THE RARER METALS.

By Frank L. Hess.

INTRODUCTION.

Great gold placer fields, now mere wastes of overturned gravels; worked-out coal fields; exhausted gold, silver, and other mines, with their sterile dumps, gaunt head frames, and decaying shaft houses and mills, testify that, unlike manufactures and agricultural products, mineral deposits are diminishing assets, and the fact that a large production of some mineral has been made in one year does not necessarily imply that it can be repeated under the impetus of great need. In estimating the possible production of any mineral for any period, a proper weighing of the attending circumstances, the statistics of production of preceding years, and a knowledge of the deposits themselves are all necessary, and these statements probably apply more forcibly to the metals used in alloy steels than to others, for these metals occur in vastly less quantities than coal, iron, copper, or the other common metals, and the individual deposits are smaller and much less widely distributed and, unlike those of copper or iron, are in very few places concentrated from lean into richer deposits.

Comparatively restricted markets and lack of knowledge concerning these metals themselves and of the minerals in which they occur have prevented prospecting for them until within the last few years, so that as a rule developments of such deposits are small.

The subjects briefly discussed here with reference to their availability as war supplies are treated more fully in Mineral Resources and other publications of the United States Geological Survey, especially those for recent years.

ANTIMONY.

Owing to its brittleness and softness antimony has comparatively few uses. Its principal use is in the hardening of lead, which it also prevents from contracting on solidifying from a molten condition. In peace its chief uses are for bearing metals and type metals. In the manufacture of munitions the metal is alloyed with lead for shrapnel bullets. The higher specific gravity of the lead is necessary to give the bullets the required weight, and the antimony is used to give the bullets a hardness that will prevent deformation when the shell explodes.

The United States has never been a large producer of antimony ores as such, but for several years its smelters have turned out between 2,000 and 3,000 tons[1] of antimony in antimonial lead—a form quite as useful as if the metals had been smelted separately and then alloyed. The production of antimony ores in the United States in 1915, under the spur of very high prices, was 5,000 tons of ore, mined and shipped, carrying about 2,100 tons of antimony, estimated to be worth $425,000. The figures for antimony in ore take no account of the loss in smelting, probably amounting to 20 per cent. Of the ore produced in 1915, 735 tons of stibnite, carrying 58 per cent of antimony, was mined in the vicinity of Fairbanks, Alaska, and 148 tons, with an unknown metallic content, near Nome.[2] In 1916 the ore shipped from Alaska amounted to 1,390 tons, carrying about 57 per cent of antimony.[2] The Alaskan deposits are new and had not been drawn on before 1915. In the main body of the United States antimony ores were taken chiefly from deposits which had been known for a long time but which, owing to their isolation, the lack of transportation, or their small size or low tenor had been worked only during periods of high prices. Such deposits were worked in Inyo, Kern, and San Benito counties, Cal.; in Humboldt and Elko counties, Nev.; and at points in Arkansas, Idaho, Montana, Oregon, Utah, and Washington.

After the war demand became marked smelters began by demanding ores carrying about 60 per cent of antimony (Sb), but before the end of 1915 they were taking ores carrying 20 per cent and were glad to obtain impure ores from South America. Figures for the output during 1916 are incomplete, but the production of antimony in ores mined and the imports increased over those of 1915.

In 1915 the antimony supplies of the United States approximated 18,600 tons, made up as follows:

	Tons.
Antimony contained in domestic ores	2, 100
Antimony contained in antimonial lead of domestic origin	2, 800
Antimony contained in antimonial lead of foreign origin	464
Antimony recovered (in alloys) from old alloys, scrap, and dross	3, 102
Antimony in imported matte and metal	8, 500
Antimony in imported ore	1, 687

Probably the first four items, accounting for nearly half of the extraordinary supplies of 1915, could be duplicated under any great public emergency. Of the remainder, consisting of imported

[1] The short ton of 2,000 pounds is the unit used in this paper.
[2] Figures compiled by Alfred H. Brooks.

metal and ore, the great bulk, about 8,500 tons, is of Chinese origin, and practically all the rest is from South America and Mexico. On account of our friendly relations with these countries and their accessibility they may properly be relied on as sources of supply and can probably repeat the production of 1915 under similar inducements.

Alaska holds possibilities of antimony production which have been discussed by Brooks.[1]

The antimony-smelting capacity of the United States includes the following plants:

Magnolia Metal Co., Matawan, N. J.
Western Metals Co., Los Angeles, Cal.
Chapman Smelting Co., 409 Battery Street, San Francisco, Cal.
Antimony Smelting & Refining Co., Seattle, Wash.

