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CANADA

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MINERALOGICAL INVESTIGATION OF A NICKEL-COPPER PIPE ORE FOR INTERNATIONAL NICKEL COMPANY OF CANADA, THOMPSON, MANITOBA

by

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MINERAL SCIENCES DIVISION

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SUMMARY OF RESULTS

The nickel in the ore occurs chiefly as pentlandite and nickeliferous pyrrhotite (0.15 wt % Ni). The pentlandite is fairly coarse-grained, but highly fractured and altered to violarite and mackinawite. The copper minerals are chalcopyrite and cubanite. They occur as irregular inclusions in pyrrhotite, as veinlets and lamellae along pentlandite cleavage planes, and as fracture fillings in magnetite. Fine grinding will be required to liberate the copper minerals.

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INTRODUCTION

In November, 1971, Mr. R.W. Bruce of the Mineral Processing Division requested a mineralogical examination of an ore sent to the Mines Branch for beneficiation testing by the International Nickel Company of Canada. The ore designated as "Pipe Ore" originated from Thompson, Manitoba. The purpose of this study is to determine, with the electron microprobe, the type and grain size of the various nickel-bearing phases, particularly the pyrrhotite.

METHOD OF INVESTIGATION

The samples examined in this study were taken at random from the first truck load of ore. Polished sections were prepared from selected pieces containing visible massive sulphides. The polished sections were examined under an ore microscope to identify the minerals and to study their grain sizes and distribution. All mineral compositions were obtained by electron microprobe analyses of the polished sections.

MINERALOGY

The ore minerals identified in this study are nickeliferous pyrrhotite, pentlandite, chalcopyrite, cubanite, nickeliferous pyrite, magnetite, chromite, maucherite, niccolite, violarite and mackinawite. They occur in a gangue that contain some asbestiform gangue minerals that were not identified.

NICKEL MINERALS

Nickeliferous pyrrhotite is the main constituent of the ore. Microprobe analysis gave nickel contents which vary from 0.06 to 0.18% nickel with an average content of 0.15% Ni.

Identification of the type of pyrrhotite using etch tests and microprobe analyses, indicates that the monoclinic-type is predominant with traces of the hexagonal.

Pentlandite is the major nickel sulphide. It is generally coarse-grained and occurs in pyrrhotite as irregular grains up to several hundred microns in diameter. Microprobe analyses gave a Ni content varying from 29.1 to 36.3 wt %; with an average composition of Ni 33.3%, Fe 34.8%, Co 1.5%, S 32.8 wt %, total 102.4 wt %.

Nickeliferous pyrite is a minor constituent of the ore. It occurs as clusters of individual crystals, several hundred microns in diameter and often containing inclusions of magnetite (Figure 1). The nickel content is variable ranging between 0.06 and 0.45% Ni, with an average value of approximately 0.26% Ni.

Mackinawite and violarite occur as secondary minerals that formed from the alteration of pentlandite.

Mackinawite was found as irregular grains up to 30 microns wide and 80 microns long. Microprobe analyses gave a composition of Co 0.9, Ni 9.9, Fe 53.2, S 37.2, total 101.2 wt %, corresponding to a formula of $Co_{.01}Ni_{.14}Fe_{.82}S_{1.0}$.

Violarite occurs as small stringers or veinlets, a few microns wide, along the pentlandite cleavage planes (Figure 2). The grains were too

small for analysis, therefore the identification was based on optical properties and on X-ray diffraction. Maucherite (Ni_3As_2) and niccolite (NiAs) were found only as very small inclusions (up to 50 microns) in the pyrrhotite.

COPPER MINERALS

Chalcopyrite and cubanite were the only copper minerals identified. Cubanite appears to be more abundant than chalcopyrite. Both minerals occur as irregular inclusions from a few microns up to several hundred microns in size and generally in the pyrrhotite but they also occur as fracture fillings in pentlandite and magnetite (Figures 3 and 4).

