

THE PHOSPHATE INDUSTRY.

I.—SOURCES OF SUPPLY OF MINERAL PHOSPHATE.

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In pre-war days very little interest was taken in mineral phosphate except by those immediately connected with the trade, but during hostilities the high price of foodstuffs of all kinds greatly encouraged the use of fertilisers, and the labour conditions in all the phosphate-producing areas created a shortage which at one time amounted to almost a world famine. This shortage, which was apparently only temporary and due to difficulties of labour and transport, has created a new interest in phosphate-mining, so that new deposits and rumours of fresh discoveries are to-day matters of world-wide interest. It only needed the British Government to decide on conserving the phosphate resources of the Empire by acquiring the rights of the Pacific Phosphate Company to imbue the public with the idea that phosphate mines and gold mines were equally lucrative propositions; but this has not been the past experience by any means. The Ocean Island deposits, being of very high grade and easily mined by very cheap labour, certainly proved very profitable to the original shareholders, but with this exception phosphate-mining has never been a very lucrative undertaking. Experience has shown that whenever consumption has overtaken production new deposits have been opened up and the shortage very soon turned into a surplus. Even to-day the existing deposits are known to contain enormous reserves in sight, which are capable of supplying the world's demands for a very considerable period.

Phosphates occur in many parts of the world, and vary in quality from a hard, rocky material, such as the Florida hard rock and Curaçao phosphates testing 75–80 per cent. phosphate of lime, to the soft, sandy deposits of North Africa, which contain from 57–65 per cent. of the same constituent. No doubt large quantities of lower-grade mineral occur in different parts of the world, but these are not generally considered workable, except in France and Belgium, where considerable quantities testing 40–50 per cent. are raised annually and are used extensively for direct application to the land. Owing to the varying nature of the deposits the methods of mining differ very widely. Where the phosphate occurs as a rock, as in the Florida hard-rock deposits, blasting is, of course, necessary, whereas in the Florida pebble fields, where the product is in the form of nodules or pebbles often lying close to the surface and in beds from 10 to 20 ft. thick, the overburden is stripped off by means of excavators and the pebble washed out by water pressure. Again, in most of the North African mines the phosphate seams occur in the sides of the hills, and the soft phosphate is dug out in galleries running into the hill and following the face of the seam. In England small deposits of coprolites in the form of hard pebbles were worked some thirty years ago in the Eastern Counties, where the formation is somewhat similar to the Florida pebble beds, but on a very much smaller scale. The coprolites lay in narrow beds at various depths, and where the deposit was close to the surface digging was a simple matter, but these accessible beds were long ago worked out. It may be interesting to note that at the beginning of the war, when the scarcity of phosphates was first being felt, the Admiralty authorities were asked to, and eventually did, supply ships to convey the phosphate from North Africa, but at first they are reported to have pointed out that they could not see their way to do so, as the Geological Survey

showed the existence of large deposits of phosphates in England. Whether as a result of this reply or not, the Ministry of Munitions afterwards opened up a coprolite bed and raised some thousands of tons, but the cost proved out of all proportion to the value of the phosphate obtained.

World production of phosphate.

During the ten years immediately preceding the war the demand for phosphates caused a gradual rise in the output, which increased, according to the statistics, from slightly under 5 million tons in 1907 to just over 7 million tons in 1913, in which year the consumption was very little short of the total production.

In 1907, as well as in 1913, the United States showed the largest output, with North Africa second, but it will be noticed from the following statistics that during that period the North African production increased at a greater rate than that of the United States.

	1907	1913
	Long Tons	Long Tons
United States	2,301,000	3,161,000
Tunisi	1,069,000	2,234,000
Algeria	315,000	461,000
France	375,000	335,000
Belgium	181,000	219,000
Christmas Island	290,000	152,000
Other Pacific Islands	190,000	422,000
Other countries	58,000	195,000
	4,779,000	7,229,000

Of the quantities designated as produced by "other countries," the sources would include Egypt, Japan, Australasia, Curaçao, Russia, etc., of which Egypt contains the most important deposits.

United States.

The first phosphate deposits to be worked in America were the South Carolina deposits, but these are now worked on a very small scale only, and in 1913 Florida and Tennessee produced 96 per cent. of the entire American output. Phosphates are also mined on a small scale in Kentucky and Arkansas, and undeveloped deposits are known to exist in North Carolina, Alabama, Georgia, Virginia, and Idaho.

