References to Ore Dressing and Metallurgical Methods

Methods in Ontario Modern and Progressive and Have Been Notable Factor in the Progress of Mining in the Province. Question Dealt with at Length in Ontario Dept. of Mines Booklet.

Last week The Advance made extended reference to the latest bulletin issued by the Ontario Dept. of Mines, Bulletin No. 83, and entitled, "Twenty-five Years of Ontario's Mining History." In last week's issue The Advance quoted the bulletin in regard to the history of mining in the province, and also in reference to the general survey of the mining industry in Ontario from 1907. This week it may be of interest to give the section of the bulletin in regard to "Ore Dressing and Metallurgical Methods." In this particular the bulletin says:—

Ore Dressing and Metallurgical Methods.

Twenty-five years ago gold mining in Ontario was an extremely small industry as judged by present-day production. During 1906, for instance, eight gold mines obtained a total of 3,926 ounces of gold from the treatment of 11,791 tons of ore. This production, however, was not the largest up to that time as the industry was then on a decline from a peak production of 27,594 ounces established in 1899. This record was not broken until 1912. Since then the industry has grown enormously and during 1931 established a new high record of 2,062,420 ounces, obtained from the treatment of 5,025-725 tons of ore.

Placer gold has not as yet been discovered in economic quantities in Ontario, and all gold produced has been obtained from lode deposits. To separate the gold from waste rock and associated minerals, metallurgical plants have been erected. Twenty-five years ago the largest plant for the treatment of gold ore in Ontario had a capacity of less than 200 tons of ore a day. At present there are four plants capable of handling 2,000 tons or more a day. The largest of these is at the Hollinger mine and has a capacity of 8,000 tons a day, though this tonnage has not yet been handled.

Before the discovery of Porcupine in 1909, the production of gold came mainly from mines in the Lake of the Woods area in northwestern Ontario. In the Lake of the Woods area, the gold was usually found in the native state, commonly called "free" gold, though occasionally in association with pyrite. Some of the mills erected were of the crudest type; others were more elaborate. In the latter, the practice was to crush the ore with stamps, then either to treat it directly by amalgamation or cyanidation or to concentrate it on Frue vanners followed by the cyanidation or chlorination of the concentrates. In the latter treatment, now obsolete, the concentrates were dead roasted then moistened with water and subjected to chlorine gas. After this they were leached with water, from which the gold was precipated with charcoal or ferrous sulphate. When cyanidation was used, either with or without concentration, the usual practice was to attempt to separate the slimes from the sands prior to cyanidation as the slimes were considered less amenable to treatment than the sands and were usually discarded. The sands were leached with cyanide solution and the gold dissolved in it was precipitated with zinc shavings.

In the Hastings area, the gold was found in intimate association with arsenopyrite at a number of properties. Various methods for the extraction of the gold from the arsenopyrite were tried, in all of which amalgamation in one way or another formed a part. Chlorination and cyanidation by ordinary methods proved unsuccessful. Finally the bromo-cyanide process, developed in Australia, was tried at the Deloro plant and proved successful in combination with amalgamation and concentration. The ore was first crushed and amalgamated and the residue concentrated on Frue vanners and tables. The concentrates were treated with bromo-cyanide solution, from which the gold was precipitated. The residue was then treated to recover the arsenic..

Since 1912, the production of gold in Ontario has been mainly derived from the Porcupine and Kirkland Lake areas.

When mills were put in operation at Porcupine during 1912, the methods evolved in the development of the cyanidation process elsewhere were used, of which the principal one was an economic method of cyaniding slimes. Cyanidation was first used at Porcupine as an accessory to amalgamation in treating the residues. As most of the ore originally handled contained very little gold in association with pyrite, much of it could be recovered by amalgamation. Later work, however, disclosed large deposits of ore in which most of the gold occurred in intimate association with pyrite, and a poor recovery was made with the amalgamation process. In consequence, a straight all-sliming cyanidation process was rapidly adopted at most of the mines. Since then this process has been used almost exclusively at Ontario gold mines. These progressive improvements have made Ontario the leader in the development of the cyanidation process. The most important improvements have been the result of the development of mechanical equipment, including pressure and vacuum crushing and grinding machinery.

In 1912, thre were four mills in operation in the Porcupine area, all of which employed amalgamation. They used tube-mills in open circuit for fine grinding, and all except one employed stamps for intermediate crushing. The Vipond mill used rolls and a ball mill for this purpose. The two largest mills, the Hollinger and Dome, which in that year treated 45,195 tons and 75,088 tons, respectively, used all-sliming cyanidation on a large scale in conjunction with amalgamation. These two plants, operated by electrical power, accomplished the same metallurgical result by two different mechanical means.

