fine-grained sandstone occurring at Farmers, Rowan County, is used as exterior and interior building stone.

*South Dakota.*—Commercial sandstone deposits occur near Hot Springs, Fall River County, and near Sioux Falls, Minnehaha County. The latter is a very hard variety known as the "Sioux quartzite." A small quantity of building stone was produced in the State in 1933.

## BASALT AND MISCELLANEOUS STONE

Although the principal use of basalt is for manufacture of crushed stone a small quantity is used as dimension stone for rough construction. That polished for memorial use is classed with the black granites.

Small quantities of certain miscellaneous rocks that fall logically in none of the four principal groups—granite, marble, limestone, and sandstone—are used as building 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. Considerable quantities of boulders used locally for special building projects are unrecorded because the Bureau has no means of establishing contact with the producers. Large quantities of rough building stone were reported from Boulder Dam in 1932, but none was reported in 1933. This accounts for most of the decrease in sales of miscellaneous stone from 157,340 tons to only 18,000 tons, as shown in the table of salient statistics.

Soapstone, a massive rock related to talc, is used for numerous purposes in the form of blocks and slabs and is therefore included as a part of the dimension-stone industry. Ground soapstone, which is similar in character and use to talc, is included in the chapter of this volume on Talc and Ground Soapstone. Soapstone is manufactured into specialized products having a relatively high unit value. It is not related to the stone ordinarily 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.

Because of its high resistance to the action of acids and heat soapstone is well adapted for furnace blocks in paper mills and for laboratory equipment, including table tops, sinks, fume hoods, and tanks. It is also used for laundry tubs and aquariums, as well as for spandrels, baseboard, floor tile, and other structural units. Most of the soapstone now marketed is produced in Nelson County, Va. The demand for soapstone was considerably lower in 1933 than in 1932.

# SLATE

By Oliver Bowles and A. T. Coons

SUMMARY OUTLINE



The continuous decline since 1928 in sales of slate other than granules and flour was almost checked in 1933 insofar as quantity was concerned, but for the fifth consecutive year the total value decreased sharply. The quantity of dimension slate sold by producers was approximately 73,240 short tons, a drop of only 1.7 percent compared with 1932, but the value declined 20.5 percent to $1,515,863, the lowest value recorded since slate statistics were first compiled.

The following table gives the principal statistical data for slate in 1932 and 1933, arranged so as to permit ready comparison of all slate products. Statistics relating to granules and flour, which have little connection with the slate industry proper, appear in the table because they are manufactured from slate, but they are properly a part of the crushed-stone industry and are included with other kinds of granules in the chapter of this volume on Crushed and Broken Stone.

*Salient statistics of the slate industry in the United States, 1932–33*

| | 1932 | | | 1933 | | | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | | Value | Quantity | | Value | Percent of change in— | |
| | Unit of measurement | Approximate equivalent short tons | | Unit of measurement | Approximate equivalent short tons | | Quantity (unit as reported) | Value |
| Domestic production (sales by producers): | *Squares* | | | *Squares* | | | | |
| Roofing slate | 144,410 | 56,140 | $1,072,255 | 153,170 | 57,920 | $967,834 | +6.1 | −9.7 |
| Mill stock: | *Sq. ft.* | | | *Sq. ft.* | | | | |
| Electrical slate | 155,410 | 1,330 | 120,514 | 190,540 | 1,700 | 132,295 | +22.6 | +9.8 |
| Structural and sanitary slate | 966,940 | 8,000 | 322,858 | 620,020 | 5,140 | 193,934 | −35.9 | −39.9 |
| Grave vaults and covers | 340,860 | 3,170 | 79,956 | 340,240 | 3,320 | 70,399 | −.2 | −12.0 |
| Blackboards and bulletin boards | 1,137,800 | 2,940 | 260,766 | 625,950 | 1,500 | 113,667 | −45.0 | −56.4 |
| Billiard-table tops | 55,310 | 510 | 22,931 | 7,750 | 70 | 2,896 | −86.0 | −87.4 |
| School slates | [1] 183,700 | 220 | 3,418 | [1] 305,150 | 330 | 5,887 | +66.1 | +72.2 |
| Total mill-stock | 2,840,020 | 16,170 | 810,443 | 2,089,650 | 12,060 | 519,078 | −26.4 | −36.0 |

[1] Reported as pieces: 1932, 345,230; 1933, 559,380; square feet approximate.

*Salient statistics of the slate industry in the United States, 1932–33*—Continued

| | 1932 | | | 1933 | | | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | | Value | Quantity | | Value | Percent of change in— | |
| | Unit of measurement | Approximate equivalent short tons | | Unit of measurement | Approximate equivalent short tons | | Quantity (unit as reported) | Value |
| Domestic production—Continued. Flagstones, etc.[2] | *Sq. ft.* 289,450 | 2,180 | $23,786 | *Sq. ft.* 354,160 | 3,260 | $28,951 | +22.4 | +21.7 |
| Total slate as dimension stone | ---------- | 74,490 | 1,906,484 | ---------- | 73,240 | 1,515,863 | −1.7 | −20.5 |
| Granules and "flour" | ---------- | 209,750 | 1,197,816 | ---------- | 186,380 | 1,180,322 | −11.1 | −1.5 |
| Grand total, domestic production | ---------- | 284,240 | 3,104,300 | ---------- | 259,620 | 2,696,185 | −8.7 | −13.1 |
| Foreign trade: Imports for consumption | ---------- | ---------- | 17,317 | ---------- | ---------- | 9,688 | ---------- | −44.1 |
| Exports: Roofing | *Squares* 1,792 | ---------- | 12,215 | *Squares* 1,155 | ---------- | 7,244 | −35.5 | −40.7 |
| Other dimension slate | ---------- | ---------- | 42,958 | ---------- | ---------- | [3] 18,798 | ---------- | −56.2 |
| Granules and "flour" | ---------- | ---------- | (4) | ---------- | ---------- | [3] 41,076 | ---------- | -------- |

[2] Includes walkways, stepping stones, and miscellaneous slate.
[3] Collected by the Bureau of Mines from shippers of products named.
[4] Figures not available.

Roofing slate showed some evidence of recovery in 1933; the number of squares sold increased about 6 percent, although the value decreased about 10 percent. As residential construction was still depressed, presumably a considerable part of the slate sold was employed in reroofing.

Total millstock decreased 26 percent in quantity and 36 percent in value compared with 1932. Structural and blackboard slate declined greatly. As these materials are used in the construction industries, which were relatively inactive in 1933, small demand was to be expected. Blackboard sales are roughly proportional to schoolhouse construction, which in 1933 was only about one-tenth of the average for the period 1922–31. Even if this class of building increases considerably in 1934 blackboard stocks are so large that no production is expected except to fill special orders.

Sales of school slate increased 66 percent in square feet and 72 percent in value, but slate for billiard-table tops dropped to the lowest point on record. The decline in the latter from over 55,000 square feet in 1932 to only 7,750 square feet in 1933 indicates either that there has been a drastic decline in the manufacture of billiard tables or that other materials have been employed.

There was little decrease in square feet of slate sold for vaults and covers, but the unit value was much lower than in 1932. Flagging and related slate products, which have become increasingly popular in recent years, gained about 22 percent in both square feet and value.

Long-continued adverse conditions have taken heavy toll of slate companies. Several quarries and mills have ceased to operate; some are closed permanently, but others may resume work when conditions improve.

The following table shows sales of dimension slate by producers in recent years.

*Slate (other than granules and flour) sold by producers in the United States, 1920–33*

| Year | Roofing | | | Millstock | | Other [1] | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | Squares | Approximate equivalent short tons | Value | Approximate short tons | Value | Approximate short tons | Value | Approximate short tons | Value |
| 1920–29 (average) | 457, 492 | 159, 872 | $4, 544, 738 | 54, 730 | $3, 590, 070 | 7, 398 | $72, 674 | 222, 000 | $8, 207, 482 |
| 1930 | 340, 140 | 127, 080 | 3, 359, 939 | 40, 120 | 2, 755, 530 | 6, 710 | 100, 732 | 173, 910 | 6, 216, 201 |
| 1931 | 277, 700 | 103, 210 | 2, 364, 861 | 29, 440 | 1, 754, 054 | 5, 790 | 66, 904 | 138, 440 | 4, 185, 819 |
| 1932 | 144, 410 | 56, 140 | 1, 072, 255 | 16, 170 | 810, 443 | 2, 180 | 23, 786 | 74, 490 | 1, 906, 484 |
| 1933 | 153, 170 | 57, 920 | 967, 834 | 12, 060 | 519, 078 | 3, 260 | 28, 951 | 73, 240 | 1, 515, 863 |

[1] Includes flagstones, walkways, stepping stones, and miscellaneous slate.

These data, together with those for total building and residential building, are plotted in figure 76. The diagram illustrates the tendency of slate to follow closely the trend in building construction and indicates that the slate industry has not suffered more severely than

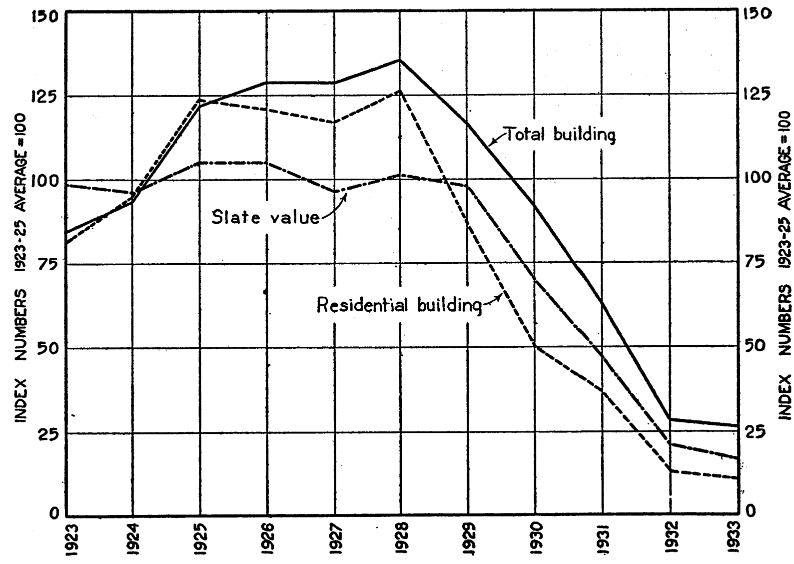


FIGURE 76.—Sales of slate compared with total building and residential building, 1923–33. The curve for slate includes all products except granules and flour; those for building represent value of contracts awarded in the 37 States east of the Rocky Mountains as compiled by the F. W. Dodge Corporation. To facilitate comparison of unlike units all data have been reduced to percentages of averages for 1923–25.

the construction industries in general. Further information on conditions in the building industries may be found in this volume in the chapter on Cement.

The following table shows sales of slate granules and flour by producers in the United States from 1929 to 1933:

*Crushed slate (granules and flour) sold by producers in the United States, 1929–33*

| Year | Granules | | Flour | | Total | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| 1929 | 395,830 | $2,321,330 | 33,110 | $176,413 | 428,940 | $2,497,743 |
| 1930 | 255,070 | 1,549,301 | 34,630 | 146,116 | 289,700 | 1,695,417 |
| 1931 | 198,450 | 1,182,684 | 31,530 | 129,833 | 229,980 | 1,312,517 |
| 1932 | 174,140 | 1,058,713 | 35,610 | 139,103 | 209,750 | 1,197,816 |
| 1933 | 146,880 | 1,024,917 | 39,500 | 155,405 | 186,380 | 1,180,322 |

*Properties and uses.*—The most characteristic feature of slate is fissility, which permits it to be split readily into thin, smooth sheets. This property makes possible the manufacture of roofing slate and, combined with easy workability, also adapts some slates for the manufacture of various mill products.

There are three main groups of slate products—roofing slate; millstock; and a group including flagging, walkways, building slate, and similar products. Millstock is subdivided into structural and sanitary products, electrical slabs, grave vaults, blackboards, billiard-table tops, and school slates. Thus, a large proportion of all slate sold is consumed by the building industries.

*Competitive conditions.*—Slate enters a highly competitive market for every use to which it is put. For roofing material it competes with tile, sheet metal, asbestos-cement shingles, wood shingles, and composition roofing; for electrical panels, with marble, soapstone, and various synthetic slabs; for structural and sanitary uses, with soapstone, marble, travertine, sandstone, and cement; and for blackboards, with plaster, wood, glass, and synthetic compounds. It is apparent therefore that prosperity in the slate industry depends largely on the ability of operators to produce high-grade products at relatively low cost and to capitalize the qualities of slate to the fullest extent. A recent report[1] emphasizes the fact that roofing-slate producers are handicapped by their inability to adopt mass-production methods and to avoid a large proportion of waste. It urges them to offset these unavoidable handicaps by giving unremitting attention to improved processes of manufacture, reduction of waste, and establishment of adequate sales agencies with readily available stocks of slate. Furthermore, it stresses that, because of the difficulty of competing with lower-priced types of roofing, producers probably will find their most profitable market in relatively high-priced building construction where the enduring qualities and architectural merits of slate may best be capitalized. For instance, a slate roof is appropriate for a stone house or any type of building where dignity and artistic blending of natural colors are desired.

The sharp decline in the roofing-slate industry, occasioned chiefly by unfavorable competitive conditions, as summarized in the report mentioned, apparently was not confined to the United States. In commenting on the report a London publication[2] states: "Written

[1] Bowles, Oliver, Consumption Trends in the Roofing-Slate Industry: Rept. of Investigations 3221, Bureau of Mines, 1933, 3 pp.
[2] Quarry Managers' Journal, vol. 16, January 1934, p. 329.

about the slate industry of the United States, every word is equally true of the slate industry of the United Kingdom."

*Recent trends and developments.*—Slate companies have taken advantage of idle periods to improve their quarries and mills. Circular saws have been equipped with detachable teeth tipped with extremely hard alloys. Substitution of such equipment for ordinary tempered-steel saws results in more rapid cutting and less breakage of corners. A newly designed cutting blade for a motor-driven machine used to trim roofing slate bears promise of considerable reduction in breakage of slate.

Further progress in utilizing waste slate has been made in Europe. Considerable quantities are pulverized and sold as filler for paint, particularly paint used for frescoes, concrete, or oil-priming coats. Some is used as filler in road tar and in the manufacture of concrete products.

Waste from the Penrhyn quarries in North Wales is pulverized and sold under the trade name "fullersite" as filler in bituminous road-surface mixtures. It is claimed that the particles, because of their flakelike character, are easily held in suspension and are distributed more evenly in tar than are equidimensional particles.

According to a recent article,[3] the Building Research Station at Garston, England, has produced a lightweight aggregate by calcining waste slate. It is claimed that certain varieties of slate heated to a very high temperature develop a cellular structure, forming a material that will float on water. It is suggested that this material may be used as an aggregate for lightweight partition slabs.

Kellow [4] gives a detailed description of a new type of channeling machine for slate quarries. It consists essentially of a rotary drill operated by a hydraulic turbine which makes the channel by drilling a closely spaced row of holes. It is claimed that a 3½-inch hole can be sunk at the rate of 2½ feet a minute. Eighteen square feet of channeled surface per hour, including the time required for moving the equipment, is an average cutting rate, and the average cost is approximately 12½ cents a square foot. The machine apparently has many advantages over the ordinary channeler, but its merits compared with those of the wire saw have not yet been demonstrated.

For some years the National Slate Association and Committee D–16 on Slate of the American Society for Testing Materials sponsored the promotion of research and the development of specifications and tests. Stagnation in the slate industry has discouraged such activities, but interest may be renewed with revival of business.

*Code of Fair Competition.*—A public hearing on the Code of Fair Competition for the Slate Industry was held in Washington, D.C., on November 9, 1933. As a result of numerous discussions conducted both before and after the hearing under the general auspices of the National Slate Association, the diverse problems of the various districts were harmonized, and the code was approved in final form January 22, 1934. Although the code was not effective in 1933, it may have profound influence on the industry in 1934 and later years.

Article VI, Marketing Practices, probably has the most important effect on the industry. Low prices have been so prevalent in the

[3] Slate Trade Gazette, Slate Waste: Vol. 39, Nov. 16, 1933, p. 78.

[4] Kellow, M., The Application of Mechanical Means to the Quarrying of Slate: Quarry Managers' Jour., vol. 16, June 1933, pp. 99–104.

past that there have been virtually no profits. It is believed that the open-price policy and the prohibition against selling below cost adopted in the code will establish the industry on a more profitable basis. According to article VI, all members of the industry are required to publish price lists and to adhere strictly to them. Except under specified conditions for liquidation of stocks, members of the industry are prohibited from selling under such terms or conditions as will result in a purchase price lower than the average production cost in the district in which the slate is quarried. It is anticipated that there may be some difficulty in enforcing the "selling-below-cost" provisions, for the elements of cost must be defined clearly and a uniform system of accounting established before they can be determined definitely. The slate industry long has needed a uniform accounting system, and several years ago the Bureau of Mines cooperated with producers in devising such a system; a report covering the subject was published.[5]

Other provisions of the code relate to wages, hours of work, general labor conditions, methods of administering the code, and prohibitions against misrepresentations, rebates, and other unfair trade practices. Strict adherence to the provisions of the code and reviving market demands may mark the beginning of a new era in the slate industry.

## REVIEW BY DISTRICTS

The active slate-producing districts of the United States are the Monson (Maine) district; the New York-Vermont district, including Washington County, N.Y., and Rutland County, Vt.; the Lehigh district, including Lehigh and Northampton Counties, Pa.; the Peach Bottom district, including York County, Pa., and Harford County, Md.; Berks County, Pa.; and the Buckingham County (Arvonia) and Albemarle County districts of Virginia. These districts produce roofing slate and millstock, and some also produce roofing granules and slate flour. In 1933 slate was produced also in Arkansas, California, Georgia, and Tennessee.

The following table shows distribution of sales of slate by States and uses.

*Slate sold by producers in the United States in 1933, by States and uses*

| State | Operators | Roofing | | Millstock | | Other uses [1] (value) | Total value |
|---|---|---|---|---|---|---|---|
| | | Squares (100 square feet) | Value | Square feet | Value | | |
| Arkansas | 3 | | | | | $35,420 | $35,420 |
| California | 5 | | | | | 39,845 | 39,845 |
| Georgia | 1 | | | | | (2) | (2) |
| Maine | 3 | 3,110 | $25,106 | 122,500 | $89,482 | | 114,588 |
| Maryland | 2 | (2) | (2) | | | (2) | (2) |
| New York | 19 | 1,820 | 13,957 | | | 277,811 | 291,768 |
| Pennsylvania | 37 | 95,050 | 537,178 | 1,799,300 | 345,000 | 241,836 | 1,124,014 |
| Tennessee | 2 | (2) | (2) | | | (2) | (2) |
| Vermont | 45 | 40,240 | 297,043 | 167,850 | 84,596 | 307,264 | 688,903 |
| Virginia | 6 | 11,880 | 84,126 | | | (2) | (2) |
| Undistributed [3] | | 1,070 | 10,424 | | | 307,097 | 401,647 |
| Total, 1933 | 123 | 153,170 | 967,834 | 2,089,650 | 519,078 | 1,209,273 | 2,696,185 |
| Total, 1932 | 111 | 144,410 | 1,072,255 | 2,840,020 | 810,443 | 1,221,602 | 3,104,300 |

[1] Flagging and similar products, granules, and flour.
[2] Included under "Undistributed."
[3] Includes output of States entered as (2) above.

[5] Bowles, Oliver, A System of Accounts for the Slate Industry: Rept. of Investigations 2971, Bureau of Mines, 1929, 25 pp.

*Maine.*—Slate produced in Maine is sold chiefly for electrical slabs; smaller quantities are sold for roofing and structural purposes. In 1933 sales of roofing slate increased slightly compared with 1932; structural and electrical slate also increased somewhat. The producing companies, all with quarries at Monson, were:

Monson Maine Slate Co. (address, Monson).
Portland-Monson Slate Co. (address, 25 Central Wharf, Portland).
Rising & Nelson Slate Co. (address, West Pawlet, Vt.).

It is reported that the slate quarries near Brownsville will be reopened.

*New York-Vermont.*—The New York slate district adjoins that of Vermont, and it is sometimes difficult to determine from the reports of producers to which State the product should be credited. These two States produce all the colored slates used for roofing.

The New York quarries produce chiefly red slate. The output is for granules and flour (red), roofing slate, millstock, and slabs for walkways, flagging, and similar purposes. In 1933 sales of squares of roofing slate decreased 11 percent in quantity and 29 percent in value compared with 1932; the quantity of slate sold for flagging and granules decreased. The producing companies in New York and their products are as follows:

Granville:
- Advance Industrial Supply Co. (address, 111 West Washington Boulevard), Chicago, Ill.); granules, roofing slate.
- Cook & Bahen Slate Co.; roofing slate.
- Hillsdale Slate Co.; roofing slate, flagging, and similar products.
- J. B. Preston Co., Inc. (address, 220 East Forty-second Street, New York); granules.
- John A. Ritchie; roofing slate.
- Salem Slate Co.; roofing slate.
- Sheldon Slate Products Co.; granules, roofing slate, flagging, and similar products.

Hampton: Staso Milling Co. (address, 332 South Michigan Avenue, Chicago, Ill.); granules and flour.
Middle Granville: Montvert Slate Co.; roofing slate.
Truthville: Wold & Vogel; roofing slate.
Whitehall: Jones & Hopkins; flagging and similar products.

Other companies operate quarries intermittently for roofing slate and sell their products through dealers or larger operators.

The Vermont quarries produce roofing slate, millstock, granules, and flagging and similar products. The colors are combinations of green and purple, generally classed as green; unfading green; unfading mottled green and purple; weathering green (sea green); purple; variegated; and "freak." There are also black and gray varieties. Most of the granules manufactured are green.

In Vermont, as in New York, much of the roofing slate is quarried and shaped by owners of small quarries worked at irregular intervals. Generally it is of unusual color and specially sized and is sold through dealers or operators of larger quarries. On account of the variety of colors found in this district much of the roofing slate commands a high price. In 1933 sales of roofing slate by producers in Vermont decreased 7 percent in quantity and 32 percent in value compared with 1932.

Millstock for structural and sanitary uses, electrical slabs, and billiard-table tops also is produced in Vermont. In 1933 millstock decreased 1.5 percent in quantity and 4 percent in value compared with 1932.

The following list includes the chief producers of roofing slate and millstock in Vermont in 1933; many small producers are omitted.

Castleton:
- Hinchey Consolidated Slate Co. (address, Fair Haven); roofing, millstock.
- The John Jones Slate Co.; millstock.

Fair Haven:
- S. Allen's Sons; roofing, millstock (idle in 1933).
- C. R. Beach; roofing.
- Harvey Bush Slate Co.; roofing.
- Durick, Keenan & Co., Inc.; millstock.
- Fair Haven Marble & Marbleized Slate Co.; roofing, millstock.
- Hydeville Slate Works (address, Hydeville); millstock.
- Mahar Bros. Slate Co., Inc.; roofing, millstock.
- W. H. Pelkey Estate; roofing, millstock.
- Sbardella & Pedro Bros. (address, North Poultney); roofing.
- Scotch Hill Slate Co., Inc.; roofing.
- Variegated Slate Co. of Vermont; millstock.

Pawlet:
- O'Brien Bros. Slate Co., Inc. (address, Granville, N.Y.); roofing.
- Owen W. Owens & Sons, Inc. (address, Granville, N.Y.); roofing.
- Vermont Black Slate Co. (address, Granville, N.Y.); roofing.
- H. G. Williams Slate Co. (address, Granville, N.Y.); roofing.

Pawlet, Poultney, and Rupert: F. C. Sheldon Slate Co. (address, Granville, N.Y.); roofing.

Pawlet and Wells: Norton Bros. (address, Granville, N.Y.); roofing.

Poultney:
- The Auld & Conger Co. (address, 1920 East Seventy-fifth Street, Cleveland, Ohio); Bush quarries; roofing. Quarries idle in 1933; sales from stock.
- Berdew Slate Co., Inc.; roofing.
- Cambrian Slate Co. (address, Granville, N.Y.); roofing.
- El Nido Slate Co.; roofing.
- The John D. Emack Co. (address, 1700 Sansom Street, Philadelphia, Pa.); roofing (idle in 1933).
- McCarty Slate Co., Inc.; roofing.
- H. A. Matot; roofing.
- Montvert Slate Co.; roofing.
- New England Slate Co.; roofing.
- A. Panda Slate Co. (address, Granville, N.Y.); roofing.
- Vermont Slate Flooring Corporation; millstock.
- John D. Williams; roofing.

Poultney and West Pawlet: Rising & Nelson Slate Co. (address, West Pawlet); roofing.

Wells:
- Evergreen Slate Co. (address, Middle Granville, N.Y.); roofing.
- Williams Bros. Slate Co. (address, Granville, N.Y.); roofing.

West Pawlet:
- Patrick Kehoe; roofing.
- I. R. Lewis & Co.; roofing.

Nearly all the firms in Vermont that produce millstock also sell slabs for flagstones, stepping stones, and similar products. Vermont produces the greater part of such slate. Granules and flour are produced at Castleton by the Staso Milling Co. (address, 332 South Michigan Avenue, Chicago, Ill.).

*Maryland-Pennsylvania.*—In the Peach Bottom district of Maryland and Pennsylvania production was confined to roofing slate, granules, and flour. The producing companies in this district in 1933 and their products were:

Harford County, Md.:
- Cardiff: Peach Bottom Slate Co. of Harford County, Md. (address, Delta, Pa.); roofing.
- Whiteford: Staso Milling Co. (address, 332 South Michigan Avenue, Chicago, Ill.); granules and flour.

York County, Pa.: Near Delta: Funkhouser Co. (address, Hagerstown, Md.); granules and flour. It is reported that production of roofing slate will be resumed near Delta at an early date.

At Lenhartsville, Berks County, Pa., slate flour was produced by the Greenwich Slate Products Co.

The Lehigh district, consisting of Lehigh and Northampton Counties, Pa., now produces all the roofing slate and millstock sold in the State.

In Lehigh County the quarries are near Emerald, Slatedale, and Slatington. The companies reporting in 1933, all of whom furnish both roofing slate and millstock, were:

Slatedale:
- J. P. Kern Slate Co.
- Shenton Slate Co.

Slatington:
- Blue Mountain Slate Manufacturing Co.
- Blue Ridge Quarries, Inc.
- Cambridge Slate Co. (idle in 1933).
- Wm. H. Dillard.
- Hankee Bros.
- Manhattan Slate Co.
- Pennsylvania Slate Blackboard Co.
- Slatington Slate Corporation.
- Edwin F. Snyder & Son.

In Northampton County the quarry operators and their products in 1933 were:

Bangor:
- Bangor Ideal Slate Mining Co.; roofing.
- Bangorvein Slate Co.; Bangor Peerless quarry; roofing, millstock.
- Columbia Bangor Slate Co.; roofing.
- North Bangor Slate Co.; roofing, millstock.
- Old Bangor Slate Co.; roofing (idle in 1933).
- Slate Products Co., Inc.; roofing, millstock.

Berlinsville: Amalgamated Slate Quarries Co. (address, Easton); Genuine Washington quarries; roofing, millstock. Idle in 1933.

Chapman Quarries: Chapman Slate Co. (address, Bethlehem); roofing.

East Bangor: The East Bangor Consolidated Slate Co.; roofing.

Edleman: The Hard-Vein Slate Co. (address, Easton); roofing.

Nazareth:
- Edelman Standard Hard-Vein Slate Co. (address, Edelman); roofing.
- James W. Hughes; roofing.

Pen Argyl:
- Albion Vein Slate Co. (address, Bangor); roofing.
- Belmont Slate Co. (address, Bangor); roofing, millstock.
- Diamond Slate Co., Inc.; millstock.
- Doney Slate Co., Inc.; roofing, millstock.
- Jackson-Bangor Slate Co.; roofing, millstock.
- Keenan Structural Slate Co.; Albion quarry; roofing, millstock.
- Parsons Bros. Slate Co.; roofing, millstock.
- Parsons Manufacturing Co.; slate "flour."
- Stephens-Jackson Co.; Courtney quarry; roofing, millstock.
- D. Stoddard & Son (address, Bangor); Albion Vein quarry; millstock.

West Bangor: Bangor Fidelity Slate Co. (address, Bangor); roofing, millstock.

Windgap:
- Bolger-Heiler Slate Co.; roofing, millstock.
- Colonial Slate Co. (address, Bangor); roofing, millstock.
- Imperial Slate Blackboard Co.; roofing, millstock.
- Phoenix Slate Co.; roofing, millstock (quarry closed Sept. 30, 1933).

Fire destroyed mills operated by the Slate Products Co. near Bangor and the Bolger-Heller Slate Co. near Windgap. The mills have not yet been rebuilt.

The following table shows sales of slate in Pennsylvania in 1933, by counties and uses:

*Slate sold by producers in Pennsylvania in 1933, by counties and uses*

| County | Operators | Roofing slate | | Millstock[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Structural and sanitary[2] | | Electrical | |
| | | Squares (100 square feet) | Value | Square feet | Value | Square feet | Value |
| Lehigh | 10 | 13,690 | $66,840 | 82,760 | $17,039 | 24,840 | $10,501 |
| Berks, Northampton, and York[3] | 27 | 81,360 | 470,338 | 739,030 | 186,895 | 14,010 | 8,169 |
| Total, 1933 | 37 | 95,050 | 537,178 | 821,790 | 203,934 | 38,850 | 18,670 |
| Total, 1932 | 36 | 86,550 | 492,917 | 1,140,750 | 328,553 | 29,360 | 17,074 |

| County | Millstock—Continued | | | | Other[4] (value) | Total value |
|---|---|---|---|---|---|---|
| | Blackboards and bulletin boards | | School slates | | | |
| | Square feet | Value | Square feet | Value | | |
| Lehigh | 276,200 | $36,835 | 305,150 | $5,887 | $574 | $137,676 |
| Berks, Northampton, and York[3] | 349,750 | 76,832 | | | 244,104 | 986,338 |
| Total, 1933 | 625,950 | 113,667 | 305,150 | 5,887 | 244,678 | 1,124,014 |
| Total, 1932 | 1,137,800 | 260,766 | 183,700 | 3,418 | 252,956 | 1,355,684 |

1 Exclusive of billiard-table material, value for which is included under "Other."
2 Includes slate for grave covers and vaults.
3 Berks and York Counties produced roofing granules and "flour" only.
4 Includes billiard-table material, as follows: 1932, 55,230 square feet valued at $22,900; 1933, 7,560 square feet valued at $2,842.

*Virginia.*—Sales of slate in Virginia were reported in 1933 by the following companies:

Albermarle County: Monticello: Monticello Slate Corporation (address, care of Buckingham Slate Corporation, Richmond); roofing. Idle in 1933; sales from stock.
Albermarle and Buckingham Counties: Esmont and New Canton: Blue Ridge Slate Corporation (address, Charlottesville); Flint Arrow and Dutch Gap quarries; roofing, granules.
Buckingham County:
  Arvonia:
    Arvonia-Buckingham Slate Co., Inc. (address, Richmond); roofing.
    Pitts Slate Corporation; roofing (new in 1933).
    Williams Slate Co., Inc.; Big Quarry; roofing.
  Ore Bank: Le Sueur-Richmond Slate Corporation; roofing.

*Other States.*—In Arkansas slate for roofing granules was taken from deposits in Montgomery County by Grimes Bros. near Amity and by Ouachita Quarries near Norman, and in Polk County by Otto J. Lehrback at Mena. The Arkansas Slate Products Co. conducted development work on properties near Mena, Polk County, but marketed no slate.

In California The Pacific Mineral Co., Ltd. (address, Richmond) operated the Chili Bar slate quarry at Placerville, Eldorado County, for granules and flour. The Union Flagstone Co. (address, Fresno) quarried slate for flagstone in Mariposa County near Le Grand; and John L. Witney, Inc., Jamestown, and W. S. McLean, San Francisco, quarried slate for roofing granules in Tuolumne County. R. B. McIlroy (address, Lone Pine) reported development of a deposit of red slate near Keeler, Inyo County, for granules and flagstone.

At Fair Mount, Ga., the Funkhouser Co. (address, Hagerstown, Md.) produces green granules and grinds slate for use as fertilizer filler.

In Tennessee the Dixie Mining & Development Co. quarries slate for millstock and walkways and similar products near Chilhowee, Blount County. It was reported that the quarries of the Southern Slate & Marble Co. (address, Empire Building Annex, Knoxville) near Maryville were reopened in 1933, and some roofing slate was produced.

## FOREIGN TRADE[6]

*Imports.*—The value of slate imported for consumption in the United States decreased 44 percent in 1933 compared with 1932. The following table shows imports from 1929 to 1933:

*Value of slate imported for consumption in the United States, 1929–33*

| | | | |
|---|---|---|---|
| 1929 | $95,073 | 1932 | $17,317 |
| 1930 | 48,065 | 1933 | 9,688 |
| 1931 | 46,581 | | |

The following table shows imports in 1932 and 1933, by countries. The absence of imports of roofing slate in 1933 is significant. The principal foreign sources of manufactured slate are Czechoslovakia, Sweden, and Germany:

*Slate (manufactured)[1] imported into the United States, 1932–33, by countries and uses*

[General imports]

| Country | 1932 | | | | 1933 (total value)[2] |
|---|---|---|---|---|---|
| | Roofing | | Other uses (value) | Total value | |
| | Square feet | Value | | | |
| Albania | | | | | $382 |
| Canada | | | | | 390 |
| Czechoslovakia | | | $2,902 | $2,902 | 4,129 |
| Danzig and Poland | | | | | 157 |
| Germany | | | | | 2,024 |
| Hong Kong | | | 13 | 13 | 19 |
| Italy | 5,168 | $519 | 9,353 | 9,872 | 93 |
| Japan | | | 220 | 220 | 19 |
| Netherlands | | | | | 111 |
| Norway | 7,350 | 155 | | 155 | |
| Sweden | | | | | 2,186 |
| Switzerland | | | | | 135 |
| United Kingdom | 63,691 | 3,773 | | 3,773 | |
| Yugoslavia | | | | | 43 |
| | 76,209 | 4,447 | 12,488 | 16,935 | 9,688 |

[1] No imports of unmanufactured material reported for 1932 and 1933.
[2] No imports of roofing slate reported for 1933.

[6] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce, except as otherwise indicated.

*Exports.*—The following table shows exports of roofing slate from 1929 to 1933. Exports in 1933 decreased 36 percent in quantity and 41 percent in value compared with 1932:

*Roofing slate exported from the United States, 1929–33*

| Year | Number of squares | Value | Year | Number of squares | Value |
|---|---|---|---|---|---|
| 1929 | 10,376 | $121,367 | 1932 | 1,792 | $12,215 |
| 1930 | 5,278 | 64,343 | 1933 | 1,155 | 7,244 |
| 1931 | 4,174 | 45,020 | | | |

The following table shows exports of roofing slate from 1931 to 1933, by countries of destination. Canada, the West Indies, and Mexico were the only countries to which roofing slate was shipped in 1933:

*Roofing slate exported from the United States, 1931–33, by countries*

| Country | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Number of squares | Value | Number of squares | Value | Number of squares | Value |
| Bermudas | | | 4 | $75 | | |
| Canada | 3,405 | $37,816 | 1,487 | 11,124 | 906 | $5,498 |
| Mexico | | | [1] 242 | [1] 320 | 7 | 35 |
| New Zealand | 262 | 1,795 | 59 | 696 | | |
| Panama | 50 | 1,166 | | | | |
| United Kingdom | 300 | 2,341 | | | | |
| West Indies: | | | | | | |
| British: Trinidad and Tobago | 66 | 562 | | | 242 | 1,711 |
| Haiti | 91 | 1,340 | | | | |
| | 4,174 | 45,020 | 1,792 | 12,215 | 1,155 | 7,244 |

[1] Reported as "surfaced roofing."

The value of exports of millstock was 56 percent less in 1933 than in 1932. Electrical slate was the only product showing a gain. The following table gives exports of millstock, granules, and flour from 1931 to 1933.

*Slate other than roofing exported from the United States, 1931–33, by uses* [1]

| Use | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value |
| School slates ... cases [2] | 11,470 | $57,746 | 2,886 | $17,975 | 1,302 | $10,167 |
| Electrical slate ... square feet | 6,950 | 4,026 | 780 | 777 | 1,800 | 2,000 |
| Blackboards ... do | 183,130 | 62,883 | 55,394 | 16,978 | 28,187 | 5,791 |
| Billiard tables ... do | 25,730 | 12,480 | 13,214 | 6,128 | 500 | 229 |
| Structural ... do | 20,360 | 6,930 | 2,499 | 1,100 | 1,462 | 611 |
| Slate granules and "flour" ... short tons | 13,880 | 79,000 | (3) | (3) | 5,873 | 41,076 |
| | | 223,065 | | [3] 42,958 | | 59,874 |

[1] Collected by Bureau of Mines from shippers of products named.
[2] Cases weigh 130 to 165 pounds each; average is 135 pounds.
[3] Figures for granules and flour not available.

*Tariff.*—Before 1913 the duty on imported slates, chimney pieces, mantels, slabs for tables, roofing slates, and all other manufactures of slate was 20 percent ad valorem. The act of October 1913 reduced it to 10 percent ad valorem, that of September 1922 raised it to 15 percent ad valorem, and the act of 1930 raised it to 25 percent ad valorem.

# CRUSHED AND BROKEN STONE

By J. R. Thoenen

## SUMMARY OUTLINE



According to preliminary figures, the total production of crushed and broken stone was 94,340,000 tons in 1933, a gain of 2 percent over 1932. The output of crushed stone was 50,000,000 tons in 1933, or 4 percent below that in 1932. The production of broken stone, on the other hand, was 44,340,000 tons in 1933, or 10 percent above that in 1932.

The output of crushed stone for concrete aggregate and road metal declined 6 percent in 1933 compared with 1932, but that for railway ballast increased 21 percent.

Production of stone for cement manufacture dropped 20 percent in 1933, but that for lime manufacture increased 25 percent. Stone for furnace flux increased 113 percent, stone used at alkali works 31 percent, stone for riprap 16 percent, agricultural limestone 10 percent, refractory stone 103 percent, and that classified as for other uses 17 percent. Stone used for asphalt filler and the manufacture of calcium carbide, on the other hand, decreased 32 percent and 36 percent, respectively, in 1933 compared with 1932.

Compilation of preliminary figures for the production of crushed and broken stone in 1933 is unusually difficult, because returns already received from companies producing 75 to 80 percent of the country's stone seem to conflict with some of the business indicators used to forecast stone production. As discussed under the summary of statistics of the construction industry in the cement chapter of this volume, declines occurred in virtually all types of construction in 1933 compared with 1932. On the other hand, returns from the crushed- and broken-stone producers so far tabulated (May 1, 1934) indicate moderate to substantial gains for the majority of uses with relatively few losses. Under these circumstances it is justifiable to disregard the usual business barometers and to compile preliminary production figures on the basis of returns received and on the expressed opinion of producers.

*Salient statistics on crushed and broken stone sold or used by producers in the United States, 1932–33, by principal uses, in short tons*

| | 1932 | 1933[1] | Percent of change in 1933 |
|---|---|---|---|
| Concrete and road metal | 48, 020, 560 | 45, 000, 000 | −6 |
| Railway ballast | 3, 974, 540 | 5, 000, 000 | +21 |
| Cement manufacture | 19, 400, 000 | 15, 500, 000 | −20 |
| Lime manufacture | 4, 000, 000 | 5, 000, 000 | +25 |
| Flux stone | 3, 991, 160 | 8, 500, 000 | +113 |
| Alkali works | 3, 211, 770 | 4, 200, 000 | +31 |
| Riprap | 3, 462, 290 | 4, 000, 000 | +16 |
| Agricultural limestone | 910, 430 | 1, 000, 000 | +10 |
| Refractory stone | 197, 430 | 400, 000 | +103 |
| Asphalt filler | 177, 110 | 120, 000 | −32 |
| Calcium carbide | 188, 050 | 120, 000 | −36 |
| Other uses | 4, 690, 080 | 5, 500, 000 | +17 |
| | 92, 223, 420 | 94, 340, 000 | +2 |
| Asphaltic stone | 314, 039 | 277, 000 | −12 |
| Slate granules and flour | 209, 750 | 187, 000 | −11 |

[1] Subject to revision.

*Indicators of production.*—The increased production of steel in 1933 is reflected in increased production of flux and refractory stone. Likewise, the decreased production of cement and the increased production of lime in 1933 are reflected in the changes in the production of limestone for those purposes.

As production of nearly all crushed and broken stone requires explosives, consumption of the latter would seem to furnish a fairly accurate indicator on which to base stone production. The Bureau of Mines reported the sale of 31,884,000 pounds of explosives to quarry and nonmetallic industries in 1933, an increase of 3 percent over 1932.

The crushed- and broken-stone industry represents roughly 90 percent of the tonnage represented in the Bureau's classification of quarry and nonmetallic industries using explosives, if commodities which require insignificant quantities are omitted. Therefore, variations in the use of explosives should be reflected in stone production. This is true to a certain extent, but study of explosive consumption and quarry production since 1928 reveals that the tonnage of stone produced per pound of explosive used increased steadily from 2.48 in 1929, 2.59 in 1930, 2.84 in 1931, to 3.34 in 1932. From this trend it would seem that an increase in explosives used indicates an even larger increase in stone production.

Under the influence of code adjustments, however, employment of labor increased in 1933 and working hours were reduced, creating a condition simulating expansion; under such conditions, efficiency tends to decline, at least temporarily. Therefore, one might expect that the tonnage produced per pound of explosive in 1933 would decrease and offset the indicated rise in stone production forecast by increased consumption of explosives.

Although the opinions of operators in the field generally indicated a larger decline in stone used for concrete and road metal than that estimated by the author, tabulated returns do not bear out this contention. The probable reason is that production from temporary and noncommercial plants apparently increased over that from such plants in 1932. Moreover, delivery from plant to consumer by autotruck again rose at the expense of railway shipments. The increase in truck delivery is a natural result of localizing production from small, temporary plants, due to the price protection afforded to such producers through either lower freight or trucking charges compared with those prevailing for more remotely located plants.

*Production trends.*—Trends in production and value per ton of crushed and broken stone by major uses since 1926 appear in the following table. The value per ton is calculated from the total value of the product as reported by producers. This value is f.o.b. plant and is the nearest approach to selling prices that can be made available from Bureau records. Preliminary figures for each class of stone in 1933, based upon early returns from producers, also are shown.

*Crushed and broken stone sold or used by producers in the United States, 1926–33, by principal uses*

| Use | 1926 | | 1927 | | 1928 | | 1929 | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Value per ton [2] | Short tons | Value per ton [2] | Short tons | Value per ton [2] | Short tons | Value per ton [2] |
| Concrete and road metal | 66, 892, 530 | $1. 12 | 78, 544, 210 | $1. 07 | 74, 384, 490 | $1. 09 | 76, 174, 770 | $1. 06 |
| Railroad ballast | 15, 623, 030 | . 82 | 16, 404, 560 | . 81 | 16, 880, 870 | . 78 | 16, 546, 490 | . 83 |
| Cement manufacture [4] | 41, 974, 000 | ------ | 44, 195, 000 | ------ | 45, 012, 000 | ------ | 43, 612, 000 | ------ |
| Lime manufacture [5] | 9, 121, 000 | ------ | 8, 830, 000 | ------ | 8, 920, 000 | ------ | 8, 540, 000 | ------ |
| Flux stone | 23, 859, 390 | . 76 | 21, 666, 070 | . 74 | 23, 123, 870 | . 73 | 24, 393, 500 | . 74 |
| Alkali works | 3, 556, 490 | . 66 | 3, 848, 490 | . 64 | 4, 231, 750 | . 61 | 5, 004, 930 | . 65 |
| Riprap | 4, 060, 280 | 1. 15 | 4, 618, 500 | 1. 02 | 3, 993, 190 | . 97 | 4, 212, 990 | 1. 20 |
| Agricultural limestone | 1, 850, 620 | 1. 66 | 2, 206, 470 | 1. 52 | 2, 186, 870 | 1. 44 | 2, 654, 580 | 1. 42 |
| Refractory stone [6] | 1, 531, 070 | 1. 25 | 1, 362, 920 | 1. 26 | 1, 348, 160 | 1. 29 | 1, 558, 200 | 1. 16 |
| Asphalt filler | 415, 920 | 3. 40 | 420, 860 | 3. 19 | 407, 350 | 3. 15 | 344, 880 | 3. 38 |
| Calcium carbide | 357, 450 | . 66 | 316, 960 | . 52 | 282, 610 | . 63 | 339, 510 | . 70 |
| Other uses [7] | 2, 062, 050 | 2. 41 | 2, 503, 820 | 2. 31 | 2, 514, 110 | 2. 13 | 5, 233, 810 | 1. 24 |
| Total stone | 171, 303, 830 | ------ | 184, 917, 860 | ------ | 183, 285, 270 | ------ | 188, 615, 660 | ------ |
| Less lime and cement | 51, 095, 000 | ------ | 53, 025, 000 | ------ | 53, 932, 000 | ------ | 52, 152, 000 | ------ |
| Total commercial stone | 120, 208, 830 | 1. 04 | 131, 892, 860 | 1. 01 | 129, 353, 270 | 1. 00 | 136, 463, 660 | . 99 |
| Asphaltic stone [9] | 672, 750 | 5. 34 | 796, 100 | 5. 86 | 760, 497 | 5. 34 | 748, 550 | 5. 44 |
| Slate granules and flour [10] | 498, 050 | 6. 02 | 459, 760 | 6. 03 | 413, 980 | 5. 97 | 428, 940 | 5. 82 |

| Use | 1930 | | 1931 | | 1932 | | 1933 [1] | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Value per ton [2] | Short tons | Value per ton [2] | Short tons | Value per ton [2] | Short tons | Value per ton [2] |
| Concrete and road metal | 74, 293, 090 | $1. 04 | 65, 811, 520 | $0. 99 | 48, 020, 560 | $0. 91 | 45, 000. 000 | (3) |
| Railroad ballast | 12, 817, 800 | . 80 | 6, 812, 890 | . 81 | 3, 974, 540 | . 82 | 5, 000, 000 | (3) |
| Cement manufacture [4] | 40, 841, 000 | ------ | 31, 736, 000 | ------ | 19, 400, 000 | ------ | 15, 500, 000 | ------ |
| Lime manufacture [5] | 6, 780, 000 | ------ | 5, 420, 000 | ------ | 4, 000, 000 | ------ | 5, 000, 000 | ------ |
| Flux stone | 17, 090, 710 | . 72 | 9, 727, 230 | . 74 | 3, 991, 160 | . 73 | 8, 500, 000 | (3) |
| Alkali works | 4, 436, 160 | . 62 | 3, 340, 290 | . 65 | 3, 211, 770 | . 65 | 4, 200, 000 | (3) |
| Riprap | 4, 292, 030 | 1. 11 | 4, 222, 570 | 1. 01 | 3, 462, 290 | . 83 | 4, 000, 000 | (3) |
| Agricultural limestone | 2, 542, 100 | 1. 30 | 1, 421, 050 | 1. 49 | 910, 430 | 1. 35 | 1, 000, 000 | (3) |
| Refractory stone [6] | 1, 197, 500 | 1. 17 | 611, 070 | 1. 04 | 197, 430 | 1. 16 | 400, 000 | (3) |
| Asphalt filler | 430, 290 | 2. 61 | 247, 450 | 3. 15 | 177, 110 | 2. 54 | 120, 000 | (3) |
| Calcium carbide | 364, 750 | . 75 | 164, 180 | . 59 | 188, 050 | . 67 | 120, 000 | (3) |
| Other uses [7] | 5, 214, 540 | 1. 09 | 2, 818, 450 | 1. 57 | [8] 4, 690, 080 | . 83 | [8] 5, 500, 000 | (3) |
| Total stone | 170, 299, 970 | ------ | 132, 332, 700 | ------ | 92, 223, 420 | ------ | 94, 340, 000 | ------ |
| Less lime and cement | 47, 621, 000 | ------ | 37, 156, 000 | ------ | 23, 400, 000 | ------ | 20, 500, 000 | ------ |
| Total commercial stone | 122, 678, 970 | . 97 | 95, 176, 700 | . 97 | 68, 823, 420 | . 88 | 73, 840, 000 | (3) |
| Asphaltic stone [9] | 664, 871 | 5. 36 | 470, 491 | 4. 78 | 314, 039 | 4. 51 | 277, 000 | (3) |
| Slate granules and flour [10] | 289, 700 | 5. 85 | 229, 980 | 5. 88 | 209, 750 | 5. 70 | 187, 000 | (3) |

1 Subject to revision.
2 Value per ton at plant as reported to Bureau of Mines by producers.
3 Figures not available.
4 Estimated quantity of limestone used in manufacture of portland and natural cement; no value shown because greater part of the stone is used by the producer without marketing as stone.
5 Estimated quantity of limestone used in manufacture of lime; no value shown because greater part of the stone is used by the producer without marketing as stone.
6 Ganister, artificial stone, mica schist, and dolomite.
7 Ammonia, baking powder, carbonic acid works, coal-mine dusting, dye works, fertilizer filler, filter beds, magnesia cement works (dolomite), mineral food, mineral (rock) wool, nitrates, phosphates, poultry grit, stucco, terrazzo, and whiting substitute; purification of copper, soap, and sulphuric acid; also in sugar and glass factories and paper mills.
8 Includes uncrushed field stone used in Pennsylvania for road base: 1932, 3,192,520 tons; 1933, about 4,000,000 tons.
9 Figures from chapter on Asphalt.
10 Figures from chapter on Slate.

Production and value of crushed and broken stone since 1926 are shown graphically in figures 77 and 78.

Production figures are presented in a somewhat different form in figure 79. In this chart the 1926 production for each major class of crushed and broken stone is selected as 100 percent, and the production for each subsequent year is plotted as a percentage of 1926. The graph thus represents index numbers for each class of material, based on 1926 production. The curves show that production in 1933

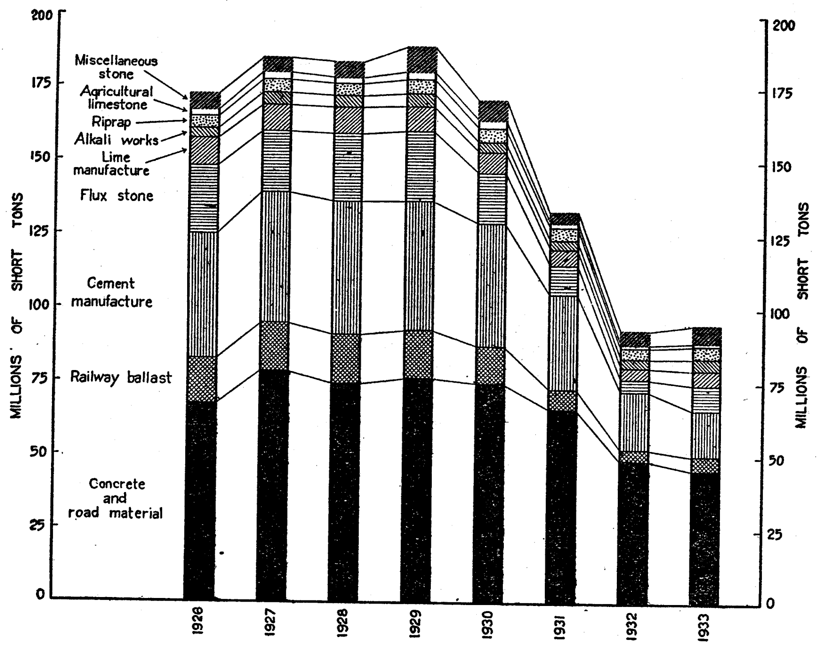


FIGURE 77.—Principal uses of crushed and broken stone, 1926–33. Figures for 1933 are subject to revision.

increased for all classes except concrete aggregate and road metal and stone used for cement manufacture.

Figure 80 presents trends in average value per ton f.o.b. plant for the same classes, also expressed in percentages based on 1926 values as 100 percent.

*Direct comparison of quarry groups.*—The following table compares data on employment and production for 119 commercial crushed-stone quarries with data for 529 quarries of all classes. The output of the 529 quarries of all classes represented 48.4 percent of the total crushed- and broken-stone production in 1932 and 51.8 percent of the preliminary figures for 1933. In both groups the comparison for the 2 years is between identical quarries.

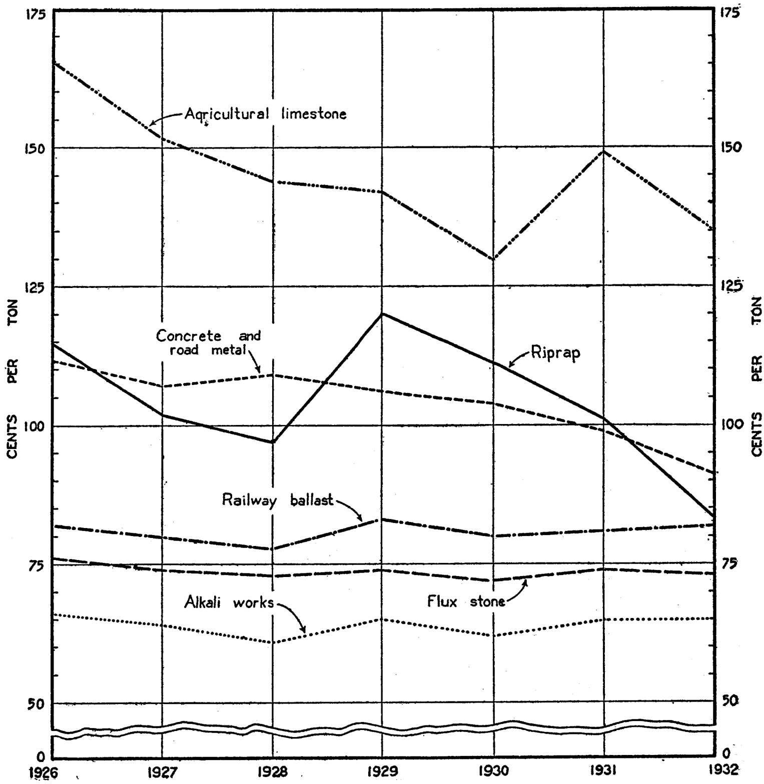


FIGURE 78.—Trends in average value per ton of crushed and broken stone, 1926–32, by principal uses.

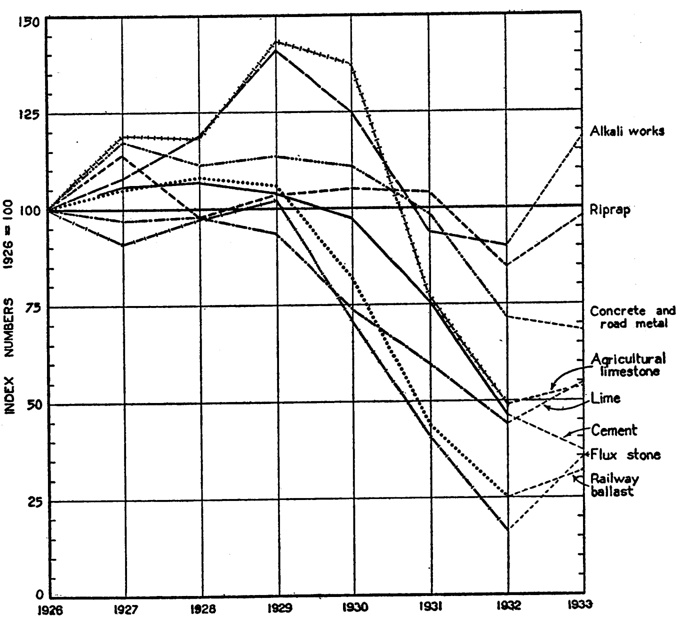


FIGURE 79.—Trends in principal uses of crushed and broken stone, 1926–33. **All curves are plotted as** percentages of 1926 production.

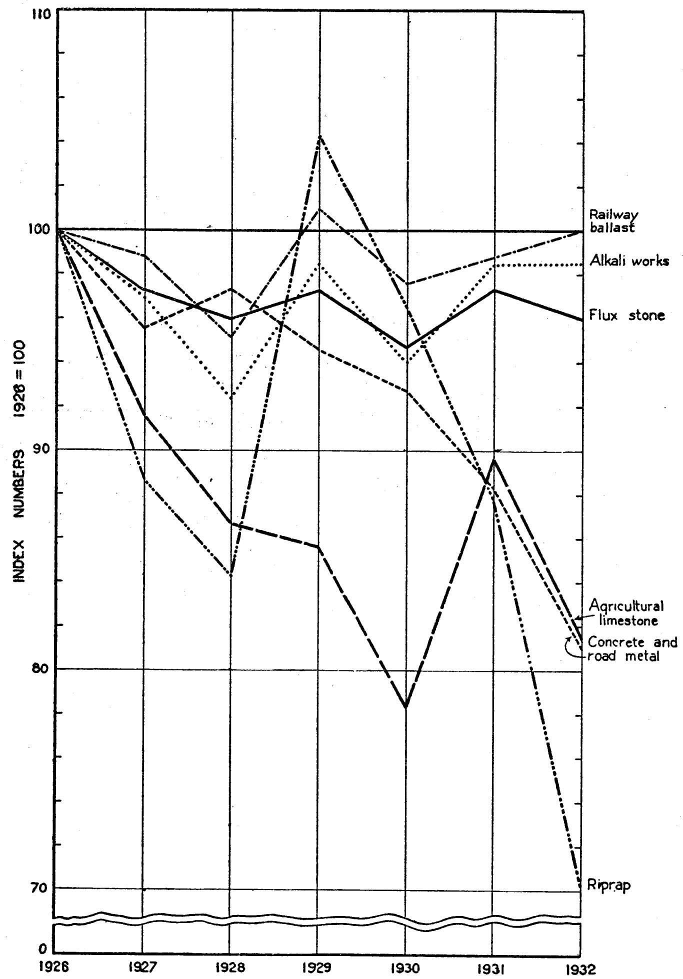


FIGURE 80.—Trends in average value per ton of crushed and broken stone, 1926–32, by principal uses. All curves are plotted as percentages of 1926 values.

*Data on production and employment for 529 identical quarries of all classes and for 119 commercial crushed-stone quarries, 1932–33*

| | 529 quarries of all classes | | | 119 commercial crushed-stone quarries | | |
|---|---|---|---|---|---|---|
| | 1932 | 1933 | Percent of change in 1933 | 1932 | 1933 | Percent of change in 1933 |
| Short tons produced | 44, 598, 794 | 46, 806, 289 | +5. 0 | 14, 889, 888 | 16, 528, 881 | +11. 1 |
| Total man-hours worked | 45, 302, 377 | 42, 612, 629 | −6. 0 | 8, 089, 758 | 7, 158, 515 | −11. 5 |
| Total man-shifts worked | 5, 384, 822 | 5, 669, 606 | +5. 3 | 913, 252 | 917, 617 | +. 4 |
| Total men employed | 26, 592 | 28, 977 | +9. 0 | 5, 239 | 5, 620 | +7. 2 |
| Average days worked | 202 | 196 | −3. 3 | 174 | 163 | −6. 3 |
| Percent of possible time worked [1] | 67. 5 | 65. 3 | −3. 3 | 58. 0 | 54. 4 | −6. 3 |
| Average weeks worked [2] | 35. 1 | 34. 0 | −3. 3 | 30. 2 | 28. 3 | −6. 3 |
| Average hours worked— | | | | | | |
| Per man | 1, 703 | 1, 470 | −13. 7 | 1, 543 | 1, 273 | −17. 5 |
| Per man per week [2] | 48. 5 | 43. 2 | −10. 9 | 51. 1 | 45. 0 | −11. 9 |
| Per shift | 8. 4 | 7. 5 | −10. 9 | 8. 9 | 7. 8 | −11. 9 |
| Average tons— | | | | | | |
| Per man-shift | 8. 28 | 8. 26 | −. 6 | 16. 32 | 18. 0 | +10. 3 |
| Per man-hour | . 98 | 1. 10 | +12. 2 | 1. 84 | 2. 31 | +25. 6 |
| Per man-year | 1, 677 | 1, 615 | −3. 7 | 2, 843 | 2, 942 | +3. 4 |

[1] 300 days assumed possible.
[2] Represents 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.

Crushed-stone producers, sand and gravel operators, and crushed-slag producers formed a joint code authority for the three industries. This is discussed in the chapter on Sand and Gravel.

# SAND AND GRAVEL

By H. H. Hughes and M. Allan

## SUMMARY OUTLINE



The total output of sand and gravel in 1933 reflected further declines in building and highway construction, but production of glass, molding, and other industrial sands increased sharply. Preliminary figures based on rail and water shipments, data on consuming markets, and partial returns from producers indicate that 71,000,000 short tons of sand and gravel were sold or used by commercial producers during 1933. This quantity represents a decline of 17 percent from the comparable figure of 85,289,076 short tons for 1932. The average value per ton apparently increased from $0.56 in 1932 to $0.59 in 1933. Less-complete data are available for estimating production by noncommercial operations, which amounted to 34,748,821 short tons in 1932, but partial returns from States and counties indicate a drop of about 5 percent in 1933 to 33,000,000 short tons. The average value per ton for noncommercial material may have increased slightly, but no definite estimate can be made. Salient statistics of the sand and gravel industry in 1932 and preliminary figures for 1933 are summarized in the following table.

*Salient statistics of sand and gravel sold or used in the United States, 1932–33, by uses*

| Use | 1932 | | 1933 [1] | | | |
|---|---|---|---|---|---|---|
| | Short tons | Value per ton | Short tons | Value per ton | Percent of change: Tonnage | Percent of change: Value per ton |
| COMMERCIAL OPERATIONS | | | | | | |
| Sand: | | | | | | |
| Glass | 1,370,255 | $1.65 | 1,820,000 | $1.68 | +33 | +2 |
| Molding | 1,118,146 | .94 | 1,700,000 | .98 | +52 | +4 |
| Building | 14,597,631 | .51 | 13,500,000 | .50 | −7 | −2 |
| Paving | 17,194,553 | .44 | 11,500,000 | .49 | −33 | +11 |
| Grinding and polishing | 419,691 | 1.52 | 710,000 | 1.50 | +69 | −1 |
| Fire or furnace | 36,698 | 1.48 | 95,000 | 1.20 | +160 | −19 |
| Engine | 1,151,011 | .60 | 1,150,000 | .62 | | +3 |
| Filter | 68,035 | 1.36 | 25,000 | 1.75 | −63 | +29 |
| Other [2] | 4,486,655 | .33 | 2,500,000 | (3) | −44 | (3) |
| Total sand | 40,442,675 | .53 | 33,000,000 | .58 | −18 | +9 |

1 Preliminary figures; subject to revision.
2 Includes some sand used for railroad ballast, fills, and similar purposes.
3 No data are available to estimate these items.

*Salient statistics of sand and gravel sold or used in the United States, 1932–33, by uses*—Continued

| Use | 1932 Short tons | 1932 Value per ton | 1933 Short tons | 1933 Value per ton | Percent of change: Tonnage | Percent of change: Value per ton |
|---|---|---|---|---|---|---|
| COMMERCIAL OPERATIONS—contd. | | | | | | |
| Gravel: | | | | | | |
| Building | 13,064,368 | $0.73 | 13,000,000 | $0.70 | | −4 |
| Paving | 25,137,550 | .59 | 18,000,000 | .61 | −28 | +3 |
| Railroad ballast [4] | 6,644,483 | .27 | 7,000,000 | .32 | +5 | +19 |
| Total gravel | 44,846,401 | .58 | 38,000,000 | .59 | −15 | +2 |
| Total sand and gravel | 85,289,076 | .56 | 71,000,000 | .59 | −17 | +5 |
| NONCOMMERCIAL OPERATIONS [5] | | | | | | |
| Total sand and gravel | 34,748,821 | .29 | 33,000,000 | (3) | −5 | (3) |
| COMMERCIAL AND NONCOMMERCIAL OPERATIONS | | | | | | |
| Grand total | 120,037,897 | .48 | 104,000,000 | (3) | −13 | (3) |

[3] No data are available to estimate these items.
[4] Includes some gravel used for fills and other purposes. The quantity of gravel reported as used exclusively for railroad ballast in 1932 was 5,113,862 short tons, valued at $0.30 a ton. Includes material produced by railroads for their own use, amounting in 1932 to 2,140,154 short tons valued at $0.14 a ton.
[5] Includes material produced by States, counties, municipalities, and other Government agencies, directly or under lease.

The trend in production and value of products in the sand and gravel industry from 1905 to 1933 is shown in figure 81. The drop in either production or value from 1932 to 1933 is not as sharp as that since 1929.

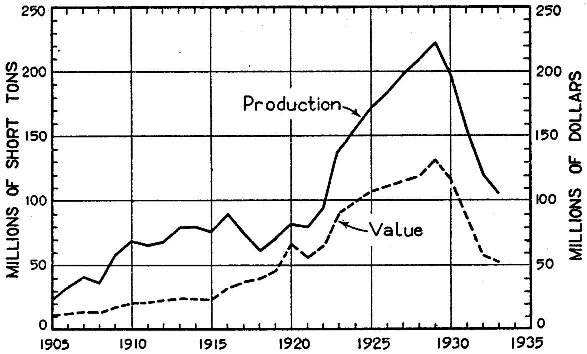


FIGURE 81.—Principal trends in the sand and gravel industry, 1905–33.

## RAIL AND WATER SHIPMENTS

Shipments of sand and gravel on class I railroads dropped from 28,764,827 short tons in 1932 to 21,818,298 short tons in 1933, and represented a decline of 24 percent compared with an estimated drop of 17 percent in commercial production of sand and gravel. The greater rate of decline for rail shipments indicates increased use of other means of transportation, notably trucks. The trend toward truck transportation since 1928 is shown in figure 82, which compares shipments of sand and gravel by rail with shipments by other modes of transportation. Glass and molding sand, nonrevenue railroad

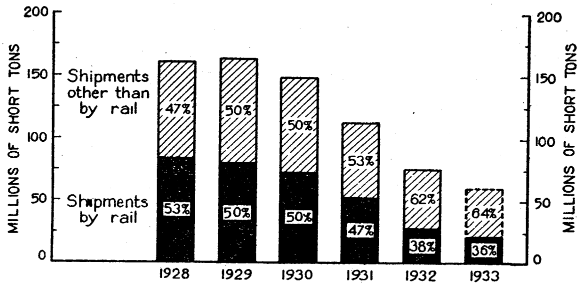


FIGURE 82.—Shipments of sand and gravel, by modes of transportation, 1928–33. Data on rail shipments are from reports of the Interstate Commerce Commission; to insure comparable results, glass and molding sand, railroad ballast, and noncommercial production have been excluded from the figures used in the comparisons. Figures for 1933 are subject to revision.

ballast, and noncommercial production are not represented in the statistics on rail shipments, and they have been excluded also from the figures on total production.

*Summary of data relating to production and consumption of sand and gravel* [1]

| | 1928 | 1932 | 1933 [2] | Percent change in 1933 from— | |
|---|---|---|---|---|---|
| | | | | 1932 | 1928 |
| Sand and gravel shipments: | | | | | |
| Rail shipments, class I roads [3] short tons.. | 85, 667, 157 | 28, 764, 827 | 21, 818, 298 | −24. 1 | −74. 5 |
| Water shipments: Pittsburgh district [4] short tons.. | 4, 689, 239 | 1, 250, 459 | 1, 540, 480 | +23. 2 | −67. 1 |
| Correlative industries: | | | | | |
| Portland-cement shipments barrels.. | 175, 838, 332 | 80, 843, 187 | 64, 086, 000 | −20. 7 | −63. 6 |
| Paving-asphalt shipments short tons.. | 1, 676, 531 | 856, 638 | 798, 607 | −6. 8 | −52. 4 |
| Cut-back asphalt shipments short tons.. | ---------------- | 440, 838 | 508, 553 | +15. 4 | -------- |
| Road-oil sales barrels.. | 3, 670, 000 | 8, 264, 824 | 6, 238, 898 | −24. 5 | +70. 0 |
| Construction: [5] | | | | | |
| Concrete-pavement contract awards [6] square yards.... | 148, 078, 000 | 96, 827, 000 | 45, 128, 000 | −53. 4 | −69. 5 |
| Construction contract awards [7].... | $6, 628, 284, 000 | $1, 351, 159, 000 | $1, 256, 601, 000 | −7. 0 | −81. 0 |
| Railway expenditures, class I roads: | | | | | |
| For ballast [8] | $35, 517, 000 | $7, 769, 853 | $8, 339, 000 | +7. 3 | −76. 5 |
| Glass production, monthly average: | | | | | |
| Glass containers [9] gross.. | 2, 366, 000 | 1, 713, 000 | 1, 960, 000 | +14. 4 | −17. 2 |
| Illuminating glassware [10] turns.. | 3, 254 | 1, 217 | 1, 387 | +14. 0 | −57. 4 |
| Polished plate glass [11] square feet.. | 10, 887, 000 | 4, 352, 000 | 7, 493, 000 | +72. 2 | −31. 2 |
| Foundry activity: | | | | | |
| Foundry and malleable pig-iron production gross tons.. | 6, 010, 372 | 1, 221, 256 | 1, 521, 945 | +24. 6 | −74. 7 |
| Malleable castings [12] short tons.. | 702, 881 | 171, 479 | 268, 638 | +56. 7 | −61. 8 |
| Freight-car loadings, all commodities: | | | | | |
| Total, monthly average [13] cars.. | 4, 229, 000 | 2, 350, 000 | 2, 415, 000 | +2. 8 | −42. 9 |

[1] Many of the data available in this table are published currently in "Survey of Current Business."
[2] Figures for 1933 are subject to revision.
[3] Interstate Commerce Commission.
[4] Chief statistician, Board of Engineers for Rivers and Harbors.
[5] Detailed statistics of construction are contained in a supplement to the cement chapter in this volume.
[6] Portland Cement Association.
[7] F. W. Dodge Corporation.
[8] Interstate Commerce Commission and Bureau of Railway Economics.
[9] Glass Container Association.
[10] Illuminating Glassware Guild.
[11] Plate Glass Manufacturers of America.
[12] U.S. Bureau of the Census.
[13] American Railway Association.

In 1928, the first year for which the Interstate Commerce Commission adopted its present freight-commodity classification, 52.8 percent of the sand and gravel included in the comparisons was shipped by rail. By 1931 the quantity had dropped to 47.3 percent of the total, and in 1932 only 37.8 percent was shipped by rail. Preliminary figures for 1933 indicate that rail shipments comprised 36.1 percent of the total. This sharp decline since 1928 reflects in part the increase in noncommercial production of sand and gravel, of which virtually all is moved by truck and of which part may have entered markets previously supplied by material from rail shipping plants.

The decline in rail shipments of sand and gravel from 1932 to 1933 was not uniform over the entire country. Interstate Commerce Commission data available by regions show that shipments increased 27.4 percent in New England. The decline was greatest in the Northwestern and Pocahontas regions, being 51.4 percent and 43.7 percent, respectively. Elsewhere the percentage of decline ranged from 12.1 to 24.8 percent.

Barge shipments of sand and gravel on the Ohio and Monongahela Rivers in the Pittsburgh district in 1933 increased 23.2 percent from 1932.

## MARKETS

Shipments of portland cement are a good indicator of sand and gravel consumption. At least half the sand and gravel consumed in an average year is used with cement for concrete in various types of construction. Cement shipments in 1933 dropped 20.7 percent from 1932. This checks closely the estimated decline of 17 percent in commercial production of sand and gravel.

Large quantities of sand and gravel also are used in construction for other purposes. Because of the importance of the construction industry as a market for cement, sand and gravel, and other nonmetallic building materials a detailed discussion of its several branches is included in this volume as a supplement to the chapter on Cement.

*Highway construction.*—Highway construction was curtailed drastically in 1933. According to statistics of the Portland Cement Association total concrete-pavement contract awards amounted to only 45,128,000 square yards, a drop of 53.4 percent from 1932.

General trends in construction of bituminous pavements are shown by statistics of asphalt shipments and road-oil sales. Shipments of paving asphalt dropped from 856,638 short tons in 1932 to 798,607 short tons in 1933, a decline of 6.8 percent. Shipments of cut-back asphalts, commonly used for mixed-in-place bituminous surfaces, increased 15.4 percent from 440,838 short tons in 1932 to 508,553 short tons in 1933. Road-oil sales declined even more than paving asphalt, dropping 24.5 percent from 8,264,824 barrels in 1932 to 6,238,898 barrels in 1933.

These data tend to confirm partial returns from sand and gravel producers indicating that production of paving sand by commercial operations amounted to only 11,500,000 short tons in 1933 (a drop of 33 percent from 17,194,553 short tons in 1932). Paving-gravel production apparently dropped 28 percent—from 25,137,550 short tons in 1932 to 18,000,000 short tons in 1933. By far the larger part of all sand and gravel produced by noncommercial operations also is used for paving, and this material should be included in total figures for aggregates consumed in highway and road construction.

*Building construction.*—Total construction contracts awarded in 37 States east of the Rocky Mountains during 1933 were valued at $1,256,601,000 according to statistics of the F. W. Dodge Corporation. This figure represents a decline of 7.0 percent from 1932 and 81.0 percent from 1928. Supplementary records of construction activity show even greater declines. The value of building permits issued in 340 cities throughout the United States dropped 21.4 percent from 1932; engineering-construction contract awards declined 12.4 percent.

In view of the general decline in building it is not surprising to find partial returns from producers indicating that commercial production of building sand in 1933 amounted to 13,500,000 short tons, a drop of 7 percent from 1932. The output of building gravel in 1933 was about the same as in 1932, amounting to 13,000,000 short tons.

*Railroad ballast.*—Demand for railroad ballast has declined sharply as a result of railroad economies during the depression, but estimated expenditures by class I railroads for ballast during 1933 increased 7.3 percent. Estimates of the Bureau of Railway Economics indicate that total ballast expenditures in 1933 amounted to about $8,339,000. Of this total, approximately $6,340,000 was charged to operating expenses and represents ballast used primarily for maintenance. The remaining $1,999,000 was charged to capital account and represents money expended for ballast to be used primarily in new construction work.

Expenditures for ballast include 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 material. The decline in expenditures for ballast by class I roads since 1929 conforms closely to the drop in ballast production as reported by producers. Furthermore, analysis of statistics for the past 5 years indicates that the ratio of crushed stone to gravel and sand ballast has remained nearly constant. On the basis of this information it seems logical to estimate that in 1933 about 7,000,000 short tons of gravel were sold for railroad ballast, fills, and related purposes, an increase of 5 percent from 1932. No attempt has been made to segregate the quantity of sand similarly used, but it is included in the group of miscellaneous sands.

Preliminary returns from producers substantiate this estimate. Commercial operations report increased ballast sales, but production by railroads for their own use declined.

*Glass production.*—Production of glass sand in 1933 was about 33 percent higher than in 1932. The tonnage reported by companies accounting for 90 percent of the output in 1932 indicates that total production in 1933 amounted to at least 1,820,000 short tons.

This advance was expected because legalization of beer and prohibition repeal created an increased demand for glass containers, and a spurt in automobile production during the summer of 1933 resulted in large orders for plate-glass manufacturers. Statistics of the Glass Container Association show that production of glass containers in 1933 increased 14.4 percent over that in 1932. The Plate Glass

Manufacturers of America reported the monthly average production of polished plate glass in 1933 as 7,493,000 square feet, an increase of 72.2 percent over 1932. Even illuminating-glassware production picked up according to figures of the Illuminating Glassware Guild, which reported an increase of 14.0 percent in 1933 compared with 1932.

*Foundry activity.*—Production of molding sand depends upon activity in foundries throughout the United States. According to statistics compiled by the Bureau of Mines, production of foundry and malleable pig iron increased from 1,221,256 gross tons in 1932 to 1,521,945 gross tons in 1933, an advance of 24.6 percent.

The United States Bureau of the Census collects statistics of foundry production. In 1932 and 1933 identical establishments comprising about 90 percent of the industry reported production of malleable castings as 171,479 and 268,638 short tons, respectively, an increase of 56.7 percent.

On the basis of these indicators of molding-sand consumption and preliminary reports of producers it is estimated that sales of molding sand in 1933 amounted to 1,700,000 short tons, an increase of 52 percent from the previous year.

*Markets for grinding and polishing sand.*—Grinding and polishing sand and blast sand are used in the dimension-stone and plate-glass industries. Markets for dimension stone were curtailed further in 1933, but activity in the plate-glass industry was reflected in an increased demand for grinding and polishing sand. Preliminary returns from producers indicate that production of this material in 1933 may have amounted to about 710,000 short tons, an increase of 69 percent compared with 1932.

*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 increased slightly from 2,350,000 cars in 1932 to 2,415,000 cars in 1933. Preliminary figures based on producers' reports indicate that engine-sand sales in 1933 were approximately 1,150,000 short tons, no appreciable change from 1932.

*Sales of miscellaneous sands.*—Complete data on markets for fire or furnace sands and filter sands are not available. Partial returns from producers, however, indicate that sales in 1933 amounted to 95,000 and 25,000 short tons, respectively. Activity in the iron and steel industry may account for the increase of 160 percent in sales of fire or furnace sand in 1933 compared with 1932, but there is no apparent reason for the indicated drop of 63 percent in production of filter sand.

The quantity of miscellaneous sands sold in 1933 is placed at 2,500,000 short tons. This estimate is based on preliminary returns from producers, and no supplementary data are available to support it.

## NONCOMMERCIAL PRODUCTION

In 1932, for the first time, statistics of the sand and gravel industry were broken down to show production by commercial operations and by noncommercial operations—States, counties, municipalities, and other Government agencies. This practice is to be continued, but it is difficult to obtain preliminary figures of noncommercial production. Reports already received from producers are the only available data.

State highway departments, which accounted for about half of the noncommercial production in 1932, reported 20 percent less material in 1933. On the other hand, nearly 200 counties not heard from in previous years reported production of 5,000,000 short tons in 1933. Some of these counties produced sand and gravel for the first time in 1933, but others may have been producing in past years without reporting their output. These returns indicate that the quantity of sand and gravel produced by noncommercial operations in 1933 was approximately 33,000,000 short tons, a drop of 5 percent from 1932, but the figure may be subject to considerable revision when all reports have been received.

The relation of noncommercial production to total output of sand and gravel from 1928 to 1933 is pictured in figure 83. In 1928, only 5 percent of all material was reported by States, counties, or municipalities, but in 1932 this type of production accounted for 29 percent of the total. Estimated noncommercial production in 1933 is 5

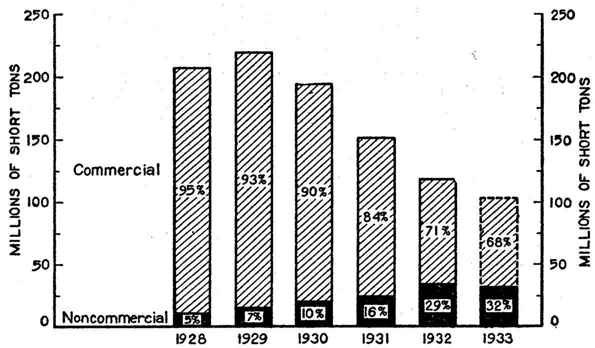


FIGURE 83.—Sand and gravel sold or used in the United States by commercial and noncommercial producers, 1928–33. Noncommercial producers include States, counties, municipalities, and other Government agencies. Figures for 1933 are subject to revision.

percent lower than in 1932, but the quantity amounts to 32 percent of the estimate for total sand and gravel production.

All sand and gravel produced by noncommercial operations does not compete directly with commercial plants. Much of it is consumed on road projects far from the marketing territory of the closest commercial operation. In 1932 only 23.2 percent of the noncommercial production was prepared; the rest was pit-run material used at or near the point of origin.

The questionnaire sent to Government agencies carries instructions to report all material produced directly by their employees or for their consumption by contractors operating under lease. The output of many contractor-owned portable plants may be included in these figures. Numerous sand and gravel pits were opened by counties and other Government agencies late in 1933 and early 1934 in connection with P.W.A. and C.W.A. projects.

## PRODUCTION TRENDS

Since 1929 the trend in production of sand and gravel for all purposes has been definitely downward. The output of paving gravel was slightly higher in 1930 than in 1929, but this was tho noteworthy exception to the general decline. The downward trend was broken somewhat in 1933. Glass, molding, and other industrial sands showed sharp increases in production, and railroad-ballast sales were slightly higher than in 1932. Production of building and paving sand and gravel in 1933, however, dropped below the 1932 level, and this decline was reflected in a drop of 13 percent in total sales of sand and gravel.

In the past 10 years gravel has become increasingly important in sand and gravel sales. According to data plotted in figure 84, gravel

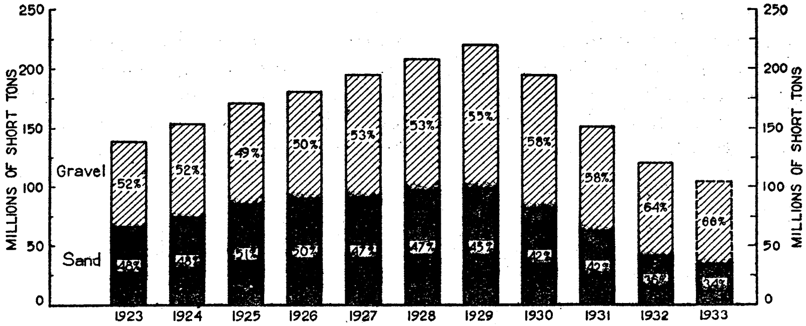


FIGURE 84.—Sand and gravel sold or used by producers in the United States, 1923–33, showing relative importance of each. Figures for 1933 are subject to revision.

comprised 52 percent of the total in 1923 and sand 48 percent. In 1932 sand sales were only 36 percent of the total and gravel sales 64 percent. Estimates for 1933 indicate that gravel comprised 66 percent of the total sand and gravel sales and sand 34 percent.

## PRICES

Complete data on sand and gravel prices for 1933 are not yet available, but preliminary figures indicate a general increase over 1932. Prices of glass sand apparently increased about 2 percent; molding sand, 4 percent; paving sand, 11 percent; engine sand, 3 percent; and filter sand, 29 percent. Building-sand prices were slightly lower (2 percent less than in 1932), while prices of grinding and polishing sand and fire and furnace sand were lower than in 1932 by 1 and 19 percent, respectively. The average value per ton of all sand accounted for increased from $0.53 in 1932 to $0.58 in 1933, or 9 percent.

Prices of building gravel apparently dropped 4 percent, but paving gravel and railroad ballast were 3 and 19 percent higher, respectively. The average value per ton of gravel advanced only $0.01, from $0.58 in 1932 to $0.59 in 1933, an increase of almost 2 percent.

Preliminary data indicate that the value of sand and gravel produced by noncommercial operations in 1933 was slightly higher than in 1932.

## CODE OF FAIR COMPETITION

Negotiations culminating in the adoption of a Code of Fair Competition for the Mineral-Aggregates Industries occupied the attention of sand and gravel producers throughout the latter half of 1933. In anticipation of the passage of the President's proposed bill for industrial recovery representatives of the National Sand and Gravel Association, the National Crushed Stone Association, and the National Slag Association, met in Washington about June 1 and decided definitely to prepare a single code for all producers of aggregates.

All interested producers met together in Chicago in July, and the draft of the code agreed upon there was submitted to the Administrator for consideration. A public hearing was scheduled for August 28 in Washington, and after 2 days' deliberation the administration and the code committee began conferences leading to final adoption. The most strenuous objectors to the code as proposed were representatives of portable-plant producers, who contended that the provisions on limitation of production would force them out of business. The portable producers then formed the National Association of Portable Stone, Sand, and Gravel Producers and met in Washington in September to draft a code. The administration, however, was able to combine the best efforts of the two groups, and the code which finally emerged from the conferences and was approved by the President on November 10 affords opportunity for both the portable- and permanent-plant producers to be represented in its administration.

In submitting the code to the President for approval the Administrator showed that he recognized the importance of the aggregates industries. He stated that the total value represented by the three groups was exceeded among mineral products in 1931 only by bituminous coal, anthracite, and pig iron. In the peak year 1929 the products of the three industries represented a total value of $209,000,000, and about 40,000 wage earners were employed. The value of these products decreased to less than half the 1929 value in 1932, and the number of employees dropped about 50 percent from 1929.

The Administrator summarized the wage and hour provisions of the code as follows:

> A 40-hour week is established, with minimum wages varying from 40¢ per hour in the Northern States to 25¢ per hour in the deep South. In an intermediate zone the minimum is to be 30¢ per hour.
>
> For certain special classes of employees, comparatively few in number, a maximum 48-hour week is permitted. All workers paid on the hourly basis are to receive time and one third when the prescribed weekly maximum hours are exceeded.
>
> Child labor is prohibited. That the industries are concerned for safety and welfare of all employees is indicated by provisions in the Code requiring the development of standards of safety, the carrying of employees' compensation insurance, and the active support of accident-prevention programs.

Some of the producers in the Southern States objected to paying the wages provided in the code for their districts. Testimony was presented to show that prevailing wage rates for common labor ranged from 10 to 20 cents an hour and that the proposed increase to 25 cents would hamper economical operation of their plants.

No decision was reached when the code was adopted regarding hours of labor for employees working as crews on floating equipment. This problem subsequently was reopened at a public hearing, but no definite decision had been reached by May 1, 1934. The principal questions arose from the fact that it would be impossible to provide lodging and boarding facilities for extra crews on dredges or barges. In all probability final decision regarding this problem may depend somewhat upon provisions adopted in codes for other types of water-transportation industries.

*Details of administration.*—The mineral-aggregates code creates a code authority composed of 1 member for each of the 3 industries in each of the 16 regions established in the code. The slag industry is represented only in the regions where slag as aggregate actually is produced. In addition to these members, 12 others are elected at large, and the president and 1 staff member from each of the 3 sponsoring associations also serve on the code authority. The code provides further for delegating duties to an executive committee of the code authority, which in turn has created an executive council. Regional, district, and State committees also are set up to administer provisions of the code.

*Trade practices.*—Besides the customary trade-practice agreements for eliminating secret rebates and prohibiting contract interference, defamation, misrepresentation, misbranding, commercial bribery, lump-sum bidding, and contingent selling, the code establishes a procedure whereby district committees may adopt the open-price policy governing uniform terms of sale and uniform credit practices. These provisions read as follows:

Sec. 2. *Cost Determination.*—(*a*) Within 120 days after the effective date, the Code Authority shall establish, subject to the approval of the Administrator, a standard, uniform accounting and costing system for each industry governed by the provisions of this Code.

(*b*) When approved by the Administrator full information concerning such uniform standard systems shall be distributed by the Code Authority to all members of the industries. Thereafter each member shall adhere to the standard uniform system for the industry or industries in which he is engaged to the extent of incorporating in his calculations of cost all of the elements prescribed by such system.

(*c*) Any district committee may, if it so elects and subject to the approval of its regional committee and the Code Authority, adopt for the producers selling within that district the open-price policy prescribed in paragraphs (*d*) and (*e*) of this section.

(*d*) No producer selling within a district described in paragraph (*c*) of this section shall sell any product at less than his prime plant cost thereof, plus ten (10) percent. Such cost shall be computed in accordance with the standard uniform accounting and costing system for the industry in which the producer is engaged and shall include all items of cost exclusive of return on capital invested, interest on borrowed capital, depreciation, depletion, administration, selling costs, and reserves.

(*e*) In any district where the open-price policy is adopted each producer selling within the district shall file with the district committee not less than five (5) days in advance of the effective date thereof, all prices, terms, and conditions of sale, which shall be f.o.b. plant, or delivered, or both, as may be directed by the district committee. Such prices, terms, and conditions of sale shall continue in effect until other prices, terms, and conditions of sale have been duly filed as herein provided. The district committee shall immediately cause copies of all such prices, terms, and conditions of sale filed with it to be distributed among the producers selling within the district and to be made available for public information.

No provision contained herein shall be construed as preventing any producer selling within a district from meeting, as of their effective date, the prices, terms, and conditions of sale, filed as herein provided by any other producer.

Except as provided in the foregoing no producer selling within a district shall deviate from the prices, terms, and conditions of sale filed by him as herein provided.

Sec. 3. *Uniform Terms of Sale.*—In each region, district, or division, the regional, district, or division committee, as the case may be, may establish, subject to the approval of the Administrator, terms of sale uniform within each region, district, or division. Such terms shall be binding upon all producers selling in that region, district, or division.

Sec. 4. *Uniform Credit Practices.*—In each region, district, or division, the regional, district, or division committee, as the case may be, may establish, subject to the approval of the Administrator, credit practices uniform within such region, district, or division. Such practices shall be binding upon all producers selling in that region, district, or division.

Several districts prepared rules and regulations for adopting the open-price policy and submitted them to the administration early in 1934. A public hearing was held in April, and some of these rules and regulations had been approved by the end of the month.

*Plant capacity and new production.*—The mineral-aggregates code contains a section providing for limitation of new productive facilities. The provisions of this section are stated as follows:

Sec. 5. *Plant Capacity and New Production.*—(*a*) To promote the fullest possible utilization of the present productive capacity of the industries governed by this Code, to curb uneconomic overproduction in the various regions herein established, and otherwise to effectuate the purposes of the Act, there shall be elected in each State, as hereinafter provided, a standing committee which shall survey its State to ascertain the available sources of supply of the products of these industries within the State, the capacity of existing production facilities, and the relation between existing capacity and the actual and potential demand in such State. This committee shall be known as the State committee and shall consist of three (3) stationary-plant producers and three (3) portable-plant producers, together with one (1) additional member who shall be elected by these six and may be chosen from outside the industries. The six representative members of the committee shall be registered producers as defined in article II of this Code and shall be elected at the time of the election of the regional committee of the region in which the State is located. Members of a State committee shall serve for 1 year from the effective date or until their successors are elected for a like term. The representatives of the stationary-plant producers shall be elected by a majority of the registered stationary-plant producers voting, and the representatives of the portable-plant producers shall be elected by a majority of the registered portable-plant producers voting. The survey and findings reported by each of these committees shall be filed with the appropriate regional committee, which shall transmit a copy thereof to the Code Authority and to the Administrator.

(*b*) If in the judgment of such a State committee, its survey and findings warrant such action, it may after due notice and hearing determine and define the areas, if any, within its State in which an ample supply of the products of the industries governed by this Code is economically available from existing production facilities. The minutes of such hearing, together with the findings of the State committee and a map showing accurately the boundaries of such areas, shall be filed by each State committee with the appropriate regional committee, which shall transmit a copy thereof to the Code Authority and the Administrator; moreover, a copy of the map, together with a summary of the committee's findings, shall be mailed to each registered producer within the region and to all governmental authorities who may properly be interested therein. The Administrator shall review said data and examine said map, and if he shall find that in the area or areas shown on such map an ample supply of the products of the industries governed by this Code is in fact economically available from existing production facilities, such area or areas shall be established as "permissive areas" and subject to the provisions contained in the remaining paragraphs of this section.

(*c*) If any State committee so recommend, the regional committee shall require, subject to review and disapproval by the Administrator, that before a new plant is installed or the producing capacity of an existing plant increased within any permissive area, notice of such intent shall be filed with the regional committee of the region in which such action is contemplated. Upon receipt of such notice the regional committee shall refer it to the State committee or committees in which such permissive area may be located, who shall collect promptly and with diligence full information concerning existing production capacity in that area. If, in the judgment of the State committee, these data disclose that such new capacity will not tend to defeat the purposes of the Act as herein set forth, the regional committee within fifteen (15) days after the receipt of such notice shall grant permission for the proposed increase in capacity. If, however, in the judgment of the State committee these data disclose that within the said area an ample supply of the products of the industries governed by the Code is economically available and that such proposed increase in capacity does tend to defeat the purposes of the Act by further increasing overproduction or otherwise, it shall be the duty of the regional committee within fifteen (15) days after the receipt of such notice to recommend to the Code Authority that permission to increase the production capacity in that area be denied. The decision of the Code Authority shall be final except as it may be modified or revised by the Administrator.

Although many State committees had submitted reports to the Administrator within a few weeks after the code was approved, no "permissive areas" actually had been created. The principal difficulty arose from the provision in the code providing that each committee "shall survey its State to ascertain the available sources of supply." Obviously any ledge of limestone, basalt, or other similar rock, as well as any deposit of sand and gravel, is an available source of supply. To follow the code literally and ascertain all the available sources of supply would require a detailed geological survey of the area. Later in the provisions reference is made to an ample supply of the products of the industries, which is "economically available from existing production facilities." This statement, of course, renders the problem less complex, but the experience of the State committees has shown that interpretation of the words "economically available" presents further difficulties.

The aggregates industries are of such a nature that evaluation of their producing capacity is relatively complex. Storage of materials is not common practice, and excess plant capacity must be maintained in anticipation of high seasonal demands. Therefore, plant capacities commonly are spoken of in terms of hourly production, although numerous correction factors obviously must be used to translate hourly production into yearly capacity or even maximum monthly output.

The code states definitely that no provision "shall be so applied as to permit monopolies and monopolistic practices, or to eliminate, oppress, or discriminate against small enterprises." The administration, of course, retains control over all provisions, for the President may cancel or modify his approval of the code at any time.

After 5 months' operation under the code the aggregates industries, of course, had not solved all their economic problems, and there still were administrative difficulties. The general opinion of producers, however, as expressed in open meetings throughout the year indicated the general usefulness of the code in meeting broad production and marketing problems.

# GYPSUM

By R. W. Metcalf

SUMMARY OUTLINE



Paralleling the continued low level of construction activity the gypsum industry during 1933 experienced a further decrease in production. Curtailment of markets for gypsum were indicated clearly by the figures of the F. W. Dodge Corporation, which show a 7-percent drop in value of total building contracts awarded compared with 1932. The value of contracts awarded for residential building, the most important outlet for gypsum products, declined 11 percent from 1932. In terms of square feet of floor space residential awards remained almost stationary, showing a small loss of 1.1 percent.

Significant of the decreased production of gypsum and the drastically curtailed sales of gypsum products in the United States in recent years is a comparison of the contract awards for residential construction with the output of crude gypsum and total sales of calcined gypsum products for building purposes in 1928 and 1933. The crude gypsum output declined 73.8 percent and sales of products manufactured from gypsum of both domestic and imported origin 76.5 percent between 1928 and 1933 compared with a drop of 91.1 percent in total value of residential contracts awarded and 87.2 percent in square feet of floor space over the same period.

Indexes of residential construction show a sharper drop beginning in the latter part of 1931 than either total building awards or the index of industrial production, as compiled by the Federal Reserve Board. Total building contracts reflect the increased activity due to the public-works program in the last quarter of 1933, but residential contracts show little gain even up to the spring of 1934.

Crude gypsum produced in the United States in 1933 totaled 1,335,192 short tons, the lowest output since 1905. Imports during the year, mostly from Canada, amounted to 359,490 tons valued at $373,919. Sales of imported and domestic crude gypsum declined further to 491,293 tons valued at $1,089,100; compared with 1932 the average value per ton dropped approximately 6 percent to $2.22, about the same level as for 1931.

Sales of gypsum products manufactured from gypsum of both domestic and foreign origin amounted to 1,060,471 tons valued at $14,555,112; the average value per ton was $13.73. Of this total 1,011,506 tons valued at $14,085,071, or 95.4 percent of the tonnage and 97 percent of the value, were sold or used for building purposes.

Imports of gypsum products declined in 1933 compared with 1932. Exports of plaster board and wall board dropped 16.9 percent in quantity and 21.9 percent in value to 1,646,733 square feet valued at $36,057.

Output and sales of gypsum and gypsum products during the first quarter of 1934 as reported to the Bureau in its quarterly canvass of the industry showed marked gains over the corresponding period in 1933, percentages of increase in most instances ranging from 20 to 50 percent.

Salient statistics of the gypsum industry for the past 5 years are summarized in the following table:

*Salient statistics on gypsum and gypsum products in the United States, 1929–33*

| | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Crude gypsum: | | | | | |
| Mined ... short tons | 5,016,132 | 3,471,393 | 2,559,017 | 1,416,274 | 1,335,192 |
| Imported: | | | | | |
| Short tons | 1,036,385 | 902,358 | 713,880 | 374,072 | 359,490 |
| Value | $1,060,874 | $916,663 | $713,313 | $346,766 | $373,919 |
| Gypsum and gypsum products sold by domestic plants: [1] | | | | | |
| Crude gypsum: | | | | | |
| Short tons | 1,149,378 | 1,083,106 | 851,443 | 516,136 | 491,293 |
| Value | $2,428,758 | $2,277,404 | $1,882,557 | $1,216,388 | $1,089,100 |
| Average value per ton | $2.11 | $2.10 | $2.21 | $2.36 | $2.22 |
| Gypsum products: | | | | | |
| For building purposes: | | | | | |
| Short tons | [2] 3,926,784 | [2] 2,641,873 | [3] 2,058,121 | [3] 1,145,097 | [3] 1,011,506 |
| Value | [2] $35,229,772 | [2] $31,740,539 | [3] $26,227,225 | [3] $16,088,875 | [3] $14,085,071 |
| Average value per ton | [2] $8.97 | [2] $12.01 | [3] $12.74 | [3] $14.05 | [3] $13.92 |
| For manufacturing uses: | | | | | |
| Short tons | [2] 255,533 | [2] 197,665 | [3] 74,265 | [3] 48,664 | [3] 48,965 |
| Value | [2] $1,808,941 | [2] $1,636,528 | [3] $610,882 | [3] $488,043 | [3] $470,041 |
| Average value per ton | [2] $7.08 | [2] $8.28 | [3] $8.23 | [3] $10.03 | [3] $9.60 |
| Total gypsum products sold: | | | | | |
| Short tons | 4,182,317 | 2,839,538 | 2,132,386 | 1,193,761 | 1,060,471 |
| Value | $37,038,713 | $33,377,067 | $26,838,107 | $16,576,918 | $14,555,112 |
| Average value per ton | $8.86 | $11.75 | $12.59 | $13.89 | $13.73 |
| Gypsum products imported: | | | | | |
| Short tons [4] | 5,409 | 7,708 | 7,364 | 3,302 | 3,110 |
| Value [4] | $152,509 | $174,456 | $113,198 | $47,313 | $46,718 |
| Gypsum and gypsum products exported: | | | | | |
| Crude, crushed, or ground: | | | | | |
| Short tons | 4,230 | 3,603 | 4,502 | 3,580 | 3,774 |
| Value | $30,870 | $22,918 | $37,816 | $18,931 | $11,049 |
| Plaster board and wall board: | | | | | |
| Square feet | 18,420,455 | 16,677,518 | 6,386,649 | 1,981,685 | 1,646,733 |
| Value | $442,983 | $431,072 | $157,897 | $46,175 | $36,057 |
| Plaster, calcined, and manufactures, n.e.s.: | | | | | |
| Short tons | 24,579 | 20,008 | 6,773 | 1,339 | 1,159 |
| Value | $481,316 | $397,810 | $196,724 | $72,094 | $72,106 |

[1] Produced from rock of both domestic and foreign origin.
[2] Some gypsum products (from imported rock) for manufacturing uses included with those for building purposes.
[3] Calcined gypsum sold for miscellaneous uses and to other manufacturers included with that for building purposes.
[4] Value includes that of manufactured plaster of paris for which weight is not recorded.

*Code of Fair Competition.*—A proposed Code of Fair Competition for the Gypsum Industry was submitted to the National Recovery Administration during 1933, and the public hearing was scheduled January 9, 1934. The code was approved in final form on May 7, 1934.

The code provides for a maximum work week of 40 hours except that, during peak production periods and emergencies, employees may work 48 hours in any week provided that the total hours of work do not average more than 40 hours a week during a 6-month period. A minimum wage rate of 40 cents an hour is established in metropolitan areas and on the Pacific coast, 30 cents an hour in the South, and 37½ cents an hour in the rest of the United States.

In commenting upon the probable economic effects of the code the Administrator stated:

The volume of sales in this industry has decreased about 75 percent since 1929. During the same period the number of employees has decreased from 7,016 to 3,251, a decrease of about 54 percent.

Practically the entire industry is now operating under the President's Reemployment Agreement, and it is not thought that the approval of the code will increase employment or pay rolls further, until volume of business increases. The increase in pay rolls under the President's Reemployment Agreement has apparently been about 20 percent and the increase in employment probably at least 8 percent.

Power to administer the code is vested in a Code Authority of 13 members, 12 of whom are directors of the Gypsum Association and 1 a representative of nonmember producers. Tonnage representation is included in the plan for voting.

The code provides for the determination of costs, and no member of the industry is permitted to sell any product below cost except to meet a competitive price legitimately filed by another producer.

Open price provisions of the code permit filing of prices with the Code Authority and state definitely that:

No member of the industry shall sell any industry product at a price or prices below or upon terms and conditions more favorable to the buyer than those stated in such member's published price lists or schedules and terms and conditions of sale then in effect.

The Code Authority is empowered to study marketing conditions and make recommendations to the industry for a merchandising plan for the sale and distribution of industry products. Such a plan is to contain whatever provisions may be necessary to insure fair selling methods by the industry and to prevent unfair competitive practices.

The code lists numerous trade-practice rules which prohibit granting of rebates or subsidies, defamation of competitors, false branding, imitation of trade marks, shipments on consignment, shipments without orders, failure to state unit price in bids on more than one product, substitution, and other unfair competitive methods.

The code will remain in effect until June 16, 1935, unless rendered inoperative by the President or Congress.

## PRODUCTION AND SALES

Crude gypsum produced in the United States in 1933 amounted to 1,335,192 short tons compared with 1,416,274 tons in 1932, a decrease of 5.7 percent. There were 53 operators reporting, the same number as in 1932.

The four leading States mining crude gypsum were New York, Michigan, Iowa, and Texas; together they accounted for about 65 percent of the total for the United States. New York produced 363,745 tons (408,208 tons in 1932); Michigan, 211,392 tons (248,542 tons in 1932); Iowa, 172,555 tons (178,087 tons in 1932); and Texas, 112,106 tons (110,360 tons in 1932).

