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MINES BRANCH INVESTIGATION REPORT IR 72-57

MINERALOGICAL INVESTIGATION OF LOW-GRADE NICKEL DRILL CORE FROM CLAIMS NEAR GIANT MASCOT MINES LIMITED, BRITISH COLUMBIA

by

L. J. CABRI AND J. H. G. LAFLAMME

MINERAL SCIENCES DIVISION

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MINERALOGICAL INVESTIGATION OF LOW-GRADE NICKEL DRILL CORE FROM CLAIMS NEAR GIANT MASCOT MINES LIMITED, BRITISH COLUMBIA

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SUMMARY OF RESULTS

A mineralogical study of diamond drill core from claims, northwest of Giant Mascot Mines, shows that the minor contents of nickel and/or cobalt in sulphides and silicates are significant. Nickel is present as pentlandite and millerite but also is a minor constituent of pyrite, pyrrhotite, and some silicates. Silicates with abundant sulphide mineralization contain no nickel but those in which sulphides are rare, contain up to 0.23 wt % Ni. Some fine textures involving nickel minerals may also present difficulties in beneficiation.

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INTRODUCTION

Twelve drill core fragments were received on September 23rd from Mr. W. E. Clarke, Chief Geologist and Manager Explorations for Giant Mascot Mines Limited, Hope, British Columbia. The drill core came from claims adjoining Giant Mascot Mines property to the northwest with the request that the mineralogy and the distribution of nickel be determined in order to provide guidance for metallurgical testing.

METHOD OF INVESTIGATION

A polished section was prepared from each of the twelve drill core pieces and examined under an ore microscope to identify the ore* minerals and their textural relations. The electron microprobe was used extensively to determine the distribution of nickel and cobalt amongst sulphides and silicates and to make some complete in-situ analyses. X-ray diffraction analysis was used in one case to try to identify an amphibole.

MINERALOGY

The samples of altered pyroxenite ranged from those containing obvious sulphide disseminations such as 71-8-155 ft and 71-8-300 ft to those with very rare sulphide grains such as 71-13-70 ft. The sulphides are distributed as multi-minerallic clusters between the silicate minerals (Figure 1) as mono-mineral grains different in texture and morphology, and as oriented fine inclusions in amphibole (Figure 2). The principal

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*The term ore mineral does not have an economic connotation, but relates to the opaque minerals, generally sulphides and oxides.

sulphide mineral is pyrite followed by pyrrhotite, pentlandite, millerite, and chalcopyrite. Magnetite and chromite are the two oxides present in the sections.

Pyrite

Pyrite occurs in a variety of textures and sizes. It occurs as irregular and large (up to 3.2-mm) across masses of irregular shape (Figure 3) that contain silicate inclusions and as very fine (micron-size) inclusions. It occasionally occurs as euhedral crystals (71-8-110 ft), or shows evidence of liquid immiscibility (or replacement of silicate) by molding around and between silicate grains (Figure 4). An unusual texture was observed (Figure 5) where micron-size pyrite droplets occur in pentlandite. This texture is similar to that reported by Muir (1971) from the Giant Nickel 4600 orebody. A complete microprobe analysis in weight per cent, for a pyrite grain was: 46.19 Fe, 0.29 Ni, 0.27 Co, and 53.54 S or $(Fe_{0.99}Ni_{0.01}Co_{0.01})S_2$ (71-4-50 ft).

Pyrrhotite

Several sections were tested by etching with 37% HI to determine the presence and proportions of the monoclinic and hexagonal varieties of pyrrhotite. Most of the pyrrhotite did not etch and is therefore of the monoclinic (magnetic) variety but, in the one instance of etching (Figure 6), the hexagonal pyrrhotite appeared as very fine lamellae. Should hexagonal pyrrhotite be present as finer lamellae, it would be difficult to detect. The pyrrhotite is not as coarse-grained as the pyrite and occurs in grains up to about 500 μ in diameter. These grains are either monomineralic or, most frequently, are associated with either pentlandite or both pyrite and pentlandite. A typical microprobe analysis in weight per cent for pyrrhotite was: 59.25 Fe, 0.53 Ni, and 39.40 S or $(Fe_{6.91}Ni_{0.06})S_{8.00}$ (71-4-50 ft).