Florida hard rock.—The deposits of "hard rock" occur very irregularly, and as to location, depth from the surface, extent, quality, and quantity, conform to no general rule; whereas at one point the phosphate may lie at the surface, in other places it may be so deeply buried as to be unworkable. The material above the phosphate is generally of a sandy, clayey nature of variable thickness. In the Florida State Geological Survey Florida hard rock is stated to contain from 79–83 per cent. tricalcium phosphate, but experience of shipments tends to prove that the rock mined contains an average of 77–79 per cent. The hard-rock phosphate was very popular in Europe before the war, no doubt owing to the facts that its high quality makes it economical to transport and that the deposits are all within easy distance of good shipping ports. Also the low percentage of iron and alumina enables a highly soluble superphosphate to be manufactured from it without fear of reversion. In 1913 the output of hard rock amounted to 477,000 tons, all of which was exported, but in 1919 the output was only 341,000 tons, of which 100,000 tons was consumed in America.

Florida land pebble.—The "land-pebble" phosphates are much more easily mined than the hard rock, and are more uniform in their occurrence, although variable from place to place. The phosphate occurs in beds of pebbles in a matrix of clay, sand, and soft phosphate, the overburden consisting of sand and sandy clay. The beds have an average thickness of from 8 to 10 ft., with a maximum of 18 to 20 ft. The highest grades of pebble

phosphate contain from 75—76 per cent. tri-calcium phosphate and the lowest grades 62 per cent., being graded for sale as 68—70, 70—72, and 75 per cent. For consumption in America the most popular grade is the 68 per cent., but it is difficult to understand why this should be, as the distances between the mines and the consuming works are often very great. Possibly the farmer may prefer a lower grade and consequently lower-priced superphosphate. In 1913 the output of pebble phosphate was 2,107,000 tons, of which 887,000 tons was exported, but in 1919 the production had fallen to less than 1 million tons, of which only 131,000 tons was exported.

Tennessee phosphate.—The phosphates which occur in Tennessee are of two kinds, known as blue and brown phosphate, respectively. The blue phosphate is a hard, rocky phosphate testing in some cases as high as 85 per cent. phosphate of lime, and the beds are thin, seldom exceeding 20 in. in thickness; the mineral contains a high percentage of iron and alumina, and is not extensively mined. The brown phosphate occurs in irregular deposits close to the surface, resting on limestone with an overburden of clay and sand mixed with phosphate; it is of several kinds, varying from a shelly rock to a mass of small pebbles, and has a reddish-brown colour. The beds average from 8 to 10 ft. in thickness, and the phosphate contains from 70—80 per cent. phosphate of lime, although, of course, there are large deposits of much lower quality. Statistics relating to the production of Tennessee phosphate are somewhat difficult to obtain, but it would appear that in 1913 the quantity mined was about 500,000 tons.

North Africa.

As regards present production, the North African phosphate deposits are second in importance to those of the United States, but it is probable that their extent is far greater than that of any other known deposit. Recent discoveries in Morocco show that there is an almost continuous series of beds running across the whole of North Africa from Morocco, through Algeria, Tunis, Cyrenaica, to Egypt, but many of these deposits are at present undeveloped, owing chiefly to their distance from the sea and the capital which would have to be spent in developing them. The Algerian deposits were the first to be opened up, but the Tunisian deposits have now been developed to a greater extent, and the Gafsa mines now produce the largest annual tonnage of any single deposit in the world.

Algeria.

The most important deposit in Algeria is at Djbel Kouif, near Tebessa, owned by the Constantine Phosphate Co. The phosphate here occurs in beds varying in thickness from 2 to 9 ft., which lie often one above the other between layers of slate and marl, the slate forming an excellent roof so that galleries can be driven into the hill-side and the phosphate easily extracted. The mineral is soft, and as the phosphate content of the beds varies between 58 to 63 per cent., an average of 61—65 per cent. can easily be maintained. The output from Constantine in 1913 was approximately 300,000 tons, but the production is limited by the capacity of the railway to the nearest port of Bone, which is 120 miles from the mines. The reserves of good-quality phosphate in these mines are enormous. The only other deposit at present worked extensively is the deposit of M'Zaita, where the phosphate occurs in beds of 1 to 6 ft. in thickness, containing from 58 to 63 per cent. phosphate of lime. This phosphate has a dark colour and is of a rocky nature, being much harder than the Constantine quality. The total output from Algeria in 1913 is given as

461,000 tons. Other Algerian deposits are dealt with under the heading Undeveloped Deposits.