Uncalcined gypsum of domestic origin sold or used by producers during 1933 totaled 420,935 tons valued at $806,325, as against 444,816 tons valued at $929,567 in 1932, representing decreases of 5.4 percent in quantity and 13.3 percent in value. Domestic calcined gypsum sales totaled 821,738 tons valued at $11,121,153, compared to 890,495 tons in 1932, a decline in tonnage of 8.9 percent and in value of 7.1 percent. The total value of sales of uncalcined and calcined gypsum

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in 1933 aggregated $15,644,212 (5.6 percent less than the preceding year).

*Gypsum mined and uncalcined and calcined gypsum sold or used by producers in the United States, 1929–33*

| 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 | |
| 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 | 1,416,274 | 444,816 | 929,567 | 890,495 | 11,976,719 | 12,906,286 |
| 1933 | 53 | 1,335,192 | 420,935 | 806,325 | 821,738 | 11,121,153 | 11,927,478 |

*Gypsum mined and uncalcined and calcined gypsum sold or used by producers in the United States in 1933, 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 | |
| Arizona | 1 | 1,100 | | | 1,091 | $10,553 | $10,553 |
| California | 5 | 57,175 | 19,330 | $67,589 | (1) | (1) | (1) |
| Iowa | 7 | 172,555 | 58,863 | 75,083 | 104,371 | 1,282,324 | 1,357,407 |
| Kansas | 2 | 62,636 | 15,338 | 15,468 | 32,152 | 325,865 | 341,333 |
| Michigan | 5 | 211,392 | 71,533 | 153,700 | 154,459 | 2,016,543 | 2,170,243 |
| Nevada | 3 | 74,249 | 37,337 | 94,502 | (1) | (1) | (1) |
| New York | 10 | 363,745 | 109,569 | 201,965 | 221,987 | 3,444,144 | 3,646,109 |
| Oklahoma | 3 | 97,008 | 39,578 | 45,091 | (1) | (1) | (1) |
| Texas | 5 | 112,106 | 17,153 | 41,904 | 75,032 | 1,016,965 | 1,058,869 |
| Other States [2] | 12 | 183,226 | 52,234 | 111,023 | [3] 232,646 | [3] 3,024,759 | [3] 3,342,964 |
| | 53 | 1,335,192 | 420,935 | 806,325 | 821,738 | 11,121,153 | 11,927,478 |

[1] Included under "Other States."
[2] Colorado, Montana, Ohio, South Dakota, Utah, Virginia, and Wyoming.
[3] This figure includes also sales from California, Nevada, and Oklahoma.

Of the total uncalcined gypsum sold (420,935 tons, valued at $806,325) by far the largest share (376,886 tons, valued at $669,029) was used in the manufacture of portland cement—89.5 percent of the tonnage and 83 percent of the value—whereas less than 3 percent was marketed as land plaster.

Building purposes accounted for 759,899 tons of calcined gypsum valued at $10,578,994. Base-coat plasters was the largest single item in point of tonnage and the second in value. Wall board with its much higher unit value topped the total value of base-coat plasters by a small amount. Plaster board came third in both quantity and value. Base-coat plasters and plaster board and lath declined in both quantity and value, and wall board increased only slightly in quantity (119,748 tons against 119,332 tons in 1932), but dropped approximately 6 percent in value to $4,088,393.

Keene's cement was marketed during 1933 by five manufacturers, whose sales totaled 13,529 tons valued at $194,075.

A total of 45,787 tons of the calcined product valued at $428,201 was used in manufacturing processes, or 5.6 percent of the total calcined sold or used. Gypsum used in plate-glass works increased by more than one-half in quantity and one-fourth in value.

*Crude gypsum and gypsum products made from domestic crude gypsum sold or used by producers in the United States, 1932–33, by uses*

| Use | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| Without calcining: | | | | |
| To portland cement mills | 386,266 | $751,650 | 376,886 | $669,029 |
| For agriculture | 15,664 | 89,086 | 11,479 | 63,892 |
| For other purposes [1] | 42,886 | 88,831 | 32,570 | 73,404 |
| Total without calcining | 444,816 | 929,567 | 420,935 | 806,325 |
| Calcined: | | | | |
| For building purposes: | | | | |
| Base-coat plasters | 468,181 | 3,962,376 | 438,126 | 3,851,940 |
| Sanded plasters | 44,026 | 337,145 | 34,529 | 241,624 |
| Finished plasters | 39,341 | 445,930 | 34,141 | 422,800 |
| Molding plasters | 23,592 | 313,454 | 22,957 | 304,836 |
| Keene's cement | 14,607 | 217,549 | 13,529 | 194,075 |
| Plaster board and lath | [2] 69,547 | 1,314,562 | [2] 59,645 | 1,148,704 |
| Wall board | [3] 119,332 | 4,342,063 | [3] 119,748 | 4,088,393 |
| Partition tile | [4] 36,586 | 262,587 | [4] 27,587 | 176,718 |
| Insulating materials | 1,688 | 26,589 | 2,557 | 34,469 |
| Other building purposes [5] | 15,250 | 213,064 | 7,080 | 115,435 |
| Total for building purposes | 832,150 | 11,435,319 | 759,899 | 10,578,994 |
| For manufacturing uses: | | | | |
| To plate-glass works | 12,173 | 99,672 | 18,467 | 127,205 |
| To terra-cotta works | 1,588 | 12,615 | 1,875 | 14,599 |
| For other manufacturing uses [6] | 27,044 | 308,913 | 25,445 | 286,397 |
| Total for manufacturing uses | 40,805 | 421,200 | 45,787 | 428,201 |
| For other purposes [7] | 17,540 | 120,200 | 16,052 | 113,958 |
| Total calcined | 890,495 | 11,976,719 | 821,738 | 11,121,153 |
| Grand total value | | 12,906,286 | | 11,927,478 |

[1] Includes gypsum sold for filler, insulating materials, pigment manufacturing, rock dust, and wall plaster.
[2] 1932: 86,321,679 square feet; 1933: 77,858,195 square feet.
[3] 1932: 154,481,024 square feet; 1933: 157,895,617 square feet.
[4] 1932: 6,594,387 square feet; 1933: 4,687,736 square feet.
[5] Includes joint filler, "roofing tile", "other tile", and pyrofill.
[6] Includes dental plaster, hydrocal, and filler.
[7] Includes calcined gypsum sold to other manufacturers and for miscellaneous uses.

*Keene's cement sold by producers in the United States, 1929–33*

| Year | Manufacturers | Short tons | Value | Year | Manufacturers | Short tons | Value |
|---|---|---|---|---|---|---|---|
| 1929 | 6 | 52,330 | $767,621 | 1932 | 4 | 14,607 | $217,549 |
| 1930 | 4 | 39,446 | 571,044 | 1933 | 5 | 13,529 | 194,075 |
| 1931 | 5 | 27,449 | 394,219 | | | | |

The quantity of calcined gypsum made into board, tile, plaster, and other products by producers was 137,485 tons (17.3 percent less than the 1932 total). The total tonnage so used in 1933 was 657,902 tons, of which 452,393 tons were used for plaster, 157,166 tons for board, 29,126 tons for tile, and the rest for "other products." New York, Iowa, and Michigan led among States manufacturing gypsum

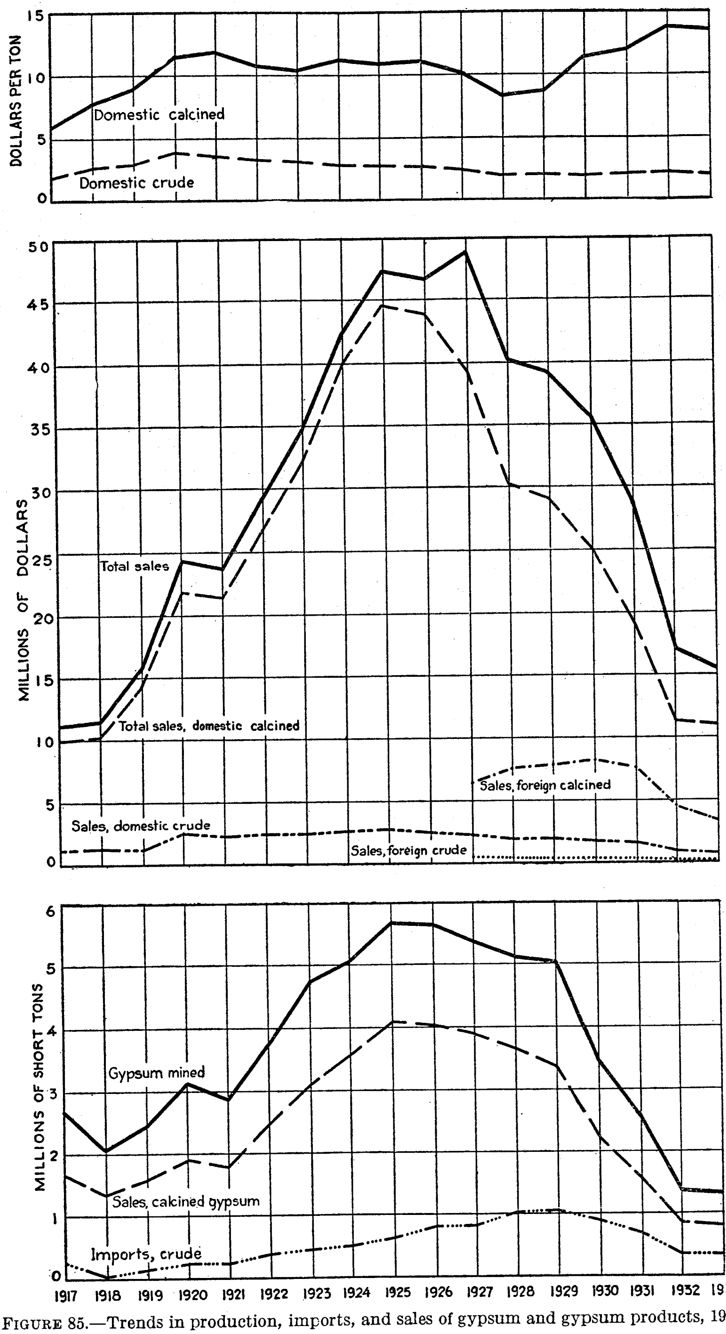


FIGURE 85.—Trends in production, imports, and sales of gypsum and gypsum products, 1917–33.

products; New York used more than twice as much calcined gypsum for these purposes as any other State.

*Calcined gypsum used in products by producers in the United States in 1933, by States and uses, in short tons*

| State | Board | Tile | Plaster | Other products | Total |
|---|---|---|---|---|---|
| Iowa | 13,628 | 6,777 | 65,907 | | 86,312 |
| Kansas | | | 19,523 | | 19,523 |
| Michigan | 19,294 | | 54,762 | 29 | 74,085 |
| New York | 65,240 | 18,670 | 105,622 | 3,872 | 193,404 |
| Texas | 13,938 | 626 | 27,858 | | 42,422 |
| Other States [1] | 45,066 | 3,053 | 178,721 | 15,316 | 242,156 |
| | 157,166 | 29,126 | 452,393 | 19,217 | 657,902 |

[1] Arizona, California, Colorado, Indiana (crude gypsum from Michigan), Montana, Nevada, Ohio, Oklahoma, South Dakota, Utah, Virginia, and Wyoming.

*Active kettles and kilns.*—Forty-one producers reported kettles and kilns in operation in 1933, three less than in 1932. The number of kettles was the same in both years, although the daily capacity reported increased slightly. Data relating to number and capacity of kettles and kilns are shown in the following table:

*Calcining kettles and kilns reported by gypsum producers in the United States in 1933, 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) | |
| Arizona | 1 | 2 | 96 | | | 96 |
| Iowa | 5 | 28 | 4,884 | 1 | (2) | [3] 4,884 |
| Kansas | 2 | 4 | 270 | 3 | 315 | 585 |
| Michigan | 5 | 22 | 2,470 | | | 2,470 |
| New York | 6 | 21 | 3,045 | 8 | 3,260 | 6,305 |
| Texas | 4 | 29 | 2,620 | | | 2,620 |
| Other States [4] | 18 | 50 | 6,286 | 8 | 2,260 | 8,546 |
| Total, 1933 | 41 | 156 | 19,671 | 20 | 5,835 | [3] 25,506 |
| Total, 1932 | 44 | 156 | 19,568 | 18 | 6,055 | 25,623 |

[1] Includes vertical kilns reported in Utah and Virginia.
[2] Capacity not reported.
[3] Capacity of kettles only in Iowa.
[4] California, Colorado, Indiana (crude gypsum from Michigan), Montana, Nevada, Ohio, Oklahoma, South Dakota, Utah, Virginia, and Wyoming.

*Plant and company changes.*—During the year a number of plant changes or improvements were made by various members of the industry. The United States Gypsum Co. erected a wall-board manufacturing plant at Midland, Calif., during the first part of the year as part of a $400,000 improvement program, and production was begun in July. Sheet-rock and other wall-board products are made. It is also understood that new partition-tile machinery has been installed at the company's New Brighton (N.Y.), plant.[1] Two companies, the Sifo Products Co.,[2] of St. Paul, Minn., and the McHenry-Millhouse Mfg. Co.,[3] of South Bend, Ind., manufacturing asphalt

[1] Pit and Quarry, vol. 25, no. 7, March 1933; Rock Products, July 25, 1933, p. 39.
[2] Pit and Quarry, September 1933, p. 16.
[3] Rock Products, June 25, 1933, p. 45.

roofing and accessories were acquired in 1933; both are now operated as divisions of the parent company and make important additions to the United States Gypsum Co. distribution facilities in the central west and Northwestern States. The company also had under construction at the end of the year a new hard-board mill at its fiber insulation-board plant at Greenville, Miss. The new board is said to be much harder than the ordinary type.[4] Production was begun in February 1934.

The National Gypsum Co., Buffalo, N.Y., took over a Cleveland (Ohio) acoustical plaster plant during the year.[5] Another important change in 1933 was the acquisition of the mines, plants, and properties of the Beaver Products Co., of North Holston, Va., formerly a subsidiary of Certain-teed Products Corporation, by the Mathieson Alkali Co., New York City.[6]

## FOREIGN TRADE [7]

*Imports.*—General imports of crude gypsum dropped in quantity in 1933 although they increased slightly in value owing entirely to an increase in value of Canadian gypsum. Most of this material enters along the Atlantic seaboard for use as a retarder in portland-cement manufacture and as land plaster. As in preceding years, Canada and Mexico supplied virtually all the imports, 338,189 tons coming from Canada and 21,277 tons from Mexico in 1933, with small quantities from Germany and the United Kingdom.

Imports of crude gypsum for consumption in the United States were the same as general imports, 359,490 net tons, valued at $373,919. Ground and calcined gypsum imports amounted to 1,907 and 1,179 tons, valued at $18,032 and $14,781, respectively. The value of manufactured plaster of paris imports for consumption was $13,305. Imports of Keene's cement amounted to only 24 tons. The total value of gypsum imports for consumption was $420,637.

*Crude gypsum imported into the United States, 1931–33, by countries*

[General imports]

| Country | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| Canada | 667,614 | $671,985 | 358,589 | $332,908 | 338,189 | $354,473 |
| Germany | | | | | 17 | 75 |
| Hong Kong | 1 | 20 | | | | |
| Italy | | | 6 | 39 | | |
| Mexico | 46,265 | 41,308 | 15,477 | 13,819 | 21,277 | 19,131 |
| United Kingdom | | | | | 7 | 240 |
| | 713,880 | 713,313 | 374,072 | 346,766 | 359,490 | 373,919 |

[4] Pit and Quarry, March 1934, p. 21.
[5] Rock Products, Aug. 25, 1933, p. 81.
[6] Pit and Quarry, August 1933, p. 12.
[7] Figures on imports and exports (unless otherwise indicated) compiled by C. Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

*Gypsum imported for consumption in the United States, 1929–33*

| Year | Crude | | Ground | | Calcined | | Manufactured plaster of paris (value) | Keene's cement | | Total value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | | Short tons | Value | |
| 1929 | 1,036,385 | $1,060,874 | 3,424 | $29,500 | 1,755 | $40,203 | $71,479 | 430 | $11,327 | $1,213,383 |
| 1930 | 902,358 | 916,663 | 4,296 | 35,120 | 2,266 | 40,839 | 61,322 | 1,146 | 37,175 | 1,091,119 |
| 1931 | 713,880 | 713,313 | 4,806 | 40,809 | 2,430 | 32,552 | 36,825 | 128 | 3,012 | 826,511 |
| 1932 | 374,072 | 346,766 | 2,076 | 14,762 | 1,174 | 13,561 | 17,948 | 52 | 1,042 | 394,079 |
| 1933 | 359,490 | 373,919 | 1,907 | 18,032 | 1,177 | 14,781 | 13,305 | 24 | 600 | 420,637 |

Crude gypsum imported in 1933, as reported to the Bureau of Mines by 13 importers, totaled 340,337 short tons compared with 351,723 tons in 1932. Crude gypsum imported and sold or used by the importer decreased only slightly from the 1932 figures, but sales of calcined gypsum dropped 21.3 percent in quantity and 25.4 percent in value. Although the total tonnage of uncalcined gypsum did not change materially, the percentages of total foreign crude disposed of in 1932 and 1933 for the manufacture of portland cement and for agricultural uses varied widely: To portland cement mills, 49.8 percent in 1932 and 34.8 percent in 1933; for land plaster, 44.5 percent in 1932 and 58.1 percent in 1933.

Three of the four classes of plasters registered sharp declines in quantity and value, but finished plasters showed a moderate gain.

*Crude gypsum imported and uncalcined and calcined gypsum, from imported rock, sold or used in the United States, 1929–33, as reported to the Bureau of Mines by the importers*

| Year | Number of importers | Crude imported (short tons) | Sold or used by the importer | | | | |
|---|---|---|---|---|---|---|---|
| | | | Without calcining | | Calcined | | Total value |
| | | | Short tons | Value | Short tons | Value | |
| 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 | 71,328 | 286,821 | 303,266 | 4,600,199 | 4,887,020 |
| 1933 | 13 | 340,337 | 70,338 | 282,775 | 238,733 | 3,433,959 | 3,716,734 |

*Imported crude gypsum and gypsum products made from imported crude gypsum sold or used in the United States, 1932–33, by uses, as reported to the Bureau of Mines by the importers*

| Use | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| Without calcining: | | | | |
| To portland-cement mills | 35,545 | $86,249 | 24,495 | $46,490 |
| For agriculture | 31,760 | 166,944 | 40,847 | 186,072 |
| For other purposes | 4,015 | 33,628 | 4,996 | 50,213 |
| Total without calcining | 71,320 | 286,821 | 70,338 | 282,775 |
| Calcined: | | | | |
| For building purposes: | | | | |
| Base-coat plasters | 164,036 | 1,554,590 | 116,726 | 1,059,583 |
| Sanded plasters | 18,519 | 136,991 | 11,955 | 89,163 |
| Finished plasters | 34,169 | 487,117 | 36,017 | 543,221 |
| Molding plasters | 11,732 | 178,733 | 6,324 | 89,001 |
| For other building purposes [1] | 66,951 | 2,175,925 | 54,417 | 1,552,903 |
| Total for building purposes | 295,407 | 4,533,356 | 225,439 | 3,333,871 |
| For manufacturing uses [2] | 7,859 | 66,843 | 13,294 | 100,088 |
| Total calcined | 303,266 | 4,600,199 | 238,733 | 3,433,959 |
| Grand total value | | 4,887,020 | | 3,716,734 |

[1] Includes Keene's cement, plaster board, lath, wall board, partition tile, roofing tile, insulating materials, and other building purposes.
[2] Includes gypsum sold to potteries, for other manufacturing uses, and to other gypsum manufacturers.

*Exports.*—Crude, crushed, or ground gypsum exported increased 5.4 percent in tonnage but fell off sharply in value from 1932. Exports of plaster board and wall board decreased in 1933 compared with 1932 but at a much less rapid rate than for the 2 years immediately preceding.

*Gypsum and gypsum products exported from the United States, 1929–33*

| 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 |
| 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 |
| 1933 | 3,774 | 11,049 | 1,646,733 | 36,057 | 1,559 | 72,106 |

## WORLD PRODUCTION

World production of gypsum by countries, as far as statistics are available, is shown in the following table;

*World production of gypsum, 1929–33, by countries, in metric tons*

[Compiled by M. T. Latus, of the Bureau of Mines]

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Algeria | 107,221 | 94,780 | 91,120 | 90,550 | (2) |
| Argentina [3] | 36,630 | 49,458 | 39,473 | 32,527 | (2) |
| Australia: | | | | | |
| New South Wales | 10,585 | 2,914 | 1,766 | 2,481 | (2) |
| South Australia | 97,148 | 41,482 | 24,596 | 45,684 | (2) |
| Victoria | 13,407 | 5,902 | 1,590 | 2,951 | (2) |
| Western Australia | 5,374 | 1,606 | 226 | 3,706 | (2) |
| Austria [4] | 43,000 | 37,350 | 48,000 | 36,000 | (2) |
| Canada | 1,111,956 | 997,942 | 800,931 | 398,883 | (5) |
| Chile | 15,434 | 17,178 | 13,173 | (6) | (2) |
| China | 51,500 | 62,100 | 71,500 | (6) | (2) |
| Cuba | 25,400 | 27,200 | (6) | (6) | (2) |
| Cyprus [7] | 12,757 | 10,452 | 9,934 | 10,995 | (2) |
| Egypt [8] | 130,000 | 130,000 | 130,000 | 130,000 | (2) |
| Estonia | 8,093 | 1,963 | 7,851 | 8,299 | (2) |
| France | 2,557,950 | 3,055,420 | 2,832,280 | (6) | (2) |
| Germany | [9] 845,000 | [9] 705,000 | [9] 490,000 | [9] 398,500 | (2) |
| Greece | ---------- | 1,365 | 3,200 | 2,167 | (2) |
| India, British | 53,572 | 57,220 | 54,493 | 55,620 | (2) |
| Italy | 683,755 | 685,530 | 587,845 | 529,821 | (2) |
| Latvia [10] | 26,875 | 35,272 | 31,431 | 36,812 | 48,251 |
| Luxemburg | 7,206 | 10,619 | 9,263 | 9,403 | (2) |
| New Caledonia | 7,116 | 3,131 | 11,550 | 11,900 | (2) |
| Palestine | 1,499 | 1,661 | 491 | 1,481 | (2) |
| Peru | 19,443 | 14,412 | 8,603 | (6) | (2) |
| Poland | (2) | 40,000 | 24,000 | (6) | (2) |
| Rumania | 76,625 | 51,252 | 53,003 | 40,018 | (2) |
| Spain | 975,662 | 1,582,604 | 827,282 | 697,230 | (2) |
| Sweden | 122 | 135 | 50 | (6) | (2) |
| Tunisia | 19,540 | 20,000 | (6) | 26,000 | (2) |
| Union of South Africa | 17,245 | 17,098 | 14,847 | 7,113 | (2) |
| United Kingdom: | | | | | |
| Great Britain | 981,566 | 851,468 | 767,011 | 1,011,399 | (2) |
| Northern Ireland | 1,453 | 193 | (6) | 41 | (2) |
| United States | 4,550,535 | 3,149,178 | 2,321,489 | 1,284,815 | 1,211,259 |
| Yugoslavia [11] | 2,340 | 1,463 | 836 | (6) | (2) |
| | 12,500,000 | 11,800,000 | 9,300,000 | 7,500,000 | (2) |

1 In addition to the countries listed, gypsum is produced in Japan, Switzerland, and the U.S.S.R. (Russia), but production data are not available.
2 Data not available.
3 Rail and river shipments.
4 Estimate furnished by Bundesministerium für Handel und Verkehr.
5 Data for crude gypsum mined not available. Shipments of crude (lump, crushed, and ground) and calcined gypsum amounted to 341,903 tons.
6 Data not available; estimate included in world total.
7 Exports of crude and calcined gypsum.
8 Approximate production.
9 Figures supplied by Deutscher Gips-Verein, E. V., Berlin, Germany.
10 Exports.
11 Serbia only.

## TECHNOLOGIC DEVELOPMENTS

One of the more important developments during the past year has been the perfecting of a process whereby grinding and calcining of gypsum is effected in one operation with a greatly reduced equipment outlay. The investment cost has been estimated at one-fifth to one-sixth of that required for the ordinary kettle process. The use of ball mills for grinding raw gypsum by one company was found economical with respect to power consumption and maintenance cost The calcining of the finer grades of molding, dental, casting and pottery plasters in rotary kilns has been successfully accomplished.

Products introduced during 1933 include a wall board with a new type of wood-grained surface, a perforated plaster-board lath, and a sound-absorbent gypsum board. A light-weight cellular wall board, weighing only 1,250 pounds per 1,000 square feet, is now manufactured. The process involves the use of hydrogen peroxide and a catalyzer mixed with the gypsum plaster. Total decomposition of the peroxide is effected, the gas evolved creating a cellular condition that becomes permanent when the plaster sets.[8] An unusually strong quick-setting casting plaster has been developed. Gypsum-coated sawdust has been tried in the West as an aggregate ingredient in concrete used for fireproofing.[9] Fire tests of building columns protected by gypsum have demonstrated the value of a sanded gypsum-plaster finish through a greater fire resistance proportionate to its thickness than for other block coverings.[10]

A new industrial application of calcium sulphate as a drying or desiccating agent is described in Industrial and Engineering Chemistry by Hammond and Withrow.[11] Soluble anhydrite, its sponsors state, has remarkable powers for removing water cheaply and efficiently from organic liquids, is not corrosive, and may be completely regenerated and reused repeatedly without noticeable loss in efficiency or rate of extraction. The material is prepared simply by heating ordinary gypsum for 3 hours in an oven at about 460° F.

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[8] Bowles, Oliver, Nonmetallic Mineral Industries: Min. and Met., vol. 15, no. 325, January 1934, p. 53.
[9] Shaw, Edmund, Rock Products Possibilities in the Small-House Market: Rock Products, vol. 36, no. 8, Aug. 25, 1933, p. 75.
[10] Mitchell, Nolan D., Fire Tests of Columns Protected with Gypsum: U.S. Bureau of Standards Jour. Res., vol. 10, no. 6, June 1933, pp. 737–755.
[11] Hammond, W. A., and Withrow, J. R., Soluble Anhydrite as a Desiccating Agent: Ind. and Eng. Chem., vol. 25, no. 6, June 1933, pp. 653–659; no. 10, October 1933, pp. 1112–1115.

# LIME

By Paul Hatmaker and A. T. Coons

## SUMMARY OUTLINE



The year 1933 promises to stand out as a significant period in the history of the lime industry. To a growing belief among many lime manufacturers that the first quarter marked the low point of the depression was added further hope as a result of the experiment in self-government to which the industry early committed itself, as it was among the first of the nonmetallic-minerals group to be granted a code under the National Industrial Recovery Act.

Total sales of lime were considerably more in 1933 than in 1932, notwithstanding the fact that rail shipments during the first 3 months were the lowest on record according to reports of the Interstate Commerce Commission. The inactivity of the first quarter, however, was more than offset by increased demand from the iron and steel industries during the summer. The following table summarizes the preliminary data of lime shipments for the year, which reflect marked improvement in the so-called "chemical uses", as well as the continued uncertainties and lack of demand which prevailed in the building and agricultural markets.

*Salient statistics for the lime industry in the United States, 1932–33*

| | 1932 | 1933 [1] | Percent of change in 1933 |
|---|---|---|---|
| Sales by producers: | | | |
| Total lime: | | | |
| Short tons | 1,959,990 | 2,224,000 | +13.5 |
| Value | $12,302,231 | $14,006,000 | +13.8 |
| Per ton | $6.28 | $6.30 | +.3 |
| Hydrated lime: | | | |
| Short tons | 852,251 | 822,000 | −3.5 |
| Value | $5,370,273 | $5,512,000 | +2.6 |
| Per ton | $6.30 | $6.71 | +6.5 |
| Imports (exclusive of dead-burned dolomite): [2] | | | |
| Short tons | 8,777 | 10,505 | +19.7 |
| Value | $96,035 | $105,264 | +9.6 |
| Exports: [2] | | | |
| Short tons | 3,579 | 3,710 | +3.7 |
| Value | $56,479 | $58,095 | +2.9 |
| Per ton | $15.78 | $15.66 | −.8 |
| Distribution of sales: | | | |
| For building: | | | |
| Short tons | 596,825 | 507,000 | −15.0 |
| Value | $3,850,950 | (3) | (3) |
| Per ton | $6.45 | (3) | (3) |
| For agriculture: | | | |
| Short tons | 244,574 | 231,000 | −6.0 |
| Value | $1,366,771 | (3) | (3) |
| Per ton | $5.59 | (3) | (3) |
| For chemical uses: | | | |
| Short tons | [4] 1,118,591 | [4] 1,486,000 | [4] +33.0 |
| Value | $7,084,510 | (3) | (3) |
| Per ton | $6.33 | (3) | (3) |

[1] Subject to revision.
[2] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.
[3] Comparable figures for 1933 not yet available.
[4] Figures include 135,733 tons of dead-burned dolomite in 1932 and 264,114 tons in 1933, an increase of 94.6 percent in 1933.

## PRODUCTION BY STATES

Ohio was again the leading State in the production of lime with an estimated output in 1933 of 524,000 short tons valued at $3,213,000, an increase of 10 percent in quantity and 28 percent in value over 1932. This advance was due to the increased production of dead-burned dolomite, which amounted to 133,000 tons in 1933 compared with 80,028 tons in 1932. Ohio also was the largest producer of hydrated lime, the greater part of which was used in construction. The estimated sales of hydrated lime in Ohio in 1933 were 255,000 tons valued at $1,476,000, a decrease of 13 percent in quantity but an increase of 11 percent in value compared with 1932.

Pennsylvania ranked next to Ohio in total lime, with an estimated output of 430,000 tons valued at $2,790,000, an increase of 15 percent in quantity and 20 percent in value over 1932. Pennsylvania also ranked second in production of hydrated lime, the output for 1933 being estimated at 138,000 tons valued at $990,000, a decrease of 9 percent in quantity and 6 percent in value.

Of the 38 States reporting production of lime in 1933, 22 show increases and 16 decreases, but for 12 of these States the gains or losses shown by the preliminary figures are virtually negligible and may be changed when final figures are available.

The accompanying table compares sales of lime in 1932 and 1933, by States.

*Lime sold by producers in the United States, 1932–33, by States*

| State | 1932 Total lime: Short tons | 1932 Total lime: Value | 1932 Hydrated lime (short tons) | 1933 [1] Total lime: Short tons | 1933 [1] Total lime: Value | 1933 [1] Hydrated lime (short tons) |
|---|---|---|---|---|---|---|
| Ohio | 475,485 | $2,511,368 | 292,742 | 524,000 | $3,213,000 | 255,000 |
| Pennsylvania | 374,244 | 2,327,131 | 152,095 | 430,000 | 2,790,000 | 138,000 |
| Missouri | 174,427 | 1,034,850 | 71,785 | 225,000 | 1,117,000 | 90,000 |
| West Virginia | 82,757 | 427,241 | 31,986 | 121,000 | 628,000 | 29,800 |
| Tennessee | 106,706 | 496,200 | 27,403 | 119,000 | 575,000 | 28,000 |
| Alabama | 92,359 | 492,248 | 19,493 | 112,000 | 557,000 | 18,000 |
| Illinois | 62,436 | 450,033 | 20,030 | 83,000 | 527,000 | 25,000 |
| Virginia | 78,771 | 435,085 | 27,968 | 82,000 | 451,000 | 35,000 |
| Indiana | 58,440 | 351,240 | 34,023 | 63,000 | 338,000 | 28,300 |
| Massachusetts | 68,959 | 527,305 | 22,870 | 55,000 | 465,000 | 21,700 |
| Michigan | 38,610 | 267,520 | (2) | 44,000 | 277,000 | 9,500 |
| California | 29,925 | 284,467 | 9,238 | 37,000 | 353,000 | 13,500 |
| Texas | 35,903 | 340,859 | 23,917 | 35,400 | 340,000 | 21,100 |
| Vermont | 29,187 | 207,032 | 6,467 | 29,500 | 209,000 | 8,800 |
| Wisconsin | 27,283 | 209,868 | 7,182 | 27,100 | 178,000 | 7,100 |
| Maryland | 26,536 | 171,312 | 16,385 | 26,000 | 160,000 | 14,000 |
| Other | 197,962 | 1,768,472 | 88,667 | 211,000 | 1,828,000 | 79,200 |
| | 1,959,990 | 12,302,231 | 852,251 | 2,224,000 | 14,006,000 | 822,000 |

[1] Subject to revision.
[2] Included under "Other."

## CONSUMING INDUSTRIES

Lime and lime products are raw materials for a host of consuming industries, of which the more important are building construction, iron and steel manufacture, agriculture, paper making, water purification, glass making, tanning, and sugar refining. About 85 percent of the 1932 production was sold for these purposes, the remainder being distributed among other chemical industries. Past trends in the major markets for lime have been discussed in detail in other publications of the Bureau of Mines.[1]

Conditions improved during 1933 in the lime-consuming industries, with the notable exceptions of building construction and agriculture. The value of building contracts awarded, according to the F. W. Dodge Corporation, was less than in 1932 until the last quarter of the year, when appreciable improvement was recorded, contrary to a usual seasonal decline. For the year as a whole, however, the value of building contracts was 7 percent less than in 1932, and building activity declined for the fifth consecutive year from the peak in 1928. A detailed account of conditions in the construction industry during 1933 is included in this volume as a supplement to the chapter on cement.

The iron and steel industry began the year at low ebb, production of steel ingots during the first quarter being considerably below that during the first quarter of 1932. Output increased in April, however, and by July it rose above the previous 10-year (1923–32) average for that month. Steel production declined during the remainder of the year, except for a slight rise in December, when the output was more than twice as much as that in December 1932.

[1] Hatmaker, Paul, and Coons, A. T., Lime: Minerals Yearbook, 1932–33, Bureau of Mines, 1933, p. 629. Hatmaker, Paul, Trade Trends in the Lime Industry: Rept. of Investigations 3227, Bureau of Mines, 1934, 18 pp.

Other chemical markets for lime likewise showed appreciable improvement during 1933 and more than compensated for the further declines in sales of agricultural and building lime. As a whole, however, the demand for lime from the "heavy" or "durable goods" industries was spotty and irregular during the year.

## CODE OF FAIR COMPETITION

At the beginning of 1933 there was a wide-spread feeling throughout the lime industry that some revision of the marketing practices prevalent during the past few years was in order. The extent to which

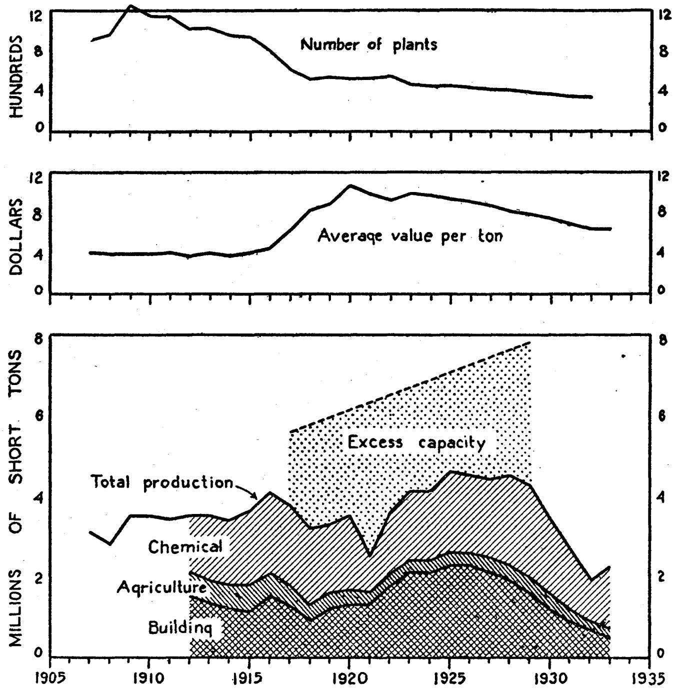


FIGURE 86.—Salient features of the lime industry, 1907–33. Estimates of productive capacity are available for only 2 years—1917 and 1929. Total production of lime in 1917 amounted to about 68 percent of capacity and in 1929 to 55 percent.

this internal pressure had affected the industry prior to the passage of the National Industrial Recovery Act is shown by the principal trade indicators, such as volume of sales, average value per ton, ratio of production to plant capacity, and number of plants in operation.

Figure 86 shows these several factors graphically, enough data being available since 1907 to bring out relatively long-time trends. In comparing the pre-war period with the post-war decade the most significant feature is the meager gain in the tonnage sold. Annual sales before the war averaged about 3.5 million tons, and the greatest quantity ever sold (in 1925) was only slightly more than 4.5 million tons. Sales gained but 13 percent in volume from 1917 to 1929 during the period of greatest industrial and building activity the Nation has yet experienced.

With sales volume increasing at a much slower rate than growth of population, important changes occurred within the industry. The number of plants in operation declined from more than 1,200 in 1909 to 343 in 1932. Even in 1932, however, at least a third of the plants were very small, their aggregate tonnage being less than 2 percent of the total for the industry. Despite this sharp drop in number of plants, productive capacity increased about 40 percent from 1917 to 1929.

As costs of production had increased over pre-war levels, much of the increase in productive capacity has been attributed to the striving for lower costs through increased volume of sales. Doubtless part of it also was due to anticipated expansion of markets, which failed to materialize because of new and highly competitive products used as substitutes for lime.

Thus, during the 8 years from 1925 to 1932, the lime industry was experiencing diminished markets and low prices. The pressure of capacity above current market requirements augmented the tendency toward price cutting and other severe competitive practices. In 1928 the lime industry entered upon a downward trend, and by 1932 sales realizations in some instances did not meet the principal items entering into cost of production; wages in some parts of the country were as low as 5 and 10 cents an hour, men worked 60 and 70 hours or more a week in many plants, and financial reserves of many companies had become depleted or nonexistent.

Into this picture of discouragement was suddenly injected the hope of betterment under the recovery legislation of 1933. Mindful of the possibilities of the National Industrial Recovery Act, the lime industry addressed itself earnestly to the business of code making, which progressed rapidly until October 3, when the President signed the code of fair competition for the lime industry, the thirty-first code to be approved.

High lights of the preparation of the code included the general convention of the industry in Atlantic City June 26 to 28, supplemented by numerous conferences of the trade relations committee of the National Lime Association (the code committee and later the code authority), which met frequently during the summer months. The code, however, was not assembled without reconciling conflicting points of view within the industry, and many compromises were made by different groups before nearly unanimous agreement was secured.

In some measure the drafting of the code was facilitated by the trade-practice studies that had been carried on during previous years. Trade-practice rules were adopted by the lime industry at a conference held under the auspices of the Federal Trade Commission, Washington, D.C., June 27, 1929. Eighteen rules defining unfair trade practice were adopted at a meeting of representatives of 70 percent of the total tonnage of lime manufactured in the United States. In fact, the code of fair competition was to some extent an accelerated crystallization of custom and thought which already had been in process of development for a number of years.

The lime code, which since October 13, 1933, has been the law of the industry, contains five articles: I—Definitions, II—Labor Provisions, III—Marketing, IV—Unfair Methods of Competition, and V—Administration.

*Definitions.*—As originally defined in the code, the lime industry included the manufacture for sale of quicklime and such of its allied products as are natural affiliates. Therefore, the products included are principally quicklime and hydrated lime, no attempt being made to include stone products which might be byproducts or coproducts of a lime plant. Dead-burned dolomite, considered for statistical purposes as part of the lime industry by the Bureau of Mines, was not included in the lime code as approved October 3, 1933. However, an amendment approved by the Administrator on February 10, 1934, created the dolomite division of the lime industry, which includes all manufacturers of dolomite refractories.

*Labor provisions.*—The statutory requirements of the National Industrial Recovery Act (par. 7A) is a mandatory provision of all codes, relating to the right of labor to collective bargaining. Maximum hours for the lime industry are limited to 40 hours a week, which may be exceeded in periods of seasonal peak demand or in the event of lack of storage facilities or emergencies; provided, however, that the average over a 6-month period does not exceed 40 hours a week. Overtime in excess of 8 hours a day must be paid for at a rate not less than one and a half times the normal rate. Exempted from the maximum-hour provisions are outside salesmen, as well as foremen, superintendents, managers, officials, or others compensated on a regular salary basis in excess of $35 per week.

Minimum rates of wages are 30 cents an hour in the South and 37.5 cents an hour in the North, the dividing line being the northern boundary of Virginia, Tennessee, Arkansas (including the manufacturing section known as "southwestern Missouri"), Oklahoma, New Mexico, and Arizona. For accounting, clerical, or other office employees, the minimum weekly wage ranges from $12 per week in towns of less than 2,500 population to $15 per week in cities of more than 500,000. Employees incapable of normal productive effort may be paid at a rate not less than 80 percent of the minimum rates of pay, but the number of such employees shall not exceed 5 percent of the total number of employees employed. Employment of persons under the age of 16 years is prohibited.

*Marketing.*—An orderly plan of distribution for the products of the industry is established whereby each manufacturer shall be upon an equal competitive basis with other manufacturers. The maintenance of a minimum price at the average cost of production is a major element of this marketing structure. The code first establishes machinery for uniform cost accounting to set forth the items of expense necessarily incurred by all manufacturers, including items that in the past were not always considered in computing individual costs. The intent of this provision is to find the actual cost of each industry product by districts, and it is provided further that the weighted average cost in each district shall be determined. This figure for a given product then becomes the minimum price at which any manufacturer in the industry may sell such product within such district.

Article III provides also for the establishment of basing points, this system having been used by the industry in former years. Basing points are established by the District Control Committees (or by the Code Authority if the district is unorganized). The primary purpose of the basing-point system of marketing is to simplify the quoting of delivered prices by consolidating a number of pricing points of origin into a single point. The use of basing points in the lime industry probably developed because of the natural conditions inherent to the location of lime plants. As is well known, lime plants generally are located close to deposits of high-grade limestone, which are in economic relationship to supplies of fuel and to markets. Satisfactory deposits of limestone for the manufacture of lime are part of certain definite geological formations, and lime plants tend either to be located in clusters or groups or to be distributed along well-defined outcrops. One point within a group of plants, therefore is selected as a basing point to serve that group.

The next step provided for in the marketing structure is price publication. The code makes it mandatory for each manufacturer always to maintain on file with his District Control Committee (or with the Code Authority if his district is unorganized) a complete list of basing-point prices, terms, and conditions of sale for each of his products. Such price lists become effective not less than 5 days after the date of filing. It is provided, however, that to meet lawful competition a manufacturer may file new prices which may become effective immediately. Failure to adhere to filed prices, terms, and conditions of sale is declared an unfair method of competition.

The marketing sections of the code also provide for the standardization of forms for quotations and contracts, with the objective of eventually standardizing such forms throughout the industry. Each district, moreover, is authorized to prepare a merchandising plan containing such provisions as may be deemed necessary to insure fair selling methods by the manufacturers in the district and to prevent unfair competitive prices; the scope or nature of such merchandising plans is not specified in the code.

The basing-point and average-cost provisions of the code were held to be experimental and tentative for a period of 4 months. At the expiration of such time the Code provided that a report should be made to the President regarding the effect of these provisions upon prices and upon such other matters as might be deemed pertinent to inform the President upon operations of the act. The report submitted at the end of the 4-month trial period strongly recommended continuing these provisions. Article III is so important a part of the lime code that it is reproduced here in full.

### Article III—Marketing

Section 1. *Uniform Cost Accounting.*—The Trade Relations Committee (hereinafter described in Article V hereof) upon reasonable notice to the District Control Committees and acting upon their recommendations, shall immediately prepare and adopt for use in the Industry, and shall submit to the Administrator for his approval not earlier than ten (10) days after submitting the same to each District Control Committee (hereinafter described in Article V hereof), a standard uniform system or method of cost accounting. Upon such approval by the Administrator all manufacturers shall maintain at all times an accurate record of all costs in accordance with such system or methods or in such other manner as will clearly indicate and make available the information required thereby. Such system or method shall specify the items which shall be included in determining each manufacturer's cost.

Sec. 2. *Standard Forms.*—Each District Control Committee, in cooperation with the Trade Relations Committee, shall prepare immediately standard forms for quotations and contracts for use by manufacturers producing in the district to the end of standardizing such forms as far as possible in all districts, which forms shall specify the terms and conditions under which quotations and contracts for sale shall be made. When so prepared and approved by the District Control Committees, copies of such forms shall be sent to the Trade Relations Committee, and shall be submitted by it to the Administrator for his approval. Upon the Administrator's approval thereof, no manufacturer in any district shall quote or sell lime or lime products on terms or conditions at variance from those specified in the forms approved for that district.

SEC. 3. *Methods of Selling.*

(a) *Establishment of Basing Points.*—The practice of determining delivered prices for lime in given markets, by the utilization of a basing point or points plus the prevailing rail freight rates, has been a long-standing custom in the Industry.

Each District Control Committee (hereinafter in this Code provided for) may establish for its district a basing point or points (and change or revise the same from time to time as conditions warrant), which basing point or points shall be fair and reasonable as to all interested parties; provided, that in the event no such District Control Committee shall have been elected in any district within twenty days after the effective date of this Code, then such basing point or points shall be established for such district by the Trade Relations Committee acting upon the recommendations of the manufacturers therein.

(b) *Weighted Average District Costs.*—Each District Control Committee shall determine within its own district, and from time to time revise and promulgate for the guidance of the Industry, the weighted average cost of each industry product manufactured in such district. Such cost shall be based upon the costs of individual manufacturers, as provided for in Section I of this Article. In case of a district having no District Control Committee the manufacturers in such district shall report to the Trade Relations Committee, or its designated agency, necessary data to enable the Trade Relations Committee to determine weighted average costs for each industry product manufactured in such district, and the Trade Relations Committee shall determine such costs and promulgate the same for the guidance of the Industry. Such average costs shall be subject to the approval of the Administrator and the substantiating data shall be open to his inspection at all times. Such determination of cost shall be made in such manner that individual figures are kept confidential and shall not be available to competitors.

After such average cost of each industry product is so determined for any district, no manufacturer in the industry shall sell any such industry product for delivery in such district at less than such average cost, plus basing rail freight. Any sale in any such district by any manufacturer at less than such average cost, plus basing rail freight, shall be an unfair method of competition.

(c) *Price Publication.*—Each manufacturer in the industry shall, within ten (10) days after the effective date of this Code, file with the District Control Committees a list showing the basing point prices, and terms and conditions of sale for each of the products offered for sale in each district by such manufacturer and after the expiration of such ten-day period, every manufacturer shall at all times maintain on file with the District Control Committees a list showing the basing point prices and terms and conditions of sale except as herein provided. Each such list shall state the date upon which it shall become effective, which date shall not be less than five (5) days after the date of filing such list; provided, however, that the first list of prices and terms and conditions of sale filed by any manufacturer, as above provided, shall take effect on the date of filing thereof. None of the prices and terms and conditions of sale shown in any list filed by any manufacturer, as herein provided, shall be changed except by the filing by such manufacturer with the District Control Committee of a new list of basing point prices and terms and conditions of sale which shall become effective on the effective date therein specified, which shall not be less than five (5) days after the date on which such new price list and terms and conditions of sale shall have been so filed. In case any district shall not have elected a District Control Committee, then the manufacturers selling within such district shall file their prices and terms and conditions of sale for such district with the Trade Relations Committee in the same manner and under the same conditions as those above stated for filing with the District Control Committees.

All such price lists and terms and conditions of sale filed with the District Control Committee shall be immediately distributed among the manufacturers within the district, and a copy filed with the Trade Relations Committee and all such price lists and terms and conditions of sale filed with the Trade Relations Committee shall be immediately distributed to all manufacturers in the Industry interested therein.

In the event that any manufacturer shall not receive sufficient notice of the filing by any other manufacturer of revisions in such other manufacturer's prices or terms and conditions of sale, as will enable him to meet such revisions of such other manufacturer on the effective date thereof, then if such manufacturer shall file with the appropriate committee such revisions in his prices and terms and conditions of sale as may be required to meet the revisions filed by such other manufacturer, within forty-eight hours after receipt of notice thereof, the revisions so filed by such manufacturer shall become effective on the same date as the revisions of such other manufacturer, or if they be already effective, shall become effective immediately.

The failure of any manufacturer to adhere to his prices, terms, and conditions of sale, filed as herein provided, and any other deviation from the provisions of this section, shall be an unfair method of competition.

*Trade practices.*—Article IV specifies 22 unfair methods of competition, including failure to adhere to the minimum wages and maximum hours. No manufacturer may sell below his individual cost, except to meet a well-established, competitive, delivered market price for a product of similar grade and quality. It is also provided that even under these conditions the Administrator shall have the power to prohibit such sales below individual cost to meet competition, if it can be shown that such practice is working an actual injury upon other manufacturers in the industry. Many of the unfair trade practices prohibited in article IV are essentially the rules adopted by the industry in 1929 under the auspices of the Federal Trade Commission. They include sections on commercial bribery, rebates and subsidies, lump-sum bids and contracts, combination sales, inducing breach of contract, defamation of competitors, use of old packages, misrepresentation, false branding, imitation of trade marks, shipments on consignment, shipments without orders, false classification, substitution, contingent sales, and splitting of commissions. Other provisions of this article deal with protected contracts and duration of agreements; stipulations as to length of contract on chemical lime, building lime, and agricultural lime; and Federal, State, county, and municipal requirements.

*Administration.*—Article V, providing the machinery necessary for administering the code, establishes the Trade Relations Committee of the National Lime Association as the Code Authority for the lime industry. The committee includes in addition such representatives of the Administrator as he may appoint thereto, such members not to exceed three in number and to be without vote.

Furthermore, the Trade Relations Committee is definitely established as a planning and fair-practice agency for the industry. Thus the Code Authority not only is charged with the administration of the code but also is delegated the important responsibility of planning for the future well-being of the industry.

The Trade Relations Committee is authorized to establish its own rules for the conduct of its business. It also is empowered to collect statistical data concerning wages, hours of labor, conditions of employment, number of employees, and other matters pertinent to the purposes of the code. The cost of code administration, including the collection of statistics, is prorated among the manufacturers.

Recommendations as to code changes may be presented to the Administrator by the Trade Relations Committee after such proposals have first received the approval of those members of the industry who in the preceding year accounted for at least 60 percent of the total tonnage produced in that year.

The Trade Relations Committee is to cooperate with the Administrator in any investigations that may be necessary to insure the observance of the code provisions. It also may delegate such of its powers or duties as it deems necessary to such subcommittees or other agencies as may be necessary. Moreover, authority is given to the Trade Relations Committee to issue interpretations of the code, subject to an appeal to the Administrator in the manner prescribed. This authority was modified by later NRA. rulings providing that all interpretations of a code by the Code Authority be approved by the NRA. before distribution to the industry.

The code also provides that the industry shall be divided into lime-industry districts, which are described initially in schedule A of the code as follows:

District 1 : Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, and that portion of New York east of the 77th meridian.

District 2 : New Jersey, Delaware, Maryland, and that portion of Pennsylvania east of the 77th meridian.

District 3 : West Virginia and that portion of New York and Pennsylvania west of the 77th meridian.

District 4 : Virginia, North Carolina, and South Carolina.

District 5a : The Ohio hydrated finishing lime plants and factories located in the State of Ohio, composed of the following : Herzog Lime & Stone Co., Forest, Ohio, Kelley Island Lime & Transport Co., White Rock, Gibsonburg, and Tiffin, Ohio; National Gypsum Company, Luckey, Ohio; National Lime & Stone Co., Carey, Ohio; National Mortar and Supply Co., Gibsonburg, Ohio; Ohio Hydrate & Supply Co., Woodville, Ohio; Washington Building Lime Co., Woodville, Ohio; Woodville Lime Products Co., Woodville, Ohio; United States Gypsum Co., Genoa, Ohio; Gibsonburg Lime Products Co., Gibsonburg, Ohio.

District 5b : State of Ohio, except the hydrated finishing lime plants described in District 5a above.

District 6 : Michigan.

District 7 : Illinois, Indiana, and that portion of Missouri east of the 93rd meridian.

District 8 : Wisconsin.

District 9 : North Dakota, South Dakota, Minnesota, and Iowa.

Districts 10 & 11 : Kentucky, Tennessee, Mississippi, Alabama, Georgia, and Louisiana east of the Mississippi River, Florida.

District 12 : Nebraska, Kansas, Oklahoma, Arkansas, Louisiana west of the Mississippi River, and that portion of Missouri west of the 93rd meridian.

District 13 : Texas.

District 14 : Washington, Oregon, Idaho, Montana, and Wyoming.

District 15 : California, Nevada, Utah, Arizona, Colorado, and New Mexico.

Each district may elect a District Control Committee charged with the power and duty of supervising and enforcing the provisions of the code within their respective districts. This provision represents a decentralization of authority to the several manufacturing districts.

Appeals may be taken from the action of the District Control Committee to the Trade Relations Committee, and from there to the Administrator, if so desired. Any interested party, moreover, has the right of complaint to either the District Control Committee or the Trade Relations Committee, in regard to any action taken by such committee.

## OPERATION UNDER THE CODE

By the effective date of the code, October 13, 1933, most districts had elected District Control Committees. Principal basing points were formally established, and price filing and publication were begun. Collection of statistical data pertaining to number of employees, man-hours, pay rolls, wage rates, hours of work, plant capacities, and shipments began in October. Although the maximum-hour and minimum-wage provisions of the code involved in some cases drastic readjustment of preexisting schedules, the industry as a whole adapted itself to the new order.

The various objectives contemplated under article III on marketing, however, could not be fully attained immediately. A cost formula, for example, had not been approved by the end of 1933, therefore this and other cost provisions of the code had not as yet become operative. A number of obstacles hindered the adoption and approval of a cost formula, as there are conflicting views on where legitimate sales expense stops and purely promotional expense begins, on the exclusion of interest on borrowed money as an item of cost, on the rate of production to be used in arriving at other fixed items of expense, and on the basis upon which property values might be computed under present conditions. These and many other questions must be answered before a satisfactory cost formula can be set up for the lime industry.

Standard forms for making quotations and contracts were held to be essential to an orderly marketing plan, in order that uniformity of tentative and actual contractual relations might prevail. It was apparent that some time must elapse before uniformity in terms and conditions of sale would prevail in all districts.

Shortly after the signing of the code, more than 40 basing points had been established among the several lime-manufacturing districts. At least one district has established every lime plant therein as a basing point for agricultural lime. Other districts have designated certain points as bases for specified grades of lime, according to marketing and manufacturing conditions.

In some districts a definite basing-point area has been established surrounding each basing point in order that a given destination will be subject to only one basing point for a given quality and grade of lime. In other districts no such areas are recognized, the lowest combination of published price and basing rail freight, considering all possible combinations, establishing the delivered price.

By the provisions of the lime code, price lists were to have been filed by all manufacturers by October 23. The task of compiling the individual filings into price lists for the districts proved to be a major one, and it was nearly the close of 1933 before all lists had been published formally.

# CLAY

By Paul M. Tyler and R. W. Metcalf

SUMMARY OUTLINE



The clay-production figures of the Bureau of Mines represent chiefly clay that is mined and sold as clay or mined under royalty or shipped into another State for fabrication. This grouping includes the bulk of the high-grade clays used for fine ceramic wares, for refractories, and for general industrial purposes but represents a relatively small part, in some years scarcely 10 percent, of the total clay mined in the United States. From a tonnage standpoint the principal use of clays is for the manufacture of common brick and other heavy clay products; however, the shaping and firing of such products are essentially steps in an integral process that begins with the mining of clay and is not completed until the clay has lost its original identity. Ordinarily no merchantable product is obtained until after the material has left the kilns, consequently the nominal value or even the tonnage of raw clay employed in operations of this sort is of interest only as a raw-material cost item to the individual manufacturer. Clays, other than acid-treated bentonites, used for clarifying or decolorizing oils and fats are classified as "fuller's earth" and included in the tabulations in that chapter of the Minerals Yearbook. Clay or shale used in cement making likewise is excluded from the tables that follow, except when the clay pits are operated as distinct units.

The industries engaged in manufacturing common brick and other heavy clay products, most of which are structural in character, have remained depressed; the consumption of common brick, in fact, has declined in recent years even more than that of other building materials. Among the clays reported by the Bureau of Mines, those used in high-grade tile and architectural terra cotta were affected by conditions in the building industry. A sharp decline in sales of clay for stoneware, however, appears to be due to less demand for jugs and crocks, as production statistics for porcelain and vitreous china plumbing fixtures indicated an increased demand in this department of the construction industry. The domestic pottery industries were relatively inactive in 1933, but recovery in other clay-consuming industries, notably paper making and refractories manufacture, were reflected favorably in the quantity and value of the leading varieties of clay produced in the United States. Exports were somewhat larger in 1933 than in 1932, and although imports increased somewhat there was no indication that foreign shippers were regaining any substantial business from domestic miners.

*Salient statistics of the clay industry in the United States, 1925–33*

| | 1925–29 (average) | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Domestic clay sold for: | | | | | |
| Pottery, stoneware....short tons.. | 225,912 | 200,937 | 147,409 | 108,135 | 114,022 |
| High-grade tile....do.... | 74,350 | 118,540 | 96,632 | 44,329 | 32,101 |
| Saggers, spurs, stilts, wads..do.... | 205,567 | 104,489 | 73,117 | 39,832 | 49,916 |
| Architectural terra cotta....do.... | 91,753 | 54,007 | 31,188 | 13,520 | 12,875 |
| Paper....do.... | 201,292 | 279,132 | 275,469 | 230,445 | 255,989 |
| Rubber....do.... | 31,996 | 31,904 | 34,501 | 33,710 | 49,615 |
| Oilcloth, linoleum....do.... | 11,885 | 9,542 | 7,411 | 5,326 | 6,715 |
| Paints....do.... | 18,047 | 13,909 | 12,920 | 7,983 | 10,859 |
| Cement....do.... | 70,913 | 68,193 | 121,196 | 50,281 | 22,747 |
| Refractories....do.... | 2,068,970 | 1,931,096 | 1,101,401 | 573,530 | 1,030,565 |
| Unspecified....do.... | 1,043,346 | 1,151,154 | 618,251 | 284,725 | 254,769 |
| Total shipments....do.... | 4,044,031 | 3,962,903 | 2,519,495 | 1,391,816 | 1,840,173 |
| Total value.... | $13,918,173 | $12,521,495 | $8,352,185 | $5,201,609 | $6,840,617 |
| Imports: | | | | | |
| Kaolin, china clay.....short tons.. | 339,014 | 236,251 | 151,426 | 99,807 | 116,180 |
| Common blue, Gross Almerode short tons.. | 12,130 | 18,900 | 15,183 | 5,880 | 7,099 |
| Other clays: | | | | | |
| Crude....do.... | 57,001 | 24,883 | 15,615 | 13,290 | 17,623 |
| Washed, treated....do.... | 4,047 | [1] 4,984 | [1] 8,376 | [1] 8,133 | [1] 9,756 |
| Total imports....do.... | 412,192 | 285,018 | 190,600 | 127,110 | 150,658 |
| Total value.... | $3,715,725 | $2,704,960 | $1,536,024 | $877,180 | $1,180,503 |
| Exports: | | | | | |
| Fire clay....short tons.. | 55,316 | 62,660 | 45,314 | 22,086 | 32,431 |
| Other clay....do.... | 54,028 | 73,870 | 61,389 | 59,273 | 66,094 |
| Total exports....do.... | 109,344 | 136,530 | 106,703 | 81,359 | 98,525 |
| Total value.... | $1,217,769 | $1,628,374 | $1,244,855 | $1,054,623 | $1,234,888 |

[1] Includes "acid-treated earths" after June 18, 1930.

## DOMESTIC PRODUCTION

In 1933 fire-clay and bentonite shipments increased approximately 50 percent, and those of ball clay made almost as good a recovery. Kaolin sales showed a gratifying gain although by a smaller percentage. Slip-clay sales, despite a marked increase compared with 1932, remained at an extraordinarily low figure. The only notable reaction was in stoneware clay, shipments of which dropped 44 percent after a much slower decline that began in 1928. Less significance attaches to the reduction in sales of "Miscellaneous clay", as this classification includes a variable coverage of sundry common clays, of which only a small part of the total output is recorded by the Bureau of Mines.

*Clay sold by producers in the United States, 1909–33, by kinds*

| Year | Kaolin or china clay and paper clay | | Ball clay | | Slip clay | | Fire clay | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 1909–13 (average). | 132,114 | $705,352 | 63,371 | $231,477 | 14,268 | $25,867 | 1,629,097 | $2,261,738 |
| 1925–29 (average). | 453,618 | 3,834,285 | 116,127 | 890,457 | 6,839 | 36,999 | 2,810,001 | 7,747,918 |
| 1930.... | 533,800 | 3,893,814 | 93,488 | 739,787 | 4,398 | 26,465 | 2,547,162 | 6,070,663 |
| 1931.... | 443,300 | 2,946,953 | 83,007 | 639,798 | 1,916 | 13,613 | 1,473,161 | 3,741,038 |
| 1932.... | 344,994 | 2,011,208 | 47,573 | 312,751 | 525 | 5,105 | 725,993 | 2,057,060 |
| 1933.... | 411,233 | 2,366,339 | 64,551 | 400,564 | 1,562 | 11,365 | 1,133,693 | 3,141,545 |

*Clay sold by producers in the United States, 1909–33, by kinds*—Continued

| Year | Stoneware clay | | Bentonite | | Miscellaneous clay | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 1909–13 (average) | 142, 569 | $143, 034 | (1) | (1) | 400, 546 | $369, 019 | 2, 381, 965 | $3, 736, 487 |
| 1925–29 (average) | 88, 575 | 188, 054 | (1) | (1) | 568, 869 | 1, 220, 458 | 4, 044, 029 | 13, 918, 171 |
| 1930 | 75, 832 | 146, 513 | 107, 405 | $858, 927 | 600, 818 | 785, 326 | 3, 962, 903 | 12, 521, 495 |
| 1931 | 57, 466 | 131, 915 | 78, 815 | 472, 045 | 381, 830 | 406, 823 | 2, 519, 495 | 8, 352, 185 |
| 1932 | 49, 736 | 82, 521 | 71, 613 | 503, 673 | 151, 382 | 229, 291 | 1, 391, 816 | 5, 201, 609 |
| 1933 | 28, 188 | 59, 581 | 117, 428 | 760, 174 | 83, 518 | 101, 049 | 1, 840, 173 | 6, 840, 617 |

[1] Sales of bentonite included under "Miscellaneous clay" before 1930 when separate figures first became available.

*Clay sold by producers in the United States in 1933, by States and kinds*

| State | Number of operators reporting sales | Kaolin or china clay and paper clay | | Ball clay | | Fire clay | | Stoneware clay | | Miscellaneous clay [1] | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Short tons | Value | Short tons | value | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| Alabama | 12 | | | | | 26,901 | $31,686 | | | 65 | $13 | 26,966 | $31,699 |
| Arizona | 1 | | | | | | | | | 11,616 | 90,986 | 11,616 | 90,986 |
| Arkansas | 1 | | | | | 122 | 731 | | | 102 | 229 | 224 | 960 |
| California | 41 | 2,262 | $15,984 | | | 65,884 | 189,037 | 1,789 | $6,376 | 47,847 | 121,656 | 117,782 | 333,053 |
| Colorado | 14 | | | | | 28,283 | 42,523 | | | 361 | 532 | 28,644 | 43,055 |
| Connecticut | 2 | | | | | (2) | (2) | | | (2) | (2) | (2) | (2) |
| Delaware | 2 | 1,876 | 24,879 | | | | | | | | | 1,876 | 24,879 |
| Florida | 2 | (2) | (2) | | | | | | | | | (2) | (2) |
| Georgia | 18 | 265,242 | 1,386,171 | | | 14,796 | 31,449 | 60 | 60 | | | 280,098 | 1,417,680 |
| Idaho | 2 | | | | | 252 | 2,868 | | | | | 252 | 2,868 |
| Illinois | 12 | | | (2) | (2) | 64,419 | 177,035 | 7,458 | 14,527 | (2) | (2) | 72,447 | 197,532 |
| Indiana | 14 | | | | | 20,083 | 27,004 | | | 31,056 | 25,741 | 51,139 | 52,745 |
| Iowa | 10 | | | | | 7,158 | 69,169 | | | 2,221 | 5,653 | 9,379 | 74,822 |
| Kentucky | 18 | 600 | 1,300 | 25,462 | $177,035 | 88,128 | 299,065 | | | | | 114,190 | 477,400 |
| Maine | 2 | | | | | 68 | 1,220 | | | 16 | 16 | 84 | 1,236 |
| Maryland | 8 | (2) | (2) | (2) | (2) | 12,744 | 30,622 | | | | | 21,459 | 65,105 |
| Massachusetts | 7 | (2) | (2) | | | (2) | (2) | | | 186 | 1,264 | 837 | 12,891 |
| Michigan | 3 | | | | | (2) | (2) | | | (2) | (2) | 114 | 546 |
| Minnesota | 3 | | | | | (2) | (2) | (2) | (2) | (2) | (2) | (2) | (2) |
| Mississippi | 1 | | | | | | | (2) | (2) | | | (2) | (2) |
| Missouri | 29 | (2) | (2) | (2) | (2) | 176,269 | 708,291 | 350 | 686 | | | 177,169 | 713,127 |
| Montana | 5 | | | | | 306 | 2,001 | | | 786 | 1,074 | 1,092 | 3,075 |
| Nebraska | 4 | | | | | | | | | 10,178 | 9,371 | 10,178 | 9,371 |
| Nevada | 1 | | | | | | | | | (2) | (2) | (2) | (2) |
| New Jersey | 25 | | | 2,095 | 14,003 | 47,992 | 218,156 | 3,873 | 15,750 | 3,485 | 8,822 | 57,445 | 256,731 |
| New Mexico | 3 | | | | | 142 | 1,505 | | | | | 142 | 1,505 |
| New York | 6 | | | | | (2) | (2) | | | (2) | (2) | 1,740 | 13,401 |
| North Carolina | 4 | 6,878 | 102,714 | | | | | 50 | 100 | | | 6,928 | 102,814 |
| North Dakota | 3 | | | | | 1 | 20 | | | 3,521 | 3,361 | 3,522 | 3,381 |
| Ohio | 50 | | | | | 157,602 | 305,803 | 9,061 | 10,971 | 1,210 | 4,008 | 167,873 | 320,782 |
| Oklahoma | 3 | | | | | | | | | 5,630 | 65,141 | 5,630 | 65,141 |
| Oregon | 2 | | | | | (2) | (2) | (2) | (2) | | | (2) | (2) |
| Pennsylvania | 62 | 19,040 | 76,656 | | | 369,514 | 867,131 | 1 | 3 | 9,389 | 14,483 | 397,944 | 958,273 |
| South Carolina | 8 | 95,633 | 572,564 | | | 21 | 250 | | | | | 95,654 | 572,814 |
| South Dakota | 2 | | | | | | | | | 344 | 1,764 | 344 | 1,764 |
| Tennessee | 7 | | | 28,213 | 167,904 | 14,930 | 51,590 | 126 | 139 | 4,953 | 4,953 | 48,222 | 224,586 |
| Texas | 5 | | | | | 1,776 | 10,728 | | | 27,175 | 197,089 | 28,951 | 207,817 |
| Utah | 5 | | | | | (2) | (2) | | | (2) | (2) | 16,152 | 141,673 |
| Vermont | 1 | (2) | (2) | | | | | | | | | (2) | (2) |
| Virginia | 3 | (2) | (2) | | | 185 | 527 | | | (2) | (2) | 4,823 | 18,145 |
| Washington | 4 | | | | | (2) | (2) | (2) | (2) | 5,103 | 4,492 | 6,101 | 7,913 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Virginia | 5 | | | | | 31,765 | 43,783 | | | | | 31,765 | 43,783 |
| Wisconsin | 1 | | | | | | | | | 60 | 60 | 60 | 60 |
| Wyoming | 6 | | | | | | | | | 21,327 | 166,837 | 21,327 | 166,837 |
| Undistributed | | 19,702 | 186,071 | 8,781 | 41,622 | 4,352 | 29,351 | 5,420 | 10,969 | 15,877 | 145,043 | 20,004 | 180,167 |
| 1933 Total | 417 | 411,233 | 2,366,339 | 64,551 | 400,564 | [3] 1,133,693 | [3] 3,141,545 | 28,188 | 59,581 | [4] 202,508 | [4] 872,588 | 1,840,173 | 6,840,617 |
| 1933 Average value per ton | | | 5.75 | | 6.20 | | 2.77 | | 2.11 | | | | 3.72 |
| 1932 Total | 407 | 344,994 | 2,011,208 | 47,573 | 312,751 | [3] 725,993 | [3] 2,057,060 | 49,736 | 82,521 | [4] 223,520 | [4] 738,069 | 1,391,816 | 5,201,609 |
| 1932 Average value per ton | | | 5.83 | | 6.57 | | 2.83 | | 1.66 | | | | 3.74 |

[1] Includes adobe, shale, etc. Slip clay and bentonite are also included in this column as a matter of statistical convenience.

[2] Included under "Undistributed."

[3] Fire-clay totals for 1933 include 11,809 tons of diaspore and burley clay, valued at $53,485, and for 1932, 6,789 tons of this material, valued at $51,798, from Missouri.

[4] These totals for 1933 include 1,562 tons of slip clay valued at $11,365 from Michigan and New York, and 117,428 tons of bentonite valued at $760,174 from Arizona, California, Nevada, Oklahoma, South Dakota, Texas, Utah, and Wyoming. Of the total bentonite, California reported 38,089 tons valued at $108,850; Oklahoma, 5,285 tons valued at $62,177; South Dakota, 344 tons valued at $1,764; and Wyoming, 21,306 tons valued at $166,630. In 1932 the same States that produced in 1933 reported 71,613 tons of bentonite valued at $503,673 and 525 tons of slip clay valued at $5,105.

## FOREIGN TRADE

*Imports.*—Although there was a small increase in tonnage and a substantial increase in value of imports of clay in 1933 receipts under virtually every category were substantially less than in any other recent year except 1932. Included in the clay import statistics herein reported are the imports of acid-treated earth, essentially a superior sort of fuller's earth and consequently governed by a different set of economic conditions than other items in the group. Imports under this classification declined in 1933 but still were higher than in 1931 or any previous year. This new German product represents a rather small tonnage, but in point of value of imports it ranks second only to English china clay. Variations in the average re-

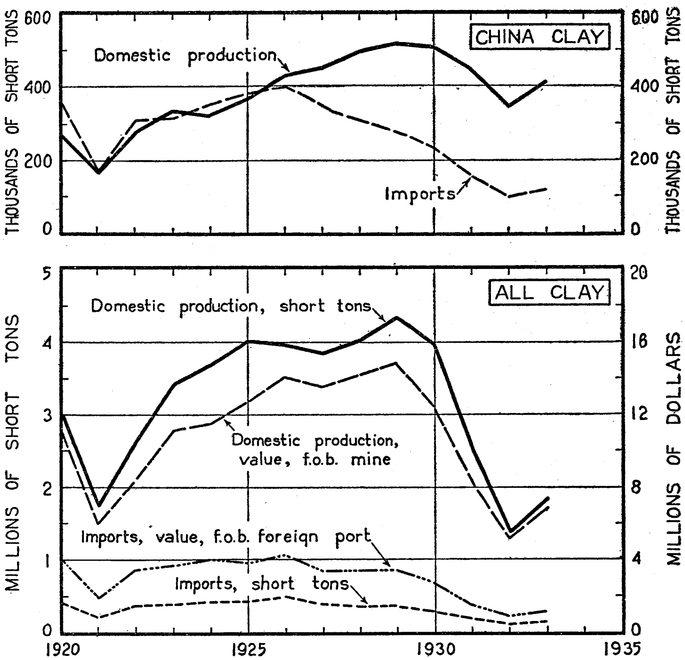


FIGURE 87.—Trends in quantity and value of domestic production and imports of clay, 1920–33.

ported or foreign-market value of imported clays sometimes are caused by changes in the relative proportions of the different kinds of clay grouped in the various statistical classifications; however, it is significant that unit values increased in every class in 1933 compared with 1932, amounting to over 30 percent for china clay and miscellaneous clays and 42 percent for Gross Almerode and other German glass-pot clays.

Import statistics for recent years are shown in the following table, and figure 87 compares the imports of china clay and of all kinds of clay with domestic output. The imports of china clay were roughly equal in tonnage to the domestic output from 1920 to 1926, but beginning about 1927 the domestic output has gained an increasingly large share of the American market. Recently domestic sales of kaolin, as reported by the Bureau of Mines, have been about three times as large as the imports, whereas during the period 1909–13 domestic mines furnished less than one-half as much as the annual imports. As previously noted the average import value is not a quantitative index of market conditions, but the sharp decline in the average value of imported china clay as shown by the figure evidences the effect of this movement upon the prices of English clay, particularly when it is remembered that it has been the cheaper kinds of clay that have been displaced chiefly by domestic clays and consequently that the imports now comprise a larger proportion of clays in the higher-price brackets, notably paper-coating clays.

*Clay imported for consumption in the United States, 1909–33*

| Year | Kaolin or china clay | | Common blue and Gross-Almerode glass-pot clay | | All other clays: Unwrought | | All other clays: Wrought | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 1909–13 (average) | 261, 266 | $1, 562, 683 | 19, 763 | $159, 788 | 31, 836 | $126, 313 | 1, 423 | $24, 312 | 314, 288 | $1, 873, 096 |
| 1925–29 (average) | 339, 014 | 3, 055, 885 | 12, 130 | 113, 307 | 57, 001 | 493, 983 | 4, 047 | 52, 549 | 412, 192 | 3, 715, 724 |
| 1930 | 236, 251 | 2, 197, 540 | 18, 900 | 154, 428 | 24, 883 | 209, 175 | [1] 4, 984 | [1] 143, 817 | [1] 285, 018 | [1] 2, 704, 960 |
| 1931 | 151, 426 | 1, 056, 393 | 15, 183 | 116, 446 | 15, 615 | 125, 326 | [1] 8, 376 | [1] 237, 859 | [1] 190, 600 | [1] 1, 536, 024 |
| 1932 | 99, 807 | 461, 191 | 5, 880 | 45, 445 | 13, 290 | 90, 140 | [1] 8, 133 | [1] 280, 404 | [1] 127, 110 | [1] 877, 180 |
| 1933 | 116, 180 | 632, 437 | 7, 099 | 69, 639 | 17, 623 | 141, 992 | [1] 9, 756 | [1] 336, 435 | [1] 150, 658 | [1] 1, 180, 503 |

[1] Includes "clays or earths, artificially activated with acid or other material", as follows: 1930 (June 18 to Dec. 31), 2,663 short tons valued at $100,779; 1931, 4,912 tons, $184,381; 1932, 7,328 tons, $267,560; 1933, 5,640 tons, $258,291; not separately classified prior to change in tariff.

*Exports.*—American fire clays of good quality are found fairly close to the Atlantic seaboard and are exported to Canada, Europe, and South America. This export trade, after being adversely affected by stagnation in the metallurgical industries in many countries, registered a fair recovery during the latter part of 1933. The statistical classification of "All other" is to a certain extent misleading, inasmuch as it covers fuller's earth and similar earthy products; the high average value of exports under this heading, generally around $15 a ton, indicates a large proportion of processed clay or bentonite.

*Domestic clay exported from the United States, 1925–33* [1]

| Year | Fire clay | | All other | | Total | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| 1925–29 (average) | 55, 316 | $434, 842 | 54, 028 | $782, 927 | 109, 344 | $1, 217, 769 |
| 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 |
| 1933 | 32, 431 | 264, 595 | 66, 094 | 970, 293 | 98, 525 | 1, 234, 888 |

[1] Statistics of exports of clays other than fire clays were not published before 1916. High unit value indicates processed clays, mainly filtering and decolorizing clays or fuller's earth, mainly from Pacific ports.

## PRICES

Trade-journal quotations for china clay tended to grow somewhat firmer toward the latter part of 1933 but generally failed to recover quite all the loss suffered during the second and third quarters of 1932. Careful study of the returns by producers indicates that the prices actually realized on sales of all clays in 1933 were a little lower in 1933 than in 1932 but that the changes were mostly small, and inasmuch as occasional increases were in evidence there is reason to hope that a bottom was in process of forming.

Because of the wide variety of clays sold and because the same clay may be marketed in various stages of preparation no single set of price quotations can be devised to portray the state of the market for all the various types of clay. For the cheaper clays, including even many kinds of clay included in the Bureau of Mines canvasses, local conditions are the governing factor. This is less true, of course, of china clay of the better class, and recently domestic paper-filler clays and one or two grades of pottery clay have been standardized sufficiently to permit making the comparisons shown in the accompanying table. Although the prices reported are somewhat nominal at times, they are representative enough to warrant the conclusion that the prices of these higher-grade clays were not reduced so drastically during the depression as those of other mineral commodities as a class. Fragmentary data before 1930 indicate that, except for a slight bulge centered in the period 1925–29, the levels reached after the recovery from the 1921 slump were maintained with little or no change until 1931 or even 1932.

*Prices of various clays in the United States, 1930–33* [1]

| | 1930 | 1931 | 1932 | 1933 | |
|---|---|---|---|---|---|
| | | | | January | December |
| China clay, f.o.b. mines South Carolina and Georgia: | | | | | |
| Crude lump No. 1 | $4.50–$6.00 | $4.50–$5.00 | $3.50–$6.00 | $3.50–$4.00 | $4.00 |
| Crushed | 6.00 | 6.00– 8.00 | 4.50– 6.90 | 4.50– 5.00 | 5.00 |
| Air-floated: | | | | | |
| No. 1 | 8.00–12.00 | 9.00–15.00 | 6.50–15.00 | 6.50– 8.00 | 9.00–$10.00 |
| No. 2 | ------------ | 5.50– 8.00 | 5.50– 6.00 | 5.50– 6.00 | 8.00 |
| Florida, washed, crushed: | | | | | |
| Superwhite | 12.00–12.50 | 12.50 | 11.75–12.50 | 11.75 | 12.75 |
| Superplastic | 12.00 | 12.00 | 11.25–12.00 | 11.75 | 12.75 |
| Delaware, No. 1 | 16.00–18.00 | 14.50–15.00 | 13.00–14.50 | 14.00 | 14.00 |
| English, f.o.b. U.S. port, lump, in bulk | 13.00–25.00 | 15.00–25.00 | 12.00–21.00 | 14.00–18.00 | 14.00– 16.00 |

[1] Metal and Mineral Markets quotations.

Undoubtedly the best sources of information as to general average prices of clay are the annual reports of producers to the Bureau of Mines; however, any series of figures that represents a composite of many highly diverse and varying individual items is subject to occasional disturbance by erratic influences, and in tabulations presented in the annual chapters of the Minerals Yearbook and its predecessor, Mineral Resources of the United States, there have been additional difficulties. Not the least of these difficulties has been occasioned by the lack of any suitable standard classification to cover the different kinds of clay. The category of china clay or kaolin might be limited commercially to relatively high-priced clays, such as are used principally in paper, fine china, rubber, etc. Most of the kaolins reported from South Carolina, North Carolina, and Delaware are of this character. Florida clays likewise may fall in this group, although there has been a disposition to group them on the border line with ball clays, because of their more plastic character. In Pennsylvania and several other States, on the other hand, hard kaolins are mined and used principally for refractory purposes or for making cement, including white cement. A sharp drop in the average value of the kaolin reported from Georgia beginning with 1931 is not caused by market conditions but merely records a change in policy of Bureau of Mines statisticians. Formerly the hard or so-called "flint kaolins" mined in various Georgia counties had been classified according to their use as "fire clays", but in 1931 they were grouped with the high-grade china clays produced in other counties. Since these harsh clays are worth only one-third to one-fourth as much as the other kaolins the average value of the output of kaolin, as reported for the State, was sharply reduced.

Great differences exist in the quality and even greater differences in the local demand for fire clays in different States. Moreover, a clay reported as worth, say, $1 a ton, when used by the manufacturer in making fire brick may be reported as worth $5 a ton if milled and sold for fire-clay mortar; in fact, some of these mortars may be prepared and sold at prices higher than $30 a ton.

After these preliminary observations a table is presented showing the average values of the different kinds of clay as reported by producers in the United States for specified years.

*Average values per short ton of various kinds of clay sold by producers in the United States, 1909–13 and 1925–33*

| Year | Kaolin | | Ball clay | Slip clay | Fire clay | Stone-ware clay | All kinds |
|---|---|---|---|---|---|---|---|
| | United States | South Carolina | | | | | |
| 1909–13 (average) | $5.35 | $3.89 | $3.65 | $1.82 | $1.39 | $1.00 | $1.57 |
| 1925–29 (average) | 8.45 | 8.93 | 7.66 | 5.42 | 2.76 | 2.12 | 3.45 |
| 1930 | 7.29 | 7.62 | 7.91 | 6.00 | 2.38 | 1.93 | 3.16 |
| 1931 | 6.65 | 6.86 | 7.71 | 7.10 | 2.54 | 2.30 | 3.32 |
| 1932 | 5.83 | 6.42 | 6.57 | 9.72 | 2.83 | 1.66 | 3.74 |
| 1933 | 5.75 | 5.99 | 6.20 | 7.28 | 2.77 | 2.11 | 3.72 |

Although the averages for 1933 were generally lower than those for the preceding year, mixed trends developed in some of the individual returns. For Florida china clay a very slight improvement was noted, and North Carolina prices remained stationary, but in other States further recessions were noted among most of the china-clay producers, with only an occasional producer reporting better average values for his product; in California the downward movement was marked. Among fire-clay producers a much larger proportion of gains was reported, but these were outweighed by price concessions suffered by others, so that the net result was a loss in average values. Most of the diaspore producers also had to shade prices. Ball clays showed little change in the values of the higher qualities, but there was a sharp improvement in values of the cheaper grades.

## CONSUMPTION TRENDS

Marked increases in the use of domestic paper clays and an even more striking increase in sales to the rubber industry have occurred in recent years. Figure 88 shows sales of clay to specified consuming

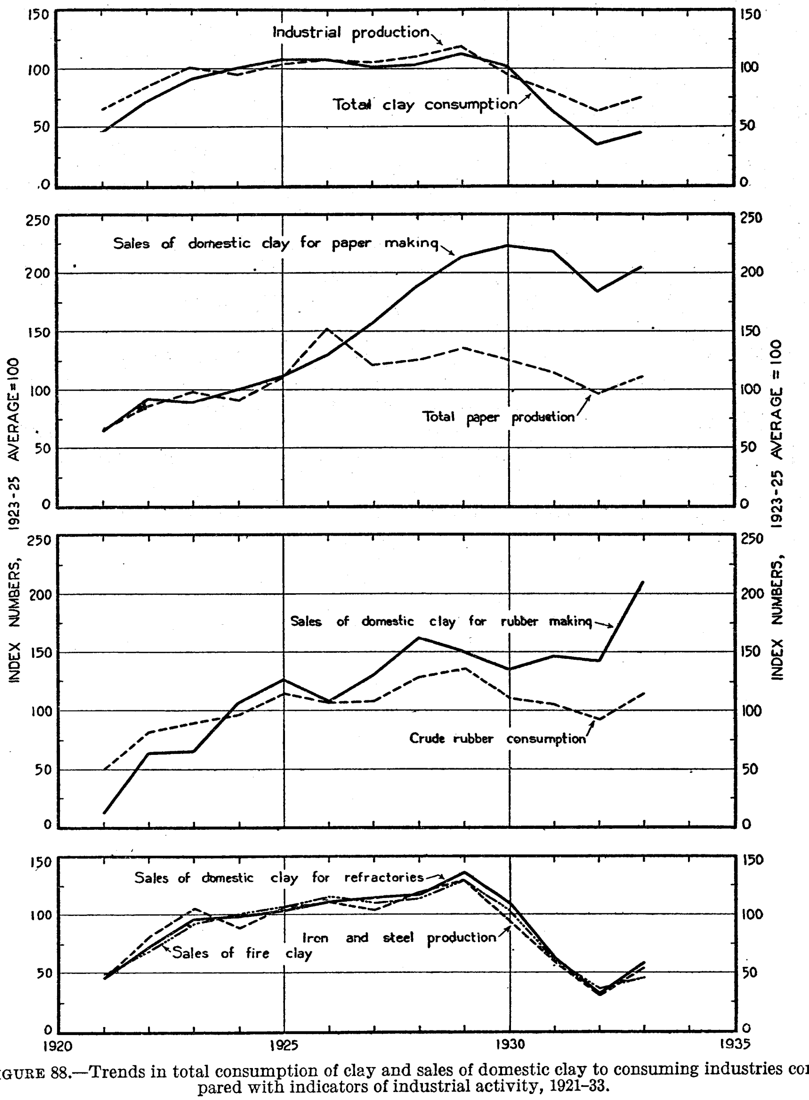


FIGURE 88.—Trends in total consumption of clay and sales of domestic clay to consuming industries compared with indicators of industrial activity, 1921–33.

industries compared with indexes of productive activity in these industries, all figures being translated into index numbers or percentages of the average figures for 1923–25. There is close correlation between shipments of fire clay and sales of all kinds of clay for refractory uses, and both these indexes follow closely the Federal Reserve Board index of iron and steel production; since the manufacture of refractories is more sensitive even than the iron and steel industry to changes in business conditions, the short-term swings in fire-clay sales depart violently from the general index of business activity. As sales to refractory industries represent one-half to two-thirds of the total sales of clay as reported by the Bureau of Mines the consumption curve for all kinds of clay indicates that the clay industry as a whole suffered more than general business after 1930. Before then, however, and after the 1921 slump, the apparent consumption of all kinds of merchant clay, calculated by adding imports to domestic production and deducting exports, fluctuated more or less in haımony with industrial activity. This is a natural result of averaging a variety of diverse uses, but any generalizations on this theme must be tempered by the knowledge that the Bureau of Mines production figures contain certain statistical anomalies resulting chiefly from the inclusion of variable amounts of clay, mainly common clay, used in heavy structural products or cement making. The curves showing that sales of domestic clay to the paper and rubber industries are increasing much faster than the consuming industries themselves likewise need explanation; normal growth in these important consuming outlets has been supplemented in the paper industry by a substantial displacement of paper clays formerly imported and in the rubber industry by changes in practice that resulted in relatively larger admixtures of clay in compounding. It has been estimated [1] that 60 percent of the total china clay consumed in the United States is used in the manufacture of paper, filling clay being used of course in much larger quantities than coating clay.

The distribution of domestic sales by kinds and uses in 1933 is shown in detail in the following table.

*Clay sold by producers in the United States in 1933, by uses, in short tons*

| Use | Kaolin | Ball clay | Slip clay | Fire clay | Stoneware clay | Bentonite | Miscellaneous clay | Total |
|---|---|---|---|---|---|---|---|---|
| Pottery and stoneware: | | | | | | | | |
| Whiteware, etc | 31,480 | 43,835 | 30 | 319 | - | - | 90 | 75,754 |
| Art pottery | 1,438 | 2,554 | - | 49 | 33 | - | 1,666 | 5,740 |
| Chemical stoneware | 158 | 2,710 | - | - | 1,210 | - | - | 4,078 |
| Stoneware | - | 500 | - | 4,629 | 22,690 | - | - | 27,819 |
| Slip for glazing | - | 28 | 603 | - | - | - | - | 631 |
| | 33,076 | 49,627 | 633 | 4,997 | 23,933 | - | 1,756 | 114,022 |
| Tile, high-grade | 7,636 | 5,724 | - | 17,243 | 800 | - | 698 | 32,101 |
| Kiln furniture, etc.: | | | | | | | | |
| Saggers | 1,404 | 770 | - | 37,840 | - | - | - | 40,014 |
| Pins, stilts, etc | 32 | - | - | 402 | - | - | 177 | 611 |
| Wads | - | 3,577 | - | 5,714 | - | - | - | 9,291 |
| | 1,436 | 4,347 | - | 43,956 | - | - | 177 | 49,916 |
| Architectural terra cotta | - | 2,300 | - | 7,381 | 2,519 | - | 675 | 12,875 |
| Paper: | | | | | | | | |
| Filler | 228,718 | - | - | 54 | - | - | - | 228,772 |
| Coating | 27,217 | - | - | - | - | - | - | 27,217 |
| | 255,935 | - | - | 54 | - | - | - | 255,989 |
| Rubber | 49,615 | - | - | - | - | - | - | 49,615 |
| Oilcloth and linoleum | 4,994 | - | - | 1,721 | - | - | - | 6,715 |
| Paints: | | | | | | | | |
| Filler or extender | 5,739 | 53 | - | - | - | - | 262 | 6,054 |
| Pigment | - | 260 | - | - | - | - | 10 | 270 |
| Kalsomine | 4,535 | - | - | - | - | - | - | 4,535 |
| | 10,274 | 313 | - | - | - | - | 272 | 10,859 |

[1] U.S. Tariff Commission, Thirteenth Annual Report, 1929: Washington, D.C., 1930, p. 87.

*Clay sold by producers in the United States in 1933, by uses, in short tons*—Contd.

| Use | Kaolin | Ball clay | Slip clay | Fire clay | Stoneware clay | Bentonite | Miscellaneous clay | Total |
|---|---|---|---|---|---|---|---|---|
| Cement manufacture | 17,653 | 93 | | 4,845 | | 156 | | 22,747 |
| Refractories: | | | | | | | | |
| Gas retorts | | | | 1,444 | 43 | | | 1,487 |
| Zinc retorts and condensers | | | | 14,427 | | | | 14,427 |
| Clay crucibles | | 85 | | 153 | | | | 238 |
| Glass pots | | | | 968 | 1 | | 1,610 | 2,579 |
| Other glass refractories | 355 | 100 | | 3,926 | | | | 4,381 |
| Fire brick and block | 8,390 | 500 | | 561,304 | | | 924 | 571,118 |
| Fire-clay mortar | 12,456 | | | 158,734 | | | 95 | 171,285 |
| Bauxite and high-alumina brick | | | | 6,547 | | | | 6,547 |
| Foundries and steel works | 1,004 | | | 213,942 | | 14,682 | 28,875 | 258,503 |
| | 22,205 | 685 | | 961,445 | 44 | 14,682 | 31,504 | 1,030,565 |
| Miscellaneous | 8,409 | 1,462 | 929 | 92,051 | 892 | 102,590 | 48,436 | 254,769 |
| | 411,233 | 64,551 | 1,562 | 1,133,693 | 28,188 | 117,428 | 83,518 | 1,840,173 |
| Total, 1932 | 344,994 | 47,573 | 525 | 725,993 | 49,736 | 71,613 | 151,382 | 1,391,816 |

## TECHNOLOGICAL DEVELOPMENTS

A study [2] of the properties of 15 English clays in common use commercially in the United States shows a general relationship between the base-exchange capacities and the transverse strengths of the clays in the unfired strength. A great deal of work has been done at the United States Bureau of Standards in the last year or two on the possibility of substituting American for English china clays in domestic commercial whiteware bodies, and out of it may grow a basis for correlating the properties of such clays. According to exchangeable base capacities American kaolins, excluding Florida kaolins, differ slightly from English china clays, whereas 3 Florida kaolins conform in this respect to 3 ball clays, the latter including 1 from Tennessee (which gave the lowest value), 1 from Kentucky, and 1 English clay (which showed the highest exchange capacity).[3]

With respect to clay admixtures in concrete, Parsons[4] reports a small (0 to 10 percent) decrease in compressive strength caused by substituting clay for 10 percent of the cement in a given mixture and an increase in this property when clay replaced 7½ percent of the fine aggregate.

Bureau of Mines investigations of pneumatic separation of kaolin revealed the importance of first removing the coarse mica and quartz as completely as possible in the grinding compartment.[5]

Laboratory studies [6] have demonstrated that upward-flow elutriation methods yield consistently lower results on mica content of kaolin than results obtained from apparatus of proper design. Even in quiescent suspension mica particles follow a zigzag path, and the best results are obtained by methods embodying the principle of the

[2] Klinefelter, T. A., Meyer, W. W., and Vachuska, E. J. Some Properties of English China Clays: Jour. Am. Ceram. Soc., vol. 16, no. 6, June 1933, pp. 269–276.

[3] U.S. Bureau of Standards, Base Exchange Capacities of Clays: Jour. Franklin Inst., vol. 215, no. 1, January 1933, p. 104.

[4] Parsons, D. A., Clay in Concrete: U.S. Bureau of Standards Jour. Research, vol 10, no. 2, February 1933, pp. 257–273.

[5] Wilson, Hewitt, and Cunliffe, Jack A., Refining of Pacific Northwest Kaolins by Air Flotation: Jour. Am. Ceram. Soc. vol. 16, no. 3, March 1933, pp. 154–162.

[6] Stewart, R. F., and Roberts, E. J., Sedimentation of Fine Particles in Liquids. A Survey of Theory and Practice (Paper presented at meeting of Inst. Chem. Eng., London, Oct. 6, 1933): Chem. Age (London), vol. 29, no. 746, Oct. 14, 1933, pp. 345–347.

Cornish mica troughs, since the flaky particles are more likely to settle in a straight line (though not vertical) in a slowly moving stream than either in a quiescent suspension or in an upward flow. To restore plasticity of clays bleached by chlorine treatment, a German patent (575395, Apr. 27, 1933) recommends the addition of 2 to 5 percent of naturally white plastic kaolin or a mixture of talc and kaolin. Paint-trade requirements with respect to clays and ochers are detailed in a recent paper by Searle.[7]

The study of domestic resources continues to occupy the attention of various State agencies. In Tennessee a State-wide survey, including both field and laboratory investigation of shales and clays, has been undertaken. The high-grade fire clays of the Ozark region are receiving microscopic study by the Missouri Bureau of Geology and Mines, and the work is being coordinated with previous work on beneficiation of these clays. Reports have recently been completed or approach completion on the clays of Indiana, Iowa, Massachusetts, New Mexico, North Carolina, Ohio, Pennsylvania, Texas, Virginia, and other States.

## THE INDUSTRY IN FOREIGN COUNTRIES

The United Kingdom, Germany, the United States, Japan, Czechoslovakia, and China, approximately in the order named, are the leading sources of china clay, including high-grade paper clay. The United Kingdom is by far the largest producer and accounts for virtually all the clay of these qualities that enters overseas trade. Next to coal, china clay is the principal raw mineral product exported from the British Isles. Moderately large clay exports are made from Germany and Czechoslovakia, but the kaolin from these two countries is shipped almost exclusively to nearby Europe, and exports from other countries are insignificant.

The china clays of the west of England have been worked for at least 100 years. They are available in a wide range of well-standardized grades; and some of these grades, notably those employed for certain coated papers, are not readily duplicated elsewhere. The deposits in Cornwall and Devon are large, relatively cheap to mine, and so favorably situated that the average rail haul to tidewater is scarcely 15 miles. Advantageous ocean rates assist further in keeping down the delivered cost of British clays, even in the far corners of the world.

Descriptions of the geology, working methods, and quality of these important deposits—which occur in granite masses and are worked principally at Lands End, Penryn, St. Austell, Bodmin Moor, and Dartmoor—have been published recently.[8] The raw kaolin usually contains 12 to 30 percent clay; the average worked today is 20 to 25 percent. The output of china clay from this area has amounted to 900,000 tons a year, but the decline in the American demand and subsequently the operation of various import restrictions, such as the French quota system, as well as the general effects of the world-wide

[7] Searle, A. B. Clays: Their Use in Paint Manufacture: Paint Manufacture, London, vol. 3, 1933, pp. 185–189.

[8] Lilley, E. R., The Geology of Some Kaolins of Western Europe: Am. Inst., Min. and Met. Eng. Tech. Pub. 475, 1932, pp. 14–20.

Curtis, A. L., Mining English China Clay; part 1.—Sands, Clays, and Minerals: Vol. 1, no. 3, January 1933, pp. 13–19.

Davies, A. R., English china clay; History, Formation, Physical and Chemical Qualities; Sands, Clays, and Minerals; Vol. 1, no. 4, July 1933, pp. 58–61.

depression, have impaired the demand so as to reduce more or less permanently the output. The low level was reached at 345,250 long tons in 1931 which was followed by an increase to 624,625 tons in 1932. These statistics include china stone (32,380 tons in 1932) and ball clay (14,702 tons in 1932) in addition to china clay. Ordinarily Cornwall furnishes 90 percent and West Devon 10 percent of the output. About three fourths of the china-clay business normally is handled by about a half dozen leading companies, but 50 or more small firms contribute to the total output. Various attempts have been made to organize effective control of the production and through cooperative arrangements primarily to eliminate competitive price cutting and perhaps also to stimulate foreign and domestic sales. The first association formed after the World War broke down in 1924, was reorganized in December 1926, but finally was dissolved in 1927. In 1932 the English China Clay Producers Federation was formed for mutual protection.

Ball clay is mined in irregular stratified deposits in South Devon. An important deposit of clay used in graphite crucibles is mined in Dorset, and good fire clays are of wide-spread occurrence in the British Isles.

Probably the earliest kaolin-producing locality in Europe was southern Germany, where china clay was worked early in the eighteenth century. The deposits extend in a curved belt from the Fichtelgebirge in northern Bavaria parallel to the northern flank of the Erzgebirge eastward to the Saarau-Strehlen in Silesia. Along this belt are situated such long-famous clay and porcelain-manufacturing centers as Dresden, Meissen, Aue, Wurzen, Halle, and Kemlitz. The kaolin is found in blanket residual deposits in basinlike areas in the granites and related crystalline rocks of southern Germany and Czechoslovakia. In the deepest parts of these basins the kaolin attains a thickness of 50 meters beneath an overburden of glacial drift 0 to 25 meters thick. Except for shallow discoloration in the uppermost portions the bulk of the deposits are white and consist almost entirely of quartz, kaolin, and small amounts of feldspar, the kaolin averaging 30 percent and sometimes amounting to 40 percent of the total material mined.

The kaolinized arkosic sandstones of Bavaria and Czechoslovakia constitute a wholly different type of deposit. Those near Altenburg in Thüringia contain more or less iron and are of limited commercial importance at present, but those in the Oberfalz district of Bavaria and in the Pilsen Basin in Czechoslovakia are major sources of paper-filler and similar quality clays. In the Oberfalz district northeast of Amberg production comes principally from the area between Hirschau and Schnaittenbach but also from Neunaigen, Kohlberg, Weiterhammer, Tanzfleck, Freihung, and Steinfels. The highest proportion of kaolin present in the sandstone is 28 percent; but the average is lower, much of that worked near Hirschau containing only 10 percent. To the north near Tanzfleck, Freihung, and Steinfels, especially at Steinfels, the kaolin content is usually only 5 percent, but the deposits contain 30 to 35 percent of feldspar which is therefore the principal product. The presence of a small amount of lead (cerussite) in the Bavarian deposits is noteworthy. The Czechoslovak deposits of this type, which are worked in large, open pits to the northwest of Pilsen, contain 25 to 40 percent kaolin, the remainder of the deposit being almost wholly quartz. Individual beds are rarely over 20 meters thick, but at Horni Briza a thickness of 70 meters (including a small amount of nonkaolin material) is found. The excellence of the quality of the kaolin for use in paper making and the ease with which it can be produced have made the Pilsen district famous throughout Europe.[9]

From the standpoint of American trade the refractory clays of Germany are more important than the white-burning clays. The Gross-Almerode deposits in Hesse yield a high-grade refractory bond clay that formerly was used very extensively in the United States for certain operations for which domestic clays have been employed successfully since 1914. Glass-pot clays also are worked in Germany in the Westernwald district near Wiesan and Shippach. In the Coblenz district at Vallendar a very pure clay is produced for use in enameling; it likewise was used extensively at one time in the United States. Activated earths and bleaching clays also are exported from Germany to the United States. A plastic ball clay is worked at Budweis, Czechoslovakia.

The chief high-grade clay deposits of France are those that supply the famous Limoges and Sevres potteries. The most important localities are Coussack-Bonneval, Haute Vienne, and St. Yrieix. A clay used extensively in the French glass-pot industry is mined near Bollene in the Department of the Marne. Pot clays are mined in several localities along the Belgian border. Glass-pot and crucible clays are obtained in the Belforge and Ardennes districts of Belgium. A kaolin deposit of considerable extent is worked on the island of Bornholm, Denmark; the material is used chiefly for paper, refractories, saggers, and pottery. Kaolin has also been reported in Portugal.[10]

Italian kaolins have not been well-liked even locally, but National Fascist agencies recently have made efforts to encourage the exploitation of domestic resources, which are said to be extensive, to replace imported clays.[11]

For a number of years active efforts have been made to develop high-grade clay deposits in Canada as a means of reducing imports of pottery wares and refractories. Exploration and development work has been done in Quebec, northern Ontario, and Saskatchewan. Washed china clay has been produced commercially at St. Remi, Quebec, and in southern Saskatchewan there are evidently large supplies of fire and ball clays. In 1933 considerable attention was focused on northern Ontario resources, and diamond drilling and other exploration work were planned. A general review of the possibilities of this area as a producer of fire clay was presented in a paper before the Canadian Institute of Mining and Metallurgy.[12]

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[9] Lilley, E. R., work cited, pp. 4–14.

[10] Ladoo, R. B., Non-Metallic Minerals: New York, 1925, p. 149.

[11] Industrial and Engineering Chemistry (News Edition), World-Wide Chemistry; Italian Kaolins Cannot Now Compete with Foreign Product: Vol. 11, no. 11, June 10, 1933, p. 176.

[12] Dyer, W. S., and Crozier, A. R., Refractory Clays of Northern Ontario, Canada: Min. and Met. Bull. 254, June 1933, pp. 238–252.

# ABRASIVE MATERIALS

By Oliver Bowles and A. E. Davis

SUMMARY OUTLINE



The value of abrasive materials sold in 1933 increased 39 percent compared with 1932, indicating that a substantial recovery in the abrasives industries evidently is under way.