Pentlandite

Pentlandite occurs in three ways, as coarse (up to 100 x 300-μ grains associated with the other sulphides, as either very fine (Figure 7, up to 10 x 50-μ) flames in pyrrhotite or as the matrix for complex grains with a myrmykitic texture (Figure 5), described previously. A typical microprobe analysis in weight per cent, for pentlandite was: 36.98 Ni, 30.11 Fe, and 32.77 S or $(Ni_{4.93}Fe_{4.22})S_{8.00}$ (71-8-300 ft).

Millerite

Millerite was not as common as pentlandite though it was observed in 71-8-300 ft, 71-8-110 ft, 71-8-600 ft, and 71-11-70 ft. It was commonly associated with pyrite and pentlandite (Figure 8) and is easily identified under crossed nicols by its intense blue to yellow anisotropism. It is not so readily noticed under plane polarized light. The coarsest grains of millerite were about 60 μ in diameter, and, in weight per cent, a typical microprobe analysis was: 62.77 Ni, 1.77 Fe, and 34.80 S or $(Ni_{0.98}Fe_{0.03})S_{1.00}$ (71-8-300 ft).

Chalcopyrite

Chalcopyrite was found as a minor constituent in some sections (71-4-50 ft, 71-8-110 ft, 71-8-155 ft, 71-8-600 ft, 71-11-70 ft, and 71-14-150 ft) and always occurred as small inclusions in other sulphides (Figure 5). The largest chalcopyrite grain was 60 μ in diameter (71-8-155 ft).

Magnetite and Chromite

Magnetite and chromite often occurred together, the chromite being the centre of a grain and the magnetite its alteration rim, but they also occurred as discrete minerals.

MINOR ELEMENT DISTRIBUTION OF NICKEL AND COBALT

The minor element content of nickel and cobalt in the sulphide minerals was studied by taking single analyses on different grains with the electron microprobe and noting the assemblage. These are reported in Table 1. The frequency of certain analyses in the Table (e.g., most on single pyrite grains suggests the frequency of the minerals present and of the different assemblages but not entirely. Some grains observed could not be microanalysed due to the small size of grains or to numerous interfering inclusions. The nickel content of the magnetite was not studied in detail but preliminary tests indicated between low and nil nickel contents. The study of the nickel content in silicates is more difficult because it is necessary to use standards very similar to the silicate being analysed. This study is possible only if a thin section or polished thin section is employed after exhaustive determination of the different silicates. Though this was not possible in this study, it is felt that the results obtained are realistic and meaningful. Two sections were studied, one low in sulphides and the other with abundant sulphides. A nickel-doped synthetic olivine was used as the standard and counts were obtained from numerous grains in each section with a differentiation into "smooth" areas and "rough" areas. These are assumed to represent olivine, pyroxene, and amphibole, for the former, and serpentine for the latter. The results clearly indicated that in the section with abundant sulphides (71-8-110 ft), none of the silicates contained any nickel but that in the section with few sulphides (71-13-70 ft), the "smooth" silicate grains contained 0.23 wt % nickel and the "rough" grains contained 0.10 wt % nickel.

CONCLUSIONS

1. Pentlandite is the major nickel-bearing mineral, and the nickel contents of pyrrhotite and pyrite are significant. The pentlandite contains more nickel than iron, which is to be expected in a millerite environment (Harris & Nickel 1972), and it contains up to 3.12 wt % cobalt.

2. Pyrite is the most abundant sulphide mineral and it contains up to 1.23 wt % nickel and up to 4.07 wt % cobalt.

3. Monoclinic pyrrhotite, the next most abundant sulphide mineral, contains between 0.09 and 2.34 wt % nickel.

4. Nickel is only present in the silicate lattice if sulphides are rare to absent, it is not detectable if sulphides are abundant. If nickel is present in silicates, more is present in the olivines, pyroxenes, and amphiboles than in the serpentine. These observations suggest that some nickel was lost during serpentinization and that the nickel sulphides were formed by a process of sulphurization of nickel-bearing silicates.

5. Beneficiation of this type of mineralization will have to recognize the minor-element content of the sulphides as well as the fine-grained textures of pentlandite in pyrrhotite and of pyrite in pentlandite.