Besides these the American Star Antimony Co., Gilham, Ark., has a plant for the electrolytic reduction of antimony, and the following firms smelt antimony and lead ores to make antimonial lead:

Metals Refining Co., Hammond, Ind.
Hoyt Metal Co., St. Louis, Mo.
International Lead Refining Co., East Chicago, Ind.
Great Western Smelting & Refining Co., Chicago, Ill.
Pennsylvania Smelting Co., Pittsburgh, Pa.
Balbach Smelting & Refining Co., Newark, N. J.
United States Metals Refining Co., Grasselli, Ind.

It must be admitted that the United States can not produce antimony in quantities equal to those now used, but it is probable that satisfactory substitutes for hardening lead may be found in using calcium, barium, strontium, magnesium, and copper.

ARSENIC.

Arsenic finds its greatest uses in insecticides, in glass making, and for dyeing, and smaller quantities are used as a weed killer, in disinfectants, in bearing metals, and for killing vermin.

So far as is known, only the white oxide is produced in this country, and very little has been made directly from arsenic minerals, because great quantities are available as a by-product in the smelting of copper, gold, silver, and lead ores.

In 1915 the United States produced, as a by-product, 5,498 tons of white arsenic, valued at $302,116. Imports amounted to 1,400 tons of white arsenic and 1,783 tons of "arsenic and sulphide of, or orpiment." The elemental arsenic amounted to probably less than 50 tons. The production in 1916 was 5,986 short tons, valued at $555,186. Imports in 1916 were 1,071 tons of white arsenic and 1,092 tons of "arsenic and sulphide of, or orpiment," valued at $232,694.

[1] Brooks, A. H., Antimony deposits of Alaska: U. S. Geol. Survey Bull. 649, 67 pp., 1916; Alaska's mineral supplies: U. S. Geol. Survey Bull. 666-P, 1917.

Considerable quantities of arsenic can easily be produced in the United States by saving more white arsenic as a by-product and manufacturing the element and the sulphide from it. Owing to the long distance of the smelters from the eastern markets, a minimum price of 4 cents a pound in New York is probably necessary for the plants to recover arsenic at even a small profit.

BISMUTH.

Bismuth, like antimony and arsenic, owing to its brittleness and softness, has very slight use alone. It is used as a component of alloys having low melting points, and as it expands on solidifying from the molten state it is used in some type and bearing metals. A number of bismuth compounds are used in treating wounds, and it is therefore of importance in time of war.

Practically all the bismuth produced in this country is obtained as a by-product in smelting copper, lead, gold, and silver ores.

The lead-silver mines at Leadville, Colo., contain pockets of ore that are comparatively rich in bismuth, but the deposits are erratic. When such ores are obtained the American Smelting & Refining Co. smelts them separately to obtain a bismuth-rich lead which is refined by the Betts electrolytic process at Omaha, Nebr.

The dusts saved by the Cottrell precipitation process at the copper smelter at Garfield, Utah, contain a considerable quantity of bismuth, and this is also extracted at the Omaha refinery, at which very complicated processes have been developed for the recovery of such by-products.

The United States Metals Refining Co. also recovers bismuth from lead refined by the Betts process at Grasselli, Ind. The bismuth comes largely from ores mined at Tintic, Utah. The ores are not themselves rich enough to work for bismuth, but the metal is left in the anode residues after the removal of the lead and is then sufficiently concentrated to be an asset.

A little bismuth ore has been produced in the Deep Creek Mountains, Utah, and near Rico and Ouray, Colo. Bismuth minerals are reported to occur in small quantities with practically all copper ores mined, especially in the deposits now being exploited in the Organ Mountains, N. Mex., and should Cottrell precipitation apparatus be put on the stacks of all the smelters the needs of the United States for bismuth in time of war could probably be met with comparative ease. No bismuth is now saved at the Anaconda smelter, yet published figures show that 800 pounds or more passes into the air each day. It would not be cheap nor easy to save the bismuth now lost, but it could probably be done if necessity arose.

NICKEL.

Nickel is now considered an essential for all good steels, except some of the special steels, such as "high-speed" steel, and it is especially useful in making armor plate. The alloy of nickel and copper known as "Monel metal," obtained by smelting the Sudbury ores without separation of the two metals, has been found very useful for valves and fittings for high-pressure steam systems, such as those used on war vessels.