Tunis.

The total output of phosphates from Tunis in 1913 is given as 2,284,000 tons, of which over 1 million tons was produced by the mines of the Société des Phosphates de Gafsa, which, as stated above, is the largest production from any single mining company in the world. This company owns the 150 miles of railway between the mines and the port of Sfax, which has an excellent harbour. The phosphate is extremely soft and outcrops in the hills in beds of from 1 to 10 ft. thick, and two qualities are produced, the lower grade testing from 58 to 60 per cent. and the higher grade 60 to 65 per cent. The Société des Phosphates Tunisiens operates the deposits at Kaala Djerda in Tunisia, close to the Algerian deposit of Djbel Kouif. Here the phosphate is again of a soft, sandy nature, containing from 57 to 60 per cent. phosphate of lime. These deposits are of more recent development than those of Gafsa, and are producing about 300,000 tons per annum. The deposits at Maknassy are somewhat similar to those at Kaala Djerda but of slightly higher quality, averaging 60 to 63 per cent. The only other important workings are those of the Société des Phosphates du Dyr, from which a soft phosphate averaging 57 to 59 per cent. is obtained. During the war the North African mines were practically the only source of supply for Europe, as America and the more distant deposits were cut off by shipping difficulties. Labour and transport difficulties, however, reduced the shipments to 820,000 tons in 1919, and the pre-war output has not yet been reached.

Belgium.

There are considerable phosphate deposits still worked in the neighbourhood of Mons and Liège, but the higher grades have been largely worked out and the average grade obtained now is from 40 to 50 per cent. phosphate of lime. The phosphate is soft and sandy, contains a high percentage of carbonate of lime, and is used extensively for application to the land in the ground state as a substitute for basic slag.

France.

There are considerable beds of soft phosphate, known as phosphatic chalk, in the Aisne, Oise, Calais and Somme districts, carrying from 40 to 65 per cent. phosphate of lime. As in the Belgian beds, the higher grades are rapidly being worked out and the output is declining, France now looking to North Africa for her phosphate requirements.

Christmas Island.

Large deposits of phosphate of very high grade occur in Christmas Island in the Indian Ocean, and in 1913, 152,000 tons was exported. These phosphates were formed like those of the Pacific Islands by the combination of organic materials with the calcareous rock, and contain over 80 per cent. tri-calcium phosphate.

Pacific Islands.

The Islands of Nauru, Ocean Island, Angaur, and Makatea exported in 1913 over 400,000 tons of high-grade phosphate containing from 80 to 85 per cent. of tri-calcium phosphate, Ocean Island contributing 189,000 tons. These deposits are similar to those of Christmas Island, the phosphate being soft and lying close to the surface; and if it were not for the relative inaccessibility of the Islands the output would be far greater. They are probably the largest deposits of very high grade phosphate which are known. Nauru is believed to possess reserves of 80 to 100 million tons and Ocean Island 50 million tons. Before the war Nauru and

Angaur belonged to Germany but are now administered by Great Britain and Japan, respectively. A good deal of attention has lately been attracted to Nauru on account of the Government scheme for working the deposits in conjunction with the New Zealand and Australian Governments. Let us hope that this experiment in Government trading may be less expensive than some others have been.

Egypt.

There are extensive phosphate beds in Egypt and in 1913 over 100,000 tons was produced, of which 60,000 tons was exported. In the Sebaila district of the Nile Valley there are large quantities of phosphate lying close to the surface in beds from 18 in. to 6 ft. thick, but the phosphate only averages 45 per cent. phosphate of lime. At Safaga, on the Red Sea, there are considerable deposits running as high as 75 per cent. which are only 18 miles from the sea. There are also large deposits of lower-grade phosphates in this neighbourhood, but they are not worked at present; the mineral outcrops in the hillside and, being soft, is easily worked. There are also extensive deposits lower down the Red Sea near Kossair which are being developed, and there is no doubt that a very large quantity of phosphate is available in this region.

Undeveloped deposits.