ACKNOWLEDGEMENTS

We wish to thank Messrs. Y. Bourgoin and E. J. Murray for the preparation of the polished sections and X-ray diffraction identification of the amphibole, respectively. We also wish to acknowlege Mr. R.G. Pinard for the photomicrographs, and Dr. D.C. Harris for advice concerning the electron-microprobe analyses.

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Harris, D.C. and Nickel, E.H. (1972): Pentlandite compositions and associations in some mineral deposits. Canad. Mineral., Vol. 11, Pt. 4, pp. 861-878.

Muir, J.E. (1971): A study of the petrology and ore genesis of the Giant Nickel 4600 orebody, Hope, B.C. Unpubl. M.Sc. thesis, Univ. of Toronto, p. 125.

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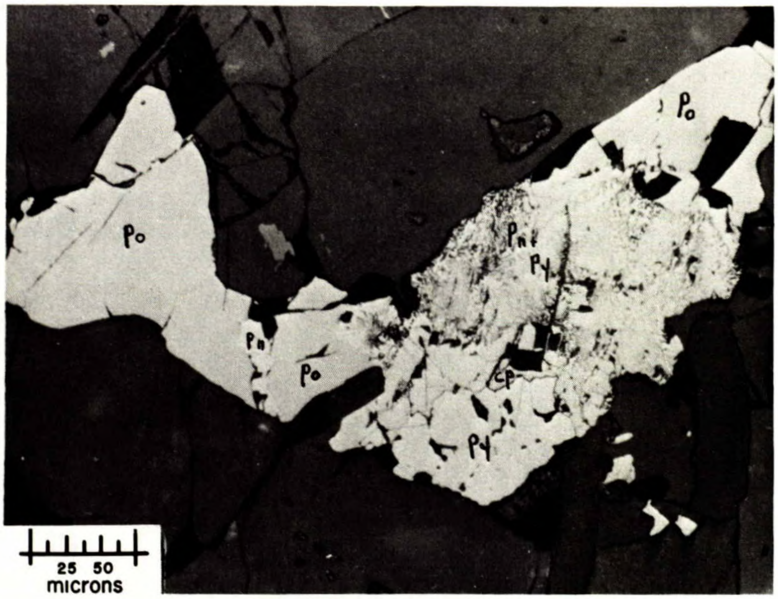

Figure 1. Photomicrograph of a multi-minerallic sulphide cluster (71-4-50 ft) containing pyrrhotite, pentlandite, pyrite, and chalcopyrite. The fine pentlandite-pyrite intergrowth is shown at a higher magnification in Figure 5. Abbreviations used throughout the legends and tables are py(pyrite), po (pyrrhotite), pn (pentlandite), cp (chalcopyrite) and ml (millerite).

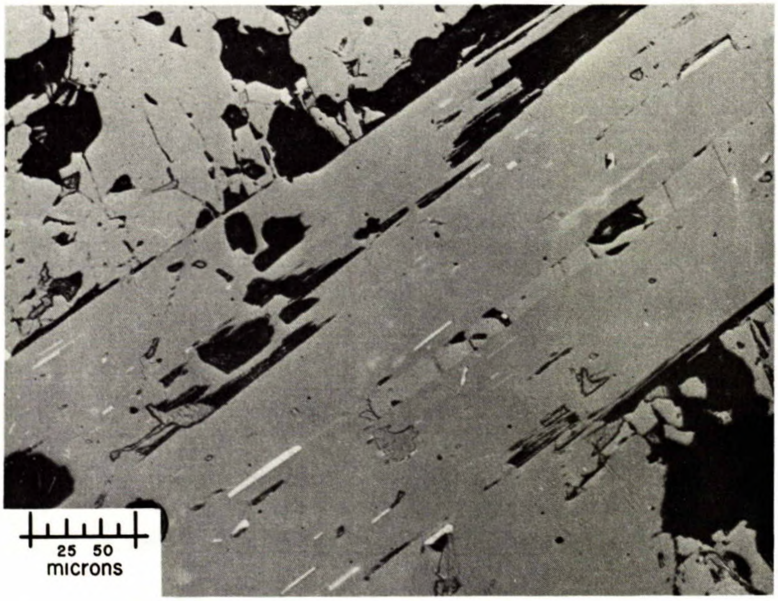

Figure 2. Photomicrograph of a prismatic amphibole crystal, containing oriented sulphide grains (white). These consist of pyrite, pyrrhotite, or pentlandite (71-8-300 ft).