Abrasive materials are important tools or agents employed in the manufacture of numerous products. Cutting, sawing, grinding, and polishing are essential processes in many manufacturing industries as diverse in character as are automobile manufacture and the finishing of memorial stones.

Abrasive materials play a prominent part in these processes; hence they are to a considerable extent indicators of industrial activity. The following table of salient statistics therefore presents not only the trend in activity of each commodity but portrays in some degree that of the industries in which abrasives are employed. As indicated in the table, there was a moderate to large increase in the sales value of each commodity in 1933. It is interesting to compare the 39-percent increase in sales value of abrasive materials in 1933 over 1932 with the 19-percent increase in the Federal Reserve Board index of industrial production. The higher percentage of increase for abrasives is due partly to their extensive use in the automobile and other industries that have had a comparatively rapid recovery, and probably partly to their use in reconditioning equipment preparatory to enlarged production schedules.

*Salient statistics of abrasive industries in the United States, 1932–33*

| | 1932 | 1933 | Percent of increase in 1933 |
|---|---|---|---|
| Domestic production: | | | |
| Natural siliceous abrasives: | | | |
| Diatomite | [1] $1, 300, 709 | [1] $1, 300, 709 | ---------- |
| Tripoli (value as sold—crude and finished) | 232, 700 | 350, 383 | 50. 6 |
| Pumice and pumicite | 235, 204 | 241, 834 | 2. 8 |
| Quartz | 59, 158 | 71, 048 | 20. 1 |
| Ground sand and sandstone | 875, 749 | 1, 106, 410 | 26. 3 |
| Special stone products: | | | |
| Grindstones and pulpstones | 247, 440 | 444, 250 | 79. 5 |
| Oilstones and related products | 63, 960 | 96, 597 | 51. 0 |
| Millstones | 4, 450 | 8, 387 | 88. 5 |
| Flint lining and grinding pebbles | 13, 070 | 47, 011 | 259. 7 |
| Garnet and emery: | | | |
| Garnet | 147, 350 | 224, 717 | 52. 5 |
| Emery | 2, 781 | 12, 283 | 341. 7 |
| Total natural abrasives | 3, 182, 571 | 3, 903, 629 | 22. 7 |
| Total artificial abrasives | 2, 876, 748 | 4, 534, 265 | 57. 6 |
| Grand total | 6, 059, 319 | 8, 437, 894 | 39. 3 |
| Foreign trade: | | | |
| Imports | 1, 330, 905 | 1, 687, 831 | 26. 8 |
| Exports | 297, 066 | 460, 849 | 55. 1 |

[1] Average for 1930–32, inclusive; annual data for those years and for 1933 not available for publication.

The history of production of each major branch of the abrasive industries from 1912 to 1933 is shown graphically in figure 89.

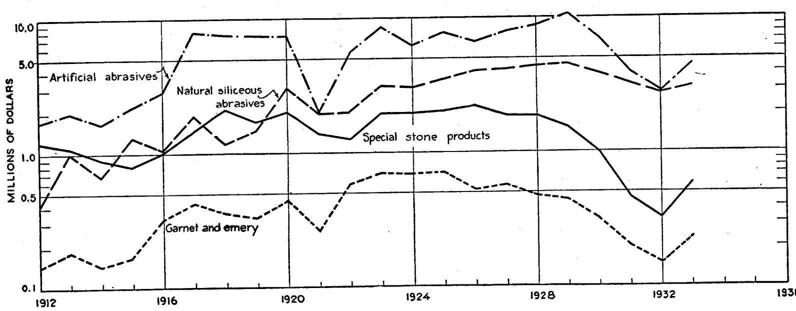


FIGURE 89.—Annual values of production of major abrasives groups, 1912–33. Artificial abrasives include silicon carbide, synthetic aluminum oxide, and various metallic abrasives, such as crushed steel, steel shot, and steel wool. Natural siliceous abrasives include pulverized quartz, sand and sandstone, diatomite, tripoli, and pumice and pumicite; in this group, figures for diatomite are partly incomplete for 1915–18, and the 3-year averages used since 1927 tend to stabilize somewhat the composite curve over recent years. Grinding and polishing sand (unpulverized) is not included; statistics appear in the chapter on Sand and Gravel. Special stone products include grindstones, pulpstones, millstones, oilstones and related quarry products, and grinding pebbles and flint lining for tube mills.

Some of the commodities included in this chapter also have important nonabrasive uses. For instance, only relatively small quantities of diatomite and tripoli are now used as abrasives, whereas formerly large quantities were so used. It seems desirable, however, to continue to include such commodities in the annual chapters of this series for purposes of comparison until the minerals in this diverse group are reclassified.

## NATURAL SILICEOUS ABRASIVES

*Diatomite.*—The Bureau of Mines is not at liberty to publish annual production figures for diatomite, but permission has been obtained to show production for 3-year periods. Such data for 1927–32 are given in the following table. Figures for 1933 may not be published, but there was a substantial increase in sales compared with 1932.

*Diatomite sold or used by producers in the United States, 1927–33* [1]

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1927, 1928, 1929 | 286,426 | $4,164,721 | 1930, 1931, 1932 | 248,273 | $3,902,126 |
| | | | 1933 | (1) | (1) |

[1] Bureau of Mines not at liberty to publish annual figures.

Diatomite (known also as diatomaceous earth, infusorial earth, and kieselguhr) is composed of minute siliceous skeletons of aquatic plants known as "diatoms", which may be of marine or fresh-water origin. The industrial importance of diatomite depends upon its characteristic properties—fineness and uniformity of grain, light weight, high porosity, and chemical inertness. 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. This characteristic distinguishes diatomite from tripoli and pumicite, which do not have organic structure.

Diatomite is included in the group of abrasive materials because it is used for polishing metal, glass, furniture, and enamel. Only relatively small quantities are now used in this way, however, and its nonabrasive uses have become increasingly important.

The principal nonabrasive uses of diatomite are for sugar refining, insulating material, filler in battery boxes, and filtering agent. For insulation it may be used as cut or sawed blocks or as prepared brick. Diatomite low in acid-soluble substance, iron, manganese, and other foreign material is a superior filler in battery boxes, a use which consumes several thousand tons annually. Diatomite has been used extensively as an admixture in concrete.

The principal centers of production are in the Western States, notably near Lompoc, Calif., where large deposits of high-grade material have been worked for many years. In 1933 diatomite was also produced in other parts of California and in Nevada, New York, Oregon, Washington, and Idaho.

At one time diatomite production was confined almost entirely to the eastern part of the country, and interest in these deposits has been renewed to some extent in recent years, although production is still small. Fresh-water deposits in Herkimer and Hamilton Counties, N.Y., have a maximum thickness of about 30 feet; the material is used principally for silver polish. A deposit about 20 feet thick extends from Fair Haven, Md., through Popes Creek on the Potomac River to Petersburg, Va., where in places it is 30 feet thick; the material is impure, grading into clay. A deposit of higher purity is exposed in Virginia along the Rappahannock River near Layton and

Wilmont. The diatomite deposits in Lake and Polk Counties, Fla., are all of the fresh-water type; much of the material occurs in peat.

The companies reporting production and sales of diatomite in the United States in 1933, with locations of the deposits from which it was obtained, are as follows:

Atomite Products Co., 1037 American Bank Building, Portland, Oreg. Deposit at Terrebonne, Deschutes County, Oreg.

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.

Hornsby, J. H., 651 Cumberland Street, Pittsburg, Calif. Deposit at Knights Ferry, Stanislaus County, Calif.

Johns-Manville Products Corporation, 22 East Fortieth Street, New York, N.Y. Deposit at Lompoc, Santa Barbara County, Calif.

Kittitas Diatomite Co., Ellensburg, Wash. Deposit at Kittitas, Kittitas County, Wash.

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, Inc., Bradley, Calif. Deposit near Bradley, Monterey County, Calif.

The Paraffine Companies, Inc., 475 Brannan Street, San Francisco, Calif. Deposit near Lompoc, Santa Barbara County, Calif.

Tri-O-Lite Products Co. Deposit and office at Carlin, Elko County, Nev.

Webley, E. J. Deposit and office at Quincy, Grant County, Wash.

Wright, J. A., & Co., Keene, N. H. Deposit at Ohio, Herkimer County, N.Y.

*Tripoli.*—The production of tripoli and related materials in 1933 was 20,878 short tons valued at $350,383, an increase of 41 percent in quantity and 51 percent in value compared with 1932.

Tripoli is an extremely fine-grained porous form of silica of the chalcedony variety, which some authorities believe has been formed by the decomposition of siliceous limestone. Rottenstone is related to Tripoli but is somewhat more earthy and less siliceous. Prospective consumers should bear in mind that the chemical and physical properties of tripoli from different localities may differ greatly.

In 1933, as in previous years, the chief sources of tripoli, were a small area in Newton County, Mo., and Ottawa County, Okla., and the Alexander-Union Counties area in southern Illinois; the other localities are included in the list of producing companies. Rottenstone is produced in Lycoming County, Pa.

Tripoli from the Missouri-Oklahoma district is used extensively for abrasive purposes in scouring and polishing powders, polishing compositions, and pastes. As an important use is for foundry facings the marked recovery in steel production in 1933 was responsible in some measure for the increased sales of tripoli. The product is also used as filter blocks and as filler in hard rubber and other products.

The Illinois product, generally known as "silica", is employed to some extent as an abrasive in metal polishes, soaps, and cleansers, but its chief consumption is in paints, fillers, ceramic wares, and foundry facings.

Rottenstone is used in the manufacture of phonograph records and as a mild abrasive for wood and metal finishing.

As the result of a questionnaire sent to producers the Bureau of Mines is able for the first time to present statistics on the quantity and value of tripoli sold by producers according to uses. The figures are incomplete, as some producers kept no record of the uses for which their material was sold and others sold their material largely through jobbers and therefore had no way of knowing the different uses.

Sales according to uses reported by eight producers totaled 14,748 short tons valued at $248,519, or 70.6 percent of the quantity and 70.9 percent of the value of total sales reported. Distribution of sales by uses is shown in the following table:

*Tripoli sold or used by producers in the United States in 1933, by uses*

| Use | Number of producers reporting | Short tons | Value as sold (crude and finished) | Percent of total accounted for: Quantity | Percent of total accounted for: Value |
|---|---|---|---|---|---|
| Abrasives | 6 | 7,034 | $109,185 | 47.7 | 43.9 |
| Concrete admixture | 3 | 866 | 13,703 | 5.9 | 5.5 |
| Filler | 4 | 1,907 | 41,163 | 12.9 | 16.6 |
| Foundry facing | 4 | 2,426 | 37,750 | 16.4 | 15.2 |
| Miscellaneous | 7 | 2,515 | 46,718 | 17.1 | 18.8 |
| Total accounted for | [1] 8 | 14,748 | 248,519 | 100.0 | 100.0 |
| Use not specified | 3 | 6,130 | 101,864 | | |
| Grand total | [1] 11 | 20,878 | 350,383 | | |

[1] A producer reporting more than one use is counted only once in arriving at total.

As less than three producers reported material for filter block, the Bureau of Mines is not at liberty to publish the figures; the sales are included with those for miscellaneous uses. Material sold for pottery and as "drilling-mud weighting material" in oil wells is also included in this classification. Some producers did not specify the miscellaneous uses.

The following table gives production data for tripoli from 1929 to 1933:

*Tripoli (including Pennsylvania rottenstone) sold or used by producers in the United States, 1929–33*

| Year | Illinois: Short tons | Illinois: Value: Crude (estimated) | Illinois: Value: As sold (crude) and finished) | Other States [1]: Short tons | Other States [1]: Value: Crude (estimated) | Other States [1]: Value: As sold (crude and finished) | Total: Short tons | Total: Value: Crude (estimated) | Total: Value: As sold (crude and finished) |
|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 1933 | 8,757 | 18,103 | 149,979 | 12,121 | 27,582 | 200,404 | 20,878 | 45,685 | 350,383 |

[1] 1929 and 1931-32: Arkansas, Missouri, Oklahoma, Pennsylvania, and Tennessee; 1930: Arkansas, Georgia, Missouri, Oklahoma, Pennsylvania, and Tennessee; 1933: Arkansas, California, Georgia, Missouri, Oklahoma, Pennsylvania, and Tennessee.

The companies reporting production and sales of tripoli (including Pennsylvania rottenstone) in the United States in 1933, with locations of the deposits from which the material was obtained, were as follows:

American Minerals Corporation, 206 Bank Street, Burlington, Vt. Deposits near Tamms, Alexander County, Ill., and near Cleveland, Bradley County, Tenn.

Barnsdall Tripoli Co., Seneca, Mo. Deposits at Seneca, Newton County, Mo., and in Ottawa County, Okla., near Seneca, Mo.

Corona Silica, Inc. Deposit and office at Rogers, Benton County, Ark.

Illinois Minerals Co. (successor to International Silica Co.), Cairo, Ill. Deposit at Elco, Alexander County, Ill.

Independent Gravel Co., 220½ West Fourth Street, Joplin, Mo. Deposit at Racine, Newton County, Mo.

Kepner, W. L., and Friend, D. N. (successors to Tri-State Quarries Co.), Joplin, Mo. Deposit near Peoria, Ottawa County, Okla.

Mepham, Geo. S., Corporation, East St. Louis, Ill. Deposit at Delta, Alexander County, Ill.

Olive Branch Minerals Co. Deposit and office at Olive Branch, Alexander County, Ill.

Penn Paint & Filler Co. Deposit and office at Antes Fort, Lycoming County, Pa.

Tennessee Valley Mineral Co. (Wm. J. Seas), route no. 3, Summerville, Ga. Deposit near Summerville, Chattooga County, Ga.

Western Talc Co., 1901 East Slauson Street, Los Angeles, Calif. Deposit near Barstow, San Bernardino County, Calif.

*Pumice and pumicite.*—Sales of pumice and pumicite in 1933 were 15 percent greater in quantity but only about 3 percent greater in value than in 1932. The relatively low value was due to a substantial drop in the price received for much of the material sold for concrete admixture. The following table shows production for the past 5 years:

*Pumice and pumicite sold or used by producers in the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 67,013 | $353,064 | 1932 | 53,214 | $235,204 |
| 1930 | 56,843 | 336,099 | 1933 | 61,220 | 241,834 |
| 1931 | 68,819 | 338,586 | | | |

Pumice and pumicite are used for very different purposes and are 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 vesicles 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 some 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.

Pumicite is used in making cleansing and scouring compounds, abrasive hand soaps, and in small quantities in 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.

The following table shows sales according to uses. Approximately 78 percent of the material is used for cleansing and scouring compounds and hand soaps. Although wider use as concrete admixture and as a constituent of acoustic plasters has been encouraged, the persistent lag in building construction has retarded growth in these fields. In 1933 sales for "other abrasive uses" and for acoustic plaster were reported by so few producers that they are included under "miscellaneous uses" to avoid disclosure of individual figures.

*Pumice and pumicite sold or used by producers in the United States, 1932–33, by uses*

| Use | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Short tons | Value | | Short tons | Value | |
| | | Total | Average | | Total | Average |
| Cleansing and scouring compounds and hand soaps | 41,912 | $147,274 | $3.51 | 47,689 | $171,490 | $3.60 |
| Other abrasive uses | 1,142 | 12,740 | 11.16 | (1) | (1) | (1) |
| Concrete admixture and concrete aggregate | 7,165 | 35,879 | 5.01 | 6,926 | 19,897 | 2.87 |
| Acoustic plaster | 2,401 | 35,033 | 14.59 | (1) | (1) | (1) |
| Miscellaneous uses [2] | 594 | 4,278 | 7.20 | 6,605 | 50,447 | 7.64 |
| | 53,214 | 235,204 | 4.42 | 61,220 | 241,834 | 3.95 |

[1] Included under "Miscellaneous uses."
[2] 1932: Includes material used as insecticide, floor sweep, heat or cold insulation, in linoleum manufacture, for filtering, as dental material, and in asphalt; 1933: Includes material used as insecticide, floor sweep, heat or cold insulation, in linoleum manufacture, for filtering, as dental material, in asphalt, acoustic plaster, and unspecified abrasive uses.

The companies reporting production and sales of pumice and pumicite in the United States in 1933, with locations of the deposits from which the materials were obtained, are as follows:

Bennett & Jourdan (successors to Earlonite Mining Co.), Selma, Calif. Deposit in Madera County near Friant (Fresno County), Calif.

Brown, Chas. Deposit and office at Shoshone, Inyo County, Calif.

California Quarries Corporation, 1300 Quinby Building, Los Angeles, Calif. Deposit in Mono County near Laws, Calif.

Cudahy Packing Co., 221 North LaSalle Street, Chicago, Ill. Deposits at Fowler, Meade County, Kans., and at Saltdale, Kern County, Calif.

Davidson Pumice Co., Norton, Kans. Deposits at Calvert, Norton County, and Meade, Meade County, Kans.

Dodson Concrete Board Co., 1463 Barwise Avenue, Wichita, Kans. Deposit at McPherson, McPherson County, Kans.

Glendinning & Co., 624 South La Brea Avenue, 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.

Johnson, G. Z., 255 California Street, San Francisco, Calif. Deposit at Pumice Mountain, Siskiyou County, Calif.

La Ritchie, Claire E. (West Coast Pumice Co.), P.O. Box 281, Klamath Falls, Oreg. Deposit near Chemult, Klamath County, Oreg.

La Rue Axtell Pumice Co., Eustis Nebr. Deposits at Eustis, Frontier County, and Ingham, Lincoln County, Nebr.

Mid-Co Products Co., 239 Railway Exchange Building, Kansas City, Mo. Deposits at Meade, Meade County, Kans., and near Gate, Beaver County, Okla.

Pearl Pumice Quarries (successor to Pumice Products Co.), 565 Montecello Road, Napa, Calif. Deposit near Napa, Napa County, Calif.

Pumice Products Co. (George Smith), 3026 Bartlett Avenue, Oakland, Calif. Deposit near Napa, Napa County, Calif. (Now operated by Pearl Pumice Quarries.)

Pumicite Co., 4025 Clara Avenue, St. Louis, Mo. Deposit at Fowler, Meade County, Kans.

Red Mountain Cinder Quarry. Deposit and office at Little Lake, Inyo County, Calif.

Tonopah & Tidewater Railway, 510 West Sixth Street, Los Angeles, Calif. Deposit at Shoshone, Inyo County, Calif.

Victorville Lime Rock Co., 2149 Bay Street, Los Angeles, Calif. Deposit near Little Lake, Inyo County, Calif.

Zimmerman, H. H., Belle Plaine, Kans. Deposit near Satanta, Haskell County, Kans.

*Quartz.*—The production of quartz in the United States in 1933 from pegmatite dikes or veins or from quartzite amounted to 11,153 short tons, valued at $71,048, an increase of 49 percent in tonnage and 20 percent in value compared with 1932. About 37 percent of the total was sold as crude or crushed quartz and about 63 percent as ground quartz. Part of the crude also may have reached ultimate consumers as ground quartz.

Quartz is used in the manufacture of fused-quartz glass and ferrosilicon; as a flux in certain metallurgical processes; as packing in acid towers and water filters; for refractory purposes; as a filler; and as the abrading agent in some kinds of sandpaper, soaps and scouring compounds, metal polishes, and safety matches. An important use is in the manufacture of whiteware and enamel. Exceptionally clear crystals of quartz are used in optical instruments and for various purposes in the electrical industry.

Production data from 1929 to 1933 are given in the following tables:

*Quartz sold or used by producers in the United States, 1929–33*

| Year | Crude [1] | | Ground [2] | | Total | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| 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 |
| 1933 | 4,094 | 14,556 | [3] 7,059 | [3] 56,492 | [3] 11,153 | [3] 71,048 |

[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, 1931–33, by States*

| State | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| California | 1,553 | $16,654 | 253 | $4,897 | (2) | (2) |
| Maryland | 444 | 4,928 | 347 | 5,200 | 371 | $5,565 |
| Massachusetts | | | 373 | 2,170 | | |
| North Carolina | 1,807 | 11,460 | 1,535 | 7,045 | (2) | (2) |
| Undistributed [3] | [4] 4,047 | [4] 36,061 | [4] 4,979 | [4] 39,846 | [4] 10,782 | [4] 65,483 |
| | [4] 7,851 | [4] 69,103 | [4] 7,487 | [4] 59,158 | [4] 11,153 | [4] 71,048 |

[1] To avoid duplication, the ground material included is only that ground by the original producers of the crude quartz or by grinders who purchase from small miners not reporting their production.
[2] Included under "Undistributed."
[3] 1931: Arizona, New Hampshire, New York, Ohio, and Wisconsin; 1932: Arizona, New York, Ohio, and Wisconsin; 1933: Arizona, California, Missouri, New Jersey, New York, North Carolina, Ohio, Tennessee, and Wisconsin.
[4] Partly estimated.

Following is a list of some recent producers and sellers of crude quartz:

Carolina Minerals Co., Inc., Spruce Pine, N.C.
Charlotte Chemical Laboratories, Inc., Charlotte, N.C.
Consolidated Feldspar Corporation, Trenton, N.J.
C. Lee Graber, M.D., 15701 Detroit Avenue, Lakewood, Ohio.
Kingman Feldspar Co., Kingman, Ariz.
Minnesota Mining & Manufacturing Co., St. Paul, Minn.
J. C. Pitman, Penland, N.C.
Spicky Polish Corporation, 1401 Third Street, San Francisco, Calif.

Following is a list of producers of "crushed" quartz:

Consolidated Feldspar Corporation, Trenton, N.J.
Ohio Quartz Products Corporation, Jackson, Ohio.
Spicky Polish Corporation, 1401 Third Street, San Francisco, Calif.

Following is a list of manufacturers of ground quartz:

Charlotte Chemical Laboratories, Inc., Charlotte, N.C.
Consolidated Feldspar Corporation, Trenton, N.J.
Eureka Flint & Spar Co., Trenton, N.J.
Harford Talc & Quartz Co., 4 Reckord Building, Towson, Md.
Minnesota Mining & Manufacturing Co., St. Paul, Minn.
Pioneer Silica Products Co., Pacific, Mo.

*Ground sand and sandstone.*—Production of ground sand and sandstone increased from 150,109 short tons, valued at $875,749, in 1932, to 202,099 tons, valued at $1,106,410, in 1933, or 35 percent in tonnage and 26 percent in value. These figures include material known in some localities as "silica flour."

Commercially notable quantities of ground sand and sandstone are sold by companies producing glass sand and other special silica sands. This pulverized silica is used widely in the ceramic trades; as a silica wash for molds in steel-foundry work; as a filler in prepared roofing, paint, and like products; in fertilizers; and as an abrasive agent in various cleaning and scouring compounds.

The following tables give production data from 1929 to 1933.

*Ground sand and sandstone sold or used by producers in the United States, 1929–33* [1]

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 302,139 | $2,039,144 | 1932 | 150,109 | $875,749 |
| 1930 | 241,947 | 1,566,815 | 1933 | 202,099 | 1,106,410 |
| 1931 | 183,880 | 1,196,425 | | | |

[1] Includes only finely ground material. Figures probably incomplete.

*Ground sand and sandstone sold or used by producers in the United States, 1932–33, by States* [1]

| State | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| Illinois, Missouri | 42,400 | $230,801 | 52,230 | $273,526 |
| Massachusetts | | | 343 | 2,509 |
| New Jersey | 58,721 | 252,141 | 67,080 | 270,346 |
| Ohio and Pennsylvania | (2) | (2) | 65,308 | 418,933 |
| Virginia, West Virginia | (2) | (2) | 13,456 | 105,021 |
| Undistributed [3] | 48,988 | 392,807 | 3,682 | 36,075 |
| | 150,109 | 875,749 | 202,099 | 1,106,410 |

[1] Includes only finely ground material. Figures probably incomplete.
[2] Included under "Undistributed."
[3] 1932: California, Delaware, Ohio, Pennsylvania, West Virginia, and Wisconsin; 1933: California, Delaware, and Wisconsin.

The following companies reported production of ground sand and sandstone in 1932 and 1933:

Cape Henlopen Sand Co., Drawer 496, Lewes, Del.
Central Silica Co., Zanesville, Ohio.
Cheshire White Quartz Sand Co., Cheshire, Mass.
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., 205 West Thirty-fourth Street, New York, N.Y.
Ottawa Silica Co., Box 506, Ottawa, Ill.
Pennsylvania Glass Sand Corporation (grinds in New Jersey, Pennsylvania, and West Virginia), Lewistown, Pa.
Potters Mining & Milling Co., East Liverpool, Ohio.
Shenandoah Silica Co., Trenton, N.J.
Standard Flint & Spar Corporation, Trenton, N.J.
Standard Sanitary Manufacturing Co., Campo, Calif.
Standard Silica Co., 400 West Madison Street, Chicago, Ill.
Wedron Silica Co., 38 South Dearborn Street, Chicago, Ill.
White Rock Silica Co., 21 North Curtis Street, Chicago, Ill.

## SPECIAL STONE PRODUCTS

*Grindstones and pulpstones.*—Although the natural grindstone and pulpstone industry has suffered severely by competition from artificial products, it recovered remarkably in 1933. Increases compared with 1932 of 87 percent in quantity and 88 percent in value in sales of grindstones and of 79 percent in quantity and 64 percent in value in sales of pulpstones indicate that the natural stones are still favored by some users. Grindstones and pulpstones are produced chiefly in Ohio and West Virginia; smaller quantities come from Washington. The following table shows sales from 1929 to 1933.

*Grindstones and pulpstones sold by producers in the United States, 1929–33*

| Year | Grindstones | | Pulpstones | | |
|---|---|---|---|---|---|
| | Short tons | Value | Pieces | Short tons | Value |
| 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 |
| 1933 | 11,197 | 298,174 | 855 | 2,979 | 146,076 |

The companies reporting grindstones and pulpstones for commercial purposes in the United States in 1933, with locations of the quarries from which the stone was obtained, are as follows:

Briar Hill Stone Co. (grindstones). Quarry and office at Glenmont, Holmes County, Ohio.

Cleveland Quarries Co., Cleveland, Ohio (grindstones). Quarries at Amherst, Lorain County, Ohio; at Berea, Cuyahoga County, Ohio; and at Marietta, Washington County, Ohio.

Columbia Stone Co. (grindstones). Quarry and office at Columbia Station, Lorain County, Ohio. Idle in 1933.

Constitution Stone Co., Constitution, Ohio (grindstones). Quarries 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. (grindstones). Quarry and office at Marietta, Washington County, Ohio.

The International Pulpstone Co., Elyria, Ohio. Quarries in Jefferson and Columbiana Counties, Ohio (idle in 1933), and in Boone County, W.Va.

Mount Pisbia Stone Co., Elyria, Ohio (grindstones). Quarry at Layland, Coshocton County, Ohio.

Nicholl Stone Co., Lorain, Ohio (grindstones). Quarry at Kipton, Lorain County, Ohio.

Ohio Valley Stone Co. (grindstones). Quarry and office at Marietta, Washington County, Ohio.

Scheel Eversharp Pulp Burr Co., Tacoma, Wash. Quarry at Rockport, Skagit County, Wash.

Smallwood-Low Stone Co., Fairmont, W.Va. (pulpstones). Quarry in Monongalia County, near Fairmont, W.Va.

Smallwood Stone Co., Union Trust Building, Cleveland, Ohio (pulpstones). Quarries at Empire, Jefferson County, Ohio (idle in 1933), and at Opekiska, Monongalia County, W.Va.

Uffington Stone Co. (pulpstones). Quarry and office at Uffington, Monongalia County, W.Va.

Walker Cut Stone Co., Tacoma, Wash. (pulpstones). Quarry at Wilkeson, Pierce County, Wash.

West Virginia Pulpstone Corporation, Builders Exchange Building, Cleveland, Ohio (pulpstones). Quarry at Morgantown, Monongalia County, W.Va.

*Oilstones and related products.*—The small natural abrasive stones included in this group have highly diversified uses. Although artificial abrasives compete with them in virtually every application the natural stones have qualities that encourage their continued use, and with the upturn in industrial activity in 1933 sales increased substantially. Although there was an increase of 77 percent in quantity sold compared with 1932, prices evidently are still greatly depressed as the increase in value of sales was only 51 percent.

Oilstones are manufactured from novaculite quarried in Arkansas; scythestones and whetstones are made chiefly of sandstone from Ohio and Indiana and of schist from Vermont; and rubbing stones are fine-grained sandstones quarried in Indiana and Ohio. The following table shows production for the past 5 years:

*Oilstones and other whetstones, hones, scythestones, and rubbing stones sold by producers in the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 838 | $212,017 | 1932 | 331 | $63,960 |
| 1930 | 651 | 137,184 | 1933 | 587 | 96,597 |
| 1931 | 370 | 81,951 | | | |

The manufacturers of oilstones and other whetstones, scythestones, and rubbing stones from natural stone in 1933, with the sources of their raw materials, are as follows:

American Rubbing Stone Co., Cincinnati, Ohio (rubbing stones). Quarry at Floyds Knobs, Floyd County, Ind.

Bracher Agate & Abrasive Co. (successor to Bracher Co.), Summit, N.J. (oilstones and whetstones). (Has no quarries. Manufactures stone purchased in various localities.)

Chaillaux, J. A. Quarries at West Baden, Ind. (Sells this stone to Norton Pike Co. Buys Arkansas and Ohio stone and manufactures it.)

Cleveland Quarries Co., Cleveland, Ohio (scythestones, lathe stones, and holystones). Quarries at Amherst, Lorain County, Ohio, and at Berea, Cuyahoga County, Ohio.

Garland Whetstone & Kaolin Co., Hot Springs, Ark. (Produces rough stone, in Garland County, for oilstones, some of which is shipped abroad, and some of which is sold to manufacturers in this country.)

Lewis Whetstone Co., W. E. Lewis, Hot Springs, Ark. (Produces rough stone, in Garland County, for oilstones, most of which is shipped to Germany.)

Norton Pike Co., 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. (Quarries owned are in Arkansas and Vermont. Stone from Ohio and Indiana is purchased.)

*Millstones.*—Sales of millstones and related products of domestic origin in 1933 increased 88 percent in value compared with 1932. Although steel rolls, disks, tube mills, and other types of grinding equipment generally have superseded the ancient buhrstones, natural millstones are still preferred for certain uses, notably for grinding paint. It is therefore interesting to review briefly the chief sources of millstones in the United States.

The principal domestic millstones are the "Esopus" stone of Ulster County, N.Y.; the "Turkey Hill" from the area near Bowmansville, Lancaster County, Pa.; the "Cocalico" stone from the area near Durlach and Lincoln, Lancaster County, Pa.; and the "Brush Mountain" stone from Montgomery County, Va. All are classed as sandstones or conglomerates, of which some are fine grained and some coarse grained. Similar stones have been obtained at times from Rowan County, N.C., and granite from Carroll County, N.H., has been used for millstones to some extent.

Imported millstones are decidedly different from those of domestic origin. The hard, porous buhrstones from France and Belgium are fine-grained quartzites containing some calcareous material. German buhrstone is said to be basaltic lava.

The following table presents production data for millstones and related products from 1929 to 1933.

*Value of millstones, chasers, and dragstones sold by producers in the United States, 1929–33*

| Year | New York | | Other States [1] | | Total | |
|---|---|---|---|---|---|---|
| | Producers | Value | Producers | Value | Producers | Value |
| 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 |
| 1933 | 7 | 5,187 | 2 | 3,200 | 9 | 8,387 |

[1] 1929 and 1931–33: North Carolina and Virginia; 1930: New Hampshire, North Carolina, and Virginia.

The following are names and addresses of the producers who reported sales of millstones and chasers of their own manufacture in the United States in 1933; the raw material from which the stones were made was obtained from Ulster County, N.Y.; Rowan County, N.C.; and Montgomery County, Va.

Coddington, George, Accord, N.Y.
Coddington, Oscar, Accord, N.Y.
Decker, Floyd, Kerhonkson, N.Y.
Esopus Millstone Co., High Falls, N.Y.
Gardner Bros., Salisbury, N.C.
Laurence, Harry, Accord, N.Y.
Schoonmaker, Cyrus, Kerhonkson, N.Y.
Smith, John, Accord, N.Y.
Snider, R. E., Cambria, Va.

*Flint lining and grinding pebbles.*—Production of grinding pebbles and tube-mill lining in 1933 was more than three and a half times as great in both quantity and value as in 1932. This notable increase indicates that activity in the mineral-grinding industries is growing and that mills are being reconditioned in preparation for further increases. Although steel balls are used extensively for grinding, a continued moderate demand for flint pebbles is to be expected because some industries require a product with a minimum content of iron. For instance, nearly all raw materials for the pottery industry are ground with flint pebbles in flint-lined mills.

According to Bureau of Mines records, the commercial production of flint pebbles and tube-mill liners in the United States includes only beach pebbles from southern California and cut cubes and liners of quartzite quarried near Jasper, Minn. The following table gives 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, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 4,630 | $66,178 | 1932 | 976 | $13,070 |
| 1930 | 3,480 | 50,816 | 1933 | 3,709 | 47,011 |
| 1931 | 2,024 | 26,211 | | | |

## GARNET AND EMERY

*Garnet.*—Sales of garnet in 1933 increased 43 percent in quantity and 53 percent in value compared with 1932.

A large part of all the garnet sold is used in the manufacture of abrasive paper and cloth. For this use it has resisted the competition of artificial abrasives comparatively well. Small quantities are employed for grinding plate glass and other products.

Garnet is claimed to be much more effective than quartz for sand-blasting. It is not yet known how it compares with carborundum sand, which is now the most widely used abrasive for this work. If the superiority of garnet can be demonstrated, sand-blasting may afford a large market, although competitive prices must be considered.

A large deposit of high-grade garnet in Warren County, N.Y., is the chief source of supply. New Hampshire ranks second. Other States in which there are deposits of possible commercial value are: Connecticut, Pennsylvania, North Carolina, Georgia, and Virginia; and Colorado, California, Idaho, Montana, Nevada, Arizona, Utah, and other Western States. There has been some interest recently in the development of the North Carolina deposits. The following table shows production of garnet for the past 5 years.

*Abrasive garnet sold or used by producers in the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 5, 961 | $435, 420 | 1932 | 1, 950 | $147, 350 |
| 1930 | 5, 003 | 314, 129 | 1933 | 2, 794 | 224, 717 |
| 1931 | 2, 946 | 193, 015 | | | |

The companies reporting sales of garnet in the United States in 1933, with locations of the deposits from which the garnet was obtained, are as follows:

Barton Mines Corporation. Deposit and office at North Creek, Warren County, N.Y.

Garnet Products Co. Deposit and office at South Danbury, Merrimack County, N.H.

Warren County Garnet Mills, 149 Orange Street, Newark, N.J. Deposit near Riparius (Johnsburg), Warren County, N.Y.

*Emery (including corundum).*—Emery, a mixture of corundum and magnetite, used principally as a grinding agent in the metal trades has been replaced extensively by artificial abrasives. However, the output, which has been small for several years, increased in both tonnage and value in 1933 to more than four times that in 1932; it was greater than in any year since 1928. In recent years production has been confined to the Peekskill district of New York.

The mineral corundum, a natural aluminum oxide surpassed in hardness only by diamond, has not been mined in the United States since 1918 insofar as Government records show. As a small tonnage of imported corundum, chiefly from South Africa, is used each year, there has been some interest in the development of domestic deposits. Such an enterprise must face competition from artificial abrasives.

The following table gives production of domestic emery for the past 5 years.

*Emery sold or used by producers in the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 924 | $10,722 | 1932 | 250 | $2,781 |
| 1930 | 555 | 5,996 | 1933 | 1,056 | 12,283 |
| 1931 | 512 | 5,557 | | | |

The companies reporting sales of emery in the United States in 1933, with the locations of the deposits from which the material was obtained, are as follows:

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

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. An important use of silicon carbide and aluminum oxide is in the manufacture of bonded abrasive wheels. 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.

The combined production of silicon carbide and aluminum oxide shows an increase of 56 percent in quantity and 68 percent in value in 1933 compared with 1932. As these abrasives are used primarily in the metal trades, the larger sales doubtless resulted from increased activity in the iron, steel, and allied industries. On the other hand, metallic abrasives decreased for the fourth consecutive year; production in 1933 was 19 percent less in quantity and 7 percent less in value than in 1932. The continued decline may be due to the fact that abrasives of this type are used extensively in the stone-working industries, which recovered little or none in 1933 because of inactivity in the building trades.

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, 1929–33*

| Year | Silicon carbide | | Aluminum oxide | | Metallic abrasives | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 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 |
| 1933 | 16, 606 | 1, 715, 989 | 30, 778 | 2, 436, 962 | 6, 844 | 381, 314 | 54, 228 | 4, 534, 265 |

## MISCELLANEOUS ABRASIVE MATERIALS

In addition to the materials already discussed, several other commodities are used for abrasive purposes. As they are highly diverse, some being natural and others artificial abrasives, they are considered briefly as a miscellaneous group.

*Abrasive diamonds.*—In the United States diamonds are produced at one locality—near Murfreesboro, Pike County, Ark. About 300 carats of gem stones and bort were produced in 1932, but no production was reported for 1933. Imports of abrasive diamonds in 1933 were valued at about $1,300,000, an increase of 22 percent over 1932 but far below imports of 1929, which were valued at about $4,000,000.

There are two types of abrasive or industrial diamonds—the black diamond (carbonado) and bort. Black diamonds, which are found chiefly in the State of Bahia (Brazil), are harder than the gem varieties and are especially valuable for cutting tools because they have no cleavage. The other variety (bort), obtained principally from South Africa, consists of cull stones from gem diamonds. Both varieties are used for abrasive purposes. Industrial diamonds are widely used in drill bits for drilling and boring rock. Diamond-toothed saws are used extensively for sawing marble, limestone, and other varieties of dimension stone. General information on abrasive diamonds may be found in a recent report by Tyler.[1]

*Abrasive sand.*—Figures on production of abrasive sand are included with those of related materials in the chapter on Sand and Gravel. In an average year 1,500,000 tons or more of sand valued at about $2,000,000 are used annually for abrasive purposes.

Sand is used extensively in sawing and rubbing granite, limestone, marble, slate, and soapstone. "Chats" (tailings from the Joplin lead-zinc region) are used to some extent in the Indiana limestone district as a substitute for sand in sawing. Sand is used also for removing surface inequalities in crude-rolled plate glass before grinding and polishing, and in sand-blasting.

*Other miscellaneous abrasives*—An artificial abrasive consisting of tin oxide or a mixture of tin oxide and oxalic acid, termed "putty powder", is used for polishing marble and granite. Rouge and crocus, forms of ferric oxide, are employed to produce a high luster—the former on precious metals and the latter on tin and cutlery. Rouge is used also for final polishing of plate glass. Chromium oxide, manganese dioxide, and magensia have limited use as abrasives. River silt is employed to a limited extent in cleansing powders and in the manufacture of bath bricks; clay as a mild abrasive in some polishes and cleansing soaps and highly burned clay (sometimes ground to

[1] Tyler, Paul M., Abrasive and Industrial Diamonds: Inf. Circ. 6562, Bureau of Mines, 1932, 25 pp.

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.

## FOREIGN TRADE[2]

*Imports and exports.*—The total value of abrasive materials imported for consumption in the United States in 1933 was $1,687,831, of which 78 percent was industrial diamonds; the value of the imports was 27 percent higher than in 1932. Exports increased 55 percent in value in 1933, the greatest gain being in abrasive-wheel exports which were more than three times those in 1932.

The following tables state the value of abrasive materials imported for consumption in the United States from 1929 to 1933; the quantity and value of such imports in 1932 and 1933, by kinds; and the value of domestic abrasive materials exported from the United States from 1929 to 1933.

*Value of abrasive materials imported for consumption in the United States, 1929–33*

| Material | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Millstones and burrstones | $6,564 | $7,050 | $2,435 | $1,794 | $1,123 |
| Grindstones | 119,264 | 66,677 | 39,171 | 14,196 | 13,615 |
| Hones, oilstones, and whetstones | 48,207 | 40,612 | 24,881 | 15,543 | 29,968 |
| Emery and corundum | 494,174 | 329,752 | 151,501 | 106,999 | 170,921 |
| Garnet | | | 149 | 356 | 20 |
| Diatomaceous earth, tripoli, and rottenstone [1] | 23,183 | 46,478 | 53,581 | 39,055 | 57,029 |
| Pumice | 143,944 | 94,387 | 77,168 | 51,062 | 75,422 |
| Diamond: | | | | | |
| Dust and bort | 89,363 | 90,945 | 20,292 | 12,860 | 47,092 |
| Glaziers' and engravers', unset, and miners' | 4,067,674 | 2,756,630 | 2,400,879 | 1,061,823 | 1,263,156 |
| Flint, flints, and flint stones, unground | 127,457 | 62,463 | 54,623 | 27,217 | 29,485 |

[1] Beginning June 18, 1930, classification reads "Tripoli and rottenstone."

*Abrasive materials imported for consumption in the United States, 1932–33, by kinds*

| Kind | 1932 | | 1933 | |
|---|---|---|---|---|
| | Quantity | Value | Quantity | Value |
| Millstones and burrstones: | | | | |
| Rough or unmanufactured ... short tons | 2 | $200 | 9 | $416 |
| Bound up into millstones ... do | 18 | 1,594 | 17 | 707 |
| Grindstones, finished or unfinished ... do | 310 | 14,196 | 413 | 13,615 |
| Hones, oilstones, and whetstones ... do | 71 | 15,543 | 82 | 29,968 |
| Emery: | | | | |
| Ore ... do | 674 | 5,524 | 293 | 6,398 |
| Grains, ground, pulverized, or refined ... pounds | (1) | (1) | (1) | (1) |
| Paper and cloth of emery or corundum ... do | (2) | 60,054 | (2) | 63,181 |
| Wheels, files, and other manufactures of which emery or corundum is the material of chief value ... pounds | 77,327 | 32,226 | 100,778 | 48,833 |
| Corundum (see also "Emery"): | | | | |
| Ore ... short tons | 188 | 8,258 | 293 | 49,442 |
| Grains, ground, pulverized, or refined ... pounds | [1] 21,348 | [1] 937 | [1] 48,257 | [1] 3,067 |
| Garnet in grains or ground, pulverized, etc ... short tons | 5 | 356 | (3) | 20 |
| Tripoli and rottenstone ... do | 2,098 | 39,055 | 4,119 | 57,029 |
| Pumice: | | | | |
| Crude or unmanufactured ... do | 4,438 | 35,464 | 6,796 | 55,826 |
| Manufactures of, or of which pumice is the component material of chief value ... short tons | (4) | 15,598 | (4) | 19,596 |
| Diamond: | | | | |
| Bort ... carats | 962 | 12,460 | 3,059 | 46,936 |
| Dust ... pounds | (4) | 400 | (4) | 156 |
| Glaziers' and engravers', unset, and miners' ... carats | 163,704 | 1,061,823 | 263,484 | 1,263,156 |
| Flint, flints, and flint stones, unground ... short tons | 3,755 | 27,217 | 4,640 | 29,485 |
| | ---------- | 1,330,905 | ---------- | 1,687,831 |

[1] Emery included with corundum; not separately classified.
[2] 9,394 reams in 1932 and 7,053 reams in 1933; weight not recorded.
[3] Less than 1 ton.
[4] Quantity not recorded.

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

*Value of domestic abrasive materials exported from the United States, 1929–33*

| Material | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Grindstones | $391, 239 | $246, 512 | $104, 602 | $85, 528 | $88, 950 |
| Abrasive wheels, emery and other | 286, 360 | 203, 371 | 115, 076 | 64, 069 | 213, 087 |
| All other natural abrasives, hones, whetstones, etc. | 423, 363 | 361, 055 | 232, 196 | 147, 469 | 158, 812 |

*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 [1]

## SUMMARY OUTLINE



Increased activity in numerous industries, more particularly the various chemical and fertilizer industries, was reflected in the market demand for sulphur during 1933. World production of sulphur increased considerably, due principally to the larger output in the United States where an excess of shipments over production decreased the sulphur stocks held at mines.

The price of sulphur, as quoted by domestic trade journals, remained unchanged throughout the year, but reports indicate that the price was lowered in some foreign markets after the marketing agreement between Sicily and the American exporters terminated in 1932. Devaluation of the dollar in 1933 placed American exporters in a relatively favorable competitive position with reference to Sicilian producers. Probably the most significant event in the foreign field was the formation late in the year of a Central Sulphur Sales Bureau to handle the sale of all Italian sulphur for both domestic consumption and export.

The United States entrenched itself further in 1933 as the principal world producer of sulphur by a large output from one new property and by the development and equipment of another property where extensive reserves are reported to exist. Both new developments are in Louisiana. Italy, including Sicily, was again the second largest producer; and Japan, ranking third, increased its output materially for the second consecutive year. Norway continued to be a factor in the market, with a sizable production and exportation of sulphur obtained in the treatment of pyrites. Spain is augmenting its out-

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

put of elemental sulphur by the recovery of sulphur from pyrites in a plant similar to that operating in Norway. Increased exports from Chile indicated a larger production in that country.

Spain continued to be the most important source of pyrites in the world; Norway, the next largest producer, increased its output materially.

Consumption of both sulphur and pyrites in the United States increased in 1933. In the sulphur industry the year was characterized by increased production, increased shipments (both domestic and export), decreased stocks, and a steady price. The following table outlines the principal features of the domestic situation during the last 2 years.

*Salient statistics of the sulphur industry in the United States, 1932–33*

| | 1932 | 1933 |
|---|---|---|
| Sulphur: | | |
| Production of crude sulphur ---- long tons -- | 890,440 | 1,406,063 |
| Shipments of crude sulphur: | | |
| For domestic consumption ---- do ---- | 756,242 | 1,114,853 |
| For export ---- do ---- | 352,610 | 522,515 |
| Total shipments ---- do ---- | 1,108,852 | 1,637,368 |
| Imports ---- do ---- | ---------- | 4,773 |
| Exports of treated sulphur ---- do ---- | 7,270 | 8,763 |
| Producers' stocks at end of year ---- do ---- | 3,031,257 | 2,799,950 |
| Price of crude sulphur f.o.b. mines ---- per long ton -- | $18 | $18 |
| Pyrites: | | |
| Production ---- long tons -- | [1] 189,703 | 284,311 |
| Imports ---- do ---- | 253,248 | 374,417 |
| Exports ---- do ---- | (2) | (2) |
| 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 -- | 600,334 | 656,102 |

[1] Revised figures.
[2] None recorded.

No codes were formulated for the sulphur or pyrites producers during the year, but enrollment under the President's Reemployment

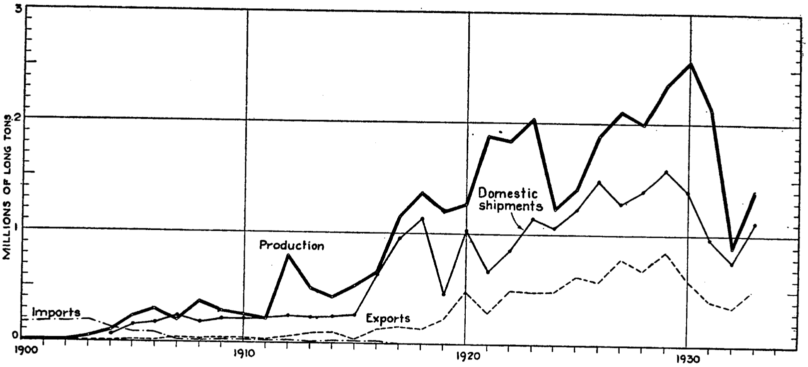


FIGURE 90.—Domestic production, domestic shipments, exports, and imports of crude sulphur, 1900–33.

Agreement proceeded as in other industries. In the sulphuric acid industry some producers contended that the acid produced as a byproduct at zinc plants should come under the Zinc Code and that the acid produced at fertilizer works should come under the Fertilizer

Code. All sulphuric acid, however, was placed under the Chemical Code, which was approved in February 1934.

The progress of the sulphur and pyrites industries in the United States during the twentieth century is shown in figures 90 and 91. Before 1900 the production of sulphur in this country was very small.

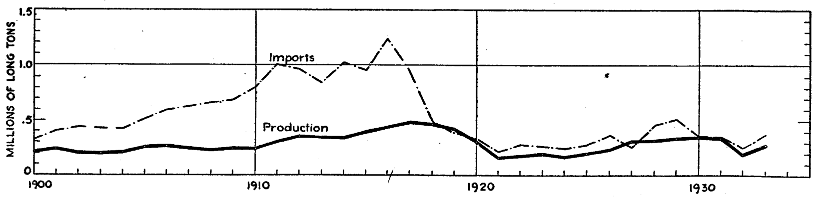


FIGURE 91.—Domestic production and imports of pyrites, 1900–33.

## SULPHUR

*Domestic production.*—Production of sulphur in the United States in 1933 totaled 1,406,063 long tons, an increase of 515,623 tons (58 percent) over 1932. The increase was shared by all the principal producers. Although production in 1933 was 29 percent below the average for the 5-year period 1928–32, shipments were only 9 percent below the average; they totaled 1,637,368 long tons valued at $29,500,000, a 48-percent increase in both quantity and value over 1932. For the second consecutive year shipments have exceeded production, resulting in further decrease in stocks at the mines. Such stocks, however, are still large, amounting to 2,799,950 long tons on December 31, 1933, or 231,310 tons below the reserve at the end of 1932.

The average quoted price for sulphur, as reported by the trade journals, was unchanged at $18 a ton f.o.b. mines throughout 1933. Spot prices for car lots were $21 per ton.

The following table records American sulphur production from 1929 to 1933.

*Sulphur produced and shipped in the United States, 1929–33*

| Year | Produced (long tons) | Shipped | | Year | Produced (long tons) | Shipped | |
|---|---|---|---|---|---|---|---|
| | | Long tons | Approximate value | | | Long tons | Approximate value |
| 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 | 1933 | 1, 406, 063 | 1, 637, 368 | 29, 500, 000 |
| 1931 | 2, 128, 930 | 1, 376, 526 | 24, 800, 000 | | | | |

Seventy-seven percent of the domestic sulphur reported for 1933 came from Texas, and the bulk of the remainder came from Louisiana; California and Utah together contributed only 1,126 long tons. Thus the two States, Texas and Louisiana, together accounted for more than 99 percent of the domestic output.

The following table lists the sulphur mines producing in the United States in 1933.

*Mines that produced sulphur in the United States in 1933*

| Operating company | Name of mine | Location of mine |
|---|---|---|
| Leviathan Sulphur Co | Leviathan | Alpine County, Calif. |
| T. N. Wade | Queen Group | Inyo County, Calif. |
| Jefferson Lake Oil Co., Inc | Lake Peigneur | Iberia Parish, La. |
| Freeport Sulphur Co | Grande Ecaille | Plaquemines Parish, La. |
| Do | Bryan Mound | Freeport, Brazoria County, Tex. |
| Do | Hoskins Mound | Do. |
| Duval Texas Sulphur Co | Palangana Dome | Benavides, Duval County, Tex. |
| Texas Gulf Sulphur Co | Long Point Dome | Long Point, Fort Bend County, Tex. |
| Do | Boling Dome | Newgulf, Wharton County, Tex. |
| Utah Sulphur Industries | Sulphurdale | Beaver County, Utah. |

*Byproduct sulphur.*—A large quantity of sulphur is recovered each year as a byproduct from copper and zinc milling and smelting. Treatment of some copper and zinc ores yields a pyrites concentrate, which is an important source of sulphur, as well as copper and zinc concentrates. Production of pyrites concentrate is discussed in the pyrites section of this report. In smelting copper and zinc concentrates the sulphur is driven off as sulphur dioxide gas, which is used in the manufacture of sulphuric acid at many smelters. Nearly 200,000 tons of sulphur were recovered annually from this source during the 5 years ended in 1932. Such sulphur is not included in the sulphur-production figures for the United States.

Data follow on production of sulphuric acid as a byproduct at smelting plants during the last 5 years. The table gives the output at both copper and zinc plants and comprises virtually all 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 include the sulphuric acid made from pyrites concentrates in Tennessee and Wisconsin. Before 1931 all the acid produced at Anaconda, Mont., was made by roasting table copper concentrates; in 1931 and 1932 some acid was made from pyrites flotation concentrates, and in 1933 all the acid came from this source. In the following table the figures for production at copper plants include the acid made at Anaconda in 1932 and preceding years but exclude it for 1933.

*Byproduct sulphuric acid (expressed as 60° B.) produced at copper and zinc plants in the United States, 1929–33, in short tons*

| | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Copper plants | 633, 438 | 651, 702 | 436, 111 | 258, 994 | 301, 075 |
| Zinc plants | 627, 018 | 536, 614 | 426, 618 | 341, 340 | 355, 027 |
| | 1, 260, 456 | 1, 188, 316 | 862, 729 | 600, 334 | 656, 102 |

There is also a small annual production (2,500 tons) of byproduct sulphur resulting from the purification of manufactured fuel gas. Only part of this output is marketed; the remainder accumulates in dumps at the various plants. Such output is not included in the sulphur-production figures for the United States. The methods of recovering sulphur in the treatment of fuel gases in the United States have been outlined by Powell.[2]

*Consumption.*—The apparent consumption of sulphur was greater in 1933 than in 1932 or 1931. The general increase in demand for sulphur is reflected in a gain of 48 percent in domestic shipments and the same relative increase in exports over 1932. The market for sulphur was slow during the early months of 1933 but improved considerably during the later months.

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, 1929–33, in long tons*

| | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Shipments | 2,437,238 | 1,989,917 | 1,376,526 | 1,108,852 | 1,637,368 |
| Imports | 1,163 | 29 | | | 4,773 |
| | 2,438,401 | 1,989,946 | 1,376,526 | 1,108,852 | 1,642,141 |
| Exports: | | | | | |
| Crude | 855,183 | 593,312 | 407,586 | 352,610 | 522,515 |
| Refined | 17,663 | 16,014 | 12,142 | 7,270 | 8,763 |
| | 872,846 | 609,326 | 419,728 | 359,880 | 531,278 |
| Apparent consumption | 1,565,555 | 1,380,620 | 956,798 | 748,972 | 1,110,863 |

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, 1929–33, by uses, in long tons*

| Use | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Heavy chemicals | 560,000 | 471,000 | 327,000 | 298,000 | |
| Electrochemicals | 23,000 | 20,000 | 16,000 | 13,000 | 491,000 |
| Fine chemicals | 15,000 | 13,000 | 12,000 | 10,000 | |
| Fertilizer and insecticides | 415,000 | 418,000 | 254,000 | 155,000 | 242,000 |
| Pulp and paper | 265,000 | 235,000 | 178,000 | 153,000 | 197,000 |
| Explosives | 67,000 | 48,000 | 39,000 | 27,000 | 37,000 |
| Dyes and coal-tar products | 47,000 | 41,000 | 39,000 | 34,000 | 40,000 |
| Rubber | 43,000 | 31,000 | 23,000 | 18,000 | 24,000 |
| Paint and varnish | 5,000 | 4,500 | 4,000 | 4,000 | 4,000 |
| Food products | 5,000 | 4,500 | 4,700 | 4,000 | 4,000 |
| Miscellaneous | 136,700 | 110,600 | 72,000 | 40,000 | 75,000 |
| | 1,581,700 | 1,396,600 | 968,700 | 756,000 | 1,114,000 |

Production of sulphuric acid, the chief use of sulphur in the United States, increased materially in 1933, due mainly to the large increase in consumption of acid by the fertilizer industry, which required 56 percent more than in 1932. Consumption of acid in most of the other industries also increased in 1933. The only decrease was in the petroleum industry, which produced more motor fuel and more lubricating oil in 1933 than in 1932. Although the figures in the table are estimates, the decline in acid consumption undoubtedly indicates that certain grades of gasoline do not receive as extensive treatment as previously and that technologic developments and new processes for

[2] Powell, A. R., Recent Developments in Special By-Products of Coal Carbonization: Proc. Am. Gas Assoc., 14th Ann. Convention, 1932, pp. 904–906.

refining petroleum products tend to eliminate the use of sulphuric acid. The following table, which shows the consumption of sulphuric acid by industries from 1929 to 1933, is based largely on estimates by Chemical and Metallurgical Engineering. The figures on acid consumed in the fertilizer industry are those supplied by the Bureau of the Census.

*Sulphuric acid (expressed as 50° B.) consumed in the United States, 1929–33, by industries, in short tons* [1]

| Industry | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Fertilizer [2] | 2,446,000 | 2,477,000 | 1,351,000 | 771,000 | 1,206,000 |
| Petroleum refining | 1,570,000 | 1,420,000 | 1,348,000 | 1,240,000 | 1,150,000 |
| Chemicals | 890,000 | 820,000 | 760,000 | 674,000 | 725,000 |
| Coal products | 935,000 | 800,000 | 570,000 | 375,000 | 468,000 |
| Iron and steel | 800,000 | 660,000 | 480,000 | 270,000 | 390,000 |
| Other metallurgical | 675,000 | 560,000 | 410,000 | 310,000 | 360,000 |
| Paints and pigments | 225,000 | 200,000 | 180,000 | 160,000 | 170,000 |
| Explosives | 195,000 | 177,000 | 175,000 | 120,000 | 140,000 |
| Rayon and cellulose film | [3] 150,000 | 145,000 | 183,000 | 176,000 | 242,000 |
| Textiles | 90,000 | 78,000 | 81,000 | 75,000 | 90,000 |
| Miscellaneous | 390,000 | 330,000 | 262,000 | 230,000 | 233,000 |
| | 8,366,000 | 7,667,000 | 5,800,000 | 4,401,000 | 5,174,000 |

[1] Figures, except those for fertilizer industry, from Chem. and Met. Eng., January 1934, p. 35, and from earlier annual review issues.
[2] Bureau of the Census, Department of Commerce.
[3] Reported as rayon only.

*Foreign trade.*—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 have been of little consequence since 1917. Imports of "sulphur and sulphur ore" in 1933 were 4,773 tons. This is the first time that sulphur has been imported into the United States since 1930, when 29 tons of "sulphur and sulphur ore" were recorded.

Exports of American crude sulphur began in 1904, when a cargo of 3,000 long tons was shipped from Louisiana. Exports totaled 522,515 tons in 1933 compared with 352,610 tons in 1932, an increase of 48 percent. During the first 4 months of 1933 exports were rather slow, averaging only slightly more than 20,000 tons per month. In May, however, foreign shipments increased, and in the last 8 months of the year averaged over 55,000 tons per month.

The following table shows the sulphur imported into and exported from the United States from 1929 to 1933.

*Sulphur imported into and exported from the United States, 1929–33*

| Year | Imports for consumption [1] | | Exports | | | |
|---|---|---|---|---|---|---|
| | | | Crude | | Crushed, ground, refined, sublimed, and flowers of | |
| | Long tons | Value | Long tons | Value | Long tons | Value |
| 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 |
| 1933 | 4,773 | 67,432 | 522,515 | 9,877,879 | 8,763 | 316,890 |

[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 1933 totaled 19,629,405 pounds valued at $316,890, an increase of 21 percent over 1932; the average value in 1933 was 1.61 cents per pound, or about $36 per long ton.

In 1933 exports increased to all countries that receive important quantities of American crude sulphur except Australia and New Zealand. In 1932 exports to Australia and New Zealand were much larger than in 1931, whereas exports to the other important consuming countries decreased substantially. Shipments of American crude sulphur to the United Kingdom in 1933 were the largest ever recorded, and shipments to Germany increased 121 percent over 1932. Although exports to Germany increased to 69,139 long tons in 1933, they are still only about one-half the average for the 5-year period from 1927 to 1931. Much of the sulphur exported to Germany is transshipped to other European countries, consequently the lower figure for the last 2 years reflects the lower demand for American sulphur not only in Germany but also in nearby countries. The competition from pyrites in the pulp industry in the Scandinavian countries, the production of elemental sulphur from pyrites in Norway, and the output of byproduct sulphur from the gas industry in Germany all tend to lower the demand for American sulphur.

Canada, with an increase of 28 percent over 1932, continued to be the best customer for American crude sulphur, taking 122,954 long tons or 24 percent of the total exports in 1933. France with 16 percent, Germany with 13 percent, and the United Kingdom with 9 percent followed in order. Together these four countries accounted for 62 percent of the total crude sulphur exported from the United States.

In 1933 Canada, also the largest importer of American treated sulphur, took 5,758,316 pounds (29 percent of the total); Australia, with 2,389,180 pounds (12 percent), again ranked second; and Germany, with 2,327,693 pounds (12 percent), increased greatly and advanced to third place. The United Kingdom, Mexico, and Uruguay followed in order; each required more than a million pounds in 1933.

The following table shows exports of crude sulphur and treated sulphur from the United States in 1933 by countries of destination.

*Sulphur exported from the United States in 1933, by destinations*

| Destination | Sulphur or brimstone | | Crushed, ground, refined, sublimed, and flowers of | |
|---|---|---|---|---|
| | Long tons | Value | Pounds | Value |
| North America: | | | | |
| Canada | 122,954 | $2,242,426 | 5,758,316 | $102,799 |
| Central America | 163 | 5,137 | 180,812 | 4,839 |
| Mexico | 5,918 | 117,173 | 1,457,211 | 26,166 |
| Newfoundland and Labrador | 4,020 | 75,386 | 30,800 | 672 |
| West Indies | 14,223 | 273,020 | 158,509 | 4,012 |
| | 147,278 | 2,713,142 | 7,585,648 | 138,488 |
| South America: | | | | |
| Argentina | 14,900 | 285,945 | 119,752 | 2,649 |
| Brazil | 4,314 | 94,158 | 862,192 | 11,509 |
| Colombia | 2 | 72 | 249,899 | 5,609 |
| Uruguay | 499 | 11,976 | 1,013,600 | 14,653 |
| Other | 40 | 1,120 | 65,338 | 1,340 |
| | 19,755 | 393,271 | 2,310,781 | 35,760 |
| Europe: | | | | |
| Belgium | | | 202,715 | 2,813 |
| Denmark | | | 553,666 | 7,553 |
| France | 84,093 | 1,623,645 | 330,900 | 4,323 |
| Germany | 69,139 | 1,393,934 | 2,327,693 | 28,626 |
| Netherlands | 27,449 | 563,965 | 197,173 | 2,794 |
| Sweden | 20,578 | 386,536 | 145,298 | 2,133 |
| United Kingdom | 47,149 | 832,392 | 1,517,242 | 21,802 |
| Other | 22,578 | 414,241 | 199,029 | 3,146 |
| | 270,986 | 5,214,713 | 5,473,716 | 73,190 |
| Asia | 1,500 | 28,500 | 888,467 | 12,946 |
| Africa: | | | | |
| Algeria | 13,824 | 252,703 | | |
| Canary Islands | | | 500,000 | 8,206 |
| Mozambique | | | 55,000 | 858 |
| Union of South Africa | 5,000 | 100,000 | 384,349 | 9,626 |
| Other | | | 20 | 3 |
| | 18,824 | 352,703 | 939,369 | 18,693 |
| Oceania: | | | | |
| Australia | 37,726 | 692,507 | 2,389,180 | 36,932 |
| New Zealand | 26,446 | 483,043 | 42,244 | 881 |
| | 64,172 | 1,175,550 | 2,431,424 | 37,813 |
| | 522,515 | 9,877,879 | 19,629,405 | 316,890 |

## INDUSTRY IN 1933, BY STATES

### TEXAS

In the 8-year period from 1925 to 1932, inclusive, over 99 percent of all the domestic sulphur produced came from Texas. In 1933, however, Texas accounted for only 77 percent of the domestic output despite an increase of 24 percent over 1932. Production in Louisiana accounts for this decline in relative output. The increased production in Texas in 1933 was shared by all the producing companies, as indicated in the following table compiled from information issued by the Texas State comptroller's office.

*Sulphur produced in Texas in 1933, by companies, in long tons*

| Company | First quarter | Second quarter | Third quarter | Fourth quarter | Total |
|---|---|---|---|---|---|
| Texas Gulf Sulphur Co | 115,489 | 129,361 | 214,582 | 189,174 | 648,606 |
| Freeport Sulphur Co | 93,015 | 98,495 | 91,025 | 113,855 | 396,390 |
| Duval Texas Sulphur Co | 5,936 | 5,377 | 16,404 | 10,254 | 37,971 |
| | 214,440 | 233,233 | 322,011 | 313,283 | 1,082,967 |

*Texas Gulf Sulphur Co.*—The plant at the older property of this company at Gulf, Matagorda County, was not in operation in 1933; shipments, however, were made from stock. The smaller plant at Long Point, Fort Bend County, maintained normal production during 1933, but no shipments have been made as yet; from March 20, 1930, when this mine was first put into operation, to December 31, 1933, it has produced nearly 190,000 tons of sulphur. The bulk of the output by this company in 1933 came from Boling Dome in Wharton County, which has been operated continuously since first production on March 20, 1929. Up to the end of 1933 this property has produced over 2,700,000 tons; its total estimated reserves of sulphur exceed 40,000,000 tons.[3]

*Freeport Sulphur Co.*—Production was continued at the two Texas plants of this company throughout 1933 at a higher rate than in 1932.

*Duval Texas Sulphur Co.*—This company makes a relatively small output at Palangana dome in Duval County. During the first half of 1933 about 11,000 long tons were produced, but during the second half the output was increased to 26,658 tons. The company was drilling for sulphur during the year on Boling dome.

### LOUISIANA

Louisiana produced 321,492 long tons of sulphur in 1933 compared with 13,401 tons in 1932, the first production since 1924. Two companies, the Jefferson Lake Oil Co., Inc., and the Freeport Sulphur Co., were the producers in 1933.

*Freeport Sulphur Co.*—In December 1933 the Freeport Sulphur Co. began to produce sulphur from the Grande Ecaille salt dome, also referred to as the Lake Washington or Cockrell dome. The dome, which is in Plaquemines Parish about 45 miles southeast of New Orleans, lies in the tidal marsh characteristic of the Delta region 10 miles southwest of the Mississippi River and 4 miles from the Gulf of Mexico. Communication between points in this uninhabited area is very difficult, as the low swamp lands are interspersed by numerous shallow lakes, bayous, and lagoons which, however, provide a circuitous water route to the property.

The occurrence of Sulphur at Grande Ecaille is typical of the other deposits in the Gulf coast region, where sulphur occurs in the cap rock which forms a mantle over the salt-plug intrusion. The salt stock appears to be roughly oval in outline, with a southeast-northwest diameter of about 3,000 feet and a northeast-southwest diam-

[3] Wolf, A. G., The Boling Dome, Texas: 16th Internat. Geol. Cong., guidebook 6, excursion A-6, Oklahoma and Texas, Washington, D.C., 1933, p. 87.

eter of about 4,500 feet.[4] The top of the salt stock lies 1,500 feet below the surface and is covered with an irregular thickness of about 250 feet of cap rock, consisting largely of limestone, calcite, gypsum, celestite, anhydrite, sulphur, and traces of pyrite and barite. The top of the cap rock is relatively flat, but the dome dips steeply away at the sides.

The terrain in the marsh area gave no indication of the underlying structure, but these unaccessible areas were prospected by geophysical methods. The dome was discovered in 1928 by means of the seismograph. In the summer of 1929 the Gulf Refining Co. of Louisiana, the Humble Oil & Refining Co., and the Shell Petroleum Corporation began prospecting for oil. Sulphur indications were encountered, and early in 1932 the Freeport Sulphur Co. acquired the sulphur rights from the three oil companies and began to explore the dome for sulphur. Benefiting by the unsatisfactory experience in prospecting methods by the oil companies, who mounted their derricks on wooden mats or piles, the sulphur company adopted drilling rigs erected on steel barges similar to those used in exploring the Jefferson Island dome. In order to move the barge about to different positions on the dome a canal 45 feet wide and 6 feet deep was dredged. When the canal had reached a new location it was enlarged for a short distance to facilitate the handling of material barges. When the canal was completed the drilling barge was towed into position and anchored with four 36-foot, heavy, steel-pipe spuds, one at each corner of the barge; drilling was then begun. At each location 80 feet of 15½-inch surface casing were set, then a 13¾-inch hole was drilled to cap rock where a 10-inch casing was set and cemented. The entire thickness of the cap rock was either sampled or cored. Two sampling methods were used—the reverse-return or air-lift system and the continuous operation of the core bits in conjunction with a sand pump.[5] Prospecting for sulphur was begun in April 1932; within a year, 18 holes had been drilled and sampled.

The chief problem in constructing a plant and equipping a property, with the terrain conditions existing in this area, was selecting the foundations. After exhaustive tests it was decided that heavy, reenforced-concrete mats supported by piling for the foundations for the buildings and hydraulically made fills supported on piling for the vats were most suitable. The mining area was filled to an elevation of from 4 to 8 feet, and with the completion of the field fill the use of drilling barges and floating equipment was discontinued, the derricks being erected on mats. The fill was made with a 20-inch hydraulic dredge.

The power plant and other permanent buildings are constructed with corrugated-asbestos roofing and siding on a steel frame designed for 125-mile winds. The floor of the plant is 12 feet above mean Gulf tide or 11 feet above the surrounding marsh and is supported by heavy piers which rest on a concrete mat 2.5 feet thick, which in turn is supported by 75-foot piles driven on approximately 2-foot 8-inch centers. The space between the floor and the mat furnishes storage for water.

The plant is equipped with six 860-hp., bent water-tube Stirling boilers with air-cooled furnaces designed to operate at 200 percent of

[4] Moresi, Cyril K., Louisiana's Sulphur Mines: Louisiana Conservation Rev., vol. 4, no. 1, January 1934, p. 48.

[5] Lundy, Wilson T., Development of the Grande Ecaille Sulphur Deposit: Tech. Pub. 533, Am. Inst. Min. and Met. Eng., 1934, p. 7.

the builder's rating. Fuel oil will be used to supply the heat, but the plant is designed to take either gas or pulverized fuel. Other equipment necessary to operation of the plant includes water heaters, pumps, turbogenerators, and air compressors. The exhaust steam from the prime movers is used to preheat the water for treatment. Sites were selected for the plant and auxiliary buildings 4,000 feet from the mining area because of surface subsidence, which is anticipated in extraction of sulphur by the Frasch process.

The large quantity of water necessary to an operation of this type is obtained from the Mississippi River, near which a 50,000,000-gallon earthen reservoir was constructed for settling the turbid water. The water is pumped from the river into the reservoir and after settling is pumped to the plant through a pipe line 9 miles long. Storage for 2,000,000 gallons of water is provided at the plant. All water for the boiler plant is given hot lime-soda treatment, and water used in mining operations is given a hot lime treatment.

The large quantities of water injected into the formation must have an outlet to maintain a relatively low formation pressure. This waste formation water is conducted to the surface through bleed wells and conveyed to a treating unit, where objectionable sulphide impurities are removed before disposal.

To provide more rapid and economical transportation a canal approximately 100 feet wide, 9 feet deep, and 10 miles long was dredged from Grande Ecaille to a point on the Mississippi River accessible to both rail and highway. Here a base was set up for receiving and handling materials. This river terminal, which was named Grandeport (La.), is being made a model industrial community for employees and their families. The sulphur produced at Grande Ecaille will be transported through the canal to Grandeport in barges where it will be loaded in river barges, vessels, or railroad cars as desired. Loading equipment at the docks permits vessels or barges on the Mississippi River to be charged at the rate of 500 tons per hour.

Production from this dome started December 8, 1933, and by the end of the year totaled 17,705 long tons, but no shipments were made. Lundy [6] has described in detail the development of the property.

*The Jefferson Lake Oil Co.*—The property of the Jefferson Lake Oil Co., known as the Jefferson Island salt dome, was put into operation in the latter part of October 1932 and produced 303,787 long tons of sulphur during 1933. Shipments for the year totaled 128,916 tons.

The Jefferson Island salt dome is in Iberia Parish about 9 miles southwest of New Iberia. The salt core of the dome is roughly elliptical in outline and has a maximum diameter of 6,300 feet on the 800-foot contour as shown by an electromagnetic, seismographic, and torsion-balance survey. More than three fourths of the dome lies beneath the bed of Lake Peigneur at an average depth of 850 feet. The southern edge of the dome, which does not lie under the lake, has a remarkable salt spine which rises 800 feet above the salt table forming the top of the rest of the salt stock. At its highest point the salt spine comes within 75 feet of the surface and is respon-

[6] Lundy, Wilson T., Work cited.

sible for the mound known as Jefferson Island. Howe and Moresi[7] consider this salt spine secondary in origin and the flowage which produced it late Pleistocene or recent. Cap rock was found in only a few holes drilled over the spine and consisted of 18 to 24 inches of porous, gray limestone. Under the lake, however, the cap rock is thicker, and the logs of a number of wells show it to be 250 to 325 feet thick. The production of sulphur has come from the cap rock beneath the lake.

The first drilling on the lake was done from piers, but later a drilling barge permanently equipped with a complete set of drilling machinery was designed and erected to explore beneath the lake for sulphur. In drilling a well a 12-inch surface casing 40 feet long is first set to shut off the lake water and silt. A 10-inch hole is then sunk to cap rock, and an 8-inch casing is set in the hole and cemented. The hole is then drilled and cored to the bottom of the sulphur-bearing formation. Seventy wells have been drilled successfully.

The power plant, which was built and put into operation in 1932, is on the shore of Lake Peigneur about 1 mile from the producing wells. The pipe lines from the plant to the center of mining operations in the lake are supported on pile trestles. Booster pumps for forcing the water into the wells and collecting sumps for sulphur also are built over the lake. The liquid sulphur from the sumps is pumped through insulated pipe lines to vats on the shore near the railroad terminal.

The power plant is equipped with five 600-hp., Babcock & Wilcox, class H boilers designed to operate continuously at 200-percent rating.[8] Two of the boilers were added to the plant in 1933.

The water supply is obtained from a deep well equipped with an electrical pump, which discharges into a large, fresh-water, 50,000,000-gallon reservoir. The water is treated in two 40,000-gallon per hour, Cochrane, hot-process units using lime and soda ash for treatment.

## CALIFORNIA

Production of sulphur in 1933 was reported from two properties in California, namely, the Queen Group near Bigpine in Inyo County and the Leviathan mine near Markleeville in Alpine County. No production in 1933 was reported from the Crater Group in Inyo County.

*Leviathan Sulphur Co.*—The property of the Leviathan Sulphur Co., which started production in 1933, is 10 miles east of Markleeville in Alpine County and about 3 miles from the Nevada State line. The main mass of the ore body is a volcanic rock containing about 40 percent sulphur. It is understood that substantial reserves have been blocked out by underground workings and diamond drills. Underground workings also have encountered amorphous sulphur and a black variety which is said to contain finely divided pyrite. Mining—mostly development work to date—is by underground methods through adits on the mountain side.

The ore is trammed from the opening to the plant, where it is crushed in a jaw crusher, separated into two sizes by a screen trommel, and conveyed to separate bins. The coarse ore is about 1-inch

[7] Howe, Henry V., and Moresi, Cyril K., Geology of Iberia Parish: State of Louisiana, Dept. of Conservation, Geol. Bull. 1, 1931, p. 149.
[8] O'Donnel, Lawrence, Mining Sulphur under Water in Louisiana: Chem. and Met. Eng., vol. 40, no. 9, September 1933, p. 456.

ring, and the fines are about 10-mesh. The ore is then drawn out into a 4½-ton retort car; the car is nearly filled with coarse ore, which is covered with a layer of fine ore. The car is then put in a steam retort and the charge heated for 1 hour. The melted sulphur passes out through the bottom of the car and into a steam-jacketed receiver; the charge in the receiver is drawn off through a steam-jacketed line to the cooling bin, where it is cooled and broken up for shipment. The recovery is poor, and a better process is being devised. The grade of the product, however, is 99.9 percent and virtually arsenic free.[9]

The shipping point is Minden, Nev., about 27 miles away. A new road was constructed in 1933 from the mine to a point on the main highway 14 miles south of Minden.

### UTAH

The Utah Sulphur Industries reported production in Beaver County in 1933; this is the first production since 1929. In 1932 new equipment was installed at the plant to recover sulphur. The sulphur deposit occurs in the crater of an old volcano, and the sulphur is recovered from the ore by flotation. Thoenen[10] has estimated the cost of 85-percent sulphur concentrates at Sulphurdale as $7 to $12.90 per short ton.

### OTHER STATES

*New Mexico.*—During 1933 it was reported that the New Mexico Acid Co. was building a new sulphur plant at Jemez, where extensive exploration revealed the presence of a sulphur deposit. No production was reported for 1933.

*Alaska.*—Early in 1932 the so-called Akun Island sulphur mine about 9 miles from Akutan post office was reported to have been sold to the Pacific Sulphur Corporation.[11]

## WORLD PRODUCTION

World production of sulphur in 1933, including the sulphur recovered in Norway and Spain from the treatment of pyrites in Germany from gas manufacture, amounted to approximately 2,000,000 long tons.

The following table shows production in the principal producing countries during the last 6 years:

*Production of sulphur in the principal producing countries, 1928–33, 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 | 60,528 | 2,195 | 5,018 | 10,867 |
| 1932 | 890,440 | 344,450 | 25,119 | 75,868 | (1) | 8,459 | 8,113 |
| 1933 | 1,406,063 | [2] 356,000 | (1) | 102,412 | (1) | [2] 16,000 | [2] 8,000 |

[1] Data not available.
[2] Estimate.

[9] Mining and Metallurgy, vol. 14, no. 323, November 1933, p. 471.
[10] Thoenen, J. R., Economics of Potash Recovery from Wyomingite and Alunite: Rept. of Investigations 3190, Bureau of Mines, 1932, p. 9.
[11] Smith, Philip S., Mineral Industry of Alaska in 1932: U.S. Geol. Surv. Bull. 857-A, 1934, p. 76.

## ITALY

Preliminary reports indicate that production of sulphur in Italy in 1933 totaled 356,000 long tons, a small increase over 1932 and the largest output since 1914. Mines on the mainland produced about 111,000 tons and those on the Island of Sicily contributed the remaining 245,000 tons. Exports of sulphur from Italy, however, decreased to 217,810 long tons in 1933 from 269,606 tons in 1932.

During the latter part of 1933 the sulphur industry in Italy, particularly in Sicily, was adversely affected by the drop in value of the American dollar. World prices for American sulphur remained at practically the same figure in dollars as before the departure from the gold standard. The lower value of the dollar effectively reduced the price of sulphur and placed the Sicilians at a disadvantage in the export markets.

With dissolution of the old obligatory consortium in 1932 a new voluntary consortium was formed by certain producers in Sicily, but this new group controlled only about one third of the sulphur output of the Island and consequently was not very effective. An official decree of August 8, 1933, provided for amplification of the autonomous technico-mining section of the dissolved obligatory consortium into the form of a Board for the Improvement of the Sicilian Sulphur Industry (Ente per il Miglioramento dell'Industria Solfifera Siciliana). The decree authorized the organization to institute geological studies, geophysical investigations, and research investigations in ore dressing and other methods of recovering minerals and provided further for other general measures to improve the Sicilian sulphur industry from a technical and economic viewpoint. This measure, however, did not alleviate the immediate distress of the sulphur industry in Sicily.

Later in the year the Sicilian situation developed graver aspects. The voluntary consortium was staggering under heavy losses, some of the most important mines had gone into liquidation, and many others were faced with the imminent possibility of closing. On October 14 the Government announced that a central sales bureau would be formed. The act creating the bureau, dated December 11, 1933, provides for a Central Sulphur Sales Bureau with headquarters at Rome, which will handle both domestic and export sales of all crude sulphur produced in Italy, whether in Sicily or on the mainland. The bureau is authorized to guarantee producers a minimum sales price, the difference, if any, between the guaranteed minimum and the actual market price to be made up out of a sum of 10 million lire appropriated by the Government for the 2 fiscal years 1933–34 and 1934–35. The quota for Sicily on which a minimum price is guaranteed is limited to the average sales tonnage for the last 3 years of the former obligatory sulphur consortium—1929–30, 1930–31, and 1931–32; the mainland quota is based on the average output of each mine during the 3-year period 1930–32. The preparation and direct sale of sulphur ore used largely in the treatment of grape vines was prohibited, but this restriction was subsequently modified. The bureau will operate until July 31, 1940. It will be administered by a board of six members, appointed by the Minister of Corporations and the Minister of Finance, whose term of office will be 4 years. In addition to the board, there are three trustees, representatives of the ministries of the Treasury and Corporations.

The Central Sulphur Sales Bureau will take over the remaining stocks of the former sulphur consortium and all stocks in the hands of private producers on the date of publication of the decree. Private operators, however, will be permitted to fulfill contracts closed before the decree was published. A decree dated January 26, 1934, authorized the bureau to guarantee sulphur producers the following minimum prices on all sulphur held at the time of publication of the act of December 11, 1933, and on sulphur produced between that date and July 31, 1934:

| Grade: | *Lire per ton* |
|---|---|
| Superior yellow | 267 |
| Inferior yellow | 257 |
| Good | 249 |
| Ordinary | 241 |

Since conclusion of the marketing agreement between Sicilian and American interests in 1932 several attempts to form a new arrangement have been made but were not culminated, due largely to points of difference between the Sicilian producers and those on the Italian mainland. American producers were able to present a united front through the Sulphur Export Corporation and preferred to deal with a single source of supply for all Italy. Concentration of all Italian sales into one organization may facilitate future negotiations with American exporters for a marketing agreement similar to those in effect in the past.

A 50-year concession to exploit sulphur mines on the Italian island of Nisiros in the Aegean has been granted by the Italian Government to an Anglo-Italian group.[12]

## JAPAN

Increased activity in the Japanese chemical industry is reflected in the increased output of sulphur in 1933 which amounted to 102,412 long tons, a gain of more than 26,000 tons over 1932 and greater than in any year since the war-expanded production of 1917.

Exports of sulphur from Japan also increased substantially, amounting to 32,115 long tons in 1933 compared with 25,998 tons in 1932 and 14,183 tons in 1931.

## SPAIN

Spain's output of sulphur in 1933 is estimated at 8,000 long tons. The bulk of the sulphur comes from Teruel, Murcia, and Albacete, with smaller quantities from mines in Almeria where the Tigon Mining & Finance Corporation, Ltd., is operating.

The above estimate does not include the sulphur recovered from pyrites in Huelva by the Rio Tinto Co., which is using the Orkla process; moreover, such sulphur is not included in the official Spanish figures for 1932. However, 1932 is believed to have been the first year in which this sulphur-extraction plant was operated successfully and apparently its production of sulphur in 1932 was about 4,500 long tons. The increasing output from this source may make Spain independent of foreign supplies of sulphur and appreciably curtail its imports from the United States and Italy.

[12] London Mining Journal, Sulphur from the Aegean: Vol. 183, no. 5131, Dec. 23, 1933, p. 903.

## PORTUGAL

A new plant for the extraction of sulphur from pyrite, presumably by the Orkla method, was being constructed during 1933 at the San Domingos mine in the Province of Alemtejo. It is understood that this plant will supply Portugal and allow a surplus for export.

## CHILE

Production of sulphur in Chile in 1933 is estimated at 16,000 long tons. Exports were about 14,000 tons, of which about 8,300 tons went to other countries in South America and the remainder to the United States and Europe.

The sulphur produced in Chile comes from two regions in the northern part of the country. The industry has been described by Griffith.[13]

## PERU

Except for a small output by local Indians, who use sulphur for medicinal purposes, no sulphur is produced in Peru. However, in the high volcanic region of southern Peru there are occurrences of sulphur [14] similar to those of northern Chile which are being worked on a commercial scale.

## GERMANY

Germany has no commercial deposits of native sulphur; and in the past its requirements have been met by imports, largely from the United States. Recently, however, successful processes for the recovery of sulphur in the manufacture of various industrial gases, such as coke-oven gas, generator gas, water gas, etc., have been applied, but production has not been appreciable until the past 2 years.

Most of the installations recover sulphur from the spent oxide mass, which is subsequently regenerated and reused in gas purification. Several installations, however, use a wet process for the removal and subsequent recovery of sulphur from gas. A new installation at Dortmund will use the Thylox process.

Extensive development of the long-distance gas-supply system from the coke industry of the Ruhr district made available large quantities of the gas-purification mass. Marketing difficulties for this by-product brought about an improved method of extracting its sulphur content in relatively pure form. The new process has been adopted by the Ruhrgas A./G. at Gelsenkirchen, Westphalia, in cooperation with all the coal-mining companies in the district, whereby the sulphur is recovered in a large central plant. This plant was established in March 1932 and produced about 5,200 long tons of sulphur in that year and 7,000 tons in 1933. The entire German production will amount to about 12,000 tons in 1933.

The lowering of the price of sulphur at the conclusion of the American-Sicilian agreement and the depreciation of the American dollar since April 1933 have made production conditions in Germany less favorable, and late in the year the German producers were asking for an import duty to protect their product in the home market.

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[13] Griffith, S. V., Sulphur in Chile: Min. Mag. (London), vol. 49, no. 3, September 1933, pp. 137–144, and vol. 49, no. 4, October 1933, pp. 213–219.

[14] Ferron, Robert D., Sulphur in Peru: Eng. and Min. Jour., vol. 135, no. 2, February 1934, pp. 64–65.

NORWAY

Sulphur is produced on a commercial scale in Norway by the Orkla process [15] at the Thamshavn Plant of the Orkla Metal Co., a subsidiary of the Orkla Mining Co. Data on the output in 1933 are not yet available, but it may be estimated at 60,000 tons. Exports of sulphur from Norway in 1933 reached a total of 58,950 long tons. The production of sulphur in Norway by this process is expected to have some effect on the foreign trade in sulphur in Norway and nearby countries in Northern Europe.

The following table, compiled from official sources, shows imports and exports of sulphur in Norway from 1928 to 1933.

*Sulphur imported into and exported from Norway, 1928–33, in long tons* [1]

| Year | Imports | Exports | | | Year | Imports | Exports | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Domestic | Other | Total | | | Domestic | Other | Total |
| 1928 | 14,721 | | | | 1931 | 6,347 | 6,393 | | 6,393 |
| 1929 | 17,551 | 574 | 203 | 777 | 1932 | 11,138 | 46,116 | 1 | 46,117 |
| 1930 | 16,480 | 1,339 | 199 | 1,538 | 1933 | (2) | (2) | (2) | 58,950 |

[1] Manedsopgaver over Vareomsetningen med Utlandet.
[2] Data not available.

The sulphur exported from Norway in 1933 went principally to Finland and Sweden; smaller quantities went to Germany and Belgium.

OTHER COUNTRIES

Less important quantities of sulphur are produced in China, Greece, Mexico, Netherland East Indies, New Zealand, Southern Rhodesia, and the U.S.S.R. (Russia). Recent reports indicate that large sulphur reserves were discovered in Soviet Russia during the past several years. Activities in sulphur exploration were also reported from Palestine, Persia, and Turkey.

## PYRITES

*Domestic production.*—Production of pyrites (ores and concentrates) in the United States amounted to 284,311 long tons in 1933, an increase of 50 percent over the production of 189,703 tons in 1932. The following table gives production during the last 5 years.

*Pyrites (ores and concentrates) produced in the United States, 1929–33*

| Year | Quantity | | Value | Year | Quantity | | Value |
|---|---|---|---|---|---|---|---|
| | Gross weight (long tons) | Sulphur content (percent) | | | Gross weight (long tons) | Sulphur content (percent) | |
| 1929 | 333,465 | 36.1 | $1,250,141 | 1932 | [1] 189,703 | [1] 35.0 | [1] $498,570 |
| 1930 | 347,512 | 35.7 | 1,028,680 | 1933 | 284,311 | 37.9 | 769,942 |
| 1931 | 330,848 | 36.7 | 974,820 | | | | |

[1] Revised figures.

[15] Ridgway, R. H., and Mitchell, A. W., Sulphur and Pyrites: Minerals Yearbook, 1932–33, Bureau of Mines, p. 685.

Of the total production in 1933, 94,061 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 37.91 percent (107,778 tons of sulphur) compared with 35.02 percent (66,432 tons—revised figures) in 1932.

The quantity of pyrites (ores or concentrates) sold or consumed by the producing companies totaled 282,583 long tons in 1933 compared with 188,872 tons (revised figures) in 1932. In 1933, 96,874 tons were sold by producers, all to domestic consumers. The prices of pyrites quoted by the trade journals are those for imported pyrites and are given in cents per long-ton unit c.i.f. Atlantic ports; the average quoted was 12 to 13 cents per long-ton unit throughout the year.

Virginia was the largest producing State in 1933; other producers were California, Colorado, Missouri, Montana, New York, Tennessee, and Wisconsin.

## INDUSTRY IN 1933, BY STATES

*California.*—Pyrites was produced from two mines in California in 1933—the Leona Heights mine at Oakland, Alameda County, and the Hornet mine in Shasta County.

*Colorado.*—Bowden and Biddle reported shipments of 4,059 long tons of pyrites in 1933 from the mill-tailings dump of the Colorado Zinc Lead mill in Lake County. The pyrites, which averaged 38 percent sulphur, was shipped to the Denver plant of the General Chemical Co., where it is used for the manufacture of sulphuric acid.

*Missouri.*—Three operators (two mines) in Franklin County and two in Crawford County reported a production of 18,355 long tons of pyrites in 1933 compared with one mine producing 3,958 tons in 1932.

The principal output in 1933 came from the Rueppele mine in Franklin County, which was operated during the first part of the year by Henry E. Aspoas, and during the latter part by the Ozark Iron & Sulphur Co. The ore, which is principally marcasite, is classed as fines and contains 42 percent sulphur. E. C. Dixon produced a small amount of pyrites from the St. Clair mine in Franklin County. The Hobo mine near Bourbon in Crawford County was reopened in February 1933 and produced marcasite fines averaging 45 percent sulphur. Pyrites was also produced in Crawford County at the Cherry Valley mine near Steelville; the output was fines averaging 48 to 50 percent sulphur.

Virtually all the pyrites produced in Missouri is marcasite. The output in 1933 was shipped to the Evans-Wallower Zinc Co. at East St. Louis, Ill., where it is roasted for acid manufacture.

*Montana.*—Prior to 1931 the acid made by the Anaconda Copper Mining Co. at Anaconda was from the roasting of a table copper concentrate, but subsequent changes in the copper plant made it desirable to discontinue production of such a concentrate. This raw material for the acid plant has been replaced by an iron concentrate consisting of rather pure pyrite recovered by flotation of tailings from the copper-flotation operation. The change was accomplished successfully, and the acid plant no longer uses copper-bearing material as a source of sulphur.[16]

[16] Larison, E. L., Sulphuric Acid and Phosphate Industries at Anaconda Reduction Works: Trans. Am. Inst. Min. and Met. Eng., Contrib. 70, 1934, pp. 8–9.

*New York*.—During 1933 the St. Joseph Lead Co. produced 19,824 long tons of pyrites concentrates at its Balmat mine, St. Lawrence County. The pyrites, which ran about 51 percent sulphur, was produced as a flotation concentrate in the treatment of ore in which zinc is the principal value.

*Tennessee*.—The pyrites produced in Tennessee in 1933 came from operations of the Tennessee Copper Co. and the Ducktown Chemical & Iron Co., both in the Ducktown Basin, Polk County. It does not enter the market as pyrites, as both companies use all their product in the manufacture of sulphuric acid.

The Tennessee Copper Co., a subsidiary of the Tennessee Corporation, operated the Burra Burra mine in 1933. The Eureka and Polk County mines were not operated during the year. The concentrating plant is equipped with a 900-ton flotation mill, where pyrites is produced as a flotation concentrate containing pyrrhotite and pyrite. Operations of the company continued at a reduced rate during the year.

The pyrites produced 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 then mixed and sent to the roasters.

*Virginia*.—The only pyrites mined in Virginia in 1933 came from the Gossan mine at Cliffview, Carroll County, operated by the General Chemical Co. The ore, which is both lump and fines, is mined by opencut and underground methods and is used for the manufacture of sulphuric acid in the company plant at Pulaski.

*Wisconsin*.—The only company reporting pyrites production in Wisconsin in 1933 was the Vinegar Hill Zinc Co. in Grant County, which makes a pyrites concentrate at its magnetic separation plant at Cuba City from raw zinc concentrates obtained from several mines in the Platteville district.

## FOREIGN TRADE

Imports of pyrites amounted to 374,417 long tons in 1933 compared with 253,248 tons in 1932, an increase of 48 percent. There were no exports in 1932 or 1933. The following table shows imports from 1929 to 1933:

*Pyrites, containing more than 25 percent sulphur, imported into the United States, 1929–33, by sources*

[General imports]

| Country | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Long tons | Value | Long tons | Value | Long tons | Value | Long tons | Value | Long tons | Value |
| Canada | 68, 243 | $240, 411 | 42, 117 | $145, 645 | 24, 245 | $109, 440 | 12, 070 | $53, 618 | 29, 970 | $131, 940 |
| Spain | 446, 093 | 1, 267, 237 | 325, 992 | 891, 352 | 327, 771 | 1, 386, 457 | 241, 178 | 637, 526 | 341, 878 | 995, 551 |
| U.S.S.R. (Russia) | | | 5 | 20 | 50 | 300 | | | 2, 569 | 4, 646 |
| | 514, 336 | 1, 507, 648 | 368, 114 | 1, 037, 017 | 352, 066 | 1, 496, 197 | 253, 248 | 691, 144 | 374, 417 | 1, 132, 137 |

The customs districts into which pyrites has been imported during the last 5 years are shown in the following table:

*Pyrites, containing more than 25 percent sulphur, imported into the United States, 1929–33, by customs districts, in long tons*

| Customs district | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Buffalo | 413 | 90 | 114 | | |
| Georgia | | 5,554 | 5,628 | | 4,066 |
| Maine and New Hampshire | 25,751 | | | | |
| Maryland | 182,249 | 175,611 | 125,559 | 100,434 | 136,113 |
| New York | 54,331 | 42,145 | 55,225 | 33,596 | 54,536 |
| Philadelphia | 166,056 | 87,178 | 128,650 | 95,640 | 135,392 |
| San Francisco | 52,514 | 7,990 | | | |
| South Carolina | 5,696 | 7,322 | 5,053 | 4,008 | 6,700 |
| Vermont | 17,326 | 19,591 | 24,131 | 12,070 | 28,446 |
| Virginia | 10,000 | 8,187 | 7,706 | 7,500 | 7,700 |
| Washington | | 14,446 | | | 1,524 |
| | 514,336 | 368,114 | 352,066 | 253,248 | 374,417 |

Considering the recoverable sulphur content of the imported pyrites as 45 percent, the quantity of sulphur available in imported pyrites in 1933 was approximately 168,500 long tons.

## WORLD PRODUCTION

The following table shows world production of pyrites and the quantity of sulphur it is supposed to replace in the market. Most of the figures are taken from official sources of the countries concerned, supplemented by information from publications of the Imperial Institute and other reliable sources.

*World production of pyrites (including cupreous pyrites), 1929–33, in metric tons*

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Algeria: | | | | | |
| Gross weight | 16,804 | 16,628 | 21,811 | 21,159 | (2) |
| Sulphur content | 7,730 | 7,483 | 10,033 | (2) | (2) |
| Australia (Tasmania): | | | | | |
| Gross weight | | | 515 | 278 | (2) |
| Sulphur content | | | (2) | (2) | (2) |
| Canada: | | | | | |
| Gross weight | 70,087 | 48,619 | 57,418 | 47,210 | 53,164 |
| Sulphur content | [3] 39,949 | 25,163 | 28,822 | 23,547 | 25,563 |
| Cyprus: [4] | | | | | |
| Gross weight | 295,772 | 242,316 | 202,993 | 180,481 | (2) |
| Sulphur content | 147,886 | 121,158 | 101,496 | 90,240 | (2) |
| Czechoslovakia: | | | | | |
| Gross weight | 23,005 | 21,669 | 20,694 | 15,640 | (2) |
| Sulphur content | 9,087 | 8,559 | 8,174 | 6,569 | (2) |
| France: | | | | | |
| Gross weight | 202,189 | 196,320 | 193,240 | 190,756 | (2) |
| Sulphur content | 91,468 | 89,660 | 88,170 | (2) | (2) |
| Germany: | | | | | |
| Gross weight | 351,909 | 289,741 | 223,997 | 175,217 | (2) |
| Sulphur content | 149,983 | 124,123 | 96,550 | 75,344 | (2) |
| Greece: | | | | | |
| Gross weight | 134,399 | 177,808 | 141,442 | (2) | (2) |
| Sulphur content | 64,434 | 85,403 | 67,356 | (2) | (2) |
| Hungary: | | | | | |
| Gross weight | 1,023 | 1,069 | (2) | (2) | (2) |
| Sulphur content | (2) | (2) | (2) | (2) | (2) |
| India, British: | | | | | |
| Gross weight | 299 | 23 | | | (2) |
| Sulphur content | (2) | (2) | | | (2) |

[1] In addition to countries listed Chosen reports production as follows: 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.

*World production of pyrites (including cupreous pyrites), 1929–33, in metric tons*—Continued

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Italy: | | | | | |
| Gross weight | 664,543 | 717,270 | 645,759 | 516,961 | (2) |
| Sulphur content | 305,847 | 314,790 | 300,407 | 237,699 | (2) |
| Japan: | | | | | |
| Gross weight | 618,743 | 561,400 | 560,374 | (2) | (2) |
| Sulphur content | (2) | (2) | (2) | (2) | (2) |
| Norway: | | | | | |
| Gross weight | 739,597 | 730,951 | 359,951 | 727,020 | 860,000 |
| Sulphur content | 323,844 | 324,084 | 160,071 | 318,990 | (2) |
| Poland: | | | | | |
| Gross weight | 9,410 | 11,046 | 3,591 | 219 | (2) |
| Sulphur content | (2) | 4,860 | 1,580 | 96 | (2) |
| Portugal: | | | | | |
| Gross weight | 384,350 | 400,224 | 287,118 | 237,637 | (2) |
| Sulphur content | (2) | (2) | (2) | (2) | (2) |
| Rumania: | | | | | |
| Gross weight | 23,851 | 24,264 | 24,784 | 5,350 | 20,450 |
| Sulphur content | (2) | (2) | (2) | (2) | (2) |
| Southern Rhodesia: | | | | | |
| Gross weight | ---------- | ---------- | ---------- | 272 | 11,080 |
| Sulphur content | ---------- | ---------- | ---------- | 109 | (2) |
| Spain: | | | | | |
| Gross weight | 3,867,250 | 3,416,465 | 2,593,933 | 2,146,441 | (2) |
| Sulphur content | 1,496,756 | 1,517,789 | 1,089,000 | 901,505 | (2) |
| Sweden: [5] | | | | | |
| Gross weight | 72,055 | 60,441 | 57,610 | 71,534 | (2) |
| Sulphur content | 27,498 | 23,404 | 22,789 | 27,963 | (2) |
| U.S.S.R. (Russia): [6] | | | | | |
| Gross weight | (2) | 241,718 | (2) | (2) | (2) |
| Sulphur content | (2) | (2) | (2) | (2) | (2) |
| Union of South Africa: | | | | | |
| Gross weight | 4,116 | 3,603 | 3,768 | 3,436 | 3,026 |
| Sulphur content | (2) | (2) | (2) | (2) | (2) |
| United Kingdom: | | | | | |
| Gross weight | 4,441 | 5,585 | 2,011 | 1,008 | (2) |
| Sulphur content | (2) | (2) | (2) | (2) | (2) |
| United States: | | | | | |
| Gross weight | 338,817 | 353,090 | 336,158 | 192,748 | 288,874 |
| Sulphur content | 122,303 | 126,220 | 123,453 | 67,498 | 109,508 |
| Yugoslavia: | | | | | |
| Gross weight | 61,153 | 50,345 | 29,495 | 15,729 | (2) |
| Sulphur content | (2) | (2) | (2) | (2) | (2) |

[2] Data not available.
[5] Exclusive of sulphur content of ore from the Boliden mine which, prior to 1932, was reported as arsenic ore and in 1932 was listed as gold, copper, and arsenic ore.
[6] Year ended Sept. 30.

*Spain.*—Figures for production of pyrites in 1933 in Spain, the principal world producer, are not yet available, but the increase in exports indicates that production may have been at a higher rate. Exports of iron pyrites increased from 1,323,954 metric tons in 1932 to 1,708,468 tons in 1933. Exports of cupreous iron pyrites containing 1.5 to 5 percent copper but more than 45 percent sulphur decreased from 352,173 to 199,490 tons.

*Norway.*—Production of pyrites is the principal mining industry of Norway, the second largest world producer of this commodity. The output in 1933 reached a new record; it is estimated at 860,000 metric tons compared with 727,020 tons in 1932. Of the total about 624,000 tons were cupreous iron pyrites; the remainder contained little or no copper. Exports of pyrites in 1933 totaled 575,918 metric tons, of which 330,695 tons were cupreous and 245,223 tons were poor in copper.

*Canada.*—Production of pyrites in Canada totaled 53,164 metric tons in 1933 compared with 47,210 tons in 1932; all came from British Columbia and Quebec in both years. The pyrites in 1933 contained 48 percent sulphur and was a little lower in grade than that in 1932 and 1931.

The total for British Columbia was 17,494 metric tons in 1933 compared with 14,334 tons in 1932. The pyrites in 1933 contained 46.7 percent sulphur and came from the Britannia mill, where a pyrites concentrate is produced in the treatment of ores for the extraction of copper.

Quebec's output increased to 35,670 metric tons in 1933 from 32,876 tons in 1932. Production in 1933 came from the 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 in 1933 contained 48.7 percent sulphur.

Canada has an important production of sulphur in the form of sulphuric acid from smelter gases. In 1933 about 26,500 metric tons of sulphur were recovered as acid manufactured from smelter gases at Copper Cliff, Ontario, and Trail, British Columbia.