The Dome mill stamped the ore in water then passed it over amalgam plates. The rejected material was classified into slimes and sands, and the latter were ground in tube-mills, then again passed over amalgam plates. The coarse materials that had escaped the tube mills and secondary plates were recovered by means of cone classifiers and returned to the tube mills to be reground.

The Hollinger mill stamped the ore iin a cyanide soluation then ground it directly in tube mills, the product of which was separated into slimes and sands. As the ore contained considerable gold in intimate association with pyrite, the sands were treated on concentrating tables, and then the concentrate was reground in grinding pans to which mercury was added to amalgamate the released gold. The residues from the tables and amalgam pans were added to the slime circuit.

At both plants the slimes were thickened, then agitated in a cyanide solution. At the Dome, a series of Pachuca tanks were used for this purpose to give continuous treatment, and mechanical agitators were used at the Hollinger. From the final agitation tank the slimes were run to storage tanks, from which they were drawn off intermittently to vacuum or pressure filters and the cyanide solution recovered. The gold dissolved in this solution was precipitated and recovered in filter presses by the Merill zinc-dust precipitation process. It was then either smelted directly to give low-grade bullion, or else treated with acid to remove impurities, water-washed, then fluxed and smelted in an oil-fired furnace to produce fine bullion.

After its mills had been operating for a short time, the Hollinger substituted a strong cyanide solution for mercury in the grinding pans, and the mill became an all-cyanide plant. This method of treating the concentrates was soon abandoned in favour of regrinding them in tube mills, followed by agitation in a strong cyanide solution. Early in 1913, they installed mechanical thickeners after the agitation tanks to obtain two steps of continuous decantation of the cyanide solution. This permitted them to precipitate part of the cyanide solution without filtering.

Later in the year the Porcupine Crown installed at their mill a series of mechanical thickeners after their agitation tanks and instituted complete counter-current decantation. In this system the agitated pulp was sent to the first thickener, and barren cyanide solution was added to the final one. The overflow from each thickener was transferred to the thickener preceeding it, and the thickened pulp from each was transferred to the next following one. The pulp from the final thickener was discarded without filtering in slime filters, and the overflow from the first thickener was sent to the precipitation plant. This counter-current treatment permitted a completely continuous operation in contrast to the intermittent operation previously obtained with slime filters. It was shortly afterwards adopted by the Vipond, McIntyre, and Hollinger mills and soon became standard practice in Ontario along with closed-circuit tube-mill grinding in cyanide solution.

Meanwhile, in 1914, the Dome mine adopted a combined sand-leaching and slime process. Instead of reducing all ore to slimes prior to cyanidation, they used cone classifiers to separate the secondary amalgam plate discharge into slimes, sands, and concentrates. The slimes were treated by cyanidation as before, and the concentrates were reground in a tube mill in closed circuit with a classifier and an amalgam plate, and the classifier overflow was returned to the slime circuit. The sands were leached with a cyanide solution separately. This process was later abandoned and all-sliming reverted to, though amalgamation was retained.

Cyanidation was also first used at Kirkland Lake in conjunction with amalgamation, but the general practice there soon changed to all-cyanidation as at Porcupine.

The first installation of the cyanide process in Kirkland Lake was at the Tough-Oakes mill in 1914, where the all-sliming continous counter-current system was used with ball-mill crushing and tube-mill grinding. The latter was performed in closed circuit with classifiers in cyanide solution. This practice was adopted at other Kirkland Lake cyanide mills which were erected later.

An important addition to gold cyanidation practice in Ontario was made in 1918-19 with the general adoption of the Crowe vacuum process for the mechanical removal of dissolved oxygen from cyanide solutions previous to precipitation. This resulted in a marked reduction in the amount of zinc required for precipitation, and in some instances resulted in a reduction of the free cyanide loss that accompanied zinc precipitation.

Meanwhile, the use of stamps as secondary crushers was gradually disappearing in favour of rolls or ball mills, or both. This resulted generally in lower costs and economy of space. About 1922, rod mills appeared as alternative equipment.

The next important change in the cyanide treatment of gold ores at Ontario plants was due to the introduction of continuous vacuum filters in 1923-24 for the purpose of filtering and washing the tailings previously discarded directly from counter-current decantation, in the effort to reduce the losses of gold and cyanide that were occurring in the tailings.

