CHROMITE.

By J. S. DILLER.

The importance of chromite as a war supply in the manufacture of armor plate, armor-piercing projectiles, stellite for high-speed tools, and automobile and other special steels can scarcely be overestimated. Fortunately for users of chromite the foreign deposits, which at the beginning of the European war were the chief source of the world's supply, are not wholly within the war arena, so that production of chromite has not only continued but has expanded without interruption to meet the demands superimposed by the war. The chief sources of supply for the United States during the last few years have been Rhodesia, New Caledonia, Turkey, and Greece.

Embargoes were placed on the shipment of chrome ore from some of the principal sources, and it was feared by some that the supply for the United States would be cut off, but after the producers received a guaranty that the ore would not be reshipped to enemy belligerents the imports, as shown in the following table, greatly increased, especially those from Rhodesia, New Caledonia, and Canada, though those from Greece have declined slightly and those from Turkey have entirely ceased.

Chromic iron imported into the United States, 1913–1916, in long tons.[a]

	1913	1914	1915	1916
Cuba	.....	.....	.....	34
Canada	.....	533	10,087	10,930
England	.....	58	2	5
Greece	.....	8,155	4,305	7,900
Japan	322	.....	.....	.....
French Oceania	6,620	30,860	28,031	[b] 30,950
Australia	.....	.....	.....	[b] 2,986
British South Africa	.....	.....	22,800	[c] 23,000
Portuguese Africa	29,000	23,200	11,230	[c] 38,850
Turkey in Asia	13,830	11,880	.....	.....
	49,772	74,686	76,455	114,655

[a] Statistics furnished by the Department of Commerce, Bureau of Foreign and Domestic Commerce.

[b] E. J. Lavino & Co., importers, credit New Caledonia with all that listed above under French Oceania and Australia, amounting to 33,936 long tons.

[c] E. J. Lavino & Co., importers, credit Rhodesia with all that listed above under British South Africa and Portuguese Africa, amounting to 61,850 long tons.

Chromic iron produced and sold in the United States, 1913–1916, in long tons.

	1913	1914	1915	1916
United States	255	591	3,281	[a] 40,000

[a] The preliminary estimate was 35,000 long tons, but later information indicates that the total amount sold was not less than 40,000 long tons. A considerable amount of ore mined but not yet sold is not included in this estimate.

The greatly increased trade, especially in steel, and the consequently larger demand for chromite have stimulated the search for it in the United States, as shown by the tenfold increase in production. On the Atlantic coast and in Wyoming there has been only a small production, but in the Pacific Coast States, especially California, the advance in the output has been remarkable. Maryland and Wyoming, with one producer in each State, made with Oregon an aggregate output of more than 3,000 long tons in 1916; in California the production was not less than 40,000 tons.

It is evident that for some time to come California will furnish the chief domestic supply. With a lively demand and good prices bodies of ore farther from lines of transportation will be worked. The production from some deposits in 1917 is expected to exceed that of 1916, but that the total output of the State will be increased is not certain. It is possible, however, that some counties—Del Norte, for instance—which produced no chromite in 1916, will produce much in 1917 on account of better transportation facilities, both by land and sea.

There were two main belts of production in California—one in the Klamath Mountains and Coast Range from Siskiyou County to San Luis Obispo County and the other in the Sierra Nevada from Plumas County to Tulare County. The larger output has come from the Klamath Mountains, because the ore bodies there are larger and railroad transportation is more convenient, features which will continue to make it for years an important producing region.

The production in Oregon is increasing in both the Klamath and Blue mountains. The ores west of Riddle are the richest yet mined in the State; in some places they run as high as 55 per cent chromic oxide, and much of the ore contains about 50 per cent. Most of the Oregon ore, however, like that of California, averages about 40 per cent of chromic oxide, and ore of that grade is commonly the basis of sale. The ore generally contains 38 to 45 per cent chromic oxide, 6 to 8 per cent silica, and 17 to 25 per cent alumina.

The largest ore body and producing mine thus far developed in Oregon is owned and operated by Collard & Moore near Holland, about 20 miles southeast of Kerby, in Josephine County. Much of the ore may be improved by concentration, and a plant of 90-ton capacity for that purpose is nearly completed. It is claimed that the ore can be concentrated to a content of 55 per cent chromic

oxide. If this can be done successfully, it will mean much for the chrome industry of the Pacific coast and will enlarge its possibilities to meet war demands. The difficulty with much of the chrome ore of the Pacific coast has been its low grade and its great distance from the principal markets. The low-grade ore, running 38 to 45 per cent chromic oxide, may be used to advantage chiefly for metallurgic purposes, such as grow out of war demands—for furnace lining and in the manufacture of chrome brick and chrome steel, for example—and by far the greater part of the California output is being so used. For chemical purposes, however, ore of higher grades is desirable, if not essential. The concentration of the ore would give it a wider market and increase its value and the demand for it. Without concentration the Pacific coast deposits can not furnish a dependable supply of high-grade chrome ore, but with successful concentration industries based on high-grade ore may be attracted to the coast. The Sawyer Tanning Co., whose plant was recently established on tidewater at Napa, Cal., has had great difficulty in obtaining sufficient high-grade ore for its own use.