# SALT, BROMINE, CALCIUM CHLORIDE, AND IODINE

By A. T. Coons

SUMMARY OUTLINE



## SALT

Salt produced for sale or use by operators of salt mines, wells, and ponds in the United States in 1933 totaled 7,604,972 short tons valued at $22,318,086, an increase of 19 percent in quantity and 12 percent in value compared with 1932. The output of evaporated salt in 1933 (2,358,954 tons valued at $15,064,491) represented 31 percent of the total quantity of salt produced, an increase of 15 percent in quantity and 12 percent in value compared with 1932. The salt content (3,461,026 tons) of the brine produced and used by producers in the manufacture of chemicals represented 46 percent of the total salt output, an increase of 25 percent in quantity. Rock salt produced (1,784,992 tons valued at $5,570,352) represented 23 percent of the total output, an increase of 13 percent in quantity and 9 percent in value. The average value of all salt in 1933 was $2.93 a short ton, 18 cents less than in 1932; that of evaporated salt, including pressed blocks from evaporated salt, was $6.39, 17 cent less than in 1932; and that of rock salt was $3.12, 10 cents less than in 1932.

Seventy-four plants (57 companies) reported operations in 1933 compared with 72 plants (59 companies) in 1932.

*Salt sold or used by producers in the United States, 1929–33*

| Year | Short tons | | | | Value [1] | |
|---|---|---|---|---|---|---|
| | Manufactured (evaporated) | In brine | Rock salt | Total | Total | Average |
| 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] 2,053,421 | 2,769,821 | [2] 1,584,731 | [2] 6,407,973 | [2] 19,938,830 | [2] 3.11 |
| 1933 | 2,358,954 | 3,461,026 | 1,784,992 | 7,604,972 | 22,318,086 | 2.93 |

[1] The values are f.o.b. mine or refinery and do not include cost of cooperage or containers.
[2] Revised figures.

Figure 92 gives the tonnage and value of salt sold or used by producers, 1924–33.

Figure 93 shows the tonnage of salt sold or used by producers in the United States, 1923–33, by classes. The brine salt represents the salt content of brine produced and used by chemical manufacturers.

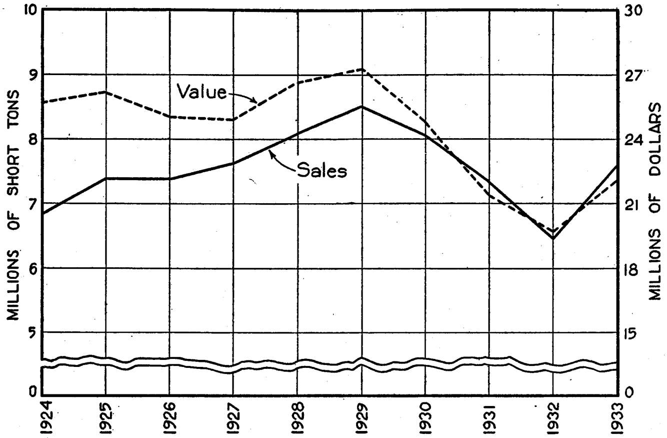


FIGURE 92.—Quantity and value of salt sold or used by producers in the United States, 1924–33.

Michigan continued to be the leading salt-producing State, followed by New York, Ohio, Kansas, and Louisiana. Michigan also retained first rank as a producer of evaporated salt, followed in 1933 by New

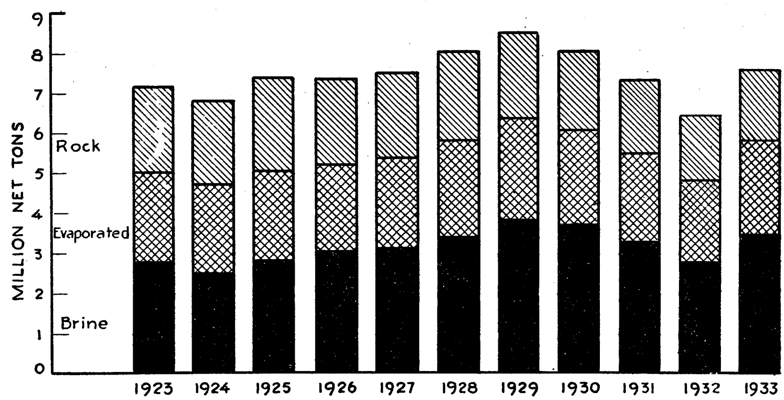


FIGURE 93.—Trends in the quantity of rock salt, evaporated salt, and brine (in terms of salt content) sold or used by producers in the United States, 1923–33.

York, Ohio, California, and Kansas. In 1933 Louisiana led in output of rock salt, followed by New York, Kansas, and Michigan. Ohio Michigan, New York, Virginia, and West Virginia produced brine from which various chemical products are manufactured.

*Salt sold or used by producers in the United States, 1931–33, by States*

| State | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| California | 334,900 | $2,000,567 | 281,349 | $1,824,021 | 331,009 | $2,018,694 |
| Kansas | 691,160 | 3,003,756 | [1] 648,800 | 2,876,239 | 732,947 | 3,039,343 |
| Louisiana | 529,280 | 1,962,690 | 488,805 | [1] 2,095,948 | 532,569 | 2,345,208 |
| Michigan | 2,053,980 | 5,760,001 | 1,715,304 | 4,845,379 | 2,090,254 | 5,679,737 |
| New York | 1,788,940 | 5,293,470 | 1,556,642 | [1] 4,785,351 | 1,847,696 | 5,120,846 |
| Ohio | 1,398,000 | 2,526,952 | 1,196,993 | 2,429,613 | 1,382,294 | 2,599,055 |
| Puerto Rico | 11,560 | 19,878 | 7,342 | 13,725 | (2) | (2) |
| Texas | 103,040 | 468,562 | 139,730 | 482,118 | 165,603 | 560,085 |
| Utah | 74,010 | 159,778 | 61,230 | 132,930 | 56,305 | 141,330 |
| West Virginia | 35,480 | 218,762 | 49,629 | 243,185 | 63,818 | 329,051 |
| Undistributed [3] | 337,720 | 126,596 | 262,149 | 210,321 | 402,477 | 484,737 |
| | 7,358,070 | 21,541,012 | [1] 6,407,973 | [1] 19,938,830 | 7,604,972 | 22,318,086 |

[1] Revised figures.
[2] Included under "Undistributed."
[3] 1931 and 1932, Nevada, New Mexico, Oklahoma, and Virginia; 1933, Nevada, New Mexico, Oklahoma, Puerto Rico, and Virginia.

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, 1932–33, by methods of manufacture*

| Method of manufacture | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| Evaporated in open pans or grainers | [1] 592,340 | [1] $4,476,854 | 573,240 | $4,634,344 |
| Evaporated in vacuum pans | [1] 1,073,153 | [1] 7,196,711 | 1,310,676 | 8,122,608 |
| Solar evaporated | 268,690 | 943,613 | 322,368 | 1,177,718 |
| Pressed blocks from evaporated salt | [1] 119,238 | 848,194 | 152,670 | 1,129,821 |
| Rock | [1] 1,558,227 | [1] 4,947,528 | 1,754,487 | 5,401,518 |
| Pressed blocks from rock salt | [1] 26,504 | 153,251 | 30,505 | 168,834 |
| Salt in brine (sold or used as such) | 2,769,821 | 1,372,679 | 3,461,026 | 1,683,243 |
| | [1] 6,407,973 | [1] 19,938,830 | 7,604,972 | 22,318,086 |

[1] Revised figures.

*Evaporated salt sold or used by producers in the United States, 1932–33, by States*

| State | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| California | 268,728 | $1,773,422 | 322,728 | $1,984,923 |
| Kansas | [1] 254,638 | 1,934,148 | 286,436 | 2,075,914 |
| Michigan | 691,911 | 3,831,751 | 799,905 | 4,313,849 |
| New York | 340,294 | [1] 3,152,722 | 355,956 | 3,335,367 |
| Ohio | 305,689 | 1,978,016 | 334,266 | 2,046,111 |
| Puerto Rico | 7,342 | 13,725 | (2) | (2) |
| West Virginia [3] | 49,629 | 243,185 | 63,818 | 329,051 |
| Undistributed [4] | 135,190 | [1] 538,403 | 195,845 | 979,276 |
| | [1] 2,053,421 | [1] 13,465,372 | 2,358,954 | 15,064,491 |

[1] Revised figures.
[2] Included under "Undistributed."
[3] Includes a quantity of salt content of brine for chemical use reported as evaporated salt with value as evaporated salt.
[4] 1932, Louisiana, Nevada, New Mexico, Oklahoma, Texas, and Utah; 1933, Louisiana, New Mexico, Oklahoma, Puerto Rico, Texas, and Utah.

Louisiana, Kansas, New York, and Michigan together produced about 92 percent of the rock salt mined in 1933 compared with 93 percent in 1932. Other States producing rock salt were Texas, California, and Utah.

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, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 2, 113, 010 | $7, 127, 681 | 1932 | [1] 1, 584, 731 | [1] $5, 100, 779 |
| 1930 | 1, 977, 370 | 6, 391, 775 | 1933 | 1, 784, 992 | 5, 570, 352 |
| 1931 | 1, 854, 170 | 5, 735, 207 | | | |

[1] Revised figures.

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, Oklahoma, Utah, California, 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, 1929–33*

| Year | From evaporated salt | | From rock salt | | Total | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| 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 | [1] 119, 238 | 848, 194 | [1] 26, 504 | 153, 251 | [1] 145, 742 | 1, 001, 445 |
| 1933 | 152, 670 | 1, 129, 821 | 30, 505 | 168, 834 | 183, 175 | 1, 298, 655 |

[1] Revised figures.

*Shipments.*—Requests to producers for a statement of their shipments of salt by States in 1933 were complied with by all but three producers. These companies stated that their records did not show shipments by States. The information received, however, covered 93 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 1933, by States, in short tons*

| Destination | Evaporated | Rock | Destination | Evaporated | Rock |
|---|---|---|---|---|---|
| Alabama | 7,028 | 33,205 | New Hampshire | 5,631 | 20,831 |
| Arizona | 6,320 | 1,839 | New Jersey | 50,952 | 99,446 |
| Arkansas | 15,757 | 18,413 | New Mexico | 4,883 | 5,065 |
| California | 183,926 | 16,135 | New York | 174,258 | 250,674 |
| Colorado | 16,249 | 886 | North Carolina | 24,612 | 42,149 |
| Connecticut | 12,751 | 4,442 | North Dakota | 10,508 | 1,051 |
| Delaware | 4,299 | 1,748 | Ohio | 109,776 | 50,620 |
| District of Columbia | 4,448 | 1,899 | Oklahoma | 34,971 | 17,352 |
| Florida | 4,261 | 20,118 | Oregon | 23,570 | 212 |
| Georgia | 12,130 | 39,746 | Pennsylvania | 99,962 | 74,041 |
| Idaho | 10,706 | 655 | Rhode Island | 6,653 | 6,402 |
| Illinois | 213,838 | 136,585 | South Carolina | 5,974 | 13,789 |
| Indiana | 64,458 | 48,768 | South Dakota | 12,696 | 13,211 |
| Iowa | 66,820 | 74,151 | Tennessee | 27,721 | 36,051 |
| Kansas | 37,974 | 120,403 | Texas | 58,889 | 116,853 |
| Kentucky | 27,401 | 15,602 | Utah | 10,143 | 1,322 |
| Louisiana | 3,161 | 46,803 | Vermont | 6,374 | 995 |
| Maine | 8,411 | 15,871 | Virginia | 35,998 | 12,855 |
| Maryland | 23,823 | 13,334 | Washington | 50,707 | 951 |
| Massachusetts | 56,619 | 26,196 | West Virginia | 63,686 | 19,414 |
| Michigan | 195,568 | 28,289 | Wisconsin | 85,296 | 27,266 |
| Minnesota | 68,574 | 58,677 | Wyoming | 5,901 | 1,969 |
| Mississippi | 2,448 | 29,363 | Other [1] | 88,697 | 35,297 |
| Missouri | 58,637 | 55,037 | | | |
| Montana | 12,175 | 1,633 | | | |
| Nebraska | 33,176 | 36,349 | Total shipments reported | 2,150,942 | 1,694,043 |
| Nevada | 2,126 | 80 | Total sales | 2,314,068 | 1,784,992 |

[1] Includes production of Puerto Rico (evaporated salt) and shipments to Alaska, Puerto Rico, and Hawaii and to Australia, Canada, Central America, Cuba, Japan, Mexico, South America, U.S.S.R. (Russia), West Indies, and countries not specified.

## CODE OF FAIR COMPETITION

A Code of Fair Competition for the Salt-Producing Industry was approved by the President on September 7, 1933. Wages ranging from 25 to 35 cents an hour and a 40- to 48-hour week are provided. In submitting the Code for approval the Administrator made the following comments:

The salt-producing industry is a minor industry in the United States. In 1929, there were 58 establishments giving employment to about 5,458 persons. In 1931, the number of firms had dropped to 53 and the number of employees to 4,728. It has been estimated that in June 1933 the number of employees had dropped to 4,387.

Operating practices in this industry differ in marked degree in various parts of the country because of the source and method used to obtain salt, the hour and wage rates previously prevailing, and the type of community in which the salt production has been carried on; because of these factors, the wage and hour provisions contained in this code are not as uniform as in most codes, but do represent substantial increases. For example, in the case of males in Louisiana, there is an increase in the hourly rate paid of approximately 80 percent and, in the case of females, 140 percent.

You will note that there is a wage differential provided for North and South, as well as for male and female labor. These differentials are not based on sex, race, or regional grounds, but solely on the basis of the kind of work performed and the varying cost of living.

Of outstanding note in this code is the "child-labor" provision, particularly that part which reads "No one under 21 years of age shall be permitted to work in the mines below ground." This is indeed a forward-looking provision.

Hours are markedly reduced from the prevailing 60- to 70-hour week. The 7-day week is eliminated, and every worker is guaranteed 1 day's rest in 7.

It is estimated that approximately 20 percent more employees will be required.

The code recognizes that salt is a cheap commodity and that its distribution is governed to a large extent by transportation costs. Each producing area has its own marketing territory in which its major salt distribution is concentrated. Transportation costs limit the extent of these territories. No change in past marketing practices is advocated, for according to the code:

Time and experience have developed an orderly method of marketing under which the producers in each producing field publish their prices applying in their respective natural marketing fields; and this industry declares its policy to be that such practices shall be continued. Each producer in each field of production shall individually publish to the trade and to the Code Committee the prices at which he will sell. Any producer may change his prices provided 10 days' prior notice thereof be given to the Code Committee. The minimum prices published in any marketing field by any producer in that field shall be the lowest prices at which any producer may sell in that field. The Code Committee shall furnish such published prices to the Administrator at his request. Upon complaint to the Code Committee, or on its own motion, the Code Committee may require the reduction of the minimum prices in existence at any time for any marketing field, by reason of the operation of the provisions of this Article, to figures which shall be found by the Committee to constitute reasonable minimum prices, the action of the Code Committee under this Article to be subject to review by the Administrator, who, in the event of their failure to act, may act upon his own motion.

No producer shall sell any grade of salt at a price which will net him, at his point of production, a price less than his current cost of production or the current cost of the lowest-cost producer in the field in which the sale is made.

Publication of prices includes terms of payment, length of contract, and other such provisions as may be necessary to inform the trade fully of all conditions of sale.

The code outlines unfair trade practices, authorizes the development of a uniform system of cost accounting, and provides for administration of the code through a Code Committee consisting of the president of the Salt Producers Association, the executive committee thereof, and two members to be chosen by the associate members of the association.

## LOCALITIES PRODUCING SALT IN THE UNITED STATES IN 1933

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 70 percent of the total salt sold or used by producers in 1933, compared with 69 percent in 1932. 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 residues 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 1933, 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 1933 from the following:

Alameda County:
  Alvarado and Mount Eden—Leslie-California Salt Co. (address, 149 California Street, San Fransisco); 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 1933.

Kern County: Fremont and Saltdale (Ceneda)—Long Beach Salt Co. of California (address, Long Beach); 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 Ave., Los Angeles); rock salt, also calcium chloride.
  Trona—Burnham Chemical Co. (address, 5653 College Avenue, Oakland); solar evaporation (from Searles Lake deposits).

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 dibromide, magnesium chloride, other magnesium salts, and insulating material. Iodine is extracted from brine obtained from oil wells.

*Kansas.*—In 1933 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 1933 were as follows:

Ellsworth County:
  Kanopolis—Crystal Salt Co. (address, Equitable Building, Denver, Colo.); rock salt.
  ——— Independent Salt Co. (address, 33 South Clark Street, Chicago, Ill.); rock salt.

Harper County: Anthony—The Anthony Salt Co.; evaporated salt (open pans or grainers), pressed blocks from evaporated salt.

Reno County:
  Hutchinson—The Barton Salt Co.; evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.
  ——— The Carey Salt Co. (east plant); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.
  ——— ——— rock salt mine); rock salt, pressed blocks from rock salt.
  ——— Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.

Rice County:
  Lyons—American Salt Corporation (address, New York Life Building, Kansas City, Mo.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt, rock salt, pressed blocks from rock salt.
  ——— Diamond Crystal Salt Co. (address, 250 Park Avenue, New York, N.Y.); evaporated salt (vaccum pans), pressed blocks from evaporated salt, rock salt, pressed blocks from rock salt.

*Louisiana.*—Louisiana in 1933 again ranked fifth in quantity of salt produced. Both rock salt and evaporated salt were produced in 1933. The firms reporting in 1933 were:

Iberia Parish:
- Avery Island—Avery Salt Co. (address, Scranton, Pa.); evaporated salt (vacuum pans), rock salt.
- Jefferson Island—Jefferson Island Salt Mining Co., Inc. (address, Columbia Building, Louisville, Ky.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt, rock salt, pressed blocks from rock salt.
- Weeks Island—Myles Salt Co., Ltd. (address, 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 1933 again ranked first among the salt-producing States. The output is obtained from both rock salt and natural brine. In 1933 reports were received from the following companies:

Manistee County:
- Manistee—Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt, also bromine.
- ——— Manistee Salt Works (address, 4200 Forest Park Boulevard, St. Louis, Mo.); evaporated salt (open pans or grainers, vacuum pans).

Mason County: Ludington—Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt. Plant idle in 1933; sales from stock.

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). Plant idle in 1933.
- ——— Saginaw Salt Products Co. (address, Saginaw); evaporated salt (open pans or grainers), also calcium chloride.
- 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 1933 the Virgin River Salt Co. produced rock salt at St. Thomas, Clark County.

*New Mexico.*—Production of salt in 1933 was reported in Torrance County by New Mexico Salt Co., Wiliard.

*New York.*—New York in 1933 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 1933 were as follows:

Livingston County:
Retsof—Retsof Mining Co. (address, Scranton, Pa.); rock salt.
Piffard—Worcester Salt Co. (address, 40 Worth Street, New York); evaporated salt (open pans or grainers, vacuum pans).
Onondaga County: Solvay (plant) and Tully (wells)—The Solvay Process Co. (address, Syracuse); evaporated salt (vacuum pans), brine for the manufacture of chemicals with the refined salt as a byproduct.
Schuyler County:
Watkins Glen—International Salt Co. (address, Scranton, Pa.); evaporated salt (open pans or grainers, vacuum pans).
——— The Watkins Salt Co.; evaporated salt (open pans or grainers, vacuum pans).
Tompkins County:
Myers—International Salt Co. (address, Scranton, Pa.); evaporated salt (open pans or grainers, vacuum pans).
——— Cayuga Rock Salt Co., Inc.; rock salt.
Wyoming County: Silver Springs—Worcester Salt Co. (address, 40 Worth St., New York); evaporated salt (open pans or grainers, vacuum pans.)

*Ohio.*—Ohio in 1933 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 1933.
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 1933 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 1933 Y. L. Stockman reported sales of such salt from near Vinson, Harmon County.

*Puerto Rico.*—In 1933 two plants reported production, as follows:

Cabo Rojo—F. Carrera & Hno. (address, Mayaguez); solar evaporation.
Lajas—Miguel Antonio Ramirez Dominguez (address, San German); solar evaporation.

*Texas.*—Salt was produced in Texas in 1933 as follows:

Anderson County: Palestine—Palestine Salt & Coal Co.; evaporated salt (open pans or grainers), pressed blocks from evaporated salt.
Harris County: Hockley—United Salt Corporation (address, 425 Cotton Exchange Building, Houston); rock salt.
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 1933 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 1933 the operators were as follows:

Kanawha County:
Malden—J. Q. Dickinson & Co.; evaporated salt (open pans or grainers), also bromine and calcium chloride.
South Charleston—Westvaco Chlorine Products, Inc.; brine used in the manufacture of chlorine; also calcium chloride and bromine manufactured from bittern of this plant by J. Q. Dickinson & Co., Malden.
Mason County:
Hartford—Liverpool Salt Co.; evaporated salt (open pans or grainers), also bromine and calcium chloride.
Mason—Ohio River Salt Corporation; evaporated salt (open pans or grainers), also bromine and calcium chloride.

## FOREIGN TRADE

Imports of salt for consumption in the United States in 1933—30,132 short tons valued at $69,307—increased 8 percent in quantity and 5 percent in value compared with 1932. Salt imported for curing fish and in bulk increased in both quantity and value; that imported in bags, barrels, and other packages increased in quantity and decreased in value. Imports from Germany about doubled in volume, and those from Spain increased 6 percent. All other countries showing imports in 1932 decreased in 1933. Exports of salt increased 65 percent in quantity and 31 percent in value over 1932. Forty-eight percent of the salt exported in 1933 went to Canada; 19.6 percent to both the Union of Soviet Socialist Republics and Japan; and 8.7 percent to the West Indies, chiefly to Cuba.

*Salt imported for consumption in the United States, 1929–33*

| 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 |
| 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 |
| 1933 | 17,429 | 25,510 | 1,802 | 16,551 | 10,901 | 27,246 | 30,132 | 69,307 |

*Salt imported into the United States, 1932–33, by countries*

[General imports]

| Country | 1932 | | 1933 | |
|---|---|---|---|---|
| | Pounds | Value | Pounds | Value |
| North America: | | | | |
| Canada | 8,117,066 | $10,597 | 2,995,702 | $5,987 |
| Mexico | 112,560 | 316 | 107,364 | 544 |
| West Indies: | | | | |
| British: | | | | |
| Jamaica | 11,313,485 | 13,908 | 10,878,002 | 14,405 |
| Other British | 88,200 | 279 | 14,500 | 50 |
| Dominican Republic | 19,200 | 32 | | |
| French | | | 81,360 | 149 |
| Netherland | 12,851,357 | 12,370 | 8,310,397 | 8,508 |
| Europe: | | | | |
| France | 66 | 34 | | |
| Germany | 2,744,349 | 7,833 | 5,562,420 | 14,043 |
| Italy | 234 | 16 | | |
| Spain | 28,087,360 | 14,831 | 29,688,400 | 19,147 |
| Sweden | 4,727 | 212 | 6,600 | 221 |
| United Kingdom | 2,068,090 | 12,932 | 1,206,875 | 6,995 |
| Asia: | | | | |
| China | | | 510 | 15 |
| Africa: | | | | |
| Egypt | | | 22,046 | 15 |
| Portuguese, other | 2,301,000 | 2,477 | | |
| | 67,707,694 | 75,837 | 58,874,176 | 70,079 |

*Salt exported from the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 109,222 | $1,008,842 | 1932 | 63,581 | $478,435 |
| 1930 | 70,478 | 715,575 | 1933 | 105,178 | 626,694 |
| 1931 | 98,710 | 775,490 | | | |

*Salt exported from the United States—1933, by countries*

| Country | Pounds | Value |
|---|---|---|
| North America: | | |
| Bermudas | 30,439 | $510 |
| British Honduras | 326,097 | 2,780 |
| Canada | 100,523,915 | 242,430 |
| Central American States: | | |
| Costa Rica | 29,270 | 382 |
| Guatemala | 2,238,440 | 7,085 |
| Honduras | 1,675,871 | 12,825 |
| Nicaragua | 661,679 | 6,348 |
| Panama | 1,176,232 | 9,208 |
| Salvador | 4,280 | 90 |
| Mexico | 1,948,094 | 14,862 |
| Miquelon and St. Pierre Islands | 1,739 | 38 |
| Newfoundland and Labrador | 15,345 | 354 |
| West Indies: | | |
| British: | | |
| Jamaica | 3,559 | 114 |
| Other British | 13,346 | 281 |
| Cuba | 18,179,497 | 95,308 |
| Dominican Republic | 98,637 | 1,976 |
| Haiti | 35,100 | 818 |
| Netherland | 106,774 | 1,159 |
| Virgin Islands of the United States | 7,863 | 204 |
| South America: | | |
| Argentina | 10,420 | 375 |
| Bolivia | 480 | 16 |
| Colombia | 28,948 | 378 |
| Ecuador | 80 | 3 |
| Guiana, British | 1,100 | 110 |

*Salt exported from the United States in 1933, by countries*—Continued

| Country | Pounds | Value |
|---|---|---|
| South America—Continued. | | |
| Uruguay | 6,248 | $162 |
| Venezuela | 1,100 | 18 |
| Europe: | | |
| Bulgaria | 450 | 10 |
| France | 21,718 | 216 |
| Germany | 1,360 | 62 |
| Sweden | 4,875 | 168 |
| United Kingdom | 24,696 | 325 |
| Asia: | | |
| Aden | 100 | 2 |
| Arabia | 84 | 6 |
| Ceylon | 408 | 36 |
| China | 20,349 | 987 |
| East Indies: | | |
| India, British | 6,837 | 213 |
| Netherland | 17,688 | 709 |
| Hong Kong | 27,566 | 942 |
| Indo-China, French | 104 | 5 |
| Japan | 40,107,665 | 42,628 |
| Kwantung | 2,664 | 104 |
| Palestine | 195 | 7 |
| Philippine Islands | 382,623 | 5,186 |
| Siam | 48 | 2 |
| U.S.S.R. (Rnssia) | 40,241,680 | 149,515 |
| Other Asia | 348 | 20 |
| Africa: | | |
| British (Union of South) | 1,170 | 45 |
| Egypt | 2,730 | 99 |
| Liberia | 87 | 2 |
| Morocco | 2,760 | 55 |
| Mozambique | 39 | 2 |
| Nigeria | 25 | 1 |
| Oceania: | | |
| British: | | |
| Australia | 1,552,730 | 17,665 |
| Malaya | 2,176 | 51 |
| New Zealand | 573,200 | 6,895 |
| Other British | 19,653 | 217 |
| French | 214,520 | 2,685 |
| | 210,355,101 | 626,694 |

## WORLD PRODUCTION

World production of salt is summarized in the following table:

*World production of salt, 1928–32 in metric tons*

| Country [1] | 1928 | 1929 | 1930 | 1931 | 1932 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada | 273,525 | 299,518 | 242,787 | 231,885 | 237,025 |
| Cuba | 2,350 | 14,515 | 24,947 | 22,680 | 31,751 |
| Guatemala | (2) | (2) | 7,915 | (2) | (2) |
| Mexico [3] | 67,000 | 67,000 | 67,000 | 67,000 | 67,000 |
| Panama | 835 | 935 | 366 | 1,035 | 6,000 |
| United States: | | | | | |
| Rock salt | 2,011,926 | 1,916,880 | 1,793,831 | 1,682,066 | 1,466,289 |
| Other salt | 5,313,281 | 5,833,666 | 5,512,996 | 4,993,028 | 4,382,619 |
| West Indies: | | | | | |
| British: | | | | | |
| Bahamas [4] | 725 | 799 | 3,193 | 12,447 | 254 |
| Grenada (Windward Islands) [4] | 37 | 70 | 155 | 131 | (2) |
| Leeward Islands [4] | 1,586 | 1,310 | 1,541 | 2,353 | 771 |
| Turks and Caicos Islands [4] | 50,846 | 62,135 | 42,208 | 27,361 | 20,956 |
| Netherland [4] | 9,778 | 4,677 | 4,820 | 6,352 | 11,502 |

[1] In addition to the countries listed salt is produced in Bolivia, Brazil, Gold Coast, Madagascar, and Southern Rhodesia, but figures of production are not available.
[2] Data not available.
[3] Estimated annual production.
[4] Exports.

*World production of salt, 1928–32, in metric tons*—Continued

| Country | 1928 | 1929 | 1930 | 1931 | 1932 |
|---|---|---|---|---|---|
| South America: | | | | | |
| Argentina [5] | 167,617 | 197,799 | 144,593 | 159,372 | 181,138 |
| Chile | 34,746 | 37,422 | 39,623 | (2) | 26,000 |
| Colombia [3] | 29,000 | 29,000 | 29,000 | 29,000 | 29,000 |
| Ecuador: | | | | | |
| Rock salt | 333 | 69 | 126 | 148 | |
| Other salt | 10,051 | 17,377 | 24,433 | 28,858 | [3] 28,000 |
| Peru | 32,669 | 30,000 | 30,000 | 28,000 | (2) |
| Venezuela | 26,228 | 25,443 | 20,722 | (2) | 23,648 |
| Europe: | | | | | |
| Albania | 5,283 | (2) | (2) | (2) | (2) |
| Austria: | | | | | |
| Rock salt | 1,607 | 3,041 | 1,063 | 862 | 912 |
| Other salt | 152,212 | 175,442 | 156,559 | 122,612 | 170,570 |
| Bulgaria: | | | | | |
| Rock salt | 4,108 | 3,653 | 1,704 | 3,900 | 3,380 |
| Other salt | 42,709 | 25,194 | 31,642 | 40,568 | 24,040 |
| Czechoslovakia | 154,243 | 166,361 | 177,693 | 190,179 | 177,413 |
| France: | | | | | |
| Rock salt and salt from springs | 1,707,506 | 1,746,076 | 1,750,880 | 1,518,310 | 1,429,654 |
| Other salt | 407,768 | 443,685 | 248,160 | 389,340 | 170,696 |
| Germany: | | | | | |
| Rock salt | 2,399,669 | 2,541,489 | 2,455,605 | 2,086,884 | 2,115,688 |
| Other salt | 509,663 | 501,024 | 501,258 | 490,975 | 485,379 |
| Greece | [3] 100,000 | [3] 100,000 | [3] 100,000 | [3] 100,000 | [3] 100,000 |
| Italy: | | | | | |
| Rock salt | [6] 341,107 | [6] 346,479 | [6] 332,001 | 327,174 | 332,315 |
| Other salt | 562,281 | 563,970 | 520,099 | 759,249 | 599,810 |
| Malta | 587 | 482 | 587 | 859 | 880 |
| Netherlands—Rock salt [7] | 41,470 | 44,914 | 49,807 | 56,141 | 60,765 |
| Poland | 548,377 | 569,488 | 534,260 | 561,089 | 491,508 |
| Portugal [4] | 46,777 | 15,317 | 27,236 | 17,010 | 55,049 |
| Rumania: | | | | | |
| Rock salt | 340,212 | 318,802 | 304,877 | 254,808 | 288,070 |
| Other salt | 2,567 | 2,698 | 2,155 | | |
| Spain: | | | | | |
| Rock salt | 146,147 | 164,837 | 164,532 | 155,448 | 152,683 |
| Other salt | 836,912 | 914,639 | 872,966 | 733,860 | 806,518 |
| Switzerland | 83,306 | 88,111 | 82,934 | 87,727 | 82,692 |
| U.S.S.R. (Russia) [8] | 2,548,106 | (2) | (2) | (2) | (2) |
| United Kingdom: | | | | | |
| Great Britain: | | | | | |
| Rock salt | 24,254 | 28,786 | 21,377 | 18,134 | 17,156 |
| Other salt | 1,938,575 | 1,962,024 | 2,066,386 | 1,897,376 | 2,223,141 |
| Ireland, Northern: | | | | | |
| Rock salt | 7,598 | 7,954 | 4,048 | 3,764 | 2,725 |
| Other salt | 7,130 | 7,093 | 8,938 | (2) | 8,747 |
| Yugoslavia | 52,128 | 44,564 | 54,636 | 52,745 | 52,846 |
| Asia: | | | | | |
| Ceylon | 44,275 | 25,482 | 9,686 | 45,539 | 17,987 |
| China (including Kwantung) [3] | 2,000,000 | 2,000,000 | 2,000,000 | 2,000,000 | 2,000,000 |
| Chosen | 134,516 | 138,000 | (2) | (2) | (2) |
| Cyprus [3] | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| India: | | | | | |
| British (including Aden): | | | | | |
| Rock salt | 157,846 | 181,164 | 178,283 | 164,491 | 174,804 |
| Other salt | 1,381,824 | 1,555,367 | 1,560,532 | 1,704,431 | 1,466,911 |
| Portuguese [3] | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| Indo-China [4] | 35,816 | 25,636 | 42,471 | 32,880 | 28,683 |
| Iraq [9] | 6,251 | 7,803 | 8,919 | 7,299 | 3,336 |
| Japan: | | | | | |
| Japan proper [10] | 637,888 | 644,151 | 628,682 | 521,125 | 572,497 |
| Taiwan | 134,515 | 164,357 | 163,217 | 199,049 | 122,110 |
| Netherland India | 253,162 | 486,907 | 313,579 | 212,373 | 207,619 |
| Palestine: | | | | | |
| Rock salt | 1,654 | 2,508 | 1,395 | 1,259 | 979 |
| Other salt | (2) | 5,233 | 6,102 | (2) | (2) |
| Philippine Islands | 71,475 | 46,876 | 40,572 | 42,570 | (2) |
| Siam | 119,332 | [11] 177,070 | [11] 181,003 | [11] 196,400 | (2) |
| Syria [3] | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Turkey [3] | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 |
| U.S.S.R. (Russia) [8] | 257,635 | (2) | (2) | (2) | (2) |

[2] Data not available.
[3] Estimated annual production.
[4] Exports.
[5] Railway shipments.
[6] Includes following quantities of salt previously reported under other salt: 1928, 273,920 tons; 1929, 283,449 tons; 1930, 258,908 tons (Relazione sul Servizio Minerario, Rome).
[7] Sales.
[8] Year ended Sept. 30.
[9] Salt issued by the Government for sale.
[10] 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.
[11] Year ended Mar. 31 of year following that stated.

*World production of salt, 1928–32, in metric tons*—Continued

| Country | 1928 | 1929 | 1930 | 1931 | 1932 |
|---|---|---|---|---|---|
| Africa: | | | | | |
| Algeria | 10,975 | 15,305 | 58,443 | 36,161 | 57,605 |
| 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) | 10,490 | 11,075 | (2) | (2) |
| Egypt [4] | 167,874 | 149,023 | 154,852 | 102,873 | 135,039 |
| Eritrea | 75,700 | 115,000 | 123,083 | (2) | (2) |
| Ethiopia—Rock salt | 20,000 | 10,000 | 10,000 | 20,000 | 25,000 |
| French West Africa | 4,000 | 4,000 | 2,200 | 6,000 | (2) |
| Kenya Colony | (2) | (2) | (2) | (2) | 194 |
| Libia (Italian Africa): | | | | | |
| Cyrenaica [3] | 10,000 | 10,000 | 10,000 | 10,000 | 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 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 |
| 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 | 39,000 | 38,972 | 25,369 | 14,000 | (2) |
| Italian | 1,656 | 4,347 | 77,970 | 240,000 | 159,100 |
| South-West Africa—rock salt | 146 | 334 | 511 | 1,093 | 2,102 |
| Sudan, Anglo-Egyptian | 12,481 | 14,951 | 14,308 | 11,437 | (2) |
| Tanganyika Territory | 5,134 | 7,387 | 6,664 | 6,845 | 6,255 |
| Tunisia | 114,045 | 120,165 | 120,345 | (2) | (2) |
| Uganda | 2,067 | 2,280 | 1,779 | 1,908 | (2) |
| Union of South Africa | [12] 83,735 | [1] 88,857 | [12] 89,338 | (2) | 62,092 |
| Oceania: | | | | | |
| Australia: | | | | | |
| Northern Territory (North Australia) | | | 120 | (2) | (2) |
| South Australia | 72,574 | 77,684 | 59,709 | 69,768 | 61,027 |
| Victoria | 52,181 | (2) | (2) | (2) | (2) |
| Western Australia [3] | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 |

[2] Data not available.
[3] Estimated annual production.
[4] Exports.
[12] 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 1933 the bromine produced amounted to 10,147,960 pounds valued at $2,040,352, an increase of 77 percent in quantity and 72.5 percent in value from 1932.

The companies that produce bromine are: The California Chemical Corporation (address, Newark), Chula Vista, Calif.; Morton Salt Co. (address, 208 West Washington St., 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, 1933); Texaco Salt Products Co. (address, care of The Texas Co., Houston, Tex.), Tulsa, Okla.; J. Q. Dickinson & Co., Malden, W.Va.; Liverpool Salt Co., Hartford, W.Va.; and Ohio River Salt Corporation, Mason, W.Va.

In 1932–33 a plant was erected near Wilmington, N.C., by the Ethyl-Dow Chemical Co. (address, 40 East Forty-Second Street, New York, N.Y.) for the direct extraction of bromine from sea water, but there was no commercial output in 1933. A description of this plant and the process used in the extraction of bromine is described in Industrial and Engineering Chemistry.[1]

*Bromine and bromine in compounds sold or used by producers in the United States, 1929–33*

| Year | Pounds | Value | Year | Pounds | Value |
|---|---|---|---|---|---|
| 1929 | 6,414,620 | $1,759,325 | 1932 | 5,727,561 | $1,182,569 |
| 1930 | 8,462,800 | 2,109,974 | 1933 | 10,147,960 | 2,040,352 |
| 1931 | 8,935,330 | 1,854,650 | | | |

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 1933 was 20 cents compared with 21 cents a pound in 1932 and 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 1934 was 36 to 38 cents.

*Bromine and bromine compounds imported for consumption in the United States, 1929–33*

| Product | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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) | [2] 7,717 | [2] 2,209 | 220 | 63 | 52 | 10 | | |
| Potassium bromide | 28,310 | 9,834 | 64,399 | 16,439 | 58,411 | 18,983 | 37,480 | 9,039 | 11,028 | $2,409 |
| Sodium bromide | 110 | 51 | 20,774 | 4,991 | | | 2,205 | 453 | 4,410 | 744 |
| Ethylene dibromide | 443,004 | 104,917 | 3,023,484 | 648,455 | 1,570,840 | 358,082 | 950,610 | 191,991 | 290,410 | 55,864 |
| Other bromine compounds | 643 | 572 | 21,594 | 13,378 | 43,636 | 23,053 | 16,153 | 7,311 | 3,049 | 2,814 |

[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.

Except for sodium bromide, the imports of which doubled, there was a large decrease in imports of bromine and bromine compounds in 1933 compared with 1932. Imports of ethylene dibromide, which were reported separately for the first time in 1928 (283,205 pounds) and which increased to a peak of 3,023,484 pounds in 1930, dropped to 290,410 pounds in 1933. This large decrease was at least partly balanced by the increase (77 percent) of domestic bromine production.

## 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.

[1] Stewart, Leroy C., Commercial Extraction of Bromine from Sea Water: Ind. and Eng. Chem., April 1934, pp. 361–369.

Production in 1933 was reported as 57,813 short tons valued at $893,442, a decrease of 13 percent in quantity and 23 percent in value from 1932.

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.; Saginaw Salt Products Co., Saginaw, Mich.; Pomeroy Salt Corporation (address, Pomeroy, Ohio), Minersville, Ohio; The Excelsior Salt Works, Inc., Pomeroy, Ohio (idle, 1933); Texaco Salt Products Co., Tulsa, Okla.; J. Q. Dickinson & Co., Malden, W.Va.; Liverpool Salt Co., Hartford, W.Va.; and Ohio River Salt Corporation, Mason, W.Va.

*Calcium (calcium-magnesium) chloride from natural brines sold by producers in the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 114, 240 | $2, 097, 061 | 1932 | 66, 286 | $1, 163, 385 |
| 1930 | 116, 160 | 2, 207, 800 | 1933 | 57, 813 | 893, 442 |
| 1931 | 86, 156 | 1, 687, 166 | | | |

*Calcium chloride imported for consumption in the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 8, 236 | $113, 573 | 1932 | 3, 569 | $48, 865 |
| 1930 | 6, 641 | 95, 921 | 1933 | 3, 583 | 48, 115 |
| 1931 | 4, 916 | 74, 546 | | | |

*Calcium chloride exported from the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 15, 425 | $362, 658 | 1932 | 17, 747 | $378, 130 |
| 1930 | 21, 350 | 513, 577 | 1933 | 15, 710 | 312, 309 |
| 1931 | 24, 351 | 566, 573 | | | |

## 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 three plants recovering iodine from oil-well brines in Los Angeles County, Calif. These plants are operated by the Deepwater Chemical Co., Ltd., Compton, Calif., the General Salt Co., Long Beach, Calif., and the Io-Dow Chemical Co. (successor to Jones Chemical Co.), Midland, Mich. In 1932 the Io-Dow Chemical Co. (Jones Chemical Co.) established a plant at Shreveport, La., where the iodine was recovered from salt brine. This plant was abandoned in August 1933.

The domestic output in 1933 was 401,525 pounds, valued at $669,289, compared with 173,953 pounds, valued at $395,951, in 1932.

A description of the iodine industry in California is given in Industrial and Engineering Chemistry.[2]

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.

*Iodine imported for consumption in the United States, 1929–33*

| Year | Crude | | Resublimed | | Year | Crude | | Resublimed | |
|---|---|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | | Pounds | Value | Pounds | Value |
| 1929 | 627, 162 | $2, 249, 266 | | | 1932 | 631, 669 | $2, 225, 661 | 100 | $269 |
| 1930 | 493, 587 | 1, 797, 754 | | | 1933 | 1, 411, 687 | 2, 936, 489 | 200 | 493 |
| 1931 | 278, 713 | 998, 079 | | | | | | | |

[2] Robertson, G. Ross, New American Iodine Industry: Ind. and Eng. Chem., April 1934, pp. 376-378.

# PHOSPHATE ROCK

By Bertrand L. Johnson and B. H. Stoddard

## SUMMARY OUTLINE



The phosphate-rock industry of the United States in 1933 recovered partly from the extreme low levels of the previous year by registering marked increases in mine production, shipments, domestic consumption, and exports. Stocks in producers' hands at the end of the year declined substantially, although slight increases were reported in the Western States. Imports also declined. Shipments of Florida land pebble and soft rock and of Tennessee rock increased, but shipments of Florida hard rock declined slightly. The output of the Western States diminished over 50 percent.

*Salient statistics of the phosphate-rock industry in the United States, 1931–33*

| | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Long tons | Value | Long tons | Value | Long tons | Value |
| Mined | 2,577,535 | (1) | 1,739,197 | (1) | 2,309,269 | (1) |
| Sold or used by producers: | | | | | | |
| Florida: | | | | | | |
| Land pebble | 1,990,806 | $6,756,428 | [2] 1,402,334 | [2] $4,382,344 | 2,066,900 | $6,020,984 |
| Soft rock | 13,436 | 65,118 | 10,063 | 24,017 | 16,841 | 48,802 |
| Hard rock | 57,224 | 380,540 | 57,579 | 373,251 | 52,382 | 347,324 |
| Total Florida | 2,061,466 | 7,202,086 | 1,469,976 | 4,779,612 | 2,136,123 | 6,417,110 |
| Tennessee | 343,622 | 1,545,607 | [3] 193,666 | [3] 776,367 | [3] 333,946 | [3] 1,373,392 |
| Idaho | 60,978 | 234,781 | 23,172 | 103,243 | 19,751 | 80,622 |
| Montana | 67,893 | 301,511 | 20,090 | 79,271 | 492 | 1,238 |
| Virginia | | | (3) | (3) | (3) | (3) |
| Wyoming | 1,000 | 4,500 | | | | |
| Total United States | 2,534,959 | 9,288,485 | 1,706,904 | 5,738,493 | 2,490,312 | 7,872,362 |
| Imports | 13,496 | 162,517 | [4] 12,982 | [4] 93,847 | 7,725 | 72,597 |
| Exports | 951,305 | 4,277,070 | 613,035 | 2,795,654 | 829,059 | 3,544,377 |
| Consumption, apparent [5] | 1,597,150 | (1) | 1,106,851 | (1) | 1,668,978 | (1) |
| Stocks in producers' hands, Dec. 31: | | | | | | |
| Florida | 733,400 | (1) | 923,230 | (1) | 792,170 | (1) |
| Tennessee | 207,650 | (1) | [3] 203,580 | (1) | [3] 200,330 | (1) |
| Other | 1,920 | (1) | 3,040 | (1) | 5,970 | (1) |
| Total stocks | 942,970 | (1) | 1,129,850 | (1) | 998,470 | (1) |

[1] No figures available.
[2] Includes small quantity of tailings.
[3] Virginia included with Tennessee.
[4] Includes imports of Russian apatite.
[5] Quantity sold or used by producers plus imports minus exports.



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As shown in figure 94, shipments, consumption, and exports of phosphate rock exhibit in general the same trends, but with minor differences for a few of the years. Stocks on hand at the end of calendar years gradually climbed to a new post-war high level of over a million tons in 1932, in excess of the domestic consumption of that year, and then declined to slightly under a million tons in 1933, about 60 percent of that year's domestic consumption. Throughout the period imports did not exceed 50,000 tons a year, and for the past few years have declined steadily.

Several articles describing the phosphate-rock deposits of the United States were published during 1933.

A general discussion of the origin, production, and distribution of phosphate rock in the United States, including a description of the principal domestic deposits, mining methods, and treatment and recent advances in the technology of the phosphate-rock industry, is given in two articles by Waggaman.[1]

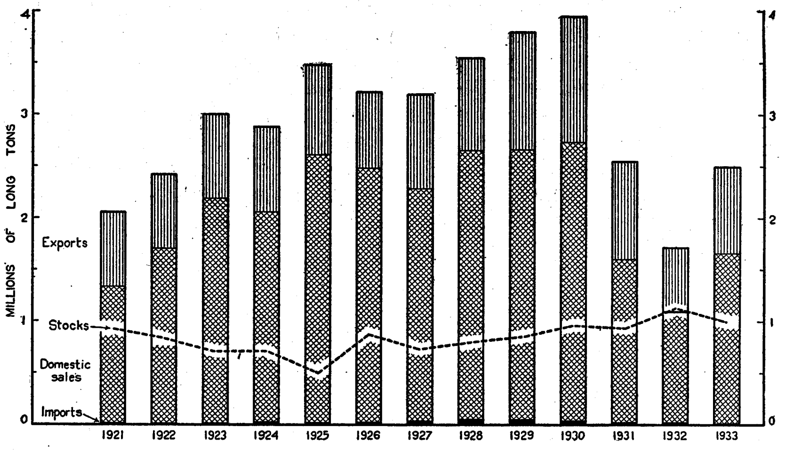


FIGURE 94.—Salient features of the phosphate-rock industry in the United States, 1921–33.

The results of a comprehensive study of the occurrence, reserves, and chemical composition of the phosphate-rock deposits of the United States by the Bureau of Chemistry and Soils, United States Department of Agriculture, were also published.[2]

Hill and Jacob [3] in a study of 40 samples of natural phosphate rock from various deposits in the United States and other countries found 0.8 to 130 parts per million of iodine in the different samples, the smallest quantities occurring in the phosphates of the western United States and the largest in the Florida hard-rock phosphate. The highest iodine content occurs in rocks of Tertiary age in Florida and Morocco. Comparison of these analyses with those of other rocks shows that the iodine content of phosphate rock is considerably higher than that of other rocks.

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[1] Waggaman, W. H., Phosphate-Rock Industry of the United States: Jour. Chem. Education, vol. 10, 1933, pp. 391–395, 476–483.

[2] Jacob, K. D., Hill, W. L., Marshall, H. L., and Reynolds, D. S., The Composition and Distribution of Phosphate Rock with Special Reference to the United States: U.S. Dept. Agriculture Tech. Bull. 364, 1933, p. 89.

Jacob, K. D., and Hill, W. L., Occurrence, Production, and Reserves of Phosphate Rock in the United States: Am. Fertilizer, vol. 78, no. 8, Apr. 22, 1933, pp. 7–9, 22, 24; no. 9, May 6, 1933, pp. 8–9, 22.

[3] Hill, W. L., and Jacob, K. D., Determination and Occurrence of Iodine in Phosphate Rock: Jour. Assoc., Official Agricultural Chem., vol. 16, 1933, pp. 128–137.

Hill, Marshall, and Jacob[4] present the results of a chemical study of the occurrence and amount of sulphur, organic matter, nitrogen, and water in phosphate rock.

Mansfield contributed an account of the western phosphate-rock deposits in the Phosphoria (Permian) formation to the Lindgren memorial volume on western ore deposits.[5]

*Domestic production and sales.*—A recent article[6] shows secular trends in the phosphate-rock industry for the period 1929 to 1933 by 12-month moving-total curves. As indicated therein, production and domestic consumption of phosphate rock can be estimated readily from monthly data available for superphosphate production; calendar year estimates covering the years 1929 to 1933, inclusive, check within 2.7 percent of the actual figures as compiled by the Bureau of Mines.

The following table shows shipments of domestic phosphate rock in 1932 and 1933 by grades. Data are shown for 14 grades, of which 4 are of outstanding importance: Shipments of 68 basis, 66 minimum; 70 minimum; 72 minimum; and 75 basis, 74 minimum. These 4 grades constituted 79 percent of the total shipments in 1932 and 80 percent in 1933.

*Phosphate rock produced in the United States and shipped in 1932–33, by grades, in long tons*

| B.P.L. content [1] (percent) | 1932 | 1933 | B.P.L. content [1] (percent) | 1932 | 1933 |
|---|---|---|---|---|---|
| Below 60 | (2) | 87,497 | 75 minimum | 106,391 | 87,323 |
| 60 to 66 | 3,291 | 2,536 | 77 basis, 76 minimum | 51,705 | 142,505 |
| 68 basis, 66 minimum | 371,428 | 507,188 | 77 minimum | 63,659 | 84,214 |
| 68 minimum | (2) | (2) | 78 basis, 76 minimum | (2) | (2) |
| 69 minimum | (2) | (2) | Above 85 (apatite) | (2) | (2) |
| 70 basis, 69 minimum | (2) | (2) | Undistributed | 136,054 | 89,529 |
| 70 minimum | 342,283 | 562,982 | | | |
| 72 minimum | 311,462 | 689,659 | | 1,706,904 | 2,490,312 |
| 75 basis, 74 minimum | 320,631 | 236,879 | Total value | $5,738,493 | $7,872,362 |

[1] Bone phosphate of lime.
[2] Included under "Undistributed"; Bureau of Mines not at liberty to publish figures.

The average grade demanded by domestic consumers has increased notably since 1921; in 1918 shipments were predominantly the 68-percent grades, but in 1933 they were chiefly the 70- or 72-percent grades. The leading export grades contain about 75 percent B.P.L. (bone phosphate of lime), but some 77-percent and considerable 68-percent and 70-percent rock are shipped abroad.

The phosphate rock mined in the United States in 1933 totaled 2,309,269 long tons, an increase of 570,072 tons (32.8 percent) over 1932, mainly due to an increase of 500,144 tons (33.4 percent) in Florida. Compared with 1932 there was a considerably larger percentage increase in the mine production of Tennessee. The Western States mine production decreased 23,075 long tons (57.0 percent) to 17,386 tons, the smallest quantity mined in any year since 1921. A small quantity of apatite-bearing nelsonite was mined in Virginia.

[4] Hill, W. L., Marshall, H. L., and Jacob, K. D., Occurrence of Sulphur, Organic Matter, Nirtrogen, and Water in Phosphate Rock: Jour. Assoc. Official Agricultural Chem., vol. 16, 1933, pp. 260-276.
[5] Lindgren Volume, Ore Deposits of the Western United States: Published by the American Institute of Mining and Metallurgical Engineers; sponsored by the Rocky Mountain Fund, 1933, pp. 491-496.
[6] Johnson, Bertrand L., Current Data on Phosphate-Rock Production: Am. Fertilizer, vol. 80, no. 2, Jan. 27, 1934, pp. 7, 26.

*Phosphate rock mined in the United States, 1929–33, by States, in long tons*

| Year | Florida | Tennessee | Western States | Total |
|---|---|---|---|---|
| 1929 | 3,125,941 | 653,265 | 42,634 | 3,821,840 |
| 1930 | 3,261,539 | 618,341 | 71,473 | 3,951,353 |
| 1931 | 2,076,803 | 370,070 | 130,662 | 2,577,535 |
| 1932 | 1,497,419 | [1] 201,317 | 40,461 | 1,739,197 |
| 1933 | 1,997,563 | [1] 294,320 | 17,386 | 2,309,269 |

[1] Includes small quantity of apatite from Virginia.

Both the total quantity and the total value of phosphate rock sold or used by producers in the United States in 1933 were greater than in the preceding year, although neither reached the levels of 1931. The quantity sold or used in 1933 was 2,490,312 long tons, an increase of 783,408 tons (45.9 percent) over 1932; the total value was $7,872,362, an increase of $2,133,869 (37.2 percent). The average selling value per ton for 1933 was $3.16 or 20 cents below the 1932 average of $3.36. In spite of the decreased average value per ton in 1933, the quantity sold in that year was enough to show a large increase in total value in 1933 over 1932.

*Phosphate rock sold or used by producers in the United States, 1929–33*

| Year | Long tons | Value | Year | Long tons | Value |
|---|---|---|---|---|---|
| 1929 | 3,760,855 | $13,153,259 | 1932 | 1,706,904 | $5,738,493 |
| 1930 | 3,926,392 | 13,996,830 | 1933 | 2,490,312 | 7,872,362 |
| 1931 | 2,534,959 | 9,288,485 | | | |

*Distribution of sales by uses.*—Phosphate rock is used chiefly in the manufacture of superphosphate, but increasing amounts are employed for other purposes. The following figures, compiled from estimates made by the producing companies, indicate the distribution of sales of phosphate rock by major uses in the United States for the past 2 years.

*Phosphate rock sold by producers, 1932–33, for consumption in the United States, by major uses, in long tons*

| Use | 1932 | 1933 | Use | 1932 | 1933 |
|---|---|---|---|---|---|
| Superphosphates | 858,657 | 1,467,441 | Fertilizer filler | 19,667 | 27,706 |
| Phosphates, phosphoric acid, and ferrophosphorus | 222,617 | 243,823 | Stock and poultry feed | 211 | 479 |
| Direct application to soil | 7,033 | 7,481 | Undistributed | 7,355 | 2,286 |
| | | | | 1,115,540 | 1,749,216 |

*Prices.*—Prices quoted by the Oil, Paint and Drug Reporter for all grades of Florida phosphate rock were the same as in 1932 until late in August 1933, when new prices for Florida rock appeared with downward revisions of 9½ to 13 percent. Tennessee rock prices quoted by the same journal remained unchanged throughout the year from those of 1932.

*Prices of Florida and Tennessee phosphate rock in 1933, per long ton, f.o.b. mine* [1]

| Grades of rock (percent) | Jan. 2–Aug. 21 | Aug. 28–Sept. 25 | Oct. 2–Dec. 25 |
|---|---|---|---|
| Florida land pebble: | | | |
| 68 minimum | $3.10–$3.25 | $2.75–$3.20 | $2.80–$3.20 |
| 70 | 3.75– 3.90 | 3.25– 3.70 | 3.30– 3.70 |
| 72 | 4.25– 4.35 | 3.75– 4.20 | 3.80– 4.20 |
| 75 basis, 74 minimum | 5.25– 5.50 | 4.75– 5.30 | 4.85– 5.30 |
| 75 minimum | 5.50– 5.75 | 4.85– 5.40 | 4.95– 5.40 |
| 77 basis, 76 minimum | 6.25 | 5.65– 6.20 | 5.75– 6.20 |
| Florida hard rock: | | | |
| 77 | 6.50 | 5.75– 6.30 | 5.85– 6.30 |
| Tennessee brown rock: | | | |
| 72 | 5.00 | 5.00 | 5.00 |
| 75 | 5.50 | 5.50 | 5.50 |

[1] Weekly quotations of Oil, Paint and Drug Reporter for 1933.

The new price schedules [7] for Florida phosphate rock grade prices according to the quality of the rock and, as the following table indicates, provide for progressive advances extending to July 1, 1935.

*Prices for Florida phosphate rock, 1933–35, per long ton of delivered rock* [1]

| Grades | Before Oct. 1, 1933 | October–December 1933 | January–June 1934 | July–September 1934 | October–December 1934 | January–June 1935 |
|---|---|---|---|---|---|---|
| Land pebble: | | | | | | |
| 68 minimum | $2.75 | $2.80 | $2.85 | $3.10 | $3.15 | $3.20 |
| 70 | 3.25 | 3.30 | 3.35 | 3.60 | 3.65 | 3.70 |
| 72 | 3.75 | 3.80 | 3.85 | 4.10 | 4.15 | 4.20 |
| 75 basis, 74 minimum | 4.75 | 4.85 | 4.90 | 5.15 | 5.25 | 5.30 |
| 75 minimum | 4.85 | 4.95 | 5.00 | 5.25 | 5.35 | 5.40 |
| 77 basis, 76 minimum | 5.65 | 5.75 | 5.80 | 6.05 | 6.15 | 6.20 |
| Hard rock: | | | | | | |
| 77 | 5.75 | 5.85 | 5.90 | 6.15 | 6.25 | 6.30 |

[1] Oil, Paint and Drug Reporter, Aug. 28, 1933. Prices advance automatically on first day of first month specified.

Open price schedules are specified by the Fertilizer Code (Art. VI.—Price Provisions; Sec. 2.—Open Price Schedules).

Average values of actual shipments of various types of phosphate rock from mines or plants, as computed from reports furnished to the Bureau of Mines by the producers, are shown in the following table.

*Average value f.o.b. mine shipping point per long ton of phosphate rock shipped, 1929–33*

[From reports of producers]

| Year | Florida | | Tennessee [1] | Western States | | | |
|---|---|---|---|---|---|---|---|
| | Hard rock | Land pebble | | Idaho | Montana | Wyoming | Total |
| 1929 | $3.69 | [2] $3.19 | $4.89 | $3.95 | $10.00 | $4.76 | $4.02 |
| 1930 | 6.33 | [2] 3.24 | 4.81 | 3.91 | 4.57 | 4.48 | 3.98 |
| 1931 | 6.65 | 3.39 | 4.50 | 3.85 | 4.44 | 4.50 | 4.16 |
| 1932 | 6.48 | [3] 3.13 | 3.98 | 4.46 | 3.95 | ---------- | 4.22 |
| 1933 | 6.63 | 2.91 | 4.11 | 4.08 | 2.52 | ---------- | 4.04 |

[1] Chiefly brown rock.
[2] Includes soft rock.
[3] Includes small quantity of tailings.

[7] Oil, Paint and Drug Reporter, Aug. 28, 1933.

## REVIEW BY STATES

*Florida.*—In Florida, the leading phosphate-rock-producing State, phosphate-rock shipments in 1933 increased to 2,136,123 long tons, exceeding both 1932 and 1931 figures; the value, however—$6,417,-110—though substantially surpassing that of 1932, was less than the 1931 figure. Improvement was confined to the land-pebble division of the industry, as the quantity and value of hard-rock shipments continued to decrease. The following large land-pebble producing companies were in operation in 1933 as in recent years:

Amalgamated Phosphate Co., 535 Fifth Avenue, New York, N.Y. Plant at Brewster, Fla.

The American Agricultural Chemical Co., 420 Lexington Avenue, New York, N.Y. Plant at Pierce, Fla.

Coronet Phosphate Co., 19 Rector Street, New York, N.Y. Plant at Plant City, Fla.

International Agricultural Corporation, 61 Broadway, New York, N.Y. Plant at Mulberry, Fla.

The Phosphate Mining Co., 110 Williams Street, New York, N.Y. Plant at Nichols, Fla.

Southern Phosphate Corporation, Baltimore Trust Building, Baltimore, Md. Plant at Ridgewood, Fla.

Swift & Co., Union Stock Yards, Chicago, Ill. Plant at Agricola, Fla.

The following companies marketed hard rock in 1933:

J. Buttgenbach & Co., Lakeland, Fla.
C. & J. Camp, Ocala, Fla.
Dunnellon Phosphate Mining Co., Savannah, Ga.

Mining operations were in progress in 1933 only at the Dunnellon no. 1 mine of the Dunnellon Phosphate Mining Co., near Hernando, Citrus County, Fla. The other two companies did no mining but shipped from stock. About four-fifths of the hard rock marketed was exported and the rest sold on the domestic market.

Two companies in 1933 marketed finely divided waste-pond phosphatic debris from hard-rock phosphate-washing operations for use as fertilizer filler and direct application to the soil. The Colloidal Phosphate Sales Co., Dunnellon, Fla., utilized the material in the Shaw Tower waste-pond deposit at Dunnellon, Marion County, Fla. Connell & Shultz, Inverness, Fla., marketed a phosphatic clay from a waste-pond deposit at Inverness, Fla.

The Lakeland Phosphate & Fertilizer Co., Bartow, Fla., mined, dried, pulverized, and marketed a phosphatic sandy clay at Bartow, Fla., in the land-pebble district for fertilizer filler and direct application to the soil.

Soft rock was also mined and shipped by the Loncala Phosphate Co., Ocala.

The controlling interest of the Coronet Phosphate Co. in the phosphate-rock blast-furnace operations and chemical activities at Pembroke, Fla., was reported to have been sold during the year to the Oldbury Electrochemical Co., long-established British-owned phosphorus producer at Niagara Falls, N.Y. The minority interest of the Florida enterprise is said still to be held by the German Metallgesellschaft.

*Florida phosphate rock sold or used by producers, 1929–33*

| Year | Hard rock | | | Soft rock | | |
|---|---|---|---|---|---|---|
| | Long tons | Value at mines | | Long tons | Value at mines | |
| | | Total | Average | | Total | Average |
| 1929 | 72,424 | $267,218 | $3.69 | (1) | (1) | (1) |
| 1930 | 81,753 | 517,229 | 6.33 | (1) | (1) | (1) |
| 1931 | 57,224 | 380,540 | 6.65 | 13,436 | $65,118 | $4.85 |
| 1932 | 57,579 | 373,251 | 6.48 | 10,063 | 24,017 | 2.39 |
| 1933 | 52,382 | 347,324 | 6.63 | [2] 16,841 | [2] 48,802 | 2.90 |

| Year | Land pebble | | | Total | | |
|---|---|---|---|---|---|---|
| | Long tons | Value at mines | | Long tons | Value at mines | |
| | | Total | Average | | Total | Average |
| 1929 | [1] 3,015,874 | [1] $9,633,856 | [1] $3.19 | 3,088,298 | $9,901,074 | $3.21 |
| 1930 | [1] 3,166,318 | [1] 10,273,076 | [1] 3.24 | 3,248,071 | 10,790,305 | 3.32 |
| 1931 | 1,990,806 | 6,756,428 | 3.39 | 2,061,466 | 7,202,086 | 3.49 |
| 1932 | [3] 1,402,334 | [3] 4,382,344 | [3] 3.13 | 1,469,976 | 4,779,612 | 3.25 |
| 1933 | 2,066,900 | 6,020,984 | 2.91 | 2,136,123 | 6,417,110 | 3.00 |

[1] Soft rock included with land pebble.
[2] Includes material from waste-pond operations.
[3] Includes small quantity of tailings.

*Tennessee.*—Tennessee, which ranks next to Florida as a phosphate rock-producing State, in 1933 experienced a substantial recovery from the preceding year. The marketed production in both quantity and value nearly reached that of 1931. Most of the phosphate-rock production marketed in 1933 came from the brown-rock fields. The balance was blue rock from the Mayfield mine of the Charleston Mining Co., at Gordonsburg, Lewis County, and a small tonnage of white-rock phosphate from the Thom's Creek deposits of the Kentucky & Tennessee Phosphate Co., Perry County.

*Tennessee phosphate rock [1] sold or used by producers, 1929–33*

| Year | Long tons | Value at mines | | Year | Long tons | Value at mines | |
|---|---|---|---|---|---|---|---|
| | | Total | Average | | | Total | Average |
| 1929 | 633,939 | $3,097,104 | $4.89 | 1932 [2] | 193,666 | $776,367 | $4.01 |
| 1930 | 611,045 | 2,938,525 | 4.81 | 1933 [2] | 333,946 | 1,373,392 | 4.11 |
| 1931 | 343,622 | 1,545,607 | 4.50 | | | | |

[1] Separate figures for brown rock and blue rock cannot be given without disclosing confidential data regarding blue-rock production.
[2] Includes small quantity of apatite from Virginia.

Tennessee's share of the domestic market for phosphate rock in the post-war years has averaged 20.7 percent, ranging between 17.5 in 1932 and 27.7 percent in 1919. In 1933 it was 20 percent and in the 5 years immediately preceding the World War averaged 24.5 percent.

*Ratio of Tennessee production to total domestic consumption of phosphate rock, 1909–13 and 1921–33*

| Year | Percent | Year | Percent |
|---|---|---|---|
| 1909–13 [1] | 24.5 | 1931 | 21.5 |
| 1921–24 [1] | 19.7 | 1932 | 17.5 |
| 1925–29 [1] | 20.6 | 1933 | 20.0 |
| 1930 | 22.4 | | |

[1] 5-year average.

The phosphate-rock deposits now worked in Tennessee are in the west-central part of the State, in the southwestern part of the Central Basin, and in the valleys of the bordering Highland Rim. Three types of phosphate rock are mined—brown, blue, and white. The brown phosphate rock is the residual weathered and leached outcrop of phosphatic Ordovician limestones exposed over a wide area in the western and southern portions of the Central Basin. The so-called blue phosphate rock is a thin, unweathered, gray to bluish black, highly phosphatic stratum of Mississippian (Carboniferous) age occurring in the western part of the phosphate region. The white-rock phosphate now mined is a white phosphate of post-Tertiary age occurring in Perry County in the extreme western part of the phosphate region in stony, brecciated, and lamellar forms.

At the larger operations the clay overburden of the brown phosphate-rock deposits is removed with drag-line excavators. The brown-rock phosphate itself is mined by drag-line excavators wherever possible, but where it is thin or lies in narrow channels ("cutters") in the limestone and cannot be so mined it is taken out by pick and shovel. The horizontally bedded blue phosphate rock is mined by underground methods, drift-mining by the single-entry room-and-pillar system. The white phosphate deposits are mined by hand methods. Most of the brown rock is washed; flotation is used at two plants. The excess moisture in the wet rock from the washers is allowed to drain off in outdoor storage piles, then the product is dried further in coal-fired direct-heat rotary driers.

The blue phosphate rock is only crushed and dried before shipment.

The phosphatic Ordovician limestones underlying the brown-rock phosphate have been mined and ground for mineral feeds and mineral supplements to mixed feeds for poultry and livestock.

In view of the interest at present attached to the phosphate-rock deposits of Tennessee because of the operations of the Tennessee Valley Authority, the following selected list of references to these deposits is given.

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———. Geology and Origin of the Phosphate Deposits of Tennessee. Eng. and Min. Jour., vol. 132, 1931, pp. 58–62.

U.S. Geological Survey. Map of Mineral Resources of the Tennessee River Basin and Adjoining Areas. Scale, 1:500,000 (1 inch-8 miles). Size, 40 by 64 inches. Price $1.

WAGGAMAN, W. H. A Report on the Natural Phosphates of Tennessee, Kentucky, and Arkansas. U.S. Dept. Agriculture, Bureau Soils Bull. 81, 1912, 36 pp.

The Tennessee Valley Authority Act of 1933 (H.R. 5081, Public Law No. 17, 73d Cong.), signed on May 18, 1933, by President Franklin D. Roosevelt, created a corporation—the Tennessee Valley Authority—to maintain and operate the properties owned by the United States near Muscle Shoals, Ala., in the interest of the national defense and for agricultural and industrial development; to improve navigation in the Tennessee River; and to control the destructive flood waters in the Tennessee River and Mississippi River Basins. The technical transfer of the Muscle Shoals properties to the Authority was effected July 1, 1933, and the formal transfer on September 1, 1933, after an inventory of the properties by the Authority. A fund of $4,000,000 was set aside for the production of fertilizers, and construction was started on a plant for such manufacture at Muscle Shoals as an addition to Nitrate Plant No. 2. Two of the electric furnaces in Nitrate Plant No. 2 were remodeled for the smelting of phosphate rock. Experiments in the manufacture of fertilizer were conducted both at Muscle Shoals and Washington, D.C. Blast-furnace phosphoric acid investigations were made by the Authority with the 6-ton blast furnace of the Bureau of Chemistry and Soils, Department of Agriculture, at the American University, Washington, D.C., from November 1933 to April 1934 on phosphate rock from Mount Pleasant, Tenn. Limited quantities of fertilizers were prepared by the Authority; early in 1934 these were distributed to the agricultural experiment stations in the seven States in the Tennessee Valley for testing on the major soils of the region and with the customary crops. In 1933 the Authority leased a considerable acreage of phosphate-rock deposits in the Central Basin of Tennessee.

*Virginia.*—The plant of the Southern Mineral Products Corporation (subsidiary of the Vanadium Corporation of America) at Piney River, Nelson County, Va., was operated in 1933. Nelsonite, the raw material, containing a substantial percentage of apatite, was recovered as a byproduct.

The geology, character of the disseminated ores, and the possible economic importance of the recently discovered large deposits of basic igneous rocks containing important quantities of disseminated ilmenite and apatite in west-central Virginia are described by Ryan.[8]

*Western States.*—While the Florida and Tennessee phosphate rock industries were making a marked recovery from the depression of 1932, adverse conditions prevailed in the Western States, and the phosphate-rock production of that region declined to the lowest point since 1922. There were but 2 producing companies, 1 each in Idaho and Montana, shipping to the producers of high-analysis superphosphates at Anaconda, Mont., and Trail, British Columbia, respectively.

*Western States phosphate rock sold or used by producers, 1929–33*

| Year | Idaho | | | Montana | | | Wyoming | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Long tons | Value at mines | | Long tons | Value at mines | | Long tons | Value at mines | | Long tons | Value at mines | |
| | | Total | Average | | Total | Average | | Total | Average | | Total | Average |
| 1929 | 35,899 | $141,931 | $3.95 | 40 | $400 | $10.00 | 2,679 | $12,750 | $4.76 | 38,618 | $155,081 | $4.02 |
| 1930 | 59,932 | 234,543 | 3.91 | 6,005 | 27,457 | 4.57 | 1,339 | 6,000 | 4.48 | 67,276 | 268,000 | 3.98 |
| 1931 | 60,978 | 234,781 | 3.85 | 67,893 | 301,511 | 4.44 | 1,000 | 4,500 | 4.50 | 129,871 | 540,792 | 4.16 |
| 1932 | 23,172 | 103,243 | 4.46 | 20,090 | 79,271 | 3.95 | | | | 43,262 | 182,514 | 4.22 |
| 1933 | 19,751 | 80,622 | 4.08 | 492 | 1,238 | 2.52 | | | | 20,243 | 81,860 | 4.04 |

Idaho was the largest phosphate-rock-producing State of the West in 1933, but its output of 19,751 long tons ($80,622) was the lowest for several years. Production came entirely from the Conda No. 1 mine of the Anaconda Copper Mining Co. at Conda, Caribou County; the phosphate rock was shipped to its plant at Anaconda, Mont., for treatment.[9]

The Garrison Mining & Phosphate Co., of Trail, British Columbia, which operates the Janney lease near Deer Lodge, Powell County, Mont., under assignment from W. P. Janney, drove 274 feet of drifts during the year, making a total on December 31, 1933, of 1,772 feet of development work on this property. The Consolidated Mining & Smelting Co. of Canada, Ltd., reports [10] shipment of 551 short tons (492 long tons) of phosphate rock from this property, which went to that company's plant at Trail, British Columbia.

Mining operations were in progress in 1933 at the Anderson mine of the Montana Phosphate Products Co. near Garrison, Powell County, Mont.; considerable phosphate rock was mined, but no shipments were made.

[8] Ryan, C. W., The Ilmenite-Apatite Deposits of West-Central Virginia: Econ. Geol., vol. 28, no. 3, May 1933, pp. 266–275.
[9] Larison, E. L., Sulphuric Acid and Phosphate Industries at Anaconda Reduction Works: Am. Inst. Min. and Met. Eng., Contrib. 70, class D, Nonferrous Metallurgy; class H, Nonmetallic Minerals, 1934.
[10] The Consolidated Mining & Smelting Co. of Canada, Ltd., Annual Report and Statements for Twelve Months Ended Dec. 31, 1933, 42 pp.

The Northwestern Improvement Co. reported only development work at the Elliston mine near Elliston, Powell County, Mont., and at the Douglas Creek mine near Hall, Granite County, Mont., during 1933.

## FOREIGN TRADE

*Imports.*—Relatively small quantities of phosphate rock are imported into the United States. In 1933 imports amounted to only 7,725 long tons valued at $72,597, less than in any of the recent preceding years. The 1933 imports constituted less than one-half of 1 percent of the domestic consumption of phosphate rock and were equivalent to less than 1 percent of the exports. Imports came from but two countries, French Oceania and the Netherland West Indies. The following table shows imports from 1929 to 1933:

*Phosphate rock, crude, imported into the United States, 1929–33, by countries*

| Country | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Long tons | Value | Long tons | Value | Long tons | Value | Long tons | Value | Long tons | Value |
| Canada | 741 | $14,144 | 830 | $16,278 | | | | | | |
| Cuba | 6,000 | 73,972 | 6,360 | 72,797 | | | | | | |
| Germany | | | | | | | 25 | $160 | | |
| Morocco, French | 16,400 | 96,102 | 6,000 | 30,000 | | | | | | |
| Netherlands | 160 | 2,060 | | | | | | | | |
| Oceania: French | 19,348 | 261,411 | 19,417 | 257,742 | 12,985 | $161,219 | 6,300 | 69,741 | 5,625 | $59,409 |
| U.S.S.R. (Russia in Europe) | | | 51 | 360 | 511 | 1,298 | [1] 6,607 | [1] 23,808 | | |
| United Kingdom | | | | | | | 50 | 138 | | |
| West Indies: Netherland | 2,250 | 21,482 | | | | | | | 2,100 | 13,188 |
| | 44,899 | 469,171 | 32,658 | 377,177 | 13,496 | 162,517 | 12,982 | 93,847 | 7,725 | 72,597 |

[1] Apatite.

Phosphate fertilizers other than phosphate rock imported for consumption into the United States include guano, various bone products, and basic slag.

In 1933 the imports of guano were more than double those of 1932. Imports of bone products decreased slightly, and basic slag imports decreased from 2,189 tons in 1932 to 863 tons in 1933.

*Phosphatic fertilizers (other than crude phosphate rock) imported for consumption in the United States, 1929–33*

| Fertilizer | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Long tons | Value | Long tons | Value | Long tons | Value | Long tons | Value | Long tons | Value |
| Bone dust, or animal carbon, and bone ash, fit only for fertilizing | 55,877 | $1,624,483 | 59,680 | $1,474,500 | 48,979 | $1,080,348 | 30,118 | $508,802 | 28,500 | $519,982 |
| Guano | 45,905 | 2,202,709 | 40,431 | 1,655,886 | 13,849 | 503,861 | 24,231 | 489,992 | 59,772 | 1,118,268 |
| Slag, basic, ground or unground | 3,998 | 54,456 | 3,913 | 54,463 | 1,464 | 15,903 | 2,189 | 21,005 | 863 | 10,698 |

The appearance in the American market in recent years of low-priced phosphatic materials of various kinds and from various countries has led domestic producers to invoke such protection as may be afforded by the Antidumping Act of 1921 and the Tariff Act of 1930.

Two investigations were made during 1933 by the United States Tariff Commission, one a general inquiry into the costs of production of phosphates and superphosphates and the other into allegedly unfair practices in the importation of apatite from the U.S.S.R. (Russia).

*Walsh resolution.*—The Tariff Commission was directed by Senate Resolution 298, Seventy-second Congress, December 8, 1932, introduced by the late Senator T. J. Walsh of Montana, to investigate under the authority conferred by section 336 of the Tariff Act of 1930 the difference 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. On August 19, 1933, the Commission ordered a public hearing, which was held on September 12, 1933, in Washington, D.C. The Anaconda Copper Mining Co., United Metal Selling Co., and the West Coast Fertilizer Tariff League presented data regarding the competitive situation between domestic and foreign superphosphate on the Pacific coast of the United States, claimed dumping of foreign superphosphate, and asked protection for the western domestic producers.

*Russian apatite.*—After a complaint had been filed on October 21, 1932, by the International Agricultural Corporation, Phosphate Recovery Corporation, and the American Cyanamid Co. against the importation of apatite from the U.S.S.R. (Russia), the United States Tariff Commission, on December 15, 1932, instituted an investigation, under section 337, title 3, part 2, 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 1547732, 1780022, and 1795100."

On December 16, 1932, the Commission published notices of its investigation and sent copies of such notice and copies of the petition and amendment thereto to the respondents named in the complaint—the Standard Wholesale Phosphate & Acid Works, of Baltimore, Md., and the Amtorg Trading Corporation, of New York City, N.Y.

On January 18 and 19, 1933, answers were received from the respondents denying the commission of any acts in violation of section 337 and requesting the dismissal of the complaint. These answers were transmitted to the complainants on January 19, 1933.

On February 9, 1933, the Tariff Commission ordered a hearing in the investigation which, after two postponements, was held in Washington, D.C., on June 5 to 8, inclusive, 1933. Briefs were filed by both parties the following month.

On January 15, 1934, the Tariff Commission issued its findings in this case. It found that the processes disclosed in Patent 1547732 and in claims 2 and 11 of Patent 1795100 are used in the flotation of apatite in the Union of Soviet Socialist Republics and that the importation of apatite so treated into the United States and the sale thereof constitute unfair methods of competition or unfair acts within the intent and meaning of section 337 of the Tariff Act of 1930. It recommended that the President direct the Secretary of the Treasury to instruct customs officers to exclude from entry into the United States phosphates and apatite floated by the process described in Patent 1547732 until July 27, 1942, and that covered by Patent 1795100 until March 2, 1948, unless produced by licensees under these patents.

The Amtorg Trading Corporation appealed from the findings of the Tariff Commission to the United States Court of Customs and Patent Appeals early in 1934, within the time allowed by law.

*Moroccan phosphate rock.*—On April 8, 1933, the importers petitioned the United States Supreme Court for a writ of certiorari to the Court of Customs and Patent Appeals; but the petition was denied on May 15, the Supreme Court refusing to review the decision of the lower court (289 U.S. 750). The previous history of this case may be digested as follows:

In 1928 the antidumping law was invoked with respect to certain imports of phosphate rock from French Morocco, 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 appriaser 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 governmental agency 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. 43306). 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. 44095) 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. 44581) 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 prodceedings 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—20 C.C.P.A., cust., 344) the judgement of the lower court.

*Exports.*—The year 1933 interrupted the downward trend of exports of phosphate rock characterizing the years 1931 and 1932, both quantity and value of the exports increasing over the preceding year but not reaching the levels of 1931. Total exports (829,059 long tons) were 35 percent greater than for the previous year, and their value ($3,544,377) was 27 percent greater.

*Phosphate rock, ground or unground, not acidulated, exported from the United States 1929–33*

| Year | Long tons | Value | Year | Long tons | Value |
|---|---|---|---|---|---|
| 1929 | 1, 142, 746 | $5, 386, 919 | 1932 | 613, 035 | $2, 795, 654 |
| 1930 | 1, 225, 722 | 5, 630, 547 | 1933 | 829, 059 | 3, 544, 377 |
| 1931 | 951, 305 | 4, 277, 070 | | | |

The following table shows the total exports of high-grade phosphate rock, land pebble (and other) phosphate rock, and shipments of each type of rock to various foreign countries over the period 1929–33. Exports of land-pebble (and other) phosphate rock were 786,695 long tons valued at $3,249,225 in 1933, an increase of 44 percent in quantity and 36 percent in value over 1932. Exports of high-grade hard rock, however, fell from 66,009 long tons valued at $405,532 in 1932 to 42,364 tons valued at $295,152 in 1933, a decrease of 36 percent in quantity and 27 percent in value.

*Phosphate rock, ground or unground, not acidulated, exported from the United States, 1929–33, by countries*

| Country | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Long tons | Value | Long tons | Value | Long tons | Value | Long tons | Value | Long tons | Value |
| **HIGH-GRADE ROCK** | | | | | | | | | | |
| Australia | | | 946 | $10, 406 | | | | | | |
| Belgium | 7, 100 | $48, 700 | 14, 930 | 97, 145 | 17, 625 | $114, 562 | 7, 100 | $46, 150 | | |
| Canada | 3, 140 | 25, 517 | 2, 187 | 21, 237 | 66, 993 | 359, 396 | 29, 469 | 156, 652 | 977 | $7, 303 |
| Cuba | | | | | | | | | 97 | 957 |
| Germany | 21, 936 | 153, 831 | 15, 652 | 107, 539 | 12, 325 | 83, 649 | 9, 590 | 67, 130 | 24, 840 | 173, 092 |
| Lithuania | | | 8, 400 | 54, 600 | 4, 200 | 27, 300 | 11, 500 | 80, 500 | 11, 000 | 77, 000 |
| Mexico | 3 | 43 | | | | | | | | |
| Netherlands | 10, 465 | 72, 605 | 4, 125 | 28, 087 | 4, 150 | 29, 050 | 1, 650 | 11, 550 | 2, 750 | 19, 250 |
| Norway | 2, 200 | 15, 400 | | | | | | | | |
| Panama | | | 2 | 43 | | | | | | |
| Poland and Danzig | 9, 500 | 66, 500 | | | | | 2, 500 | 16, 250 | 2, 700 | 17, 550 |
| Sweden | 13, 130 | 90, 435 | 19, 750 | 128, 375 | | | 4, 200 | 27, 300 | | |
| | 67, 474 | 473, 031 | 65, 992 | 447, 432 | 105, 293 | 613, 957 | 66, 009 | 405, 532 | 42, 364 | 295, 152 |
| **LAND PEBBLE AND OTHER** | | | | | | | | | | |
| Belgium | 29, 102 | $141, 765 | 16, 705 | $85, 522 | 4, 403 | $16, 211 | | | 9, 764 | $39, 812 |
| Canada | 25, 244 | 192, 222 | 45, 561 | 303, 410 | 54, 519 | 260, 029 | 18, 723 | $94, 830 | 14, 210 | 51, 102 |
| China | 3, 599 | 12, 597 | | | | | | | | |
| Cuba | 17, 196 | 77, 702 | 9, 901 | 54, 449 | | | 27 | 390 | 62 | 321 |
| Czechoslovakia | | | | | | | | | 2, 998 | 14, 540 |
| Denmark | 35, 287 | 161, 660 | 28, 991 | 126, 991 | 25, 006 | 112, 537 | 21, 337 | 90, 483 | 28, 696 | 116, 453 |
| Estonia | 3, 600 | 12, 600 | | | | | | | | |
| France | 2, 200 | 6, 622 | 1, 502 | 4, 806 | | | 2, 197 | 9, 144 | 2, 750 | 6, 875 |
| Germany | 246, 748 | 1, 110, 183 | 281, 547 | 1, 216, 147 | 172, 728 | 697, 167 | 68, 058 | 311, 280 | 130, 446 | 587, 678 |
| India (British) | | | 1, 403 | 5, 261 | | | | | | |
| Irish Free State | | | 10, 456 | 44, 653 | 3, 300 | 12, 243 | | | | |
| Italy | 122, 224 | 589, 656 | 96, 169 | 464, 181 | 62, 327 | 289, 906 | 65, 523 | 292, 173 | 87, 767 | 384, 690 |
| Japan | 230, 548 | 827, 316 | 287, 372 | 1, 051, 927 | 220, 389 | 830, 486 | 143, 446 | 520, 095 | 157, 362 | 485, 527 |
| Latvia | 16, 228 | 75, 957 | 4, 150 | 20, 211 | | | | | 13, 144 | 64, 173 |
| Lithuania | 7, 510 | 44, 060 | 3, 142 | 8, 852 | | | | | | |
| Mexico | 2 | 41 | 44 | 725 | 50 | 210 | | | | |
| Netherlands | 162, 224 | 787, 384 | 164, 562 | 760, 487 | 166, 029 | 755, 876 | 96, 507 | 436, 875 | 153, 130 | 639, 662 |
| Norway | | | | | 402 | 2, 312 | 300 | 1, 050 | | |
| Panama | | | | | | | 1 | 20 | | |
| Poland and Danzig | 39, 129 | 217, 644 | 36, 999 | 203, 053 | 12, 035 | 70, 237 | 6, 386 | 33, 875 | 20, 418 | 114, 450 |
| Salvador | 32 | 1, 765 | | | | | | | | |
| Spain | 76, 818 | 374, 946 | 64, 984 | 321, 162 | 77, 962 | 366, 066 | 77, 696 | 360, 697 | 73, 178 | 327, 715 |
| Sweden | 32, 325 | 161, 631 | 52, 853 | 277, 052 | 31, 047 | 175, 471 | 41, 325 | 214, 102 | 63, 720 | 299, 836 |
| United Kingdom | 9, 677 | 38, 744 | 29, 615 | 114, 768 | 9, 201 | 41, 292 | 2, 200 | 10, 120 | 27, 400 | 108, 141 |
| U.S.S.R. in Europe | 4, 000 | 23, 000 | | | | | | | | |
| Yugoslavia and Albania | 11, 579 | 56, 393 | 23, 774 | 119, 458 | 6, 614 | 33, 070 | 3, 300 | 14, 988 | 1, 650 | 8, 250 |
| | 1, 075, 272 | 4, 913, 888 | 1, 159, 730 | 5, 183, 115 | 846, 012 | 3, 663, 113 | 547, 026 | 2, 390, 122 | 786, 695 | 3, 249, 225 |

Exports of high-grade hard rock from the different customs districts are shown in the following table. Most of this type of rock in 1933 (98 percent) was exported from the Florida district (41,342 long tons valued at $287,459) the exports from which were slightly greater (13 percent) in 1933 than in the previous year. Only 522 tons valued at $2,588 were exported from the Montana-Idaho district, as against 29,263 tons valued at $154,255 exported in 1932; this decrease was due to a greatly lessened demand from Canada.

*High-grade hard-rock phosphate exported from the United States, 1932–33, by customs districts*

| Customs district | 1932 | | 1933 | | Customs district | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|
| | Long tons | Value | Long tons | Value | | Long tons | Value | Long tons | Value |
| Buffalo | 151 | $1,767 | 455 | $4,715 | Maryland | | | 45 | $390 |
| Florida | 36,540 | 248,880 | 41,342 | 287,459 | Montana-Idaho | 29,263 | $154,255 | 522 | 2,588 |
| Michigan | 55 | 630 | | | | 66,009 | 405,532 | 42,364 | 295,152 |

The drop of the dollar in 1933 tended to strengthen American export business. To facilitate orderly marketing under the abnormal conditions thereby created and particularly to check the downward trend in gold prices, international conversations were begun during the year. A limited stock company, the Société Commerciale des Phosphates d'Algerie et de Tunisie, representing French North African producers, was formed in October to allocate quotas among its member companies and to join in the agreement with American exporters which was consummated in December 1933; the sales director of the Moroccan Office Cherifien des Phosphates was made chairman.

The situation in the European phosphate-rock market was complicated further during the year by the large quantities of Russian apatite entering that market, high-grade flotation apatite concentrates being sold to fertilizer manufacturers and lump apatite to the steel companies (presumably for increasing the yield of basic slag for fertilizer purposes).

## WORLD PRODUCTION

Production of phosphate rock increased in the principal producing countries in 1933, the increases in the five leading countries ranging from 5 percent in Algeria to 58 percent in Nauru and Ocean Islands. The United States production increased 46 percent, but increases in the French North African colonies were all small: Algeria, 5 percent; Tunisia, 8 percent; and Morocco, 12 percent.

Reports from countries which in 1932 produced about 82 percent of the total output indicate that the world production rose in 1933 to about 8,300,000 metric tons, an increase of about 24 percent over the previous year.

In 1933 the United States was the leading producer; Tunisia, Morocco, Nauru and Ocean Islands, and Algeria followed in order.

*World production of phosphate rock, 1929–33, by countries, in metric tons*

[Compiled by M. T. Latus, of the Bureau of Mines]

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Algeria | 747,035 | 846,686 | 564,898 | 569,571 | 597,800 |
| Angaur Island [1] | 65,494 | 56,345 | 60,202 | (2) | (2) |
| Australia: | | | | | |
| New South Wales | 71 | 26 | 96 | 229 | (2) |
| South Australia | ---- | ---- | 523 | 654 | (2) |
| Belgium | 40,330 | 40,380 | 49,100 | 25,810 | (2) |
| Canada | 1,075 | [3] 36 | ---- | 1,194 | 2,008 |
| China | [4] 8,000 | [4] 8,000 | [4] 8,000 | [4] 8,000 | (2) |
| Christmas Island (Straits Settlements) [5] | 119,756 | 121,858 | 66,906 | 85,548 | (2) |
| Egypt | 215,311 | 313,478 | 257,011 | 349,780 | (2) |
| Estonia | 8,352 | 4,850 | 4,580 | 1,133 | (2) |
| France | 179,620 | 159,800 | 107,980 | (2) | (2) |
| India (British) | [3] 22 | 308 | [3] 111 | 123 | (2) |
| Indo-China | 18,772 | 30,300 | 12,871 | 373 | (2) |
| Japan | 14,573 | 27,713 | 21,148 | 18,707 | (2) |
| Madagascar | 13,441 | 11,150 | 8,000 | (2) | (2) |
| Makatea Island [5] | 242,990 | 176,075 | 111,422 | 120,650 | (2) |
| Morocco, French [6] | 1,608,249 | 1,779,008 | 900,731 | 987,317 | 1,107,333 |
| Nauru and Ocean Islands [7] | 585,844 | 512,265 | 392,172 | 438,466 | 691,168 |
| Netherland India | 3,172 | 1,258 | 110 | 2,724 | 7,946 |
| Netherland West Indies: Curacao [5] | 103,289 | 87,497 | 80,928 | 65,407 | 85,550 |
| New Caledonia | (2) | (2) | (2) | 1,000 | (2) |
| Philippine Islands | 1,492 | (2) | 260 | (2) | (2) |
| Poland | 39,294 | 40,000 | (2) | (2) | (2) |
| Rumania | 1,626 | 1,829 | ---- | ---- | (2) |
| Seychelles Islands [5] | 12,789 | 15,977 | 4,730 | 14,213 | (2) |
| Spain | 7,626 | 5,400 | 7,734 | 9,980 | (2) |
| Taiwan | ---- | 57 | (2) | (2) | (2) |
| Tunisia | 2,511,000 | 3,326,000 | 2,148,000 | 1,678,000 | 1,810,000 |
| Union of South Africa | ---- | ---- | 1,906 | 1,183 | (2) |
| United States (sold or used by producers) | 3,821,217 | 3,989,411 | 2,575,645 | 1,734,300 | 2,530,282 |
| U.S.S.R. (Russia) [4] | 81,000 | 224,000 | 330,000 | (2) | (2) |

[1] Exports during fiscal year ended Mar. 31 of year following that stated.
[2] Data not available.
[3] Apatite only.
[4] Estimated. (Imp. Inst., London.)
[5] Exports.
[6] Shipments, including exports as follows: 1929, 1,591,933 tons; 1930, 1,760,812 tons; 1931, 882,909 tons; 1932, 972,692 tons; 1933, 1,091,174 tons.
[7] Exports during fiscal year ended June 30 of year stated.

## CODE OF FAIR COMPETITION FOR FERTILIZER INDUSTRY

The Code of Fair Competition for the Fertilizer Industry was approved by the President on October 31, 1933. A Fertilizer Recovery Committee had been appointed by the National Fertilizer Association on May 16–17, 1933, a month before the National Industrial Recovery Act became effective. This committee prepared a tentative draft of the code of trade practices which it presented to the ninth annual convention of the National Fertilizer Association on June 20, 1933, when a new and enlarged Fertilizer Recovery Committee was appointed. On July 18, 1933, the proposed code was mailed to all fertilizer manufacturers, and on August 29, 1933, it was submitted to the National Industrial Recovery Administration for formal approval. A public hearing on this code was held in Washington on September 6, 1933, and the code was signed by President Roosevelt on October 31, 1933, becoming effective on November 10, 1933. It is to terminate June 16, 1935, if a Presidential proclamation or Congressional resolution declares that the emergency recognized by the National Industrial Recovery Act has ended. The code is subject to cancelation or modification at any time by the President and to alteration, amendment, or supplement at any time by a majority vote of the Fertilizer Recovery Committee, subject to the approval of the President.

Before the adoption of the code the National Fertilizer Association had petitioned on August 4, 1933, the National Recovery Administration for permission to substitute certain wage and labor provisions (art. III, secs. 2 and 3) of the proposed fertilizer code for similar provisions (pars. 2, 3, and 6) in the President's Reemployment Agreement; the Administrator agreed to this substitution on August 21, 1933.

The Fertilizer Code does not cover the production of phosphate rock, nor the distribution of phosphate rock to producers (art. II, sec. 12.—"The term 'producer' means any member of the industry engaged in the business of preparing, mixing, manufacturing, or importing mixed fertilizer, superphosphate, and for other fertilizer material for sale * * *") and to persons other than dealers or consumers (art. II, sec. 8.—"The term 'dealer' means any person, other than a producer, engaged in the business of buying mixed fertilizer, superphosphate, and/or other fertilizer material for the purpose of selling at a profit. One buying for his own use, or principally for his own use and that of his tenants, shall not be deemed to be a dealer. A group of unincorporated consumer buyers acting collectively or through an individual for the purpose of contracting for a joint order is not a dealer * * *"). It does, however, cover certain phases of the sale and distribution of phosphate rock to dealers and/or consumers, whether made directly or through agents.

The Fertilizer Recovery Committee, which constitutes the Code Authority, is authorized to require the submission by producers at reasonable times of reports containing information necessary for the administration and enforcement of the code, but phosphate-rock producers are not required thereunder to submit any information concerning their costs of production, wages, hours of labor, or prices to others than dealers or consumers (art. II, sec. 1).

An open price schedule system is established for the fertilizer industry (art. VI, sec. 2).

The code recognizes the rights of farmers' cooperative organizations in their production, purchases of fertilizers from manufacturers, and sales to members, including the distribution of patronage dividends (art. VII, sec. 3).

Producers in each zone, acting in accordance with procedures established by the Fertilizer Recovery Committee and subject to its approval, are authorized to prepare uniform rules, not inconsistent with any provisions in the code, governing the methods of quoting prices, methods of distribution, and methods of delivery, including trucking allowances, to be used in the sale of phosphate rock to consumers and dealers in such zone or subdivision thereof (art. VII, sec. 7).

Idaho, Utah, Montana, Colorado, Wyoming, and Nebraska, are exempt from all regulatory rules pertaining to sales (art. VII, sec. 8).

Minimum rates of pay (25 cents an hour in the Southern area, 35 cents in northern and midwestern areas, and 40 cents an hour in Pacific coast area) with 1⅓ normal rate for all time over 8 hours a day, except in case of office employees, are established by the code, as are also maximum hours of labor (40 hours a week, but in continuous processes such as superphosphate manufacture the work week may cover 48 hours). One day of rest a week is authorized. Foremen, superintendents, managers, salesmen, chemists, and officials are exempt from hours of work provisions. Employment of children under 16 years of age is not permitted. Right of collective bargaining by the employee and freedom of choice as to his relations to labor organizations are recognized (art. IV).

Numerous unfair practices are prohibited (art. VIII).

Members of the industry in each State are subject to any requirements of State law more stringent than those specified in the code.

For the purpose of administration the United States is divided into 12 trade zones, in each of which is a fair practice and planning committee or zone committee; this operates under the Fertilizer Recovery Committee, and its actions are subject to review by that committee and by the National Recovery Administration (art. III).

The accompanying chart, prepared by the National Fertilizer Association, presents in diagrammatic form those portions of the fertilizer code applicable to the phosphate-rock industry.

Work is in progress on a separate phosphate-rock code of fair competition covering the sale and distribution of phosphate rock as specified in article II, section 16, of the Fertilizer Code; after approval of the code by the President the sale and distribution of phosphate rock will be exempted entirely from the Fertilizer Code. In this connection the Phosphate Rock Institute, Inc., with headquarters at 30 Church Street, New York, N.Y., has been formed comprising virtually all domestic phosphate-rock producers.

## TECHNOLOGY

*Utilization of western phosphate rock.*—Pike [11] discusses the economics and technology of a proposed process for the production of monopotassium phosphate at Green River, Wyo., utilizing phosphate rock from Idaho, potash-bearing wyomingite from the Leucite Hills of Wyoming, coal from Rock Springs, Wyo., and sodium salts suitable for base exchange according to the Lemberg reaction with the potassium of the wyomingite from either the sodium carbonate brine of the Green River wells or the sodium chloride waters of Great Salt Lake, Utah.

*Flotation.*—As indicated in the chapter of this series covering 1932 developments, flotation is the most significant step in advance in the entire history of the phosphate-rock industry, not only reducing costs by doubling recoveries but also enlarging available reserves and rendering economical the re-treatment of old debris dumps. By the end of 1934 probably 30 percent of the output of Florida pebble will be flotation concentrates; at two plants in Tennessee flotation serves to raise the B.P.L. content of low-grade brown rock to an extent unattainable by former methods. The first two Florida installations built by the Phosphate Recovery Corporation, a jointly owned subsidiary of the International Agricultural Corporation and the Minerals Separation North America Corporation (near Mulberry, Fla.), have been described by Heinrichs [12] and Martin.[13]

[11] Pike, R. D., Proposed Manufacture of Monopotassium Phosphate at Green River, Wyo.: Ind. and Eng. Chem., ind. ed., vol. 25, no. 3, March 1933, pp. 256–261; no. 4, April 1933, pp. 374–378.

[12] 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.

[13] Martin, H. S., Milling Methods and Costs at the No. 2 Concentrator of the Phosphate Recovery Corporation: Am. Inst. Min. and Met. Eng., Contrib. 51 (class H, Nonmetallic Minerals), June 1933, p. 15. Paper read at the New York meeting, February 1933, of the American Institute of Mining and Matallurgical Engineers.

*Manufacturers of potash, phosphate rock, and nitrogen carriers*

[Until separate code is approved for producers and/or importers of potash, phosphate rock, and/or nitrogen carriers respectively]

**As to Production**

- Does not apply

**As to Distribution to Fertilizer Manufacturers and Others than Dealers and/or Consumers**

- Does not apply

**As to Distribution to Dealers and/or Consumers**

Must comply with:

- Art. IV—Labor provisions [1]
- Art. VI, Sec. 2—Open price schedules [1]
- Art. VII, Sec. 3—Distribution through cooperative associations [1]
- Art. VII, Sec. 7—Methods of quoting prices, methods of distribution, and methods of delivery [1 2]
- Art. VIII—Unfair practices prohibited

**As to Administrative Requirements**

Must comply with:

- Art. III—Administration (sec. 2)
- Art. IX—Reports and statistics [3]
- Art. XI—Fees and expenses

[1] These articles do not apply in Idaho, Utah, Montana, Colorado, Wyoming, and Nebraska.
[2] Requires further action to become operative.
[3] Except as to submitting reports or information concerning costs of production, wages, hours of labor, or prices to others than dealers or consumers.

No details of the Tennessee operations have been published. At one of the Florida plants current washer debris is used as feed for flotation and is pumped as produced to the flotation feed bins. The waste-pond debris hydraulicked at the other plant consists principally of quartz and phosphate grains between minus 8- and plus 200-mesh size. This material is pumped at 15 to 20 percent solids to the flotation plant, where it is sized and deslimed to a product ranging from minus 24- to plus 150-mesh by the use of vibrating screens and duplex and bowl classifiers. Plus 24-mesh material is reduced to flotation size by a rod mill.

After the final desliming of the flotation feed in bowl classifiers the rake product from the classifier is treated with reagents and mixed in rotating barrel-type mixers at 50 to 75 percent solids. The flotation agents used consist of enough alkali to give a slight alkalinity to the pulp, soap-forming fatty acids, a nonfrothing or collecting oil, and a small portion of a strong frother; the total consumption is about 1½ pounds to 1 ton of feed. The pulp is then diluted to approximately 25 percent solids and fed to cascade flotation machines. The rougher concentrate from these machines goes to mechanical subaeration machines, the concentrate from these going to a second set, the concentrate from which is dewatered and stored in filter bins. Tailings from both sets of subaeration machines are pumped back to the bowl classifiers for re-treatment. Further treatment of the stored concentrates is the same as that given the washer concentrates. The flotation process is stated to give recoveries of better than 90 percent, with the average tailings running from 4 to 5 percent B.P.L.

*Phosphoric acid-phosphate rock reaction.*—Marshall, Rader, and Jacob [14] in a recent article discussed several factors affecting the reaction between phosphoric acid and various types of phosphate rock produced in the United States.

*Blast-furnace operations.*—Easterwood [15] gives a detailed history of the technologic development of the present phosphoric acid blast-furnace operations of the Victor Chemical Works at Nashville, Tenn., where phosphate rock-pulverized coal briquets are smelted with coke and silica gravel in a 95-foot blast furnace; ferrophosphorus, elemental phosphorus, anhydrous phosphorus pentoxide, and liquid phosphoric acid are produced. Trisodium phosphate is made from the ferrophosphorus.

*Volatilization of fluorine in phosphate rock.*—Reynolds and Jacob [16] present the results of a study of the fluorine content of phosphate rock in the manufacture of elemental phosphorus and phosphoric acid from phosphate rock by furnace processes.

Reynolds, Jacob, and Rader [17] report the results of a study of the action of silica and water vapor on phosphate rock at high temperatures in relation to the volatilization of the fluorine content of the rock and the conversion of the insoluble phosphate into forms readily

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[14] Marshall, H. L., Rader, L. F., Jr., and Jacob, K. D., Factors Affecting the Phosphoric Acid-Phosphate Rock Reaction: Ind. and Eng. Chem., vol. 25, no. 11, November 1933, pp. 1253–1259.

[15] Easterwood, H. W., Making Phosphoric Acid in the Blast Furnace: Chem. and Met. Eng., vol. 40, no. 6, June 1933, pp. 283–287. (An abridgment of a paper presented, under the title of "Manufacture of Phosphoric Acid by the Blast-Furnace Method", before the Chicago meeting of the American Institute of Chemical Engineers, June 14–16, 1933.)