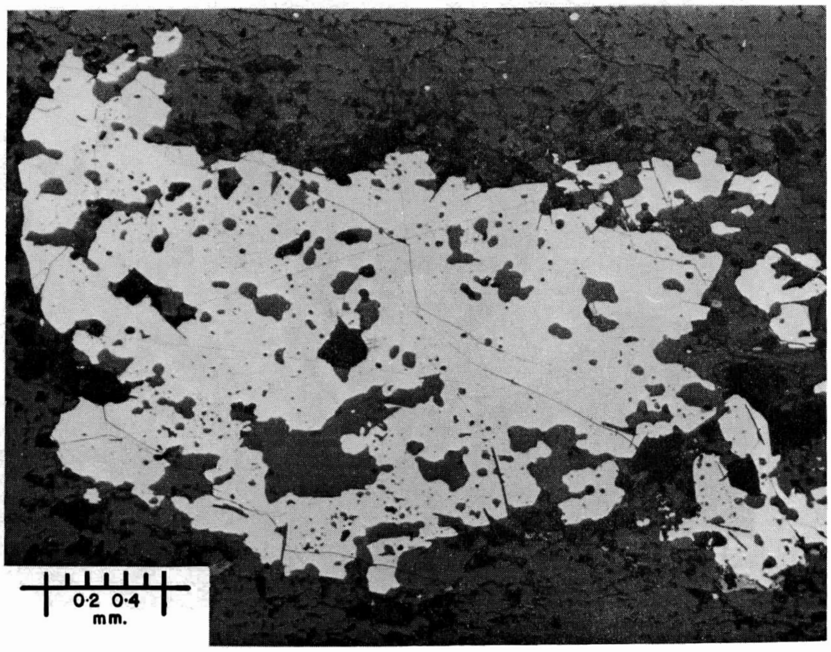

Figure 3. Photomicrograph of a large irregular pyrite grain with silicate inclusions (71-8-300 ft).

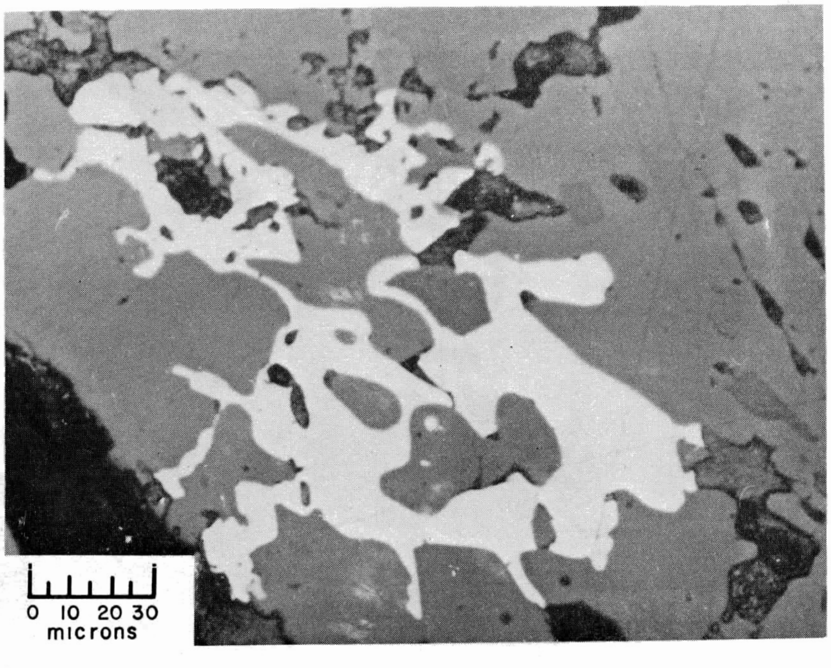

Figure 4. Photomicrograph showing pyrite molded around silicate grains suggesting crystallization of pyrite from a liquid after crystallization of the silicates (71-8-300 ft).