OXIDES

Magnetite and chromite were the only oxides identified in the ore. The textural features of the magnetite suggest two stages of deposition, primary and secondary. The primary magnetite, like chromite, occurs either as euhedral crystals or as large irregular grains up to a few millimeters in diameter. Generally the chromite occurs within the cores of magnetite or as zoned crystals.

The secondary magnetite is generally fine-grained, very seldom exceeding 30 microns. It occurs as inclusions in pyrite (Figure 1), along fracture planes in pentlandite, and within the shear or fracture planes of the pyrrhotite.

SUMMARY

Nickeliferous pyrrhotite and pentlandite are the principal nickel-bearing phases while chalcopyrite and cubanite are the principal copper minerals. The pyrrhotite is the monoclinic variety and contains approximately

0.15 wt % nickel. Pentlandite is relatively coarse-grained, but highly fractured and altered to secondary violarite and mackinawite. The alteration may affect the flotation characteristics of pentlandite.

Chalcopyrite and cubanite vary in grain size from a few microns up to several hundred microns. These minerals occur as inclusions in pyrrhotite, fracture fillings in magnetite, and as lamellae along cleavage planes in pentlandite.

Other nickel phases are maucherite, niccolite, and nickeliferous pyrite (0.06 - 0.45 wt % Ni) but are too sparse to be of importance.

Magnetite and chromite are minor constituents of the ore. Primary magnetite occurs with chromite and is fairly coarse-grained but secondary magnetite occurs as inclusions in pyrite and as fracture fillings in pyrrhotite and pentlandite.

The intense fracturing or metamorphism of the ore has resulted in the alteration of the various minerals, particularly pentlandite, and in the formation of fibre-like gangue minerals. These features may present difficulties in separation of the ore minerals.

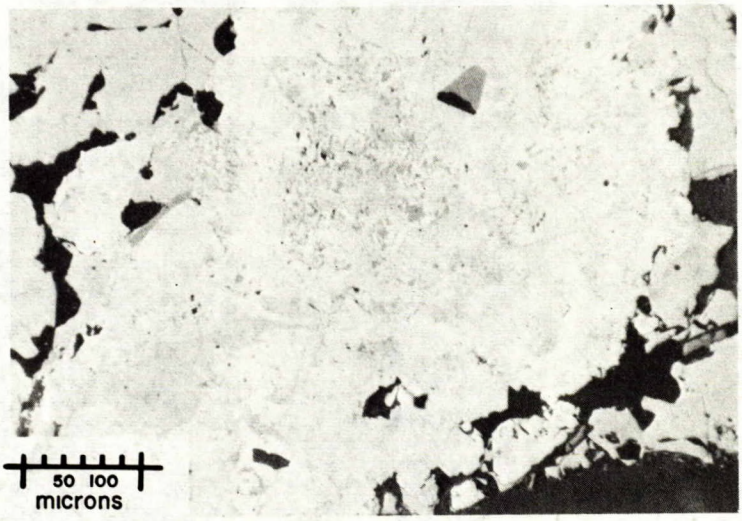

Figure 1. - Photomicrograph showing a cluster of pyrite crystals (white) containing secondary magnetite inclusions (grey) enclosed in pyrrhotite. The dark areas are holes.

