

which have only just this last year begun to earn dividends. Some of the mines have doubtless seen their best days, for the bonanza veins have been pretty well worked out; but even these will be important producers and have unexplored territory in which there is a reasonable chance that more ore will be found. In the mines which still have considerable quantities of high grade ore in sight, a large percentage of the definitely known ore has been taken out, and it is not likely that an equal quantity of such bonanza ore will be found. Some ore of equal richness and a large quantity of lower grade ore is, however, almost certain to be discovered as development proceeds.

Among mines which are certain to produce a large tonnage of high grade ore, Nipissing, Coniagas, and Crown Reserve are in remarkably good condition. Three mines, Townsite, Cobalt Lake and Casey Cobalt have only recently become important producers, and may be expected to figure more largely in future shipments. The Drummond mine has been re-opened with satisfactory results, and the Seneca-Superior has made several shipments of rich ore from a vein discovered only last summer.

With improved methods of mining, careful sorting and jigging of the ore as it is brought from the mine, treatment of high grade ore by the amalgamation-cyanide process, and of low grade ore by straight concentration and of slime tails by cyanidation, a very satisfactory recovery of silver is made at a low cost. Without allowing for further improvements made as experience is gained, it is evident that 12-ounce ore, enclosing occasional small veins of high grade ore, can be profitably mined. With this assurance and a knowledge of present conditions, one may well hesitate to predict the life of Cobalt as a silver producer. In any case, a large production for several years is assured. The profit that will be made during this period will depend largely on the amount of high grade ore that is discovered during development. How long the process of exhaustion will take is beyond human ken. But, considering the past production and the present conditions, it is safe to assume that Cobalt will be producing silver for many years to come.

## SUDBURY, COBALT AND PORCUPINE GEOLOGY

In the June 7 issue of the Engineering and Mining Journal, New York, Dr. W. G. Miller and C. W. Knight discuss the geology of Ontario's three most important mining districts. As the authors state in their opening paragraphs, the pre-Cambrian areas south of Lake Superior have for several years been closely studied by a large number of geologists and engineers on account of their great deposits of iron and copper. Similar formations in Ontario are much less well known; but the discovery of nickel, silver and gold ores and the large production that has resulted from the development

of such deposits, has shown the desirability of much closer study of the geology of Northern Ontario. At Sudbury, Cobalt, and Porcupine, much has been learned in the past few years. Some relationships between these districts are brought out by the authors.

Sudbury is the oldest and most important district, having produced about 167,000 tons of nickel and 107,000 tons of copper. Cobalt, though much younger than Sudbury, is, perhaps, more widely known. Since the first discovery, in 1903, the district has produced about 170,000,000 ounces silver, valued at about \$90,000,000, and netting the mine owners about \$50,000,000. During the past year, Cobalt produced about one-eighth the total yield of the world, making Canada as a source of silver second only to Mexico and United States. Porcupine is still younger, gold having been first found in important quantity there in 1909. Already, in spite of many serious handicaps, this district has assumed considerable importance, two large deposits and a few smaller ones having been developed to such an extent that a production of several million dollars is assured.

The nickel, silver and gold deposits of these three districts are very dissimilar. They belong to three distinct types. There are, however, some features in common and it is these features which the authors deal with.

"The ore deposits of all three of these areas are in rocks that are classified as of pre-Cambrian age. While the deposits differ greatly, both as regards form and mineral content, it is believed that all of them owe their origin to igneous intrusions. At Sudbury, the intrusive rock is quartz-norite, at Cobalt quartz-diabase, and at Porcupine, granite."

As the paper is a short one, the authors do not elaborate arguments to account for their belief as to the origin of the ores, but state briefly that:

"In the opinion of most observers who have studied them, the Sudbury ores, essentially a mixture of pyrrhotite and copper pyrites, are direct segregation deposits from the norite magma, but there may also have been some later deposition of ore minerals.

"The Cobalt ores, essentially arsenides of cobalt and nickel with native silver, are, like those of Sudbury, believed to be directly connected with intrusions of igneous rocks. Not only at Cobalt, but in the surrounding region, about 5,000 square miles in extent, the ores are associated with quartz-diabase in such a way as to lead to the belief that they were deposited from heated, impure waters that followed the diabase intrusion. Thus both the Sudbury and Cobalt ores may be considered as coming from molten magmas, the former by direct segregation with the intervention of little water, while those of Cobalt may be looked on as the end product of the diabase intrusion, deposition taking place from aqueous solution.

"While granite is not exposed at most of the Porcupine mines, it surrounds the gold area. The rocks in which the veins occur form what may be called a large