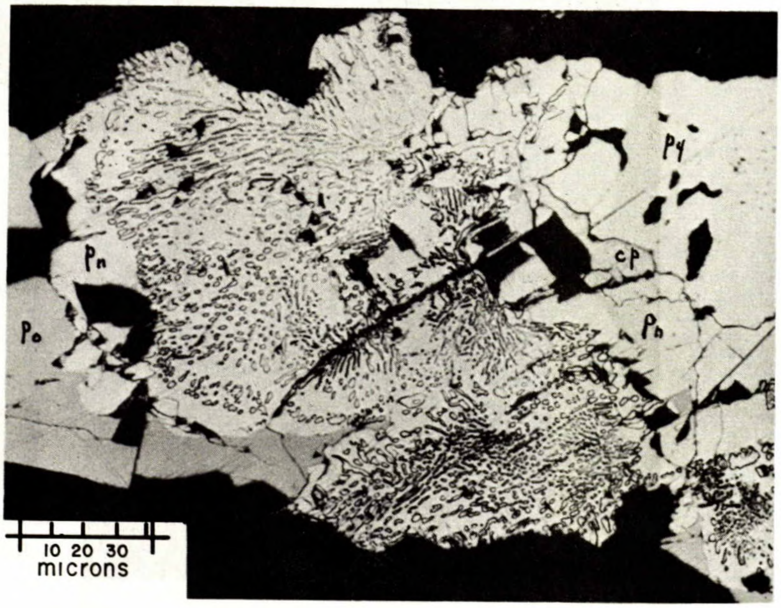

Figure 5. Photomicrograph showing detail of pentlandite-pyrite intergrowth from Figure 1. The "droplet-like" pyrite grains appear with higher relief compared to the pentlandite matrix (71-4-50 ft).

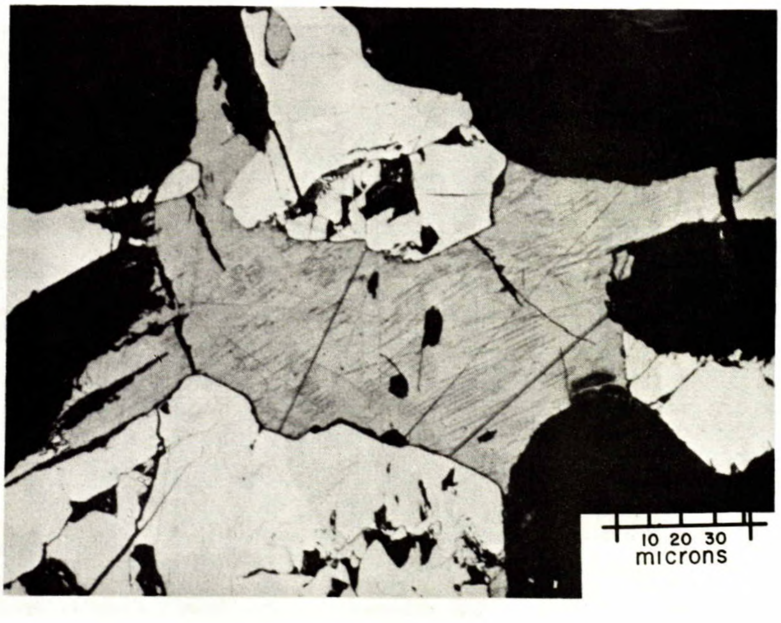

Figure 6. Photomicrograph showing details of etching in pyrrhotite (71-8-155 ft). The grey area is monoclinic pyrrhotite while the darker fine lamellae are etched hexagonal pyrrhotite. The associated sulphide is pyrite (white).