[16] Reynolds, D. S., and Jacob, K. D., Volatilization of Fluorine in Manufacture of Phosphorus and Phosphoric Acid by Furnace Processes: Ind. and Eng. Chem., vol. 25, December 1933, pp. 1321–1323.

[17] Reynolds, D. S., Jacob, K. D., and Rader, L. F., Jr., Phosphate Fertilizers by Calcination Process. Action of Silica and Water Vapor on Phosphate Rock: Ind. and Eng. Chem., vol. 26, no. 4, April 1934, pp. 406–412. Paper presented before the division of fertilizer chemistry at the 86th meeting of the American Chemical Society, Chicago, Ill., Sept. 10–15, 1933.

available as plant food. Heating 40-mesh phosphate rock for 30 to 60 minutes at 1,400° C. in the presence of sufficient silica and water vapor results in the volatilization of 95 to 100 percent of the fluorine content of the phosphate rock and the conversion of 85 to 95 percent of the phosphorus into a citrate-soluble condition.

## SUPERPHOSPHATES

Salient features of the superphosphate industry in the United States are shown in the following tables:

*Summary of statistics for superphosphate industry in the United States, 1931–33, in long tons*

| | 1931 | 1932 | 1933 |
|---|---|---|---|
| Production:[1] | | | |
| Bulk superphosphate 16 percent A.P.A.[2] basis | 2,744,528 | [3] 1,765,971 | 2,694,870 |
| Base and mixed goods 16 percent A.P.A. only | [4] 68,951 | 80,559 | 117,046 |
| Shipments:[1] | | | |
| Bulk superphosphates, to consumers 16 percent A.P.A. basis | 1,030,665 | [3] 709,074 | 824,176 |
| Bulk superphosphates, to others do | [4] 548,120 | 840,010 | 953,880 |
| Base and mixed goods 16 percent A.P.A. only | [4] 427,035 | 875,291 | 1,131,707 |
| Stocks (Dec. 31):[1] | | | |
| Bulk superphosphates 16 percent A.P.A. basis | 1,313,522 | 1,076,520 | 1,089,179 |
| Base and mixed goods 16 percent A.P.A. only | 521,509 | 341,727 | 497,589 |
| Exports of superphosphates [5] | 81,587 | 23,883 | 35,371 |
| Imports of superphosphates [5] | 5,337 | 21,881 | 23,705 |
| Sales of phosphate rock by producers for superphosphate production | 1,335,236 | 858,657 | 1,467,441 |

[1] Bureau of Census Monthly Statistics Superphosphate Industry.
[2] Available phosphoric acid.
[3] Revised figures.
[4] May to December, inclusive.
[5] Bureau of Foreign and Domestic Commerce.

*Superphosphates imported into the United States in 1931–33, by countries* [1]

| Country | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Long tons | Value | Long tons | Value | Long tons | Value |
| Belgium | | | 1,189 | $28,131 | 2,537 | $51,878 |
| Canada | 74 | $1,323 | 2,475 | 54,034 | 3,499 | 63,878 |
| Cuba | 3,000 | 44,117 | 3,000 | 44,662 | | |
| France | | | 52 | 771 | | |
| Germany | 126 | 4,990 | | | 146 | 3,631 |
| Italy | | | | | 10 | 227 |
| Japan | 1,968 | 29,082 | 13,880 | 172,464 | 12,154 | 158,126 |
| Netherlands | 169 | 1,282 | 1,172 | 14,623 | 5,068 | 35,496 |
| United Kingdom | | | 113 | 1,159 | 291 | 2,081 |
| | 5,337 | 80,794 | 21,881 | 315,844 | 23,705 | 315,317 |

[1] Not separately recorded prior to Jan. 1, 1931.

*Superphosphates (acid phosphates) exported from the United States, 1931–33 by countries*

| Country | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Long tons | Value | Long tons | Value | Long tons | Value |
| Canada | 78,852 | $900,134 | 20,547 | $218,640 | 28,611 | $263,242 |
| China | | | | | 605 | 10,447 |
| Cuba | 2,661 | 36,684 | 3,189 | 35,998 | 6,055 | 55,887 |
| Dominican Republic | | | 86 | 3,523 | 95 | 4,307 |
| United Kingdom | | | 56 | 630 | | |
| Other | 74 | 3,870 | 5 | 105 | 5 | 83 |
| | 81,587 | 940,688 | 23,883 | 258,896 | 35,371 | 333,966 |

# FULLER'S EARTH

By W. W. Adams and R. W. Metcalf [1]

SUMMARY OUTLINE



The sharp downward trend of production [2] of fuller's earth in the United States that followed the all-time peak year 1930 was arrested in 1933 by an output that was virtually the same as in 1932; it amounted to 251,158 short tons, a decrease of only 0.7 percent. The total value of the output, however, dropped from $2,440,736 in 1932 to $2,315,974 in 1933, or 5.1 percent, and the average value per ton from $9.65 to $9.22. Salient statistics of the industry in 1932 and 1933 are summarized in the following table.

*Salient statistics of the fuller's earth industry in the United States, 1932–33*

| | 1932 | 1933 | Percent of change in 1933 |
|---|---|---|---|
| Sold or used by producers: | | | |
| Short tons | 252, 902 | 251, 158 | −0. 7 |
| Value | $2, 440, 736 | $2, 315, 974 | −5. 1 |
| Average per ton | $9. 65 | $9. 22 | −4. 5 |
| Distribution of domestic production, by uses: | | | |
| Bleaching, clarifying, decolorizing, or filtering— | | | |
| Mineral oils: | | | |
| Short tons | 233, 028 | 232, 896 | −. 1 |
| Percent of total | 92. 2 | 92. 7 | |
| Vegetable oils and animal fats: | | | |
| Short tons | 17, 528 | 15, 975 | −8. 9 |
| Percent of total | 6. 9 | 6. 4 | |
| Miscellaneous uses: | | | |
| Short tons | 2, 346 | 2, 287 | −2. 5 |
| Percent of total | 0. 9 | 0. 9 | |
| Imports: | | | |
| Unwrought or unmanufactured: | | | |
| Short tons | 96 | 17 | −82. 3 |
| Value | $1, 040 | $260 | −75. 0 |
| Wrought or manufactured: | | | |
| Short tons | 3, 789 | 4, 078 | +7. 6 |
| Value | $32, 927 | $42, 050 | +27. 7 |
| Total imports: | | | |
| Short tons | 3, 885 | 4, 095 | +5. 4 |
| Value | $33, 967 | $42, 310 | +24. 6 |
| Exports: | | | |
| Short tons | 14, 194 | 14, 895 | +4. 9 |
| Value | $128, 157 | $137, 262 | +7. 1 |

[1] Figures on imports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce; those on exports supplied by the producers. No exports of fuller's earth recorded by the Bureau of Foreign and Domestic Commerce.

[2] Wherever production is mentioned in this chapter reference is to quantities shipped, delivered, or used by producers.

Sixteen plants contributed to the output of fuller's earth in 1933, five less than in 1932. As usual, most of the production came from Georgia and Florida; in these 2 States and Alabama and Illinois 9 plants produced 182,600 short tons having a total value of $1,657,-093 or an average of $9.07 per ton. Production west of the Mississippi River was reported by seven plants—in Colorado, Nevada, Texas, and Utah; the output totaled 68,558 tons valued at $658,881, an average of $9.61 per ton. Production east of the Mississippi River increased 2.3 percent in quantity but decreased 4.6 percent in total value, the average value per ton being 67 cents less than in 1932. Plants west of the Mississippi River reported decreases of 7.9 percent in tonnage

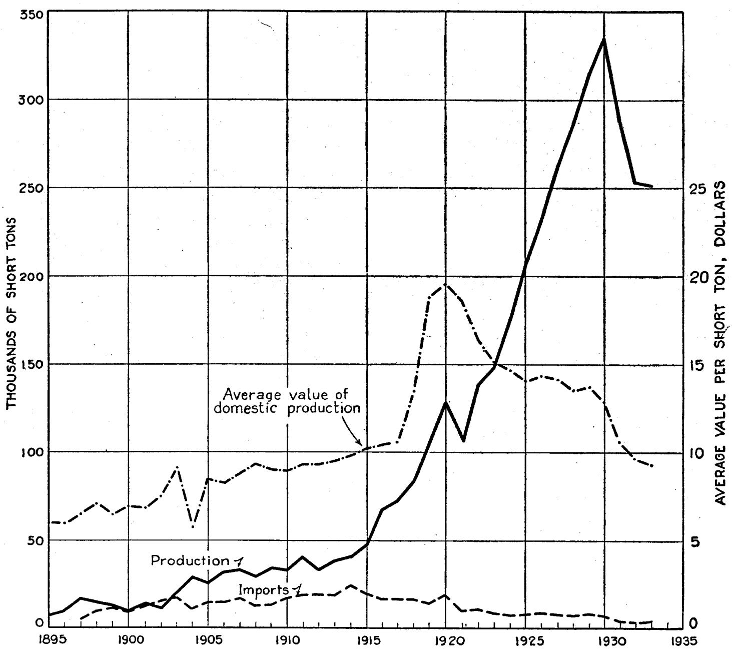


**Figure 95.**—Trends in production, imports, and average value per short ton of fuller's earth, 1895–1933.

and 6.3 percent in total value; the average value per ton was 16 cents more than in 1932.

*Definition.*—Fuller's earth is a mineral substance resembling clay, with physical qualities that give it a high capacity for absorbing basic colors from solution in mineral, vegetable, or animal oils. For statistical purposes the Bureau of Mines classes as fuller's earth all natural bleaching or filtering claylike materials, provided they require no chemical treatment for activation.

## LONG-TIME TRENDS IN THE INDUSTRY

In the United States fuller's earth was discovered first in Arkansas in 1891 and next in Florida in 1893; however, no production figures before 1895 are available.

Records show that Florida was the sole producer of fuller's earth in 1895 and 1896, although small quantities may have been produced elsewhere for local consumption or for experimental purposes. Colorado and New York became producers in 1897, but the output in both States was small. Utah began production in 1898. Arkansas first appeared among producing States in 1901, 10 years after fuller's earth was discovered in that State. Alabama and Massachusetts first reported production for 1904; Georgia, South Carolina, and Texas for 1907; California for 1908; Nevada for 1918; Illinois and Pennsylvania for 1922; Arizona for 1927; and Idaho for 1931.

Some States have produced fuller's earth continuously since their first year of reported output; others have ceased production and have not reappeared as producers; and others ceasing production for a period of years, have resumed operations and continued among the producing States through 1933.

The following table and figure 95 show the entire quantity of fuller's earth produced in the United States since the first reported output in 1895.

*Production, imports, and exports of fuller's earth, 1895–1933*

[Value of production in United States and of exports therefrom represents value at mines; value of imports represents value at foreign port from which material was shipped]

| Year | United States production | | | | Imports | | | | Exports | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Producers reporting sales | Short tons | Value at mines | | Unwrought or unmanufactured | | Wrought or manufactured | | Producers 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 | 5 | 3,700 | (1) |
| 1924 | 13 | 177,994 | 2,632,342 | 14.79 | 296 | 3,385 | 7,006 | 89,103 | 5 | 6,319 | $97,691 |
| 1925 | 14 | 206,574 | 2,923,965 | 14.15 | 215 | 2,619 | 7,800 | 108,676 | 5 | 6,195 | 91,975 |
| 1926 | 14 | 234,152 | 3,356,482 | 14.33 | 158 | 2,290 | 8,940 | 121,384 | 5 | 6,650 | 105,641 |
| 1927 | 16 | 264,478 | 3,767,038 | 14.24 | 550 | 5,679 | 7,030 | 103,602 | 6 | 12,287 | 191,835 |
| 1928 | 17 | 287,012 | 3,895,991 | 13.57 | 354 | 6,710 | 7,239 | 125,293 | 8 | 16,494 | 198,374 |
| 1929 | 17 | 315,983 | 4,309,723 | 13.64 | 608 | 11,583 | 7,694 | 140,849 | 7 | 21,264 | 258,408 |
| 1930 | 15 | 335,644 | 4,326,705 | 12.89 | 386 | 5,805 | 6,849 | 150,715 | 7 | 14,237 | 161,128 |
| 1931 | 22 | 288,400 | 3,055,570 | 10.59 | 136 | 1,534 | 3,877 | 47,430 | 6 | 8,368 | 77,945 |
| 1932 | 21 | 252,902 | 2,440,736 | 9.65 | 96 | 1,040 | 3,789 | 32,927 | 8 | 14,194 | 128,157 |
| 1933 | 16 | 251,158 | 2,315,974 | 9.22 | 17 | 260 | 4,078 | 42,050 | 5 | 14,895 | 137,262 |

[1] Figures not available.

[2] July to December only.

## CODE OF FAIR COMPETITION

In accordance with the National Industrial Recovery Act, a code of fair competition was approved on March 23, 1934, by the National Recovery Administrator, effective March 30, pursuant to authority vested in him by the President of the United States. Previous to approval of the code and for that part of the calendar year 1933 after August 31, the President's Reemployment Agreement, as authorized by section 4 (a) of the National Industrial Recovery Act, was applicable to such individual companies as had signed the agreement.

The code of fair competition covers the mining and manufacturing of fuller's earth and the selling of fuller's earth by those who mine or manufacture it.

In general, but with some exceptions, the code provides that the work-week shall be limited to 40 hours averaged over a semiannual period, either from January 1 to June 30 or from July 1 to December 31, with a maximum of 48 hours during any one week for any employee. With certain exceptions, no employee may work more than 10 hours in any 24-hour period. Restrictions as to hours of work generally do not apply to persons employed in any executive, managerial, or supervisory capacity, or to technical assistants who earn not less than $35 per week, or to traveling salesmen.

A minimum rate of 35 cents an hour is provided, except that 30 cents per hour is permissible in North Carolina, Virginia, Arkansas, Kentucky, Oklahoma, Texas, and Louisiana and 24 cents an hour is permitted in Mississippi, Alabama, Florida, Georgia, and South Carolina. Different rates are provided for clerical and office workers. Persons under 16 may not be employed, and persons under 18 may not work at operations or occupations hazardous in nature or dangerous to health. Employees may organize freely and bargain collectively. Moreover, every employer is expected to make reasonable provisions for the safety and health of his employees while at work.

A code authority of four members is provided for, the members to be chosen by a method of selection approved by the National Recovery Administrator.

The code lists the following as constituting unfair competition, which is prohibited:

(1) Selling below cost of production as determined on the basis of cost accounting approved by the code authority, provided that selling below production cost is permissible if necessary to meet the prices of competitors who do not violate the code.

(2) Giving secret rebates, refunds, credits, or unearned discounts, or extending to purchasers services or privileges not extended to all purchasers under similar conditions.

(3) Giving money or anything of value to employees or representatives of customers to promote sales.

(4) Making or publishing false statements concerning products that will tend to deceive purchasers or injure the business of competitors.

(5) Selling any grade of product contrary to screen standards established by the code authority.

(6) Allowing cash discounts, except where provided in contracts in force on the date of approval of the code.

(7) Making an allowance for sifting in excess of 2 pounds per bag of a minimum shipping weight of 120 pounds and proportionately less for bags of smaller content.

(8) Allowing rebates, for bags returned, different from the price originally charged or allowing freight on returned bags.

(9) Extending credit beyond 30 days, without approval of the code authority, except that credit terms may permit payment on or before the 15th of the month following that in which shipment was made.

(10) The code provides further that contracts in force on date of approval of the code and which contain provisions at variance with the code may continue in force until their date of expiration but may not be renewed unless the right of renewal is specifically reserved to the other party (not the code member) to the contract.

(11) Code members must insert in all contracts for operating work within the industry a provision whereby the employees of the contractor or subcontractor shall be subject to the provisions of the code.

Each member of the industry must file a list of his selling prices with the Code Authority. This list fixes the date on which it becomes effective, which is to be not less than 5 days after the date of filing, provided that the first list of prices filed with the code authority becomes effective on the date of filing. Prices in any list filed must not be changed, except by filing with the code authority a new list of prices, to become effective on the date specified therein and not less than 5 days after the filing of the new list. Lists of prices filed with the code authority are open to inspection by any member of the industry.

## USES

Fuller's earth was employed originally by fullers to full or scour and cleanse cloth of grease and by furriers to remove grease from fur. These early uses long ago ceased to be important in the United States.

Nearly 93 percent of all fuller's earth produced in the United States in 1933 was used for decolorizing mineral oils; about 6 percent was employed similarly in treating vegetable oils and animal fats; and less than 1 percent was utilized for fulling cloth, as a binder, as a filler, or for other purposes. Production from 1927 to 1933, classified by uses, is given in the following table. Figures for years before 1927 are not available.

*Fuller's earth sold or used by producers in the United States, 1927–33, by uses*

| Year | Bleaching, clarifying, decolorizing, or filtering— | | | | Other uses | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Mineral oils | | Vegetable oils and animal fats | | | | | |
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 1927 | 243, 009 | (1) | 15, 363 | (1) | 6, 106 | (1) | 264, 478 | $3, 767, 038 |
| 1928 | 258, 645 | $3, 579, 273 | 24, 288 | $277, 197 | 4, 079 | $39, 521 | 287, 012 | 3, 895, 991 |
| 1929 | 301, 607 | 4, 164, 093 | 10, 685 | 112, 902 | 3, 691 | 32, 728 | 315, 983 | 4, 309, 723 |
| 1930 | 326, 087 | 4, 220, 751 | 8, 312 | 93, 367 | 1, 245 | 12, 587 | 335, 644 | 4, 326, 705 |
| 1931 | 272, 177 | 2, 883, 074 | 14, 133 | 159, 073 | 2, 090 | 13, 423 | 288, 400 | 3, 055, 570 |
| 1932 | 233, 028 | 2, 244, 772 | 17, 528 | 180, 208 | 2, 346 | 15, 756 | 252, 902 | 2, 440, 736 |
| 1933 | 232, 896 | 2, 129, 567 | 15, 975 | 171, 454 | 2, 287 | 14, 953 | 251, 158 | 2, 315, 974 |
| PERCENT OF TOTAL | | | | | | | | |
| 1927 | 91. 9 | (1) | 5. 8 | (1) | 2. 3 | (1) | 100 | 100 |
| 1928 | 90. 1 | 91. 9 | 8. 5 | 7. 1 | 1. 4 | 1. 0 | 100 | 100 |
| 1929 | 95. 4 | 96. 6 | 3. 4 | 2. 6 | 1. 2 | . 8 | 100 | 100 |
| 1930 | 97. 1 | 97. 5 | 2. 5 | 2. 2 | . 4 | . 3 | 100 | 100 |
| 1931 | 94. 4 | 94. 4 | 4. 9 | 5. 2 | . 7 | . 4 | 100 | 100 |
| 1932 | 92. 2 | 92. 0 | 6. 9 | 7. 4 | . 9 | . 6 | 100 | 100 |
| 1933 | 92. 7 | 92. 0 | 6. 4 | 7. 4 | . 9 | . 6 | 100 | 100 |

[1] Figures not available.

## REVIEW BY STATES

*Alabama.*—Alabama's entire production of fuller's earth in both 1933 and 1932 was from Barbour County. Before 1932 no production from the State had been reported since 1924, when the output was from De Kalb County.

*Colorado.*—Increased production was reported from Mineral County, the only county in Colorado producing in 1933. No output in the State was reported from 1915 to 1927, inclusive. Production in 1914 was from Washington County.

*Florida.*—Gadsden and Marion Counties were the centers of production in Florida in 1933. As in 1932, Florida ranked second among the producing States. From 1895 to 1923, inclusive, Florida produced more fuller's earth than any other State, but in 1924 Georgia took first place.

*Georgia.*—Three counties in Georgia—Decatur, Twiggs, and Wilkinson—produced fuller's earth in 1933. Beginning with 1924 Georgia has had a larger yearly production than any other State.

*Illinois.*—Pulaski County was the sole producer of fuller's earth in Illinois in 1933.

*Nevada.*—All Nevada production in 1933 was from Nye County.

*Texas.*—The output of fuller's earth in Texas in 1933 was from four counties—Burleson, Fayette, Gonzales, and Walker.

*Utah.*—Utah's entire production in 1933 was from Sevier County.

In addition to the eight States that accounted for the production of fuller's earth in the United States in 1933 Arizona, Arkansas, California, Idaho, Massachusetts, New York, Pennsylvania, and South Carolina have reported production in past years.

## FOREIGN TRADE

*Imports.*—Imports of fuller's earth into the United States increased 5.4 percent in quantity and 24.6 in value in 1933 over 1932. The quantity imported was equivalent to 1.6 percent of the domestic production. Although imports in 1933 exceeded those in 1931 and 1932 they were less than in any other year including 1897, when continuous figures begin. Published records of imports from 1884 to July 1897 do not show figures for fuller's earth, as such imports were not separately classified during that time. Before 1884 figures for imports are available for the years 1867 to 1883.

Imports reached a peak in quantity in 1914 and in value in 1918. The tonnage imported during 1933 equaled 27.5 percent of that exported. Yearly imports since 1897 are shown in the table on page 971.

*Exports.*—The fuller's earth exported during 1933 came from 5 of the 16 producing deposits and totaled 14,895 short tons valued at $137,262, an average of $9.22 per ton. The quantity exported equaled 5.9 percent of the total produced. In comparison with 1932 exports increased 4.9 percent in tonnage and 7.1 percent in total value; the average value per ton in 1932 was $9.03. Exports to Canada in 1933 were 10,271 short tons valued at $99,631, or 69 percent of the total quantity of fuller's earth exported and 73 percent of its total value. The rest of the exports (4,624 tons valued at $37,631) were shipped chiefly to Germany, Peru, U.S.S.R. (Russia), and Mexico; small quantities were sent to other countries not specified in the producers' reports to the Bureau of Mines. Yearly exports since 1923 are shown in the table on page 971.

# TALC AND GROUND SOAPSTONE [1]

By Alden H. Emery and B. H. Stoddard

SUMMARY OUTLINE



Domestic producers in 1933 sold 160,554 short tons of talc and ground soapstone with an average value, f.o.b. plant, of $10.47 a ton. This increase of 30.3 percent in quantity and 23.5 percent in total value compared with 1932 arrested the downward trend which began in 1930, but it was not enough to raise sales to the level of 1931. The value per ton continued to fall, as it has for many years—$12.50 per ton in 1928, $11.96 in 1929, $11.75 in 1930, $11.31 in 1931, $11.05 in 1932, and $10.47 in 1933. Further price declines should make possible the wider use of talc in ceramics and increase domestic production.

As the following table shows, talc is sold largely in ground form. Of the talc and ground soapstone sold in 1929 only 5.3 percent was not ground; in 1930, 3.0 percent; in 1931, 4.2 percent; in 1932, 4.7 percent; and in 1933, 3.8 percent.

*Talc and ground soapstone sold by producers in the United States, 1929–33, by classes*

| Year | Crude | | Sawed and manufactured | | Ground | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 1929 [1] | 11,228 | $87,820 | 473 | $140,928 | 208,082 | $2,399,914 | 219,783 | $2,628,662 |
| 1930 [1] | 4,972 | 48,913 | 385 | 90,370 | 174,028 | 1,969,055 | 179,385 | 2,108,338 |
| 1931 [1] | 6,673 | 47,382 | 181 | 51,740 | 156,898 | 1,753,350 | 163,752 | 1,852,472 |
| 1932 [1] | 5,635 | 51,657 | 107 | 17,749 | 117,479 | 1,292,227 | 123,221 | 1,361,633 |
| 1933 | 5,985 | 46,553 | 86 | 20,819 | 154,483 | 1,613,952 | 160,554 | 1,681,324 |

[1] Includes talc only.

*Code of Fair Competition.*—In August 1933 representatives of 25 of the 32 producers of talc and soapstone in the United States perfected a permanent organization for code purposes under the name of The

[1] The term "ground soapstone" is used in this chapter to include material marketed in the crude form. So far as is known, all of this reaches the consumer as a ground product. Architectural soapstone is included in the chapter on dimension stone.

National Association of Talc and Soapstone Producers.[2] On August 28 this group presented a code of fair competition to the National Recovery Administration and, after several revisions, a public hearing was held on November 21.[3] The code was approved in revised form on March 21, 1934.[4]

## REVIEW BY STATES

The order of importance of the States as producers of talc and ground soapstone in 1933 was unchanged from 1932; in fact, the proportionate share of each in tonnage of sales varied only 2.1 percent or less from the preceding year. New York sold 51 percent of the total quantity, Vermont 22.6 percent, and California 9.1 percent. In value these three States produced 57.6, 17.8, and 11.0, respectively, none varying more than 1 percent from its proportionate value for 1932.

*Talc and ground soapstone sold by producers in the United States, 1931–33, by States*

| State | 1931 [1] | | 1932 [1] | | 1933 | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| California | 11,605 | $180,582 | 9,979 | $139,322 | 14,545 | $185,268 |
| New York | 84,977 | 1,059,790 | 62,833 | 764,692 | 82,618 | 969,338 |
| North Carolina | 15,283 | 170,250 | (2) | (2) | 11,947 | 135,180 |
| Vermont | 38,424 | 318,322 | 30,361 | 250,130 | 36,233 | 299,558 |
| Virginia | (2) | (2) | 90 | 1,260 | 9,348 | 40,058 |
| Washington | | | | | (2) | (2) |
| Wisconsin | 3,583 | 11,646 | | | | |
| Undistributed [3] | 9,880 | 111,882 | 19,958 | 206,229 | 5,863 | 51,922 |
| Total | 163,752 | 1,852,472 | 123,221 | 1,361,633 | 160,554 | 1,681,324 |

[1] Includes talc only.
[2] Included under "Undistributed."
[3] 1931: Georgia, Maryland, New Jersey, Pennsylvania, and Virginia; 1932: Georgia, Maryland, New Jersey, Pennsylvania, and North Carolina; 1933: Georgia, Maryland, New Jersey, Pennsylvania, and Washington.

*Producers of talc and soapstone in the United States in 1933*

| Producer | Material | Product | Location of mine |
|---|---|---|---|
| CALIFORNIA | | | |
| A. C. Getty, Bigpine | Talc | Ground | Near Bigpine, Inyo County. |
| W. S. McLean, 1919 San Bruno Avenue, San Francisco. | Soapstone | do | Butte County. |
| Pacific Coast Talc Co., 2149 Bay Street, Los Angeles. | Talc | do | 7 miles north of Silver Lake station, San Bernardino County. |
| Pacific Minerals Co., Ltd., 337 Tenth Street, Richmond. | Soapstone | do | Shrub, Eldorado County. |
| Sierra Talc Co., 428 Union League Building, Los Angeles. | Talc | do | Near Darwin, Inyo County. |
| Western Talc Co., 1901 East Slauson Avenue, Los Angeles. | do | do | Tecopa, Inyo County. |
| John L. Whitney, 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 | Do. |

[2] Pit and Quarry, Talc and Soapstone Association Formed: Vol. 26, no. 3, September 1933, p. 16. Rock Products, Talc and Soapstone Producers Write Code: Vol. 36, no. 8, Aug. 25, 1933, p. 37.
[3] Eng. and Min. Jour., vol. 134, no. 12, December 1933, p. 537.
[4] Code of Fair Competition for the Talc and Soapstone Industry, approved Code No. 350, Registry No. 1039-10, 1934, pp. 287-302.

*Producers of talc and soapstone in the United States in 1933*—Continued

| Producer | Material | Product | Location of mine |
|---|---|---|---|
| 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. |
| MICHIGAN | | | |
| Michigan Talc Mining Co., 514 Morgan Building, Detroit. | Talc | do | Ishpeming, Marquette County. |
| NEW JERSEY | | | |
| Jersey Materials Co., 412 Easton Trust Building, Easton, Pa. | Talc and serpentine. | do | Above Marble Hill, on Delaware River near Phillipsburg, Warren County. |
| NEW YORK | | | |
| Carbola Chemical Co., Inc., Natural Bridge. | Talc | 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 | | | |
| W. R. Lunsford, Marble | do | Rough | Marble, Cherokee County. |
| Nantahala Co., Nantahala | do | Rough, blanks, crayons. | Hewitt, Swain County. |
| Notla Talc Co., Murphy | do | Rough, crayons, ground. | Near Murphy, Cherokee County. |
| Standard Mineral Co., Inc., 230 Park Avenue, New York, N.Y. | Pyrophyllite | Ground | 2½ miles from Hemp, Moore County. |
| Talc Mining & Milling Corporation, 178 Whiton Street, Jersey City, N.J. | Talc | do | Glendon, Moore County. |
| PENNSYLVANIA | | | |
| C. K. Williams & Co., 640 North 13th Street, Easton. | Soapstone | Crude | Near Easton, Northampton County. |
| VERMONT | | | |
| Eastern Magnesia Talc Co., Inc., Burlington. | Talc | Crayons, ground | Johnson, Lamoille County, and Waterbury, Washington County. |
| Vermont Mineral Products, Inc., Chester. | do | Ground | Near Chester, Windsor County. |
| Vermont Talc Co., Chester | do | do | Windham, Windham County. |
| VIRGINIA | | | |
| Blue Ridge Talc Co., Inc., Henry | Soapstone | Rough, ground | Near Henry station, Franklin County. |
| Bull Run Talc & Soapstone Co., Inc., Clifton station. | Talc | Ground | 3 miles north of Clifton, Fairfax County. |
| Virginia Alberene Corporation, 419 Fourth Avenue, New York, N.Y. | Soapstone | Dimension stone, furnace blocks, special products, ground. | Schuyler, Nelson County. |
| WASHINGTON | | | |
| Asbestos-Talc Products of Washington, Inc., Burlington. | Talc | Ground | Near Burlington, Skagit County. |

*California.*—In 1933 the output of talc and ground soapstone in California increased 4,566 short tons (45.8 percent) in quantity and $45,946 (32.9 percent) in value over 1932. Eighty-nine percent of the total was ground and used in the cosmetic, ceramic, rubber, paint, and paper trades. The average value per ton of the crude material was $7.34 and of the ground product $13.40. Seven producers operating in Butte, Eldorado, Inyo, San Bernardino, and Tuolumne Counties contributed the entire output.

It was reported that the preliminary development of a talc mine and plant near Ione, Calif., was completed during the year. A 70-foot shaft was sunk, and mining on a small scale was expected to start by October 1, 1933. The talc was to be ground, sacked at the mine, and trucked to Sacramento for distribution.[5]

*Georgia.*—The Georgia Talc Co., one of the largest producers in former years, resumed operations during 1933. This company and the Cohutta Talc Co., Dalton, furnished the total commercial output of this State, most of which was manufactured into talc crayons, although some also was sold for use in rubber manufacture.

*Maryland.*—The Harford Talc & Quartz Co., Towson, produced high-grade refractory talc for use in the manufacture of lava tips for gas burners, electrical insulation, and other heat-resisting purposes. Herbert I. Oursler produced talc schist from his property near Henryton, Carroll County.

*Michigan.*—During 1933 the Michigan Talc Mining Co. was organized and capitalized for $150,000, to open and operate a talc deposit near Ishpeming. A shaft was sunk 100 feet and a drift carried into the vein. This was the first talc production in Michigan, but no sales were made. The raw material will be hauled by truck to the railroad and shipped either directly to users or to the company mill in Detroit.[6]

*New Jersey and Pennsylvania.*—In New Jersey, the Jersey Materials Co. purchased the property near Phillipsburg formerly owned by the Rock Products Co., erected a plant, and produced ground talc. In Pennsylvania, C. K. Williams & Co. produced crude soapstone at its property near Easton, Northampton County.

*New York.*—For many years the entire output of talc in New York has been contributed by the same producers—the Carbola Chemical Co., Inc., the International Pulp Co., and the W. H. Loomis Talc Corporation. Granular talc from Lewis County and fibrous talc from St. Lawrence County composed the entire output in 1933—82,618 short tons, valued at $969,338. Compared with 1932 these figures show an increase of 31.5 percent in quantity and 26.8 percent in value. The average value of the product was $11.73 per ton. The material was ground and used largely in the ceramic industry, as an inert extender in paint, and as a paper filler.

*North Carolina.*—Commercial production of talc and pyrophyllite in North Carolina declined in 1933 compared with 1932. Virtually the entire output was ground before shipment. W. R. Lunsford, Marble, a new operator, shipped his entire production as crude material. The Nantahala Co., in addition to shipments of crude talc, manufactured talc crayons. The Notla Talc Co. produced and sold talc crayons and ground talc. The pyrophyllite produced by the Standard Mineral Co. was sold for use largely in the ceramic, paint, and rubber industries.

During the year the Gerhardt Talc Corporation, with authorized capital stock of $100,000, was chartered to develop a talc deposit near Staley.[7] A separating and crushing plant is to be installed at the deposit, which is said to contain excellent talc.

*Vermont.*—In 1933 the total output of talc in Vermont showed gains of 19.3 percent in quantity and 19.8 percent in value compared

[5] Pit and Quarry, California Talc Mine Nearing Completion: Vol. 26, no. 4, October 1933, p. 16.
[6] Pit and Quarry, New Michigan Talc Mine and Plant in Operation: Vol. 26, no. 5, November 1933 p. 14; Rock Products, vol. 36, Aug. 25, 1933, p. 83.
[7] Rock Products, Talc Deposits to be Developed: Vol. 36, Feb. 25, 1933, p. 65.

with 1932. Virtually the entire commercial production was ground and was valued at $8.27 per short ton. A small quantity of talc crayons also was produced.

*Virginia.*—Shippers of talc and ground soapstone in Virginia in 1933 were the same as in 1932. The output of the State consisted almost entirely of ground soapstone produced by the Virginia Alberene Corporation at Schuyler, Nelson County. Architectural soapstone almost equaled the ground product in tonnage and was many times greater in value. During the year the Rapidan Soapstone Co. near Somerset leased its property to Richmond interests who plan to reopen the quarry, which has been idle several years.[8]

*Washington.*—The Asbestos-Talc Products of Washington, Inc., produced ground talc for use in roofing paints, concrete mixtures, and other commodities.

## FOREIGN TRADE

*Imports.*—The average value of domestic talc and ground soapstone sold in the United States in 1933 was $10.47 per ton. In contrast to this the average value of imported talc was $17.68.

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 suited for cosmetics. Italy supplied 29 percent of our 1933 imports at an average value of $29.16 per ton. China supplied a small quantity of material, probably high-grade stone for carving, at an average price of almost $185 a ton. France is an important producer of French (tailor's) chalk, and toilet and lava grades of talc; 25 percent of our imports, with an average value of $15.08, came from France. Only Canada among the important sources of imports supplied talc and soapstone at an average value less than that of domestic sales.

Although the average value per ton of imports customarily has been higher than that of domestic sales it also has been declining annually—$21.54 in 1929, $20.55 in 1930, $18.47 in 1931, $17.91 in 1932, and $17.68 in 1933. This decline is at a greater rate than the decline in value of domestic production over this same period—$11.96 in 1929 to $10.47 in 1933.

In 1930 and 1931 imports of talc declined at a rate comparable to the drop in domestic sales. In 1932, imports held up better than domestic sales, and in 1933 the recovery was shared by imports, but not to as great an extent. In 1930 and 1931 imports for consumption were equivalent to 14.4 percent of domestic sales, in 1932 to 16.3 percent, and in 1933 to 13.8 percent.

*Talc imported for consumption in the United States, 1929–33*

| 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 |
| 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 |
| 1933 | 248 | 2,628 | 21,899 | 388,888 | 22,147 | 391,516 |

[8] Rock Products, vol. 36, Dec. 25, 1933, p. 39.

On a tonnage basis Italy was the chief source of talc and soapstone imported into the United States in 1932; but in 1933 Canada ranked first, with almost 40 percent of the tonnage. Italy supplied 29 percent and France, declining slightly from 1932, 25 percent; Japan, with an increase of 188 percent from 1932, contributed about 5 percent of the total.

The average value of Italian imports was $29.16 per ton compared with $9.57 for Canadian material. Hence, in comparing values Italy led with 46.6 percent, France was second with 21.2 percent, and Canada was third with 21 percent. Imports from China amounted to only 134 tons (0.6 percent) but accounted for 6.4 percent of the value.

*Talc, steatite or soapstone, and French chalk, crude, manufactured, or ground, imported into the United States, 1932–33, by countries*

[General imports]

| Country | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| Africa: | | | | |
| British: | | | | |
| Union of South Africa | 29 | $765 | 29 | $709 |
| Austria | 33 | 896 | 1 | 69 |
| Canada | 6,379 | 58,097 | 8,422 | 80,590 |
| China | 147 | 24,649 | 134 | 24,754 |
| Egypt | | | 22 | 347 |
| France | 5,952 | 76,436 | 5,397 | 81,404 |
| Germany | (1) | 29 | 1 | 79 |
| Hong Kong | 1 | 96 | (1) | 28 |
| India (British) | | | 60 | 1,002 |
| Italy | 6,917 | 190,068 | 6,140 | 179,040 |
| Japan | 368 | 4,979 | 1,061 | 14,196 |
| Kwantung | 34 | 360 | 168 | 1,575 |
| Norway | 44 | 296 | 22 | 158 |
| U.S.S.R. (Russia in Europe) | 74 | 438 | | |
| | 19,978 | 357,109 | 21,457 | 383,951 |

[1] Less than 1 ton.

*Exports.*—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, 1929–33*

| Year | Description | Short tons | Value |
|---|---|---|---|
| 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 | do | (1) | 646,605 |
| 1933 | do | (1) | 618,026 |

[1] Quantity not recorded.

## WORLD PRODUCTION

The following table gives the world production of talc and soapstone, 1929 to 1933, insofar as figures are available:

*World production of talc and soapstone, 1929–33, by countries, in metric tons*

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Australia: | | | | | |
| New South Wales | 555 | 280 | 230 | 293 | (2) |
| South Australia | 776 | 811 | 817 | 1,071 | (2) |
| Tasmania | 23 | 14 | 15 | 5 | (2) |
| Austria (exports) | 19,603 | 18,530 | 16,979 | 17,276 | (2) |
| Canada [3] | 14,069 | 10,742 | 10,710 | 10,980 | 13,761 |
| Egypt | | | | 232 | (2) |
| Finland | 2,848 | 2,800 | 3,000 | 1,625 | (2) |
| France | 105,560 | 85,900 | (2) | (2) | (2) |
| Germany (Bavaria) | 6,805 | 5,794 | 4,208 | 3,197 | (2) |
| Great Britain | 29 | 188 | 163 | 262 | (2) |
| Greece | 150 | 256 | 484 | (2) | (2) |
| India (British) | 7,333 | 6,967 | 5,217 | 6,617 | (2) |
| Italy | 40,810 | 38,131 | 38,620 | 32,404 | (2) |
| Morocco, French (exports) | 610 | 561 | 693 | 837 | (2) |
| Norway | 8,332 | 14,996 | 11,392 | 13,536 | (2) |
| Rumania | 1,077 | 3,353 | 3,068 | 1,798 | (2) |
| Spain | 5,164 | 5,438 | 6,585 | 6,574 | (2) |
| Sweden | 7,026 | 5,117 | 4,837 | 4,525 | (2) |
| Union of South Africa (Transvaal) | 464 | 380 | 336 | 251 | 271 |
| United States | [4] 199,383 | [4] 162,734 | [4] 148,553 | [4] 111,784 | [5] 149,082 |
| Uruguay (exports) | 786 | 1,463 | 1,789 | (2) | (2) |

[1] In addition to the countries listed talc is produced in Argentina, Brazil, and the U. S. R. R. (Russia) but data of production are not available.
[2] Data not available.
[3] Excluding soapstone, which is reported only by value and was as follows: 1929, $47,986; 1930, $50,168; 1931, $34,439; 1932, $46,751; 1933, $43,593. Soapstone is sold in the form of both blocks and powder.
[4] Figures represent sales of talc only. Bureau of Mines not at liberty to publish figures for soapstone.
[5] Figures represent total mine production of talc and soapstone.

## TECHNICAL DEVELOPMENTS

It is generally accepted that talc imparts to ceramic products the property of resistance to thermal shock. Accordingly it has been an important ingredient of electric-stove plates, gas-stove backwalls, and radiants. The widespread use of this material in saggers[9] and in certain types of whiteware bodies is a comparatively recent development that has gained ground rapidly.

Thiemecke[10] studied the effect of relatively pure talc on cone 10 sagger bodies. He found that the use of talc—

Resulted in (*a*) better working properties in the plastic state; (*b*) increased dry and fired mechanical strengths, hence less loss of saggers in handling; (*c*) smoother fired surfaces; (*d*) darkening of the fired color from a buff to a golden brown; (*e*) decreased total shrinkage; (*f*) decreased absorption with possible better heat-conductivity; (*g*) lower coefficient of expansion, giving increased heat-shock resistance; (*h*) decreased sag tendency; and (*i*) increased mullite development.

King and Evans[11] prepared 5 sagger bodies containing 0- to 20-percent talc (5-percent increments), and fired them at cones 9–10. Absorption (3 half bars) was 13.5 percent for the body containing no talc and decreased gradually to 10.4 percent for the 20-percent talc body. The original modulus of rupture (10 bars) for bodies with no

[9] Bowles, Oliver, Nonmetallic-Mineral Industries: Min. and Met., vol. 15, no. 325, January 1934, pp. 52–55.
[10] Thiemecke, H., Notes on Cone 10 Sagger Bodies with Talc as a Component: Jour. Am. Ceram. Soc., vol. 17, 1934, pp. 2–6.
[11] King, R. M. and Evans, C L., Resistance to Sudden Temperature Change of Some Bodies of the System Talc-Clay-Mullite: Jour. Am. Ceram. Soc., vol. 16, 1933, pp. 360–362.

talc was 2,702, increasing to a maximum of 3,380 for 10-percent talc bodies and decreasing to 3,030 for bodies containing 20-percent talc. The modulus after one quenching increased gradually from 650 to 985. The number of quenchings was 5 for no talc, 6 for 5-percent talc bodies, 10 for 10-percent, 13 for 15-percent, and more than 25 for 20-percent. In other words, up to 20-percent talc in a typical sagger body increases markedly the resistance to thermal shock.

Hagar [12] in discussing the use of talc in saggers says:

> During the past year talc has been used in saggers by * * * plants * * * making wall and floor tile, semiporcelain, electrical porcelain, and vitreous china. In many cases plants using talc in their saggers report they are obtaining twice the life on glost saggers from cone 3 to 7 and from 50 percent to double the life on bisque and procelain saggers from cone 9 to cone 11. In no case reported has the talc sagger failed to more than justify the extra cost of the material.

There are at least 10 manufacturers in the Midwest section alone who are using talc in carload quantities for saggers. Many others are using talc in 1- to 5-ton batches.

The amount of talc used is 8 to 15 percent of the weight of clay and grog. Thiemecke [13] says that the improvement in physical properties of fired bodies imparted by talc in amounts greater than 15 percent does not warrant additions exceeding this limit.

Betz [14] reports the successful use of 10 to 30-percent talc in bodies for small kiln furniture, such as bats, setters, props, covers, and supports. Using a mixture of plastic fireclay (nonsiliceous) 20 percent, Florida clay 15 percent, Georgia clay 45 percent, and talc 20 percent he got no deformation at cone 12 under usual load conditions. Droppings were eliminated and

> The resistance of the body to repeated heating and cooling in the tunnel kiln was excellent. The body had a long life and was mechanically strong * * * On a cost-per-turn basis this mixture proved to be more economical than the fireclay-grog type of body formerly used.

Hagar says [15] that there was no measurable difference in shrinkage between a sagger body containing 0, 8, 10, 12, and 14 percent talc, when burned to cone 11. The absorption on these bodies was: No talc, 14.8 percent; 8 percent talc, 11.8 percent; 10 percent talc, 11.5 percent; 12 percent talc, 11.3 percent; and 14 percent talc, 11.0 percent. Obviously talc increased the density of the body. For best results absorption should be 11 to 14 percent.

A fireclay-grog mixture burned to cone 18, alternately heated and cooled over 15-minute intervals for 18 hours, lost 70 percent of its original strength. The same mixture plus 15 percent talc, tested in the same way, lost only 5 percent of its strength.

There is no special combination of clays necessary to produce results with talc. Most plants merely incorporate the material in the regular sagger mixes they have been using; however, still better results can be obtained by employing special mixes. For example, use of talc with fine grog will overcome the well-known tendency of the fine material to lower resistance to thermal shock and at the same time will gain the greater strength and increased sagging resistance imparted by fine grog. In the same way talc offsets the tendency of siliceous clays to fail due to thermal shock.

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[12] Hagar, Donald, Lengthening Sagger Life with Talc: Ceram. Age vol. 21, February 1933, pp. 35–37, 63.
[13] See footnote 10.
[14] Betz, George C., Improving Kiln Furniture with Talc: Ceram. Age, vol. 21, April 1933, pp. 104–105, 125.
[15] See footnote 12.

Talc [16] reaches a critical temperature between cones 13 and 14. Even a small amount of talc in a sagger body at that temperature will cause failure. Hence, such a body should not be used in bottom saggers where the flame is likely to impinge. Betz [17] gives curves showing the behavior of a talc body under the standard load test for refractories; failure was very sudden.

In 1933 King and Evans [18] presented data on the effect of talc in practical working bodies of the clay-talc-mullite system. Using Florida kaolin 30 to 60 percent, talc 0 to 70 percent, mullite 0 to 50 percent, each in 10-percent increments, 19 bodies were fired at cones 7–8 and at cones 13–14. Shrinkage, absorption, modulus of rupture, and number of quenchings were measured. These data show that, when the firing temperature was sufficient to cause appreciable vitrification, talc bodies showed high resistance to thermal shock and lowered reduction of modulus of rupture after quenching.

Another recent development is the use of talc in wall tile and semi-vitreous pottery bodies to decrease crazing. Hagar [19] says that commerical bodies of this kind usually contain 10 percent or less talc (customarily 4 to 6 percent) used in combination with the regular fluxes. Experimental work has been conducted on bodies in which the talc entirely replaces other fluxes. The higher the percentage of talc the greater the resistance of the resulting body to crazing. However, the development and use of high-talc bodies have been retarded by the low price levels for tile and the high costs of the raw materials.

Talc also lowers the maturing temperature, normally cones 10 and 11, and effects fuel savings. Low-talc bodies can be matured at cone 8 and high-talc bodies at cone 4 and lower.

Talc also opens the way for the manufacture of a one-fired product. One western company is reported to be making a floor and wall tile containing up to 65 percent talc. Use of large percentages of this mineral have made firing easier and quicker and eliminated warping.

Soapstone shapes sawed from natural block have been used for years, but sawing such shapes is wasteful. It has been reported that, of the soapstone removed from the quarry, only 50 percent or less is salable. During 1933 the Canadian Department of Mines reported [20] that powdered soapstone mixed with 10 percent or less by weight of liquid sodium silicate can be pressed at 500 pounds per square inch or less to give shapes that will have sufficient strength and durability to meet any requirements that have been met by shapes sawed from natural block. Firing to 900° C. results in a great increase in strength and durability over that obtained by simple drying.

Results of other technical investigations were reported during 1933 by Rieke and Thurnauer [21], Mamykin and Permiakov [22], and Meljuschev.[23]

[16] See footnote 12.
[17] See footnote 14.
[18] See footnote 11.
[19] Hagar, Donald, Talc May Stop That Crazing: Ceram. Age, vol. 21, March 1933, pp. 74–75.
[20] Phillips, J. G., The Production of Shapes from Soapstone Dust: Canadian Dept. Mines, Mines Branch Rpt. 726, 1933, pp. 67–74.
[21] Rieke, R., and Thurnauer, H., Effect of Talc Additions on the Firing Behavior and Some Technically Important Properties of Pure kaolin: Ber. Deut. Keram, Gesell., vol. 13, 1932, pp. 245–253; Chem. Abs. (abs.), vol. 27, 1933, p. 277.
[22] Mamykin and Permiakov, Talc as a Refractory: Uralskiy Tehnik, vol. 7, no. 1, 1931, pp. 12–17; Jour. Inst. Metals (abs.), vol. 50, no. 4, 1932, p. 274; Ceram. Abs. (abs.), vol. 12, June 1933, p. 230.
[23] Meljuschev, K., Lining Cement Revolving Furnaces: Stroitel. Material (Moscow), no. 7, 1932, pp. 11–17; Feuerfest (abs.), vol. 8, no. 10, 1932, p. 158; Ceram. Abs. (abs.), vol. 12, February 1933, p. 66.

## HEALTH HAZARDS

There is growing recognition in the United States of the seriousness of dust inhalation in mining, metallurgy, and allied industries. For years it has been known that inhalation of certain dusts caused development of a fibrotic condition in the lungs and predisposed the victim to tuberculosis.

Realizing that this condition developed slowly the Bureau of Mines in 1924 began the development of a rapid test to indicate the relative tendencies of dusts of various compositions to produce this fibrotic condition on inhalation. This work, dropped by the Bureau because of curtailment of appropriations in 1933, was continued by the Public Health Service. The first description of the test has just been published.[24] By this method soapstone gave an inert reaction; namely, it was not absorbed and did not cause formation of progressive fibrotic nodules but remained unaffected and uneliminated in the tissues. This might be interpreted as meaning that, in time, such accumulations will fill the air spaces in the lungs and impair respiration even if not causing fibrosis. It seems desirable then to avoid exposure to soapstone dust. Tests using talc are now being conducted by the Public Health Service. From preliminary results it seems likely that the effect will be similar to that from soapstone.

Dreesen [25], in a recent article on the effects of certain silicate dusts on the lungs, says that—

> The silicate dusts of tremolite talc * * * induce a fine, diffuse, bilateral fibrosis of the lungs which is definitely demonstrable in the X-ray. While very dusty conditions prevail in certain departments * * * it cannot be said that the resultant pneumoconiosis has led to disability.

More recent work by the Public Health Service in another talc district has led to similar conclusions.

Bloomfield [26] gives figures for the average dust content of the air in certain dusty industries. The jack-hammer drillers in talc mining were said to be working in air containing 2,159.8 million particles per cubic foot of air, and the muckers in a concentration of 44.8 million particles. The packers in the finishing mills were breathing 50.1 million and the crushers and cylindermen 14.0 million particles per cubic foot. In contrast, street cleaners in residential districts breathed 1.7 million particles per cubic foot of air.

Dreesen [27] reported an average of 1,440 million particles of dust per cubic foot of air breathed by jack-hammer operators in a tremolite talc mine; millers were exposed to a concentration of 52 million and outside workers to an average of 4 million particles per cubic foot of air. Sixty-eight percent of the talc particles were less than 2 microns in diameter; 1 to 5 microns is considered the most dangerous size of dust.

From these findings it is believed that talc and soapstone present no serious hazard comparable to that from quartz. On the other hand, they have not been proved definitely harmless and should be avoided if possible.

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[24] Miller, John W., and Sayers, R. R., The Physiological Response of the Peritoneal Tissue to Dusts Introduced as Foreign Bodies: Public Health Repts., vol. 49, no. 3, Jan. 19, 1934, pp. 80–89.
[25] Dreesen, Waldemar C., Effects of Certain Silicate Dusts on the Lungs: Jour. Indus. Hygiene, vol. 15, March 1933, pp. 66–78.
[26] Bloomfield, J. J., Dust in Industry: Mech. Eng., vol. 55, 1933, pp. 229–233, 262.
[27] See footnote 25.

# FLUORSPAR AND CRYOLITE

By H. W. DAVIS

SUMMARY OUTLINE



## FLUORSPAR

*Summary.*—Increased demand for fluorspar by the industries using it greatly stimulated activity in the fluorspar industry in 1933 and resulted in considerable prospecting and development work and in the mining, milling, and shipping of substantially larger quantities of fluorspar than in 1932. The demand, however, required only a small part of the potential productive capacity of mines and mills.

Keen competition for the small volume of business offered during the first 4 months of 1933 kept the price of fluxing-gravel fluorspar at $9 to $9.50 a short ton f.o.b. Illinois-Kentucky mines. In the latter half of the year, however, the price showed a substantial improvement, opening at $13 in July and closing at $15.75 in December. Domestic ground fluorspar in bulk dropped to $23.50 a ton in April but recovered during the latter part of the year and reached $27.80 a ton in December. Imported fluxing-gravel fluorspar at tidewater (duty paid) fluctuated between $16 and $18.50 a short ton in 1933.

*Salient statistics of the fluorspar industry in the United States, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| Domestic shipments: | | | | |
| Gravel | 19,140 | $232,351 | 61,216 | $782,976 |
| Lump | 1,291 | 22,155 | 2,127 | 34,401 |
| Ground | 4,820 | 137,993 | 9,587 | 221,801 |
| | 25,251 | 392,499 | 72,930 | 1,039,178 |
| Stocks at mines or shipping points: | | | | |
| Ready to ship | 55,211 | (1) | 44,777 | (1) |
| Crude | 41,999 | (1) | 42,008 | (1) |
| | 97,210 | (1) | 86,785 | (1) |
| Imports: | | | | |
| Containing more than 97 percent $CaF_2$ | 6,152 | 87,854 | 5,165 | 73,404 |
| Containing not more than 97 percent $CaF_2$ | 7,084 | 44,811 | 5,244 | 31,639 |
| | 13,236 | 132,665 | 10,409 | 105,043 |
| Exports | 25 | 553 | 71 | 967 |
| Consumption (by industries): | | | | |
| Metallurgical | 39,500 | (1) | 66,500 | (1) |
| Ceramic | 9,500 | (1) | 10,300 | (1) |
| Chemical | 7,000 | (1) | 7,800 | (1) |
| | 56,000 | (1) | 84,600 | (1) |
| Stocks at consumers' plants Dec. 31: | | | | |
| Metallurgical | 56,400 | (1) | 57,800 | (1) |
| Ceramic | 1,600 | (1) | 2,700 | (1) |
| Chemical | 11,000 | (1) | 8,000 | (1) |
| | 69,000 | (1) | 68,500 | (1) |

[1] Figures not available.

A substantial increase in consumption of acid-grade fluorspar as a refrigerating medium, the initial importation of fluorspar from the newly opened deposit in Newfoundland, the production results at the new mill at Deming, N.Mex., and the construction of a station on the Kentucky side of the Ohio River for loading fluorspar were noteworthy in 1933.

Shipments of fluorspar in 1933 amounted to 72,930 short tons, an increase of 47,679 tons compared with 1932 but 51,866 tons below the average for the 5-year period 1926 to 1930. Imports in 1933 were 10,409 short tons, a decline of 2,827 tons compared with 1932 and 52,314 tons below the average from 1926 to 1930. The average price per ton of fluorspar sold by domestic producers to steel plants was $12.77, an increase of 64 cents over 1932 but $3.50 below the average from 1926 to 1930. Consumption of fluorspar in the United States was 84,600 short tons, an increase of 28,600 tons over 1932 but 91,000 tons below the average from 1926 to 1930. Stocks of fluorspar at consumers' plants were 68,500 short tons, about the same as in 1932 but 27,600 tons below the average from 1926 to 1930.

Trends in production, imports, consumption, and average value of fluorspar over a series of years are shown in figure 96.

*Production and shipments.*—In 1933 fluorspar was produced at 66 mines or prospects which yielded the equivalent of about 59,000 short tons of merchantable fluorspar. In 1932, 40 mines or prospects were worked, yielding about 17,000 tons of merchantable fluorspar.

Shipments of fluorspar from domestic mines aggregated 72,930 short tons valued at $1,039,178 in 1933, an increase of 189 percent in quantity and 165 percent in total value compared with 1932, but only 58 percent of the average annual shipments for the 5-year

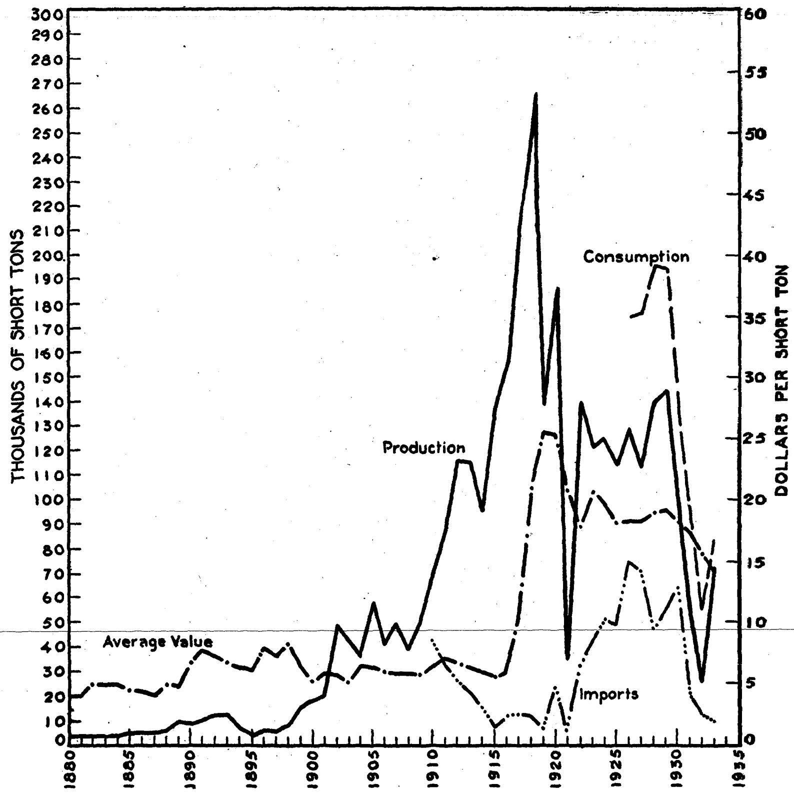


FIGURE 96.—Trends in production of fluorspar in the United States, 1880–1933; in imports, 1910–33; in consumption, 1926–33; and in average value per ton, 1880–1933.

period, 1926 to 1930. The general average value for all grades was $14.25 a ton in 1933, $1.29 less than the 1932 average. The value recorded for domestic fluorspar is the price paid f.o.b. mine shipping point by the consumer and excludes the cost of containers. The general average value per ton of the fluorspar shipped to steel plants from the Illinois-Kentucky district was $12.83 in 1933 compared with $12.17 in 1932.

The following table presents such details of shipments of fluorspar from 1930 to 1933, by States, as may be published without revealing, except by permission, data supplied by individual producers.

*Fluorspar shipped from mines in the United States, 1930–33, by States*

| 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 |
| **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 | | | 3,842 | | | 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 |
| **1933** | | | | | | | | | | | | |
| Illinois | 29,694 | 395,492 | 13.32 | 357 | | | 6,024 | | | 36,075 | 543,060 | 15.05 |
| Kentucky | 30,035 | 371,669 | 12.37 | 1,716 | 34,401 | 16.17 | 2,863 | 221,801 | 23.14 | 34,614 | 469,451 | 13.56 |
| New Mexico | 294 | 9,037 | 12.13 | ---------- | | | 700 | | | 994 | 19,889 | 13.27 |
| Nevada | 451 | | | 54 | | | ---------- | ---------- | ---------- | 505 | | |
| Colorado | 742 | 6,778 | 9.13 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | 742 | 6,778 | 9.13 |
| | 61,216 | 782,976 | 12.79 | 2,127 | 34,401 | 16.17 | 9,587 | 221,801 | 23.14 | 72,930 | 1,039,178 | 14.25 |

*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, 1932–33, by uses*

| Use | 1932 | | | | 1933 | | | |
|---|---|---|---|---|---|---|---|---|
| | Per-cent | Short tons | Value | | Per-cent | Short tons | Value | |
| | | | Total | Aver-age | | | Total | Aver-age |
| Steel | 74.77 | 18,881 | $228,933 | $12.13 | 82.66 | 60,279 | $769,889 | $12.77 |
| Foundry | 2.08 | 524 | 7,636 | 14.57 | 1.42 | 1,039 | 13,791 | 13.27 |
| Glass | 14.24 | 3,596 | 101,765 | 28.30 | 9.29 | 6,778 | 147,985 | 21.83 |
| Enamel and vitrolite | 4.99 | 1,261 | 36,318 | 28.80 | 4.25 | 3,100 | 76,932 | 24.82 |
| Hydrofluoric acid and derivatives | 2.92 | 738 | 14,603 | 19.79 | 1.30 | 950 | 18,604 | 19.58 |
| Miscellaneous | .90 | 226 | 2,691 | 11.91 | .98 | 713 | 11,010 | 15.44 |
| | 99.90 | 25,226 | 391,946 | 15.54 | 99.90 | 72,859 | 1,038,211 | 14.25 |
| Exported | .10 | 25 | 553 | 22.12 | .10 | 71 | 967 | 13.62 |
| | 100.00 | 25,251 | 392,499 | 15.54 | 100.00 | 72,930 | 1,039,178 | 14.25 |

*Fluorspar shipped from mines in the United States, 1929–33, 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 |
| 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 |
| 1933 | 60,279 | 12.77 | 1,039 | 13.27 | 6,778 | 21.83 | 3,100 | 24.82 |

| Year | Hydrofluoric acid and derivatives | | Miscellaneous | | Exported | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Average value | Short tons | Average value | Short tons | Average value | Short tons | Average value |
| 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 |
| 1933 | 950 | 19.58 | 713 | 15.44 | 71 | 13.62 | 72,930 | 14.25 |

*Consumption—stocks at consumers' plants.*—The following table gives data on consumption of fluorspar in 1932 and 1933 and on stocks at consumers' plants at the close of these years.

*Fluorspar consumed and in stock in the United States, 1932–33, by industries, in short tons*

[Partly estimated by Bureau of Mines]

| Industry | 1932 | | 1933 | |
|---|---|---|---|---|
| | Consumption | Stocks at consumers' plants Dec. 31 | Consumption | Stocks at consumers' plants Dec. 31 |
| Basic open-hearth steel | 36,300 | 55,000 | 61,300 | 56,000 |
| Electric furnace steel | 2,100 | 700 | 3,400 | 900 |
| Foundry | 600 | 500 | 900 | 600 |
| Ferro-alloys | 200 | 100 | 300 | 200 |
| Hydrofluoric acid and derivatives | 7,000 | 11,000 | 7,800 | 8,000 |
| Enamel and vitrolite | 2,400 | 600 | 3,200 | 1,100 |
| Glass | 6,700 | 700 | 7,000 | 1,300 |
| Miscellaneous | 700 | 400 | 700 | 400 |
| | 56,000 | 69,000 | 84,600 | 68,500 |

The following table shows the relation of consumption of fluorspar to production of basic open-hearth steel from 1929 to 1933 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, 1929–33*

| | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Production of basic open-hearth steel long tons | 47,232,419 | 34,268,316 | 22,130,398 | 11,742,682 | 20,057,146 |
| Consumption of fluorspar in basic open-hearth steel production short tons | 155,600 | 109,000 | 66,200 | 36,300 | 61,300 |
| Consumption of fluorspar per ton of steel made pounds | 6.6 | 6.3 | 6.0 | 6.2 | 6.1 |
| Stocks of fluorspar on hand at steel plants at end of year short tons | 70,700 | 89,000 | 67,600 | 55,000 | 56,000 |

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 following table shows the variation in average consumption of fluorspar per ton of basic open-hearth steel over a 5-year period in certain plants that make about 88 percent of the total.

*Average consumption of fluorspar per ton of steel, 1929–33, in pounds*

| 1929 | 1930 | 1931 | 1932 | 1933 | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|---|---|
| 14.727 | 16.931 | 16.111 | 14.176 | 18.944 | 5.822 | 6.276 | 6.219 | 6.646 | 6.754 |
| 6.043 | 6.559 | 5.781 | 4.572 | 3.864 | 10.470 | 10.651 | 7.784 | 6.056 | 8.148 |
| 4.825 | 4.768 | 4.613 | 5.122 | 4.687 | 5.569 | 5.311 | 2.437 | 2.636 | 4.097 |
| 6.674 | 6.544 | 2.431 | 6.136 | 5.731 | 11.510 | 9.720 | 5.774 | 6.356 | 5.386 |
| 3.815 | 2.545 | 4.867 | 6.281 | 6.871 | 6.589 | 6.118 | 5.822 | 6.118 | 6.590 |
| 7.215 | 5.661 | 5.856 | 5.171 | 5.858 | 7.880 | 6.606 | 3.791 | 6.260 | 6.099 |
| 6.237 | 5.555 | 4.978 | 6.842 | 4.289 | 6.622 | 7.087 | 7.049 | 6.322 | 7.449 |
| 7.344 | 7.705 | 6.590 | 5.302 | 5.659 | | | | | |

*Quoted prices.*—The following table shows representative quoted prices on fluxing-gravel, foundry-lump, and ceramic-ground fluorspar at Illinois-Kentucky mines, on fluxing-gravel fluorspar in Colorado, and on imported fluxing-gravel fluorspar at seaboard in 1933. 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 1933*

| Month | Illinois-Kentucky (f.o.b. mines) | | | Colorado (f.o.b. mines) [1] | Imported (at seaboard, duty paid) [1] |
|---|---|---|---|---|---|
| | Fluxing gravel (not less than 85 percent $CaF_2$ and not over 5 percent $SiO_2$) | Foundry lump (not less than 85 percent $CaF_2$ and not over 5 percent $SiO_2$) | Ground (bulk) (95 to 98 percent $CaF_2$ and not over 2½ percent $SiO_2$) | Fluxing gravel (82 percent $CaF_2$ and not over 5 percent $SiO_2$) | Fluxing gravel (not less than 85 percent $CaF_2$ and not over 5 percent $SiO_2$) |
| January | $9.00 | | $26.00 | $10.00 | $16.52-$16.96 |
| February | 10.25 | $10.50 | 24.43 | 10.00 | 16.52- 16.96 |
| March | 9.00 | | 24.43 | 10.00 | 16.52- 16.96 |
| April | 9.75 | 10.50 | 23.64 | 10.00 | 16.52- 16.96 |
| May | 11.75 | | 25.80 | 10.00 | 16.07- 16.96 |
| June | 12.25 | | 23.90 | 10.00 | 16.07- 16.96 |
| July | 14.00 | 14.25 | 25.17 | 10.00 | 16.07- 16.96 |
| August | 14.50 | 16.00 | | 10.00 | 17.86- 18.30 |
| September | 14.75 | 16.00 | 26.21 | 10.00 | 18.08- 18.53 |
| October | 14.50 | | 27.89 | 10.00 | 18.08- 18.53 |
| November | 15.00 | 15.50 | 26.77 | 15.00 | 18.08- 18.53 |
| December | 15.75 | | 27.80 | 15.00 | 18.08- 18.53 |

[1] Metal and Mineral Markets, vol. 4, 1933.

*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 1933 was 86,785 short tons, a decrease of 11 percent from 1932. These stocks consisted of about 42,000 tons of crude fluorspar (calculated to be equivalent to 18,000 tons of ready-to-ship fluorspar) and of 44,777 tons of ready-to-ship fluorspar.

*Stocks of fluorspar at mines or shipping points in the United States, 1932–33, by States, in short tons*

| State | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Crude [1] | Ready-to-ship | Total | Crude [1] | Ready-to-ship | Total |
| Colorado | 235 | 40 | 275 | 255 | 20 | 275 |
| Illinois | 8,021 | 33,054 | 41,075 | 8,904 | 28,966 | 37,870 |
| Kentucky | 33,570 | 21,856 | 55,426 | 32,368 | 15,614 | 47,982 |
| Nevada | 125 | 209 | 334 | 433 | 125 | 558 |
| New Mexico | | 52 | 52 | | 52 | 52 |
| Texas | 48 | | 48 | 48 | | 48 |
| | 41,999 | 55,211 | 97,210 | 42,008 | 44,777 | 86,785 |

[1] The greater part of this crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

## INDUSTRY IN 1933, BY STATES

### COLORADO

Increased demand for Colorado fluorspar in 1933 resulted in considerable prospecting and development work at several prospects in Chaffee County, some of which reached the productive stage. The White King mine, also in Chaffee County, was reopened, and operations were resumed at the Lehman mine and mill in Boulder County. Shipments of fluorspar increased from 333 short tons in 1932 to 742 tons in 1933, of which 498 tons came from Chaffee County, 224 tons from Boulder County, and 20 tons from Jackson County. The Ranch mine in Chaffee County—the only one worked in 1932—was reported exhausted in 1933. At the mine near Northgate in Jackson County the main heading on the lower level was advanced 30 feet, and the plant and equipment were maintained in condition to operate when demand justifies.

### ILLINOIS

Increased demand for fluorspar in 1933 greatly stimulated activity in Illinois, resulting in considerable prospecting and development work and in the mining, milling, and shipping of substantially greater quantities of fluorspar than in 1932. The demand, however, required only a small part of the potential productive capacity of mines and mills. Several mines, inactive in 1932, and the Lead Hill mine, idle for several years, were reopened in 1933; washing and jigging plants were installed at the Lead Hill and Dimick mines; and a ring-roller mill and 5-cell jig were added to the milling equipment of the Crystal mine.

Approximately 66,000 short tons of fluorspar-bearing rock, equivalent to about 30,000 tons of merchantable fluorspar, were mined at 15 mines or prospects in Illinois in 1933 compared with 7,500 tons, equivalent to 3,800 tons of merchantable fluorspar, mined at 6 mines or prospects in 1932. Of the crude ore mined in 1933, 37,400 tons were from mines where the fluorspar occurs in veins chiefly in fault fissures and 28,600 tons from mines where the fluorspar occurs in flat-lying tabular masses, locally called blanket formations.

Fluorspar-bearing material milled in Illinois in 1933 totaled 92,400 tons, from which 31,968 tons of merchantable fluorspar were recovered—a ratio of 2.89 :1. The low recovery was due to the milling of 26,726 tons of tailings from the Hillside mine.

Shipments from Illinois in 1933 were 36,075 short tons, an increase of 275 percent over 1932. Of the total, 16,274 tons were shipped to destination by river or by river and rail.

### KENTUCKY

In Kentucky, as in Illinois, improved demand for fluorspar in 1933 resulted in the reopening of several mines, improvements and additions to mill equipment, and considerable prospecting and development work. Consequently, production of merchantable fluorspar increased from approximately 11,000 short tons in 1932 to about 27,000 tons in 1933; the number of mines or prospects operated increased from 30 to 41; and shipments to consumers increased from 14,725 to

34,614 tons. Of the 1933 shipments, 3,523 tons went to destination by river or by river and rail.

*Caldwell County.*—Fluorspar mining in Caldwell County again was confined chiefly to the properties of the S. L. Crook Corporation and the Princeton Fluor Spar Co. The Tyrie property, adjoining the mine of the Princeton Fluor Spar Co., was being developed by C. F. Lester in 1933. Production of merchantable fluorspar increased from about 1,000 tons in 1932 to about 1,800 tons in 1933.

*Crittenden County.*—The reopening of several mines and increased output at other mines in Crittenden County resulted in a production of about 22,000 tons of merchantable fluorspar in 1933 compared with 10,000 tons in 1932. The Lafayette mines near Mexico, Ky., were reopened October 1, 1933, and pumped out down to the new 400-foot level, on which installation of new equipment was continued; mining was resumed on the 250-foot level. The Two Brothers mine near Salem was also reopened, the mill equipment having been overhauled. At the Kentucky mill an additional table and another jig were added to the equipment. A loading station on the Ohio River near Casad, Ky., was completed by the Franklin Fluorspar Co., and a considerable movement of fluorspar by river was reported.

*Livingston County.*—In Livingston County the reopening of the Bonanza and Hudson mines, both inactive for several years, and greatly increased production at the Split Nickel mine are reflected in the output of 2,900 tons of fluorspar in 1933 compared with 130 tons in 1932. The Klondike mine near Smithland was inactive in 1933, but the stock pile at the mine was shipped during the year.

## NEVADA

Shipments of fluorspar from Nevada were 505 short tons in 1933 compared with 49 tons in 1932.

The chief producing mine in Nevada in 1933 was the Baxter mine, 5½ miles from Broken Hills in Mineral County, which shipped 447 tons. This mine is opened by a main shaft 110 feet deep and three auxiliary shafts—one 30-foot shaft 125 feet west of the main shaft and two 40-foot shafts 1,000 feet west and 750 feet east, respectively, of the main shaft. At the shaft 1,000 feet west of the main shaft a hoist has been installed and an engine house built.

The other active mine in Nevada was the Daisy mine, 4½ miles southeast of Beatty in Nye County, which shipped 58 tons in 1933. The grinding unit installed in 1932 at the mill (at Beatty) serving this mine was not operated in 1933.

## NEW MEXICO

Shipments of fluorspar from New Mexico amounted to 994 short tons in 1933, compared with 529 tons in 1932, and consisted of 294 tons of metallurgical-gravel fluorspar produced near Las Cruces in Dona Ana County and 700 tons of ground fluorspar produced near Deming in Luna County.

The La Purisima Fluorspar Co., which was engaged chiefly in developing ore and building a mill in 1932, shipped 700 short tons of ground fluorspar in 1933. The fluorspar deposits of the company are northeast of Deming in Luna County, and the ore is trucked to the mill on a railroad siding at Deming. The mill consists of crushers, elevators, flotation machines, driers, and other necessary equipment.

## IMPORTS AND EXPORTS[1]

The total imports of fluorspar into the United States in 1933 were 10,409 short tons (5,165 tons containing more than 97 percent and 5,244 tons containing not more than 97 percent calcium fluoride) valued[2] at $105,043, a decrease of 21 percent in both quantity and total value from 1932. The value assigned to the foreign fluorspar averaged $10.09 a ton. The cost to consumers in the United States includes, in addition, the duty, loading charges at the docks, ocean freight, insurance, consular fee, and freight from docks to manufacturers' plants.

Of the imports in 1933, about 43 percent was metallurgical-gravel fluorspar, 20 percent ceramic-ground fluorspar, and 37 percent acid-lump fluorspar.

The imports were equivalent to 14 percent of the total shipments of domestic fluorspar in 1933 compared with 52 percent in 1932.

*Fluorspar imported into the United States, 1932–33, by countries*

[General imports]

| Country | Containing more than 97 percent calcium fluoride | | Containing not more than 97 percent calcium fluoride | | Total | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| **1932** | | | | | | |
| Australia | (1) | $196 | | | (1) | $196 |
| China | | | 112 | $671 | 112 | 671 |
| France | | | 1,578 | 9,588 | 1,578 | 9,588 |
| Germany | 3,903 | 62,938 | 1,939 | 7,356 | 5,842 | 70,294 |
| Italy | 66 | 537 | 1,391 | 11,311 | 1,457 | 11,848 |
| Spain | 595 | 8,996 | 2,064 | 15,885 | 2,659 | 24,881 |
| Union of South Africa | 1,587 | 14,809 | | | 1,587 | 14,809 |
| United Kingdom | (2) 1 | 378 | | | (2) 1 | 378 |
| | 6,152 | 87,854 | 7,084 | 44,811 | 13,236 | 132,665 |
| **1933** | | | | | | |
| China | 27 | 413 | | | 27 | 413 |
| France | | | 204 | 1,247 | 204 | 1,247 |
| Germany | 3,773 | 51,585 | 560 | 3,251 | 4,333 | 54,836 |
| Italy | | | 534 | 4,533 | 534 | 4,533 |
| Newfoundland | | | 320 | 2,646 | 320 | 2,646 |
| Spain | 635 | 8,728 | 3,626 | 19,962 | 4,261 | 28,690 |
| Union of South Africa | 713 | 12,449 | | | 713 | 12,449 |
| United Kingdom | 17 | 229 | | | 17 | 229 |
| | 5,165 | 73,404 | 5,244 | 31,639 | 10,409 | 105,043 |

(1) Less than 1 ton of optical fluorspar.
(2) Optical fluorspar.

[1] Figures on imports (unless otherwise indicated) compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce; those on exports supplied by the producers. No exports of fluorspar recorded by the Bureau of Foreign and Domestic Commerce.

[2] As defined in sec. 402 of the tariff act of 1930, "The value of imported merchandise * * * is the foreign value or the export value, whichever is higher—that is, the market value or the price at which the merchandise, at the time of exportation to the United States, is offered for sale in the principal markets of the country from which exported, including the cost of containers or coverings and all expenses (including any export tax) incident to placing the merchandise in condition ready for shipment to the United States."

*Fluorspar imported into the United States, 1929–33, 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 |
| 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 |
| 1933 | 713 | 12,449 | | | 204 | 1,247 | 4,333 | 54,836 | 534 | 4,533 |

| Year | Spain | | United Kingdom | | All other | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 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 |
| 1933 | 4,261 | 28,690 | 17 | 229 | 347 | 3,059 | 10,409 | 105,043 |

The following table, compiled from data courteously furnished the Bureau of Mines by importers, shows the quantities of imported fluorspar delivered to consumers in the United States in 1932 and 1933 and the selling price at tidewater, duty paid, irrespective of the year of importation into the United States; it differs from the preceding tables, which show the quantities received in the United States during 1932 and 1933.

*Imported fluorspar delivered to consumers in the United States, 1932–33*

| Industry | 1932 | | | 1933 | | |
|---|---|---|---|---|---|---|
| | Short tons | Selling price at tidewater, including duty | | Short tons | Selling price at tidewater, including duty | |
| | | Total | Average | | Total | Average |
| Steel | 5,387 | $88,892 | $16.50 | 6,208 | $105,800 | $17.04 |
| Glass | 2,958 | 83,636 | 28.27 | 1,288 | 33,160 | 25.75 |
| Enamel | 1,027 | 28,786 | 28.03 | 939 | 24,953 | 26.57 |
| Hydrofluoric acid | 3,618 | 92,073 | 25.45 | 3,971 | 90,313 | 22.74 |
| Cement | 261 | 4,661 | 17.86 | | | |
| | 13,251 | 298,048 | 22.49 | 12,406 | 254,226 | 20.49 |

Manufacturers of glass and enamel purchased a much smaller proportion of fluorspar from importers in 1933 than in 1932. For example, in 1933 such manufacturers purchased 2,227 short tons from importers and 9,878 tons from domestic producers, whereas in 1932 their purchases were 3,985 and 4,857 tons, respectively. In 1933, as in 1932, most of the acid-grade fluorspar purchased was supplied by importers, who sold 3,971 tons compared with 950 tons sold by domestic producers.

Producers of fluorspar reported exports of 71 short tons valued at $967 in 1933 compared with 25 tons valued at $553 in 1932. In 1933 all the fluorspar exported went to Canada; in 1932, 20 tons went to Peru and 5 tons to Canada.

*Fluorspar reported by producers as exported from the United States, 1929–33*

| Year | Short tons | Value | | Year | Short tons | Value | |
|---|---|---|---|---|---|---|---|
| | | Total | Average | | | Total | Average |
| 1929 | 506 | $11,621 | $22.97 | 1932 | 25 | $553 | $22.12 |
| 1930 | 281 | 6,160 | 21.92 | 1933 | 71 | 967 | 13.62 |
| 1931 | 311 | 5,599 | 18.00 | | | | |

## FLUORSPAR IN FOREIGN COUNTRIES

### CANADA [3]

The production of fluorspar in Canada was 73 short tons valued at $1,064 in 1933 compared with 32 short tons valued at $464 in 1932. The output in both years was from Hastings County, Ontario.

Imports of fluorspar into Canada were 2,219 short tons valued at $21,165 in 1933 compared with 1,009 short tons valued at $22,965 in 1932.

### NEWFOUNDLAND

Fluorspar has been reported in the vicinity of Cape Chapeau Rouge, Districts of Burin East and Burin West, near East St. Lawrence, Newfoundland, and 9½ square miles comprising 48 locations have been recorded according to the Minister of Agriculture and Mines for Newfoundland.

According to Donald,[4] mining of fluorspar in Newfoundland was begun in March 1933, and about 1,600 tons were shipped, chiefly to Canada. Development work carried on during 1933 was reported to have revealed sufficient ore bodies to warrant a better-equipped plant and increased output in the future.

George W. Spencer, vice president of Leonard J. Buck, Inc., in a letter to the author states that only one shipment of fluorspar was forwarded to the United States from Newfoundland during 1933 and that it was shipped by the St. Lawrence River and Great Lakes waterways. The deposit from which this shipment came is the only one being worked and is in the Districts of Burin East and Burin West, virtually on tidewater at Little St. Lawrence Bay; it is reported to be extensive. The distance from the deposit to the dock from which shipments are made is approximately 1 mile, and the fluorspar is shipped chiefly by water. The geographical location is favorable for water shipments both to Atlantic ports in the United States and by the St. Lawrence River and Great Lakes waterways to Great Lakes ports. The method of mining employed is trenching or open-pit. Analysis of fluorspar produced and shipped shows the typical

[3] Data from Dominion Bureau of Statistics, Preliminary Report on the Mineral Production of Canada During the Calendar Year 1933: Ottawa, 1934, p. 32.

[4] Donald, G. K., American Consul General, St. John's, Newfoundland, Notes on Mining in Newfoundland in 1933: MS Rept., Jan. 15, 1934.

steel grade to contain 90 to 91.15 percent calcium fluoride and 4 to 5 percent silica. A higher-grade fluorspar showing 94 to 96 percent calcium fluoride and under 1 percent silica has also been shipped. A still higher-grade fluorspar containing 97½ to 99½ percent calcium fluoride, under 0.1 percent silica, a very minor percentage of calcium carbonate, and about 0.1 to 0.6 percent combined iron and alumina has also been produced. Production in the early part of 1934 was reported at 150 to 200 tons per week.

## WORLD PRODUCTION

*World production of fluorspar, 1929–33, by countries, in metric tons*

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Australia: | | | | | |
| New South Wales | 96 | 205 | 12 | ---------- | (1) |
| Queensland | 602 | 763 | 529 | 1,240 | (1) |
| Canada | 16,211 | 73 | 36 | 29 | 66 |
| Chosen | 1,470 | 2,297 | 2,648 | 7,577 | (1) |
| France | 52,968 | 58,660 | 23,800 | (1) | (1) |
| Germany: [2] | | | | | |
| Bavaria | 50,797 | 48,063 | 26,780 | 21,915 | (1) |
| Prussia | 37,717 | 30,272 | 12,842 | 7,794 | (1) |
| Saxony | 18,491 | 11,871 | 6,937 | (1) | (1) |
| Great Britain | 42,432 | 30,266 | 20,242 | 15,675 | (1) |
| Italy | 5,740 | 6,655 | 5,850 | 6,450 | (1) |
| Newfoundland | ---------- | ---------- | ---------- | ---------- | 1,930 |
| Norway [3] | 101 | 382 | 275 | 287 | (1) |
| South-West Africa | 565 | ---------- | ---------- | 610 | (1) |
| Spain | 13,478 | 11,296 | 6,017 | 7,018 | (1) |
| Union of South Africa | 2,715 | 1,520 | 2,197 | 1,317 | (1) |
| United States | 132,847 | 86,952 | 48,520 | 22,907 | 66,161 |

[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 Tveitstá mine.

## CRYOLITE

Cryolite occurs in commercial quantity and is mined at only one place—Ivigtut, Greenland. The greater part of the product is shipped to Copenhagen; the remainder is exported to the United States, from which country some is reexported to Canada.

The ore shipped to the United States ranges from approximately 70-percent pure to over 90-percent pure cryolite. The ores of varying gradations of purity generally are mixed in shipment; except in rare cases, the material is run through the purification plant as it is received. The method of purification consists essentially of a series of magnets, tables, jigs, and flotation.

The purified cryolite is used chiefly in the metallurgy of aluminum and in making opaque glass. A considerable quantity of ground cryolite is being used in insecticide preparations. Although fine cryolite resulting from the purification process has been so used for many years, an efficient method of grinding cryolite to a fineness that would permit it to be used for insecticides was discovered only recently.

According to the Bureau of Foreign and Domestic Commerce the United States imported 4,141 long tons of cryolite valued at $298,316 in 1933 compared with 3,782 long tons valued at $291,357 in 1932.

# FELDSPAR

By H. O. Rogers and R. W. Metcalf [1]

SUMMARY OUTLINE



Overshadowing all other factors influencing the feldspar industry in 1933 was the legalization of beer and the consequent rise in demand for bottles, glass-lined tanks, enameled vessels, and allied specialties. The total output of crude feldspar, including both potash and lime-soda spars, was 150,633 tons in 1933, an increase of 43.9 percent over 1932 and slightly more than in 1931 when production totaled 147,119 tons. In spite of the substantial rise, the 1933 output was 28.5 percent short of the 1928 peak. (See fig. 97.) The value of the crude

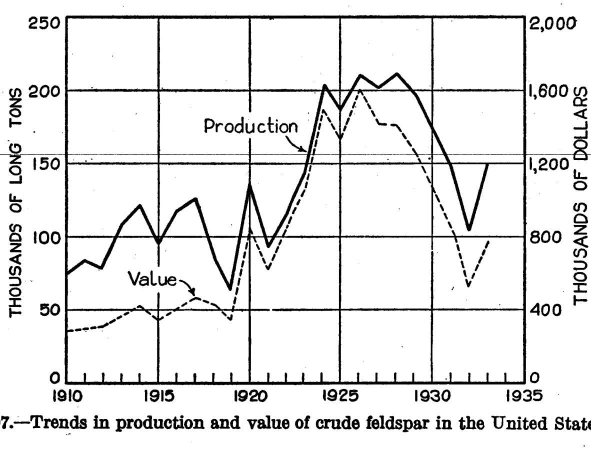


Figure 97.—Trends in production and value of crude feldspar in the United States, 1910–33.

feldspar produced in 1933 was reported as $778,826, an average per ton of $5.17 compared with $5.15 in 1932.

All major producing States shared the increase in output. In North Carolina, the leading producer, the output increased 47 percent, and in Virginia it nearly doubled; in New Hampshire and Maine increases of 42.5 and 35.1 percent, respectively, were reported. On the other hand, production fell off in a few of the minor producing

[1] Figures on imports (unless otherwise indicated) compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

States, but these losses had little significance in the industry as a whole.

Production of ground feldspar also rose sharply in 1933, total sales by merchant mills being 133,008 short tons compared with 107,749 tons in 1932. The total value of the ground feldspar sold during the year was $1,617,552, an increase of 30.4 percent over 1932. The average price realized by the mills for domestic spar advanced to $11.80 per short ton in 1933, from $11.27 in 1932; prices for Canadian spar also were higher, averaging $19.07 in 1933 compared with $18.98 in 1932.

*Salient statistics of the feldspar industry in the United States, 1932–33*

| | 1932 | 1933 | Percent of change in 1933 |
|---|---|---|---|
| Crude feldspar sold or used by producers: | | | |
| Long tons | 104,715 | 150,633 | +43.9 |
| Value | $539,641 | $778,826 | +44.3 |
| Average per long ton | $5.15 | $5.17 | +.4 |
| Ground feldspar sold by merchant mills: | | | |
| Short tons | 107,749 | 133,008 | +23.4 |
| Value | $1,240,492 | $1,617,552 | +30.4 |
| Domestic: | | | |
| Short tons | 104,289 | 126,418 | +21.2 |
| Value | $1,174,833 | $1,491,904 | +27.0 |
| Average per short ton | $11.27 | $11.80 | +4.7 |
| Canadian: | | | |
| Short tons | 3,460 | 6,590 | +90.5 |
| Value | $65,659 | $125,648 | +91.4 |
| Average per short ton | $18.98 | $19.07 | +.5 |
| Feldspar imported for consumption: | | | |
| Crude: | | | |
| Long tons | 1,872 | 3,239 | +73.0 |
| Value | $14,346 | $21,877 | +52.5 |
| Ground: | | | |
| Short tons | 28 | 27 | −3.6 |
| Value | $218 | $242 | +11.0 |

*Uses.*—Feldspar is used chiefly in the ceramic industry. At present approximately 57 percent of the output is consumed in the manufacture of brick, tile, pottery, and enamel and sanitary ware. Another important outlet is the glass industry which in recent years has absorbed about 30 percent of the production. Feldspar is used in glass manufacture primarily as a source of alumina but also contains other valuable ingredients, such as alkalies, soda, and potash. Because of these constituents it melts without becoming entirely fluid and when cool forms a strong, colorless, or only slightly colored glass. In most forms of pottery, feldspar is an essential ingredient of both the body and the glaze. Electrical insulators and similar forms of porcelain also contain feldspar. A more detailed discussion of the uses of feldspar appears in Mineral Resources of the United States, 1930, part II, pages 138 and 139.

## MARKET CONDITIONS

As indicated previously, the principal factor influencing the feldspar industry in 1933 was the passage of the Cullen bill and the return of legal beer on April 7, resulting in a sharp upturn in demand for feldspar in the glass industry. In addition, large quantities of ceramic tile, glazed brick, enameled brick, and similar products were used in brewery construction and modernization. Largely because of the increased activity in this field, feldspar production rose abruptly after the first quarter of the year. One large producing company reported that shipments in April were 30 percent higher than the average for the first quarter, and to take care of this windfall of unexpected business from the glass industry the company was forced to install an additional unit at one of its mills especially designed for preparing granular feldspar for glass manufacture.[2]

*Continued dullness in construction.*—Aside from business directly traceable to repeal of the prohibition laws there were few significant developments in the feldspar market in 1933. During the early months of the year the construction industry slumped to a new low level, and although a moderate revival occurred after the recovery program got under way the improvement was not sufficient to offset the dullness that characterized the industry in the early months. The total value of building contracts awarded during the year decreased 7 percent compared with 1932. Moreover, the small upturn that did occur was due chiefly to contracts let for types of buildings that could be financed from public works funds; residential building was depressed acutely throughout the year. Compared with 1932 the value of residential construction in 1933 declined 11 percent.

With the construction industry still in the doldrums, many important markets for feldspar have been sharply restricted. For example, shipments of bathroom sanitary-ware accessories in 1933 were 15 percent less than in 1932, a decline in almost perfect correlation with the record of residential building operations for the year. On the other hand, substantial gains were reported in certain other branches of ceramics; porcelain plumbing fixtures increased 7 percent, porcelain enameled flatware 6.2 percent, and vitreous china plumbing fixtures 38.2 percent. The market for feldspar in the illuminating glassware industry also expanded appreciably in 1933.

*Trend of prices.*—Responding to improved market conditions the price of feldspar advanced in 1933. During the early months of the year trade-journal quotations hovered close to the low levels that prevailed in 1932, but about midsummer the prices of most grades rose sharply. The general trend is illustrated by the quotations on Virginia feldspar. In 1932, for example, quotations on No. 1 Virginia spar (160-mesh) averaged $14.50 per ton, whereas the average for 1933 was $14.71. Increases of similar proportions were likewise reported for most other grades. In nearly all instances the advances took place in August, after the President's Reemployment Agreement became effective, but on some grades the increases were announced somewhat earlier. Thus, quotations on No. 1 glassmakers' spar, which had been maintained at $9.50 per ton since February 1932, advanced to $10.50 per ton in March 1933. Similarly, quotations on enamelers' spar, which throughout most of 1932 averaged $13 per ton f.o.b. Virginia, rose to $13.50 in February 1933 and to $13.75 in March.

In contrast to the general upward trend, the price of the best Maine pottery feldspar fell off conspicuously during 1933 and averaged $16.79 per ton compared with $19 in 1932. The available quotations on western grades of feldspar show little significant change compared with 1932.

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[2] Ceramic Industry, May 1933, p. 219.

*Imports of feldspar.*—Imports of crude feldspar for consumption increased to 3,239 long tons in 1933 from 1,872 tons in 1932. Although this is a large gain, the tonnage is still low compared with predepression years when imports ranged from 27,000 to 30,000 tons. The value of the crude feldspar imported was $21,877 in 1933 compared with $14,346 in 1932.

Imports of ground feldspar totaled 27 short tons valued at $242 in 1933 compared with 28 tons valued at $218 in 1932.

Imports of finished ceramic products rose sharply in 1933. The quantity of china and porcelain goods imported, for example, advanced 27.2 percent over 1932, and the market for foreign crockery and stoneware increased 46.2 percent; there was also a substantial rise in the value of the pottery imports. In spite of these gains foreign ceramic ware played a relatively minor part in the domestic market.

*Competition of Cornwall stone.*—Another factor bearing directly on the market for domestic feldspar is the use of Cornwall stone in certain branches of the ceramic industry. Cornwall stone (also known as "china stone") is a decomposed granite consisting mainly of kaolinized feldspar and quartz with small amounts of muscovite mica, fluorspar, topaz, and tourmaline. In England this material always has been used extensively in the pottery industry, and as American potters inherited many of their methods and formulas from England substantial quantities of Cornwall stone have been imported. However, with large deposits of virgin feldspar available in this country there has been little actual need for Cornwall stone, and in spite of deep-rooted traditions the indications are that imports have been gradually declining. In fact, since 1929 imports of Cornwall stone have been reduced drastically. The sharp decrease in imports during the past few years may be attributed largely to the general business depression, but there is some basis for the opinion that domestic feldspar is permanently supplanting Cornwall stone.

At present the use of Cornwall stone in the United States is confined almost exclusively to the manufacture of wall-tile and to glazes.[3] It is still used in tile because of its long firing range with minimum warpage, but there is little doubt that a material with comparable characteristics could be produced in this country if the necessary experimental work were undertaken. In fact, George A. Willis, Department of Ceramic Engineering, North Carolina State College, recently completed an investigation of a mineral discovered in western North Carolina of approximately the same geologic character and chemical composition as English Cornwall stone which seemed to indicate that the American product is a suitable substitute. If these preliminary findings are established definitely, imports of Cornwall stone probably will decline further in the future.

Satisfactory statistics covering imports of Cornwall stone never have been recorded, but a summary of the available information follows:

[3] Unpublished paper by J. H. Weis and J. E. Boyd.

*Crude and ground Cornwall stone imported for consumption in the United States 1922–33*

| Year | Crude | | Ground | |
|---|---|---|---|---|
| | Long tons | Value | Long tons | Value |
| 1922 (Sept. 22–Dec. 31)[1] | | | 103 | $1,512 |
| 1923 | 197 | $1,280 | 210 | 3,659 |
| 1924 | 312 | 2,710 | 14 | 53 |
| 1925 | 606 | 5,577 | | |
| 1926 | 4,548 | 43,799 | 81 | 2,020 |
| 1927 | 5,003 | 48,129 | 536 | 10,482 |
| 1928 | 5,228 | 50,033 | 651 | 10,917 |
| 1929 | 6,484 | 58,738 | 1,091 | 17,523 |
| 1930 | 4,015 | 35,562 | 779 | 9,828 |
| 1931 | 1,901 | 15,708 | 1,512 | 17,289 |
| 1932 | 1,620 | 7,780 | 556 | 5,087 |
| 1933 | 673 | 2,351 | 90 | 899 |

[1] Imports not separately classified prior to change in tariff.

These figures, however, apparently are incomplete. A field check by the United States Tariff Commission for the period from July 1, 1927, to June 30, 1929, showed that during those 2 years 5,590 long tons of ground Cornwall stone valued at $86,500 were imported. The foregoing table indicates that the recorded value of imports during those years was only about $21,000. If the results of this field check are accepted as representative, it follows that about 75 percent of the ground Cornwall stone entering the United States does not enter as such but probably as feldspar, flint, china clay, or some other similar product.

*Productive capacity.*—Like many other mining industries, the feldspar industry is characterized by an excess of productive capacity. The existence of capacity beyond market needs has been especially noteworthy in the milling branch of the industry. Even in 1929, when demand was fairly active, the grinding mills operated at only about 28 percent of their potential capacity. In 1933 the operating rate of the grinding mills was reported as 13 percent of capacity.[4] During the past few years of adverse business conditions there has been some liquidation of capacity in the feldspar industry, but the net change has not been of great significance. Capacity, once installed, displays remarkable vitality, as plants and equipment of defunct companies often are taken over by new or existing organizations.

In many branches of the mineral industry capacity tends to be kept in excess of market requirements by the opening of new deposits where initial production costs are low. This tendency forces the older mines into the position of marginal operations which resist elimination by adopting improved technique, more efficient management, or other devices that prolong their economic life span and, in some measure, offset their natural disadvantages. The feldspar industry is now in the midst of one of these cycles, and during the past few years there has been a broad shift of production from New England to recently opened deposits in the South. Even the industrial depression has failed to check the movement; when New England producers were

[4] National Recovery Administration, Code of Fair Competition for the Feldspar Industry: Approved Code no. 206, p. 155.

already engaged in a sharp competitive struggle new operations continued to spring up in Virginia and North Carolina. In 1932, when the depression was most severe, two new grinding mills were opened in the South and in 1933 at least two additional companies were organized to operate feldspar mines and grinding mills.

The prospects of the feldspar industry in the immediate future are brighter since the adoption early in 1934 of a code of fair competition in compliance with provisions of the National Industrial Recovery Act. Producers hope the code will eliminate many unfair trade practices of the past. The minimum wages prescribed in the code are more than 100 percent above the minimum paid by the industry in some sections of the country in 1933; and with minor exceptions a 40-hour week is established, a reduction of approximately 25 percent compared with the maximum weekly working hours before the adoption of the code. By narrowing the wide differentials in wages and hours the code, if effective, probably will tend to curb migration of the industry to the Southern States. Overdevelopment also will be checked by the provision of the code which prohibits producers from adding to their present plants and equipment without permission from the code authority.

*New developments.*—During 1933 a large deposit of a unique feldspathic rock was located south of Roseland, Nelson County, Va., Roseland being at the northern end of the area. The rock is an antiperthite, that is, an intergrowth of albite and orthoclase, of which the albite forms the larger part. The rock where unaltered is white and contains no other minerals. It has been greatly shattered, and later deep-seated solutions have brought in quartz, zoisite, pyroxene, ilmenite, and rutile; in certain places it has weathered into large bodies of a very white clay. Although the deposit is extensive it must be quarried in places where free from other minerals and weathering. It is being developed by J. W. Powell, Union Trust Building, Washington, D.C., for the ceramic, glass, and stucco trade.

## REVIEW OF INDUSTRY BY STATES

The term "crude feldspar" is applied to the lump spar shipped from the mine or quarry contrasted with ground spar, the finished product of the crushing and pulverizing mill. Statistics of production are presented separately for crude and ground spar; in accordance with the usual practice in the industry the crude is reported in long tons of 2,240 pounds and the ground in short tons of 2,000 pounds.

In years of normal business activity the quantity of ground spar produced from domestic crude averages about 87 percent of the crude output; the remaining 13 percent includes spar used for purposes not requiring fine grinding and that lost or discarded during grinding. In 1932 part of the tonnage that had been added to stocks in 1931 apparently was withdrawn, as sales of ground domestic spar represented nearly 89 percent of the crude feldspar produced. In 1933, however, as sales of ground domestic spar were only 75 percent of the total crude output, indications are that heavy stocks were accumulated at grinding mills in anticipation of increased prices.

*Crude feldspar.*—Crude feldspar sold or used by producers in the United States in 1933 amounted to 150,633 long tons valued at $778,826, an increase of 43.9 percent in quantity and 44.3 percent in value compared with 1932. The average value of crude feldspar in 1933 at mine or nearest shipping point was $5.17 a long ton, 2 cents higher than in 1932 but 68 cents lower than in 1931 and $2.48 below the peak in 1926. The average value of crude feldspar as reported by individual producers ranged from $2.71 to $10.64 a long ton. For New England the value ranged from $3 to $8.69; for New York, Pennsylvania, and Virginia, from $3.50 to $10.64; for North Carolina, from $3.25 to $6.91; and for the Western States, from $2.71 to $7.11.

*Crude feldspar sold or used by producers in the United States, 1928–33*

| 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 | 1933 | 150,633 | 778,826 | 5.17 |

Crude feldspar was produced in 12 States in 1933, 2 less than in 1932; Maryland and Nevada, each of which reported a small output in 1932, did not produce in 1933. North Carolina, with an output of 85,962 long tons or 57 percent of the total, remained by far the most important producer; Virginia with 13,459 tons held second place; and New Hampshire with 12,425 tons ranked third. The other producing States, in order of importance, were Maine, Colorado, New York, South Dakota, Arizona, Connecticut, Minnesota, California, and Pennsylvania.

Although the increase in output in 1933 was shared by all the major-producing States, production in California, New York, and South Dakota declined compared with 1932, and Maryland and Nevada, which together produced 140 tons in 1932, made no output in 1933. These losses, however, had minor significance and were overshadowed by the large increases reported by the important producing States. In Virginia, for example, the output practically doubled, and in North Carolina, the leading producer in 1933, the output was 47 percent higher than in 1932; even more striking gains were made by some of the smaller producers, as in Pennsylvania where production rose from 25 to 213 tons.

*Crude feldspar sold or used by producers in the United States, 1931–33, by States*

[Value is at mine or nearest shipping point]

| State | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Long tons | Value | Long tons | Value | Long tons | Value |
| Arizona | (1) | (1) | 1,232 | $4,496 | (1) | (1) |
| California | 4,465 | $30,857 | (1) | (1) | 1,433 | $10,189 |
| Colorado | 2,953 | 14,927 | 5,612 | 20,304 | (1) | (1) |
| Connecticut | (1) | (1) | (1) | (1) | (1) | (1) |
| Maine | 10,220 | 65,417 | 8,345 | 41,874 | 11,273 | 48,380 |
| Maryland | ---------- | ---------- | 90 | 1,157 | ---------- | ---------- |
| Minnesota | (1) | (1) | (1) | (1) | (1) | (1) |
| Nevada | (1) | (1) | 50 | 300 | ---------- | ---------- |
| New Hampshire | 12,573 | 102,140 | 8,718 | 61,416 | 12,425 | 82,978 |
| New York | 6,160 | 29,959 | 6,255 | 34,705 | 6,138 | 41,736 |
| North Carolina | 86,429 | 505,525 | 58,465 | 300,877 | 85,962 | 471,312 |
| Pennsylvania | (1) | (1) | 25 | 171 | 213 | 1,442 |
| South Dakota | 11,062 | 39,013 | 6,067 | 22,256 | 3,220 | 12,058 |
| Virginia | 9,331 | 48,545 | 6,759 | 31,990 | 13,459 | 52,758 |
| Undistributed | 3,926 | 24,676 | 3,097 | 20,095 | 16,510 | 57,973 |
| | 147,119 | 861,059 | 104,715 | 539,641 | 150,633 | 778,826 |

[1] Included under "Undistributed."