These continuous filters proved so successful in operation that when the Porcupine Paymaster mill was erected in 1925, two of them were installed in series in place of the usual counter-current decantation equipment with considerable economy of space and no loss in economic results. Since then practically every new mill erected has installed series filtration, and some of the older ones have discarded all or part of their counter-current decantation equipment .

With this new system, it also became general practice to use double agitation by reagitating the pulp from the first filter in cyanide solution before sending it to the second filter. At the same time further economy in space has resulted from the use of tray thickeners instead of the older single type. Fine pebbles, used exclusively in tube mills at first as grinding media, have been gradually replaced by iron or forged-steel balls with a consequent increase in the capacity of the tube mills.

At Kirkland Lake most of the gold was found in intimate association with pyrite, as at Porcupine. In addition, an appreciable amount occurs in association with tellurides. The problem of liberating the gold in association with sulphides or tellurides has been approached in a number of ways in Ontario. At Porcupine the suphides have been removed either on concentrating tables or in bowl classifiers for regrinding and reagitation, or else disposed of by extremely fine grinding and long circulation double closed circuits with concentrating cones. At Kirkland Lake several other methods have been tried in the attempt to recover the gold in association with tellurides, as the latter have proved difficult to treat by the usual cyanidation process and the loss in the tailings has been quite high as compared with Porcupine losses. The Wright-Hargraves mill in 1926 introduced flotation cells into the ordinary cyanide circuit after the tube mills and classifiers for the purpose of cutting out the tellurides from the pulp as flotation concentrates. These were treated separately with bromo-cyanide and returned to the slime circuit at the agitators in the attempt to break up the refractory tellurides. Both of these practices proved unsatisfactory and were later abandoned.

Numerous experiments have been made at Kirkland in the past few years to reduce the loss of values in tailings from straight cyanidation by retreating the tailings by flotation methods, but satisfactory results were not obtained until recently.

The first large-scale plant to employ flotation for this purpose was put in operation at the Lake Shore mine in March, 1932. The method used is to treat the cyanide tailings, which are 95 per cent. 200-mesh, in oil flotation machines from which a concentrate is obtained. The concentrate is then ground in a strong cyanide solution and then agitated in a new type or agitator, which also acts as a defrother. After agitation, the pregnant cyanide solution is filtered from the pulp and the latter discarded. The pregnant solution is then sent to the gold precipitation unit.

The new type of agitator, besides acting as a defrothing machine, greatly reduces the time of agitation required for the dissolution of gold in cyanide solutions, which is accomplished by forcing air into the solution to supply oxygen more rapidly for the chemical reaction of the gold with the cyanide solution. It is likely that this new machine will gradually replace the older types of agitators for all cyanidation work.

Meanwhile, prior to 1929, the McIntyre mill at Porcupine had been experimenting with flotation as a primary treatment for their ore. To confirm laboratory results they erected a small flotation plant in 1929, the operation of which proved so successful that in the following year work was started on a new 2,000-ton mill to employ flotation as a primary treatment to precede cyanidation. The mill was completed and put in operation during 1931. After reducing the ore to about 60-mesh it is sent directly to flotation cells, which remove practically all of the sulphides, plus free and attached gold, as a concentrate. The tailings from the flotation cells containing values below the economic limits of cyanidation are immediately discarded. The flotation concentrates, comprising only about 15 per cent. of the original ore by weight, are then finely ground and cyanided.

This process has been made possible by the recent discovery of flotation agents that have a greater selectivity for minerals particles than any previously known. The advantages of this process, for ores that can be economically treated by flotation, include not only the reduction in milling costs due to the elimination of 85 per cent. or so of the mill feed from fine grinding and cyanidation, but also a reduction in plant construction and equipment costs. It is thus possible that the flotation process will play the major part in the future recovery of gold from Ontario ores.

Ottawa Journal:—Bet those British delegates would be glad to give us a preference on some of our recent weather.

Brampton Conservator::—Two hundred Russian emigrants sailed from Halifax on Monday. Many of them are children of Russian parents, born in Canada. They are going to Russia, where they allege work has been promised them. Frequently the statement is made that conditions are better in that country than in Canada, but those responsible have heretofore refrained from showing their faith in such allegations by returning to that land. The reports of the two hundred who are now making the journey home will, if results are satisfactory, cause others to follow their example, which will be good news for the people of Canada. Of one thing the emigrants may rest assured, they will not long be allowed to carry on agitation against the government of Russia as they have done against the government of Canada.