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Mines Branch Investigation Report IR 71-38

THE OCCURRENCE OF NICKEL IN ORE SAMPLES FROM DUMBARTON MINES LIMITED, BIRD RIVER, MANITOBA

by

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Copy No.

June 2, 1971

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SUMMARY OF RESULTS

The principal ore minerals are pentlandite and chalcopyrite. Most of the nickel occurs as pentlandite, which varies in nickel content between 32.6 and 37.7%, and has a cobalt content of up to 6.5%. Pyrrhotite, the principal sulphide mineral, was found to contain chemically combined nickel in amounts varying from 0.3 to 0.9%, and appears to account for about a third of the nickel in the ore. Amphibole, the major gangue mineral, has a relatively uniform nickel content averaging 0.06%.

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INTRODUCTION

An investigation of the occurrence of nickel in ore from Dumbarton Mines Limited was undertaken as part of a broad investigation of low-grade nickel ores in Canada. Samples from different parts of the deposit were kindly provided by Mr. Brian Weir, the geologist for the property.

The deposit is reported to lie along a granite-andesite contact, and to consist of about 1.2 million tons grading 1.23% Ni and 0.37% Cu (1). Two types of ore are recognized: disseminations along layers in "chert" beds, and associations with magnetite in amphibolitized andesite.

SAMPLES

The samples were described by Mr. Weir as follows:

1. Massive sulphides; 0.6% Ni.
2. Coarse amphibole and sulphides. The fines ran 1.48% Ni.
3. Good ore; 1.5% Ni.
4. Magnetite and sulphides; about 0.01% Ni, 0.11% Cu.
5. Same area as No. 4; 0.18% Ni, 0.13% Cu.
6. Low grade from east heading; 0.16% Ni, 0.01% Cu.
7. Sediment; 0.21% Ni, 1.12% Cu.
8. Massive sulphide; $>$ 1.5% Ni.
9. Near barren andesite contact.

PROCEDURE

Polished sections were prepared from each of the samples, and these sections were then examined under the ore microscope; minerals comprising the sections were analysed individually by an M.A.C. electron-probe microanalyser following a procedure described in detail elsewhere (2). The limits of detection for nickel are approximately as follows: in silicates, 0.02% Ni; in sulphides, 0.03% Ni; and in magnetite, 0.04% Ni.

RESULTS OF INVESTIGATION

Mineralogical Description of Samples

Sample 1: Relatively massive pyrrhotite with appreciable amounts of pentlandite, pyrite and chalcopyrite, and abundant inclusions of gangue minerals, chiefly quartz and carbonates (calcite and siderite) with minor amphibole and magnetite. The pyrrhotite contains 0.4% Ni, the amphibole contains 0.06% Ni, and none was detected in the pyrite or carbonate minerals. The pentlandite has a relatively high cobalt content of 6.2%, (Table 1).

Sample 2: Irregular patches and veinlets of sulphides in amphibole. The principal sulphide is pyrrhotite (with 0.8% Ni); pentlandite is quite abundant, and chalcopyrite occurs in minor amounts. The amphibole contains 0.07% Ni. Small grains of rutile are also present.

Sample 3: Rather similar to Sample No. 2. The pyrrhotite in this sample contains 0.9% Ni, and the amphibole 0.06% Ni. Some serpentine also appears to be present; its nickel content is 0.05%.

Sample 4: Abundant magnetite, as individual grains in gangue, and as coalesced aggregates. The sulphides, chiefly pyrrhotite and chalcopyrite, occur along discontinuous bands. Some pentlandite is also present. The pyrrhotite contains 0.5% Ni, and amphibole, the principal gangue mineral, contains 0.06% Ni. No nickel was detected in the magnetite. The pentlandite in this sample has a high cobalt content (Table 1).

Sample 5: Similar to Sample No. 4.

Sample 6: Disseminated pyrrhotite and magnetite in gangue, chiefly amphibole. Minor amounts of chalcopyrite and pentlandite, the latter occurring largely as exsolution "flames" in pyrrhotite. The pyrrhotite contains 0.3% Ni, and the amphibole 0.05%. Nickel in magnetite is below the limit of detection.

Sample 7: Irregular areas and veinlets of pyrrhotite, chalcopyrite and pentlandite in a groundmass of quartz and feldspar. The pyrrhotite contains 0.4% Ni; none was detected in either the quartz or feldspar. The pentlandite in this sample contains an intermediate amount of cobalt.