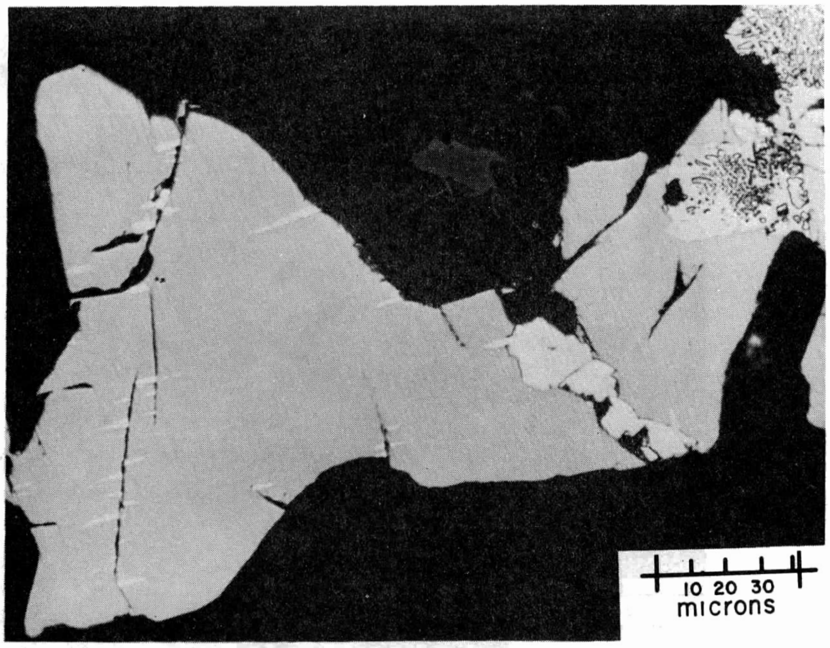

Figure 7. Photomicrograph showing exsolution "flames" of pentlandite (white) in pyrrhotite as well as a coarser variety of pentlandite cutting across the pyrrhotite grain (71-4-50 ft). The top right hand corner shows the myrmykitic intergrowth of pyrite in pentlandite. This is an enlargement of part of Figure 1.

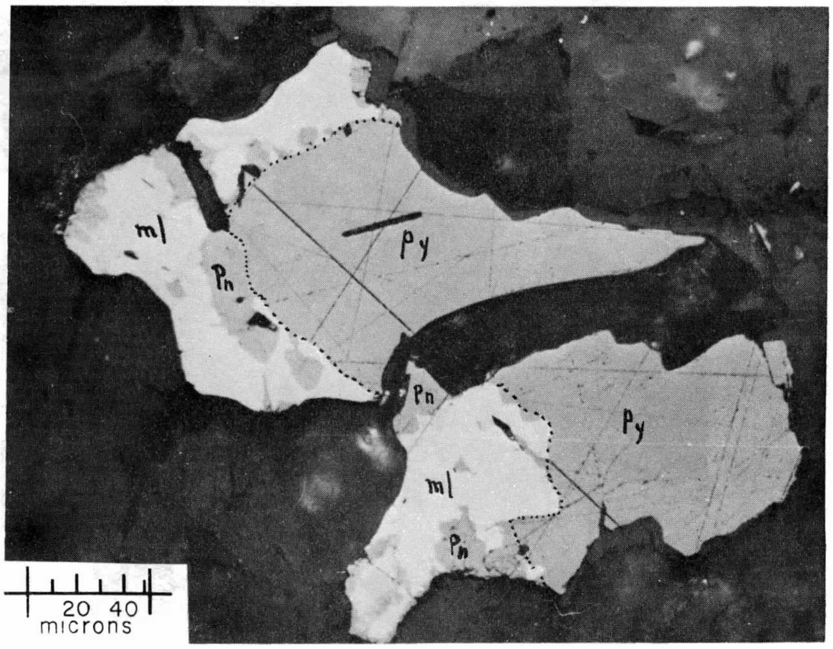

Figure 8. Photomicrograph of a pyrite-pentlandite-millerite grain under partly crossed nicols. The boundary between pyrite and pentlandite has been sketched in (71-8-300 ft).