Although the manufacture of metallic or practically pure nickel was developed in this country by Joseph Wharton in the seventies, the discovery and development of deposits larger than any in the United States, first in New Caledonia and then at Sudbury, Ontario, moved the center of production out of this country. However, the smelting and refining of nickel had been carried to so great a degree of perfection and the plants that had been erected were so large that up to this time the United States has remained the largest refiner.

No direct production of nickel from American nickel ores is known to have been made in this country since 1909, when the American Lead Co. operated a smelter at Fredericktown, Mo., for a short period; but in the electrolytic refining of copper the nickel, which is found in small quantity in practically all blister or other copper that has not been previously electrolytically refined, goes into solution in the electrolyte. The electrolyte must be watched in order that not more than 1 per cent of nickel shall accumulate, for a greater quantity is said to interfere with the smooth deposition of the copper and thus to cause short-circuiting and other troubles.

From the electrolyte the nickel is saved as nickel sulphate. Formerly a large quantity of nickel-ammonium sulphate was also made, but none is now reported. The other companies sell the nickel sulphate, which is used for nickel plating, but the American Smelting & Refining Co. reduces the salts saved in its refineries to metal. All other salts saved could be reduced to metallic nickel by electrolysis, with little trouble.

The first nickel known to have been recovered in this country as a by-product in the electrolytic refining of copper was obtained in 1908. During the six years 1911–1916 the saving was as follows:

Nickel content of salts and metallic nickel produced as a by-product in the electrolytic refining of copper, 1911–1916.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1911	445	$127,000	1914	423	$313,000
1912	328	93,600	1915	822	533,222
1913	241	79,393	1916	918	671,192

The imports of nickel as metal, in ore, matte, oxide, and alloys during 1915 amounted to 28,300 tons, and the exports to 13,209 tons, so that the domestic consumption for that year apparently amounted to nearly 16,000 tons. The 822 tons saved from electrolytic copper refining in 1915 therefore amounted to a little more than 5 per cent of the consumption.

The imports of nickel as metal in ore, matte, oxide, and alloys during 1916 amounted to 36,325 short tons, valued at $9,901,887. The exports were 16,702 tons, so that the domestic consumption for that year apparently amounted to 20,540 tons. The 918 tons saved from electrolytic copper refining in 1916 therefore amounted to a little more than 4.4 per cent of the consumption.

In case of urgent necessity, nickel plating and other uses of nickel, except for armor plate and other war appliances, could be somewhat curtailed, and although armor plate of good quality can be made without nickel, it is so valuable in this connection that common sense would seem to demand the utilization of all possible sources in the United States until every war need has been met.

The principal nickel deposits in this country as now known are apparently the deposits worked in the past by Wharton and others at Gap, Pa.; sulphide of nickel and cobalt (linnaeite) with lead, copper, and iron sulphides in dolomite near Fredericktown, Mo.; nickel-bearing veins on the east side of the Stillwater Range, 45 miles southeast of Lovelock, Nev.; sulphide-bearing amphibolite dikes near Key West, Nev.; genthite deposits in Nickel Mountain, 3½ miles west of Riddles, Oreg.; and a deposit 4 miles south of Julian, San Diego County, Cal., in connection with an amphibolite dike. A complete digest of the known facts concerning these and other nickel deposits in the United States has been published.[1]

How much could be produced from these deposits in an emergency can only be guessed at now, but were strong efforts made toward production alone probably 2,000 or 3,000 tons of nickel in ore could be obtained. For its conversion copper smelters already built could probably be used, the excess sulphur in the sulphide ores being used to sulphidize the silicate ores.

A source of nickel which, though not domestic in origin of ore, is nevertheless available is in the iron ores imported into this country from Mayari, Cuba. These ores carry not far from 1 per cent of combined nickel and cobalt, mostly nickel. The two metals go into the iron, and if this iron is used as a basis for steel, then so much less nickel will have to be added to give the desired result. During 1915, 337,004 tons of such ore was imported. No analyses are at hand showing how much of the nickel is lost in the smelting

[1] U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 743–766, 1917.

operation, but the percentage in the pig iron should not be less than in the ore.

The main source of the nickel now imported by the United States is Sudbury, Ontario. A very much smaller part comes from New Caledonia. Both of these localities are in countries with which the United States now holds the most friendly relations.

TUNGSTEN.