T. W. Gruetter has recently established at Kerby, Oreg., a custom plant for concentrating black sand to win its gold and platinum. The black sand of the Klamath Mountains usually contains a considerable amount of chromite, and it is believed that by adding magnetic separators to Gruetter's plant to remove the other minerals from the tailings sufficient chromite may be obtained from the black sand in chromiferous serpentine areas to make the operation financially successful. The process will evidently yield a high grade of chrome ore, which may be suitable for special uses.

The relation of these experiments in concentration to the whole problem of obtaining high-grade chrome ore on the Pacific coast will be better understood when attention is called to the fact that by the disintegration and washing away of the weathered serpentine (an intrusive igneous rock in which practically all the chromite deposits occur) the heavy grains of chromite are left behind, and, consequently, the soil or surface wash in the watercourses of serpentine areas becomes enriched by the accumulation of residual chromite. Chromite boulders and sand are therefore, as a rule, more abundant in the surface soil than in the solid serpentine beneath. Many prospectors who find boulders of chromite on the surface feel confident that there is a large body of chromite beneath, but a few shallow prospect holes usually prove that the occurrence consists simply of surface soil enriched by residual chromite, and disappointment results.

The prices of chromite in California on the basis of 40 per cent chromic oxide ranged in 1916 from $14 a ton f. o. b. early in the season to $20 toward the end of the year. To this must be added

for the eastern buyer a freight rate for carload lots ranging from $10 a ton to Chicago to $14.86 a ton to the eastern seaboard, thus making the California 40 per cent ore cost on the eastern seaboard from $28.86 to $34.96 a ton.

Chromite is now being produced in eastern Oregon and also in Inyo County, Cal., at points east of the Pacific mountain belt and nearer the consumer than those in the mountains near the coast. The output from these two localities may ultimately prove to be large, and the shortening of the haul would materially reduce the cost of transportation.

The long haul across the continent is one of the chief difficulties in supplying the western chromite to the consumer, and this difficulty would be augmented in time of war by the other demands of transcontinental traffic. If, however, a greater production could be developed on the eastern slope of the Rocky Mountains, as near Glenrock, Wyo., where railroads are more numerous and transportation available on lines that are not transcontinental, the war supply of chromite would be more conveniently enlarged. There is good reason to believe that the serpentine of the Laramie and Big Horn mountains may contain considerable bodies of chromite.

In the Atlantic States, where most of the chromite produced in this country is used, the only production is in the vicinity of Baltimore, where the chrome industry of the United States was started by the Tysons many years ago. At first bodies of chromite were quarried from the serpentine areas about Baltimore and northeastward into Pennsylvania, but as the supply of known ore bodies became exhausted the chromiferous residual deposits of the soil and the stream gravel of the small valleys within the serpentine areas were washed for chrome sand. A small output of chrome sand is now obtained at Soldiers Delight, near Baltimore. The washing is done during low water in summer by means of a sort of sluice box locally called a "buddle." The sand is commonly passed through the buddle five times to reach the desired concentration, when it may contain as much as 55 per cent chromic oxide. Formerly the product was all exported for use in manufacturing special colors, but lately some of it has been used in the United States in making chrome steel, and the demand for it is increasing. This enterprise suggests the possibility of considerable expansion in the utilization of chromite sand in Maryland and Pennsylvania.

The only other Atlantic Coast State in which there are known deposits of chromite that may be workable is North Carolina. The deposits occur in five counties in the western part of the State and are described by Pratt and Lewis.[1] No large deposits of chromite

[1] Pratt, J. H., and Lewis, J. V., Corundum and the peridotites of western North Carolina: North Carolina Geol. Survey, vol. 1, 1905.

have yet been found in North Carolina, but the prospects already opened show that extensive deposits may exist in that region. Railroads traverse Yancey County, where chromite deposits should be diligently sought.

There is considerable chromite in Cuba, but scarcely anything is known of its occurrence in Mexico or Central and South America.

Ferrochrome, the alloy used in making chrome steel, is now manufactured in the United States by electro-metallurgic methods, almost wholly in the East, at the plants of the Electro Metallurgical Co. at Niagara Falls and elsewhere. It is reported, however, that the Noble Electric Steel Co. has three furnaces at Heroult, Cal., operating to their full capacity in producing manganese, chrome, and silica steels.

Prospecting for chromite may disclose other supplies, and the most profitable deposits will be those in serpentine areas that are adjacent to cheap rail or water transportation or connected with it by good roads. Cheap concentration may in places improve the grade of the ore available for profitable mining.

With the known supplies of chromite and others whose discovery within the limit of practicable transportation throughout the United States is confidently expected, there is good reason to believe that the domestic output of chromite could be so increased as to go far toward supplying the demand if in the event of war our imports, except those from Canada, were cut off.

Vogt and others have made extensive researches concerning the genesis of chromite. The distinction between primary and secondary ores and their relation to geotectonic features that determine the distribution of chromite in the field are geologic problems of great importance.

The metallurgy of chromite has apparently been so developed in the hydro-electric process as to utilize to advantage relatively low-grade ores such as are most abundant in the United States, and the further development of that process on the Pacific coast, where water power abounds, would greatly diminish the handicap of long transportation.

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