*Ground feldspar.*—Almost all the feldspar consumed industrially is prepared by fine grinding. Even that used for facing cement blocks, for covering prepared roofing, and for similar purposes is crushed to small sizes and more or less graded by screening. It has not been practicable to canvass all consumers of feldspar to determine the quantities used by them, but all known merchant mills or grinders—that is, those that quarry or purchase crude spar and grind it for sale to other establishments—have been canvassed during the past 12 years.

Ground feldspar sold by commercial mills in 1933 totaled 133,008 short tons valued at $1,617,552, an increase of 23.4 percent in tonnage and 30.4 percent in value compared with 1932. There were 20 producing companies in 1933 operating in 14 States; 25 mills were active, 2 less than in 1932. In 1933, of the mills reporting, 22 handled domestic spar exclusively and 3 imported (Canadian) spar exclusively, and of the total quantity ground 95 percent (126,418 tons) was from domestic spar and 5 percent (6,590 tons) from imported spar; in 1932 Canadian spar comprised slightly more than 3 percent of the total.

*Ground feldspar sold by merchant mills [1] in the United States, 1928–33*

| Year | Number of active mills | Domestic | | | Canadian [2] | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Short tons | Value | | Short tons | Value | | Short tons | Value |
| | | | Total | Average | | Total | Average | | |
| 1928 | [3] 31 | 202,844 | $2,951,281 | $14.55 | [2] 24,813 | [2] $507,747 | $20.46 | 227,657 | $3,459,028 |
| 1929 | [3] 33 | 209,808 | 2,880,824 | 13.73 | 20,774 | 415,428 | 20.00 | 230,582 | 3,296,252 |
| 1930 | [3] 34 | 167,380 | 2,167,352 | 12.95 | 14,161 | 283,563 | 20.02 | 181,541 | 2,450,915 |
| 1931 | [3] 29 | 132,542 | 1,630,917 | 12.30 | 11,382 | 222,476 | 19.55 | 143,924 | 1,853,393 |
| 1932 | 27 | 104,289 | 1,174,833 | 11.27 | 3,460 | 65,659 | 18.98 | 107,749 | 1,240,492 |
| 1933 | 25 | 126,418 | 1,491,904 | 11.80 | 6,590 | 125,648 | 19.07 | 133,008 | 1,617,552 |

[1] Does not include potters or others who grind for consumption in their own plants.
[2] Figures for 1928 include some Cornwall stone.
[3] Corrected figures.

The average value of the ground feldspar from domestic crude in 1933 was $11.80 per short ton, an increase of 4.7 percent over 1932, but it varied widely in different States, ranging from a low of $7.70 to as high as $19.48. The average value of ground feldspar from imported crude in 1933 was $19.07 per ton, an increase of 9 cents over 1932.

Except for Connecticut and Pennsylvania, feldspar-grinding plants were operated during 1933 in each of the 12 States producing crude spar; in addition, grinding mills were operated in 4 other States—Illinois, New Jersey, Ohio, and Tennessee.

North Carolina led by a wide margin in output of ground spar, as it did in crude; Tennessee ranked second, and Colorado third. These three States accounted for 55 percent of the total; the remaining 45 percent came chiefly from Virginia, Maine, New Jersey, New York, New Hampshire, South Dakota, and Arizona, with comparatively small tonnages from Minnesota, Ohio, California, and Illinois.

Production of ground feldspar in Colorado, Minnesota, Ohio, South Dakota, Virginia, and Tennessee made substantial gains over 1932 but the output from mills in North Carolina increased only 1.1 percent. Production decreased in both New York and California. The most pronounced decline occurrred in California.

*Ground feldspar sold by merchant mills [1] in the United States, 1932–33, by States*

| State | 1932 | | | | | 1933 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number of active mills | Domestic | | Canadian | | Number of active mills | Domestic | | Canadian | |
| | | Short tons | Value | Short tons | Value | | Short tons | Value | Short tons | Value |
| California | 2 | (2) | (2) | | | 1 | 1,312 | $17,227 | | |
| Colorado | 1 | 5,200 | $39,000 | | | 1 | 10,300 | 79,310 | | |
| Maine | 4 | 7,334 | 95,369 | | | 3 | 9,492 | 129,259 | | |
| New Hampshire | 1 | 3,389 | 43,579 | | | 1 | 5,873 | 76,102 | | |
| New Jersey | 3 | 5,967 | 108,679 | | | 3 | 9,365 | 164,932 | | |
| New York | 4 | (2) | (2) | (2) | (2) | 4 | (2) | (2) | 6,495 | $123,689 |
| Ohio | 1 | (2) | (2) | | | 2 | (2) | (2) | 95 | 1,959 |
| North Carolina | 5 | 59,225 | 614,936 | | | 4 | 63,074 | 707,667 | | |
| Tennessee | 1 | | | | | 1 | | | | |
| Undistributed [3] | 5 | 23,174 | 273,270 | 3,460 | $65,659 | 5 | 27,002 | 317,407 | | |
| | 27 | 104,289 | 1,174,833 | 3,460 | 65,659 | 25 | 126,418 | 1,491,904 | 6,590 | 125,648 |

[1] Does not include potters or others who grind for consumption in their own plants.
[2] Included under "Undistributed."
[3] 1932: Arizona, California, Illinois, Minnesota, New York, Ohio, South Dakota, and Virginia; 1933: Arizona, Illinois, Minnesota, New York, Ohio, South Dakota, and Virginia.

## WORLD PRODUCTION

The following tables show the most recent available figures on output of feldspar in the chief producing countries. Aside from the United States and Canada such countries are Czechoslovakia, Norway, and Sweden, but 1933 statistics for them are not yet available. In Canada production of feldspar in 1933 was 9,588 metric tons, an increase of 50 percent compared with 1932.

*World production of feldspar, 1929–33, by countries, in metric tons*

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Argentina (shipments) | 427 | 196 | 172 | 369 | (2) |
| Australia: | | | | | |
| New South Wales [3] | 58 | 86 | 103 | 590 | (2) |
| South Australia [3] | | | | 65 | (2) |
| Western Australia (exports) | 21 | | 106 | 367 | (2) |
| Canada (shipments) | 34,044 | 24,309 | 16,640 | 6,393 | 9,588 |
| Egypt | | | 26 | 179 | (2) |
| Finland (exports) | 460 | 620 | 67 | 1,529 | (2) |
| France | 12,300 | 12,800 | 10,700 | (2) | (2) |
| Germany (Bavaria) | 7,697 | 5,150 | 5,000 | 3,550 | (2) |
| India (British) | | | 339 | 481 | (2) |
| Italy | 6,800 | 5,750 | 4,750 | 5,217 | (2) |
| Norway (exports) | 26,524 | 19,922 | 15,105 | 13,015 | (2) |
| Rumania | 2,479 | 1,963 | 3,068 | 681 | (2) |
| Sweden | 39,092 | 38,596 | 33,113 | 23,693 | (2) |
| United States (shipments) | 200,872 | 174,545 | 149,480 | 106,396 | 153,051 |

[1] In addition to countries listed feldspar is produced in Czechoslovakia. Official figures of output are not available, but it is estimated that the annual production is approximately 30,000 metric tons. (Stat. Com. Czechoslovak Ceramic Society.)
[2] Data not available.
[3] Includes some china stone.

*Feldspar, produced in Canada, sold in 1928–33*

| Year | Long tons | Value | Year | Long tons | Value |
|---|---|---|---|---|---|
| 1928 | 28,479 | $284,942 | 1931 | 16,378 | $186,961 |
| 1929 | 33,506 | 340,471 | 1932 | 6,292 | 81,982 |
| 1930 | 23,925 | 268,469 | 1933 | 9,437 | 104,633 |

# ASBESTOS

By Oliver Bowles and B. H. Stoddard [1]

SUMMARY OUTLINE



Asbestos is useful for the manufacture of brake linings, packings, and heat-insulating products because of its fibrous structure and noninflammability. Although it is important in industry, relatively small quantities are domestic material; less than 4 percent of consumers' requirements was mined in the United States in 1933. As the following summary of statistical data shows, the domestic-asbestos industry, although small, gained notably in 1933, with increases of 33 percent in tonnage and 24 percent in value over 1932.

The manufacture of asbestos products, an important industry, also showed growing activity, as apparent consumption of raw asbestos in 1933 increased about 25 percent over that in 1932. Imports, which have primary significance because they constitute about 97 percent of domestic requirements, increased 24 percent in quantity and 57 percent in value in 1933; the striking increase in value is due to the importation of nearly twice as much of the higher-grade fibers (crudes) in 1933 as in 1932.

*Salient statistics of the asbestos industry, 1932–33*

| | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value | Short tons | Value |
| Domestic asbestos (chrysotile and amphibole) sold or used by producers [1] | 3,559 | $105,292 | 4,745 | $130,677 |
| Imports (unmanufactured) | 96,754 | 2,250,200 | 119,494 | 3,540,675 |
| Exports (unmanufactured) | 1,707 | 94,936 | 1,378 | 88,521 |
| Apparent consumption | 98,606 | 2,260,556 | 122,861 | 3,582,831 |
| Exports of asbestos products | (2) | 1,608,880 | (2) | 1,696,546 |

[1] Bureau of Mines not at liberty to publish figures separately for chrysotile and amphibole.
[2] Figures not available.

The following table on apparent consumption of raw asbestos, value of products manufactured, and value of products exported

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

shows the major trends during recent years. The apparent consumption is determined by adding production to imports and subtracting exports. If stocks on hand at the beginning and end of the year were known consumption could be determined more accurately, but the Bureau has no record of such stocks. Bureau of the Census figures for value of asbestos products manufactured in 1933 are not yet available, but moderate recovery is indicated by the substantial increase (25 percent) in raw materials used and by the smaller increase (5½ percent) in value of products exported.

*Raw asbestos consumed in the United States and asbestos products manufactured in and exported from the United States, 1924–33*

| Year | Raw asbestos—apparent consumption | Asbestos products | |
|---|---|---|---|
| | | Manufactured [1] (value) | Exported (value) |
| | *Short tons* | | |
| 1924 | 182,280 | (1) | $2,529,795 |
| 1925 | 230,669 | $80,144,936 | 2,383,325 |
| 1926 | 257,875 | (1) | 3,481,814 |
| 1927 | 226,365 | 87,200,889 | 2,687,086 |
| 1928 | 231,984 | (1) | 3,999,022 |
| 1929 | 264,873 | $101,597,171 | $4,640,599 |
| 1930 | 212,152 | (1) | 4,193,510 |
| 1931 | 137,875 | 60,574,579 | 2,606,166 |
| 1932 | 98,606 | (1) | 1,608,880 |
| 1933 | 122,861 | (2) | 1,696,546 |

[1] Figures from Bureau of the Census; collected biennially for odd years.
[2] Figures not yet available.

*Market conditions.*—The industry has suffered severely during the depression period because asbestos is used primarily in the capital-goods industries; in the turbulent conditions that prevailed during the early months of 1933 activity was at low ebb. Improvement began in June, and a steady increase in demand throughout the latter half of the year resulted in Canadian companies increasing their production schedules materially. The marked recovery in automobile manufacture had a beneficial effect, but the low level of building activity depressed the insulation-roofing and building-material branches of the industry.

*Prices.*—Price quotations as given in Metal and Mineral Markets indicate a small but consistent increase for all grades of asbestos except Russian fiber, which was quoted at constant prices throughout 1933—No. 2 at $150 to $175 and No. 3 at $125 a ton. The price level of asbestos from other sources remained virtually uniform during the first half of the year but increased gradually during the second half although some grades did not change until December.

The following table shows prices at the beginning and end of 1933 as quoted in the Engineering and Mining Journal Metal and Mineral Markets reports.

*Price quotations of asbestos per short ton in January and December 1933*

| Grade | January | December |
|---|---|---|
| Canadian: | | |
| Crude No. 1 | $400–$450 | $450 |
| Crude No. 2 | 200 | 200–225 |
| Spinning fiber | 80–110 | 90–135 |
| Magnesia and compressed sheet fibers | 80–90 | 90–100 |
| Shingle stock | 45–60 | 45–65 |
| Paper stock | 30–35 | 32.50–37.50 |
| Cement stock | 18–20 | 19–23 |
| Canadian—Continued. | | |
| Floats | $15 | $16–18.50 |
| Rhodesian: | | |
| Crude No. 1 | 170 | 210 |
| Crude No. 2 | 120 | 160 |
| Vermont: | | |
| Shingle stock | 40–45 | 45 |
| Paper stock | 30–35 | 35 |
| Cement stock | 18–22 | 23 |

*New developments.*—Asbestos-cement products are used increasingly in Europe as roofing, ceilings, partitions, paneling, linings of interior and exterior walls, water pipes, and gutters. It is claimed that the pipes and gutters are waterproof, require no painting, and compare favorably in strength with cast iron. It has been found that wooden flooring may be nailed to a subflooring consisting of concrete to which about 10 percent of asbestos has been added. Asbestos-composition products are becoming popular for floor tile in homes and on ships.

Larger quantities of asbestos are being consumed in the manufacture of awnings and household appliances.

Corrosion-resistant chemical equipment consisting of asbestos and a phenol-formaldehyde condensation product is now on the market.

Interest in synthetic asbestos has increased, but its practical utility apparently has not yet been demonstrated.

Turner & Newall, Ltd., of Great Britain, has acquired controlling interest in Keasbey & Mattison Co., of Ambler, Pa.; the latter company owns the important Bell Asbestos mine in Canada.

*Imports.*—The following table shows foreign sources of asbestos supplies which are of unusual interest. More than two-thirds of the crude fiber imported in 1933 originated in Africa, chiefly in Rhodesia. Although restrictions on imports from Soviet Russia were lifted on April 5, 1933, by order of the President, no direct imports of crudes from that source were recorded, but small tonnages of mill fiber and shorts were received. Substantial quantities of Russian fiber usually are imported by way of Germany, but in 1933 such imports were very small.

The most striking feature of the import situation is the large increase in the quantity of short fiber from other sources than Canada. Although imports of shorts from Canada were virtually the same (about 64,000 short tons) in 1932 and 1933, imports from other sources increased from 672 to 4,055 tons. More than half of the non-Canadian shorts in 1933 came from Cyprus, and most of the remainder from Italy and Soviet Russia.

*Asbestos (unmanufactured) imported into the United States in 1933, 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 | 233 | $20,173 | | | | | 233 | $20,173 |
| Other | 2,091 | 214,384 | | | | | 2,091 | 214,384 |
| Canada | 804 | 167,795 | 48,112 | $2,170,151 | 63,999 | $854,647 | 112,915 | 3,192,593 |
| Germany | 6 | 669 | | | 36 | 1,064 | 42 | 1,733 |
| Italy | 17 | 8,929 | | | 939 | 7,764 | 956 | 16,693 |
| Malta, Gozo, Cyprus | | | | | 2,274 | 37,395 | 2,274 | 37,395 |
| U.S.S.R. (Russia in Europe) | | | 176 | 17,339 | 795 | 39,439 | 971 | 56,778 |
| United Kingdom | 1 | 587 | | | 11 | 339 | 12 | 926 |
| | 3,152 | 412,537 | 48,288 | 2,187,490 | 68,054 | 940,648 | 119,494 | 3,540,675 |

*Exports.*—Very little raw asbestos is exported, but substantial quantities of manufactured goods are sold to other countries. The following table shows the types of asbestos products exported in 1932 and 1933.

*Manufactured asbestos products exported from the United States, 1932–33, by kinds*

| Grade | 1932 | | 1933 | |
|---|---|---|---|---|
| | Quantity | Value | Quantity | Value |
| Brake lining: | | | | |
| Molded and semimolded | (1) | $396, 543 | (1) | $468, 549 |
| Not molded ... linear feet | 1, 959, 796 | 299, 220 | 1, 651, 425 | 256, 018 |
| Paper, millboard, and roll board ... short tons | 293 | 61, 062 | 439 | 62, 851 |
| Pipe covering and cement ... do | 1, 226 | 136, 140 | 910 | 93, 936 |
| Textile yarn and packing ... do | 452 | 431, 218 | 568 | 510, 186 |
| Magnesia and manufactures ... do | 610 | 91, 117 | 695 | 91, 836 |
| Asbestos roofing ... squares | 30, 886 | 59, 306 | 85, 532 | 150, 283 |
| Other manufactures, except roofing ... short tons | 647 | 134, 274 | 839 | 62, 887 |

[1] Quantity not recorded.

*Code of Fair Competition.*—In order to administer effectively its code, established under the National Recovery Administration, the asbestos products-manufacturing industry organized as the Asbestos Institute, comprising the five following divisions: (1) Asbestos paper and allied products, (2) asbestos cement products, (3) asbestos magnesia products, (4) asbestos textile products, and (5) brake linings and related friction products. The institute represents the first organization of the asbestos products-industry as a whole.

A hearing on the code was held October 19, 1933; the code was signed by the President November 1 and became effective November 13, 1933. To create a working organization, each of the five subdivisions elected three members to serve as subcode authorities and another to serve on the code authority. The five members of the code authority then elected a sixth member. The practical effects of code provisions on the industry cannot be judged as yet.

## REVIEW BY STATES

*Alaska.*—Alaska Asbestos, Inc., owners of the Bear Creek mine on Admiralty Island, reported that the property has been equipped fully for operation, including buildings, machinery, and a road to within 1 mile of the quarry. The deposit is said to contain a large supply of good-grade, long-fibered amphibole.

*Arizona.*—Mining operations were practically suspended in Arizona during 1933. The Ash Creek mine of the Johns-Manville Products Corporation 40 miles northeast of Globe was idle the entire year; sales were made from stocks on hand. There have been no sales from the Bear Canyon mine of the Bear Canyon Asbestos Co. (address Ambler, Pa.) since 1930. A highway from Springerville to Globe, under construction in 1933, will reduce the cost of transportation and encourage greater activity.

*California.*—No sales of asbestos produced in California are recorded for 1933, but the United Asbestos Corporation has erected a mill and constructed a trestle and track preparatory to operating in 1934 the Phoenix mine 9 miles southwest of Monticello.

*Maryland.*—The Powhatan Mining Corporation produced long-fibered asbestos (anthophyllite) in 1933 at the Jenkins mine near Pylesville and fabricated it into chemical filters at its plant at Woodlawn, Baltimore. The company also produces short-fibered material commercially.

*Montana.*—Peter F. Karst sold amphibole, reported to be ½-inch fiber and No. 1 grade, from his property 20 miles southwest of Gallatin Gateway. Samples from occasional pockets and lenses in this deposit, sent to the Bureau of Mines for examination, were strong, silky fibers of spinning quality. This is the only amphibole asbestos of such quality in the United States known to the Bureau.

*Vermont.*—Total sales of asbestos (chrysotile) in Vermont in 1933 increased compared with 1932. The entire output was made by the Vermont Asbestos Corporation of America at its property in Lamoille County near Hyde Park.

*Washington.*—Amphibole was produced in Washington in 1933 by the Asbestos-Talc Products of Washington, Inc., at Burlington for use in asbestos cement. This company also manufactures "Asbesto-Fill", a heat-insulating building material, and "Asbestocite", an article consisting of asbestos fiber and talc and used in roofing paints and plastics.

## WORLD PRODUCTION

The chief asbestos-producing areas of the world are Canada, Rhodesia, the Union of South Africa, and the U.S.S.R. (Russia). Relatively small quantities are produced in Cyprus, Italy, Australia, and several other countries.

The following table shows world production by countries for a series of years, insofar as figures are available.

*World production of asbestos, 1929–33, in metric tons*

| Country [1] | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Africa: | | | | | |
| Portuguese East Africa | | [2] 16 | | (3) | (3) |
| Southern Rhodesia | 38,677 | 34,260 | 21,810 | 14,302 | 27,381 |
| Swaziland | | | | 5 | (3) |
| Union of South Africa | 29,970 | 17,491 | 14,221 | 10,951 | 14,412 |
| Australia: | | | | | |
| New South Wales | | | 8 | | (3) |
| South Australia | 1 | | 6 | 20 | (3) |
| Western Australia | 259 | 144 | 116 | 112 | (3) |
| Canada [4] | 277,647 | 219,641 | 149,047 | 111,562 | 141,006 |
| China | 277 | 315 | 264 | (3) | (3) |
| Cyprus [2] | 14,017 | 5,487 | 3,628 | 1,626 | (3) |
| Finland | 1,563 | 1,188 | 581 | 756 | (3) |
| France | 750 | 503 | (3) | (3) | (3) |
| Greece | (3) | 2 | 10 | (3) | (3) |
| India, British | 324 | 34 | 6 | 91 | (3) |
| Italy | 2,847 | 851 | 632 | 1,284 | (3) |
| Japan [5] | 1,000 | 1,000 | 1,000 | 1,000 | (3) |
| Turkey | (3) | (3) | 4 | 58 | (3) |
| U.S.S.R. (Russia) | [6] 29,520 | 54,083 | 64,674 | (3) | (3) |
| United States | 2,862 | 3,848 | 2,928 | 3,229 | 4,305 |

[1] In addition to countries listed Madagascar reported production of 545 kilograms of asbestos in 1929. No exploitation of the deposits has been reported since that time.
[2] Exports.
[3] Data not available.
[4] Exclusive of sand and gravel, production of which is reported as follows: 1929, 17,215 tons; 1930, 36,949 tons; 1931, 6,540 tons; 1932, 3,151 tons; 1933, 5,850 tons.
[5] Approximate production.
[6] Year ended Sept. 30.

## CANADA

Asbestos production in Canada during 1933 recovered remarkably, gaining 29 percent in quantity and 71 percent in value over 1932—a year of unusually low output.

Canadian producers took advantage of the quiet years of the depression to improve their processes and equipment. The Asbestos Corporation, Ltd., introduced at the King mine a system of block caving similar to that employed in the large copper mines of Arizona. Both safety and efficiency have been promoted thereby.

The following table shows production figures for 1933 as published in the preliminary report of the Quebec Bureau of Mines.

*Production of asbestos in the Province of Quebec for 1933*

| Designation of grade | Shipments and sales | | Average value per ton |
|---|---|---|---|
| | Short tons | Value | |
| Crudes | 1,306 | $341,734 | $261.66 |
| Fibers | 82,605 | 3,843,887 | 46.53 |
| Shorts | 74,456 | 1,025,556 | 13.77 |
| Total | 158,367 | 5,211,177 | 32.90 |
| Sand, gravel, and stone (waste rock only) | 6,445 | 3,215 | .50 |
| Total | 164,812 | 5,214,392 | |

Quantity of rock mined in 1933: 1,566,919 tons.
Quantity of rock milled in 1933: 1,329,814 tons.
Quantity of tailings re-treated in 1933: 521,930 tons.

## AFRICA

*Rhodesia.*—The Rhodesian industry recovered decidedly in 1933. The tonnage produced was almost double and the value nearly three times that in 1932. Evidently the marketing agreement between Rhodesian and Russian producers brought favorable results. Dividends paid by Turner & Newall, Ltd., which controls most of the output, were increased from 3¾ percent in 1932 to 5 percent in 1933. Earnings were 6.5 percent in 1933 compared with 4.2 percent in 1932. The fiber is high-grade chrysotile occurring in serpentine.

The following table shows Rhodesian production for a series of years.

*Asbestos produced in Rhodesia, 1924–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1924–28 (average) | 33,394 | £772,236 | 1931 | 24,042 | £386,494 |
| 1929 | 42,634 | 1,186,627 | 1932 | 15,766 | 197,092 |
| 1930 | 37,765 | 1,070,847 | 1933 | 30,182 | 555,993 |

*Union of South Africa.*—Production in the Union of South Africa in 1933 increased 32 percent in quantity and 69 percent in value compared with 1932.

The following table shows output for several years:

*Asbestos produced in the Union of South Africa, 1924–33, by sources*

| Year | Short tons | | | | Total value |
|---|---|---|---|---|---|
| | Trans-vaal | Cape Province | Natal | Total | |
| 1924–28 (average) | 11, 652 | 3, 888 | | 15, 540 | £244, 301 |
| 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 | 116, 401 |
| 1933 | 12, 662 | 3, 225 | | 15, 887 | 197, 120 |

Cape of Good Hope asbestos is the blue variety (crocidolite) which occurs in banded ironstones occupying a belt extending through Prieska and Kuruman. Both chrysotile and amosite are mined in the Transvaal, the former under unusually favorable conditions in the Barberton district and the latter about 30 miles north of Lydenburg. As noted in the following table each type gained substantially, amosite showing a remarkable increase in tonnage and chrysotile a substantial recovery in value.

*Asbestos produced in the Union of South Africa, 1931–33, by varieties and sources*

| | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value |
| Amosite (Transvaal) | 2, 087 | £20, 608 | 1, 391 | £13, 906 | 3, 090 | £31, 099 |
| Chrysotile (Transvaal) | 9, 938 | 125, 439 | 7, 715 | 45, 692 | 9, 572 | 105, 715 |
| Blue (Cape) | 3, 651 | 100, 536 | 2, 964 | 56, 803 | 3, 225 | 60, 306 |
| | 15, 676 | 246, 583 | 12, 070 | 116, 401 | 15, 887 | 197. 120 |

## U.S.S.R. (RUSSIA)

The principal asbestos-producing area of the Soviet Union is the Bajenova district, about 90 kilometers northeast of Sverdlovsk (Ekaterinburg). The fiber is the chrysotile variety occurring in serpentine. Although production was almost at a standstill during the revolutionary period recovery has been rapid and extensive in recent years. Definite figures of production in 1932 and 1933 have not yet been obtained. The importance of Soviet Russia as a source of fiber for the United States is uncertain; the significance of the fact that imports of high-grade asbestos were not resumed after import restrictions were removed is not yet apparent. Increasing quantities doubtless are being employed in asbestos-products factories in Russia.

The following table shows production and exports for several years:

*Production and exports of Russian asbestos, 1929–33 in metric tons*

| Year | Production | Exports | Year | Production | Exports |
|---|---|---|---|---|---|
| 1929 | 39, 942 | 12, 603 | 1932 | (1) | 15, 915 |
| 1930 | 54, 083 | 15, 749 | 1933 | [2] 72, 000 | (1) |
| 1931 | 64, 674 | 13, 239 | | | |

[1] Data not available. [2] Unofficial estimate.

## CYPRUS

Production of short-fiber chrysotile in Cyprus has declined greatly since 1929. As there are no asbestos-products plants on the island the entire output is exported, principally to European countries.

The following table shows exports in recent years:

*Asbestos exported from Cyprus, 1929–33*

| Year | Long tons | Value | Year | Long tons | Value |
|---|---|---|---|---|---|
| 1929 | 13,796 | £292,971 | 1932 | 1,600 | £27,214 |
| 1930 | 5,400 | 116,092 | 1933 | [1] 1,158 | (2) |
| 1931 | 3,571 | 66,381 | | | |

[1] First 6 months.
[2] Data not available.

## ITALY

Italy has produced asbestos since ancient times. For many years production consisted entirely of the tremolite variety. Tremolite, well adapted for manufacture of acid filters, occurs in the Susa Valley in western Torino near the French border. It is mined also in the Aosta Valley, northeastern Torino, and near Sondrio, northern Lombardy. In recent years the production has been chiefly chrysotile from the Balangero mine about 20 kilometers north of Turin.

The table of world production on page 1013 shows the output for recent years.

## OTHER COUNTRIES

*Australia.*—Asbestos deposits have been worked in a small way in various parts of Australia. Chrysotile is obtained principally from Western Australia, smaller quantities coming from Queensland, New South Wales, and Tasmania. Crocidolite occurs at several places in South Australia and limited quantities have been produced at Hawker about 250 miles north of Adelaide.

*Bulgaria.*—Considerable quantities of anthophyllite occur in southern Bulgaria. A production of several hundred tons in 1933 was reported unofficially.

*China.*—Small quantities of asbestos are obtained from various parts of China. The Laiyuan mines in Chihli probably are the most important. The output is shipped to manufacturing plants in Tientsin. Part of the fiber evidently is of spinning grade.

*Newfoundland.*—A deposit of chrysotile asbestos discovered near Port au Port is thought to represent a continuation of the Quebec belt. No data on its quality or extent are available.

*Turkey.*—Small quantities of asbestos have been produced near Kutaia, western Turkey. An output of 58 metric tons valued at about $24 a ton was recorded for 1932. Very promising samples of cross-fiber chrysotile, some of which could be classed as crude No. 1, were sent to the U.S. Bureau of Mines for examination; the source is said to have been a deposit near Sarĭkamĭş, Province of Karş, Turkish Armenia. The percentage of fiber to rock is unusually high, but no data on the extent of the deposit are available.

# BARITE AND BARIUM PRODUCTS

By Paul M. Tyler and B. H. Stoddard

SUMMARY OUTLINE



A definite upturn in demand and an upward tendency in dollar cost of imported barite developed a more optimistic outlook for the southern barite-mining industry in 1933; and on April 1, 1934, Missouri producers were heartened by a freight rate reduction from $9 to $5.85 per short ton to Atlantic seaboard points, thereby affording them the prospect of getting business in eastern markets. More fundamental even than these signs of superficial betterment may be the latent strength being engendered by marked progress in methods of beneficiation, which promise to place the American product on a better competitive footing in respect to quality as well as cost.

Figure 98 shows recent trends in sales of crude barite from domestic mines, imports, consumption, and prices in the United States, and in figure 99 the trend for crude barite consumption is compared with lithopone sales, value of total paint sales, crude rubber consumption, and general industrial production. In recent years virtually two-thirds of the barite consumed in the United States has been employed in the manufacture of lithopone, which in turn is used principally as a pigment in paints, enamels, and lacquers and to a smaller extent in floor coverings and textiles and in rubber manufacture. Sales of ground barite are the second most important outlets for barite, and these likewise are dominated by the requirements of the paint and rubber trade. Even the barium chemical industry is strongly affected by the demand for paint ingredients. The resistance offered by the various branches of the barium-products industry to the depressing influences of the general business recession is noteworthy.

Salient statistics covering barite and leading barium products are summarized in the following table:

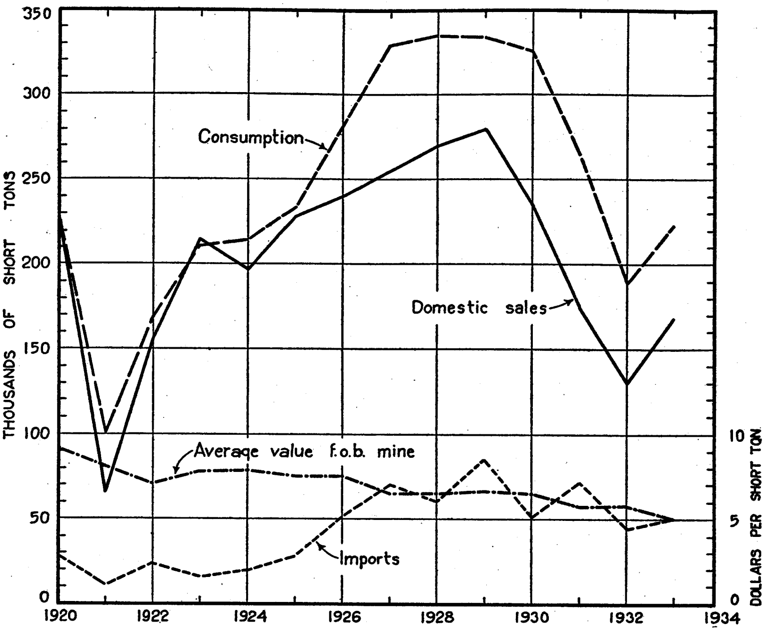


FIGURE 98.—Trends in production (domestic sales), imports, consumption, and prices (average value f.o.b. mines) of crude barite, 1920–33.

*Salient statistics on barite and barium products in the United States, 1925–33*

| | 1925–29 [1] | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Crude barite: | | | | | |
| Produced ... short tons | 244,527 | 237,505 | 210,930 | 133,572 | 146,402 |
| Sold or used by producers: | | | | | |
| Short tons | 253,403 | 234,932 | 174,520 | 129,854 | 167,880 |
| Value: [2] | | | | | |
| Total | $1,750,580 | $1,538,171 | $994,655 | $745,955 | $852,611 |
| Average | $6.93 | $6.55 | $5.70 | $5.74 | $5.08 |
| Imports for consumption: | | | | | |
| Short tons | 59,488 | 52,111 | 73,080 | 45,758 | 49,957 |
| Value: [3] | | | | | |
| Total | $202,899 | $179,579 | $329,114 | $177,954 | $216,955 |
| Average | $3.40 | $3.45 | $4.50 | $3.89 | $3.62 |
| Apparent new supply [4] ... short tons | 312,891 | 287,043 | 247,600 | [5] 175,612 | 217,837 |
| Domestic ... percent | 81.4 | 81.8 | 70.5 | [5] 73.9 | 77.1 |
| Reported consumption (total) short tons | 298,093 | 325,195 | 265,270 | [5] 189,409 | 223,047 |
| arium products: | | | | | |
| Sold or used by producers: | | | | | |
| Short tons | 261,937 | 250,712 | 228,326 | 177,836 | 215,525 |
| Value | $20,292,458 | $18,793,515 | $16,365,522 | $12,191,374 | $14,170,890 |
| Imports for consumption: | | | | | |
| Short tons | 26,207 | 18,201 | 12,912 | 10,561 | 9,596 |
| Value | $1,170,149 | $905,091 | $624,272 | $385,651 | $461,588 |
| Exports of lithopone: | | | | | |
| Short tons | 2,644 | 3,665 | 3,821 | 3,212 | 1,186 |
| Value | $271,314 | $380,047 | $341,257 | $270,195 | $107,923 |

[1] Average.
[2] F.o.b. mine shipping point.
[3] Declared value f.o.b. foreign market.
[4] Barite sold or used by producers plus imports.
[5] Corrected figures.

*General conditions.*—A sociological problem of some magnitude is afforded by the barite-mining industry, especially in Washington County, Mo., the principal producing locality. Since most persons, including many in the mining profession itself, visualize mining in the romantic aspect of boom towns or as a highly organized industry, such as is conducted in the Western States, on the Lake Superior iron ranges, or in the Pennsylvania coal fields, it comes as surprise to many to learn that substantial contributions to our mineral output are made by a rural population entrenched in the hills and country communities of the South and middle West. The spectacular growth of mass production following a half century of increasing industrialization has obscured almost completely the fact that in the United States, even as in Europe, mines and factories are interspersed with small farms in many localities and that those who dwell in communities of this sort are able to maintain a virtually self-contained existence that involves few purchases from outside. Money wages that in a different environment would scarcely cover the rent of a small room often suffice to maintain a large family in relative comfort when food and shelter are obtainable without cash outlay. Labor is characteristically more fluid in the United States than in older countries and tends to flow from farm to factory and back to the farm as industrial conditions change, but those who have spent their lives in a community of this sort are generally fearful and often incapable of seeking their fortunes where existence is predicated solely upon a job, acquired savings, or charity.

In 1928 the contract price for mining "tiff" in Washington County was $3 a ton, and the average man put out 2½ tons a week.[1] A few years ago most of the workers were getting at least $6 a week and according to local standards were fairly well off. By 1932, however, the "tiff diggers" were being paid only $1.50 a ton and in many places were fortunate to get $3 a week, working full time. As the rate for hand work declined it ceased to be economical to employ mechanical means. Those formerly employed for wages were forced to take up hand mining on contract, and unless they were fortunate in getting a good place to work their earnings frequently dropped to a dollar a week or less. In 1933 relief from these conditions was sought in an application to the NRA for a local code, which was followed in the early part of 1934 by an application for a code to cover the entire industry; the petition stated that the Washington County reemployment office listed 3,000 men as unemployed.

In addition to cost handicaps the American barite-mining industry has suffered hitherto because the quality of its product often has been inferior to that offered from abroad. Barite from Georgia and certain other domestic localities is of the "hard" or "crystalline" variety, which is adjudged by consumers to be worth less than the soft, crumbly barite, which costs less to grind, decrepitates more readily in roasting, and otherwise seems to constitute a more desirable raw material. For the present at least such inherent characteristics of the mineral cannot be modified, but in commercial terms these disadvantages are encompassed in a price differential of approximately $0.50 a ton, and consequently they may be offset

[1] Weigel, W. M., The Barite Industry in Missouri: Am. Inst. Min. and Met. Eng. Tech. Pub. 201, 1929.

by other circumstances which likewise can be evaluated on a dollars-and-cents basis. A further objection to American barite has been its frequent contamination with limonite, silica, and other coatings or inclusions that were not removed by the ordinary methods of mechanical preparation. Impure barite, regardless of its crystalline characteristics, cannot be sold for as high a price as high-grade material, such as has been furnished by European firms, and by increasing the purity of their product American miners are promised not only a better price for their material but also larger sales.

Opportunities now exist for establishing at convenient points central cleaning plants to supply 98-percent barite and perhaps other grades of uniform analysis. The indicated margin of profit for a custom plant of this sort is attractive merely on the basis of purchasing barite from miners in one or more producing localities at

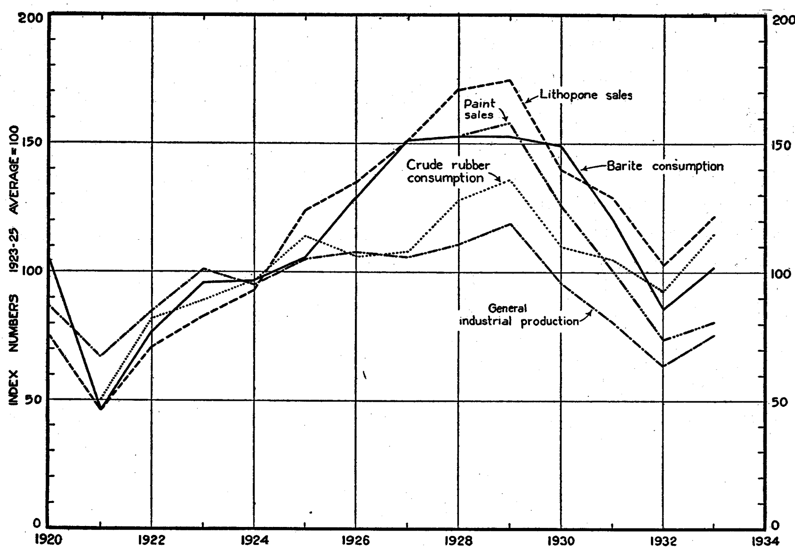


FIGURE 99.—Crude barite consumption and lithopone sales (domestic) compared with general industrial production, crude rubber consumption, and value of total paint sales, 1920–33.

present prices. To the known advantages of a central buying agency would be added the premium obtainable for a really high-grade product, the quality of which could be depended upon. Doubtless an even greater opportunity awaits the establishment of enterprises to utilize hitherto unworkable sources of barite.

Flotation has wrought revolution in the concentration of sulphide ores of various metals but has been adapted less readily to the beneficiation of nonmetallic minerals. The time has come, however, when barite can be cleaned economically by flotation. No known technical barrier exists for a commercial treatment plant for the removal of iron and silica, where these can be liberated within the limits of ordinary fine grinding. Fluorite for the moment presents certain difficulties, as it tends to follow the barite into the concentrate, but even this mineral can doubtless be removed when suitable conditions for differential flotation are worked out. Inasmuch as fluorspar-barite mixtures occur in several localities, an nvestigation of this problem was begun late in 1933 by the Bureau of Mines at its Southern Experiment Station, Tuscaloosa, Ala.

*Market areas.*—The market for crude barite in the United States is concentrated mainly in three areas. The Pacific coast market, which is the smallest, is virtually self-contained, as barite mined in Nevada and California is consumed at plants in Modesto, El Portal, and Oakland, Calif.; practically no barite from foreign or other domestic sources enters this market. The midwestern market is supplied mainly from Missouri, and in recent years only a small portion of the Missouri output was sold outside of the midwestern market; however, this market is not self-contained, for consumers in this area normally obtain over 20 percent of their crude barite from Georgia and Tennessee. The main competitive market is the eastern area. The relative significance of imports has grown in recent years, and nearly all the imports of crude barite are consumed in the Eastern States, which are also the main market for southern barite; ordinarily less than 1 percent of the domestic barite sold in this area is from Missouri. The Southern States produce a little ground barite in local mills, but this area is primarily concerned in supplying crude barite to outside territory. Roughly four-fifths of the sales of Georgia and Tennessee crude is shipped to eastern and one-fifth to midwestern consumers.

About three-fourths of the ground barite produced by midwestern mills, and a much larger part of the small output of the southern grinding plants, is shipped to Eastern States.

*Prices.*—Trade-journal prices for crude barite, after sagging for several years, began to stiffen during the second quarter of 1933. In June California crude, which had dropped to $5.50 earlier in the year, was marked up to $6 a short ton; and in September the quotation for Georgia crude barite, which had remained nominally at $6 to $6.50 since the middle of 1931, was advanced to $6.50 to $7 a long ton. A similar improvement was recorded in the Missouri field, where high-grade ore (95 percent $BaSO_4$; under 1 percent iron) was increased in price from $4.50 to $5 a short ton with a corresponding increase in the price of second grade (93 percent) from $4 to $4.50 a ton; a 90-percent grade was quoted at $4 a ton at the end of 1933. Actual realized prices, as reported by producers to the Bureau of Mines, were $5.87 per short ton in California and $6.55 per long ton in Georgia. In the Missouri field the average was $4.54 per short ton; individual operators reported average receipts ranging from $3 to over $6, but most of them got $3.50 to $4.50. These prices are much lower than those received by miners in other States, because many small operators sell their product to local merchants at prices that do not include hauling expense, which ranges from $0.50 to $3 a ton or more, depending upon the distance from the railroad and also depending somewhat upon the quality of the ore or what the traffic can bear. For the country as a whole the apparent average sales price dropped to $5.08 in 1933 compared with $5.74 in 1932. The decline reflects mainly a sharp reduction of almost $1 per ton in the Missouri average. It does not follow, however, that there was any such reduction in the actual value of the Missouri output f.o.b. cars; in a depression year a much larger proportion of the production is supplied by small operators, whose valuations are not comparable with those of larger operators because they fail to account for hauling expenses and sundry other charges incident to making up carload shipments from different sources, as well as possible profit for local buyers.

No change has been reported for several years in the quoted price of $23 per ton f.o.b. St. Louis for ground barite, and in 1933 producers' valuations were about the same; the average value as reported to the Bureau of Mines was higher in 1933 than in 1932, but this was because sales of low-grade material were relatively smaller. Quotations for ground witherite likewise were unchanged, at $37 and $40 a ton for 100-mesh and 300-mesh grindings, respectively, f.o.b. works.

*Range of quotations on barite and barium products, 1931–33* [1]

| | 1931 | 1932 | 1933 |
|---|---|---|---|
| Crude barite, f.o.b. mines: | | | |
| California ... short ton | ----------- | $6.00 –$7.00 | $5.50 –$7.00 |
| Georgia ... long ton | $6.00 –$6.50 | 6.00 – 6.50 | 6.00 – 7.00 |
| Missouri [2] ... short ton | 6.00 – 6.50 | 5.00 – 6.00 | 4.50 – 5.00 |
| Ground, barite, bbl., St. Louis ... do | 23.00 | 23.00 | 23.00 |
| Ground witherite, works [3] ... do | 42.00 –47.00 | 40.00 –42.00 | 40.00 |
| Lithopone, 400-lb. bbl., l.c.l ... pound | .04¾– .05 | .04¾– .05 | .04¾– .05 |
| Barium carbonate, 200-lb. bags ... short ton | 56.50 –60.00 | 47.00 –57.00 | 56.50 –61.00 |
| Barium chlorate, 112-lb. kegs, New York ... pound | .14 – .15 | .13¾– .15 | .13¾– .16 |
| Barium chloride, 600-lb. bbl., works ... short ton | 63.00 –69.00 | 63.00 –69.00 | 61.50 –74.00 |
| Barium dioxide, 88 percent, 690-lb. drums ... pound | .12 – .13 | .11 – .13 | .11 – .13 |
| Barium hydrate, 500-lb. bbl ... do | .04¾– .05½ | .04¾– .05½ | .04¼– .05 |
| Barium nitrate, 700-lb. casks ... do | .07¼– .08¼ | .07 – .08 | .07¼ |
| Blanc fixe, 400-lb. bbl ... short ton | 75.00 –90.00 | 60.00 –80.00 | [4] 42.50 –75.00 |

[1] Metal and Mineral Markets, New York (weekly). Chemical Industries (formerly Chemical Markets), New York (monthly).
[2] Beginning in March 1931, 95 percent barium sulphate, less than 1 percent iron; previously 93 percent $BaSO_4$.
[3] Beginning October 1931, 90 percent through 300 mesh; previously 90 percent through 200 mesh.
[4] Lowest price for pulp grade.

As quotations for barium chemicals are more or less nominal they tend to lag behind actual prices, but such revisions as were made were mainly upward. A substantial increase in the price of barium nitrate may be noted; the apparent advance in barium chloride, which after drifting along under $65 per ton was sharply raised to $74 to $75 toward the close of 1933, was due to change in basing point.

Foreign prices of crude and ground barite as reported in various trade journals were generally firm in 1933, a French source quoting crude barite (97–98 percent) at 80 francs per metric ton and a British journal reporting ground barite (according to grade) at £7 10s. to £9 per long ton throughout the year. In another trade journal the French price was given month after month as 110 francs. A study of foreign valuations as reported on imports into the United States indicates further that prices of crude barite in European currencies remained unchanged in 1933 at about the same levels as in the latter part of 1932, although the average Reichsmark value of German exports was lower for the year. In France barium chemicals and lithopone prices softened early in the year and despite some recovery later were generally lower in December than they had been in January. British quotations remained nominally stationary.

*Technology.*—In the Barium volume [2] of Gmelins Handbook of Inorganic Chemistry, R. J. Meyer reviews the literature on barium compounds to April 1932. The physical properties of the element are likewise covered in great detail. Different methods of manufactuirng barium salts from barite and witherite have been discussed in a French article.[3] For purifying barite, the dominant German barite concern [4] has patented a process involving heating at about 1,300° C. with a small amount of carbonaceous material so as to reduce about 1 percent of the barium sulphate to barium sulphide, which reacts in water solution with inorganic impurities to form metal sulphides that may be removed by flotation followed by leaching with mineral acid. The same concern has obtained a British patent (389044, Oct. 31, 1932) for preparing pure barium compounds by processes involving the use of zinc oxide. A brief review [5] of investigations in flotation of barite further indicates the active interest in Germany in the utilization of low-grade and off-grade material. The uses of witherite were covered in a paper by H. C. Meyer,[6] who subsequently described [7] the methods employed for processing this less common barium mineral. Continued interest in the use of barium in the glass and enamel industries is indicated, especially by European publications.

The use of metallic barium has so far failed to attain tonnage proportions. Although rarely employed in regular foundry work, barium is nevertheless a highly useful metal. It has become an important addition to spark-plug wires and emitter alloys generally. A recent British patent [8] covers the production of an 80- to 90-percent barium-aluminum alloy (for use in discharge tubes for the removal of residual gases and for the activation of cathodes) by the aluminothermic reduction of barium oxide. Methods for preparing low-barium (up to 35 percent) alloys with aluminum were summarized by Alberti.[9]

## CRUDE BARITE

*Sales.*—Barite was mined in only 7 States in 1933 compared with 9 States in 1932, but mine output increased almost 10 percent and shipments of crude barite increased 29 percent. Stocks at mines, chiefly in Missouri, after increasing steadily for several years, were reduced during 1933 but amounted at the close of the year to about 6 months' production at the current rate, or almost double the normal carry-over of a decade ago. The principal increases in production were in Georgia and Tennessee, both States showing large advances over 1932, though still far below the operating scale of other recent years. Missouri sales increased 31 percent, amounting to 67 percent of the total sales compared with 65.8 percent in 1932 and 53.5 percent in 1931; the quantity, 112,335 tons, was considerably lower than the

[2] Gmelins Handbuch der anorganischen Chemie, Achte voellig neue bearbeitete Auflage; herausgegehen von der Deutschen chemischen Gesellschaft, bearbeitet von R. J. Meyer, System-Nummer 30: Barium, pp. xvi, 390 (Berlin: Verlag Chemie B. m.b.H., 1932).

[3] Lemaire, E., Barium and Its Industry: Ind. chimique, vol. 19, no. 226, 1932, p. 819; Jour. Am. Ceram. Soc., Ceram. Abs., vol. 12, no. 4, April 1933, p. 170.

[4] Sachtleben A. G. für Bergbau und chemischen Industrie, Refining Heavy Spar: German Patent 559322, July 31, 1928; Chem. Abs., vol. 27, no. 4, Feb. 20, 1933, p. 817.

[5] Hamann, J., Untersuchungen über die Flotation von Schwerspat: Metall u. Erz, vol. 30, no. 22, November 1933, pp. 455–57, Halle a. S.

[6] Meyer, H. C., Witherite as a Chemical Raw Material: Chemical Markets, vol. 32, no. 4, April 1933, pp. 317–19.

[7] Meyer, H. C., Processing Witherite: Eng. and Min. Jour., vol. 134, no. 7, July 1933, pp. 283–84.

[8] Vereinigte Glühlampen und Electricitäts A.-G., Alloys: British Patent 695989: Metal Ind. (London), vol. 44, no. 4, Jan. 26, 1934, p. 119.

[9] Alberti, E., Preparation of Aluminum-Barium Alloys: Metall u. Erz, vol. 30, 1933, pp. 231–233; Chem. Abs., vol. 27, Sept. 20, 1933, p. 4511.

high record of 132,640 tons in 1930 but compares favorably with other years. Shipments from California increased to 9,266 tons in 1933 compared with 7,789 tons in 1932 and 17,500 in 1931. Virginia, Nevada, and South Carolina complete the list of producing States in 1932.

*Consumption by uses.*—The barite-consuming industries of the United States used 223,047 short tons of domestic and imported barite in 1933 compared with 189,409 tons in 1932, an increase of 18 percent compared with 1932 but 16 percent less than in 1931 and 33 percent less than in 1928 or 1929. Changes in the distribution of crude barite according to specified consuming industries are shown in the accompanying table.

Crude barite was consumed in 13 States. In 1933, 1 plant in California resumed operations but 1 in West Virginia was idle, so the total number of plants engaged in the manufacture of barium products remained at 31, the same as in 1932 and 1 more than in 1931.

*Crude barite (both domestic and imported), used in the manufacture of barium products in the United States, 1929–33, in short tons*

| Year | In manufacture of— | | | Total | Year | In manufacture of— | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Ground barite | Lithopone | Barium chemicals | | | Ground barite | Lithopone | Barium chemicals | |
| 1929 | 58,770 | 223,188 | 52,448 | 334,406 | 1932 | [1] 36,402 | 120,378 | 32,629 | [1] 189,409 |
| 1930 | 69,426 | 178,944 | 76,825 | 325,195 | 1933 | 38,026 | 131,761 | 53,260 | 223,047 |
| 1931 | 35,393 | 157,181 | 72,696 | 265,270 | | | | | |

[1] Corrected figures.

*Domestic and imported crude barite used in the manufacture of barium products in the United States in 1933, by States, in short tons*

| State | Product manufactured | Plants [1] | Barite used |
|---|---|---|---|
| Missouri | Ground barite and chemicals | 5 | 51,510 |
| Illinois | Ground barite, lithopone, and chemicals | 6 | 44,840 |
| Delaware and Maryland | Lithopone and chemicals | 2 | 31,509 |
| New Jersey | do | 3 | 34,609 |
| Pennsylvania | do | 2 | 27,079 |
| California | Ground barite, lithopone, and chemicals | 5 | 14,002 |
| West Virginia | Chemicals | 2 | 19,498 |
| Kansas | Lithopone | 1 | |
| New York | Ground barite and chemicals | 2 | |
| Georgia | Ground barite | 1 | |
| South Carolina | do | 1 | |
| Texas | do | 1 | |
| | | 31 | 223,047 |

[1] A plant producing more than one product is counted but once in arriving at State totals.

*Imports.*—Imports of crude barite for consumption in the United States in 1933 were 49,957 short tons, valued at $216,955, a slight increase in quantity compared with the imports during 1932, which represented the smallest tonnage imported in any year since 1925. The higher nominal value reported for 1933 was caused only in part by the progressive advance in the average declared or foreign market values of imports from Germany, which rose from $2.19 a ton in May to $4.15 a ton in November compared with an average of $3.15 for 1932 and $3.31 for 1931. This movement is in cargo lots of about 7,000 long tons each. Imports credited to Netherlands bore an average declared value of $5.97 a short ton, which upon investigation is found to have been the average delivered price at American ports (exclusive of duty) instead of the foreign market value; this barite is of German origin, water-borne from Cologne and transshipped from Netherlands. Italy, which hitherto had furnished only insignificant quantities of crude barite to the United States, made one substantial shipment in 1933.

*Crude barite imported into the United States, 1932–33, by countries*

| Country | 1932 | | 1933 | |
|---|---|---|---|---|
| | Short tons | Value [1] | Short tons | Value [1] |
| Germany | 35,915 | $113,135 | 31,383 | $105,558 |
| Italy | 28 | 111 | 6,492 | 43,292 |
| Netherlands | 8,181 | 55,006 | 9,913 | 59,212 |
| Spain | ---------- | ---------- | 1,187 | 2,650 |
| U.S.S.R. (Russia) | 1,634 | 9,702 | 982 | 6,243 |
| | 45,758 | 177,954 | 49,957 | 216,955 |

[1] Nominally the value at port of shipment exclusive of transportation and other shipping expense and of mport duty.

*World production.*—The following table shows the output of barite by various countries from 1929 to 1933, as far as statistics are available.

*World production of barite, 1929–33, in metric tons*

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Algeria | 1,200 | 2,403 | 944 | 890 | (1) |
| Australia: | | | | | |
| New South Wales | 154 | 176 | 124 | 309 | (1) |
| South Australia | 2,001 | 1,560 | 1,468 | 1,728 | (1) |
| Tasmania | 10 | ---------- | ---------- | ---------- | (1) |
| Western Australia | 2 | ---------- | ---------- | ---------- | (1) |
| Austria | 300 | 496 | 87 | 275 | (1) |
| Belgium | ---------- | ---------- | 120 | (1) | (1) |
| Canada | 95 | 60 | 15 | ---------- | 18 |
| Chosen | (1) | 6,096 | 5,460 | 6,569 | (1) |
| France | 41,625 | 32,650 | 11,300 | (1) | (1) |
| Germany: | | | | | |
| Bavaria | 23,406 | 17,778 | 7,835 | 5,853 | (1) |
| Prussia [2] | 260,811 | 217,925 | 160,482 | 102,167 | (1) |
| Saxony | 1,870 | 480 | 2,534 | (1) | (1) |
| Great Britain | 58,011 | 59,647 | 46,312 | 57,548 | (1) |
| India (British) | 3,810 | 6,906 | 5,745 | 3,004 | (1) |
| Irish Free State | 41 | 1,524 | 864 | ---------- | (1) |
| Italy | 25,955 | 23,420 | 24,326 | 21,861 | (1) |
| Portugal | ---------- | ---------- | 80 | ---------- | (1) |
| Southern Rhodesia | 264 | 249 | ---------- | ---------- | (1) |
| Spain | 5,806 | 5,552 | 8,539 | 8,934 | (1) |
| United States | 251,533 | 213,126 | 158,321 | 117,801 | 152,297 |

[1] Data not available.
[2] Official figures which, it is reported, cover only output of mines included under the mining law.

## BARIUM PRODUCTS

*Sales.*—Sales of ground barite, lithopone, blanc fixe, and other leading barium chemicals recovered substantially in 1933. The large increase in consumption of blanc fixe is especially notable in view of the trend toward calcium-base instead of barium-base titanium pigments, formerly an important outlet for precipitated barium sulphate. To avoid duplication the output of barium chemicals as reported by the Bureau of Mines includes only the products of primary producers that purchase crude barite of domestic or foreign origin. Chemicals made by secondary manufacturers are not included herein.

Increased sales of lithopone were due to general improvement in all the principal consuming industries; the 16-percent recovery in this material compares favorably with the 11-percent increase in sales of lead pigments but falls short of the 40-percent jump in the quantity of zinc-oxide pigments sold or used by producers in 1933.

*Barium products sold or used by producers in the United States, 1929–33* [1]

| Year | Ground barite | | | Lithopone | | | Blanc fixe (precipitated barium sulphate) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Plants | Short tons | Value | Plants | Short tons | Value | Plants | Short tons | Value |
| 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 |
| 1933 | 13 | 34,601 | 683,432 | 11 | 140,831 | 11,751,500 | 9 | 30,744 | 1,197,131 |

| Year | Artificial barium carbonate (chemically precipitated) | | | Barium chloride | | | Other barium chemicals [3] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Plants | Short tons | Value | Plants | Short tons | Value | Plants | Short tons | Value |
| 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 |
| 1933 | 4 | 3,810 | 181,857 | (2) | (2) | (2) | 9 | 5,539 | 356,970 |

[1] To avoid duplication, the barium chemicals reported here do not include the output of firms that make these chemicals from such products as barium chemicals and imported barite and witherite purchased in the open market; the total for barium chemicals is therefore not shown here.
[2] Included under "Other barium chemicals."
[3] Figures cover chemicals as follows—(1929: 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; 1933: Binoxide, chloride, hydroxide, and sulphide.

*Lithopone sold or used by producers, 1931–33, by consuming industries*

| Industry | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|
| | Short tons | Percent of total | Short tons | Percent ot total | Short tons | Percent of total |
| Paints, enamels, and lacquers | 119,446 | 78.7 | 93,465 | 76.8 | 106,995 | 76.0 |
| Floor coverings and textiles | 20,780 | 13.7 | 17,601 | 14.5 | 18,472 | 13.1 |
| Rubber | 5,833 | 3.8 | 3,955 | 3.2 | 5,078 | 3.6 |
| Other | 5,791 | 3.8 | 6,646 | 5.5 | 10,286 | 7.3 |
| | 151,850 | 100.0 | 121,667 | 100.0 | 140,831 | 100.0 |

*Imports and exports.*—Imports of barium products are a minor factor in the aggregate consumption. Despite rising prices in terms of American dollars, increases were noted in certain items in 1933. Exports of lithopone, moreover, apparently failed to benefit from the exchange situation, the average price was somewhat increased, but the quantity was less than during any recent year since 1924.

*Barium compounds imported for consumption in the United States, 1929–33*

[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 |
| 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 |
| 1933 | 2,632 | 30,492 | 5,596 | 313,341 | (5) | 82 | 245 | 12,093 | 49 | 1,632 |

| 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 |
| 1929 | 4,376 | $99,335 | 78 | $3,049 | 615 | $56,770 | 202 | $11,809 | (6) | (6) |
| 1930 | [7] 2,562 | [7] 52,282 | 7 | 372 | 407 | 31,985 | 220 | 12,235 | (6) | (6) |
| 1931 | [7] 2,352 | [7] 39,964 | 6 | 201 | 423 | 29,796 | 345 | 25,570 | 221 | $18,870 |
| 1932 | [7] 2,680 | [7] 34,336 | 39 | 1,208 | 330 | 21,421 | 235 | 10,494 | (8) | 11 |
| 1933 | [7] 2,949 | [7] 47,324 | 6 | 526 | 359 | 31,140 | 281 | 15,542 | 110 | 9,416 |

[1] 133 pounds.
[2] 222 pounds.
[3] 122 pounds.
[4] 328 pounds.
[5] 1,440 pounds.
[6] Not separately recorded prior to 1931.
[7] Beginning June 18, 1930, imports recorded as "Witherite, crude, unground."
[8] 22 pounds.

*Lithopone exported from the United States, 1929–33*

| Year | Short tons | Value: Total | Value: Average | Year | Short tons | Value: Total | Value: Average |
|---|---|---|---|---|---|---|---|
| 1929 | 4,556 | $463,235 | $101.68 | 1932 | 3,212 | $270,195 | $84.12 |
| 1930 | 3,665 | 380,047 | 103.70 | 1933 | 1,186 | 107,923 | 91.00 |
| 1931 | 3,821 | 341,257 | 89.31 | | | | |

## THE INDUSTRY IN FOREIGN COUNTRIES

Germany is by far the principal foreign source of crude barite, generally producing a larger tonnage even than the United States. Great Britain, France, and Italy are also large producers, but the aggregate output of all countries other than the United States and Germany normally amounts to scarcely one-half the output from either of the two principal producing countries.

*Algeria.*[10]—The Société Anonyme des Mines et Carrières de Bou-Mahni owns a considerable deposit of barite in the Djurjura Mountains above the small port of Dellys, 65 miles east of Algiers. Reserves have been estimated at 25 million tons, of which a considerable portion is white crystallized material that requires no mechanical treatment. In 1927 a small company was formed to work the deposit, but partly because of shipping difficulties work had to be suspended in 1932. The corporation was later taken over by financially capable French interests, the reorganization having been completed on March 28, 1933. Meanwhile the local harbor has been improved with a view to accommodate vessels of 18-feet draft. Milling facilities are already installed at Dellys for maintaining an output of 40 tons of ground barite a day and may be increased to meet a contract from a well-known French firm calling for 3,000 tons annually.

*Canada.*[11]—A small commercial shipment of barite was reported from Tianago, Penhorwood Township, Ontario, in 1933, but there has been no important production of barium minerals from Canada for some years. Other deposits of barite are found in Ontario in the Thunder Bay district, in the Porcupine district (near Nighthawk Lake), and in North Burgess and Yarrow Townships, Lanark County. Barite is also reported in Colchester and Hants Counties, Nova Scotia.

*Chosen.*[12]—Barite of excellent quality is found in an extensive deposit in Shodore, Kinka district, Kogen Province. The deposit is estimated at 1,000,000 tons and contains over 90 percent of barium sulphate. The output of ore amounted to 6,000 tons in 1930 and 5,500 tons in 1932. Japan has been utilizing German barite and barium salts, but with the establishment of a mill at the Shodo mine the Chosen material has lately begun to replace the German product on the Japanese market. A new deposit of large extent has recently been discovered in Shoka, Kokai Province, and will be developed when the demand and traffic facilities warrant.

*France.*—A considerable quantity of barite is reported as occurring in abandoned mine dumps near Grenoble on the Plateau de Brandes close to Bourg d'Oisons, Commune of Huez en Oisons, Department of Isère; the elevation is given as 5,550 feet above sea level and transport conditions may not be favorable.[13] A general description of barite deposits in France has recently been published by Charrin,[14] who contends that French resources justify expanding production far in excess of 50,000 tons annually and developing a large export business. Barite veins are found in all the mountain masses, in the Alps and Pyrenees, as well as in the Maures and in the Vosges and in and about the Central Plateau. Crude barite is exported from France but in only small quantity; and imports normally are large, often amounting to a third or more of the large domestic demand. The lithopone industry is of considerable magnitude, and in recent years French exports of this pigment have been consistently larger than imports.

*Germany.*—After declining steadily for several years the German barite industry showed definite revival in 1933, owing to improved

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10 Touchette, J. I., Am. vice consul, Algiers, Algeria.
11 Mineral Production of Canada (Preliminary Report), Dominion Bureau of Statistics, 1934, p. 31.
12 Bureau of Foreign and Domestic Commerce, World Trade Notes on Chemicals and Allied Products: Vol. 7, no. 45, Nov. 6, 1933, p. 8.
13 Touchette, J. I., Am. vice consul, Algiers, Algeria, U. S. Consular Rept. 62971, Mar. 31, 1933.
14 Charrin, M., La Baryte en France: Mines et Carrières, no. 113, March 1932, pp. 17-26.

demand at home and abroad. Exports of crude barite rose to 110,731 metric tons in 1933 compared with 103,477 tons in 1932 and 173,712 tons in 1929; the price decline was checked, but the average value for the year was only 14.9 marks, as against 15.7 marks in the previous year and 18.1 marks in 1929. Exports of ground barite amounted to 53,556 metric tons valued at 2,371,000 marks in 1933. The United States is the leading buyer of German crude barite, taking as much as one-third of the total exports. Other leading buyers, absorbing most of the remainder, are, in approximate order of importance, Netherlands, Belgium, France, Great Britain, and Czechoslovakia. Roughly one-third of the total barite exports consists of ground barite, which naturally has a wider distribution than the crude material. Although Great Britain, Netherlands, and certain other industrial countries figure prominently even in this trade, practically half the shipments of German ground barite go to less industrialized countries.

By far the bulk of the German output of barite is mined in the Westphalia district of Prussia in the vicinity of Meggen-on-the-Lenne, and recently 75 percent or more of the reported production of the nation has been contributed by one company—the Sachtleben A.G. of Cologne, a joint subsidiary of the I. G. Farbenindustrie and Metallgesellschaft, and itself a merger (1925) of three companies. The lithopone works of this completely integrated concern are situated at Homberg, in the Lower Rhineland, and at Schoeningen in Brunswick. In output of crude barite Bavaria is the second State, and a relatively small yield is reported from Saxony. However, the official statistics cover only the mines that come under the mining law and consequently are incomplete. There are productive deposits in Baden and several other States. Among other fairly important producing localities may be mentioned those in the Harz, around Nassau, Odenwald, Richelsdorf, Thüringian Forest, and Spessart.

Following its bad slump in 1932 the German lithopone industry likewise showed an upward tendency early in 1933. Prices, however, were adversely influenced in January by dissension in the ranks of the cartel—the Lithopone Kontor G. m. b. H.—which since 1926 has fixed prices and handled sales of the producer members, comprising all the important manufacturers. An increase in the exports from 11,890 metric tons in 1932 to 13,053 tons in 1933 was accompanied by a decline in the value from 4,062,000 to 3,567,000 marks.

*Great Britain.*—Considerable quantities of barite are produced in Great Britain, and this country is likewise the source of most of the world's witherite, but domestic needs are so large that a quantity almost equal to the home production must be imported annually, chiefly in the form of ground barite. This large local demand is principally for use in paints, in electric cable insulation, as a filler in the rubber industry, and for weighting textiles and leather. Inasmuch as British imports of barite have been valued at around £200,000 annually, it is of interest to note that the Arras barite mine in Scotland has recently been equipped to produce 20,000 tons a year, roughly half the normal imports.[15] The barite is taken to Glasgow for milling and may be distributed from there by coastwise vessels. The product is claimed to be of as good quality as any in Europe. Ground-barite imports into the United Kingdom in 1933 amounted to 14,742 gross tons as against 14,236 tons in 1932 and 25,047 tons in 1930.

[15] Chemistry and Industry (London), British Barytes Trade: Vol. 52, no. 15, Apr. 14, 1933.

Exports for the same years were 1,398 tons, 1,684 tons, and 1,335 tons, respectively.

*Hungary.*[16]—A lithopone plant erected by Metallhandels A. G. of Budapest at its Nagytetenyer works is said to have a capacity adequate to cover all home requirements. Operations were scheduled to start in April 1933.

*Italy.*—Italy has become a fairly important source of ground barite. As the product is whiter and as it has been rather cheap, it is preferred by some consumers to German material.

*U.S.S.R.* (*Russia*).—Reports of various discoveries of barite and one of impure witherite have emanated from Soviet sources recently. Imports of barium minerals and salts into the U.S.S.R. were never very large and in recent years have dwindled to negligible proportions. Exports have also declined, and with domestic requirements increasing it appears to be impossible to foresee whether the U.S.S.R. henceforth will be a net exporter or importer of barite.

[16] Bureau of Foreign and Domestic Commerce, World Trade Notes on Chemicals and Allied Products: Vol. 7, no. 16, 1933, p. 4.

# POTASH

By J. H. Hedges

SUMMARY OUTLINE



Outstanding developments in the potash industry during 1933 were the 131-percent increase in American potash output and the beginning of large-scale production from newly opened deposits in Spain and the U.S.S.R. Potash-production statistics, however, do not tell the whole story of rapidly changing world conditions in the potash trade.

During the year Spanish producers inaugurated an aggressive sales campaign, particularly in the United States and the Netherlands. Early in the year prices were cut 15 percent in the Netherlands market, and additional discounts of 5 to 8 percent were offered. Following failure of negotiations between the Franco-German Cartel and the Spanish producers to reach a marketing agreement, the cartel is reported to have offered an additional reduction of 15 percent in the Netherlands market to purchasers agreeing to buy no Spanish potash. Notwithstanding this offer Spain appears to have won the major part of the Dutch market and to have encroached heavily on the American import trade, formerly monopolized by France and Germany.

Russian potash was not a factor in world trade in 1933. When development of extensive Ural deposits was begun in 1931 it was thought that many years would pass before the growing needs of the country's expanding agriculture could be met and an exportable surplus produced. However, rising output from the Solikamsk mines in the latter part of the year, the prospect of early production from Berezniki, and the continuing need for foreign credit to purchase materials and equipment abroad have drawn the U.S.S.R. (Russia) into world trade in potash, and offerings of Russian potash in several foreign markets, including the United States, were made early in 1934. With costs difficult to estimate but certainly low on any basis of calculation, the U.S.S.R. may be in position to undersell in almost any market whatever potash she is able to allot for export. It is reported that 25,000 tons have been allocated for sale in the American market in 1934.

With these new factors assuming growing importance the picture is quite different from that of a few years ago, when Germany dominated the potash trade and controlled the price structure. Significant changes have occurred, and further shifts may be expected in the next few years.

World production of potash increased about 8 percent in 1933, reversing the downward trend begun in 1929. Output in 1933 was around 1,480,000 metric tons of $K_2O$ compared with 1,370,000 tons in 1932 but was still 760,000 tons (about 34 percent) below the peak of 2,240,000 tons in 1928.

The output of the principal producing countries in 1932 and the best available estimates for 1933 are shown in the following table:

*Output of potash in principal producing countries, 1932–33, in metric tons of $K_2O$*

| Country | 1932 | 1933 [1] | Country | 1932 | 1933 [1] |
|---|---|---|---|---|---|
| Germany | 871,354 | 900,000 | Poland | 57,044 | 30,000 |
| France | 321,229 | 326,008 | All others | 12,830 | 35,000 |
| United States | 56,236 | 130,070 | | | |
| Spain | 54,811 | 61,416 | Total | 1,373,504 | 1,482,494 |

[1] Subject to revision.

Final figures for 1932 give Poland third place in world output, by a narrow margin over the United States, but estimates for 1933 put the United States third and Poland fifth. The estimate of 35,000 tons for "All others" in 1933 is believed to be low, as Russia alone reported a gross output of 300,000 tons, which probably represents 30,000 tons or more of $K_2O$, although information regarding the average grade of the product is not available.

Expansion in world markets in 1933 appears to have somewhat exceeded increased output, with consequent reduction in stocks and general improvement in the trade. On the other hand, newly developed competitive conditions introduce uncertainties that partly offset these favorable factors.

In the United States production and sales of potash expanded notably, and American producers supplied 41.3 percent of domestic requirements compared with 32.3 percent in 1932. However, Spanish and Russian competition, possible reciprocal trade agreements affecting potash, probable increases in fertilizer prices due to higher costs under the Fertilizer Code, and reduction in acreage of cotton, tobacco, and other crops by agricultural relief measures introduce indeterminable factors which make the outlook for 1934 somewhat uncertain.

Under the National Recovery Administration the major potash producers are classed with the chemical industry and operate under the Code of Fair Competition for the Chemical Manufacturing Industry, approved February 10, 1934. It is understood that wages in the potash industry were already well above the minimum prescribed and that other provisions of the code will not greatly affect operations of the producing companies. On the other hand, the potash industry will be affected indirectly by the Fertilizer Code which, it is understood, will increase materially the cost of fertilizer manufacture. Higher prices for fertilizer, in the face of agricultural surpluses, might easily result in lower sales; the alternative might be lower prices for raw materials.

The output from New Mexico saline deposits and California brines increased. Cement-kiln dust and distillery waste supplied smaller quantities than in 1932, and no production was reported from the interesting but relatively unimportant source of cotton-boll ashes. As in 1932, small shipments of alunite were made for direct application to soil.

Domestic producers supplied 41.3 percent of the American market for potash in 1933 and, in addition, exported nearly 30,000 tons of crude potash materials. Sales of domestic potash were 47.5 percent of domestic requirements for the year. The relation between consumption and domestic sales from 1923 to 1933, inclusive, in terms of short tons of $K_2O$, is shown graphically in figure 100. Salient

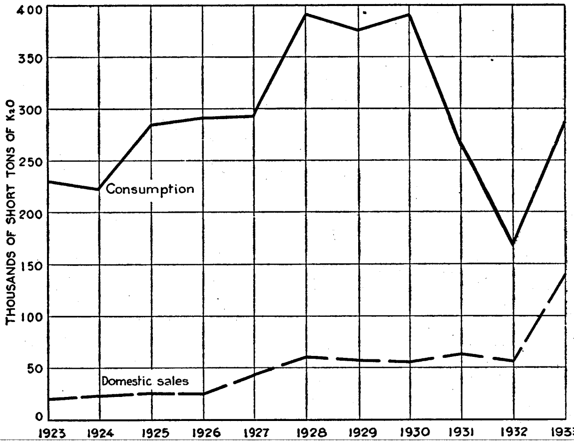


FIGURE 100.—Trends in domestic sales and consumption of potash ($K_2O$), 1923–33.

statistics of the industry for 1932 and 1933 are summarized in the following table:

*Salient statistics of the potash (crude potash materials) industry in the United States, 1932–33*

| | 1932 | 1933 | | 1932 | 1933 |
|---|---|---|---|---|---|
| Production...short tons.. | 143,120 | 333,110 | Exports: | | |
| Sales: | | | Fertilizer material: | | |
| Short tons | 121,390 | 325,481 | Short tons | 2,034 | 28,086 |
| Value | $2,102,590 | $5,296,793 | Value | $70,028 | $901,931 |
| Average per ton | $17.32 | $16.27 | Other: | | |
| Imports: | | | Short tons | 887 | 1,275 |
| Short tons | 330,964 | 479,429 | Value | $241,179 | $301,596 |
| Value | $8,841,838 | $11,816,458 | | | |

*Prices.*—Contrary to usual custom no new list prices for the 1933–34 season were announced by potash sellers. In lieu of new lists, provisional discounts of 10½ percent from 1932–33 base prices were announced in May, with a retroactive guarantee against any lower prices that might be quoted later. The only change was a reduction in the list price for 90 to 95 percent sulphate to $42.15 per ton. Pending stabilization of international exchanges and approval of a Potash Code the provisional discount was continued until October 15, when all sellers lowered the discount to 5 percent, limited to November 30. Subsequently, the 5-percent discount was continued through December, and domestic producers also offered 2½ percent off list price for January-February delivery on orders received prior to January 1.

Throughout 1933, as in 1932, sales were on the basis of net minimum $K_2O$ guarantee for the various grades, with no charge for overtest; thus, advantage lay with the dealer who could give most units, or, in other words, whose product exceeded the minimum guaranteed percentage of $K_2O$ by the widest margin.

Base prices of foreign potash materials prevailing from 1925 to 1932, as supplied by N. V. Potash Export My., Inc., are given in the following table:

*Quoted prices per short ton of different grades of potassium salts, c.i.f. Atlantic and Gulf ports, 1925–32* [1]

| | | 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 | [2] 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 | [2] 26.20 | ---------- |
| Manure salts, 30 percent $K_2O$ | in bags | 20.00 | 21.75 | 21.95 | [2] 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 | [2] 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 | [2] 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] The 1932 list price was continued through 1933 except for sulphate, 90 to 95 percent $K_2SO_4$, which was reduced to $42.15 per ton. Discounts were 10½ percent from May to Oct. 15 and 5 percent from Oct. 16 to Dec. 31.
[2] Price not quoted after May 1, 1931.

The 1932 schedule of base prices for domestic potash materials per short ton c.i.f. Atlantic and Gulf ports, continued for the 1933 season, was as follows:

| | | |
|---|---|---|
| Manure salts, 25 percent $K_2O$ minimum | in bulk | $15.00 |
| Manure salts, 30 percent $K_2O$ minimum | do | 19.15 |
| Potash muriate, 95 to 98 percent KCl (equivalent to 60 to 62 percent $K_2O$) | do | 40.50 |
| | in bags | 42.30 |

*Consumption and uses.*—Consumption of potash in the United States in 1933, measured by domestic sales less exports plus imports, was 775,549 short tons of crude salts, equivalent to 293,000 tons of $K_2O$, valued at $15,909,724, compared with 449,433 tons of material containing 167,665 tons of $K_2O$ and valued at $10,633,221 in 1932. This represents an increase of 72.6 percent in gross tonnage, 74.8

percent in $K_2O$, and 49.6 percent in value from 1932 and exceeds 1931 consumption of $K_2O$ by 12 percent. Of the quantity consumed, approximately 38 percent of the crude material containing 41 percent of the $K_2O$ and representing 26 percent of the total value was of domestic origin. About 93 percent of the total supply was used in the manufacture of fertilizers. Imports ($K_2O$) for use in the chemical industries increased about 31 percent from 1932.

## PRODUCTION AND SALES

Domestic production of potash salts reached a new high in 1933, being more than double the output ($K_2O$) in any previous year. The increase resulted from expanded operations in the New Mexico field and a substantial rise in output from California brines. Production from all other domestic sources declined materially. The total output of potash salts in 1933 was 333,110 short tons containing 143,378 tons of $K_2O$, an increase of 133 percent in gross tonnage and 131 percent in $K_2O$ compared with 1932. The average grade of the salts produced, in terms of equivalent $K_2O$, was 43 percent compared with 43.3 percent in 1932, 47.7 percent in 1931, and 57.9 percent in 1930. Large shipments of manure salts in 1932 and 1933 account for the lower average grade as compared with previous years. Output of crude and refined salts evidently continued at about the same ratio in 1933 as in 1932. During 1934 substantial shipments of crude salts from a newly opened mine in New Mexico, the second in the State to enter the market, may be expected to lower further the average $K_2O$ content of the domestic product, unless refinery output is materially increased.

Sales of domestic potash material increased 168 percent, from 121,390 short tons in 1932 to 325,481 tons in 1933. The average grade (42.7 percent $K_2O$) was somewhat lower than in 1932 (45.8 percent $K_2O$), but the total potash content ($K_2O$) increased 150 percent, from 55,620 in 1932 to 139,067 tons in 1933. The value increased 152 percent, from \$2,102,590 in 1932 to \$5,296,793 in 1933. The average value per ton was \$16.27 compared with \$17.32 in 1932. The value per unit (20 pounds) of $K_2O$ was 38.1 cents compared with 37.8 cents in 1932.

The total tonnage of potash materials as reported by producers is made up of both crude and refined salts containing varying quantities of $K_2O$; to avoid duplication, however, for refined material only the final weight is included rather than the larger tonnage of crude required in its production. Hence the domestic production of crude salts in 1933 is larger than shown in the following table although the figure truly represents the operators' output of both crude and refined salts without duplication. To reduce different grades of salts to a common denominator, the production and sales are also calculated in terms of $K_2O$ content, the resulting figures are reliable indicators of trends in the industry, and are generally used in the trade because potash commonly is sold on the $K_2O$ basis.

Production and sales by States and by sources cannot be given without disclosing individual output. 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:

*Potassium salts produced, sold, and in stock in the United States, 1929–33*

| 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) |
| 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 |
| 1933 | 4 | 333,110 | 143,378 | 4 | 325,481 | 139,067 | 5,296,793 | 4 | 46,943 | 20,891 |

## REVIEW BY STATES

Potash salts extracted from natural brines in California and potash minerals mined from bedded deposits in New Mexico accounted for 98 percent of the domestic production in 1933. In addition potash was recovered from cement-kiln dust and distillery waste, and small lots of alunite or other potash-bearing rocks were shipped for direct application to soil as a fertilizing agent.

The principal producers were the United States Potash Co., Inc., 342 Madison Avenue, New York, and Carlsbad, N.Mex.; American Potash & Chemical Corporation, 70 Pine Street, New York, and Trona, Calif.; United States Industrial Chemical Co., Inc., 60 East Forty-second Street, New York, and Baltimore, Md.; and North American Cement Corporation, 1004 Baltimore Trust Building, Baltimore, and Security, Md.

*California.*—Refined muriate of potash and borax were recovered in 1933 from the natural brines of Searles Lake, San Bernardino County, by the American Potash & Chemical Corporation. Capacity of its refinery at Trona was reported doubled during the year, and output of very high-grade muriate was materially increased. Construction was started on a plant to utilize residue from the borax and potash refineries in the manufacture of soda ash and salt cake.

*New Mexico.*—The United States Potash Co., Inc., completed its second full year of operation in 1933. Output from its mine and refinery near Carlsbad was nearly quadrupled, shipments of both crude and refined material continuing throughout the year. The crude sylvinite averaged about 26 percent $K_2O$, and the product of the refinery was muriate of exceptional purity. This company was the major factor in the remarkable growth of domestic production in 1933.

The Potash Co. of America was engaged during the year in sinking a three-compartment shaft to the potash beds at a depth of approximately 1,000 feet. The shaft was begun in February 1933 and completed early in 1934. The Santa Fe Railroad has constructed a 20-mile spur to the mine from La Huerta just north of Carlsbad. A milling plant has been erected, and the company plans to build a refinery at a later date. A sales office has been established in the Mercantile Trust Building, Baltimore, Md., and the company anticipates a substantial production of manure salts in 1934.

Continued interest in the possible development of other potash mines in the New Mexico area was evidenced by the appearance of several new companies in the field. In all, 11 companies have been organized to explore for potash in the Carlsbad field. Of these, the United States Potash Co., Inc., and the Potash Co. of America are now producing; the New Mexico Potash & Chemical Co. has drilled two tests and is completing a third on the Lommasson permit, a few miles south of the No. 1 shaft of the United States Potash Co., Inc.; the Carlsbad Potash Co. has drilled one well on the Crosby permit; a Denver group, operating as the Texas Potash Corporation (not to be confused with the Dallas company of the same name), has acquired about 20,000 acres north of the Potash Co. of America holdings and is understood to be planning to drill core tests.

New Mexico has levied a special tax on her newest industry. Confiscatory rates were proposed, but saner counsels prevailed and the bill finally enacted provides a 2-percent general business tax on all industry plus one-fourth of 1 percent on mineral mined and one-half of 1 percent on refined material. This is understood to mean 2¼ percent on crude salts sold and 2½ percent on refined material.

*Maryland.*—At Baltimore the United States Industrial Chemical Co. continued to manufacture potash material from distillery wastes; and at Security, near Hagerstown, the North American Cement Corporation continued the byproduct recovery of potash from cement-kiln fume. Output from both sources was somewhat less than in 1932.

*Utah.*—Following the finding of specimens of potassium nitrate in the vicinity of Maple Canyon near Moroni, Sanpete County, a group of Mount Pleasant and Moroni citizens obtained prospecting permits on about 14,000 acres of land.

Potassium nitrate has been found in caves or seams or as incrustations on protected rock surfaces in many localities in 23 States. Hundreds of occurrences have been studied and many of the most promising extensively explored. After an extended investigation of the quantity and mode of occurrence of nitrates in this country, the United States Geological Survey [1] announced that the hope of finding commercial bodies of natural nitrates in the United States is very remote.

*Kansas.*—Identification of the potash mineral polyhalite in a sample of cuttings from a well in Trego County, taken from a depth of about 2,000 feet, was announced by the United States Geological Survey. The polyhalite was only about 5 percent of the sample and hence had no commercial interest in itself. However, its occurrence suggests the possibility of discovering richer deposits of potash salts in this locality, which is part of the great Permian salt basin that extends south into Texas and New Mexico and from which potash is now being mined in the latter State.

*Texas.*—The Texas Potash Corporation of Dallas, successor to the Standard Potash Co., is reported to be planning further exploration of potash beds disclosed at a depth of about 2,000 feet by two core tests drilled by the latter company in 1925 in Midland County a few miles southeast of Odessa. Additional drilling probably will be done before a shaft is put down. It is understood that the main interest

[1] Mansfield, G. R., and Boardman, L., Nitrate Deposits of the United States: U.S. Geol. Survey Bull. 838, 1932, p. 100.

attaches to a bed of polyhalite 5 feet or more thick and that an economical process has been perfected for the manufacture of potassium sulphate and byproducts from this mineral. It is reported that the Connell ranch at Metz, Ector County, has been leased for potash, and exploration by drilling is planned. Government well No. 4, drilled on this land, penetrated several beds of polyhalite of minable thickness and possible commercial interest.

## GOVERNMENT ACTIVITIES

Forced by reduced funds to severe retrenchment in all directions, the three Government agencies most concerned with development of the infant potash industry could undertake no new projects. The Bureau of Mines and the Bureau of Chemistry and Soils continued their investigations of potash recovery processes, and the United States Geological Survey, in addition to administering potash prospecting permits and leases and supervising potash production from public lands, examined for potash the drill cuttings from a large number of wells drilling for oil.

It is understood that the blast-furnace work of the Bureau of Chemistry and Soils eventually will be transplanted to Muscle Shoals, where it will be incorporated in the Tennessee Valley Authority's complete fertilizer-manufacturing project.

## IMPORTS AND EXPORTS [2]

Imports of potash materials for consumption totaled 479,429 short tons containing 171,854 tons (35.8 percent) of potash in 1933 compared with 330,964 tons containing 113,505 tons (34.3 percent) of potash in 1932, an increase of 148,465 tons (44.9 percent) in gross weight and 58,349 tons (51.4 percent) in potash content. In 1933, 89 percent of the potash material imported was classified for use chiefly in the manufacture of fertilizers compared with 87 percent in 1932 and 92 percent in 1931.

Imports for agricultural use increased 47.8 percent in gross tonnage, 55 percent in total potash content, and 46.2 percent in value, whereas imports for use chiefly in the chemical industries increased 25.1 percent in gross tonnage, 31.3 percent in tons of $K_2O$, and 10.7 percent in value.

The quantity, average grade, and total value of potash salts imported for consumption in 1932 and 1933, classified by uses, are shown in the following table:

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

*Potash materials imported for consumption in the United States, 1932–33*

| Material | Approximate equivalent as potash ($K_2O$) (percent) | 1932 Short tons | 1932 Approximate equivalent as potash ($K_2O$) Short tons | 1932 Approximate equivalent as potash ($K_2O$) Percent of total | 1932 Value | 1933 Short tons | 1933 Approximate equivalent as potash ($K_2O$) Short tons | 1933 Approximate equivalent as potash ($K_2O$) Percent of total | 1933 Value |
|---|---|---|---|---|---|---|---|---|---|
| Used chiefly in fertilizers: | | | | | | | | | |
| Kainite | 14.0 | 55,299 | 7,440 | 6.6 | $457,318 | 48,307 | 6,760 | 3.9 | $359,605 |
| | 20.0 | (1) | (1) | (1) | (1) | 65,921 | 13,180 | 7.7 | 608,721 |
| Manure salts | [2] 24.0<br>[2] 30.0 | 113,038 | 27,130 | 23.9 | 1,254,720 | 126,696 | 38,010 | 22.1 | 1,329,423 |
| Muriate (chloride) | 52.0 | 87,761 | 45,640 | 40.2 | 2,794,979 | 118,203 | 61,470 | 35.8 | 3,791,789 |
| Potash-magnesia sulphate | 27.0 | (1) | (1) | (1) | (1) | 15,445 | 4,170 | 2.4 | 348,780 |
| Sulphate | 50.0 | 31,440 | 15,720 | 13.8 | 1,201,571 | 50,999 | 25,500 | 14.9 | 1,913,110 |
| Other potash fertilizer material [3] | 60.0 | 391 | 240 | .2 | 2,759 | | | | |
| | | 287,929 | 96,170 | 84.7 | 5,711,347 | 425,571 | 149,090 | 86.8 | 8,351,428 |
| Used chiefly in chemical industries: | | | | | | | | | |
| Bicarbonate | 46.0 | 151 | 69 | | 15,316 | 148 | 68 | | 20,137 |
| Bitartrate (argols) | 20.0 | 9,054 | 1,811 | | 996,003 | 6,747 | 1,349 | | 720,683 |
| Bitartrate (cream of tartar) | 25.0 | 15 | 4 | | 3,448 | 1 | (4) | | 165 |
| Bromide | 39.6 | 19 | 8 | | 9,039 | 6 | 2 | | 2,409 |
| Carbonate, crude | 61.0 | | | | | | | | |
| Carbonate, crude or black salts | 50.0 | 5,228 | 3,189 | | 428,576 | 6,738 | 4,110 | | 662,784 |
| Carbonate, refined | 67.0 | | | | | | | | |
| Caustic | 80.0 | 2,490 | 1,992 | | 258,416 | 3,367 | 2,694 | | 394,267 |
| Chlorate and perchlorate | 36.0 | 5,751 | 2,070 | | 418,978 | 6,838 | 2,462 | | 576,240 |
| Chromate and bichromate | 40.0 | (5) | (5) | | 172 | 1 | (5) | | 417 |
| Citrate | 43.0 | 2 | 1 | 15.3 | 1,198 | 4 | 2 | 13.2 | 2,164 |
| Cyanide | 70.0 | 27 | 19 | | 18,533 | 43 | 30 | | 31,352 |
| Ferricyanide (red prussiate) | 42.0 | 43 | 18 | | 22,545 | 58 | 24 | | 27,723 |
| Ferrocyanide (yellow prussiate) | 44.0 | 19 | 8 | | 4,190 | 9 | 4 | | 2,648 |
| Iodide | 28.0 | 3 | 1 | | 12,045 | 1 | (6) | | 3,451 |
| Nitrate (saltpeter), crude | 40.0 | 19,115 | 7,646 | | 830,647 | 28,664 | 11,466 | | 880,493 |
| Nitrate (saltpeter), refined | 46.0 | 963 | 443 | | 76,121 | 936 | 431 | | 73,987 |
| Permanganate | 29.0 | 89 | 26 | | 15,871 | 103 | 30 | | 20,242 |
| Rochelle salt | 22.0 | 11 | 2 | | 2,230 | 18 | 4 | | 2,678 |
| All other | 50.0 | 55 | 28 | | 17,163 | 176 | 88 | | 43,190 |
| | | 43,035 | 17,335 | 15.3 | 3,130,491 | 53,858 | 22,764 | 13.2 | 3,465,030 |
| Grand total | | 330,964 | 113,505 | 100.0 | 8,841,838 | 479,429 | 171,854 | 100.0 | 11,816,458 |

[1] Not separately recorded prior to 1933.
[2] Potash ($K_2O$) content estimated as 24 percent in 1932; recorded as 30 percent in 1933.
[3] Chiefly wood ashes from Canada.
[4] 413 pounds.
[5] Quantity of bichromate imported was as follows—1932: 786 pounds, approximate equivalent as $K_2O$ 314 pounds; 1933: 1,892 pounds, approximate equivalent as $K_2O$ 757 pounds.
[6] 617 pounds.

Although consumption of potash increased 75 percent from 1932, imports expanded only 51 percent and were less in both volume and value than in any post-war year since 1921, except 1932, or any pre-war year after 1908. The approximate $K_2O$ equivalent of the potash salts imported annually in the past 5 years is shown in the following table:

*Approximate equivalent as potash ($K_2O$) of potash-bearing materials imported for consumption in the United States, 1929–33, in short tons*

| | | | |
|---|---|---|---|
| 1929 | 324, 638 | 1932 | 113, 505 |
| 1930 | 342, 454 | 1933 | 171, 854 |
| 1931 | 214, 785 | | |

The original source of material entering the United States cannot be determined from import statistics, as imports are credited to the country from which the last shipment was made. Thus countries that produce little or no potash appear in the following table as exporters of substantial amounts to the United States. Shipments from Belgium and the Netherlands originate largely in France or Germany, although some Spanish material might be included, particularly among those from the Netherlands. Probably about 380,000 tons (80 percent) of the material imported came from Germany and France, divided about 70 to 30; Spain ranked third and Chile fourth in exports of potash salts to this country.

*Potash materials imported into the United States in 1933, 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) | Potash-magnesia sulphate (27) | Manure salts (30) | Kainite | | Bitartrate | |
|---|---|---|---|---|---|---|---|---|
| | | | | | (14) | (20) | Argols or wine lees (20) | Cream of tartar (25) |
| Africa: Algeria and Tunisia | | | | | | | 438 | |
| Argentina | | | | | | | 872 | |
| Belgium | 9, 947 | 3, 299 | | 3, 967 | 2, 835 | 2, 073 | | |
| Canada | 1, 971 | 65 | | 1, 364 | | | 7 | |
| Chile | | | | | | | 156 | |
| Czechoslovakia | 54 | 42 | | | | | | |
| France | 105 | 134 | | 3, 073 | 1, 396 | 1, 408 | 1, 805 | |
| Germany | 56, 167 | 34, 552 | 15, 085 | 68, 349 | 20, 927 | 26, 481 | | |
| Italy | | | | | | | 2, 273 | 6 |
| Japan | | 741 | | | | | | |
| Netherlands | 17, 646 | 11, 332 | 250 | 31, 887 | 12, 239 | 27, 567 | | |
| Palestine | 3, 040 | | | | | | | |
| Peru | | | | | | | 24 | |
| Portugal | | | | | | | 501 | |
| Spain | 28, 926 | 280 | | 18, 056 | 10, 910 | 8, 392 | 671 | |
| U.S.S.R. (Russia in Europe) | 123 | | | | | | | |
| United Kingdom | 224 | 554 | 110 | | | | | |
| | 118, 203 | 50, 999 | 15, 445 | 126, 696 | 48, 307 | 65, 921 | 6, 747 | 6 |
| Approximate equivalent as potash ($K_2O$) | 61, 470 | 25, 500 | 4, 170 | 38, 010 | 6, 760 | 13, 180 | 1, 349 | 2 |

*Potash materials imported into the United States in 1933, in short tons*—Continued

| Country | Caustic (80) | Carbonate (61) | Cyanide (70) | Nitrate (saltpeter), crude (40) | Chlorate and perchlorate (36) | All other (50) | Total | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Short tons | Value |
| Africa: Algeria and Tunisia | | | | | | | 438 | $50,888 |
| Argentina | | | | | | | 872 | 58,927 |
| Austria | | | | | | 18 | 18 | 6,800 |
| Belgium | 10 | | | 66 | | 32 | 22,229 | 526,039 |
| Canada | 8 | | | 21 | | (1) | 3,436 | 103,304 |
| Chile | | | | 16,113 | | | 16,269 | 331,636 |
| China | | 1 | | | | | 1 | 177 |
| Cuba | | | | | | (1) | (1) | 53 |
| Czechoslovakia | | 458 | | | | 62 | 616 | 54,664 |
| Finland | | | | | 23 | | 23 | 1,724 |
| France | | | 1 | 179 | 605 | 1 | 8,707 | 319,474 |
| Germany | 3,189 | 5,170 | 42 | 12,152 | 5,863 | 1,421 | 249,398 | 6,673,480 |
| Hong Kong | | 3 | | | | | 3 | 386 |
| India, British | | | | 33 | | | 33 | 1,277 |
| Italy | | | | | | | 2,279 | 250,897 |
| Japan | | | | | | 1 | 742 | 29,266 |
| Netherlands | | 1,076 | | | 11 | 11 | 102,019 | 1,810,873 |
| Palestine | | | | | | | 3,040 | 87,979 |
| Peru | | | | | | | 24 | 3,497 |
| Portugal | | | | | | | 501 | 51,920 |
| Spain | | | | | | | 67,235 | 1,330,304 |
| Sweden | 160 | 3 | | | 147 | | 310 | 66,842 |
| Switzerland | | | | | 236 | | 236 | 25,853 |
| U.S.S.R. (Russia in Europe) | | | | | | | 123 | 3,857 |
| United Kingdom | (1) | 33 | | 100 | | 11 | 1,032 | 45,746 |
| | 3,367 | 6,744 | 43 | 28,664 | 6,885 | 1,557 | 479,584 | 11,835,863 |
| Approximate equivalent as potash ($K_2O$) | 2,694 | 4,114 | 30 | 11,466 | 2,479 | 779 | 172,003 | |

[1] Less than 1 ton.

Exports of potash fertilizer material recovered most of the ground lost in 1932, when foreign shipments fell to the lowest point recorded since statistics have been available. The increase from 1932 was 26,052 short tons (1,281 percent) in quantity and $831,903 (1,188 percent) in value. The best customer was Japan, with Canada second. Total exports in 1932 and 1933 and the receiving countries are shown in the following table. Muriate was not classified separately for 1933.

*Potash fertilizer material exported from the United States, 1932–33, by destinations*

| Destination | 1932 | | | | | | 1933 | |
|---|---|---|---|---|---|---|---|---|
| | Chloride or muriate | | Other potash fertilizer | | Total | | | |
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| Brazil | | | | | | | 1 | $49 |
| Canada | 319 | $11,052 | 281 | $8,209 | 600 | $19,261 | 7,223 | 239,972 |
| Cuba | 92 | 2,936 | 161 | 7,236 | 253 | 10,172 | 467 | 16,534 |
| Guatemala | | | | | | | 3 | 215 |
| Honduras | 2 | 222 | 2 | 201 | 4 | 423 | 32 | 1,464 |
| Japan | 1,176 | 40,013 | | | 1,176 | 40,013 | 18,948 | 599,982 |
| Philippine Islands | | | | | | | 1,411 | 43,662 |
| Venezuela | | | 1 | 159 | 1 | 159 | | |
| West Indies ("Other British") | | | | | | | 1 | 53 |
| | 1,589 | 54,223 | 445 | 15,805 | 2,034 | 70,028 | 28,086 | 901,931 |

Exports of potassium salts other than fertilizer material increased 43.7 percent in quantity and 25.1 percent in value. They are shown in the following table:

*Potassium salts (not fertilizer) exported from the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 1,523 | $583,668 | 1932 | 887 | $241,179 |
| 1930 | 1,256 | 498,774 | 1933 | 1,275 | 301,596 |
| 1931 | 1,158 | 370,935 | | | |

## WORLD PRODUCTION

Official reports of world production of potash materials in 1933 are not yet complete; however, estimates believed to be fairly accurate place the total at about 1,480,000 metric tons. Final figures probably will be somewhat more than this amount. Germany is credited with 61 percent; France, 22 percent; United States, 9 percent; Spain, 4 percent; Poland, 2 percent; and all others, 2 percent. Growth of output from the United States and Spain may be expected to continue, and the U.S.S.R. (Russia) doubtless will become an important factor in 1934. Available official figures for world production of potash materials from 1929 to 1933 are given in the following table:

*World production of potash minerals and equivalent $K_2O$, 1929–33, in metric tons*

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

| Country and mineral [1] | 1929 | | 1930 | | 1931 | | 1932 | | 1933 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Output | Equivalent $K_2O$ | Output | Equivalent $K_2O$ | Output | Equivalent $K_2O$ | Output | Equivalent $K_2O$ | Output | Equivalent $K_2O$ |
| Australia: Western Australia, alunite | 39 | 3 | ------ | ------ | ------ | ------ | ------ | ------ | (2) | (2) |
| Chile, perchlorate of potash [3] | 1,259 | (2) | 2,409 | (2) | (2) | (2) | (2) | (2) | (2) | (2) |
| Chosen, alunite | 10,812 | (2) | 11,708 | (2) | 14,183 | (2) | 16,320 | (2) | (2) | (2) |
| Egypt, crude potassium salts | ------ | ------ | ------ | ------ | 1 | (2) | 8 | (2) | (2) | (2) |
| Ethiopia, potassium salts | [4] 2,650 | (2) | [4] 1,500 | (2) | (2) | (2) | (2) | (2) | (2) | (2) |
| France (Alsace), crude potassium salts | 3,124,816 | [5] 492,097 | 3,135,170 | [5] 506,370 | 2,196,740 | [5] 367,879 | 1,900,943 | [5] 321,229 | 1,896,401 | [5] 326,008 |
| Germany, crude potassium salts: | | | | | | | | | | |
| Carnallite [6] | 2,317,940 | 222,506 | 1,867,548 | 179,087 | 1,059,278 | 100,985 | 635,940 | 61,245 | (2) | (2) |
| Kainite, sylvinite, and hartsalz | 10,998,278 | 1,565,269 | 10,094,703 | 1,429,427 | 6,992,122 | 976,657 | 5,779,591 | 810,109 | (2) | (2) |
| India (British), nitrate of potash [7] | 5,000 | 2,300 | 4,700 | 2,200 | 6,600 | 3,100 | 9,100 | 4,400 | (2) | (2) |
| Italy: | | | | | | | | | | |
| Alunite | 105 | 11 | 825 | 83 | 990 | 102 | 700 | 71 | (2) | (2) |
| Leucite rock | 37,727 | (2) | 41,200 | (2) | 16,000 | (2) | 44,000 | (2) | (2) | (2) |
| Palestine, crude potassium salts [8] | ------ | ------ | 6,000 | 1,200 | 13,000 | 2,600 | 19,800 | 3,960 | (2) | (2) |
| Poland, crude potassium salts: | | | | | | | | | | |
| Kainite | 137,858 | 14,062 | 100,783 | 10,209 | 59,120 | 7,165 | 44,692 | 4,759 | (2) | (2) |
| Sylvinite | 220,770 | 49,673 | 204,826 | 45,021 | 202,199 | 45,576 | 231,966 | 52,285 | (2) | (2) |
| Spain: | | | | | | | | | | |
| Alunite | 1,599 | (2) | 3,864 | (2) | 23,985 | (2) | (2) | (2) | (2) | (2) |
| Crude potassium salts | 243,949 | 24,395 | 286,436 | 28,644 | 250,087 | 28,116 | 409,888 | 54,811 | (2) | 61,416 |
| Potassic earth | 850 | (2) | 900 | (2) | 1,100 | (2) | 750 | (2) | (2) | (2) |
| U.S.S.R. (Russia), potassium salts | [9] 6,980 | (2) | (2) | (2) | (2) | (2) | (2) | (2) | [10] 300,000 | (2) |
| United States, crude potassium salts | 97,812 | 55,873 | 95,989 | 55,583 | 121,490 | 57,951 | 129,836 | 56,236 | 302,191 | 130,070 |

[1] In addition to countries listed Persia is reported to produce a small quantity of nitrate of potash near Hamadan, but statistics of production are not available.
[2] Data not available.
[3] Produced at nitrate plants from caliche. It is reported that crude potash salts are mined in Chile at the deposits near Iquique and in the Salar de Atacama, but no figures of production are available.
[4] Muriate of potash produced in Eritrea from crude salts mined in Ethiopia.
[5] Figures relate to merchantable products.
[6] Includes some natural kieserite.
[7] Estimated production (Imperial Institute, London).
[8] Extracted from waters of the Dead Sea.
[9] Made from sunflower ash. Output for year ended Sept. 30, 1929.
[10] Produce at Solikamsk potash mines.