The almost indispensable place that tungsten now occupies in the making of high-speed tool steels is indicated by the price to which tungsten ores rose when, after the beginning of the European war, the full demand for lathe tool steels was felt. The highest price recorded before the war was about $15 a unit (1 per cent per ton), but in the spring of 1916 the price rose above $90 a unit, ores selling in the Boulder field, Colo., for $93.50 a unit, and in New York prices of $100 or more were said to be asked. The quantities produced increased almost as much in proportion. A slump in 1914 had brought the production for the year down to an equivalent of 990 tons of concentrates carrying 60 per cent WO_3; in 1915 the output increased to 2,332 tons, and it is probable that in 1916 it amounted to 5,200 tons. Imports during 1916 were 3,973 tons of ore, presumably carrying about 60 per cent WO_3, valued at $7,353,691, and 43 tons of ferrotungsten, valued at $157,711. Not only were the prices, production, and imports very high, but the standards of purity were temporarily lowered. Tungsten ores containing phosphorus, sulphur, bismuth, tin, and copper, which at other times would have received little consideration from most buyers, were taken readily.

After the middle of 1916, however, prices dropped considerably and by the early part of 1917 had reached $17.50 a unit for concentrates carrying 60 per cent WO_3. This price would have been considered high before the beginning of the war, but those whose easily worked ore bodies have been exhausted or who have poor deposits find the price low and are asking for a tariff that will raise it still higher.

Until the beginning of the war the United States had been able to supply its own needs of tungsten, for though at times ores, ferrotungsten, and metal were imported, the exports probably balanced or overweighed the imports.

The great demand for tool steel to cut enormous quantities of shells, rifle barrels, and other war steel overran the producing capacity of the mines, and every available known source of tungsten was drawn upon. The effect upon American deposits was far from uniform. Companies were formed whose basis for stock selling was

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merely a more or less shadowy title to some tract of land in the neighborhood of paying mines; some persons held claims on which they did no work, refusing large prices in the hope of receiving entirely unreasonable sums; but many deposits were worked in a businesslike manner. In a considerable number of mines, particularly in the Boulder field, the principal known ore shoots were worked out to meet the demand, and in these mines the cost of production from remaining ore bodies was materially increased.

On the other hand, some operators discovered shoots from which the ore could be removed profitably at a price as low as $6 a unit. This figure, however, does not allow expense to be put into exploratory work for other ore shoots. Creek beds and residual material near outcrops of veins were worked over by men and boys, and low-grade material from old dumps carrying ore too lean to be worked under low prices was crushed and jigged or otherwise concentrated. These sources contributed a considerable portion of Boulder County's recent production and of course yield but temporary supplies. The Boulder field produced an equivalent of about 2,260 tons of concentrates carrying 60 per cent WO_3.

A number of prospectors in other fields found deposits too late to mine ores that could be sold at the very high prices prevailing in the first half of 1916 and have done little with them. The contact-metamorphic deposits at Toulon, Humboldt County, Nev., and near Bishop, Inyo County, Cal., did not come into active production before the close of 1916.

In the Atolia district of California the production rose beyond that of any former year, though not quite equal to that of the Boulder field, and more than 2,000 tons was shipped. A quantity of scheelite concentrates was taken from the stream and residual gravels, and it is probable that this part of the production can not be duplicated, but the production from veins, forming very much the larger part, can probably be repeated under an impetus of high prices and the possible need of the country.

Very little tungsten ore was produced from the deposits in the State of Washington, but it is reported on good authority that one or more deposits should be productive, especially under the high prices that have prevailed. Data are not yet at hand to show the probabilities of future production in Arizona, South Dakota, and Missouri. Field investigation by the Geological Survey is now being made. It seems likely that the production from New Mexico might be increased. Alaska became an important producer, with 250 tons of ore, and can probably repeat the output.

High-water mark in the production of tungsten ores in this country may have been reached, but it is not impossible that under the incentive of prices reaching, say, $35 a unit, and the added zest of patriotism, the figures for 1916 might be exceeded. It may be found advisable, however, to operate many properties under Government supervision, particularly isolated deposits held by men of little means, suitable provision being made for the payment of the owners, and it might be desirable to extend such supervision to at least some of the larger mines. It is probable that under such operations some unproductive properties held only to be unloaded on some one with more means or energy, usually at prices far from reasonable, might thus be made to contribute at least a small quantity of ores which might be greatly needed.

