MINES BRANCH

DEPARTMENT OF MINES

OTTAWA, CANADA

The Ore Testing and Research Laboratories, Mines Branch, Department of Mines, Ottawa

by

W. B. Timm

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THE ORE TESTING AND RESEARCH LABORATORIES [+] MINES BRANCH, DEPARTMENT OF MINES, OTTAWA

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The purpose of this talk is to give our listeners an idea not only of the experimental and research work conducted on the treatment of ores in the Ore Testing and Research Laboratories at Ottawa, but also an idea of the processes through which an ore must pass before a marketable article, that is, metal, is produced.

Perhaps at no time in the history of the Dominion has there been so great an interest shown by the public in the mining industry as in the past few years. Many important discoveries of economic minerals have been made, and new mining districts opened up. In northwestern Manitoba the Flin Flon, the Sherritt-Gordon, the Mandy, and other mines are in course of development. Preparations are being made for the establishment of large metallurgical works in this district. In the Sudbury area of Ontario the Errington mine and the high grade Frood discoveries of the International and Mond Nickel companies, make this one of the worlds important mining districts.

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[++] Chief Engineer, Division of Ore Dressing and Metallurgy.

From its ores will be produced copper, nickel, zinc, lead, gold, silver, and the platinum group metals. In western Quebec the Horne smelter commenced operations last December, producing blister copper containing high gold values from the ores of the Horne mine. The Amulet, the Aldermac, the Abana, and other mines of the district are in course of development.

The inducements offered to capital to invest in the mining industry are, that Canada possesses large areas of unprospected ground favourable to the occurrence of minerals in economic quantities; that her mining laws are most just and equitable; that conditions with regard to climate are favourable, to labour good, and most important is the stability of her Government.

Some of the leading mines have made handsome profits. In some cases the market price of their shares has increased manyfold. The result has been an almost feverish activity on the part of the public to invest in mining stocks. From the dividend paying stocks it has been carried to the purely speculative issues. Prices keep on rising with every favourable report from the mines. Dazzled by the vision of quick profits and by glowing reports from brokerage houses, many of the investors are not aware of or fail to realize the difficulties that must be overcome before an ore can be mined and the metals extracted and sold at a profit.

The metals used in the arts and the industries rarely occur in nature in the pure state. They occur as compounds with some other elements scattered through a large amount of rock or other valueless material. Galena, the most common lead mineral, is a compound of lead and sulphur; sphalerite, the most common zinc mineral, is a compound of zinc and sulphur; chalcopyrite, the most common copper mineral is a compound of copper, iron, and sulphur. Gold is

generally alloyed with a certain amount of silver.

Many copper ores, such as those of the Hidden Creek mine, the Britannia mine, and the Copper Mountain mine in British Columbia contain less than two per cent copper, or forty pounds of metal in a ton of ore. Over 1,960 pounds of valueless material has to be removed from every 2,000 pounds of ore to obtain 40 pounds of copper metal. The ores of the large Porcupine gold mines contain less than one-half ounce, and those of the rich Kirkland Lake gold mines less than one ounce of gold disseminated through a ton of ore. Practically a whole ton of valueless rock must be removed thus to obtain less than an ounce of the metal gold.

The science and art of obtaining the metals from an ore or from the valuable minerals in an ore is called metallurgy. For instance, amalgamation, the process in which gold and silver are recovered from the ore by forming an amalgam with mercury, is a metallurgical operation, as is the subsequent operation of recovering the mercury from the amalgam by retorting, leaving the gold and silver to be melted down into bullion. This process is used on high grade and spotty gold ores. Leaching the finely ground ore with cyanide solution and precipitation of the gold and silver from solution by means of zinc dust as practiced in the gold camps at Porcupine and Kirkland lake, is a metallurgical operation. The methods of smelting the copper-nickel ores of the Sudbury district at Copper Cliff and Conniston; the copper ores of the Horne mine at Noranda; the lead ores and concentrates of the British Columbia mines at Trail and the iron ores at Sault Ste. Marie and Hamilton, Ontario, and Sydney, Nova Scotia, are metallurgical operations. The electrolytic deposition of the metals, such as lead, zinc, copper, nickel, silver, and gold from solution, is a metallurgical operation.

One, two, or more minerals are frequently found in an ore, intimately associated with one another and with a large quantity of valueless iron minerals. Moreover, the minerals are generally so fine grained that the ore has to be crushed and ground to the fineness of flour or cement to free or dissociate them. The preparation of the ore after it comes from the mine, by crushing and grinding, by concentration and separating the minerals one from another, and the removing of the valueless portions, is called ore dressing.

Generally the word ore is used in the broad sense to mean all metal bearing rock which contains one or more economic minerals. Technically, an ore is a metal bearing mineral or aggregate of minerals mixed with barren rock matter called gangue, and capable of being mined at a profit. The mineral or aggregate of minerals mixed with barren rock matter has to be in such quantity and of such grade that it can be successfully won from the ground, concentrated, and the minerals separated and reduced to the metals at a profit to the operating company.