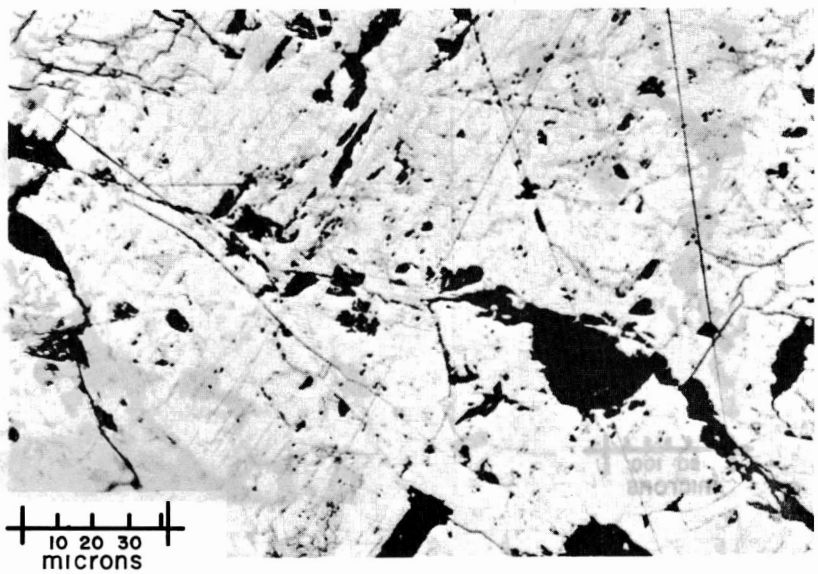

Figure 2. - Photomicrograph showing small stringers of violarite replacing pentlandite along cleavage planes. The black areas are holes.

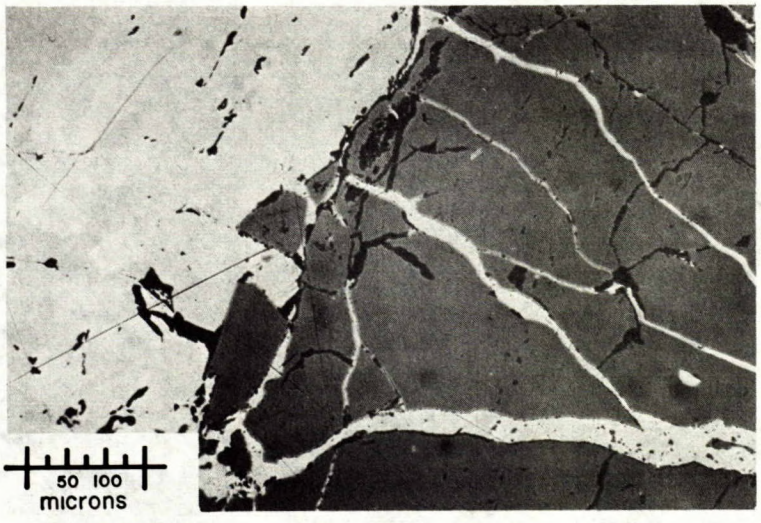

Figure 3. - Photomicrograph of cubanite (light grey) in pyrrhotite (medium grey) and occurring as fracture fillings in primary magnetite (dark grey).

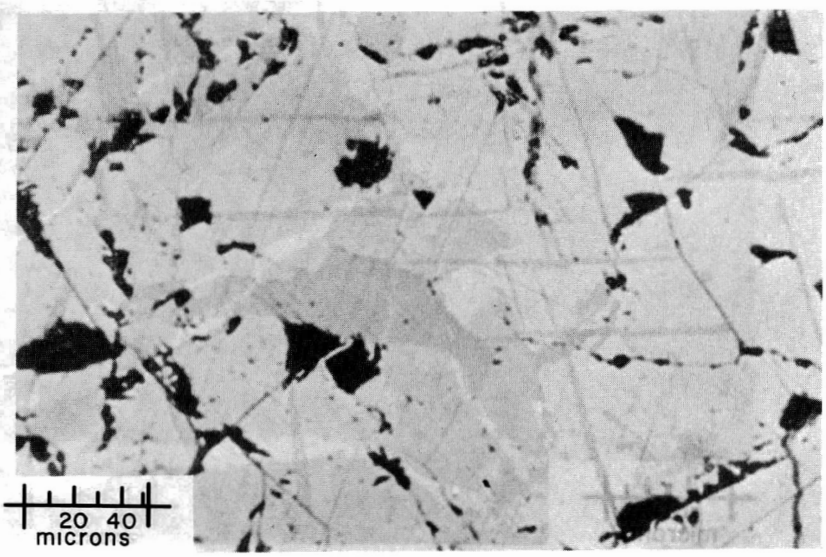

Figure 4. - Photomicrograph showing lamallae of chalcopyrite (grey) occurring along the cleavage planes of pentlandite (white). The black areas are holes.

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