It is not likely that so much high-speed tool steel will be needed again at one time as was needed at the beginning of 1916. Huge quantities of lathes and other metal-cutting machinery were erected in the shortest possible time, and all these had to be equipped with tools. It may not be necessary to erect many more, and those in place are probably fairly well equipped. The flow of scrap back to the steel works will be large and will correspondingly decrease the demand for new metal, so that the future draft on ores may not be as heavy as it has been recently.

The source of imported tungsten ores is of great interest. The largest part of the imported ore came from South America—Argentina, Bolivia, Peru, and possibly a little from Chile—and considerable quantities came from Mexico, Japan, Chosen, and the East Indies. In the present war it seems impracticable for an enemy to shut out these supplies.

When the great demand came in 1916 American manufacturers were called upon to supply munitions to England, France, Italy, and Russia. For our own needs our own supplies of tungsten ore would probably be ample, but should the United States further help other powers with war steel it might be necessary to call on the other nations for some tungsten supplies.

Plants now in existence for the reduction of tungsten ores to metal or ferrotungsten will probably be sufficient to handle all the ore supplied. In the main the processes are simple, and little complicated or expensive machinery is required, though ores carrying low percentages of tungsten require more careful treatment than the high-grade ores.

MOLYBDENUM.

The consumption of molybdenum in the United States and, in fact, in the world, is much smaller than that of gold, if by consumption is understood the absorption into the channels of trade or the holding in stock, which may be described as a passive use. However, in 1915, the latest year for which statistics are complete, the United States was the largest producer of molybdenum ore, although it has not been a large user.

Estimated world's production of molybdenum ores in 1915.[a]

Country.	Ore mineral.	Quantity (short tons).	Estimated percentage of molybdenum.	Weight of molybdenum (short tons).
Canada	Molybdenite	14.3	.50	7.2
New South Wales	do	35.5	54	19.2
Norway	do	87.0	45	39.1
Peru	do	3.0	49	1.5
Queensland	do	109.0	54	58.8
Spain	Wulfenite	29.0	20	5.8
United States	Molybdenite and wulfenite	3,498.0	2.6	91.0
				222.6

[a] Hess, F. L., Molybdenum: U. S. Geol. Survey Mineral Resources, 1915, pt. 1, p. 810, 1917.

There seems to have been a marked growth in the demand for ferromolybdenum during the present year, and steel makers who have not been users are now making inquiry for it.

The United States contains many deposits of molybdenite, some of which seem to be capable of supplying the country's needs in full under all discernible prospective circumstances. The large deposits are, however, of low grade—from 0.7 to 2.5 per cent.[1]

The principal deposits of molybdenum ores known are on Chalk and Bartlett mountains and Quandary Peak, in Summit County, and near Empire, on the east side of Red Mountain, Colo.; in Copper Canyon, on the east slope of the Hualpai Mountains, Mohave County, at the old Yuma mine, Pima County, and at the Mammoth and Collins mines, Pinal County, Ariz.; and near Emigrant and at other places in Montana. Many smaller deposits, or deposits on which less development work has been done, occur in practically all the Rocky Mountain and Pacific slope States.

Some of the deposits, such as the wulfenite-bearing veins at the Yuma, Mammoth, and Collins mines and the molybdenite deposits in Copper Canyon, Ariz., are now (1917) being actively exploited. The deposit on Red Mountain was rather extensively worked in 1915, but the owners later abandoned operations, assigning as a reason that they did not pay.

A large amount of experimental work has been done on the deposits in Summit County, Colo., and the owners are sanguine as to the outlook for profitable exploitation.

Should the United States Government require molybdenum in considerable quantity it might be necessary, as with tungsten deposits, to have some part of the operations carried on under the supervision of Government agents, in order to insure a supply of ore at the time needed.

[1] Horton, F. W., Molybdenum; its ores and their concentration, with a discussion of market, prices, and uses: U. S. Bur. Mines Bull. 111, 132 pp., 1916.

Some of the ores carry copper, vanadium, tungsten, and other undesirable constituents, and means for the elimination of these impurities or for their avoidance in mining would have to be taken. Much of the ore could be mined comparatively free from them, however, and there is little doubt that all the molybdenum ore necessary could be obtained within the borders of the country.

The reduction of the ore is not difficult and could be accomplished in plants already built, or, if desirable, new plants could be quickly erected.

VANADIUM.

Vanadium is probably to be classed as one of the highly desirable but not absolutely necessary constituents of high-speed and other tool steels, spring, gun, automobile, and machine steels. All are apparently improved by it, but all have been made of good quality without it.