Very often you will see in the press the grade of an ore expressed in dollars and cents, presumably the gross value per ton figured at the market price for the metals. While the statement may be perfectly correct, it is misleading, as the public does not generally realize the high cost of obtaining some of the metals from their ores. This gross value, in the case of the base metal sulphide ores of copper, nickel, lead, and zinc, is a very much higher figure than the net value of the ore in the ground after deducting mining, concentrating, freight, smelting, refining, and marketing charges. While a gold ore of a gross value of $10 per ton can be made a very profitable enterprise on a basis of 200 tons daily, a base metal sulphide ore of this gross value would show very little or no profit

on this tonnage basis.

The great Sullivan mine in British Columbia lay idle for years awaiting a purchaser, although it contained ore of a gross value of over $30 per ton. Some ten years of careful experimental test and research was conducted before a profitable method of treatment was evolved. Today some 4,000 tons of ore of a gross value of between $15 and $20 per ton are being concentrated daily, furnishing the raw material for the greatest lead-zinc metallurgical works in the world.

The Tetreault lead-zinc mine at Notre Dame des Anges, Quebec which was worked at intervals before and during the war, made a profit from the lead content of the ore, but could not recover the zinc in a marketable form. As the result of research on the treatment of the ore both marketable lead and zinc concentrates are now made with high recoveries. From an uncertain enterprise the operation of this mine was turned into a very profitable one, even at much lower post war prices for the metals.

The Flin Flon mine was discovered in 1915. Since 1920 when the extent of the ore bodies was more or less determined, a vast amount of experimental work has been done to indicate whether the ore could be treated at a profit. The result of this work is the company's decision to proceed with the venture, with the establishment of large metallurgical works. The Sherritt Gordon ores in the same district are being tested in a like manner.

The same is true of the Sudbury Basin ores. Some two years of careful research has already been conducted on the Errington mine ore and a pilot plant of 200-tons daily capacity is about ready for operation to further investigate the treatment process required to make this a profitable enterprise.

And so with the copper and copper-zinc ores of western Quebec.

Whether the Amulet, the Aldermac, the Abana, and other properties in the district develop into profitable mines depends on, firstly, the tonnage of ore reserves, secondly, the grade of the ores, and lastly, the successful treatment of the ores to show a profit to the operating companies.

In the few instances given above I have shown the importance of experimental test and research work to the successful operation of Canadian mining enterprises. There are instances in the past where ore treatment plants have been erected before an adequate supply of ore has been assured, or before the treatment process has been worked out. To avoid such mistakes and to provide a place where ores could be thoroughly tested to determine the most profitable method of treatment, the Dominion Government has established at Ottawa well equipped and up to date ore testing and experimental laboratories. Some dozen or more mining, metallurgical, and chemical engineers are engaged on this work, all having a knowledge of operating conditions in the industry, and with a special aptitude and ability for research Besides this technical staff, and under their supervision, an operating staff of some twenty is engaged in conducting the test operations.

The experiment station consists of a number of laboratories, one for the dressing of metallic ores, one for the dressing of non-metallics, one for metallurgical tests on leaching and electrolytic work, one for metallurgical tests on roasting, calcining, sintering, metallizing, and smelting, and chemical laboratories for assaying and analyzing the ores and the products of all test operations.

Ore shipments are received from all parts of the Dominion. Each ore is examined chemically and microscopically to determine its character, the minerals present, their association, and their grain

size. Numerous small scale tests are then conducted to determine the best treatment process for the recovery of the minerals. These tests are confirmed and checked by large scale tests under conditions which approach very closely to those obtaining in practice. The results from these latter tests are those that might be expected from actual plant operations. A report is issued to the shipper of the ore who has then available the necessary information to proceed with the erection of his treatment plant.

The process most commonly used in the treatment of base metal sulphide ores is flotation. Its application has made possible the profitable treatment of many such ores. This process, on which improvements are still being made, is the greatest advance in ore dressing of the present century. By its use much lower grade ores can be treated, and higher grade concentrates obtained, than by former processes, resulting in economies in smelting and refining methods for producing the metals. Not only can native metals and metallic sulphides be separated from the gangue minerals, but two or more sulphide minerals can be separated from one another.

Besides the testing of ores, research is being carried on for the improvement of existing processes and the development of new methods of ore treatment. This work is especially directed towards the utilization of our mineral resources which, under present conditions and by known processes, cannot be worked commercially.

The importance of research to mining is recognized throughout the world and is being stressed almost daily by financial and political leaders in most countries. In the United States a dozen or more experiment stations are maintained, generally at the university centre of the principal mining states of the union. In addition, many consulting engineers and manufacturers of metallurgical equipmer

maintain their own testing laboratories.

In Canada, the work is centred in the one Government station at Ottawa. Since its inception in 1910 over 300 investigations have been conducted on individual ores, and a number of broad researches have been undertaken - a service that has been of great assistance to the development and progress of the mining industry in Canada.