Sample 8: Massive pyrrhotite, with relatively abundant pentlandite and minor chalcopyrite. The nickel content of the pyrrhotite is 0.7%.

Sample 9: Irregular areas and veinlets of sulphides in a gangue consisting largely of amphibole. Pyrrhotite, with 0.7% Ni, is the principal sulphide, and it shows evidence of altering to marcasite. The marcasite has a variable nickel content, values from 0.2 to 5% having been found. Pentlandite is quite abundant. A few grains of pyrite, containing 0.5% Ni were observed; chalcopyrite is present as a minor constituent. Some large grains of magnetite and ilmenite occur in this sample; the magnetite was found to contain 0.05% Ni, the ilmenite, none. Several veinlets of goethite (with no detectable nickel) cut across the gangue minerals. The amphibole contains a relatively uniform nickel content of 0.08%.

Composition of Pentlandite

The results of the electron-probe analyses of pentlandites from the various samples are shown in Table 1; none was analysed from Sample No. 6 because the small grain size of the pentlandite precluded accurate analyses.

TABLE 1

Pentlandite Analyses

Sample No.	Ni Wt %	Fe Wt %	Co Wt %	S Wt %	Total Wt %
1	33.3	28.2	6.2	33.3	101.0
2	37.7	28.1	1.5	33.1	100.4
3	35.9	27.8	1.7	32.6	98.0
4	33.0	27.5	6.3	32.7	99.5
5	32.6	27.3	6.5	33.5	99.9
7	33.9	28.0	4.8	32.2	98.9
8	37.0	28.8	1.3	33.6	100.7
9	37.1	27.8	1.7	32.7	99.3

Table 1 shows that the only significant differences between the compositions of the various pentlandite samples are in their nickel and cobalt contents; as the cobalt content rises, that of nickel decreases, which indicates a partial substitution of nickel by cobalt. The empirical formulae of the pentlandites with the highest and lowest cobalt contents are, respectively, $Ni_{4.261}Fe_{3.747}Co_{0.851}S_{8.000}$ and $Ni_{4.826}Fe_{3.946}Co_{0.168}S_{8.000}$.

Nickel Content of Other Minerals

The minerals containing minor amounts of nickel are shown in Table 2. These figures show that pyrrhotite and amphibole consistently carry nickel values; the average values are 0.6 and 0.06% Ni, respectively. Average values for the other minerals are not shown because of the small number of determinations. The high nickel content of the marcasite in Sample No. 9 may be spurious because of the wide range of nickel values obtained; the analysed grains were very small, and they may contain submicroscopic particles of nickel minerals.

TABLE 2

Nickel Content of Other Minerals

Sample No.	(Figures in Wt % Ni)					
	Pyrrhotite	Pyrite	Marcasite	Amphibole	Serpentine	Magnetite
1	0.4	< 0.03	-	0.06	-	-
2	0.8	-	-	0.07	-	-
3	0.9	-	-	0.06	0.05	-
4	0.5	-	-	0.06	-	< 0.04
5	0.4	-	-	0.06	-	< 0.04
6	0.3	-	-	0.05	-	< 0.04
7	0.4	-	-	-	-	-
8	0.7	-	-	-	-	-
9	0.7	0.5	2.5	0.08	-	0.05
Average	0.6			0.06		

CONCLUSIONS

The majority of the nickel is present as pentlandite, but an appreciable amount is also present as pyrrhotite. If the pentlandite:pyrrhotite ratio is about 1:20, which appears to be a reasonable estimate that conforms with the average nickel content, then about one third of the nickel is present as pyrrhotite. The amphibole has a low, but relatively uniform nickel content of 0.06%, which cannot be expected to be recovered in the beneficiation process.

REFERENCES

1. S. Karup-Møller and J.J. Brummer (1970): "Geology and Sulphide Deposits of the Bird River Claim Group of Maskwa Nickel Chrome Mines Ltd., Southeastern Manitoba", paper presented at the 1970 Annual Meeting of the Geological Association of Canada and the Mineralogical Association of Canada at Winnipeg, Man.

2. E.H. Nickel (1971): "The Distribution of Nickel Among Minerals of Asbestos-Bearing Rock in the Eastern Townships of Quebec", Mineral Sciences Division Internal Report MS 71-51, Mines Branch, Ottawa.

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