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## FOREIGN DEVELOPMENTS

*Germany.*—After extensive investigation of the potash industry the Reich Government first reorganized and later abolished the Potash Council of 30 members representing the various national interests concerned with the industry. The reorganization, early in the year, consisted chiefly of a realinement of membership to give larger representation to agriculture at the expense of workers in the potash industry, the total number of members remaining the same. The recently enacted law abolishing the Potash Council places the industry completely under Government control in the person of the Minister of National Economy, whose decrees regulating conduct of the industry replace decisions formerly rendered by representative bodies under the old scheme for socialization of German industries. Other provisions of the law continue existing quotas of producing groups for 20 years and prohibit development of fresh production and opening of new mines until 1953. A more detailed discussion of the law by Consul Sydney B. Redecker is presented in Special Circular 380, Chemical Division, Bureau of Foreign and Domestic Commerce.

Sales of German potash increased 11 percent (from 846,000 metric tons in 1932 to 937,000 tons in 1933). Improvement in the domestic market accounted for 80,000 tons of the increase; exports expanded only 5 percent, to 220,000 tons. The low level of exports, notwithstanding general improvement of world markets, is chargeable to growing competition from Spanish and American mines in two of Germany's best markets, the Netherlands and the United States. Efforts to reach an agreement with the independent Spanish producers, heretofore unsuccessful, doubtless will continue, in line with the syndicate policy of avoiding costly trade wars whenever possible. The early months of 1934 witnessed substantial gains in both domestic and export trade.

*France.*—Sales of French potash are reported to have expanded substantially in 1933, although production was maintained at virtually the 1932 level. Sources hitherto reliable estimate the sales increase as around 45 percent. If this is correct, well over 100,000 metric tons of $K_2O$ were sold from stock, materially improving the position of the industry. According to consular reports, about 2 percent of the increase is credited to the domestic market, the remainder representing gains in export trade. Shipments from Strasbourg to Antwerp via the Rhine, constituting the greater part of exports from Alsace, increased about one third; no other export figures are available. The educational campaign to improve domestic sales continued, with the fertilizer exhibition train organized several years ago visiting small towns and villages in the agricultural districts.

*Spain.*—Potash was discovered in the Suria district in 1912 and production was first recorded in 1925, but Spain did not attain a position of importance in the potash trade until 1932 when the second producing mine reached full-scale operation and a third mine began shipments of crude potash material. The year 1933 witnessed further expansion and large gains in export trade, particularly in the important Dutch and American markets.

Domestic consumption is small, and producers must seek foreign outlets for the greater part of their product. Competitive bidding for foreign trade is said to have reduced prices to unprofitable levels, and increases are anticipated when existing contracts expire. Exports of potash salts increased from 16,000 metric tons in 1928 to 66,000 tons in 1932 and 200,000 tons in 1933. The declared value dropped from 153.79 gold pesetas per ton in 1932 to 100.15 in 1933.

Of the three operating companies, Minas de Potasa de Suria, S.A., controlled by Belgian Solvay interests, is the oldest; until 1933 it was the largest producer of potash salts. Production is reported as around 200,000 tons a year, averaging about 10 percent $K_2O$. This company markets its product through Potasas Reunidas S.A. of Madrid, which is controlled by N.V. Potash Export My. of Amsterdam, sales agents for the Franco-German Cartel.

Union Espanola de Explosivos operates its potash mine near Cardona through a wholly owned subsidiary, Sociedad Industria, Comercio, y Mineria. The output of this mine in 1932 was 190,271 metric tons containing 31,395 tons (16.5 percent) of potash ($K_2O$). It is reported to have produced 220,000 tons of crude and refined salts in 1933. The refinery is said to manufacture both muriate and sulphate.

Potasas Ibericas, S.A., organized in 1929 by French interests to develop a deposit near Sallent, was the third company to produce and ship Spanish potash. Its No. 1 shaft was completed in July 1932, and shipments that year totaled 18,177 tons averaging 18 percent $K_2O$. Figures for 1933 are not available, but the company was reported to be operating at the rate of about 100,000 tons annually. A second shaft was completed in December 1933, and the refinery now under construction is expected to begin operation by July 1934. This company is understood to be exporting virtually its entire output and is the largest seller of Spanish potash in American and Dutch markets.

*Poland.*—Since Polish producers joined the European cartel in March 1932, receiving a quota of 4 percent of the syndicate's foreign sales, they have withdrawn from the American market, and no imports of potash from Poland were received in 1933. Official figures of Polish production in 1933 are not yet available, but estimates from German sources place it at approximately 30,000 tons of $K_2O$. This estimate, if correct, would represent a reduction of nearly 50 percent from the 57,044 metric tons reported for 1932.

*U.S.S.R (Russia).*—An output of 300,000 metric tons of potash salts from the mines at Solikamsk was reported for 1933. Classification and grade of the material are not given. Information regarding Russian mines is meager and conflicting; however, it appears that the Solikamsk mines are now fully equipped for production and for manufacture of refined salts. As high as 3,000 tons of crude salts per day have been produced, and it is expected that the output will be 4,500 tons a day, or about 1,500,000 tons a year. The refinery is said to be designed to handle 3,500 tons of salts a day and to turn out 600 to 650 tons of 85-percent KCl. These figures indicate an expected recovery of about 100 kilos of $K_2O$ from each ton of crude material. A second mine near Berezniki about 30 kilometers from Solikamsk is being opened and equipped for production on the same scale as the first. Thus, announced plans call for an output of around 3,000,000 tons per year of crude salts containing over 300,000 tons of $K_2O$. One hundred and twenty-three short tons of Russian muriate were imported in the United States in 1933.

*Palestine.*—The validity of the concession granted Palestine Potash, Ltd., for the extraction of salts from the Dead Sea is being contested by a group of capitalists, reported to be mainly French. At the request of the British High Court, evidence in the case was taken before the Turkish Commercial Court at Istanbul. In 1932 Palestine Potash, Ltd., produced 19,800 metric tons of potash salts containing 3,960 tons (20 percent) of $K_2O$. Production figures for 1933 are not yet available, but 3,040 short tons of muriate were imported into the United States compared with 500 tons in 1932. The company reported that its entire output of potash and bromine was disposed of without difficulty. Products of the company are transported by motor lorry about 25 miles to Jerusalem and thence by rail to the Palestine ports of Jaffa and Haifa or to Port Said.

*Sweden.*—Announcement was made in the Chemiker-Zeitung that a plant has been established at Kalix for the production of potash from feldspar.

# MAGNESIUM AND ITS COMPOUNDS

By E. P. Partridge and A. E. Davis

SUMMARY OUTLINE



Magnesium and its compounds serve industry in five principal ways—as refractory oxide materials in the form of dead-burned magnesite and dead-burned dolomite, used chiefly in the manufacture of open-hearth steel but also in other high-temperature industrial operations; as heat-insulating materials in the form of basic magnesium carbonate, derived chiefly from dolomite and used in "85-percent magnesia" brick, sheet, and pipe covering; as magnesite cement, compounded from caustic calcined magnesite and magnesium chloride solutions and used in flooring and stucco; as magnesium salts, chiefly the chloride and sulphate, derived from natural brines and used in a number of industries; and as metallic magnesium, derived in turn from the magnesium chloride recovered from natural brines and used as a light-weight material in a variety of structural shapes and machine parts.

The sources indicated above are those most significant at present. Actually the various products might be derived from any of the raw materials indicated, as well as from the mineral brucite (magnesium hydroxide). Thus, basic magnesium carbonate is at present manufactured from sea water in California, and metallic magnesium was for a time produced from magnesite in this country.

This report discusses the domestic production and imports of crude magnesite and the calcined products derived therefrom; of dolomite for specified uses in which it is competitive with magnesite; of metallic magnesium; and of magnesium salts.

## MAGNESITE

The magnesite industry of the United States is located in California and Washington, whereas the open-hearth steel plants, which are the chief market for dead-burned magnesite, are highly concentrated in the eastern industrial regions centered on Pittsburgh and Chicago. Dolomite available comparatively close to these regions has tended to supplant magnesite as a source of refractory material, as discussed in previous annual chapters in Mineral Resources of the United States.

Although the primary market for caustic calcined magnesite in the production of magnesite cement floors and wall finishes is not concentrated in any one locality, it is limited by the intense competition of other commodities on the basis of both cost and properties.

*Salient statistics for the magnesite industry in the United States, 1929–33*

| | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Crude: | | | | | |
| Mined: | | | | | |
| Short tons | 187, 660 | 129, 320 | 73, 602 | 38, 462 | 108, 187 |
| Value [1] | $1, 500, 000 | $1, 033, 130 | $499, 239 | $283, 304 | $840, 000 |
| Sold by producers: | | | | | |
| Short tons | | 1, 120 | 1, 325 | 575 | 1, 576 |
| Value | | $14, 410 | $14, 849 | $5, 474 | $20, 769 |
| Average per ton [2] | | $12. 87 | $11. 21 | $9. 52 | $13. 18 |
| Imports for consumption: | | | | | |
| Short tons | 300 | 842 | 499 | 9 | 11 |
| Value | $3, 179 | $8, 687 | $5, 415 | $372 | $200 |
| Apparent new supply short tons | 300 | 1, 962 | 1, 824 | 584 | 1, 587 |
| Percent domestic | | 57. 1 | 72. 6 | 98. 5 | 99. 3 |
| Caustic calcined: | | | | | |
| Sold by producers: | | | | | |
| Short tons | 11, 390 | 8, 580 | 5, 900 | 3, 374 | 8, 141 |
| Value | $405, 020 | $260, 010 | $180, 997 | $103, 196 | $249, 115 |
| Average per ton [2] | $35. 56 | $30. 30 | $30. 68 | $30. 59 | $30. 60 |
| Imports for consumption: | | | | | |
| Short tons | 6, 500 | 3, 911 | 2, 891 | 1, 777 | 1, 850 |
| Value | $145, 844 | $66, 523 | $62, 938 | $29, 351 | $33, 081 |
| Apparent new supply short tons | 17, 890 | 12, 491 | 8, 791 | 5, 151 | 9, 991 |
| Percent domestic | 63. 7 | 68. 7 | 67. 1 | 65. 5 | 81. 5 |
| Dead-burned: | | | | | |
| Sold by producers: | | | | | |
| Short tons | 78, 700 | 49, 460 | 28, 231 | 14, 836 | 43, 613 |
| Value | $1, 542, 840 | $903, 450 | $545, 253 | $308, 327 | $774, 875 |
| Average per ton [2] | $19. 60 | $18. 27 | $19. 31 | $20. 78 | $17. 77 |
| Imports for consumption: | | | | | |
| Short tons | 50, 379 | 41, 417 | 10, 349 | 7, 613 | 23, 509 |
| Value | $731, 246 | $624, 713 | $180, 436 | $109, 340 | $341, 780 |
| Apparent new supply short tons | 129, 079 | 90, 877 | 38, 580 | 22, 449 | 67, 122 |
| Percent domestic | 61. 0 | 54. 4 | 73. 2 | 66. 0 | 65. 0 |

[1] Partly estimated by the Bureau of Mines; most of the crude is processed by the mining companies, and very little enters the open market.
[2] Average receipts f.o.b. mine shipping point.

## DOMESTIC PRODUCTION

Reacting to the general improvement in industrial activity during 1933, the production of crude magnesite and the sales of both caustic and dead-burned magnesite increased markedly from the low levels reached in 1932. During 1933 the output from 3 mines operated by 2 companies in Washington and California totaled 108,187 short tons, an increase of 181 percent over the quantity of crude magnesite mined during 1932.

Of the magnesite mined in the United States during 1933, only 1,576 short tons, or slightly less than 1.5 percent, were sold in the crude form. This material was valued at $20,769. Sales of domestic calcined magnesite materials were as follows: Dead-burned, 43,613 short tons valued at $774,875, an increase of 194 percent in quantity and 151 percent in value; and caustic calcined, 8,141 short tons valued at $249,115, an increase of 141 percent in both quantity and value. In addition to a large increase in sales of magnesite for refractory purposes, there were also increases reported in sales for plastic, insulating, and medicinal uses.

*California.*—The Sierra Magnesite Co., Ltd., was the only concern that mined and sold magnesite in California during 1933. Operations

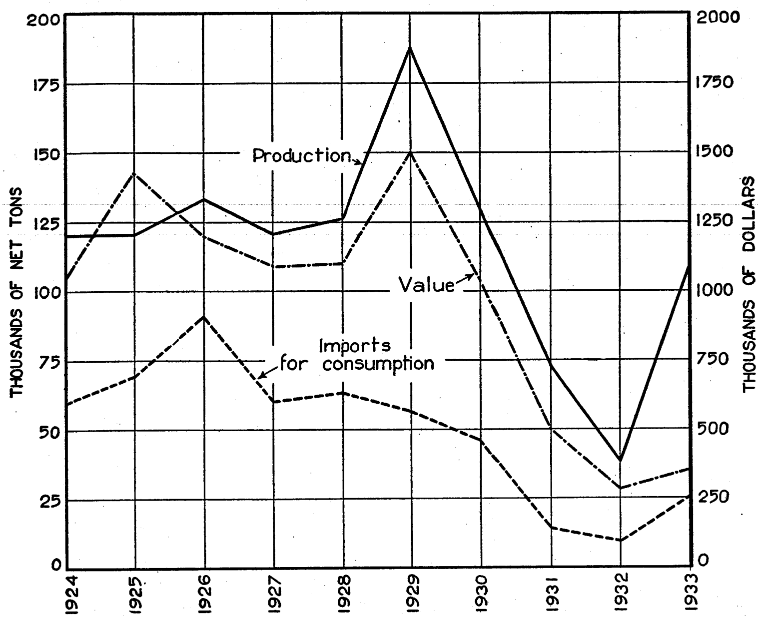


FIGURE 101.—Trends in production, value, and imports for consumption of magnesite, 1924-33. "Production" and "value" refer to domestic crude magnesite; "imports for consumption" to calcined magnesite, 1 ton of which is equivalent to approximately 2.1 tons of crude magnesite.

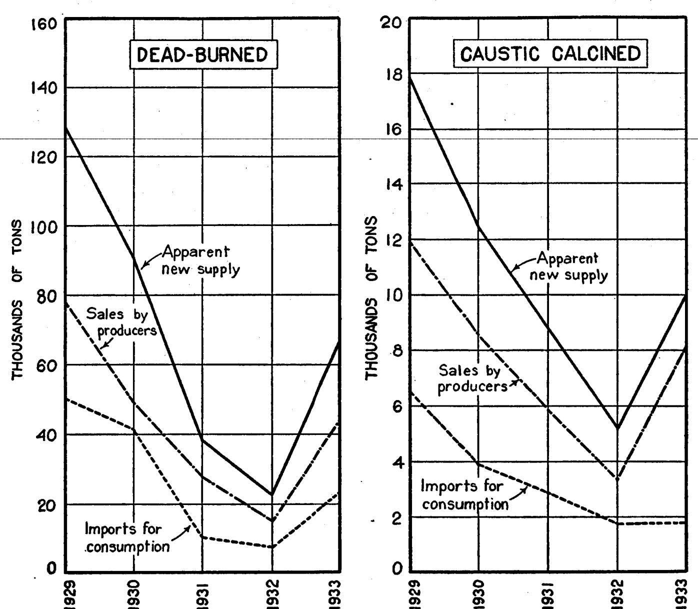


FIGURE 102.—Trends in sales by producers and imports for consumption of dead-burned and of caustic calcined magnesite, 1929-33.

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.

*Nevada.*—The United States Brucite Corporation reported no production during 1933 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 1933.

*Prices.*—The following prices were quoted in trade journals and by producers during 1933:

*Quoted prices of magnesite products per short ton, 1933, in dollars*

| | F.o.b. California mines | | | | | F.o.b. Chewelah, Wash.: Dead-burned magnesite [1] |
|---|---|---|---|---|---|---|
| | Dead-burned magnesite | | | Caustic calcined magnesite [1] | | |
| | Standard grade | 94 percent grade (artificial periclase) [1] | 88 percent grade | Ground, 95 percent grade | 90 percent grade | |
| Jan. 5 to Aug. 24 | | | [1] $35.00 | | | |
| Jan. 5 to Sept. 28 | $25.00 | $65.00 | | $38.00 | $35.00 | $22.00 |
| Aug. 24 to Dec. 28 | | | [2] 33.00 | | | |
| Sept. 28 to Dec. 28 | 25.00 | 65.00 | | 40.00 | 37.50 | 22.00 |

[1] Quotations from the Engineering and Mining Journal, Metal and Mineral Markets.
[2] Represents 90-percent grade (artificial periclase).

## IMPORTS

The table of salient statistics for the magnesite industry at the beginning of this chapter gives the "imports for consumption" of crude, caustic calcined, and dead-burned magnesite in 1933. These quantities must not be confused with those shown as "general imports" in the following tables. Thus, while the total imports for consumption for 1933 exceeded those for 1932 by 170 percent, the corresponding increase in general imports was only 96.5 percent. Of the total of 17,527 tons of magnesite listed under general imports for 1933, 89.4 percent was dead-burned or grain material for refractory use, and the rest was mostly caustic calcined magnesite, almost evenly divided between the lump and ground forms. The quantity of crude magnesite imported was insignificant.

*Magnesite imported into the United States, 1929–33, by countries, in short tons*

[General imports]

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Austria | 31,908 | 26,304 | 10,214 | 4,540 | 10,412 |
| Belgium | 22 | 32 | 54 | | |
| Canada | | 83 | 289 | 47 | 3,063 |
| Czechoslovakia | 12,520 | 19,080 | 5,635 | 2,393 | |
| Germany | 59 | 264 | 95 | 55 | 3 |
| Greece | 310 | 976 | 779 | 77 | 17 |
| India, British | 4,259 | 2,563 | 1,305 | 1,127 | 921 |
| Italy | 1,634 | 5 | 14 | | |
| Netherlands | 2,055 | 1,102 | 713 | 427 | 449 |
| Norway | | | | | 5 |
| Turkey in Asia and Europe | | | | | 11 |
| U.S.S.R. (Russia in Europe) | 276 | 714 | 4,714 | | 2,007 |
| United Kingdom | 139 | 72 | 93 | 25 | 257 |
| Yugoslavia and Albania | | | | 229 | 382 |
| | 53,182 | 51,195 | 23,905 | 8,920 | 17,527 |

*Magnesite imported into the United States in 1933, 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 | | | | | | | 10,412 | $144,359 |
| Canada | | | | | | | 3,063 | 43,603 |
| Germany | | | | | 3 | $318 | | |
| Greece | | | | | 17 | 383 | | |
| India, British | | | 921 | $10,894 | | | | |
| Netherlands | 11 | $200 | | | 438 | 10,051 | | |
| Norway | | | | | | | 5 | 298 |
| Turkey in Asia and Europe | | | 11 | 174 | | | | |
| U.S.S.R. (Russia in Europe) | | | | | | | 2,007 | 32,908 |
| United Kingdom | | | 1 | 74 | 78 | 2,956 | 178 | 12,893 |
| Yugoslavia and Albania | | | | | 382 | 8,231 | | |
| | 11 | 200 | 933 | 11,142 | 918 | 21,939 | 15,665 | 234,061 |

Although shipments of dead-burned magnesite from Austria accounted for 59.4 percent of the total general imports, the reappearance of Canadian material in the United States in appreciable quantity was the most significant new development in the import situation. The 3,063 short tons of dead-burned magnesite received from Canada, comprising 17.5 percent of the total general imports for 1933, greatly exceeded the quantity from this source for any year since 1920. The U.S.S.R. (Russia) was the third important source of dead-burned magnesite, supplying 11.5 percent of the total general imports. A noticeable increase in imports from the U.S.S.R. may be anticipated following the establishment of diplomatic relations.

Nearly all of the 933 short tons of lump caustic calcined magnesite listed under general imports for 1933 came from British India, while the Netherlands, Yugoslavia, and Albania supplied nearly 90 percent of the 918 short tons of ground caustic calcined magnesite that entered the United States in that year.

## WORLD PRODUCTION

Between 97 and 98 percent of the total world production of crude magnesite was mined in nine countries during the years 1928–32, inclusive. The relative significance of the various sources is indicated in the accompanying table. The most important feature is the great increase in production in the U.S.S.R. during a period when production in the established industries elsewhere consistently declined. Yugoslavia is the only country other than the U.S.S.R. showing marked increase in production during the period covered.

*World production of magnesite, 1928–32, by countries, in metric tons* [1]

| Country | 1928 | 1929 | 1930 | 1931 | 1932 |
|---|---|---|---|---|---|
| Australia: | | | | | |
| New South Wales | 10,840 | 9,097 | 8,794 | 3,480 | 5,199 |
| Queensland | | | | | 132 |
| South Australia | 46 | 137 | 37 | | 117 |
| Victoria | 73 | 27 | 64 | 51 | 29 |
| Austria | 310,000 | 438,000 | 304,396 | 179,440 | 134,409 |
| Canada | 33,311 | 39,216 | 25,073 | 24,345 | (2) |
| China | (2) | 32,189 | 29,482 | 30,000 | (2) |
| Czechoslovakia [3] | 87,396 | 101,118 | 71,388 | 38,918 | 33,965 |
| France | 600 | | | (2) | (2) |
| Greece | 104,421 | 84,023 | 68,509 | 49,990 | 44,699 |
| India, British | 24,798 | 23,874 | 16,788 | 5,419 | 14,087 |
| Italy | 11,690 | 17,172 | 4,122 | 3,470 | 460 |
| Norway | 932 | 1,809 | 2,206 | 1,580 | 1,311 |
| Southern Rhodesia | | | | | 14 |
| Turkey | | 196 | 357 | 2,197 | 310 |
| Union of South Africa | 1,481 | 1,709 | 1,910 | 1,357 | 1,418 |
| U.S.S.R. (Russia) [4] | [5] 119,985 | 132,710 | 152,000 | 246,000 | (2) |
| United States | 115,393 | 170,241 | 117,317 | 66,770 | 34,892 |
| Yugoslavia [6] | 6,267 | 6,615 | 32,036 | 32,209 | 33,317 |

[1] Unless otherwise stated, quantities in this table represent crude magnesite mined.
[2] Data not available.
[3] 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.
[4] Year ended Sept. 30.
[5] Exclusive of 8,799 tons of magnesite sand.
[6] Serbia only.

*Austria.*—Export shipments of both dead-burned magnesite and caustic calcined magnesite were higher in 1933 than 1932. The quantity of dead-burned magnesite exported increased from 14,930 to 37,535 metric tons during the year, due chiefly to large shipments to the United States, with Germany, France, Italy, and United Kingdom the other chief markets. The quantity of caustic calcined magnesite exported during 1933 increased only from 15,615 to 19,108 metric tons, with Germany the principal market, followed by France and Czechoslovakia.

*Czechoslovakia.*—The geology, mineralogy, chemical composition, and state of development of the magnesite deposits have recently been reviewed.[1]

*Greece.*—Practically all the magnesite mined is exported, only about 50 tons being consumed annually within the country.

*U.S.S.R. (Russia).*—The erection of several new plants for magnesite products is included in the second 5-year plan.

[1] Ulrich, F., Giobertite Deposits in Czechoslovakia and the Present State of Their Mining: Chimie et industrie, vol. 29, special no., June 1933, pp. 298–304.

## DOLOMITE

Dolomite, which contains both magnesium carbonate and calcium carbonate, is distributed widely throughout the United States. For comparison, the sales of dolomite and of its products for uses in which it might be considered competitive with magnesite have been segregated so far as possible from sales for uses it shares with limestone or other stone.

*Dolomite and dolomitic lime sold or used by producers in the United States for specified purposes, 1929–33*

| | 1929 | 1930 | 1931 | 1932 | 1933 [1] |
|---|---|---|---|---|---|
| Dolomite for— | | | | | |
| Basic magnesium carbonate: | | | | | |
| Short tons | 84,750 | 111,740 | 80,820 | 62,930 | 83,640 |
| Value | $129,383 | $189,219 | $122,525 | $82,822 | $99,630 |
| Carbon dioxide | (2) | (2) | (2) | (2) | (2) |
| Dead-burned dolomite or refractory stone: | | | | | |
| Short tons | 516,400 | 453,350 | 268,500 | 72,240 | 196,540 |
| Value | $461,444 | $356,025 | $183,020 | $45,186 | $180,160 |
| Dolomitic lime for— | | | | | |
| Refractory (dead-burned dolomite): | | | | | |
| Short tons | 488,032 | 351,740 | 243,769 | 135,733 | 261,812 |
| Value | $4,261,942 | $3,045,082 | $1,866,971 | $1,055,339 | $2,064,870 |
| Sulphite pulp: | | | | | |
| Short tons | 51,000 | 38,400 | 32,000 | 24,000 | 25,127 |
| Value | $398,000 | $295,000 | $233,000 | $148,000 | $144,098 |
| Total (calculated as raw stone), short tons | 1,654,000 | 1,360,000 | 922,000 | 472,000 | 884,000 |

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

The quantity of dead-burned dolomite used for refractory materials has always greatly exceeded the quantity of dead-burned magnesite. During 1933 there were sold or used 264,118 short tons of dead-burned dolomite with an average value of $7.93 per ton, compared with 43,613 short tons of dead-burned magnesite with an average value of $17.77 per ton.

Basic magnesium carbonate for use as a heat-insulating material is produced exclusively from dolomite.

## MAGNESIUM

*Uses.*—Magnesium, both as the technically pure material and in the form of various alloys, has become increasingly useful wherever light weight must be combined with strength. Parts fabricated from magnesium or its alloys have proved advantageous in reducing the dead weight of busses, trucks, trailers, airplanes, and portable equipment of all types, including pneumatic and electric hand tools, molds, and patterns, and in reducing the inertia forces in reciprocating, oscillating, and rotating parts of textile equipment, bookbinding machinery, computing machines, bread-slicing machines, and power sewing machines.

Magnesium alloys are now available in sheets up to 4 by 20 feet in size, extruded sections, and structural shapes, including 6-inch I-beams, sand and permanent-mold castings, and forgings. Die castings up to 18 inches in length have also been produced.

The 7-foot spherical gondola used in the successful Settle-Fordney stratosphere flight was constructed from a magnesium alloy, the shell being fabricated from plates one-eighth inch thick joined by welding.

*Domestic production.*—The entire domestic consumption of primary magnesium, aside from negligibly small imports, has been supplied since 1927 by the Dow Chemical Co., which produces it by electrolysis of fused magnesium chloride derived from its salt wells near Midland, Mich. This industry exhibited signs of healthy growth during 1933, the new magnesium ingot sold or used totaling 1,434,893 pounds, an

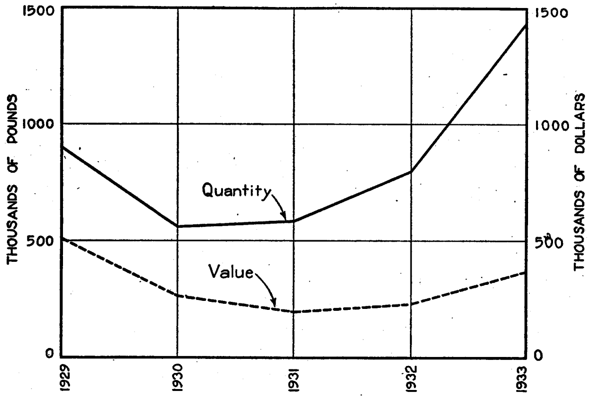


FIGURE 103.—Quantity and value of new magnesium ingot sold or used by producers in the United States 1929–33.

increase of 81 percent over 1932, and the average price for domestic consumption dropping from 29 to 26 cents per pound.

*New magnesium ingot and stick sold or used by producers in the United States. 1929–33*

| Year | Pounds | Value | |
|---|---|---|---|
| | | Total | Average price per pound, domestic consumption |
| 1929 | 908,351 | $512,313 | $0.56 |
| 1930 | 559,631 | 268,864 | 48 |
| 1931 | 580,463 | 199,633 | .34 |
| 1932 | 791,699 | 228,653 | .29 |
| 1933 | 1,434,893 | 377,181 | .26 |

*Magnesium products other than ingot magnesium manufactured and sold or used by producers in the United States, 1929–33, in pounds*

| Product | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| Alloy ingot | 13,145 | 12,297 | 65,314 | 128,751 | 165,729 |
| Castings | 116,350 | 99,443 | 127,398 | 132,049 | 165,599 |
| Powder and shavings | 36,663 | 30,832 | 23,924 | 19,825 | 32,064 |
| Wire and ribbon | 7,736 | 7,898 | 2,906 | 4,650 | 8,464 |
| Sheet | 8,512 | 1,348 | 9,433 | 17,796 | 57,750 |
| Other [1] | 13,915 | 13,673 | 27,139 | 39,277 | 102,357 |
| Total | 183,176 | 153,194 | 190,800 | 213,597 | 366,234 |

[1] Includes principally forgings and shapes together with minor quantities of rods, tubing, etc.

Sales of fabricated magnesium products also showed a decided upturn in 1933. The percent increases from 1932 to 1933 in weight of products manufactured and sold or used were as follows: Castings, 25 percent; sheet, 225 percent; and forgings and extruded shapes, with which are included small quantities of rod and tubing, 161 percent.

The increase in the sale of castings during 1933 was due not only to a renewal of activity in the manufacture of airplane engines but also to the development of new uses in the general fields of portable equipment and reciprocating and rotating machine parts. Although most magnesium castings are now made in sand molds the use of permanent molds for parts used in large quantities increased during 1933 until it reached a more commercial basis than heretofore.

The large increases in the sales of sheet and structural shapes of magnesium alloy during 1933 was due largely to the more extensive use of these forms in the construction of trailers and truck bodies.

*Imports and exports.*—Imports of magnesium have been negligible in recent years, as indicated by the following figures for 1932 and 1933. Until 1933 virtually no magnesium was exported from the United States, but during that year the decrease in price, coupled with the trend in foreign exchange, led to the shipment of an appreciable amount into foreign markets.

*Magnesium imported for consumption in the United States, 1932–33, by classes*

| Class | 1932 | | 1933 | |
|---|---|---|---|---|
| | Pounds | Value | Pounds | Value |
| Metallic and scrap | | | | |
| Alloys (magnesium content) | 101 | $84 | | |
| Powder (magnesium content) | 772 | 821 | 560 | $702 |
| Sheets, tubing, ribbons, wire, and other n.s.p.f. (magnesium content) | 62 | 144 | 15 | 32 |
| | 935 | 1,049 | 575 | 734 |

## MAGNESIUM SALTS

*Domestic production.*—The production of natural magnesium salts (sulphate, chloride, and carbonate) in the United States in 1933 was 77,609,072 pounds, valued at $1,097,042, compared with 59,466,257 pounds, valued at $896,085, in 1932. The Bureau of Mines is not at liberty to publish production figures on magnesium salts separately as there were less than three producers each of magnesium chloride and magnesium carbonate and too large a percentage of the total production of magnesium sulphate was reported by one company to publish those figures without disclosing individual production.

Magnesium sulphate was produced in the United States in 1933 from natural brines by the Dow Chemical Co. at Midland, Mich., and the Texaco Salt Products Co. at West Tulsa, Okla. (address, Houston, Tex.), and from natural deposits of epsomite near Oroville, Okanogan County, Wash., by the Magnesia Products Co. (address, Portland, Oreg.). Commercial magnesium chloride made from natural brines and bittern waters was produced by the California Chemical Corporation (address, 220 Bush St., San Francisco, Calif.) and by the Dow Chemical Co. Magnesium carbonate was produced from sea water by a patented process by the Marine Chemicals Co., Ltd., South San Francisco, Calif.

*Imports.*—Virtually all the magnesium chloride and magnesium sulphate imported into the United States originates in the German potash industry, where these salts are recovered as byproducts. As the following table shows, the quantity of magnesium chloride imported has decreased continuously since 1929, but the imports of magnesium sulphate, after a marked decrease from 1929 to 1930, have subsequently increased.

Much of the magnesium carbonate imported comes from Great Britain.

*Magnesium compounds imported for consumption in the United States, 1929–33*

| 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 |
| 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 |
| 1933 | [1] 408,137 | 2,997 | 10,006,980 | 60,517 | 404,137 | 69,479 | 624,602 | 26,655 | 11,977 | 572 |

[1] No anhydrous reported

# MICA

By F. W. Horton and B. H. Stoddard

SUMMARY OUTLINE



Definite improvement in both price and demand for all classes of mica in the United States in 1933 was reflected in an increased activity in domestic mining of mica during the latter part of the year and in a large increase of imports. The advance in prices was initiated by the depreciation of the dollar in terms of the currencies of those countries exporting mica to the United States and was sustained by a coincidental increase in the domestic demand. On the whole, conditions within the industry were distinctly better than in 1932, and there was a substantial increase in the value of sales by producers of all classes of mica. The quantities of both wet- and dry-ground mica sold established new high records. During the last half of the year the consumption of sheet mica increased sharply, and stocks of large, clear mica, radio-condenser and radio-tube-support mica, and electrical mica for use in heating elements for flatirons, toasters, percolators, and similar equipment were largely depleted. Consumption of splittings also increased, and stocks were lowered in spite of large imports.

Mica production in the United States is limited almost entirely to muscovite; no amber (phlogopite) mica is mined and only a little biotite, which is ground. Over 90 percent of the domestic production of sheet mica in 1933 came from New Hampshire and North Carolina, and the remainder from Connecticut, Maine, South Carolina, and New Mexico, in order of the total quantity sold. The United States produces enough punch and scrap mica to satisfy virtually all its requirements, but normally only 15 to 35 percent of the domestic consumption of sheet mica larger than punch and less than 5 percent of the consumption of splittings are of domestic origin. India furnishes most of this material. Domestic requirements of amber mica come from Canada and Madagascar.

The following table summarizes the principal statistics of the mica industry in the United States from 1930 to 1933, inclusive:

*Salient statistics of the mica industry in the United States, 1930–33*

| | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|
| Domestic mica sold or used by producers: | | | | |
| Uncut sheet: | | | | |
| Punch and circle: | | | | |
| Pounds | 1, 253, 782 | 757, 647 | 258, 512 | 253, 243 |
| Value | $61, 230 | $33, 317 | $7, 976 | $10, 199 |
| Average per pound | $0. 05 | $0. 04 | $0. 03 | $0. 04 |
| Larger than punch and circle: | | | | |
| Pounds | 211, 703 | 205, 306 | 80, 485 | 111, 297 |
| Value | $116, 077 | $78, 513 | $37, 906 | $42, 980 |
| Average per pound | $0. 55 | $0. 38 | $0. 47 | $0. 39 |
| Total uncut sheet: | | | | |
| Pounds | 1, 465, 485 | 962, 953 | 338, 997 | 364, 540 |
| Value | $177, 307 | $111, 830 | $45, 882 | $53, 179 |
| Average per pound | $0. 12 | $0. 12 | $0. 14 | $0. 15 |
| Scrap: | | | | |
| Short tons | 6, 732 | 6, 621 | 7, 040 | 8, 751 |
| Value | $109, 100 | $99, 415 | $83, 777 | $98, 159 |
| Average per ton | $16. 21 | $15. 02 | $11. 90 | $11. 22 |
| Total sheet and scrap: | | | | |
| Short tons | 7, 465 | 7, 102 | 7, 209 | 8, 933 |
| Value | $286, 407 | $211, 245 | $129, 659 | $151, 338 |
| Ground: | | | | |
| Dry-ground:[1] | | | | |
| Pounds | 11, 912, 232 | 10, 724, 952 | 10, 505, 884 | 12, 877, 593 |
| Value | $190, 635 | $168, 783 | $126, 714 | $135, 178 |
| Average per pound | $0. 016 | $0. 016 | $0. 012 | $0. 010 |
| Wet-ground: | | | | |
| Pounds | 3, 149, 545 | 4, 888, 100 | 4, 903, 962 | 6, 783, 412 |
| Value | $161, 623 | $267, 653 | $184, 126 | $263, 503 |
| Average per pound | $0. 051 | $0. 055 | $0. 038 | $0. 039 |
| Total ground: | | | | |
| Pounds | 15, 061, 777 | 15, 613, 052 | 15, 409, 846 | 19, 661, 005 |
| Value | $352, 258 | $436, 436 | $310, 840 | $398, 681 |
| Consumption of splittings:[2] | | | | |
| Pounds | 3, 035, 880 | 2, 046, 090 | 902, 985 | 1, 428, 329 |
| Value | $1, 265, 137 | $764, 672 | $268, 830 | $343, 161 |
| Imports for consumption: | | | | |
| Unmanufactured:[3] | | | | |
| Pounds | 4, 549, 461 | 4, 549, 122 | 2, 970, 742 | 3, 853, 906 |
| Value | $405, 760 | $132, 865 | $78, 496 | $178, 953 |
| Manufactured: | | | | |
| Cut: | | | | |
| Pounds | 72, 402 | 16, 707 | 23, 097 | 39, 787 |
| Value | $100, 498 | $19, 774 | $16, 824 | $25, 609 |
| Splittings:[4] | | | | |
| Pounds | 2, 326, 780 | 1, 527, 656 | 944, 628 | 1, 343, 329 |
| Value | $767, 414 | $463, 928 | $184, 920 | $255, 401 |
| Built-up: | | | | |
| Pounds | 6, 001 | 1, 787 | 12, 956 | 15, 244 |
| Value | $8, 499 | $3, 483 | $6, 871 | $10, 795 |
| Ground: | | | | |
| Pounds | 688 | 1, 200 | 111, 771 | 537, 776 |
| Value | $57 | $36 | $383 | $1, 388 |
| All other manufactured mica:[5] | | | | |
| Pounds | 2, 813 | 1, 947 | 1, 287 | 3, 441 |
| Value | $1, 388 | $698 | $173 | $1, 611 |
| Total manufactured: | | | | |
| Pounds | 2, 408, 684 | 1, 549, 297 | 1, 093, 739 | 1, 939, 577 |
| Value | $877, 856 | $487, 919 | $209, 171 | $294, 804 |
| Total imports: | | | | |
| Pounds | 6, 958, 145 | 6, 098, 419 | 4, 064, 481 | 5, 793, 483 |
| Value | $1, 283, 616 | $620, 784 | $287, 667 | $473, 757 |
| Exports (all classes of mica): | | | | |
| Pounds | 4, 732, 864 | 5, 239, 007 | 3, 098, 737 | 3, 125, 873 |
| Value | $262, 826 | $258, 135 | $132, 755 | $117, 863 |

[1] Includes fine unground mica recovered in washing kaolin but not mica recovered by milling mica schist.
[2] Figures for South America and the United States not included.
[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 1933 was 8,933 short tons valued at $151,338 compared with 7,209 short tons valued at $129,659 in 1932. This total consisted of 364,540 pounds of uncut sheet valued at $53,179 and 8,751 short tons of scrap valued at $98,159. Of this amount North Carolina produced 162,672 pounds of sheet valued at $21,107 and 6,918 tons of scrap valued at $74,711 and New Hampshire 167,464 pounds of sheet valued at $22,008 and 532 tons of scrap valued at $9,563. As compared with 1932, total sales of domestic mica in 1933 increased 23.9 percent in quantity and 16.7 percent in value.

*Uncut sheet mica.*—Total sales of uncut sheet mica increased 7.5 percent in quantity and 15.9 percent in value compared with 1932. Punch and circle mica sold by producers totaled 253,243 pounds valued at $10,199—a decrease of 2 percent in weight but, owing to a rise in average price, an advance of 27.9 percent in value over sales in the previous year. Sales of larger sizes of sheet aggregated 111,297 pounds valued at $42,980—a gain of 38.3 percent in quantity and 13.4 percent in value over those in 1932.

*Scrap mica.*—The quantity of scrap mica sold by producers in 1933 increased 24.3 percent in weight and 17.2 percent in value compared with 1932. The figures for scrap mica include a considerable tonnage of fine mica obtained as a byproduct in washing kaolin in North Carolina but do not include mica recovered in grinding mica schist.

The following tables show the quantity and value of the various classes of domestic mica sold or used by producers in the United States and in the two principal producing States—New Hampshire and North Carolina—from 1929 to 1933, inclusive.

*Domestic mica sold or used by producers in the United States, 1929–33*

| Year | Sheet mica | | | | | | Scrap mica | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Uncut punch mica | | Uncut mica larger than punch | | Total uncut sheet mica | | | | | |
| | Pounds | Value | Pounds | Value | Pounds | Value | Short tons | Value | Short tons | Value |
| 1929 | 1,752,044 | $98,989 | 283,084 | $187,332 | 2,035,128 | $286,321 | 6,253 | $117,901 | 7,271 | $404,222 |
| 1930 | 1,253,782 | 61,230 | 211,703 | 116,077 | 1,465,485 | 177,307 | 6,732 | 109,100 | 7,465 | 286,407 |
| 1931 | 757,647 | 33,317 | 205,306 | 78,513 | 962,953 | 111,830 | 6,621 | 99,415 | 7,102 | 211,245 |
| 1932 | 258,512 | 7,976 | 80,485 | 37,906 | 338,997 | 45,882 | 7,040 | 83,777 | 7,209 | 129,659 |
| 1933 | 253,243 | 10,199 | 111,297 | 42,980 | 364,540 | 53,179 | 8,751 | 98,159 | 8,933 | 151,338 |

*Mica sold or used by producers in chief producing States, 1929–33*

| State and year | Sheet mica | | | | | | Scrap mica | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Uncut punch mica | | Uncut mica larger than punch | | Total uncut sheet mica | | | | | |
| | Pounds | Value | Pounds | Value | Pounds | Value | Short tons | Value | Short tons | Value |
| New Hampshire: | | | | | | | | | | |
| 1929 | 913,552 | $48,885 | 71,226 | $33,772 | 984,778 | $82,657 | 1,657 | $35,977 | 2,149 | $118,634 |
| 1930 | 616,204 | 29,275 | 56,860 | 24,029 | 673,064 | 53,304 | 449 | 8,743 | 786 | 62,047 |
| 1931 | 349,168 | 17,342 | 91,996 | 19,026 | 441,164 | 36,368 | 295 | 5,465 | 516 | 41,833 |
| 1932 | 121,487 | 3,607 | 24,527 | 14,371 | 146,014 | 17,978 | 344 | 5,585 | 417 | 23,563 |
| 1933 | 117,333 | 3,940 | 50,131 | 18,068 | 167,464 | 22,008 | 532 | 9,563 | 616 | 31,571 |
| North Carolina: | | | | | | | | | | |
| 1929 | 737,473 | 40,081 | 156,727 | 110,212 | 894,200 | 150,293 | 3,245 | 53,855 | 3,692 | 204,148 |
| 1930 | 610,216 | 30,567 | 138,858 | 81,884 | 749,074 | 112,451 | 4,744 | 75,400 | 5,119 | 187,851 |
| 1931 | 310,366 | 12,894 | 79,060 | 38,763 | 389,426 | 51,657 | 5,312 | 79,601 | 5,507 | 131,258 |
| 1932 | 85,803 | 2,906 | 41,893 | 15,416 | 127,696 | 18,322 | 4,837 | 56,842 | 4,901 | 75,164 |
| 1933 | 117,826 | 5,322 | 44,846 | 15,785 | 162,672 | 21,107 | 6,918 | 74,711 | 6,999 | 95,818 |

*Ground mica.*—The quantity of ground mica sold by domestic producers in 1933 was 19,661,005 pounds valued at $398,681 and established a new high record as to quantity but not as to value. Sales increased 27.6 percent in weight and 28.3 percent in value over those in 1932 and consisted of 12,877,593 pounds of dry-ground mica valued at $135,178 and 6,783,412 pounds of wet-ground valued at $263,503. The figures for dry-ground mica include sales of byproduct mica recovered in washing kaolin by the Harris Clay Co. and the General Mica Co. in Mitchell County, N.C., but do not include fine mica obtained from grinding muscovite schists. The augmented sale of the ground product, which, in spite of the business depression, has increased since 1929 to a record quantity in 1933, indicates better appreciation of the usefulness of ground mica and constitutes a bright spot in the outlook for domestic mica mining. There were 13 grinders of scrap mica in 1933. Eight of them used dry-grinding processes and 5 wet-grinding.

The following tables show the weight and value of ground mica sold by producers in the United States, according to the method of grinding, from 1929 to 1933 and the distribution of the 1933 sales to various industries.

*Ground mica sold by producers in the United States, 1929–33, by methods of grinding*

| Year | Dry ground | | Wet ground | | Total | |
|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value |
| 1929 | 3,637,192 | $62,029 | 5,395,005 | $328,332 | 9,032,197 | $390,361 |
| 1930 [1] | 11,912,232 | 190,635 | 3,149,545 | 161,623 | 15,061,777 | 352,258 |
| 1931 [1] | 10,724,952 | 168,783 | 4,888,100 | 267,653 | 15,613,052 | 436,436 |
| 1932 [1] | 10,505,884 | 126,714 | 4,903,962 | 184,126 | 15,409,846 | 310,840 |
| 933 [1] | 12,877,593 | 135,178 | 6,783,412 | 263,503 | 19,661,005 | 398,681 |

[1] Includes sales of mica suitable for roofing material without grinding.

*Ground mica sold to various industries in the United States in 1933*

| Industry | Quantity | | Value |
|---|---|---|---|
| | Pounds | Percent of total | |
| Roofing [1] | 11,510,915 | 58 | $112,109 |
| Wall paper | 4,679,950 | 24 | 194,014 |
| Rubber | 1,925,835 | 10 | 63,068 |
| Miscellaneous [2] | 1,544,305 | 8 | 29,490 |
| | 19,661,005 | 100 | 398,681 |

[1] Includes sales of mica suitable for roofing material without grinding.
[2] Figures cover mica used for molded electric insulation, paint manufacture, surfacing on asphalt shingles, Christmas-trees snow, manufacture of axle greases and oil, annealing, concrete and foundry facing, pipe-line enamel, plastic specialties, and other purposes.

## CONSUMPTION OF SPLITTINGS AND BUILT-UP MICA

The use of mica in the electrical industries was given great impetus by the invention in 1894 of built-up mica made of thin mica films, called splittings, cemented by shellac. Inasmuch as built-up mica can be made in sheets (plate mica) of almost any desired size and milled to uniform thickness, it is more easily fabricated than sheet mica. Further, it is much cheaper and can be made into tubes of circular, triangular, or complex cross-section having multiple compartments and with proper binders may be hot- or cold-molded into almost any desired shape. Hence the manufacture of built-up mica soon became the major branch of the mica industry in the United States, and splittings acquired preponderant importance in the trade. Because of cheap labor and abundant supplies of suitable mica from which splittings can be made, India immediately captured the world market for splittings and today produces virtually all the muscovite splittings used in the United States and abroad. Various methods of splitting mica by machine have been attempted, but none has been notably successful in splitting muscovite, although a small production of amber splittings was made from Canadian phlogopite for several years in the United States by machine methods. However, the bulk of amber splittings used are produced by hand in Madagascar and Canada. The Western Electric Co., Kearney, N.J., and the New England Mica Co., Waltham, Mass., produced splittings in 1933, but their output was almost negligible compared with domestic requirements.

Domestic consumption of splittings in 1933 was about 1,428,329 pounds valued at $343,161 compared with 902,985 pounds valued at $268,830 in 1932, an increase of 58.2 percent in quantity and 27.7 percent in value. Most of the splittings used in the United States are India grades 5, 5½, and 6.

The accompanying tables show the weight, value, and source of the mica splittings consumed in the United States from 1929 to 1933, inclusive, and of the stocks on hand December 31, 1932 and 1933. Stocks at the end of 1933 decreased 10.4 percent in quantity and 17.4 percent in value compared with those at the close of 1932.

*Mica splittings consumed in the United States, 1929–33, by sources*

| Year | India | | Canada | | Madagascar | | South America | | United States | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value |
| 1929 | 2,969,224 | $2,012,974 | 506,712 | $237,832 | 285,403 | $197,438 | (1) | (1) | 20,948 | $1,645 |
| 1930 | 2,450,642 | 1,064,160 | 422,221 | 125,330 | 163,017 | 75,647 | | | | |
| 1931 | 1,713,954 | 648,169 | 163,091 | 52,258 | 162,545 | 63,443 | | | 6,500 | 802 |
| 1932 | [2] 671,647 | [2] 193,854 | 73,810 | 13,655 | 157,528 | 61,321 | | | (2) | (2) |
| 1933 | 1,088,796 | 233,075 | 84,494 | 34,412 | 255,039 | 85,674 | (1) | (1) | (1) | (1) |

[1] Bureau of Mines not at liberty to publish figures.
[2] Small quantity of domestic splittings included under India.

*Stocks of mica splittings on hand Dec. 31, 1932 and 1933*

| Source | 1932 | | 1933 | |
|---|---|---|---|---|
| | Pounds | Value | Pounds | Value |
| Canada | 188,029 | $54,436 | 185,192 | $64,617 |
| India | 1,360,196 | 391,506 | 1,178,644 | 312,589 |
| Madagascar | 268,909 | 114,290 | 264,716 | 85,586 |
| Total | 1,817,134 | 560,232 | 1,628,552 | 462,792 |

Figure 104 shows the quantity and value of mica splittings and sheet mica larger than punch consumed in the United States from 1923 to 1933, inclusive. The graph shows clearly the preponderant importance of splittings in the domestic market, the adverse effects of the business depression in 1930 to 1932, inclusive, and the improvement in the industry in 1933. The marketed production of domestic sheet mica larger than punch also is compared in both quantity and value with the total consumption of these sizes. The graph shows clearly that domestic consumers depend upon foreign sources for at least three-quarters of their consumption of sheet mica larger than punch and that the quantity and value of imported splittings have during the period covered always greatly exceeded those of domestic and imported sheet combined and have been 3 to 25 times those of domestic sheet.

## PRICES

*Domestic sheet mica.*—Demand for all classes of sheet mica was small during the first half of 1933, and the price of domestic sheet was forced to exceptionally low levels through the competition of foreign mica, which in spite of low prices could still be imported at a profit because of the high valuation of the dollar in terms of foreign currencies. In March domestic punch mica sold at $0.02 per pound, and the average prices paid by one of the largest buyers for Nos. 1 and 2 Mixed were as follows: 1½ by 2 inches, $0.11; 2 by 2 inches, $0.25; 2 by 3 inches, $0.45; 3 by 3 inches, $0.65; 3 by 4 inches, $0.75; 3 by 5 inches, $1; and 4 by 6 inches, $1.33 per pound. In the three smaller sizes mentioned, black spotted and heavy clay stained mica sold for $0.08, $0.15, and $0.25 per pound, respectively. However, during the latter half of the year prices were stimulated by an increased demand and by the depreciation of the dollar, which caused a rise in the dollar price of competitive foreign micas. By December prices had risen to approximately their average in 1932, and Nos. 1 and 2 Mixed sold for the following prices per pound: 1½ by 2 inches, $0.20; 2 by 2 inches, $0.32; 2 by 3 inches, $0.49; 3 by 3 inches, $0.77; 3 by 4 inches, $0.98; 3 by 5 inches, $1.28; and 4 by 6 inches, $1.75. The average price of punch and circle mica in 1933 was $0.04 per

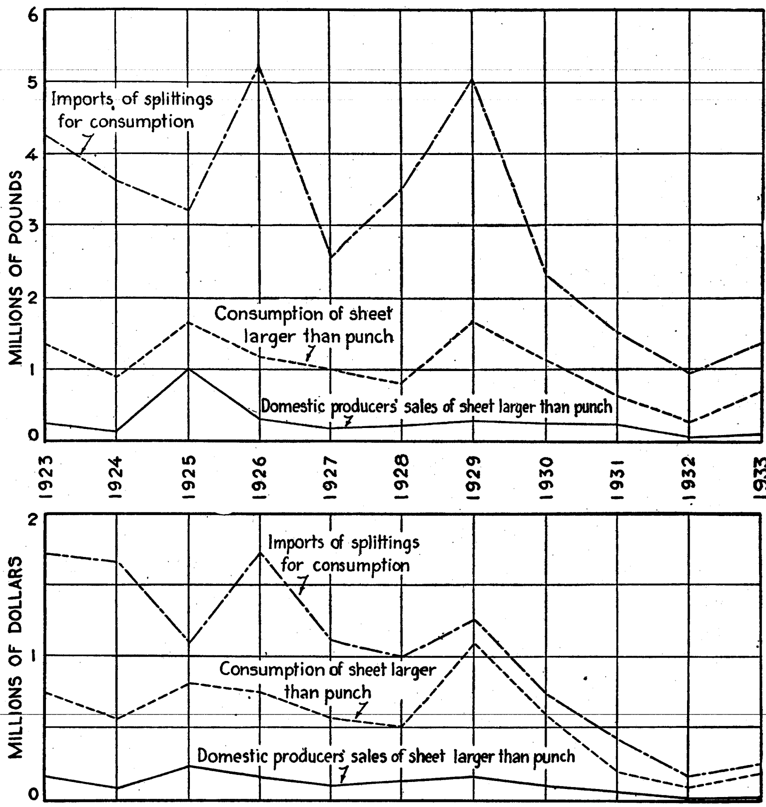


FIGURE 104.—Comparision of the consumption of mica splittings and the consumption and production of sheet mica larger than punch in the United States, 1923–33.

pound compared with $0.03 in 1932, but the average of all larger sheet mica dropped to $0.39 per pound compared with $0.47 in the previous year. The average price of all domestic uncut sheet sold during 1933 was $0.15 per pound, compared with $0.14 in 1932. The accompanying table shows the range of prices for domestic, rough-trimmed, uncut sheet mica, as reported by producers in 1933.

*Range of prices per pound paid for domestic, rough-trimmed, uncut sheet mica in 1933*

| Size | Clear | Stained | Size | Clear | Stained |
|---|---|---|---|---|---|
| Punch | $0.02–$0.05 | $0.02–$0.03½ | 3 by 4 inches | $0.60–$1.40 | $0.40–$0.90 |
| 1½ by 2 inches | .10– .25 | .07– .15 | 3 by 5 inches | .70– 1.80 | .50– 1.15 |
| 2 by 2 inches | .20– .40 | .10– .25 | 4 by 6 inches | .80– 2.25 | .60– 1.25 |
| 2 by 3 inches | .30– .75 | .20– .40 | 6 by 8 inches | 1.50– 3.25 | .80– 1.50 |
| 3 by 3 inches | .40– 1.00 | .30– .60 | 8 by 10 inches | (1) | (1) |

1 None reported for 1933

*Foreign sheet mica.*—Prices of foreign mica in terms of foreign currencies remained nearly stationary during 1933, but depreciation of the dollar caused a considerable rise in dollar prices; for Indian mica it amounted to almost 50 percent. The following table shows the average prices of various grades of domestic and Indian mica in New York in 1933.

*Approximate average quoted prices, per pound, of uncut sheet mica in New York in 1933*

| 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 | $0.16 | $0.09 | 6 | $0.57 | $0.49 | $0.34 | | |
| 2 by 2 | .28 | .16 | 5 | 1.77 | 1.39 | 1.39 | $0.49 | $0.34 |
| 2 by 3 | .45 | .27 | 4 | 2.44 | 1.69 | 1.54 | 1.09 | .64 |
| 3 by 3 | .67 | .48 | 3 | 2.89 | 2.29 | 1.99 | 1.62 | .99 |
| 3 by 4 | .86 | .67 | 2 | 3.49 | 2.74 | 2.59 | 2.14 | 1.47 |
| 3 by 5 | 1.10 | .84 | 1 | 4.24 | 3.64 | 3.12 | 2.89 | 1.99 |
| 4 by 6 | 1.48 | 1.00 | A-1 | 6.79 | 5.44 | 5.29 | 4.09 | 2.14 |
| 6 by 8 | 1.70 | 1.30 | (1) | 8.29 | 6.79 | 6.04 | 5.29 | 2.22 |

[1] Special.

Owing to the restriction of mining operations in Madagascar and to the appreciation of the franc and Canadian dollar in terms of the United States dollar the price of amber sheet increased considerably, and Canadian phlogopite was mined more extensively than in 1932. On September 1, 1933, the leading Canadian producer of amber mica quoted the following prices per pound, f.o.b. Ottawa, for a good grade of thumb-trimmed phlogopite: 1 by 3 inches, $0.25; 2 by 3 inches, $0.40; 2 by 4 inches, $0.50; 3 by 5 inches, $0.75; 4 by 6 inches, $1.25; and 5 by 8 inches, $2.

*Mica splittings.*—The prices of all grades of both muscovite and phlogopite splittings increased from 25 to 45 percent during 1933, reflecting the advance in foreign exchange. Average prices per pound of Indian splittings, duty paid, in New York were as follows: No. 4, book-packed, $1.20; loose, $0.75. No. 5, book-packed, $0.83; loose, $0.45. No. 5½, book-packed, $0.75; loose, $0.35. No. 6, book-packed, $0.60; first-quality loose, $0.25; second-quality loose, $0.175; third-quality loose, $0.13. As usual, the largest sales were of the cheaper grades. The demand for amber splittings was better than in 1932. The average prices per pound in New York were as follows: No. 4 amber, $0.65; No. 5, $0.45; No. 6, $0.40. The average prices per pound of splittings consumed in the United States in 1933 were as follows: India splittings, $0.214; Canadian splittings, $0.289; and Madagascan splittings, $0.336.

*Scrap mica.*—The average price of scrap mica in 1933 was $11.22 per short ton, or $0.68 per ton less than in 1932. There has been a steady recession in the price of scrap since 1929, when it averaged $18.86 per ton. This decrease has been due largely to inroads made in the market for dry-ground mica by considerable tonnages of washed mica recovered as a byproduct in mining kaolin in western North Carolina and by mica derived from the grinding of mica schist. To a lesser degree, imports of scrap have curtailed the market for the domestic product.

*Ground mica.*—The average price of dry-ground mica decreased slightly to $0.01 per pound compared with $0.012 in 1932. The average price of the wet-ground product, however, advanced to $0.039 per pound as compared with $0.038 in the previous year. The demand for both grades was excellent, and the quantities of each sold exceeded those in any of the previous 10 years.

## MINING METHODS

Mica mining in all countries is characterized by many small operations worked with a minimum of mechanical equipment and financing, because the extreme irregularity of the pegmatites and of the occurrences of mica in them tend to discourage large, systematic operations. Domestic mica mines may be divided into three groups—(1) small mines, which are generally operated irregularly and with little or no mechanical equipment; (2) medium-size mines which have been successful in a small way and have been equipped with some machinery; and (3) large, well-equipped mines, which are operated according to systematic mining methods.

The mines of the first group are operated in a most elementary manner. The mine workings are irregular and follow the occurrence of the mica in the pegmatite along rich streaks and from one pocket to another. As little waste rock as possible is taken out because it is difficult to remove through the small tunnels and openings. This method of mining is called "groundhogging" or "gophering." Considerable good sheet mica may be recovered from these small mines, but broadly considered they are uneconomic, as only a small percentage of the mica in the deposit is recovered and the workings are usually left in an unfavorable condition for reopening. These small operations may be justified, however, in that they serve to prospect deposits, a few of which may finally be developed into good mines. Most small mines are usually operated as open pits and usually are abandoned as soon as water level is reached. Where the deposits are opened by a tunnel natural drainage is of great assistance.

Where small operations disclose good quantities of mica, mechanical equipment may be purchased and mining systematized. Air compressors, jackhammers, and pumps may be installed. An incline may be driven in the pegmatite to serve as a haulageway over which cars of mica and waste may be brought to the surface. Any systematic stoping is generally impossible because of the irregularity of the deposits. The mica is recovered by driving simple breast stopes at those places where it occurs most plentifully. The habit of occurrence of mica in pegmatites is commonly pronounced; for example, in many places the mica is confined to a zone within 6 or 8 feet of the hanging wall, or rich pockets may be found only in connection with large masses of quartz. These habits of occurrence may be a valuable aid in mining. Stulls are placed in the stopes to prevent slabbing from the walls, and timbering is used whereever necessary to hold the roof. Some flat-lying pegmatites have been worked by room-and-pillar methods.

Well-organized operations are carried on in the few mines of the third class. The ordinary practice is to sink a vertical shaft to cut the hanging wall at depth or to sink an inclined shaft along the footwall. Drifts are run from this shaft into the pegmatite, and the mica-bearing rock is removed by breast or overhead stoping. A good example of such a well-planned mine is the Alexandria, of the General Electric Co., at Alexandria, N.H. This mine is lighted by electricity, and considerable blocked-out ground has been developed from time to time.

In mica mining care must be taken not to drill through or place powder charges in rich pockets of mica crystals, which should be removed as far as possible by mining around them. An experienced drillman will readily detect mica under the drill because of its peculiar resilience. Generally 40-percent dynamite is used. After a round of shots has been fired and the fumes have cleared the mica is hand-picked from the muck and bagged before it is hoisted to the surface. Where feldspar is recovered as a byproduct all of the muck may be hoisted to the surface, where the feldspar and any good mica that has been overlooked underground is sorted out.

A great deal of mica is recovered as a byproduct of feldspar mining. Most feldspar mines are worked as opencut quarries, although there are also some large underground operations.

On the whole, mica mining, particularly if conducted by inexperienced operators, is extremely hazardous financially, and on account of the irregularity of the deposits and of the occurrences of mica within them it is rare that a large-scale operation is justified.

## PREPARATION OF MICA FOR MARKET

The preparation of mica for market is necessarily a hand operation, as judgment is required to split, trim, and properly grade it. Except for the possible development of mechanical methods for producing splittings, the preparation of mica will probably be conducted by hand methods for an extended period, and labor will therefore continue to be a most important element in its cost.

All the many forms in which manufactured mica is used are derived from two main classes of raw material—sheet and scrap—and the preliminary preparation of mica for market consists primarily of separating it into these two classes. Mica houses, or trimming sheds, where the mica is stored and prepared for market, are provided at most of the larger mines. Generally, however, the small producers and many feldspar miners who recover mica as a byproduct sell their output as it comes from the mine, or roughly graded, to firms who prepare it for the trade.

*Cobbing and rough sorting.*—The rough crystals of mica, as they are taken from the mine, are of various shapes and sizes and are commonly referred to as "mine-run", "book", or "block" mica. This last term is unfortunate, as it is also applied to imported sheet mica. Mine-run mica is dirty and ordinarily has considerable rock adhering to it. The rough books are first cobbed—that is, all adhering rock is broken off with small hammers—and all loose dirt is removed. If mine-run mica is exceptionally dirty it is sometimes passed over coarse screens. As the rough mica is cobbed it is examined carefully, and all books that are obviously so defective that they will yield no sheet mica are thrown into the scrap pile. In this way much badly ruled, fishbone, distorted, and otherwise defective mica is sorted out and requires no further handling except as scrap.

*Rifting.*—Cobbed mica that has not been rejected as scrap is split into sheets about one-sixteenth of an inch thick. This operation is performed by both men and women known as "rifters." A knife having a stout, double-edged, 3-inch blade with a V point is generally used in rifting, and the edges of "tight" books are sometimes pounded with light hammers to loosen the laminae so that the rifting knife may be inserted. Considerable judgment and skill are required to split the blocks to the best advantage—that is, in such a way that imperfections shall be removed as far as practicable and so that the maximum yield of high-grade mica may be obtained. Consequently, only thoroughly experienced rifters are employed. The products of rifting are sheet stock, which goes to the trimmers; punch or washer stock, which is commonly left with rough edges and is used for making disks, washers, and other punched forms; and scrap.

*Trimming.*—After rifting, the edges of the mica sheets, which are generally ragged and partly crushed, are trimmed to remove the tangled ends of the laminae and thus facilitate further splitting. Trimmed sheet is known as "block", "uncut", or "unmanufactured" mica and is graded according to size and quality. Trimming may be done in a number of ways; but in general it is best accomplished with a sharp, thin-bladed knife held at a small angle with the cleavage of the sheet, so that a beveled-edged cut is produced. This beveled edge aids materially in further splitting, as the edges of each lamina project slightly beyond those of the one adjoining it, thus freeing them from entanglement. The bevel also presents a broader surface to the point of the splitting knife than a cut perpendicular to the cleavage, and assists the splitter in gaging the relative thickness of the sheets to be split. Mica should always be bevel-trimmed in this way where further splitting is contemplated.

In India most mica, particularly that marketed through Calcutta, is bevel-trimmed with sickle-shaped knives and is known as "sickle-trimmed" or "India-trimmed." Sickle-trimmed mica is most irregular in shape and commonly has reentrant angles, but its preparation is generally excellent, all flaws and cracks being cut out. In this respect it is far superior to the usual run of domestic knife-trimmed mica, in which many imperfections are often allowed to remain. Because of its careful preparation Indian sickle-trimmed mica has won an enviable reputation in the trade and has given rise to the term "close-trimmed", in contradistinction to "rough-trimmed", where imperfections are only partly removed. Mica from Madagascar, Guatemala, Argentina, and Brazil is usually sickle-trimmed. Another type of Calcutta trimming, known as "knife-trimmed" mica, yields sheets with straight unbeveled edges in the shape of irregular polygons. Most African mica is trimmed in this way, although some of it is sickle-trimmed.

Mica from the Madras district in India is cut with shears into rough rectangles and is known as "Madras-cut" or "shear-trimmed" mica. The edges are not beveled but are cut normal to the cleavage. "Thumb-trimming" of mica consists simply in breaking off with the fingers as much of the inferior material around the edges of the sheet as possible. It accomplishes little, but it may be warranted with certain micas, especially if the block mica is manufactured by the producer, as it saves the expense of more careful trimming. Domestic producers, in trimming their mica, should bear in mind that sickletrimming yields less waste and a larger weight of block than any other method. On the other hand, most consumers prefer the rectangular or Madras trimming, as by purchasing the proper sizes waste can be reduced to a minimum and predetermined with accuracy. Trimming, of course, produces a large percentage of scrap mica.

*Grading*—No other mineral product is so difficult to classify as mica or approaches it in the multiplicity of existing grades for size and quality, which vary widely according to the country in which the mica is produced.

Domestic sheet muscovite is divided into three principal classes according to quality, as clear, slightly stained or spotted, and heavily stained or spotted. As regards size, the domestic classification is as follows: The smallest size, designated as punch, must be large enough to yield a circle 1½ inches in diameter if stained and 1¼ inches if clear. The next size is circle mica, which yields disks larger than punch and up to 2 inches in diameter. Then follow the rectangular sizes 1½ by 2, 2 by 2, 2 by 3, 3 by 3, 3 by 4, 3 by 5, 4 by 6, 6 by 6, 6 by 8, 8 by 10 inches, and larger. Each size includes mica of the designated dimensions and all larger sizes until the next class is reached. Thus a sheet that would cut a rectangle 4½ by 7 inches would be classed as 4 by 6.

Muscovite for glazing, commonly known as stove mica, is classified according to quality as no. 1 stove or no. 2 stove. No. 1 stove must be clear and free from cracks and stains but may contain bubbles, whereas no. 2 stove may be somewhat spotted and stained.

The grading of Indian mica for size is based upon the area of usable mica corresponding to the areas in a standard chart, the general adoption of which for grading sheet mica and splittings is advocated by the American Society for Testing Materials (A.S.T.M. designation D351–33T).

The Indian material is graded for quality in the nine following classes in descending order of value: 1, Clear; 2, clear and slightly stained; 3, fair stained; 4, good stained; 5, stained; 6, heavy stained; 7, black spotted; 8, black stained; and 9, badly stained. The American Society for Testing Materials, in attempting to standardize grading for quality (A.S.T.M. designation D351–33T), has combined the four poorer grades listed above and adopted the grading described herewith.

*Grade and description*

| | |
|---|---|
| Clear | Free of all mineral and vegetable inclusions, stains, air inclusions, waves, or buckles. Hard transparent sheets. |
| Clear and slightly stained | Free of all mineral and vegetable inclusions, cracks, waves, and buckles but may contain slight stains and air inclusions. |
| Fair stained | Free of mineral and vegetable inclusions and cracks. Hard. Contains slight air inclusions and is slightly wavy. |
| Good stained | Free of mineral inclusions and cracks but contains air inclusions and some vegetable inclusions and may be somewhat wavy. |
| Stained | Free of mineral inclusions and cracks but may contain considerable clay and vegetable stains and may be more wavy and softer than the better qualities. |
| Black stained or spotted | Same as "stained" but contains mineral inclusions. |

The exact grading of mica for quality is extremely difficult, as it depends entirely upon personal interpretation of standards. As an aid to more uniform grading the American Society for Testing Materials proposes to prepare a set of master standards according to the above description from which photographs or transparent autochrome plates can be furnished.

Muscovite splittings are graded for size according to the Indian system, but the method of packing the splittings and their quality are also factors in determining their grade. The usual grades recognized in the trade are No. 6, cheap loose-packed; No. 6, medium loose-packed; No. 6, ordinary loose-packed; No. 6, second-quality loose-packed; No. 6, first-quality loose-packed; No. 5, special-quality loose-packed; No. 6, second-quality pan-packed; No. 6, first-quality pan-packed; No. 5, second-quality pan-packed; No. 5, first-quality pan-packed; No. 4½, pan-packed; No. 6, book-packed; No. 5, second-quality book-packed; No. 5, first-quality book-packed; No. 4½, book-packed. Sizes larger than No. 4 are rare. In book-packing all splittings from one block are piled like a deck of cards, and the individual splittings in the book are dusted with powdered mica to prevent them from sticking. In this form they are ideal for laying in the manufacture of plate or built-up mica. Pan-packing consists of laying the splittings radially in a circular pan, usually 7 to 9 inches in diameter, depending on the size of the splittings, to form a thin layer that is fairly coherent and that can be used as a unit in the manufacture of mica plate. The grades of splittings vary widely and overlap. Hence they are usually sold under trade names, such as "Walrus" or "Rabbit", the quality of common brands being fairly uniform and well known to mica buyers and consumers.

Sheet phlogopite or amber mica if of Canadian origin is classified for size on the basis of its maximum rectangular dimensions, but the sizes differ from the United States standards. They are as follows: 2 by 3, 2 by 4, 3 by 5, 4 by 6, 5 by 8 inches, and larger. These sizes are either thumb- or knife-trimmed and are graded for quality as No. 1, silver amber, and No. 2, dark amber. Canadian amber splittings are graded for size as 1 by 1 undersize, 1 by 1, 1 by 2, and 1 by 3 inches, and for quality according to color.

Madagascan mica, whether muscovite or phlogopite, is graded according to the following classification, which is enforced by the local Bureau of Mines.

*Madagascan system of grading mica for size*

| Series | Grade | Size of rectangle (square inches) | Series | Grade | Size of rectangle (square inches) |
|---|---|---|---|---|---|
| 1 | 00 | Over 48. | 3 | 5 | 3 to 6. |
| 1 | 0 | 36 to 48. | 3 | 6 | 1 to 3. |
| 1 | 1 | 24 to 36. | 3 | All splittings. | |
| 2 | 2 | 15 to 24. | 4 | Smaller sheet than grade 6. | |
| 2 | 3 | 10 to 15. | 4 | Scrap and ground mica. | |
| 2 | 4 | 6 to 10. | | | |

Madagascan phlogopite is graded for quality according to its hardness, which conforms closely to the color of the mica. Silver amber is graded as soft, brown amber as medium, and amber-black to silver-black as hard. Only the soft and medium amber micas are made into splittings, which at present are confined to No. 5 and No. 6 grades. Madagascan muscovite is loosely graded for quality into clear and stained mica.

In addition to the gradings already described, a dozen other countries contribute mica to the world's supply and none prepares or grades mica similarly, so that the great desirability of universal standards for grading is apparent. The adoption of such standards would cause many temporary inconveniences to producers, brokers, and consumers but would be of great ultimate benefit to the mica industry.

## CODE FOR THE MICA INDUSTRY

A hearing on the Code of Fair Competition for the Mica Industry was held in Washington, D.C., on November 17, 1933, and the code presented was approved by the Administrator for Industrial Recovery on February 24, 1934, except as to provisions covering the importation of mica and mica products and their sale by the importer.

The code consists of 10 articles, which are summarized as follows:

Article I states the purpose of the code.

Article II gives definitions and sets forth the following five divisions of the mica industry: The mining division, the importing division, the sheet-mica division, the wet-ground mica division, and the dry-ground mica division, including grinders of shop or scrap mica, grinders of mica schist, and those recovering mica from clay washing. The manufacturers of plate and other built-up mica are operating under the Code of Fair Competition for the Electrical Manufacturing Industry.

Article III deals with working hours and comprises six sections, summarized as follows:

1. No employee shall work more than 40 hours a week or more than 8 hours a day, provided, however, that for 6 weeks in any 6-month period an employee may work 48 hours a week.
2. Outside salesmen, executives, or managers earning not less than $35 a week are not restricted as to working hours. Emergency maintenance or repair workers are limited to 48 hours per week.
3. Engineers, firemen, and cleaners may work 48 hours a week and not over 56 hours during any 6 weeks of any 6-month period.
4. Watchmen may work 54 hours a week.
5. No employer shall permit any employee to work for a time which if totaled with working time expended with another employer in the industry would exceed the maximum allowed by the code.
6. No employee shall work more than 6 days in any 7-day period.

Article IV specifies the minimum wages shown in the following table in the different divisions of the industry in two geographical sectons—the southern section, which embraces Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia, and the northern section, which includes all other States and Territories of the United States.

*Minimum hourly wages in the mica industry*

| | Southern section | Northern section |
|---|---|---|
| Mining division | $0.25 | $0.30 |
| Importing division | .30 | .35 |
| Sheet mica division | .25 | .30 |
| Wet-ground mica division: | | |
| In grinding operations | .30 | .35 |
| In other operations | .25 | .30 |
| Dry-ground mica division: | | |
| In grinding operations | .275 | .325 |
| In other operations | .25 | .30 |

Article V states that no person under 16 years of age shall be employed in the industry or any persons under 18 years of age in work which may be hazardous or dangerous to health.

Article VI establishes a national code authority, consisting of the chairmen of the divisional code authorities and not more than three other members appointed by the administrator but without vote. It also defines the duties and powers of the code authority.

Article VII establishes a divisional code authority of three members in each division of the industry and specifies how the members shall be elected and their duties and powers under the general supervision of the national code authority.

Article VIII outlines a code of definite competitive practices and provides for the drafting of rules and regulations by the divisional code authority to make the code effective.

Article IX provides for enforcement of the provisions of the code and the arbitration of disputes within the industry.

Article X guarantees that employees have the right to organize and to bargain collectively through their representatives and that they shall not be required to join any company union. It also provides for cancelation or modification of the code by the President, and allots one vote in the affairs of the mica industry to each corporation, partnership, or individual that is a member of the code, and provides that it becomes effective the second Monday after its approval by the President.

It is difficult to predict the total economic effects of the code, but the short-time results will doubtless be increased wages, shorter hours, and a probable increase in employment. Hearings on the code brought out that some mica miners received 10 cents an hour and worked 50 to 60 hours a week compared with the established 25-cent hourly wage and 40-hour week under the code.

## FOREIGN TRADE

*Imports.*—The high valuation of the dollar in terms of the rupee and pound sterling during the first half of 1933 and a substantial rise in domestic prices of mica during the last half of that year encouraged large imports, which totaled 5,793,483 pounds valued at $473,757, an increase of 42.5 percent in quantity and 64.7 percent in value compared with 1932. There were gains in both quantity and value of every class of mica imported, with the exception of a minor class designated as films and splittings (cut or stamped to dimensions). In unmanufactured mica the increase amounted to 883,164 pounds, or 29.7 percent, and the value increased $100,457, or 128 percent. Imports of splittings increased 398,701 pounds or 42.2 percent, and their value increased $70,481, or 38.1 percent.

Stocks of mica in bonded warehouses on December 31, 1933, amounted to 80,772 pounds of unmanufactured mica valued at $55,210, and 789,847 pounds of manufactured mica (virtually all splittings) valued at $192,459.

The accompanying tables show the classification, quantity, and value of mica imported for consumption in the United States in 1933 and the countries from which it was last shipped, which are not necessarily those where it was produced.

*Mica imported for consumption in the United States in 1933, by kinds*

| Kind | Pounds | Value |
|---|---|---|
| Unmanufactured: | | |
| Waste and scrap, valued at not more than 5 cents per pound | 3,237,758 | $13,892 |
| Untrimmed phlogopite mica from which rectangular pieces not exceeding in size 1 by 2 inches may be cut | 49,675 | 3,596 |
| Other: | | |
| Valued at not above 15 cents per pound | 186,314 | 23,553 |
| Valued at above 15 cents per pound | 380,159 | 137,912 |
| | 3,853,906 | 178,953 |
| Manufactured: | | |
| Cut mica | 39,787 | 25,609 |
| Films and splittings: | | |
| Not cut or stamped to dimensions: | | |
| Not above 12 ten-thousandths of an inch in thickness | 1,268,393 | 219,977 |
| Over 12 ten-thousandths of an inch in thickness | 74,604 | 34,753 |
| Cut or stamped to dimensions | 332 | 671 |
| Mica plates and built-up mica | 15,244 | 10,795 |
| All manufactures of which mica is the component material of chief value | 3,441 | 1,611 |
| Mica ground or pulverized | 537,776 | 1,388 |
| | 1,939,577 | 294,804 |
| | 5,793,483 | 473,757 |

*Mica imported into the United States in 1933, by kinds and by countries*

[General imports]

| Country | Unmanufactured | | | | | | | | Manufactured | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Waste and scrap, valued at not more than 5 cents per pound (duty 25 percent) | | Untrimmed phlogopite mica from which rectangular pieces not exceeding in size 1 inch by 2 inches may be cut (duty 15 percent) | | Other | | | | Cut mica (duty 40 percent) | | Films and splittings | | | | | | Mica plates and built-up mica (duty 40 percent) | | All manufactures of which mica is the component material of chief value (duty 40 percent) | | Mica ground or pulverized (duty 20 percent) | |
| | | | | | Valued at not above 15 cents per pound (duty 4 cents per pound) | | Valued at above 15 cents per pound (duty 4 cents per pound+25 percent) | | | | Not cut or stamped to dimensions | | | | Cut or stamped to dimensions (duty 45 percent) | | | | | | | |
| | | | | | | | | | | | Not above 12 ten-thousandths of an inch in thickness (duty 25 percent) | | Over 12 ten-thousandths of an inch in thickness (duty 40 percent) | | | | | | | | | |
| | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value | Pounds | Value |
| Africa: | | | | | | | | | | | | | | | | | | | | | | |
| Madagascar | | | | | | | | | | | 41,690 | $5,662 | | | | | | | | | | |
| Mozambique | | | | | | | | | | | 135 | 29 | | | | | | | | | | |
| Union of South Africa | 458,305 | $1,710 | | | | | | | | | | | | | | | | | | | | |
| Other British South Africa | | | | | | | 590 | $476 | | | | | | | | | | | | | | |
| British East Africa | | | | | 49 | $6 | 639 | 254 | | | | | | | | | | | | | | |
| Argentina | | | | | 552 | 66 | 9,220 | 2,950 | 3,200 | $2,508 | | | | | | | | | | | | |
| Brazil | | | | | 6,971 | 766 | 20,538 | 5,957 | | | | | | | | | | | | | | |
| Canada | 1,976,540 | 8,682 | 41,096 | $2,940 | 4,054 | 527 | 2,155 | 973 | | | 56,600 | 22,632 | | | | | | | | | | |
| China | | | | | | | | | 6 | 14 | | | | | | | | | | | | |
| France | | | | | 3,879 | 492 | | | 258 | 149 | 37,141 | 4,932 | | | | | | | | | | |
| Germany | | | | | | | 2,035 | 2,613 | 11,882 | 10,352 | | | 14 | $111 | | | 5,874 | $5,456 | 24 | $97 | | |
| India, British | 471,211 | 2,659 | | | 146,618 | 18,360 | 276,774 | 91,979 | 30,897 | 16,274 | 778,823 | 101,180 | 73,484 | 34,449 | 332 | $671 | | | 3,417 | 1,514 | | |
| U.S.S.R. (Russia) | 331,702 | 841 | | | | | | | | | | | | | | | | | | | 537,776 | $1,388 |
| United Kingdom | | | | | 20,337 | 2,899 | 69,408 | 31,623 | 465 | 1,257 | 3,681 | 1,697 | 1,188 | 214 | 250 | 84 | 9,370 | 5,339 | | | | |
| | 3,237,758 | 13,892 | 41,096 | 2,940 | 182,460 | 23,116 | 381,359 | 136,825 | 46,708 | 30,554 | 918,070 | 136,132 | 74,686 | 34,774 | 582 | 755 | 15,244 | 10,795 | 3,441 | 1,611 | 537,776 | 1,388 |

*Exports.*—Exports of mica in 1933 amounted to 3,125,873 pounds valued at $117,863, an increase of 27,136 pounds or 0.9 percent in quantity but a decrease of $14,892 or 11.2 percent in value compared with 1932. The accompanying table shows the weight, value, and destination of the mica exported from the United States in 1933. As mica is not classified in export schedules it is impossible to state what kinds are exported.

*Mica and manufactures of mica exported from the United States in 1933, by countries*

| Country | Pounds | Value | Country | Pounds | Value |
|---|---|---|---|---|---|
| North America: | | | Europe—Continued. | | |
| Canada | 1,442,066 | $37,954 | Italy | 4,124 | $3,197 |
| Central America: | | | Netherlands | 25,228 | 1,861 |
| Costa Rica | 7 | 15 | Spain | 2,819 | 250 |
| Guatemala | 36 | 24 | Sweden | 514 | 42 |
| Honduras | 4 | 9 | Switzerland | 979 | 38 |
| Nicaragua | 1 | 3 | United Kingdom | 983,630 | 42,797 |
| Panama | 221 | 592 | Asia: | | |
| Salvador | 44 | 97 | China | 770 | 164 |
| Mexico | 14,389 | 1,339 | East India: | | |
| West Indies: | | | British: | | |
| British: | | | Malaya | 6 | 2 |
| Jamaica | 35 | 302 | India | 37 | 135 |
| Other | 5 | 2 | Japan (including Chosen) | 159 | 117 |
| Cuba | 1,006 | 666 | Philippine Islands | 60 | 176 |
| Netherland | 19 | 120 | Africa: | | |
| South America: | | | British: | | |
| Argentina | 5,450 | 378 | Union of South Africa | 25 | 27 |
| Brazil | 690 | 900 | Belgian Congo | 1 | 3 |
| Chile | 261 | 418 | Portuguese: | | |
| Colombia | 14 | 67 | Mozambique | 18 | 18 |
| Ecuador | 259 | 160 | Madagascar | 2,000 | 58 |
| Peru | 39 | 74 | Oceania: | | |
| Uruguay | 12 | 38 | British | 3 | 7 |
| Europe: | | | Australia | 646 | 78 |
| Belgium | 231,935 | 9,528 | French | 7 | 7 |
| France | 147,094 | 4,424 | | | |
| Germany | 260,930 | 11,614 | Total | 3,125,873 | 117,863 |
| Hungary | 330 | 162 | | | |

*World production of mica, 1929–33, in metric tons*

[Compiled by M. T. Latus, of the Bureau of Mines]

| Country | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada (sales) | 3,677 | 1,061 | 1,214 | 280 | 775 |
| Guatemala | [1] 1 | (2) | (2) | (2) | (2) |
| United States (sales) | 6,596 | 6,772 | 6,443 | 6,540 | 8,104 |
| South America: | | | | | |
| Argentina [3] | 119 | 100 | 51 | 55 | (2) |
| Bolivia [1] | 2 | 15 | 1 | 8 | (2) |
| Brazil [1] | 45 | 52 | 54 | 42 | (2) |
| Colombia | ------- | 15 | (2) | (2) | (2) |
| Europe: | | | | | |
| Italy | ------- | ------- | 12 | 9 | (2) |
| Norway [1] | 59 | 53 | 48 | 103 | (2) |
| Sweden | 66 | 73 | 65 | 61 | (2) |
| Asia: | | | | | |
| Ceylon | (4) | ------- | 2 | 2 | (2) |
| Chosen | 26 | 29 | 18 | 20 | (2) |
| India, British [5] | 5,897 | 4,212 | 2,691 | 2,389 | 2,932 |
| Africa: | | | | | |
| Kenya Colony and Protectorate | 2 | ------- | ------- | (2) | (2) |
| Madagascar [6] | 380 | 348 | 235 | (2) | (2) |
| Rhodesia: | | | | | |
| Northern | 3 | 4 | 1 | ------- | 1 |
| Southern | 172 | 164 | 67 | 13 | 4 |
| Tanganyika Territory | 29 | 21 | 9 | 12 | (2) |
| Union of South Africa (Transvaal) (sales) | 1,464 | 501 | 477 | 250 | 565 |
| Oceania: | | | | | |
| Australia: | | | | | |
| New South Wales | 3 | ------- | ------- | ------- | (2) |
| Northern Territory (Central Australia) | 24 | 26 | 28 | 30 | (2) |
| South Australia | ------- | ------- | 2 | ------- | (2) |

[1] Exports.
[2] Data not available.
[3] Rail and river shipments.
[4] Less than 1 ton.
[5] Exports. The figures for output are incomplete, and a more accurate idea of the size of the industry is to be obtained from the export figures. (Rec. Geol. Surv. of India, vol. 59, pt. 3, p. 273 Calcutta, 1926.) Output is reported as follows: 1929, 2,704 tons; 1930, 2,679 tons; 1931, 1,979 tons; 1932, 1,662 tons.
[6] Exports reported as follows: 1929, 427 tons; 1930, 397 tons; 1931, 120 tons; 1932, 130 tons.

# NATURAL SODIUM COMPOUNDS AND BORON MINERALS

By A. T. Coons

SUMMARY OUTLINE



The outstanding feature of the natural sodium compounds industry since the World War has been its steady growth. From an output of only 42,683 short tons in 1920 production has climbed to a peak of 305,047 tons in 1933, an increase of 13 percent over 1932 and 2.6 percent over the former peak of 1930.

Although production has been maintained on a relatively stable plane price declines have been unavoidable; returns to producers were particularly low in 1932 but somewhat higher late in 1933.

The output of sodium compounds (not including common salt) from natural salines and brines in the United States, as indicated by sales or shipments by producers, was 305,047 short tons valued at $4,599,912 in 1933, compared with 269,496 tons valued at $4,122,238 in 1932. These totals cover sodium carbonate (soda ash and trona), sodium bicarbonate, sodium sulphate (salt cake and Glauber's salt), and sodium borate (borax and kernite).

Figure 105 gives quantity and value of natural sodium compounds produced in the United States from 1924 to 1933.

*Salient statistics on natural sodium compounds sold or used by producers in the United States, 1929–33*

| Year | Carbonates [1] | | Sulphates [2] | | Borates [3] | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 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 |
| 1933 | 70,461 | 918,295 | 46,539 | 245,240 | 188,047 | 3,436,377 | 305,047 | 4,599,912 |

[1] Soda ash, bicarbonate, and trona; in 1930 includes sal soda also.
[2] Salt cake and Glauber's salt.
[3] 1929–30: Borax and kernite; 1931–33: Borax, kernite, and boric acid (calculated as borax).



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*Boron minerals.*—The output of boron minerals in 1933, as reported to the Bureau of Mines by producers, amounted to 188,047 short tons valued at $3,436,377, an increase of 3 percent in quantity and 14 percent in value compared with 1932.

*Boron minerals [1] sold or used by producers in the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 169,870 | $4,515,375 | 1932 | 181,915 | $3,023,844 |
| 1930 | 177,360 | 5,351,999 | 1933 | 188,047 | 3,436,377 |
| 1931 | 178,550 | 4,931,295 | | | |

[1] 1929–30: Borax, kernite, colemanite, and boric acid; 1931–33: Borax, kernite, and boric acid (calculated as borax).

In 1933, as in 1931 and 1932, the boron minerals included in the totals were confined to the sodium borates known as "borax" and

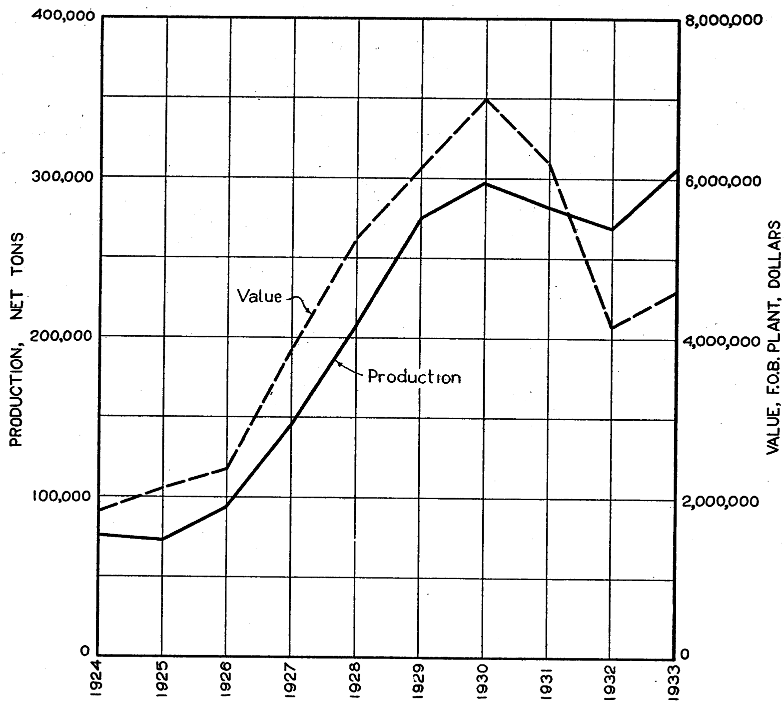


FIGURE 105.—Quantity and value of natural sodium compounds produced in the United States, 1924–33.

"kernite." Before 1927 the source of all the borax except that made at Searles Lake and Owens Lake was colemanite (calcium borate) mined in California and Nevada. In 1927 kernite mined in Kern County, Calif., replaced colemanite, production of which virtually ceased after 1927, although small shipments were made through 1930.

*Review of operations.*—In 1933 most of the material included in the sales of sodium carbonate was soda ash—normal sodium carbonate ($Na_2CO_3$)—and was produced in California from the waters of Owens Lake in Inyo County, by the Natural Soda Products Co. at Keeler and the Pacific Alkali Co. at Bartlett, and the waters of Searles Lake in 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., near Mina, Mineral County, Nev., by the Rhodes Alkali & Chemical Corporation; and near Monahans, Ward County, Tex., by the Ozark Chemical Co. of Tulsa, Okla. The sodium sulphate deposit at Wabuska, Lyon County, Nev., owned by the American Sodium Co. was not operated in 1933. Hydrated sodium sulphate ($Na_2SO_4 \cdot 10H_2O$) (Glauber's salt) was produced near Casper, Natrona 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. There was a small output of sodium sulphate (salt cake and Glauber's salt) near Twentynine Palms, San Bernardino County, Calif., by the Chemical Mines Co.; the work was experimental, and none of the product was shipped. The Salt Lake Sodium Products Co. (Great Salt Lake Chemical Co., owner), Salt Lake City, Utah, erected a plant in 1933 for the production of sodium sulphate near Saltair on Great Salt Lake and expects to manufacture in 1934. No output of sodium sulphate was reported from Washington.

The sodium borate produced in 1933 includes borax ($Na_2B_4O_7.10H_2O$) obtained in California from Searles Lake brines in San Bernardino County, by the American Potash & Chemical Co. at Trona and 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 and by the Western Borax Co., Ltd., near Kramer. Boric acid also was produced by the American Potash & Chemical Co.; in the figures for sales from 1931 to 1933 on page 1075 this product, calculated as borax, is included with sodium borate.

*Foreign trade.*[1]—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. Exports of sodium sulphate in 1933 were small and were not recorded separately. Total imports of sodium sulphate in 1933 increased 57 percent in quantity and 34 percent in value compared with 1932; increases were shown for all grades of these salts. Exports of sodium borate (borax) in 1933 decreased 2 percent in quantity and 7 percent in value from 1932. No crude sodium borates were imported in 1933; imports of the refined product increased 74 percent in quantity and doubled in value compared with 1932.

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

*Sodium sulphate exported from the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 1,666 | $53,176 | 1932 | 1,435 | $24,155 |
| 1930 | 4,436 | 113,253 | 1933 | (1) | (1) |
| 1931 | 4,652 | 75,784 | | | |

[1] Not separately classified in 1933.

*Sodium sulphate imported for consumption in the United States, 1929–33*

| Year | Crude (salt cake) | | Crystallized (Glauber's salt) | | Anhydrous | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Short tons | Value | Short tons | Value | Short tons | Value | Short tons | Value |
| 1929 | 91,633 | $829,793 | 1,161 | $9,517 | 5,552 | $116,935 | 98,346 | $956,245 |
| 1930 | 70,337 | 800,432 | 1,156 | 9,241 | 9,934 | 200,143 | 81,427 | 1,009,816 |
| 1931 | 72,746 | 803,509 | 924 | 9,615 | 10,315 | 193,041 | 83,985 | 1,006,165 |
| 1932 | 61,124 | 644,074 | 304 | 2,848 | 8,855 | 153,612 | 70,283 | 800,534 |
| 1933 | 99,269 | 885,306 | 629 | 8,677 | 10,371 | 179,529 | 110,269 | 1,073,512 |

*Sodium borate (borax) exported from the United States, 1929–33*

| Year | Short tons | Value | Year | Short tons | Value |
|---|---|---|---|---|---|
| 1929 | 79,884 | $2,934,660 | 1932 | 89,641 | $2,677,626 |
| 1930 | 82,931 | 3,057,794 | 1933 | 87,677 | 2,498,035 |
| 1931 | 86,938 | 3,358,609 | | | |

*Sodium borates imported for consumption in the United States, 1929–33*

| Year | Crude | | Refined | |
|---|---|---|---|---|
| | Short tons | Value | Pounds | Value |
| 1929 | 5,090 | $157,793 | 7,504 | $1,323 |
| 1930 | | | 16,681 | 1,993 |
| 1931 | 570 | 16,507 | 1,516 | 251 |
| 1932 | | | 610 | 128 |
| 1933 | | | 1,061 | 259 |

# PRECIOUS AND SEMIPRECIOUS STONES (GEM MINERALS)

By Sydney H. Ball

SUMMARY OUTLINE



Precious and semiprecious stones include minerals used primarily for personal adornment and decorative purposes. To be so prized the stones must possess beauty of color and "fire" or play of colors, must not be too common, and must be hard enough to withstand ordinary wear. Among the less regal members of the group, fashion may temporarily determine the popularity of a gemstone. The quality of hardness also accounts for the many industrial uses of the diamond and, to a less extent, the ruby and sapphire.

Almost 100 mineral substances have been used for decorative purposes, and while there is no hard and fast division as to precious and semiprecious stones, the diamond, the emerald, the ruby, and the sapphire are usually included in the former and frequently, by courtesy, an organic substance, the pearl. These gems, however, are sometimes equaled in beauty by exceptionally fine opals, aquamarines, tourmalines, spinels, chrysoberyls (including cat's eye and alexandrite), and spodumenes (hiddenite and kunzite).

The diamond industry is much more highly organized than that of any other precious stone, and the diamond output represents almost 95 percent of the world's gem production.

*Production in the United States.*—For well over 2,000 years gem mining has been a minor industry in America as the American Indian, no less than his white successor, was an admirer of gems. The industry, however, has never been an important one in the United States. Statistics are not at hand for recent years, but from 1880 to 1924 the American production was valued at $9,800,000, a yearly average of $223,000 with a maximum of $534,000 in 1909 and a minimum of $60,000 in 1923. In 1933 the value of the production was probably under $20,000 and consisted largely of rose quartz from South Dakota, agatized wood from Arizona, a small quantity of turquoise from the Southwest, a few sapphires and agate for the tourist trade from Montana, amazonstone from Colorado, and a little rose quartz from California.

Virtually all of the known precious and semiprecious stones have been found in the United States, but important deposits are unusual. Among the more notable American occurrences responsible for a certain production are sapphires in Montana, diamonds in Arkansas, tourmalines in Maine and California, hiddenite in North Carolina, kunzite in California, amazonstone in Colorado, rose quartz in South Dakota and California, and turquoise in New Mexico, Arizona, and Nevada. The Montana sapphire mines have been responsible for the major part of this country's production, the gems being used partly in jewelry but largely industrially as watch jewels.

*Trade in precious stones in 1933.*—The year 1933 was slack in the precious-stone industry due to the world-wide depression and the shifting of currency values and high tariffs. On the whole, however, employment was better in 1933 than in 1932, and the sales trend is upward. In America, jewelry sales, judging from the excise tax from July 1, 1933 to March 31, 1934, were $37,239,917, a 57-percent increase over the corresponding period of 1932–33.

*Imports and domestic tariff.*—Imports of precious stones into the United States in 1933 were as follows:

| | Value |
|---|---|
| Diamonds: | |
| Rough, uncut, 31,595 carats | $1, 662, 224 |
| Cut, but not set, 178,937 carats | 8, 360, 283 |
| Glaziers', engravers', and miners', not set, 260,784 carats | 1, 249, 200 |
| Pearls and parts, not strung or set | 776, 141 |
| Other precious stones: | |
| Rough, uncut | 76, 038 |
| Cut, but not set | 644, 475 |
| Imitation precious stones, except opaque | 932, 189 |
| Imitation precious and semiprecious stones, opaque, including imitation pearls | 11, 487 |
| Marcasites | 39, 884 |

The rate of duty on various types of gems and their imitations remains the same as that given in Minerals Yearbook, 1932–33, page 803.

*Codes under the NRA.*—The jewelry industry is now operating under a number of codes; for instance, the diamond dealers and the diamond cutters each have their own codes. The Code of Fair Competition for the Precious Jewelry Producing Industry has rather drastic articles as to trade terminology, fair practices as to advertising, marketing, and sales terms. The definition of certain terms relating to precious stones in the Code of Fair Competition for the Retail Jewelry Trade is particularly interesting; the code forbids auctions except in case of dire necessity or for legitimate liquidation.

*American jewelry tax.*—The Federal 10-percent tax continued throughout 1933; it has netted the Government little revenue—only $3,068,494 was collected in 1932. There are indications that the tax is a difficult one to administer and that its effects are felt sharply by the jewelry business in the United States in which 1,261 houses failed in 1932 with liabilities of $35,627,308.

*Resolutions of Fourth International Jewelers Congress, Rome, May 1933.*—The congress, among other resolutions, refused to adopt the definitions of "perfect", "blue white", "commercial white", and other terms used by American diamond dealers; all diamonds are to be weighed in metric carats.

Synthetic and imitation stones must be offered and invoiced as such, and the words "synthetic" and "imitation" must be written in the same character as the name of the stone involved.

The congress also adopted certain definitions for various precious stones, eliminating the use of the word "olivine" for members of the chrysolite family and confining its use to the green garnet, uvarovite; also an identification service for diamonds, pearls, and precious stones will be fostered by the congress.

## DIAMOND

All indexes of the diamond industry improved in 1933 compared to those of 1932. Among favorable factors were a curtailed production; a slight decrease in world stocks; better prices for rough and cut goods; larger sales of rough and cut goods, as indicated by increased American imports, and higher stock-market valuation of shares with several companies returning to the dividend list. The improvement is tangible, but the industry can only improve markedly provided prosperity returns to America, which normally should absorb over 75 percent, in value, of the world's diamonds.

The known reserves of diamonds are not excessive, being of the order of those of gold, zinc, and lead rather than of copper or coal. During the year no discoveries of importance were made, and as the world becomes better known, the possibility of finding new fields of importance that might greatly disturb the market becomes progressively less. The centralization and unification of the industry continued in 1933, and hereafter the production of the Government-owned South African mines is to be sold through the Diamond Corporation (see p. 1087).

The low price of small stones during the past 2 years has led many to become "diamond conscious" for the first time, and at some future date ideas of size, quality, and cut will improve to the benefit of the industry. As some small measure of prosperity returns it is expected that many will be disposed to satisfy their long-deferred desire for luxuries.

*Share dealings.*—Except in June and July, when sales were relatively large, 1933 was a year of small dealings in diamond-mining shares. This was due to continental buying, where such shares have always been popular. The appreciable advance of January was lost in February; from March to June prices rose; they receded in July, gained in August and September, and suffered a slight loss in the final quarter of the year. Diamond shares gained about 32 percent in price during the year. Five selected stocks at the end of the year were about 33 percent of the all-time high (1927) and 363 percent of the all-time low (June 1932). Of the 13 principal diamond-mining companies, 8 are paying dividends.

*Market.*—Some 95 percent of the output of the world's diamond mines is sold to the Diamond Corporation of London, and it in turn sells to brokers and larger cutters. In 1933, as usual, the corporation only put on the market such quantities of rough stones as could be readily absorbed and refrained from selling for several extended periods in the year. The corporation continued to assist in coordinating production with demand and in determining the quotas of each producer, also to lead in other matters pertaining to the good of the industry.

It further held itself ready to take off the market the production of the few independent producers still operating, provided this seemed desirable. When England, South Africa, and the United States went off the gold standard the corporation raised the price of diamonds, produced under the gold standard, in the currencies of those countries commensurately. When South Africa went off the gold standard the corporation, fearing the price structure might be injured by alluvial diamonds produced at depreciated currency costs, instructed its buyers to purchase alluvial stones at rates obtaining when South Africa was on the gold standard. In June the corporation decided to sort Congo goods in the same way as South African. Few sales agencies know their products better or handle their sales more astutely than the Diamond Corporation.

In 1933 the corporation's sales of rough stones, while by no means noteworthy, were appreciably greater than those in 1932. In January, June, July, and October sales were large, most of the other months being quiet. Prices were firm throughout the year, and the price of large, rough stones was increased 20 percent in June with a slight increase in the smaller sizes.