The world's supply of vanadium is practically controlled by American firms, though the largest known deposit lies in Peru, at Minasragras. The second largest source, considered as a whole, is in the vicinity of Placerville and Vanadium, San Miguel County, Colo. There are many smaller deposits in the mines that contain carnotite (hydrous potassium-uranium vanadate) in southwestern Colorado and southeastern Utah and vanadinite (lead chlorvanadate) in New Mexico and Arizona.

The American Vanadium Co., which controls the Peruvian deposits, usually keeps large stocks of material on hand in this country, so that even should the unexpected happen and that source of supply be cut off there would probably be a considerable stock of these ores to draw on. The Peruvian ore is different from any found in this country, being a vanadium sulphide carrying an excess of sulphur. It is roasted before shipping and then carries about 25 per cent vanadium. Considerable quantities of ferrovanadium made from this ore are exported.

The ore found in the Placerville-Vanadium area, Colorado, is a light-green sandstone, the grains of which are partly cemented by roscoelite, a vanadium-bearing mica. The sandstone contains certain thin, flat veins one-half to three-fourths of an inch thick, which look like shale and have been so called and which are composed almost wholly of roscoelite and carry about 8 per cent of vanadium. From these veins the roscoelite has apparently spread into the sandstone, which may carry a maximum of 4 per cent vanadium but as mined probably carries 1 to 1.5 per cent. The Primos Chemical Co., the only company operating on these deposits, has a plant at Vanadium for the reduction of the ore to hydrous ferric vanadate. This product is then shipped to the East for further treatment. Much smaller quantities are saved as a by-product in the treatment of carnotite ores for radium. It is estimated that in 1915 about 627 tons of vanadium was produced from these two sources.

The extent of the vanadinite deposits is uncertain. The vanadinite occurs only in the oxidized parts of some lead-bearing veins, especially in New Mexico and Arizona. If efforts were made toward its recovery, perhaps 50 tons or more of vanadium might be recovered from this source, but great efforts would have to be made.

It is possible that approximately 30,000 tons of high-speed steels were produced in this country in 1916. About 0.6 per cent of vanadium is used in some of the best steels, and at this rate, one-third being allowed for waste, about 300 tons of vanadium would be required, so that if the production of this large tonnage of steel should be repeated the United States would still have one-third of its production to use in other steels.

If all outside supplies of vanadium were shut off, the worst that could be said is that the country would be inconvenienced—it would not suffer.

TIN.

Among the vagaries of ore deposits which seem to show a nonhomogenous earth, as pointed out many years ago by Becker, is the erratic distribution of the metals.

The United States is immensely rich in iron, copper, gold, silver, lead, zinc, and tungsten and, compared with other countries, has large deposits of some other metals, such as mercury, molybdenum, titanium, vanadium, uranium, and radium, but of a few metals it has, from present knowledge, a scarcity, and particularly does it lack nickel, cobalt, and tin.

In the United States proper the known tin deposits are almost negligible. A little tin is mined spasmodically in North and South Carolina, Texas, and South Dakota. Alaska produces 100 or 200 tons a year (the yield of metallic tin was 140 tons from Alaska in 1916), but when it is noted that the United States annually uses between 40,000 and 50,000 tons of tin the inadequacy of our output is apparent. Moreover, the output is not likely to be greatly increased from known deposits.

Our chief source of supply has been the Malay Peninsula, controlled by Great Britain. The only source of supply on the Western Continent is from the mines of Bolivia, whose output of about 30,000 tons is equal to about two-thirds of our imports. The Bolivian supply formerly went to Europe, mostly to Germany, for smelting. Since the beginning of the war efforts have been made, with some success, to divert this ore to the United States, and the American Smelting & Refining Co. has erected a combined smelting and electrolytic refining plant at Maurer, N. J., with estimated capacity by July 1, 1917, of 18,000 tons of tin annually, for the treatment of Bolivian and other tin ores. It is reported that another smelting company will erect a plant in this country with capacity, when in full operation, of 20,000 tons of tin a year, for smelting Bolivian ores. At the same time, all other supplies have been in the hands of friendly nations, so that our needs have been amply met.

However, if all outside supplies should be cut off the United States would be forced to turn to substitutes, such as glass and aluminum as food containers; sherardizing and galvanizing in place of tin plating for many articles; zinc, lead, or aluminum sheet in place of tin plate for many other articles; and tight folding and crimping in place of soldering. The country would frequently be inconvenienced, but it could supply the lack.