MICA, MONAZITE, AND LITHIUM MINERALS.

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MICA.

Mica is valuable on account of its cleavage, flexibility, elasticity, and nonconductivity of heat and electricity, a combination of properties in which it is unsurpassed by any other abundant mineral. The extensive employment of mica in electric appliances requires a large quantity in the aggregate, although the quantity used in a lamp socket, for example, is extremely small.

Much mica is ground for use in decoration and for insulation. About 90 per cent of the mica produced in the United States is scrap, which is eventually ground into powder, but the remaining 10 per cent is sheet mica, worth from five to seven times as much as the scrap. Sheet mica has become a necessity in everyday life, and much of the ground scrap mica is, in a way, a by-product of the manufacture of sheet mica, consisting largely of the trimmings resulting from the cutting of the sheet mica into regular forms.

Sheet mica is found in many countries. It has been produced in the United States, Canada, Brazil, Argentina, German East Africa, Transvaal, British Nyassaland, Natal, Madagascar, India, Ceylon, Australia, China, and Japan. Small quantities are also mined in Mexico, Guatemala, Norway, Russia, southwestern Africa, and Chosen, but at least 97 per cent of the annual output of sheet mica is mined in the United States, Canada, and India. The United States produces about 60 per cent and India about 30 per cent. The India mica, which has to be transported a considerable distance and is therefore well selected and trimmed before shipping, is of greater value, weight for weight, than the American mica. The value of the annual output in India is about 60 per cent of the total value of the world's production; that of the output in the United States is about 20 per cent.

The imports of sheet mica exceed the domestic output in both quantity and value. In 1916 more than $1,000,000 worth of sheet mica, unmanufactured and manufactured, was imported More mica

is imported from Canada than from India, but the value of the India mica is greater. The mica from India comes both direct and through England.

The demand for mica in 1915 was brisk, and in the United States the average price of sheet mica, rough trimmed and cut, was 68 cents a pound, the highest since 1900. Since 1915 similar or slightly higher prices have prevailed.

The relation of imported to domestic mica is shown in the following tables:

Mica consumed in the United States, 1912–1916.

Year.	Quantity.			Value.		
	Domestic production (short tons).	Imports (short tons).	Percentage of domestic.	Domestic production.	Imports.	Percentage of domestic.
1912	3,650	1,166	76	$331,896	$755,584	31
1913	6,172	[a] 1,265	83	436,060	947,783	32
1914	4,008	[a] 611	87	329,956	629,484	34
1915	4,236	[a] 613	87	428,769	692,269	38
1916	4,866	[a] 856	85	594,391	1,071,356	36

[a] Estimated.

Until 1916 there was a slight, steady increase in the percentage of the total produced by the United States. The decline in the percentage for 1916, is, however, slight.

Sheet mica consumed in the United States, 1912–1916.

Year.	Quantity.			Value.		
	Domestic production (short tons).	Imports (short tons).	Percentage of domestic.	Domestic production.	Imports.	Percentage of domestic.
1912	423	995	30	$282,823	$748,973	27
1913	850	[a] 1,120	43	353,517	943,018	27
1914	278	[a] 409	40	278,540	625,396	31
1915	277	[a] 441	39	378,259	688,411	35
1916	433	[a] 675	39	524,485	1,067,936	33

[a] Estimated.

Beginning with 1914, there was a considerable decrease in the amount and value of unmanufactured mica imported, but a considerable increase in the imports of cut or manufactured mica.

The mica obtained in this country and from India is muscovite; that from Canada is phlogopite. For certain pieces of electric machinery phlogopite is preferable to muscovite, and deposits of phlogopite in New York and New Jersey are now being examined. The mica from these two deposits is of good quality and it is hoped that they will become commercial sources.

Is the dependence of the United States on foreign countries for sheet mica due to an inherent deficiency in the domestic supply of mica or to economic conditions that may have no direct bearing on the amount of mica available in this country? In other words, if the United States had to depend on its own resources for mica, could it supply the demand, irrespective of cost?

In the report on the production of mica in 1912 Sterrett [1] says: "The mica mines of the United States are capable of a large annual production and could be made to supply all but that small part of the domestic demand which calls for the softer Canadian amber mica." He states further: "The quality of the best domestic mica as to transparency, color, cleavage, and flexibility is equal to that of the same variety produced in India and other countries." The conditions outlined for 1912 are the same to-day. The amount of mica produced could be very materially increased. However, the cost of operating mines in the United States is very large in comparison with the cost in India, where labor is cheap.

Much of the mica mined in the United States is obtained from deposits operated entirely by hand, and, especially in North Carolina, a good part of the output is obtained by farmers who work their deposits intermittently when the crops do not require their attention. Were a demand for mica to become imperative, and were the mica mined economically and with care (a valuable bunch of sheet mica can be easily ruined by careless use of a drill or pick), then the United States, already producing 60 per cent of the world's output of sheet mica, could easily produce enough to meet all its own demands. Possibly the further exploitation and development of the phlogopite deposits in New York and New Jersey will show that this country could become independent of the world with respect to mica.

It is understood that sheet mica has come to be of importance as a war mineral through its use abroad in making windows of masks worn for defense against asphyxiating gases, and for other uses where a transparent, noninflammable, nonshattering material is necessary, as in automobile goggles and in windows for armored cars.