World sales of cut goods were relatively satisfactory and doubled those in 1932, due partly to spurts of investment buying in America, Germany, and France, as confidence in the currencies was temporarily lost. In January and February sales were satisfactory, and June to October were good months. In May the price of large stones was increased 20 percent and that of smaller stones raised, although late in the year the price of the latter dropped somewhat.

In 1933 investment buying was large due to disturbances in currency values, for in times of financial stress, as in those of revolution, diamonds, particularly fine stones, are among the commodities purchased to obviate loss through currency inflation. In the Paris "Vu", Lewisohn in listing the world's richest men emphasizes the relatively small losses sustained in the past few years by the leading Indian princes, who have always kept a substantial part of their fortunes in gold and precious stones, compared to the heavy losses sustained by western financial leaders with fortunes in stocks and bonds.

From July to the end of the year fear for stability of the dollar caused some Americans to purchase diamonds. The purchasers were favorably impressed by the unified control of production and sales in the industry, the relative stability of diamond prices during the panic, and the expectation of price appreciation provided currency depreciation took place. It may be that the substantial prices received for diamonds by friends forced to liquidate during the panic, as opposed to the smaller salvage value of other luxuries, also influenced purchasers. Provided the original purchase was made a decade ago (see fig. 106), the owner doubtless even profited by the distress sale. The diamond is a commodity largely immune to the fatal consequences of currency fluctuations, and the portability of the stones and their ready translation into cash in any market likewise are important considerations.

Investment buying in France became apparent in February and continued throughout the year. Investment buying also occurred in England during the summer. Such buying in America, France, Germany, Hungary, and England partly caused the shortage of fine goods, and price advances. It is reported that the Jewish emigrés from Germany during the past year were not permitted to take gold out of the country; however, many had converted their fortunes into diamonds and were thus able to leave with part of their capital to start anew in other lands.

As already mentioned, the low price of small stones during the past 2 years has led to diamond consciousness; at some future date ideas of size, quality, and cut will improve, to the benefit of the industry. Moreover, many young people who have become engaged during the past 4 years have deferred purchasing an engagement ring until more prosperous times, and eventually the diamond merchant will benefit. With repeal, dining out is becoming more prevalent in the United States and with it the more frequent use of formal gowns and jewelry.

*Stocks.*—A year ago the writer estimated that the total diamond stocks held by the Diamond Corporation of London, the South African producers including the Government, producers in other countries, and the cutters in Antwerp and Amsterdam were worth about $100,000,000. It is believed that in 1933 about as many rough diamonds were sold as were produced and that the stock on January 1, 1934, is no greater in carats than it was a year ago; due to higher prices, however, the value has probably increased. Sales by the corporation are not made public, but in 1933 they are understood to have exceeded £2,000,000, a higher value than that for 1932, which in turn showed a gain over 1931.

In Antwerp and Amsterdam, American buyers found an unusually restricted assortment of cut goods; indeed, from time to time throughout the year there were shortages in certain lines. In the United States retail stocks continued very low; the same is true of stocks of the American importer and wholesaler. The British retailer likewise carried barely enough stock to transact business, as did retailers in other centers such as Budapest, Paris, and Rome. In 1933, therefore, world diamond stocks, including those of the corporation and those in jewelers' hands, decreased.

*Prices.*—Prices of both rough and cut stones were firm for the first 3 months of the year. In May good cut stones of 3 carats or more increased 20 percent in price, which, of course, reacted favorably upon the price of rough stones. In May "seconds" sold by the New York loan societies brought surprisingly good prices, a condition noted in London in March and April.

In consequence of the price advances noted and the depreciation of the dollar American buyers arriving in Europe in the summer found prices in American currency 50 to 70 percent above those in May. Such prices curtailed American buying but tended to mark up stones in stock in America. In America the recent low of diamond prices was reached in June 1932 and extended to March 1933. A fine 1-carat brilliant, which in 1928–29 sold for $750, in the period of low prices brought only $500; the price by September 1933, however, had increased to about $650. Figure 106 shows the price of a 1-carat cut stone of good quality from 1550 A.D. to date.

*Century of Progress diamond exhibit.*—The industry's exhibit was one of the major attractions at the Chicago Century of Progress; wide interest was shown in the diamond mine, the grease tables and the diamond-cutting exhibit, the diorama of the Kimberley opencut, and the painting of a Congo mine. Among the fine gems shown were the Tiffany Yellow and the beautiful Maximilian diamond; there was also a rather complete assortment of rough gems. These stones were protected by the latest type of automatically controlled safes, tear gas, electric eye and burglar-proof glass, and heavily armed guards. The exhibit of the use of industrial gems was unusually complete.

*Imports into the United States.*—In 1933 diamonds, cut and uncut accounted for a little over 80 percent of the imports of all precious stones, pearls, and imitation precious stones; if the imitation stones are excluded diamonds accounted for 87 percent of the total imports.

*Diamonds imported into the United States in 1933, by countries*

| Country | Rough or uncut | | | Cut, but not set | | |
|---|---|---|---|---|---|---|
| | Carats | Value | Value per carat | Carats | Value | Value per carat |
| Belgium | 10,432 | $591,866 | $56.73 | 131,942 | $5,887,244 | $44.62 |
| Brazil | 471 | 1,000 | 2.12 | | | |
| British Guiana | 190 | 1,900 | 10.00 | | | |
| Canada | | | | 25 | 1,003 | 40.12 |
| France | | | | 478 | 39,954 | 83.58 |
| Germany | 105 | 2,144 | 19.46 | 47 | 1,948 | 41.45 |
| Netherlands | 4,196 | 275,994 | 61.01 | 45,609 | 2,314,588 | 50.75 |
| Switzerland | | | | 12 | 1,158 | 96.50 |
| Union of South Africa | 13,423 | 704,278 | 52.47 | 177 | 14,968 | 84.56 |
| United Kingdom | 2,015 | 63,974 | 31.75 | 647 | 99,420 | 153.66 |
| | [1] 31,595 | [1] 1,662,224 | 52.61 | 178,937 | 8,360,283 | 46.69 |

[1] Includes 763 carats valued at $21,068 not distributed by country of origin.

Total imports of all kinds of goods into the United States in 1933 were 32.5 percent of the average for 1923–25; the value of diamond imports in 1933 was only 18.9 percent of the 1923–25 average and 19.3 percent of the 1929 value but showed a gain of 107.3 percent over 1932.

In 1933 Belgium (70.4 percent) and the Netherlands (26.5 percent) accounted for 97 percent of the American imports of cut stones. The Union of South Africa accounted for 42.5 percent of the rough stones imported, and Belgium and the Netherlands accounted for 35.7 and 16.7 percent, respectively.

The value per carat of cut stones imported into the United States reached a peak of $100.07 in 1929. For the succeeding 3 years the value per carat fell, due partly to decreases in diamond prices but largely to diminished purchasing power in the United States which caused Americans to purchase smaller stones of poorer quality. The slight increase in the 1933 price over that of 1932 is encouraging.

Imports of rough diamonds vary greatly from year to year and normally do not depend on good or bad times. The value of imports reached their peak in 1926; since then the general tendency has been downward. In 1933, however, the value of imports slightly exceeded that in 1932. The high point in quantity of imports was reached in 1929. The quality of stones imported, as shown by price per carat, decreased from 1926 to 1930, picked up appreciably in 1931, fell again in 1932, but rose sharply in 1933 when unusually fine rough stones were imported.

As usual, August and September were months of large importation due to stocking up for the Christmas trade.

Canada is less "diamond conscious" than America but imports a small quantity of cut diamonds. Imports into Canada, which in 1930 were valued at $2,014,713, had fallen by 1933 to $331,878.

*Diamond cutting.*—The world diamond-cutting industry had a better year in 1933 than in 1932. Unemployment was less acute, and

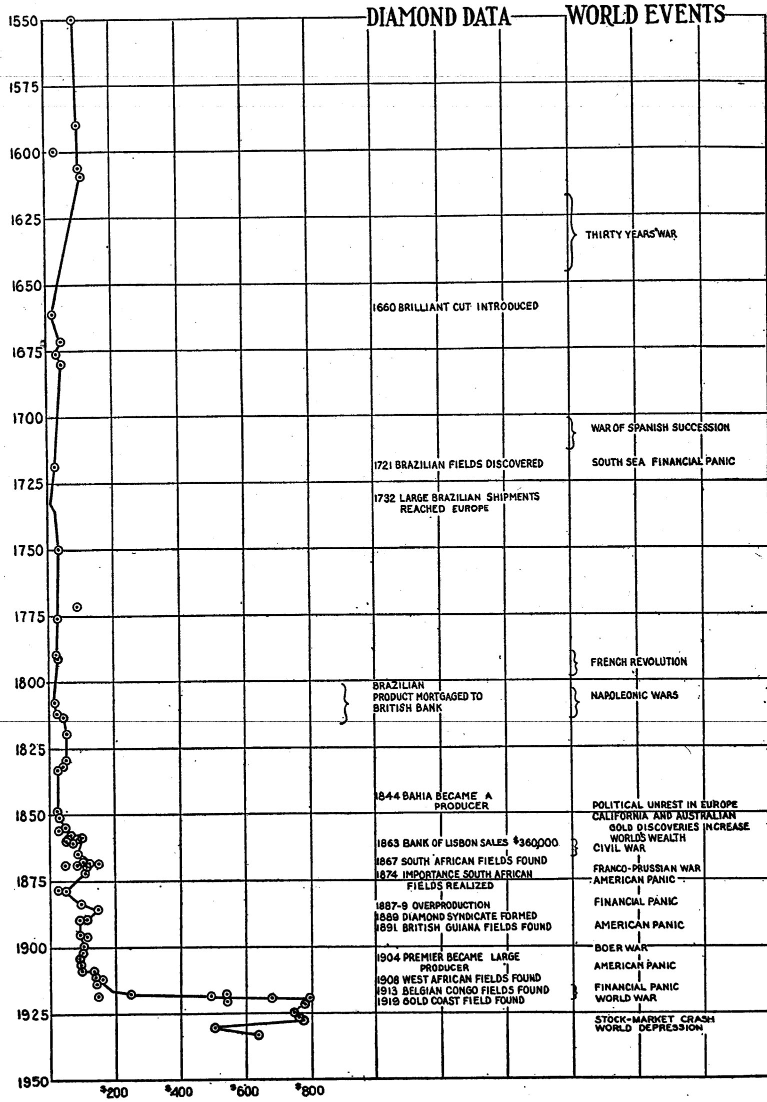


FIGURE 106.—Trend of diamond quotations, 1550–1933. Data represent the price of a fine 1-carat cut stone.

the master cutters did better financially, although the profit in cutting rough stones was still discouragingly small. However, cutters are partly the creators of their own troubles, for as soon as a particular cut, size, or grade is in demand all hasten to produce it, and a surplus with weakened prices too often results.

Employment in Antwerp averaged about 41 percent of the Union's membership (1932, 27 percent) and in Amsterdam about 27 percent (1932, 15 percent). In May, owing to the Nazi anti-Semitic attitude, the diamond merchants of Amsterdam and Antwerp, largely Jews, refused to send diamonds to Germany for cutting, thus benefiting the artisans of their own cities. In midsummer a number of German-Jew cutters fled from Germany and settled in Antwerp.

Antwerp with 20,000 to 25,000 artisans, Amsterdam with 5,000, and Hanau and other German cities with 3,500 to 4,000 are the principal cutting centers. Kimberley, Capetown, Johannesburg, New York, Paris, London, the Jura Mountains, and Geneva are minor cutting centers. There are also a few cutters at Rio de Janeiro and in cities of India and Borneo. In 1933 the South African subsidized industry continued on its stormy way. As the South African master cutters must purchase their rough stone at prices comparable to those paid by European cutters hereafter, less 10-percent export tax, their advantageous positions will largely disappear.

The Comptoir Diamantaire Anversois (capital 30,000,000 francs) has been formed to distribute credits better in the Antwerp market. The Hollanders likewise have formed a central organization (capital 6,000,000 guilders) for the purchase of rough stones and the sale of polished goods, which is also to subsidize the cutting of small stones. In 1933 the Germans set up a syndicate to buy rough stones to make their trade independent of Antwerp and Amsterdam.

*World production.*—The world's production of diamonds in 1933 was approximately 3,775,000 carats, worth about $14,100,000.

The following table gives, with the accuracy available statistics permit, the diamond production in carats for the past 4 years.

*Production of diamonds by countries, 1930–33, in carats* [1]

| Country | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|
| South Africa: | | | | |
| Mines | 2,242,460 | 1,470,376 | 307,431 | 14,149 |
| Alluvial | 918,706 | 647,044 | 488,096 | 492,404 |
| | [2] 3,163,590 | [2] 2,119,155 | [2] 798,382 | 506,553 |
| Angola | 329,823 | 351,495 | 367,334 | [3] 374,000 |
| Brazil | 115,000 | 80,000 | 34,000 | (4) |
| British Guiana | 110,042 | 63,479 | 61,780 | (4) |
| Congo | 2,519,300 | 3,528,200 | 3,990,069 | [3] 1,931,000 |
| Gold Coast [5] | 861,119 | 880,479 | 842,297 | 863,722 |
| Sierra Leone | ----------- | ----------- | 749 | 32,017 |
| South-West Africa | 415,047 | 71,532 | 17,944 | ----------- |
| Tanganyika | 13,107 | 7,790 | 1,391 | [3] 1,250 |
| Miscellaneous [6] | 3,000 | 3,600 | 3,725 | 1,825 |
| Grand total | 7,530,028 | 7,105,730 | 6,117,671 | [7] 3,774,367 |

[1] In 1933 Rhodesia disappeared as a producer, and Sierra Leone appears for the first time as a producer of some importance; Tanganyika Territory is now unimportant. As the South African pipe mines were shut down, the year's production came from the alluvial mines except for about one-fifth of 1 percent produced by debris washers (i.e., tailings treatment).
[2] Includes a small quantity of diamonds recovered from tailings re-treatment.
[3] Estimated.
[4] Figures not available.
[5] Exports year ending Mar. 31.
[6] Includes India, Borneo, New South Wales, and in certain years Venezuela, French Equatorial Africa, Arkansas, and Rhodesia.
[7] Includes estimates for Brazil and British Guiana.

In quantity and value the 1933 production was about 62 percent and 81.3 percent, respectively, of that in 1932. The value of the 1933 output was about one-fifth that of normal years; an unusually large percentage of the production was bort, and material suitable for cutting amounted to only about 55 percent of comparable production in 1932. Although the South African pipe mines were shut down and most other producers curtailed their production, further curtailment appears necessary. Even if world demand increases, there is a considerable stock to liquidate.

Diamond producers have been in a difficult position for the past 4 years; many companies have closed down, and a few weak ones have been liquidated. This has been due partly to loss of sales volume but largely to low prices received for the product, companies producing finer stones having suffered most. However, prices received by producers in 1933 were better than those obtained in 1932. Further "seconds" appeared on the market from time to time; for instance, in February and March 1933 old cut stones from Russia reached Paris and Antwerp, although this source must soon be exhausted.

*South African conference.*—On May 22, 1933, Patrick Duncan, Minister of Mines of the South African Government, Sir Ernest Oppenheimer, and other representatives of the larger South African mines began a conference which reached a provisional agreement in September, replacing the Inter-Producers' agreement and the latter's sales agreement with the corporation. Although still unsigned, its articles are now operative. The Union Government, the Administrator of South-West Africa, the Diamond Corporation, and the principal producers are to form a Diamond Producers' Association with a board composed of 2 representatives of the companies, 1 of the Union Government, 1 of the South-West African administration, and 1 of the Diamond Corporation. Stocks are to be sorted at a single office at Kimberley, and sales quotas for each producer, including the Government as one of the producers, are established. Sales are to be made through The Diamond Trading Co., Ltd., controlled by the corporation, including sales to South African cutters (at London prices less the export tax). The board, to maintain prices, can purchase alluvial goods in the open market. The first shipment under the agreement is to be shown in London in March 1934. The representatives of the coalition government throughout the negotiations showed their desire to safeguard the stability of the diamond industry. Apparently it is understood that for the time being the cutting industry in South Africa is not to be expanded, that few new alluvial fields are to be opened to exploitation during the depression, and that the Government accepts a quota for its Namaqualand mines. The Diamond Corporation, to allay fear that its stock might be thrown upon the market, agreed to consider itself a producer and like other producers to accept a sales quota. In other words, the stock will be liquidated over a period of years. Early in October Mr. Havenga, Minister of Finance for the Union, stated that once demand improved markedly the Government would forego its Namaqualand quota in favor of the Kimberley, Jagersfontein, and Koffiefontein pipe mines.

It is expected that the selling quotas will be as follows: South African Government 10 percent, Diamond Corporation 31½ percent, De Beers 30 percent, Consolidated South-West Africa 14½ percent, Jagersfontein 6 percent, Premier 6 percent, and Cape Coast Exploration 2 percent.

*South African production.*—South Africa in 1933 produced 506,552.64 carats worth about £1,560,404. This is only 9 percent of the 1928 production. Outside of a few gems recovered from mine tailings (14,149 carats valued at £7,589) the production came from alluvial diggings, as all of the pipe mines were shut down.

The production during the last half of the year somewhat exceeded that of the first half due to better average prices. Transvaal and Cape Colony each furnished about 49 percent of the total value and the Orange Free State the remainder; Transvaal, however, produced about 73 percent of the quantity in carats and Cape Colony 23 percent.

*Production and sales of diamonds in South Africa, 1933*

| | Production | | Sales | | |
|---|---|---|---|---|---|
| | Carats | Value [1] | Carats | Value | Value per carat |
| | | | | | S. d. |
| Transvaal | 371, 243 | £757, 433 | 414, 686 | £862, 472 | 41 7 |
| Cape Colony | 118, 548 | 776, 622 | 170, 084 | 952, 812 | 112 0 |
| Orange Free State | 16, 760 | 26, 349 | 61, 273 | 108, 563 | 35 5 |
| | 506, 551 | 1, 560, 404 | 646, 043 | 1, 923, 847 | 59 7 |

[1] Estimated.

The only pipe production, that from debris washing, was from the Cape—3,022 carats, valued at £2,523 (16s. 8d. per carat)—and from the Orange Free State—11,127 carats, valued at £5,066 (9 s. 1d. per carat).

*Production of diamonds in South Africa in 1933, by alluvial fields*

| Field | Carats | Value | Value per carat | Field | Carats | Value | Value per carat |
|---|---|---|---|---|---|---|---|
| Transvaal: | | | S. d. | Cape Colony—Con. | | | S. d. |
| Klerksdorp | 57, 057. 75 | £253, 668 | 88 11 | Taungs | 22. 75 | £104 | -------- |
| Lichtenburg | 304, 858. 00 | 493, 402 | 32 4 | Gordonia | 366. 50 | 1, 916 | -------- |
| Pretoria | 9, 327. 50 | 10, 363 | 22 3 | Kenhardt | 15. 25 | 52 | -------- |
| | 371, 243. 25 | 757, 433 | 40 10 | | 114, 169. 50 | 772, 640 | 135 4 |
| Cape Colony: | | | | Orange Free State: | | | |
| Kimberley | 8, 482. 75 | 47, 148 | 111 2 | Boshof | 2, 231. 50 | 10, 977 | 98 5 |
| Namaqualand | 50, 687. 45 | 393, 221 | 155 2 | Winburg | 2, 964. 40 | 7, 955 | 53 8 |
| Barkly West | 43, 778. 00 | 269, 891 | 123 4 | Hoopstad | 194. 00 | 1, 170 | 120 7 |
| Herbert | 6, 711. 00 | 33, 822 | 100 10 | Kroonstad | 153. 26 | 709 | 92 6 |
| Hay | 61. 50 | 360 | 117 1 | Bethulie | 9. 50 | 30 | -------- |
| Prieska | 1, 003. 50 | 6, 913 | 137 9 | Vredefort | 46. 01 | 307 | -------- |
| Hopetown | 2, 305. 30 | 17, 343 | 150 6 | Philippolis | 34. 75 | 135 | -------- |
| Mafeking | 699. 75 | 1, 674 | 47 10 | | | | |
| Vryburg | 35. 75 | 196 | -------- | | 5, 633. 42 | 21, 283 | 75 7 |

To December 31, 1933 South Africa has had a total recorded production (in addition to stolen and smuggled stones) of diamonds valued at some £310,200,000, or well over one-fourth of its gold production and almost one-fifth of its total mineral output. During the

14 years, 1920–33, South Africa has produced 33,581,481 carats and sold 29,951,531, an excess production of 3,629,950 carats. The lack of balance between production and sales, which was first apparent in 1927, was due to the exploitation of the Lichtenburg and Namaqualand alluvial fields. Exports in 1932 were £1,955,523 and in 1933 about £2,075,000.

Due to better average prices 1933 was a less distressing year among the alluvial miners than 1932, and by midsummer higher prices increased somewhat the number of diggers. The Government has assured the industry that few new alluvial areas will be thrown open to mining until the depression is over, a policy generally followed in 1933. On April 28, 1933 claims, rendered void, on the Grasfontein diggings, Lichtenburg district, became relocatable to qualified citizens. On June 17 the farms Nooitgedacht and Winkelhoek in the Zwartruggens district, Transvaal, were proclaimed alluvial diggings. In addition to the owners' and discoverers' rights, 1,212 claims were to be allotted by ballot on July 14 to 606 diggers qualified by residence in the Lichtenburg, Klerksdorp, and Rustenburg districts. Late in 1933 a syndicate composed of Standerton people found diamonds on the farm Vaalbank on the Vaal River, east of Vereeniging.

On January 17, 1934 general interest was aroused by the finding of the Jonker Diamond at Elandsfontein near the Premier mine, the surprise being the greater as the field was considered a low-grade one. This egg-shapped stone, said to be flawless and of fine color, weighs 726 carats and is the fourth largest diamond ever found. It was sold to Sir Ernest Oppenheimer, representing the Diamond Corporation, for £63,000 or about $434 a carat, an extremely high price for rough stones, particularly as the loss in cutting will be high. That such a reward came to an old digger down on his luck is one of the romances of diamond mining. The state benefitted to the extent of £27,600 by the sale. A 287-carat stone had been found on the same diggings a few days before by another digger named Pohl. Naturally, a rush to the field followed, but most were disappointed as claims have been allotted only to those with residential qualifications.

To indicate how recent large-scale diamond mining is it may be recalled that Erasmus Stephanus Jacobs, who as a small boy in 1867 found the first South African diamond, died at Beaconsfield, South Africa, in May 1933.

During 1933 the South African Government Namaqualand mines were operated on a reduced scale; emphasis was centered on better recovery and prevention of theft and on development to areas covered by deep overburden. Recent Namaqualand production has been as follows:

| Year | Carats | Value | Value per carat |
|---|---|---|---|
| | | | £ s. d |
| 1929 | 265,844 | £1,748,465 | 6 11 6½ |
| 1930 | 142,125 | 1,274,364 | 8 19 4 |
| 1931 | 137,895 | 940,946 | 6 16 4 |
| 1932 | 99,196.6 | 643,795 | 6 9 10 |
| 1933 | 50,687.45 | 393,221 | 7 15 2 |

De Beers Consolidated Mines, by far the most important unit of diamond production, Premier, New Jagersfontein, and the other underground ("pipe") mines of South Africa were shut down during the year, but most of them bettered their financial position through sales of stones on hand. New Vaal River, a producer of fine river stones, declared the first dividend in 1933 that has been paid since 1928. Nooitgedacht Diamonds, one of the newer alluvial mining companies, paid a maiden dividend. Cape Coast Exploration, while its Namaqualand property is temporarily down, made a reasonable profit in 1933 and paid an initial dividend on January 26, 1934.

*Belgian Congo-Angola.*—The Central Africa diamond field (Belgian Congo and Angola) began to show the effects of the curtailment program begun in the fall of 1932 and had a smaller production than in 1932, but for the third year in succession it was the largest diamond producer of the world, although the value of its production was surpassed by that of South Africa. In 1932 this field's total production passed the all-time production of India and in 1933 that of Brazil.

By the introduction of machinery the mines are reducing costs and the labor force necessary for operation. Giants sluice off the overburden at a number of mines. Late in 1933 the Belgian Congo export tax was reported to have been increased from 3 to 6 percent. All six operating companies are dividend payers and have a long life before them.

The Forminière (Société Internationale Forestière et Minière du Congo) is the original company; besides important diamond production, it has interests in Congo tin, gold mining, plantation, trading, and ranching enterprises. Since its foundation the company has paid the colony over 193,000,000 francs, and the stockholders have received about 82,500,000 francs. In addition, the company has spent over 47,000,000 francs in road building and in a sanitary campaign. Dividends paid stockholders have more than doubled their original investment. Diamond production for the past 5 years has been approximately as follows: 1929, 324,000 carats; 1930, 328,000 carats; 1931, 429,000 carats; 1932, 490,000 carats; and 1933, estimated 402,600 carats. In 1933 an average of 16 mines was operated compared to 23 in 1932.

Beceka (Société Minière du Beceka) produces industrial diamonds mainly, less than 10 percent of its production being suitable for cutting. Its production in 1929 was 1,400,000 carats, in 1930 about 1,969,500 carats, in 1931 about 2,885,095 carats, in 1932 about 3,188,000 carats, and in 1933 1,413,500 carats (estimated).

Kasai-Luebo-Lueta companies (Société Minière du Kasai, Société Minière du Luebo, Société Minière du Lueta) exploit their concession as a unit through the Forminière, an interesting example of profitable unit operation of three properties which if operated separately would be doubtfully profitable.

In the gold placers of northeastern and eastern Congo a few rather fine diamonds are recovered as a byproduct. To the west of the Kasai field the Sobemco (Société de Recherches Minières au Congo) late last year found diamonds in the upper drainage of the Wamba River.

In Portuguese West Africa the Forminière groups and English (the Oppenheimer group), French, and Portuguese financiers own

Diamang (Companhia de Diamantes de Angola). Operating results in recent years were as follows:

*Results of diamond operations in Portuguese West Africa, 1927–32*

| Year | Cubic meters treated | Carats produced | Carats per cubic meter | Net profit | Dividend per £ share |
|---|---|---|---|---|---|
| | | | | | *s.* |
| 1927 | 203,492 | 201,511 | 0.99 | £108,433 | 1 |
| 1928 | 231,980 | 237,511 | 1.02 | 109,110 | 1 |
| 1929 | 264,323 | 311,933 | 1.18 | 122,032 | 1 |
| 1930 | 341,708 | 329,823 | .97 | 109,480 | 1 |
| 1931 | 397,526 | 351,495 | .89 | 105,949 | 1 |
| 1932 | 407,945 | 367,334 | .90 | 107,908 | 1 |

The 1933 production is estimated at about 373,600 carats, notwithstanding curtailment begun about October 1, 1932. In 1933, 100 whites and 5,011 blacks were employed. From the formation of the company in 1917 to December 31, 1933 the production has been 3,031,250 carats. The Diamang field is in the northeast corner of the colony. Diamonds also occur, although not in commercial quantities, in the extreme southwest corner, the south-central part and the eastern part of the colony.

*Gold Coast.*—The Gold Coast diamond deposits, discovered in February 1919, are said to be known over an area of some 20,000 square miles. The stones are small (15 to 25 per carat) but of good quality. The largest diamond yet found weighed 9 carats and was worth £15. 5s. The total exports from 1919 to 1933 have been 5,001,460 carats valued at £3,956,594. The estimated gross production in 1933 was about 1,100,000 carats.

All exploitable deposits so far known occur in the Birrim Valley, although a few stones have been found at several other places in the colony. The diamonds occur in stream gravels and drift overlying pre-Cambrian schists, basic lava members in the latter being considered the source. Costs of the principal producers per carat have been reduced appreciably. The producers in 1933 were the Consolidated African Selection Trust, West African Diamond Syndicate, the Holland Syndicate and Cayco (London), Ltd., and the Akim Ashanti Mining Co. Markwa, Ltd., owns five mining leases in the Birrim Valley.

The predominant producer is the Consolidated African Selection Trust, with concessions covering approximately 54 square miles in the Birrim Valley. It also owns about 32 percent of the stock of Cape Coast Exploration in Namaqualand and has valuable diamond deposits in Sierra Leone. The latter produce relatively large stones, so that the company will present for sale a good assortment in sizes. In the Gold Coast it employs about 18 whites and 1,200 blacks. The company does not give out production figures but, in addition to storing some "rubbish" in Africa, it exports about 630,000 carats. The year 1933 is reported to have been satisfactory and the company is increasing its dividend.

The West African Diamond Syndicate in 1933 produced about 220,000 carats, a slight decrease compared to the 228,000 carats produced in 1932. The company treats its concentrates in a two-stage magnetic separator and has decreased theft by concentrating all diamond picking at a single station to which concentrates are sent in locked containers.

*South-West Africa.*—The mandated area of South-West Africa has been particularly hard hit by the world depression, as it depended largely for its revenue upon copper and diamond mining, the latter usually accounting for 45 to over 60 percent of the exports. Revenue from copper and diamonds, which was £240,000 in 1926, fell to £10,348 in 1932–33. Production of diamonds in recent years is given in the following table:

*Production and sales of diamonds in South-West Africa, 1926–32*

| Year | Production | | | Sales | | |
|---|---|---|---|---|---|---|
| | Carats | Value | Stones per carat | Carats | Value | Value per carat |
| | | | | | | *S. d.* |
| 1926 | 683,801 | | 6.7 | 726,808 | £2,050,688 | 56 5 |
| 1927 | 723,877 | | 5.9 | 577,341 | 1,620,862 | 56 2 |
| 1928 | 503,142 | | 6.3 | 564,383 | 1,389,864 | 49 3 |
| 1929 | 597,187 | | 5.3 | 533,101 | 1,617,698 | 60 8 |
| 1930 | 415,047 | | 5.8 | 214,036 | 640,253 | 59 10 |
| 1931 | 71,532 | £208,081 | 4.8 | 103,000 | 300,000 | 58 2 |
| 1932 | 17,944 | 85,503 | .9 | 44,000 | 211,000 | 95 4 |

The principal producer, Consolidated Diamond Mines of South-West Africa, shut down its mine in 1932, although in 1932 and 1933 it continued successful development work north of the Orange River. When times again become better it will be one of the first companies participating in the Diamond Corporation to recover, as the company has large reserves of a well-varied assortment of diamonds which can be mined cheaply.

*Miscellaneous producers.*—Due to low diamond prices many persons have turned to gold mining; in consequence, British Guiana's diamond production was small in 1933. The colony has built a road into the Potaro River field and is to build a branch therefrom to the Mazaruni field. State aid is being given to some of the gold and diamond miners.

"Gemstones" (Imperial Institute, London, 1933) gives the following estimates of Brazil's diamond production:

| Year | Gem (carats) | Low grade and bort (carats) | Carbonado (carats) | Year | Gem (carats) | Low grade and bort (carats) | Carbonado (carats) |
|---|---|---|---|---|---|---|---|
| 1928 | 65,000 | 100,000 | 25,000 | 1931 | 30,000 | 50,000 | 10,000 |
| 1929 | 50,000 | 75,000 | 19,000 | 1932 | 15,000 | 19,000 | 3,000 |
| 1930 | 45,000 | 70,000 | 17,500 | | | | |

Matto Grosso and Goyaz were the principal producers, followed by Bahia, Minas Geraes, and Parana. The 1933 production probably did not exceed that in 1932. In September 1933 it was rumored that stones of extraordinary size, said to be diamonds, had been found recently near the headwaters of the Saobento River, Minas Geraes.

One was said to weigh 2,700 carats and another 400 carats, and five other large stones were reported.

Diamonds were first found in Sierra Leone by members of the Colonial Geological Survey in 1930. They occur in the gravel of Kenja River and in the Kono district near the French Guinea border. Prospecting was begun in 1931 by the Consolidated African Selection Trust, the principal producer on the Gold Coast. Late in 1932 the company applied for a mining lease on 252 acres, and in 1933 the colonial government announced that an agreement providing for exploitation of the diamond deposits and marketing of the product was to be signed with the company. The colony is to participate in the profits of this monopoly. Consolidated will form a separate company to work the Sierra Leone deposits. The first stones, which are of excellent quality and good size, were exported in October 1932. Exports in 1932 amounted to 749 carats valued at £1,565 or £2 1s. 10d. per carat. The 1933 production was 32,017 carats worth some £82,000 or about 53s. per carat. The production for the first 9 months came from Shongbo, but in September a second deposit was opened up. An average of about 125 men was employed in prospecting.

The 1933 production of Tanganyika Territory, a declining producer, was about 1,250 carats valued at about £2,730. The principal production has come from the Mabuki gravel deposit. Kimberlite occurs near Mabuki and in the Shinyanga district some 60 miles to the south, and of the 20 known occurrences some are slightly diamondiferous. The colony's total production has been about 100,000 carats, the largest stone weighing 92.5 carats. The principal producer has been the Tanganyika Diamonds, Ltd., which more recently has turned to gold mining.

The first diamond in French Equatorial Africa was found in 1915 near Ippy in the Oubangui-Chari region, but the discovery was unimportant. In 1928, however, a geologist of the Compagnie Equatoriale de Mines found somewhat more important deposits north of Bria.[1] Other reports suggest that the deposits owned by the Equatoriale or its subsidiaries are of small yardage and not of high content. In 1930 washing tests were begun, and in 1931 diamonds were recovered in prospecting. Production has been as follows: 1930, 34 carats; 1931, 1,260 carats; and 1932, 1,644 carats. French official sources report that due to low prices the mines were shut down in 1932. The stones are of good quality, averaging about one-fifth carat each. The stones now found in the stream gravels were components of a conglomerate lens in sandstone, resembling the Congo Lubilash formation. The original source of the diamond is unknown, but Dr. Polinard considers its derivation from a basic igneous rock improbable. The geologic, although not the commercial, similarity to the Kasai (Belgian Congo) deposits is striking. Other stones are reported to have been found in French Equatorial Africa about 120 miles farther north.

Diamonds have been reported to exist on the Ivory Coast. A small stone or stones have been found in the Kakamega gold field, Kenya.

India, once the premier diamond producer of the world, now has a production of only about 675 carats a year. In 1931 it produced 639 carats, worth £2,569 (80s. 5d. per carat), and in 1932, 1,254 carats. For some time the Penna State, central India, has been the principal

[1] Middleton, J. L., Diamonds in Equatorial Africa: Eng. and Min. Jour., May 1932, p. 285.

producer. India now imports a considerable quantity of diamonds, recent imports being as follows:

| | |
|---|---|
| 1928 | £654, 259 |
| 1929 | 654, 413 |
| 1930 | 377, 936 |
| 1931 | 304, 529 |
| 1932 | 428, 855 |

Borneo, once an important diamond producer, still furnishes a few stones, and its cutting industry imports a fair quantity of rough stone from South Africa. During the past 10 years its production has averaged about 460 carats. The 1931 production was 294 carats worth £1,663 (113 s. per carat) and that of 1932, 274 carats.

New South Wales in 1930 produced 677 carats (worth £714); in 1931, 725 carats (worth £694); and in 1932, 251 carats (worth £252). The price, about 20 shillings per carat, does not indicate very fine stones.

Rhodesia had produced from the year of discovery, 1903, to December 31, 1933, some 15,781 carats, worth £75,253. In 1932 and 1933 there was no production, and the only commercial deposit, Samabula Forest, appears to be about exhausted.

Production from near Murfreesboro, Ark., United States of America, was about 300 carats of diamonds and bort in 1932. The mines were not operating in 1933.

Venezuela presumably produced a few hundred carats of diamonds in 1933 from the region contiguous to British Guiana.

*Industrial diamonds.*—The demand for diamonds for industrial purposes is a good barometer of business activity, and the increased sales in 1933, first noted in Germany and later in America and England, indicate world revival of business. There is a scarcity of industrial stones, as the South African pipe mines are shut down and Brazilian carbonado production was only one-third of normal. Demand became good in March and continued rather strong throughout the year, with shortages in better grades.

Imports of industrial diamonds into the United States during the past 8 years are given in the following table. The price per carat has fallen from 1929 to date due to the larger imports of very small and hence low-priced, off-color gem stones for diamond drilling.

*Industrial diamonds imported into the United States, 1926–33* [1]

| Year | Carats | Value | Value per carat | Year | Carats | Value | Value per carat |
|---|---|---|---|---|---|---|---|
| 1926 | 41, 475 | $1, 939, 735 | $46. 77 | 1930 | 145, 958 | $2, 756, 630 | $18. 89 |
| 1927 | 34, 645 | 2, 149, 912 | 62. 06 | 1931 | 224, 970 | 2, 400, 879 | 10. 67 |
| 1928 | 38, 342 | 2, 756, 895 | 71. 90 | 1932 | 163, 704 | 1, 061, 823 | 6. 48 |
| 1929 | 46, 901 | 4, 060, 577 | 86. 58 | 1933 | 258, 300 | 1, 246, 748 | 4. 83 |

[1] Includes glaziers', engravers', and miners' diamonds.

Several makers of oil-burning furnaces find the best possible atomizer is a diamond with a hole bored in it. Ordinary nozzles have a short life, but even without resetting a diamond nozzle will last 5 years. In laboratory tests under high temperature, oil charged with carborundum and containing 1 percent sulphuric acid was forced under pressure through the orifice in the diamond. Such a test, together with the fact that diamond tools are used in truing carborundum wheels, shows the great difference in hardness of the two substances. The diamonds used are off-color gem stones, and holes in them are generally from 0.013 to 0.0025 inch in diameter. As several important makers of oil burners have standardized on such nozzles and as about 1 family in 30 in the United States has an oil burner, the quantity of industrial diamonds likely to be consumed in this new use may be large.

For a number of years attempts have been made to introduce diamonds more generally in the superabrasive field. A great deal of experimental work has been done in an effort to shape diamond dust or grains held together by a suitable binder into grinders, lapping wheels, tools, etc. Until recently, attempts to find a suitable binder have been unsuccessful, but at present Swiss and German manufacturers are marketing such products, which are reported to be giving satisfactory service.

The use of diamonds in the automobile industry is expanding, as it is in many scientific processes, such as testing heat-hardened metal parts, testing smoothness of metallic automobile parts, and preparing microscopic slides.

The demand for black diamonds (carbonado) was much less in 1933 than a couple of years ago owing to the use of small gem stones in diamond drilling. The price of carbonado has decreased markedly in the same period; 2-carat stones selling for $175 per carat in 1929 now are worth about $75 to $90. Carbonado, which once brought $65 a carat in the Bahia fields, late in 1931 brought $30 a carat and in 1933, $12 to $20 a carat. Brazilian production and exportation has decreased greatly, and small shipments only reach the Amsterdam market. As carbonado has a definite place in truing wheels and other industrial uses, there is always a certain demand, and available stocks are small.

## AMBER

Sales of amber increased greatly in 1933 and as stocks were reduced the German amber-mining industry expanded markedly early in 1934. At Palmmicken, East Prussia, the principal center, 375 men are employed, and they are working 40 rather than 20 hours a week.

The South Manchurian Railway engineers estimate that the coal deposits of Fushun contain about 435,000 tons of amber. At present about 4 tons a day are being produced. The amber is used almost exclusively in making lacquer and suffices for about one-half of Japan's requirements.

## AMETHYST

Early in 1933 a Mexican company began to exploit amethyst deposits northwest of Taxco, Guerrero. Some of the material is reported to be fine and is in demand among local jewelers.

## EMERALD

Colombia for centuries has been the source of the world's finest emeralds. In 1933 the Muzo mine, which has been shut down for some years, was reopened with a production worth about $25,000. This was done under the direction of P. W. Rainier, Government mining engineer, who also sampled the debris from former mining with favorable results. An American group markets the production of the Government mines by contract on a commission basis. The Colombian Emerald Co. produced from its Chivor mine about 4,000 carats in 1933.

## SAPPHIRE

A number of miners worked the Anakie (Queensland) sapphire fields in 1933, the most active center being Iguana Flat. The production approximated £4,000. First blues in the rough sold for £7 per ounce and second blues for 7 shillings per ounce. Most of the product was exported to France and Switzerland. Among the more notable finds were a blue sapphire of 498 carats and a zircon of 259 carats.

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# PART IV. MINE SAFETY

## SAFETY IN MINING

By D. Harrington [1]

SUMMARY OUTLINE



Although it is impossible to give definite final figures at this time on Nation-wide accident occurrence in 1933, sufficient data are at hand to indicate that the progress in safety in the mining industry, which first became apparent in 1930 and was accentuated in 1931 and 1932, was continued and much improved in 1933. This improvement was of considerable magnitude in coal mining, both bituminous and anthracite, but was not so distinctive in other branches of the mining industry. Although there was a considerably increased volume of work done in all phases of mining in 1933 over that done in 1932, the exact amount of the increase is not yet known. Usually increasing activity in mining is accompanied by even greater increase in the rate of occurrence of accidents to the workers, but happily it appears that this "rule" was not operating in 1933—at least in the coal-mining industry.

### COAL MINING

Preliminary data compiled from figures furnished the Bureau of Mines through the various State mine inspectors, as well as by the operators, indicate that with 1,013 persons killed in the production of about 377,339,000 tons of coal, the year 1933 had by far the fewest number of persons killed in coal mining in the United States in any year of the present century, the previous low being in 1932, with 1,207 fatalities; and in addition the tentative fatality rate—2.68 per million tons of coal produced—is by far the lowest of which there is a record, the previous low being 3.31 in 1931.

The year 1933 was remarkable also in the fact that both anthracite and bituminous mining acted in unison to bring about the new all-time

[1] Statistics in this discussion compiled by W. W. Adams, L. E. Geyer, and M. E. Kolhos of the Demographical Division, Bureau of Mines.

low fatality rates. The tentative bituminous fatality rate for 1933 of 2.39 killed per million tons produced is the lowest in the history of the industry (782 persons being killed), and the tentative anthracite rate of 4.68 has a similar distinction (231 being killed).

States which had definitely improved occurrence of fatal accidents in 1933 over 1932 are Colorado (18 instead of 28), Illinois (71 instead of 119), Indiana (24 instead of 31), Iowa (6 instead of 18), Michigan (1 instead of 3), New Mexico (4 instead of 20), Oklahoma (7 instead of 11), Pennsylvania anthracite (231 instead of 249), Pennsylvania bituminous (141 instead of 162), Virginia (18 instead of 74), and West Virginia (248 instead of 267). States with poorer records for coal-mine fatalities in 1933 than in 1932 are Missouri (9 fatal accidents in 1933 and 7 in 1932), North Dakota (5 instead of 2), Ohio (52 instead of 36), Tennessee (14 instead of 9), and Wyoming (9 instead of 6). The coal mines operated in Idaho and Texas did not have a fatality in 1933. All these figures are preliminary or tentative for 1933 but are the final data for 1932 as given by the Demographical Division of the United States Bureau of Mines.

Falls of roof and coal caused 571 fatalities or about 56 percent of the 1,013 coal-mine fatalities for 1933, against 619 out of a total of 1,207 in 1932, with the percentage about 51. Notwithstanding this higher percentage of roof falls in 1933, the fatality rate from falls of roof and coal per million tons of coal produced in 1933 was but 1.513 against 1.732 in 1932. The higher percentage of roof-fall accidents in 1933 was due chiefly to the fact that very few deaths occurred from explosions of gas or dust last year, thus automatically increasing the percentages of the other main causes of fatal accidents in the coal mines, even though the rate of accident occurrence for those causes was in some instances lowered.

Haulage caused 188 fatalities in 1933, or over 18 percent of the total for the year, against 180 in 1932, or approximately 15 percent of that year's total. The rate of occurrence of haulage fatalities per million tons of coal produced in 1933 was 0.498—very little change from the rate of 0.500 for 1932.

In fatalities from gas and dust explosions, 1933 established new low records, there being but 39 fatalities from this source, constituting but 3.8 percent of the fatalities for the year instead of the average of about 14 percent for the past 10 years; in the previous year there were 169 fatalities from this cause, about 14 percent of the total for that year. The fatality rate from explosions of gas or dust per million tons of coal produced in 1933 was but 0.103, whereas that of 1932 was 0.470. The vast improvement in our coal mines with respect to occurrence of explosions and of fatalities from them may be seen from the following data: In the 5 years 1906–10, inclusive (or those immediately preceding the functioning of the United States Bureau of Mines as an agency looking to the advancement of safety in mining) there were 84 major coal-mine explosion disasters in the United States (a major disaster being one causing the loss of 5 or more lives), this being at the rate of almost 17 major coal-mine disasters per year; in 1933 but 1 major disaster occurred in the coal mines of the United States and that one cost 7 lives. Fatalities from explosions of gas or dust caused 2,388 fatalities in the coal mines of the United States in the 5-year period 1906–10, inclusive, or about 478 annually, whereas in 1933 only 39 persons were killed in both major and minor coal-mine explosions in the United States. If the fatality rate from coal-mine explosions of 1.059 persons killed per million tons produced in the 5-year period 1906–10, inclusive, had continued to the 1st of January 1934, there would have been 13,340 fatalities from explosions of gas or dust in our coal mines instead of the 6,378 which actually occurred according to available statistics; if the 1.059 rate had been in effect in 1933 there would have been nearly 400 persons killed in our coal mines by explosions instead of the 39 as given in the tentative figures now at hand.

Explosives caused but 28 fatalities in our coal mines in 1933 (about 2.7 percent) against 36 in 1932, the percentage being about 3. The fatality rate from the use of explosives per million tons of coal produced in our coal mines in 1933 was 0.074, or somewhat lower than the rate of 0.100 of the previous year. These figures do not, however, include fatalities in explosions of gas or dust initiated by or through explosives.

Fifty-five persons were killed in or around our coal mines in 1933 from electricity, the percentage of the total fatalities being about 5.4; in the previous year 47 were killed from this cause, the percentage of total fatalities for the year being about 4. The fatality rate from electricity on the million-ton production basis in 1933 was 0.146, while that of 1932 was 0.1310. In neither 1932 nor 1933 does the number of accidents from electricity or the fatality rate include fatalities from explosions of gas or dust caused by electricity; however, both 1932 and 1933 were remarkable in the relatively few fatalities in the coal mines of the United States in explosions of electrical origin, contrasting favorably in this respect with the years 1927 to 1931, inclusive, every one of which had a black record in fatalities from explosions of electrical origin.

In 1933 only 16 persons are known to have been killed in or around mines by or through machinery, this being but about 1½ percent of the total and being much more favorable than the 28 killed from the same cause in 1932, the percentage of the total of that year being about 2.3. The fatality rate on the million-ton basis from machinery accidents in 1933 was 0.043 and was 0.078 in 1932. These figures do not include fatalities from machinery in which haulage accidents were involved or fatalities from machinery in which electricity initiated explosions of gas or dust.

Surface and miscellaneous accidents caused 116 fatalities in 1933, or about 11.4 percent of the total for the year, 128 having been due to the same causes in 1932, the percentage of the total being about 10.6.

The 1,013 fatalities (the tentative total) in the coal mines of the United States in 1933 constitute the smallest number of fatalities in any year in the coal mines of this country during the present century, and the tentative rate of 2.68 fatalities per million tons of coal produced is by far the lowest (or best) fatality rate in the recorded history of coal mining in the United States. The fatality rate per million tons of coal produced for the 5-year period 1906–10, inclusive, was 5.89, for the next 5-year period (1911–15) it was 4.76, for the next (1916–20) it was 3.86, for the next (1921–25) it was 3.96, and for the next (1926–30) it was 3.75. The rate was 3.31 for 1931 and 3.36 for 1932; the foregoing therefore indicates that the 2.68 (tentative) rate for 1933 is by far the best rate in the past 27 years.

During the 5-year period 1906–10 (preceding the functioning of the Bureau of Mines) 13,288 persons were killed in the coal mines of the United States, an average of 2,658 per year, or more than 2½ times the 1,013 killed in 1933 in the coal mines of this country. If the fatality rate of 5.89 per million tons of coal produced, which applied to the 5-year period 1906–10, had continued in effect to January 1, 1934, the number of fatalities for the period 1911 to 1933, inclusive, would have been 24,300 greater than those actually occurring. Hence, because of numerous factors, one of the most effective of which is the safety work of the United States Bureau of Mines, the lives of more than 1,000 workers in and around the coal mines of the United States have been saved annually during the period that the Bureau of Mines has been in existence. If the 5.89 coal-mining fatality rate of the 1906–10 period had been in effect in 1933, instead of the approximately 1,013 deaths which did occur the number would have been about 2,225, which indicates rather vividly the fact that present-day coal-mine safety is much advanced compared with the "good old days" of 1906–10.

All the foregoing data as to the occurrence of fatalities in United States coal mines during 1933 are based on tentative or preliminary figures which probably will be slightly revised upon receipt of additional belated information from some States. Final figures on 1933 will probably not be available until late in the fall of 1934.

All the foregoing data have been based upon fatalities and on coal tonnage because information on these items of coal-mining operations is fairly quickly available in tentative form after the expiration of the calendar year. Final figures not only as to coal-mine fatalities and tonnage but also as to nonfatal accidents, man-hours of exposure, etc., for 1932 were released in January 1934 and have some interest in connection with the tentative figures for 1933 as given previously in this chapter.

The following table gives data as to number of mines, tonnage, number employed, and average days of exposure per man in the coal mines of the various States of the United States in 1932. Slight differences, if any, between accident figures published by the United States Bureau of Mines and those published by the mine officials of some States are due to differences in defining a mine accident or to variations in classes of mines canvassed.

TABLE 1.—*Summary of number of mines, coal produced, men employed, and days of exposure per man per year in producing and nonproducing coal mines, in 1932, by States*

| State | Number of mines | Coal produced (short tons) | Men employed | | | | Average days of exposure per man |
|---|---|---|---|---|---|---|---|
| | | | Underground | Open-cut | Surface | Total | |
| Alabama | 194 | 7,856,939 | 17,734 | 112 | 2,597 | 20,443 | 107 |
| Alaska | 7 | 102,700 | 70 | | 50 | 120 | 189 |
| Arkansas | 65 | 1,033,471 | 3,736 | 50 | 539 | 4,325 | 92 |
| Colorado | 231 | 5,598,721 | 7,348 | 14 | 1,387 | 8,749 | 142 |
| Illinois | 588 | 33,474,553 | 39,998 | 1,693 | 5,906 | 47,597 | 112 |
| Indiana | 162 | 13,323,573 | 7,629 | 1,592 | 1,418 | 10,639 | 145 |
| Iowa | 212 | 3,862,435 | 7,180 | 107 | 799 | 8,086 | 151 |
| Kansas | 147 | 1,952,885 | 2,630 | 625 | 336 | 3,591 | 130 |
| Kentucky | 439 | 35,299,582 | 35,760 | 30 | 6,477 | 42,267 | 155 |
| Maryland | 80 | 1,428,937 | 2,748 | | 357 | 3,105 | 150 |
| Michigan | 5 | 446,149 | 852 | | 88 | 940 | 159 |
| Missouri | 205 | 4,069,598 | 4,111 | 890 | 676 | 5,677 | 161 |
| Montana | 62 | 2,125,225 | 1,139 | 47 | 339 | 1,525 | 145 |
| New Mexico | 42 | 1,263,386 | 2,225 | | 377 | 2,602 | 127 |
| North Dakota | 147 | 1,739,658 | 696 | 304 | 311 | 1,311 | 186 |
| Ohio | 562 | 13,909,451 | 20,254 | 300 | 2,726 | 23,280 | 127 |
| Oklahoma | 93 | 1,255,466 | 2,389 | 217 | 457 | 3,063 | 120 |
| Pennsylvania, bituminous | 1,119 | 74,775,862 | 92,927 | 97 | 11,508 | 104,532 | 153 |
| Tennessee | 75 | 3,537,882 | 6,445 | | 1,080 | 7,525 | 148 |
| Texas | 19 | 636,590 | 565 | 27 | 107 | 699 | 152 |
| Utah | 39 | 2,852,127 | 2,155 | | 687 | 2,842 | 176 |
| Virginia | 76 | 7,692,180 | 8,760 | | 1,616 | 10,376 | 144 |
| Washington | 63 | 1,591,426 | 2,284 | 4 | 528 | 2,816 | 160 |
| West Virginia | 740 | 85,608,735 | 72,679 | | 13,086 | 85,765 | 167 |
| Wyoming | 65 | 4,170,963 | 3,370 | 10 | 793 | 4,173 | 150 |
| Other States [1] | 36 | 101,378 | 190 | 49 | 93 | 332 | 118 |
| Total, bituminous | 5,473 | 309,709,872 | 345,874 | 6,168 | 54,338 | 406,380 | 146 |
| Pennsylvania anthracite | | 49,855,221 | 94,210 | 2,312 | 24,721 | 121,243 | 161 |
| Grand total: | | | | | | | |
| 1932 | | 359,565,093 | 440,084 | 8,480 | 79,059 | 527,623 | 149 |
| 1931 | | 441,750,978 | 496,973 | 8,491 | 84,241 | 589,705 | 168 |

[1] Includes Arizona, California, Georgia, Idaho, North Carolina, Oregon, and South Dakota.

Table 1 shows that the 309,709,872 tons of bituminous coal produced in 1932 came from 5,473 mines, Pennsylvania (bituminous) having the greatest number (1,119), West Virginia next with 740, Illinois third with 588, while Michigan had only 5 and Alaska only 7.

In number of persons employed Pennsylvania (anthracite) ranked first in 1932 with 121,243, Pennsylvania (bituminous) second with 104,532, and West Virginia third with 85,765; Alaska had 120, Texas 699, and Michigan 940.

West Virginia held first rank in 1932 in coal production with 85,608,735 tons, Pennsylvania (bituminous) second with 74,775,862 tons, Pennsylvania (anthracite) third with 49,855,221 tons, and Kentucky fourth with 35,299,582 tons. Table 2 gives data by States for man-hours of exposure in the coal mines of the United States in 1932.

TABLE 2.—*Summary of man-hours of exposure at producing and nonproducing coal mines in 1932, by States*

| State | Underground | Opencut | Surface | Total |
|---|---|---|---|---|
| Alabama | 17,095,760 | 98,340 | 2,793,156 | 19,987,256 |
| Alaska | 110,112 | | 71,248 | 181,360 |
| Arkansas | 2,758,552 | 37,500 | 381,056 | 3,177,108 |
| Colorado | 8,484,912 | 14,488 | 1,861,168 | 10,360,568 |
| Illinois | 34,327,698 | 2,507,317 | 5,616,775 | 42,451,790 |
| Indiana | 7,987,519 | 2,607,532 | 1,733,957 | 12,329,008 |
| Iowa | 8,701,383 | 113,860 | 975,431 | 9,790,674 |
| Kansas | 2,607,845 | 597,694 | 436,755 | 3,642,294 |
| Kentucky | 44,886,097 | 1,200 | 8,378,011 | 53,265,308 |
| Maryland | 3,275,776 | | 450,992 | 3,726,768 |
| Michigan | 1,094,344 | | 102,888 | 1,197,432 |
| Missouri | 5,231,804 | 1,275,645 | 872,632 | 7,380,081 |
| Montana | 1,265,611 | 73,068 | 439,420 | 1,778,099 |
| New Mexico | 2,238,305 | | 431,748 | 2,670,053 |
| North Dakota | 1,059,334 | 566,598 | 466,314 | 2,092,246 |
| Ohio | 20,353,201 | 487,467 | 2,928,658 | 23,769,326 |
| Oklahoma | 2,280,736 | 257,916 | 433,072 | 2,971,724 |
| Pennsylvania, bituminous | 113,849,458 | 114,430 | 14,420,424 | 128,384,312 |
| Tennessee | 7,907,099 | | 1,330,149 | 9,237,248 |
| Texas | 794,491 | 19,512 | 122,302 | 936,305 |
| Utah | 2,867,254 | | 1,139,281 | 4,006,535 |
| Virginia | 10,163,630 | | 1,853,618 | 12,017,248 |
| Washington | 2,857,017 | 3,264 | 748,740 | 3,609,021 |
| West Virginia | 97,928,404 | | 17,210,246 | 115,138,650 |
| Wyoming | 3,862,654 | 24,960 | 1,132,851 | 5,020,465 |
| Other States [1] | 192,496 | 51,968 | 81,988 | 326,452 |
| Total bituminous | 404,181,692 | 8,852,759 | 66,412,880 | 479,447,331 |
| Pennsylvania anthracite | 119,217,854 | 3,663,201 | 34,062,944 | 156,943,999 |
| Grand total: 1932 | 523,399,546 | 12,515,960 | 100,475,824 | 636,391,330 |
| 1931 | 670,051,882 | 12,937,803 | 121,404,445 | 804,394,130 |

[1] Includes Arizona, California, Georgia, Idaho, North Carolina, Oregon, and South Dakota.

Both tables 1 and 2 show that proportionately the anthracite mines have a much greater exposure than bituminous mines, as the anthracite mines of Pennsylvania produced only 49,855,221 tons of coal in 1932, or less than 14 percent of the Nation's coal tonnage but had 156,943,999 man-hours of exposure or nearly 25 percent of the total exposure of 636,391,330 man-hours. Pennsylvania (anthracite), with 119,217,854 man-hours, held first place in man-hours of exposure in 1932, Pennsylvania (bituminous) was second with 113,849,458 man-hours, West Virginia third with 97,928,404, and Kentucky fourth with 44,886,097. This tabulation shows that over 82 percent of the man-hours of exposure in and around the coal mines of the United States in 1932 represented underground workers, nearly 16 percent being for surface workers and about 2 percent for those employed in opencut operations. It also indicates that man-hours of exposure for 1932 as compared with 1931 remained about stationary for opencut operations, whereas there was about a 17-percent decrease for surface workers and nearly 22-percent decrease for underground employees. The total decrease of man-hours of exposure in the coal mines of the United States in 1932 compared with 1931 was nearly 21 percent.

Table 3 gives data by States, as to the number of the various kinds of fatal and nonfatal accidents that occurred in the coal mines of the United States in 1932, as well as the rate of both fatal and nonfatal accidents per million man-hours of exposure.

TABLE 3.—*Summary of fatal and nonfatal injuries and of accident rates per million man-hours of exposure in 1932, by States*

| State | Killed | Injured | | | | Rate per million man-hours | | |
|---|---|---|---|---|---|---|---|---|
| | | Permanent total disability | Permanent partial disability | Temporary | Total | Fatal | Nonfatal | Fatal and nonfatal |
| Alabama | 21 | 1 | 53 | 904 | 958 | 1.051 | 47.931 | 48.982 |
| Alaska | | | | 14 | 14 | | 77.195 | 77.195 |
| Arkansas | 4 | 1 | 4 | 145 | 150 | 1.259 | 47.213 | 48.472 |
| Colorado | 28 | 1 | 24 | 1,103 | 1,128 | 2.703 | 108.874 | 111.577 |
| Illinois | 119 | | 208 | 5,124 | 5,332 | 2.803 | 125.601 | 128.404 |
| Indiana | 31 | 7 | 37 | 1,838 | 1,882 | 2.514 | 152.648 | 155.162 |
| Iowa | 18 | | 9 | 920 | 929 | 1.838 | 94.886 | 96.724 |
| Kansas | 11 | 1 | 3 | 286 | 290 | 3.020 | 79.620 | 82.640 |
| Kentucky | 102 | 11 | 227 | 3,346 | 3,584 | 1.915 | 67.286 | 69.201 |
| Maryland | 3 | | 10 | 212 | 222 | .805 | 59.569 | 60.374 |
| Michigan | 3 | 1 | | 99 | 100 | 2.505 | 83.512 | 86.017 |
| Missouri | 7 | | 6 | 565 | 571 | .948 | 77.370 | 78.318 |
| Montana | 3 | | 3 | 134 | 137 | 1.687 | 77.049 | 78.736 |
| New Mexico | 20 | | 2 | 164 | 166 | 7.490 | 62.171 | 69.661 |
| North Dakota | 2 | | | 155 | 155 | .956 | 74.083 | 75.039 |
| Ohio | 36 | | 36 | 1,835 | 1,871 | 1.515 | 78.715 | 80.230 |
| Oklahoma | 11 | | 4 | 305 | 309 | 3.702 | 103.980 | 107.682 |
| Pennsylvania, bituminous | 162 | 11 | 141 | 9,432 | 9,584 | 1.262 | 74.651 | 75.913 |
| Tennessee | 9 | 1 | 22 | 372 | 395 | .974 | 42.762 | 43.736 |
| Texas | 1 | | | 184 | 184 | 1.068 | 196.517 | 197.585 |
| Utah | 10 | | 6 | 450 | 456 | 2.496 | 113.814 | 116.310 |
| Virginia | 74 | 2 | 58 | 778 | 838 | 6.158 | 69.733 | 75.891 |
| Washington | 9 | | 14 | 330 | 344 | 2.494 | 95.317 | 97.811 |
| West Virginia | 267 | 27 | 461 | 8,968 | 9,456 | 2.319 | 82.127 | 84.446 |
| Wyoming | 6 | 1 | 22 | 258 | 281 | 1.195 | 55.971 | 57.166 |
| Other States [1] | 11 | | | 16 | 16 | 3.063 | 49.012 | 52.075 |
| Total bituminous | 958 | 65 | 1,350 | 37,937 | 39,352 | 1.998 | 82.078 | 84.076 |
| Pennsylvania anthracite | 249 | 14 | 98 | 19,508 | 19,620 | 1.587 | 125.013 | 126.600 |
| Grand total: 1932 | 1,207 | 79 | 1,448 | 57,445 | 58,972 | 1.897 | 92.666 | 94.563 |
| 1931 | 1,463 | 98 | 1,773 | 78,478 | 80,349 | 1.819 | 99.888 | 101.707 |

[1] Includes Arizona, California, Georgia, Idaho, North Carolina, Oregon, and South Dakota.

From table 3 it appears that Pennsylvania (anthracite) mines held the unenviable position of first place in the number of injuries of all kinds (fatal and nonfatal) in coal mining in 1932, or 19,620, Pennsylvania (bituminous) being second with 9,584, West Virginia third with 9,456, and Illinois fourth with 5,332. West Virginia holds an unenviable position also in that it had the greatest number of permanent total disability injuries (27), Pennsylvania (anthracite) was second with 14, and Kentucky and Pennsylvania (bituminous) were tied for third place with 11 each. Inasmuch as permanent total disability accidents in at least some respects must be classed as even worse than fatalities, it is noteworthy that in 1932 the following States, insofar as available information indicates, had no permanent total disability injuries: Alaska, Illinois, Iowa, Maryland, Missouri, Montana, New Mexico, North Dakota, Ohio, Oklahoma, Texas, Utah, and Washington.

In the rate of fatal accidents per million man-hours in the coal mines of the United States in 1932 New Mexico, with 7.490, ranks the highest or poorest, Virginia second with 6.158, and Oklahoma third with 3.702, the average for the coal mines of the United States being 1.897, or slightly higher than the rate of 1.819 for 1931.

In the rate of nonfatal accidents per million man-hours in the coal mines of the United States in 1932, Texas with 196.517 ranks first (or poorest), Indiana second with 152.648, Illinois third with 125.601, and Pennsylvania (anthracite) a close fourth with 125.013. The rate for the United States as a whole in 1932 was 92.666, or somewhat better than the rate of 99.888 in 1931. It is significant that only 9 of the 26 States and Territories listed in table 3 as having produced coal in 1932 had a higher rate of nonfatal accidents per million man-hours than the average for the country as a whole (92.666). The States with the rate higher than that of the country as a whole are Texas (196.517), Indiana (152.648), Illinois (125.601), Pennsylvania (anthractie) (125.013), Utah (113.814), Colorado (108.874), Oklahoma (103.980), Washington (95.317), and Iowa (94.886).

United States coal mines had 1,207 fatal accidents and 58,972 nonfatal accidents in 1932—practically 49 nonfatal accidents to each fatality; this ratio in 1931 was about 55 nonfatal to each fatal accident. In the bituminous mines in 1932 the ratio was about 43 nonfatal to each fatal accident, and in the anthracite mines the ratio was about 79 nonfatal to each fatality.

Table 4 gives data by States as to the rate of both fatal and nonfatal accidents per million tons of coal produced in United States coal mines in 1932.

TABLE 4.—*Summary of accident rates per million short tons of coal mined, output per man-hour, man-hours per ton, length of work day, and hours per man per year in 1932, by States*

| State | Rate per million tons | | | Tons per man-hour | Man-hours per ton | Average hours per day | Average hours per man per year |
|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | Fatal and nonfatal | | | | |
| Alabama | 2.673 | 121.930 | 124.603 | 0.393 | 2.544 | 9.17 | 978 |
| Alaska | | 136.319 | 136.319 | .566 | 1.766 | 8.00 | 1,511 |
| Arkansas | 3.870 | 145.142 | 149.012 | .325 | 3.074 | 8.02 | 735 |
| Colorado | 5.001 | 201.475 | 206.476 | .540 | 1.851 | 8.34 | 1,184 |
| Illinois | 3.555 | 159.285 | 162.840 | .789 | 1.268 | 7.99 | 892 |
| Indiana | 2.327 | 141.253 | 143.580 | 1.081 | .925 | 8.00 | 1,159 |
| Iowa | 4.660 | 240.522 | 245.182 | .395 | 2.535 | 8.02 | 1,211 |
| Kansas | 5.633 | 148.498 | 154.131 | .536 | 1.865 | 7.82 | 1,014 |
| Kentucky | 2.890 | 101.531 | 104.421 | .663 | 1.509 | 8.16 | 1,260 |
| Maryland | 2.099 | 155.360 | 157.459 | .383 | 2.608 | 8.00 | 1,200 |
| Michigan | 6.724 | 224.140 | 230.864 | .373 | 2.684 | 8.00 | 1,274 |
| Missouri | 1.720 | 140.309 | 142.029 | .551 | 1.813 | 8.07 | 1,300 |
| Montana | 1.412 | 64.464 | 65.876 | 1.195 | .837 | 8.07 | 1,166 |
| New Mexico | 15.830 | 131.393 | 147.223 | .473 | 2.113 | 8.07 | 1,026 |
| North Dakota | 1.150 | 89.098 | 90.248 | .831 | 1.203 | 8.56 | 1,596 |
| Ohio | 2.588 | 134.513 | 137.101 | .585 | 1.709 | 8.01 | 1,021 |
| Oklahoma | 8.762 | 246.124 | 254.886 | .422 | 2.367 | 8.06 | 970 |
| Pennsylvania, bituminous | 2.166 | 128.170 | 130.336 | .582 | 1.717 | 8.01 | 1,228 |
| Tennessee | 2.544 | 111.649 | 114.193 | .383 | 2.611 | 8.29 | 1,228 |
| Texas | 1.571 | 289.040 | 290.611 | .680 | 1.471 | 8.82 | 1,339 |
| Utah | 3.506 | 159.881 | 163.387 | .712 | 1.405 | 8.00 | 1,410 |
| Virginia | 9.620 | 108.942 | 118.562 | .640 | 1.562 | 8.06 | 1,158 |
| Washington | 5.655 | 216.158 | 221.813 | .441 | 2.268 | 8.00 | 1,282 |
| West Virginia | 3.119 | 110.456 | 113.575 | .744 | 1.345 | 8.03 | 1,342 |
| Wyoming | 1.439 | 67.371 | 68.810 | .831 | 1.204 | 8.00 | 1,203 |
| Other States [1] | 9.864 | 157.825 | 167.689 | .311 | 3.220 | 8.32 | 983 |
| Total, bituminous | 3.093 | 127.065 | 130.158 | .646 | 1.548 | 8.09 | 1,180 |
| Pennsylvania anthracite | 4.994 | 393.540 | 398.534 | .318 | 3.148 | 8.05 | 1,294 |
| Grand total: | | | | | | | |
| 1932 | 3.357 | 164.009 | 167.366 | .565 | 1.770 | 8.08 | 1,206 |
| 1931 | 3.312 | 181.888 | 185.200 | .549 | 1.821 | 8.10 | 1,364 |

[1] Includes Arizona, California, Georgia, Idaho, North Carolina, Oregon, and South Dakota.

The foregoing tabulation gives New Mexico first rank as having the highest or worst fatality rate per million tons of coal produced in 1932, or 15.830; Virginia is second with 9.620 and Oklahoma third with 8.762; the anthracite rate is 4.994, and the rate for all coal mining in the United States 3.357 or slightly higher than the 3.312 rate in 1931, which was the lowest rate in the history of coal mining in the United States, except the rate in 1933 (preliminary) which was 2.68.

The highest or worst rate of nonfatal injuries per million tons of coal produced in 1932 was that of Pennsylvania (anthracite), the rate being 393.540; Texas was second with 289.040 and Oklahoma third with 246.124; the average for the United States as a whole was 164.009, or considerably lower or better than the rate of 181.888 in 1931.

In 1932 Pennsylvania (anthracite) had the highest rate of combined fatal and nonfatal accidents per million tons of coal produced, its rate being 398.534, Texas was second with 290.611, Oklahoma third with 254.886, and Iowa fourth with 245.182. The average for the coal mines of the United States was 167.366, a materially lower rate than that of 185.200 in 1931. Only 7 of the 26 States listed in table 4 as having produced coal in 1932 had combined fatal and nonfatal accidents per million tons of coal higher than the average for the country of 167.366, those 7 being Pennsylvania (anthracite), Texas, Oklahoma, Iowa, Michigan, Washington, and Colorado. The rate for all the bituminous mines of the United States was 130.158, or less than one-third the Pennsylvania (anthracite) rate of 398.534.

Montana, with a combined fatal and nonfatal accident rate of but 65.876 per million tons of coal produced, had the distinction of having the lowest rate of all the coal-mining States in 1932, Wyoming is second with 68.810 and North Dakota third with 90.248; all the other States have rates higher than 100.000.

## METAL AND NONMETALLIC MINERAL MINING

Nation-wide data on accidents in metal mining for 1933 will not be available until late in the fall of 1934, nor are tentative or preliminary figures on a Nation-wide basis yet at hand. However, data on 190 identical mines for 1933 are given here and compared with similar data for 1932 from these mines. These 190 mines produced 18,652,354 tons of ore in 1933, or slightly more than the 18,155,012 tons produced in 1932, although only 19,536 men were employed in 1933 against 20,544 in 1932. The number of shifts worked in 1933 was 4,463,300, the number in 1932 being 4,488,305, with man-hours 36,285,332 in 1933 and 36,917,234 in 1932. Thirty-nine persons were killed in 1933 and 33 in 1932; 2,220 were injured (nonfatally) in 1933 and 2,260 in 1932. The number killed per million man-hours in these 190 mines was 1.08 in 1933 and 0.89 in 1932, indicating a trend for the worse in 1933; the number injured nonfatally per million man-hours of exposure in 1933 was 61.18 and in 1932 was 61.22, practically identical performances from the point of view of safety for the 2 years as regards nonfatal injuries. The foregoing figures appear to indicate that metal mining, which was by no means active in the early part of 1933 and not very active even later in that year, probably receded at least slightly rather than advanced in its safety performances.

Definite data on occurrence of accidents in metal and nonmetallic mineral mining in 1932 released by the United States Bureau of Mines in November 1933 are the latest available on a Nation-wide basis on accidents in those industries, and table 5 gives by States much of the salient information on accident occurrence in those industries.

TABLE 5.—*Summary of men employed, man-hours of exposure, accidents, and accident rates in the metal-mining industry [1] in 1932, by States*

| State | Men employed | Man-hours of exposure | Average days of exposure per man | Average hours per man per year | Killed | Injured | Rate per million man-hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fatal | Nonfatal | Fatal and nonfatal |
| Alabama | 2,888 | 2,968,053 | 106 | 1,028 | 2 | 71 | 0.67 | 23.92 | 24.59 |
| Alaska | 3,149 | 5,993,752 | 238 | 1,903 | 5 | 214 | .83 | 35.70 | 36.53 |
| Arizona | 3,750 | 6,181,834 | 206 | 1,648 | 9 | 300 | 1.46 | 48.53 | 49.99 |
| California | 5,646 | 10,051,955 | 222 | 1,780 | 25 | 929 | 2.49 | 92.42 | 94.91 |
| Colorado | 1,891 | 3,822,568 | 253 | 2,021 | 11 | 420 | 2.88 | 109.87 | 112.75 |
| Florida | 758 | 1,561,634 | 216 | 2,060 | 1 | 48 | .64 | 30.74 | 31.38 |
| Georgia | 282 | 686,872 | 244 | 2,436 | | 17 | | 24.75 | 24.75 |
| Idaho | 3,232 | 4,989,429 | 193 | 1,544 | 9 | 403 | 1.80 | 80.77 | 82.57 |
| Illinois | 118 | 80,668 | 83 | 684 | | 6 | | 74.38 | 74.38 |
| Iowa | 123 | 100,535 | 103 | 817 | | 8 | | 79.57 | 79.57 |
| Kansas | 764 | 1,088,418 | 165 | 1,425 | 4 | 66 | 3.68 | 60.64 | 64.32 |
| Kentucky | 359 | 389,489 | 113 | 1,085 | | 21 | | 53.92 | 53.92 |
| Michigan | 7,368 | 11,707,925 | 188 | 1,589 | 5 | 327 | .43 | 27.93 | 28.36 |
| Minnesota | 3,511 | 6,258,736 | 194 | 1,783 | 2 | 88 | .32 | 14.06 | 14.38 |
| Missouri | 2,095 | 2,660,957 | 159 | 1,270 | 3 | 131 | 1.13 | 49.23 | 50.36 |
| Montana | 2,200 | 4,577,740 | 260 | 2,081 | 8 | 275 | 1.75 | 60.07 | 61.82 |
| Nevada | 1,345 | 2,263,787 | 210 | 1,683 | 2 | 122 | .88 | 53.89 | 54.77 |
| New Jersey | 635 | 1,249,810 | 246 | 1,968 | 1 | 54 | .80 | 43.21 | 44.01 |
| New Mexico | 1,442 | 2,816,678 | 247 | 1,953 | 1 | 153 | .36 | 54.32 | 54.68 |
| New York | 960 | 1,441,636 | 188 | 1,502 | 2 | 40 | 1.39 | 27.75 | 29.14 |
| North Carolina | 176 | 381,337 | 231 | 2,167 | | 16 | | 41.96 | 41.96 |
| Oklahoma | 956 | 1,311,112 | 170 | 1,371 | 2 | 167 | 1.53 | 127.37 | 128.90 |
| Oregon | 334 | 388,396 | 142 | 1,163 | | 17 | | 43.77 | 43.77 |
| Pennsylvania | 332 | 227,445 | 73 | 685 | | | | | |
| South Dakota | 1,473 | 3,829,054 | 325 | 2,599 | | 183 | | 47.79 | 47.79 |
| Tennessee | 1,096 | 1,944,506 | 202 | 1,774 | 2 | 53 | 1.03 | 27.26 | 28.29 |
| Texas | 1,237 | 3,341,025 | 331 | 2,701 | 2 | 114 | .60 | 34.12 | 34.72 |
| Utah | 2,711 | 6,147,450 | 283 | 2,268 | 9 | 583 | 1.46 | 94.84 | 96.30 |
| Virginia | 815 | 1,166,011 | 147 | 1,431 | 1 | 51 | .86 | 43.74 | 44.60 |
| Washington | 286 | 306,076 | 134 | 1,070 | 1 | 16 | 3.27 | 52.27 | 55.54 |
| Wisconsin | 569 | 1,046,794 | 212 | 1,840 | | 56 | | 53.50 | 53.50 |
| Wyoming | 41 | 27,383 | 84 | 668 | | | | | |
| Other States [2] | 746 | 1,029,261 | 153 | 1,380 | | 65 | | 63.15 | 63.15 |
| Total: | | | | | | | | | |
| 1932 | 53,288 | 92,038,326 | 208 | 1,727 | 107 | 5,014 | 1.16 | 54.48 | 55.64 |
| 1931 | 80,940 | 156,177,859 | 231 | 1,930 | 158 | 8,709 | 1.01 | 55.76 | 56.77 |

[1] The figures also cover the mining of nonmetallic minerals other than coal but do not include the milling and smelting of ores. A separate report is published by the Bureau of Mines for mills and smelters.
[2] Includes Arkansas, Connecticut, Louisiana, Maine, Maryland, Massachusetts, New Hampshire, Ohio, South Carolina, and Vermont.

One of the first features brought out in table 5 is the relatively few persons engaged in the metal and nonmetallic mineral mines (other than coal) in the United States in 1932; only 53,288 were employed in those industries, according to the data in this table. In the same year the Pennsylvania anthracite mines employed 121,243, the bituminous mines of Pennsylvania 104,532, and the coal mines of West Virginia 85,765, while all the coal mines of the United States had 527,623 employed in 1932 or nearly 10 times the number engaged in metal and nonmetallic mineral mining.

On the basis of number killed per million man-hours of exposure the rate of 1.16 for metal and nonmetallic mineral mines for 1932 is considerably higher than the rate of 1.01 for 1931, when 80,940 were employed. In 1932 Kansas had the highest or poorest fatality rate per million man-hours in its metal mines (3.68), with Washington second (3.27), followed by Colorado (2.88), and California (2.49). Several States, most of them with relatively light employment and man-hours of exposure, escaped in 1932 without fatalities in their metal or nonmetallic mineral mines—Georgia, Illinois, Iowa, Kentucky, North Carolina, Oregon, Pennsylvania, South Dakota, Wisconsin, and Wyoming. In this group South Dakota with 3,829,054 man-hours of exposure and Wisconsin with 1,046,794 man-hours, both without a fatality in 1932, indicated excellent safety performance, the South Dakota record being especially impressive with 1,473 employed and working 325 average shifts per man for the year.

Of the 10 metal-mining States with the largest number of man-hours of exposure in 1932—Michigan (11,707,925), California (10,051,955), Minnesota (6,258,736), Arizona (6,181,834), Utah (6,147,450), Alaska (5,993,752), Idaho (4,989,429), Montana (4,577,740), South Dakota (3,829,054), and Colorado (3,822,568)—South Dakota with no person killed had the best fatality record per million man-hours of exposure, Minnesota ranked second with a fatality rate per million man-hours of 0.32, Michigan third with a rate of 0.43, and Alaska fourth with a rate of 0.83, whereas Colorado had the highest or worst rate (2.88), then California with 2.49, Idaho with 1.80, and Montana with 1.75.

In nonfatal accidents per million man-hours of exposure the 1932 rate of 54.48 for all metal mines was somewhat lower or better than 55.76 for 1931. Oklahoma in 1932 had the highest or worst metal-mining nonfatal injury rate per million man-hours (127.37), then Colorado (109.87), Utah (94.84), and California (92.42). Minnesota's metal mines in 1932 had the lowest or best nonfatal injury rate per million man-hours (14.06), then Alabama (23.92), Georgia (24.75), Tennessee (27.26), New York (27.75), and Michigan (27.93).

In the combined fatal and nonfatal injury rate per million man-hours of exposure Minnesota easily took the lowest or best rate of 14.38, with Alabama second (24.59), Georgia third (24.75), Tennessee fourth (28.29), Michigan fifth (28.36), and New York sixth (29.14). In the combined fatal and nonfatal rate Oklahoma had the highest or worst showing (128.90), Colorado being second highest (112.75), Utah third (96.30), and California fourth (94.91).

Metal mining had a slightly lower combined fatal and nonfatal injury rate per million man-hours in 1932 than in 1931, the combined rate being 55.64 in 1932 and 56.77 in 1931. With 107 fatalities and 5,014 nonfatal accidents in metal mines in 1932, the rate of occurrence of nonfatal to fatal accidents was about 49 to 1, this rate being about 55 to 1 in 1931.

Table 6 presents data on accident occurrence and rates in metal and nonmetallic mineral mines in 1932:

TABLE 6.—*Summary of men employed, man-hours of exposure, accidents, and accident rates in metal and nonmetallic mineral mines in 1932, by type of mine*

| Type of mine | Men employed | Man-hours of exposure | Average days of exposure per man | Average hours per man | Killed | Injured | Rate per million man-hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fatal | Nonfatal | Fatal and nonfata |
| Copper | 9,555 | 18,608,421 | 240 | 1,948 | 23 | 859 | 1.24 | 46.16 | 47.40 |
| Gold, silver, and miscellaneous metal | 21,094 | 40,165,270 | 237 | 1,904 | 61 | 2,988 | 1.52 | 74.39 | 75.91 |
| Iron | 11,954 | 15,908,514 | 148 | 1,331 | 7 | 264 | .44 | 16.59 | 17.03 |
| Lead and zinc (Mississippi Valley) [1] | 3,999 | 5,531,228 | 171 | 1,383 | 9 | 375 | 1.63 | 67.80 | 69.43 |
| Nonmetallic mineral | 6,686 | 11,824,893 | 201 | 1,769 | 7 | 528 | .59 | 44.65 | 45.24 |
| | 53,288 | 92,038,326 | 208 | 1,727 | 107 | 5,014 | 1.16 | 54.48 | 55.64 |

[1] Includes fluorspar mines in Illinois and Kentucky.

This table indicates that gold, silver, and miscellaneous metal mining had nearly 44 percent of the man-hours worked in metal and nonmetallic mineral mining in the United States in 1932, about 57 percent of the fatalities, and the highest combined fatal and nonfatal injury rate per million man-hours (75.91), the average for the entire metal-mining industry being 55.64. Lead and zinc mining in the Mississippi Valley had the next highest combined fatal and nonfatal injury rate (69.43), and copper mining was third with a combined rate of 47.40. Iron-ore mining, with a combined rate of 17.03 and with but 7 fatalities and 264 nonfatal accidents to its 11,954 employees, had by far the best or lowest combined fatal and nonfatal injury rate per million man-hours. The combined fatal and nonfatal rate for nonmetallic mineral mining was 45.24 or considerably below the rate for the metal and nonmetallic mineral mining industries as a whole.

Evidently the gold, silver, copper, lead, and zinc producers have not yet learned how to mine as safely as the producers of iron ore, and this appears to be true whether the mining is by open-pit or underground methods. This fact is shown rather clearly by a study of tables 7 and 8.

TABLE 7.—*Accident rates and man-hours of exposure underground in metal and nonmetallic mineral mines in 1932, by type of mine*

| Type of mine | Men employed | Man-hours of exposure | Average days of exposure per man | Average hours per man per year | Killed | Injured | Rate per million man-hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fatal | Nonfatal | Fatal and nonfatal |
| Copper | 5,441 | 10,153,047 | 234 | 1,866 | 21 | 700 | 2.07 | 68.94 | 71.01 |
| Gold, silver, and miscellaneous metal | 13,494 | 26,396,453 | 244 | 1,956 | 52 | 2,464 | 1.97 | 93.35 | 95.32 |
| Iron | 6,975 | 8,242,252 | 141 | 1,182 | 5 | 204 | .61 | 24.75 | 25.36 |
| Lead and zinc (Mississippi Valley) [1] | 3,420 | 4,750,658 | 172 | 1,389 | 8 | 342 | 1.68 | 71.99 | 73.67 |
| Nonmetallic mineral | 1,991 | 2,932,961 | 179 | 1,473 | 2 | 210 | .68 | 71.60 | 72.28 |
| | 31,321 | 52,475,371 | 207 | 1,675 | 88 | 3,920 | 1.68 | 74.70 | 76.38 |

[1] Includes fluorspar mines in Illinois and Kentucky.

TABLE 8.—*Accident rates and man-hours of exposure in opencut metal and nonmetallic mineral mines in 1932, by type of mine*

| Type of mine | Men employed | Man-hours of exposure | Average days of exposure per man | Average hours per man per year | Killed | Injured | Rate per million man-hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fatal | Nonfatal | Fatal and nonfatal |
| Copper | 1,171 | 2,072,976 | 221 | 1,770 | 1 | 52 | 0.48 | 25.08 | 25.56 |
| Gold, silver, and miscellaneous metal | 313 | 377,655 | 133 | 1,207 | | 18 | | 47.66 | 47.66 |
| Iron | 1,607 | 2,729,634 | 175 | 1,699 | 1 | 30 | .37 | 10.99 | 11.36 |
| Lead and zinc (Mississippi Valley) [1] | 76 | 54,640 | 90 | 719 | | 1 | | 18.30 | 18.30 |
| Nonmetallic mineral | 2,158 | 3,276,114 | 160 | 1,518 | | 146 | | 44.56 | 44.56 |
| | 5,325 | 8,511,019 | 175 | 1,598 | 2 | 247 | .23 | 29.02 | 29.25 |

[1] Includes fluorspar mines in Illinois and Kentucky.

In 1911, the first year of active work of the United States Bureau of Mines, the number of persons killed per thousand 300-day workers in and around the mines of the United States other than coal mines was 4.45; in 1932 this figure was reduced to 2.89, and it was but 2.53 in 1931. If the rate of 4.45 for 1911 had continued through to January 1, 1931, there would have been 12,085 persons killed in metal mining in the United States (all mines other than coal mines) instead of the 9,645 that were killed. If the fatality rate of 4.45 had been in effect in 1931 there would have been 278 killed in our metal mines instead of 158, and if the 4.45 rate had been in effect in 1932 there would have been 165 metal-mine fatalities in the United States instead of 107. The fatality rate per thousand 300-day workers in our mines other than coal mines has been falling steadily, though not very rapidly. For the 5-year period 1911–15, inclusive, the rate was 4.01, for the next 5-year period (1916–20, inclusive) it was 3.70; for the 5-year period 1921–25, inclusive, it was 3.23, and for the period 1926–30, inclusive, it had fallen to 3.02. For 1930 it was 2.92, for 1931 it was 2.53, and for 1932 it was 2.89; 1928 had the lowest rate (2.50).

In nonfatal injuries our noncoal mines have also made slow but steady improvement. The nonfatal injury rate per thousand 300-day workers was 198.37 for the 5-year period 1911–15, inclusive; it was 241.34 for the next 5 years (1916–20, inclusive) and 273.04 for the 5 years 1921–25, inclusive, then 210.20 for the period 1926–30, inclusive, and 139.56 in 1931 and 135.57 in 1932. The rate for 1932 (135.57) is by far the lowest in the entire period during which the data have been assembled by the Bureau of Mines, the rate for the 20-year period 1911–30, inclusive, being 228.79.

The progress of the metal-mining industry in safety during the last 5-year period for which definite figures are available (1928–32, inclusive) is clearly seen in the rates for these years on occurrence of all kinds of accidents (fatal plus nonfatal) per thousand 300-day workers.

In 1928 the rate was 208.11, in 1929 it was 203.14, in 1930 it had fallen to 170.78, then to 142.03 in 1931 and to the all-time low of 138.47 in 1932.

In 1911 there were 26,577 nonfatal accidents in our metal mines, whereas in 1932 there were 5,014; in 1911 there were 695 fatalities in our metal mines, and but 107 in 1932. Although most of these accident decreases are due to decrease in personnel and in industrial activity there is no question that our metal-mining industry is in large part becoming "safety-mined", but there are portions of the industry, generally in the smaller mining operations, in which progress is so slow as to be almost imperceptible.

## QUARRYING

Final Nation-wide data as to accident occurrence in the quarry industry in 1933 will not be available for several months, or until some time in the late summer or fall of 1934. However, the Safety Statistics Division of the Bureau of Mines, has assembled some significant figures as to data on accident occurrence in 622 identical quarries in the years 1932 and 1933. These 622 plants produced 53,117,345 tons of rock in 1933, or somewhat more than the 51,339,952 tons of 1932, and employed more men (32,705) in 1933 than in 1932 (30,443). Man-hours worked were 47,577,268 in 1933 against 51,684,848 in 1932, a rather marked decrease in working time, notwithstanding the increased production. Twenty-two persons were killed and 1,754 injured nonfatally in 1933 against 17 killed and 1,830 injured in 1932. The fatality rate per million man-hours of exposure was 0.46 in 1933, or considerably higher than the 0.33 rate of 1932; the nonfatal rate was 36.93 in 1933 against 35.41 in 1932. The rate of fatal plus nonfatal accidents per million man-hours was 37.39 in 1933 and but 35.74 in 1932; hence if the 1933 accident experience of these 622 quarries with employment of about half the quarry workers of the United States is indicative of the experience of the industry as a whole, the quarry industry will be found to have deteriorated to some extent in its safety record for 1933.

Table 9 gives the latest available data, by States, concerning accident occurrence in the quarries of the United States in 1932.

TABLE 9.—*Summary of men employed, man-hours of exposure, accidents, and accident rates in the quarrying and related industries [1] in 1932, by States*

| State | Men employed | Man-hours of exposure | Average days of exposure per man | Average hours per man per year | Killed | Injured | Rate per million man-hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fatal | Nonfatal | Fatal and nonfatal |
| Alabama | 1,591 | 2,380,264 | 163 | 1,496 | | 172 | | 72.26 | 72.26 |
| Arizona | 84 | 122,640 | 183 | 1,460 | | 7 | | 57.08 | 57.08 |
| Arkansas | 131 | 184,930 | 185 | 1,412 | | 3 | | 16.22 | 16.22 |
| California | 3,411 | 5,077,454 | 210 | 1,489 | 1 | 297 | 0.20 | 58.49 | 58.69 |
| Colorado | 301 | 285,858 | 123 | 950 | | 12 | | 41.98 | 41.98 |
| Connecticut | 376 | 568,900 | 183 | 1,513 | | 21 | | 36.91 | 36.91 |
| Florida | 216 | 436,991 | 227 | 2,023 | | 3 | | 6.87 | 6.87 |
| Georgia | 2,045 | 3,431,266 | 194 | 1,678 | 1 | 108 | .29 | 31.48 | 31.77 |
| Idaho | 51 | 69,725 | 170 | 1,367 | | 4 | | 57.37 | 57.37 |
| Illinois | 2,816 | 4,647,416 | 231 | 1,650 | 2 | 95 | .43 | 20.44 | 20.87 |
| Indiana | 2,720 | 4,216,491 | 182 | 1,550 | 1 | 179 | .24 | 42.45 | 42.69 |
| Iowa | 1,115 | 2,368,170 | 207 | 2,124 | | 65 | | 27.45 | 27.45 |
| Kansas | 812 | 1,143,397 | 164 | 1,408 | 3 | 47 | 2.62 | 41.11 | 43.73 |
| Kentucky | 1,093 | 1,841,977 | 187 | 1,685 | | 78 | | 42.35 | 42.35 |
| Maine | 1,039 | 1,283,026 | 152 | 1,235 | 1 | 66 | .78 | 51.44 | 52.22 |

[1] The figures cover quarrying, stone-crushing, rock-dressing, and the manufacture of cement and lime.

TABLE 9.—*Summary of men employed, man-hours of exposure, accidents, and accident rates in the quarrying and related industries in 1932, by States*—Con.

| State | Men employed | Man-hours of exposure | Average days of exposure per man | Average hours per man per year | Killed | Injured | Rate per million man-hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Fatal | Nonfatal | Fatal and nonfatal |
| Maryland | 792 | 1,486,355 | 212 | 1,877 | 1 | 44 | 0.67 | 29.60 | 30.27 |
| Massachusetts | 2,008 | 3,610,277 | 216 | 1,798 | 1 | 196 | .28 | 54.29 | 54.57 |
| Michigan | 1,777 | 2,725,512 | 177 | 1,534 | | 58 | | 21.28 | 21.28 |
| Minnesota | 1,010 | 1,632,712 | 202 | 1,617 | | 123 | | 75.33 | 75.33 |
| Missouri | 2,315 | 4,596,088 | 234 | 1,985 | 1 | 215 | .22 | 46.78 | 47.00 |
| Montana | 148 | 247,934 | 209 | 1,675 | | 9 | | 36.30 | 36.30 |
| Nebraska | 268 | 629,233 | 288 | 2,348 | | 5 | | 7.95 | 7.95 |
| New Hampshire | 505 | 670,008 | 166 | 1,327 | 1 | 26 | 1.49 | 38.81 | 40.30 |
| New Jersey | 1,397 | 1,925,914 | 157 | 1,379 | 1 | 67 | .52 | 34.79 | 35.31 |
| New York | 3,264 | 5,623,416 | 197 | 1,723 | | 152 | | 27.03 | 27.03 |
| North Carolina | 463 | 743,649 | 193 | 1,606 | | 45 | | 60.51 | 60.51 |
| Ohio | 4,036 | 6,803,346 | 195 | 1,686 | 2 | 226 | .29 | 33.22 | 33.51 |
| Oklahoma | 557 | 802,096 | 175 | 1,440 | | 24 | | 29.92 | 29.92 |
| Oregon | 180 | 192,885 | 135 | 1,072 | 1 | 10 | 5.18 | 51.84 | 57.02 |
| Pennsylvania | 9,293 | 14,659,919 | 181 | 1,578 | 10 | 446 | .68 | 30.42 | 31.10 |
| Rhode Island | 120 | 168,253 | 172 | 1,402 | | 3 | | 17.83 | 17.83 |
| South Carolina | 45 | 44,010 | 159 | 978 | 1 | 4 | 22.72 | 90.89 | 113.61 |
| South Dakota | 214 | 260,707 | 146 | 1,218 | | 23 | | 88.22 | 88.22 |
| Tennessee | 1,762 | 3,237,903 | 205 | 1,838 | 1 | 164 | .31 | 50.65 | 50.96 |
| Texas | 1,300 | 2,592,424 | 222 | 1,994 | 1 | 79 | .39 | 30.47 | 30.86 |
| Utah | 217 | 288,116 | 166 | 1,328 | | 18 | | 62.47 | 62.47 |
| Vermont | 2,823 | 5,615,834 | 246 | 1,989 | | 201 | | 35.79 | 35.79 |
| Virginia | 1,579 | 3,162,082 | 220 | 2,003 | 2 | 79 | .63 | 24.98 | 25.61 |
| Washington | 667 | 826,617 | 154 | 1,239 | | 53 | | 64.12 | 64.12 |
| West Virginia | 1,007 | 1,238,212 | 162 | 1,230 | | 25 | | 20.19 | 20.19 |
| Wisconsin | 881 | 1,150,286 | 152 | 1,306 | | 96 | | 83.46 | 83.46 |
| Wyoming | 93 | 147,718 | 197 | 1,588 | | 9 | | 60.93 | 60.93 |
| Other States [2] | 344 | 569,849 | 181 | 1,657 | | 17 | | 29.83 | 29.83 |
| | 56,866 | 93,709,860 | 195 | 1,648 | 32 | 3,574 | .34 | 38.14 | 38.48 |

[2] Includes Louisiana, Nevada, and New Mexico.

Table 9 indicates that 56,866 persons were engaged in quarry work in the United States in 1932, this being in excess of the number engaged in metal and nonmetallic mineral mining, as there were but 53,288 persons employed in those mines in 1932 insofar as available data indicate. The States with greatest number employed in quarrying in 1932 were Pennsylvania (9,293), Ohio (4,036), California (3,411), New York (3,264), Vermont (2,823), Illinois (2,816), and Indiana (2,720). Of the 42 States listed in the table, 25 had no fatal accidents in quarries in 1932. South Carolina had the highest fatality rate per million man-hours (22.72), Oregon had the next highest (5.18), then Kansas (2.62), and New Hampshire (1.49). Of the States with the largest employment and amount of man-hours of exposure, New York with 5,623,416 man-hours and no fatalities had the best record but Vermont with 5,615,834 man-hours and no fatalities was not far behind, and California with 5,077,454 man-hours and 1 fatality had a fatality rate of only 0.20 per million man-hours.

Florida with a fatal plus nonfatal rate of but 6.87 per million man-hours of exposure had the lowest or best combined rate, and since no fatality entered into this the rate was certainly an excellent one. Nebraska had a combined rate of 7.95, also was without a fatality. Arkansas, with a combined rate of 16.22 (also without a fatality), had the third lowest place. Of the States with the larger number of employees and man-hours of exposure Illinois had the best combined fatal plus nonfatal rate (20.87), New York being next with a rate of

27.03, then Pennsylvania with a rate of 31.10, and Vermont with a rate of 35.79. The combined rate for the entire industry in 1932 was 38.48; hence Illinois, New York, Pennsylvania, and Vermont—all with man-hours of exposure in excess of 4,500,000 in 1932—had a combined fatal and nonfatal rate lower than the average rate for the industry in the Nation at large.

That quarrying is sharing in the progress of the past few years in safety in other branches of the mining and allied industries may be seen from the fact that for the 10-year period 1921 to 1930 inclusive the quarrying industry of the United States had a combined fatal plus nonfatal injury rate of 157.79 per thousand 300-day workers, whereas the rate for 1931 was but 106.04 and for 1932 but 97.33. The quarry fatality rate in 1932 of 0.86 per thousand 300-day workers is by all odds the lowest rate for any year in the annals of the industry.

## PETROLEUM

The United States Bureau of Mines does not assemble Nation-wide accident statistics in the petroleum industry; the Department of Accident Prevention of the American Petroleum Institute in April 1934 issued its Annual Summary of Injuries in the Petroleum Industry for 1933, and from this publication the following data were obtained.

The report for 1933 covers 232,862 workers, the accident frequency being 13.00 and accident severity 1.90; similar figures for 1932 were 226,304 employed, with accident frequency 12.28 and accident severity 1.91. It therefore appears that compared with 1932 there was an increase of 5.9 percent in accident frequency and a decrease of about 0.5 percent in accident severity.

That the petroleum industry has participated in the downward trend of accident occurrence of the past few years in the mining industry is seen from the fact that accident frequency in the industry was 31.15 in 1927, 27.33 in 1928, 26.78 in 1929, 18.05 in 1930, 14.14 in 1931, 12.28 in 1932, and 13.00 in 1933; accident severity was 2.65 in 1927, 2.69 in 1928, 2.49 in 1929, 2.37 in 1930, 2.06 in 1931, 1.91 in 1932, and 1.90 in 1933.

The report of the American Petroleum Institute says:

> By applying the frequency rate of 1927 (31.15 injuries to each 1,000,000 hours worked) to the hours reported by companies each year since 1927, a reduction of 41,910 injury cases is reflected. Had these 41,910 injuries occurred, each would have cost the companies approximately $300 in medical and compensation claims, or a total of $12,573,000. However, the real satisfaction that the industry has is the knowledge that it has reduced anguish, suffering, and financial loss to its employees and has reduced the charitable burden of the Nation by a reduction in the number of industrial cripples.

## CONCLUSION

The number of fatalities as well as the fatality rate per million tons of coal produced have fallen steadily, though with a few peaks in isolated years. The significance as well as the magnitude of this decrease in the coal-mining fatality rate is apparent when it is considered that if the 5.89 fatality rate for the 5-year period 1906–10 had continued to the 1st of January 1934, the number of fatalities in the coal mines of the United States would have been 24,300 greater than they actually were; hence, during the 23 years' life of the

Bureau of Mines the fatality rate has been reduced sufficiently to indicate an average annual saving of life of more than 1,000 persons per year. Similar figures as to prevention of nonfatal accidents are not available, but it is estimated that about 50 nonfatal accidents occur to 1 fatality; hence it is probable that about 50,000 nonfatal accidents annually have also been eliminated.

If the cost to the operator of a life is put into cold-blooded dollars and cents, and a relatively low amount, such as $5,000, is taken as the value of a life, it can readily be seen that, irrespective of ethical or humanitarian considerations and not considering nonfatal accidents, the annual saving of somewhat more than 1,000 lives may be considered as worth more than $5,000,000 to the mine operators, or almost five times the total amount being expended by the Bureau of Mines during the present fiscal year, and nearly double the entire expenditure of the Bureau for any year of its existence. If in addition it is conceded that as many as 50,000 nonfatal accidents per year have been prevented (and the assumption is by no means a wild one), and if the cost to the operator in compensation, hospitalization, etc., of a nonfatal accident is placed at $100, at least an additional $5,000,000 has been saved to the coal industry annually through the safer operation of the past 23 years.

The benefits to the workers in and around coal mines due to this increased safety of operation are much more impressive than are those to the mine operator. The prevention of the death of 24,300 coal-mine workers in the past 23 years has obviously avoided a vast amount of suffering, pain, and misery of various kinds to the families who would have been bereft of their loved ones. And the prevention of 50,000 or more nonfatal accidents annually for 23 years certainly has saved the miners, their families, their friends, and the community a large amount of pain, inconvenience, misery, and other losses of a similar nature.

The financial losses which the workers have avoided through this increased safety of coal-mine operation are in themselves colossal. The average age of the coal-mine worker who is killed is about 35 years, and in general he should under normal conditions have a future active working period of at least 20 years. In normal times he should earn at least $1,000 annually; hence in his 20 years' active life expectancy he would receive approximately $20,000 for his services. The saving of the life of about 24,300 coal-mine workers in the past 23 years, through the decreased death rate in coal mining, has therefore prevented a financial loss to them of at least $486,000,000, and this does not take into consideration the financial losses saved to the worker through the elimination of large numbers of nonfatal accidents. Hence, for the past 23 years an annual saving of more than $21,000,000 has been made to coal-mine workers in the prevention of fatalities; $21,000,000 is far more than the total expenditures on safety work by the United States Bureau of Mines since its establishment in 1910. The coal-mine worker is therefore unquestionably reaping annual dividends of several hundred (probably several thousand) percent on the expenditures of the Federal Government in the promotion of safety in coal mining. The workers in other parts of the mining and allied industries are reaping similar benefits, but possibly on a somewhat reduced scale.

Although unquestionably progress has been made toward the safe operation of mines—much, if not most of it, in the past 5 years—it would be a terrible mistake to assume that the ultimate in safe operation of mines has been reached, as this is anything but the truth. The latest available statistics indicate that mining still has the highest or worst accident rate of the major industries of the United States—and that the industrial accident rate of the United States is the highest or worst of the countries of the world with the exception of Chile. Although progress has been made and is being made toward safer operation of our mines, the work has only begun, and the end should not be at hand until accident occurrence in our mines (coal, metal, and nonmetallic) has been reduced at least 75 percent below what it is at present.

Unquestionably many, probably most, oldtimers in mining—including both officials and workers—on reading the above statement will immediately say that it is utterly out of the question to reduce present-day accident occurrence in the mining and allied industries at least 75 percent. Their conclusion could not have been very successfully refuted as late as 6 or 7 years ago; however, since about 1925 so many instances are available of reduction in accident frequency, accident severity, and accident cost of 90 percent or over, as compared with past records, that placing the figures for possible accident reduction for mining at 75 percent is well within the bounds of conservatism.

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