If any doubts existed concerning a sufficiency of phosphate for the world's requirements for many years to come, they should have disappeared after the important discoveries made during the war. The most promising of these is in Morocco where development has already commenced and sample shipments are early expected. These deposits are situated at El-Beroudj, about 80 miles south-east of Casablanca, and are said to contain hundreds of millions of tons of phosphate. The beds occur in the Beni Meshine Plateau beneath limestone and vary in thickness from 4 to 6 ft. Some of the phosphate is believed to contain as much as 75 per cent. calcium phosphate, and if the bulk proves to be as rich as this, the deposit will be a very valuable one for European requirements.

Large deposits of phosphates were prospected in Palestine during the year 1916 by a German professor, who reported that the discoveries were very important, and the fact that a military railway has been since constructed running very close to the deposit may have an important bearing on its development. At one point borings showed a deposit of great thickness, approximately 65 ft., with an average test of 72 per cent. and in places 83 per cent. phosphate of lime. There appear to be many deposits in Palestine of an unusual thickness varying in phosphate content from 62 to 83 per cent., and, if reports be correct, it should not be long before these beds are developed on a large scale.

Another large deposit which has not yet been developed is known to exist at Djebel Onk in Algeria, 50 miles south of Tebessa. This deposit would be dependent on the Tebessa-Bone railway, which appears to be only capable of dealing with the present traffic, but it is reported that an extension is contemplated to Djebel Onk. These deposits are estimated to contain at least one thousand million tons of phosphate averaging 60—70 per cent., and must be looked upon as very important.

It has been impossible in the space available to deal with every known phosphatic deposit in detail, but all the more important have been referred to in an attempt to show the magnitude of the industry which has arisen from Lawes' first experiments in dissolving coprolites.

SOCIETY OF CHEMICAL INDUSTRY.

MEETING OF COUNCIL.

A short meeting of the Council was held on August 5 to transact certain routine business prior to the departure of the President for Canada. Sir William Pope stated that he had received a letter from Monsieur P. Kestner intimating that the Annual Meeting of the Société de Chimie Industrielle will be held in Paris from October 9 to 12, and asking that the Society would send a number of delegates; a few members of Council had already undertaken to attend the meeting, and he hoped that others would send in their names.

NEWS FROM THE SECTIONS.

OTTAWA.

The annual meeting was held on April 14, with Mr. F. J. Hambly in the chair. The hon. secretary, Mr. S. J. Cook, read his report which intimated, *inter alia*, that Mr. E. Stansfield, the chairman of the Section, had severed his connexion with the Department of Mines, in which he was chief engineering chemist of the Fuel-Testing Division, and had gone to the University of Alberta to take up some special research work on the utilisation of the lignite-coals in that province.

During the past session the Section has held 6 meetings (exclusive of the annual meeting), at which the average attendance was 44—an improvement upon the previous year. At the opening meeting, Mr. H. H. Claudet, manager of the General Engineering Co., gave an address on "Mineral Flotation Processes." The meeting in December was devoted to an address by Mr. R. T. Elworthy on "The History and Manufacture of Helium." At the third meeting a cinematograph film portraying the Story of Coal was shown; at the fourth, Mr. P. L. Peek described the operations of the British America Nickel plant at Deschenes, and subsequently the members visited the plant and made a thorough inspection. The subject of "Vitamins" was discussed at the January meeting, "Cements and Super-cements" at the February meeting, and at the last meeting Mr. F. E. Lathé, chief chemist to the British America Nickel Corporation, gave a lecture on "Principles underlying Copper-Leaching and Precipitation."

During the past session the Section enrolled 17 new members and 30 Associates, which compares with 15 members and 32 Associates in the year 1919-20. The most important event of the year was the dissolution of the Canadian Section of the Society and the establishment of five independent Sections, of which Ottawa is one.

Taken in review, states the report, the past year may be considered successful, although it may be open to question whether in future it will be desirable to hold so many joint meetings with other societies as were held this session. The tendency, when this is done, is for some of the members of the Society to consider themselves relieved, as it were, of their responsibilities. It seems desirable, therefore, to suggest that the incoming Committee should seek to strengthen the position of the Section, and, in view of the visit of the parent Society to Canada this year, it will probably be found essential for every member in Canada to exert himself in the interests of the Society in order that the desired results may be attained.

Mr. F. J. Hambly was elected chairman of the Section for the ensuing year, Mr. S. J. Cook was re-elected hon. secretary, and as the result of a ballot the following were elected to serve upon the