MONAZITE.

The mineral monazite contains a variable but small percentage of thoria, which is extracted and sold in the trade as thorium nitrate. Upon ignition this nitrate is changed to the oxide or thoria, which glows intensely when heated and is used in the manufacture of incandescent mantles for gas lights. Monazite occurs throughout the world but forms only a very small fraction of 1 per cent of the rock containing it. On decomposition of this rock the monazite and

[1] Sterrett, D. B., U. S. Geol. Survey Mineral Resources, 1912, pt. 2, p. 1085, 1913.

other resistant minerals are not attacked chemically but remain unaltered and, being much heavier than the products of decomposition, are gradually but slowly concentrated in the residue from the broken-down rock. If the ocean encroaches on an area of such decomposed rock, the selective action of the sea waves will still further concentrate the heavier minerals along the beaches. River waters will likewise effect a concentration of the heavy minerals.

In both North Carolina and South Carolina such river deposits were first worked about 1887 and soon yielded large quantities of monazite sand, the production in 1895 exceeding 1,500,000 pounds. At this time monazite from the rich coastal deposits of Brazil entered the market, and the domestic production fell to almost nothing, that for the two years 1896 and 1897 being worth only $3,480. The price of thorium nitrate, which was about $200 a pound in 1895, when the production in the Carolinas reached its maximum, was rapidly lowered to about $7 a pound in Europe in 1900. During the next new years it rose to about $11 a pound, and the increase in price together with a world-wide search for additional deposits of monazite sand, served to revive the industry, until in 1905 over 1,000,000 pounds of monazite sand was again produced in the Carolinas. Much of this output was exported to Germany. In 1906 and again in 1910 the price of thorium nitrate was considerably reduced, and in 1913 it was selling in this country at $2.60 a pound. At this low price it became unprofitable to mine monazite sand wherever the cost of mining was high. After 1905 the domestic production gradually decreased, and since 1911 it has been inappreciable.

In 1909 monazite sand was discovered in Travancore, India, and soon large amounts were produced. The Carolina sand has had to compete with these deposits and others in Brazil, which could be mined very cheaply. Most of the Brazilian sand and all of the India sand was exported to Germany until the beginning of the European war. Since then most of the sand has been sent to this country, which imported nearly 2,500,000 pounds of monazite sand in 1916. With this increase in imports of monazite sand there has been a steady decline in imports of thorium nitrate, from 119,044 pounds in 1913 to 909 pounds in 1916. In other words, the United States is manufacturing its own thorium nitrate, chiefly from sand imported from Brazil and India. The price of thorium nitrate has gradually increased since the war and now is about $8 a pound, or three times as much as in 1913. This advance in price has again stimulated the domestic production of monazite sand, and small amounts were produced in 1915 and 1916.

There is still an abundance of monazite sand in the Carolinas, but the Carolina deposits can not be worked extensively in competition with foreign sand. As the United States consumes about one-fourth

of the thorium nitrate used in the world, it requires a yearly production of about 2,000,000 pounds of monazite sand (90 per cent monazite containing 5 per cent thoria. Even in its most prosperous times the domestic output did not reach that figure. Whether such a domestic production could be sustained year by year if all imports were cut off can not be told. The Carolinas, however, could produce enough monazite sand to make this country independent of other sources for several years at least, and if the ashes of broken mantles were conserved by consumers, enough thorium nitrate could be obtained from domestic sources to serve for some time.

The factors that have prevented a thorough test of the extent of the domestic deposits in recent years are the better quality and cheapness of the imported foreign sands. Both the Brazilian sand and that of India contain a higher natural concentration of monazite and a higher content of thorium oxide than the American sand, the sand from Brazil averaging about 6 per cent thoria and that from India about 9 per cent. The cheapness of labor and transportation in these foreign countries has also deterred domestic exploitation. The market price of thorium nitrate is a good indicator for domestic production of monazite sand, for only at a high price for this manufactured salt can the domestic sands be profitably worked. The importation of large quantities of foreign sand rich in thoria prevents a very high price being paid for thorium nitrate.

LITHIUM MINERALS.

The chemical products derived from lithium minerals can not be considered necessary for every-day life. Such products, however, find several applications, especially in military uses, in which they serve a useful purpose. Lithium minerals are produced in this country in varying amounts up to 1,000 tons a year.

The United States has been the largest continuous producer of lithium minerals (spodumene, lepidolite, and amblygonite) and has in the past exported a considerable quantity of the yearly output. Lithium minerals have also been mined in Germany, Austria, Sweden, France, Australia, and Spain, but the amount produced in this country is probably larger than that in the other countries combined. As the domestic production has been ample to satisfy the needs of this country, and the crude minerals have been also treated here, the European war has not induced special efforts for larger development of the deposits, and there has been practically no change in the production of lithium minerals since 1913.

California and South Dakota have furnished all the lithium minerals produced in this country. Such minerals have been found

abundantly in Massachusetts and in Maine, but at present prices the deposits in these two States have not been exploited. The amount of lithium minerals still available is very large, and if an increased demand were to arise, the United States could supply many times the present output for a long time to come.