TABLE 1

Minor Element Content (Weight Per Cent) of Sulphides for Specific Assemblages

	Pyrrhotite (po)								Pyrite (py)								Pentlandite (pn)			
	po		po+pn		po+py		po+py+pn		py		py+po		py+pn		py+pn+po		pn	pn+po	pn+py	pn+py+po
Sample No	Ni	Co	Ni	Co	Ni	Co	Ni	Co	Ni	Co	Ni	Co	Ni	Co	Ni	Co		Co	Co	Co
71-4-50 ft	0.40	n. d.+	0.73	n. d.	0.34	n. d.	0.50	n. d.	0.18	0.17	0.80	0.17	0.45	0.15	1.23	1.60		0.41	n. d.	0.30
	0.54	n. d.	0.85	n. d.			0.32	n. d.	0.52	0.61					0.67	0.87		n. d.		n. d.
							0.35	n. d.	0.60	0.26					0.08	1.20				
							0.53	n. d.	0.74	0.52					0.29	0.27				
									0.55	0.38										
71-4-110 ft	2.34	n. d.	0.99	n. d.			1.13	n. d.	0.05	1.58					0.25	4.07		0.65		0.99
	1.12	n. d.	0.90	n. d.			0.72	n. d.	0.04	3.44					0.83	2.90				1.32
	0.79	n. d.					1.01	n. d.							0.05	0.42				1.21
							0.85	n. d.							0.11	2.15				n. d.
71-8-110 ft	1.00	n. d.	0.90	n. d.			1.23	n. d.	0.07	1.55	0.37	0.31*	0.24	0.49	0.18	0.28			n. d.	
	0.14	n. d.					1.06	n. d.	0.18	n. d.	0.32	0.04*			0.18	n. d.			0.73	
							0.88	n. d.	n. d.	n. d.	0.56	0.22**								
									0.40	n. d.	0.28	n. d.								
									0.27	n. d.										
									0.30	0.12										
									0.37	0.05										
									0.27	n. d.										
									0.69	0.09										
									0.33	0.16										
									0.35	n. d.										
71-8-155 ft	0.74	n. d.	0.49	n. d.			0.63	n. d.	0.04	0.48			n. d.	n. d.	0.04	1.19		1.37		n. d.
	0.34	n. d.	0.41	n. d.			0.63	n. d.	0.10	0.22			0.07	0.19	n. d.	1.40		2.14		n. d.
			0.63	n. d.			0.54	n. d.	0.09	1.30					n. d.	0.99				
			0.50	n. d.			0.85	n. d.	0.07	1.37					0.04	0.19				
			0.61	n. d.			0.95	n. d.	0.05	1.15					0.14	0.79				
			0.67	n. d.					0.10	0.36										

*py + millerite, **py + chalcopyrite

+n. d. - not detected

(continued)

TABLE 1 continued -

	Pyrrhotite (po)								Pyrite (py)								Pentlandite (pn)			
	po		po+pn		po+py		po+py+pn		py		py+po		py+pn		py+pn+po		pn	pn+po	pn+py	pn+py+po
Sample No.	Ni	Co	Ni	Co	Ni	Co	Ni	Co	Ni	Co	Ni	Co	Ni	Co	Ni	Co	Co	Co	Co	Co
71-8-300 ft	0.76	n.d.[+]	0.37	n.d.			0.35	n.d.	0.40	0.23	0.44	0.33[*]	0.18	0.57	0.17	1.18		0.16	n.d.	0.55
	0.35	n.d.					0.42	n.d.	0.44	0.23	0.79	n.d.								
	0.44	n.d.							0.86	0.01	0.12	0.14								
									0.96	0.93	0.06	0.86								
									0.32	0.25	0.89	n.d.								
									0.22	0.21										
									0.23	0.32										
71-8-600 ft							0.40	n.d.												
71-11-70 ft			0.54	n.d.					0.08	1.59			0.15	n.d.				n.d.		
			0.44	n.d.					0.08	0.88			0.13	n.d.				n.d.		
			0.40	n.d.					0.03	1.74			0.17	0.84				n.d.		
			0.28	n.d.					0.08	0.74			0.03	1.23						
			0.10	n.d.					0.20	0.76			0.13	1.12						
													0.37	0.38						
													0.30	n.d.						
													0.05	1.65						
													0.30	n.d.						
													0.27	0.03						
													0.03	0.39						
71-11-150 ft	0.40	n.d.	0.09	n.d.					0.13	n.d.							0.77	0.87		
									0.22	n.d.							0.86	0.19		
																	0.77			
																	1.26			
71-13-150 ft																	0.62			
																	3.12			
71-14-70 ft																	1.19			
																	0.95			
																	0.81			
71-14-150 ft			0.14	n.d.			n.d.	n.d.							0.38	n.d.	0.95			
							0.59	n.d.									0.51			
																	0.64			
																	0.67			

[+] n.d. - not detected.

[*] py + millerite.