Mineralogy, Geochemistry and Geology of the Kerr Sulphurets Copper - Gold Porphyry Deposit, Northwestern British Columbia.

D.C. Harris, S.B. Ballantyne, R.V. Kirkham

Introduction

In 1986, the Geological Survey of Canada in collaboration with companies working the Sulphurets area and the British Columbia Geological Survey Branch, commenced an intergrated project in the Sulphurets area emphasizing ore geology, broad-scale lithogeochemistry, and systematic mineralogy. With the exploration activities on the Kerr property (now known as the Kerr Sulphurets), detailed mineralogical and geochemical studies were focussed on this property.

Location and Past Exploration History

The Kerr Sulphurets property is located in NTS 104B/8 in rugged terrain on the eastern side of the Coast Mountains, about 70 kilometres north of Stewart in northwestern British Columbia. Access to the area is by helicopter from Stewart or with special arrangements, from the Tide Lake airstrip 50 kilometres north of Stewart or by barge along Bowser Lake and tractor road up the Bowser River valley and Knipple Glacier to Brucejack Lake. The Kerr Sulphurets property is only accessible by helicopter.

The property was initially owned by Sulphurets Gold Corporation who formed a joint venture with Western Canadian Mining having a 70% interest. From 1983-1989 Western Canadian Mining carried out a geochemical, geological, geophysical, trenching program with 9,748m of diamond drilling. This work outlined a potential porphyry copper-gold deposit with at least 66 million tonnes averaging 0.8 percent copper and 0.33 gram per tonne gold. In 1990, the property was purchased by Placer Dome who continued a diamond drilling program that by the end of 1991 had outlined a geological reserves of 126,000,000 tonnes with an average grade of 0.61% Cu, 0.27 g/t Au with a cut-off grade of 0.3% Cu.

The first property sample provided to us was from a trench that assayed 5.7 oz/t gold. This sample was provided by Chris Graff, Sulphurets Gold Corp. and the gold occurrence was the initial interests in the exploration program of Western Canadian Mining. The potential for a porphyry copper zone only became known when two of the holes from the 1987 program intersected extensive copper mineralization. Mineralogical studies of the trench sample revealed visible gold of 820 fineness in quartz-carbonate veinlets with associated pyrite, sphalerite, tennantite, minor chalcopyrite and galena.

During the Geological Survey of Canada's 1986 summer field program, Mr. E.R. Kruchkowski, Catear Resources Ltd. who was working a property in the Sulphurets camp, brought to our

attention the presence of a bornite occurrence down slope and north of the Kerr property that he had examined briefly in the 1960's during a regional geochemical program by Granduc Mines Ltd. The bornite occurrence is within the Tedray claims that is now part of the Kerr Sulphurets property.

Present Studies

As mentioned above, Western Canadian Mining commenced a drill program in 1987 that intersected extensive copper mineralization. Drill hole 87-8 was of particular interests because analytical results gave 1.1% Cu over 86.7m with no visible copper-bearing minerals. Detailed mineralogical studies of samples from this drill hole revealed that the major copper mineral was chalcopyrite, but rimmed with a bluish secondary copper sulfide close to chalcocite in composition and with trace amounts of fine dendritic native copper and tennantite. The secondary copper sulfide also occurred as coatings on the associated pyrite that masked its identity. Western Canadian Mining's 1988 exploration program included 22 drill holes totalling 3589 metres as well as geological, geophysical and geochemical surveys. This intergrated program outlined a large tonnage, near surface, high grade metamorphosed porphyry copper-gold deposit from which drill core were collected for study. In 1990, more drill core were collected from the 1989 drill program and the 1990 holes of Placer Dome. To date, samples of drill core and/or assay rejects have been studied from 24 drill holes(Table 1). For those drill holes from which assay rejects were used, every third interval was selected and these samples were used for X-ray diffractometer analyses of the gangue minerals and for eleven holes, whole rock geochemical analyses. A portion of each sample was sieved to -80+200 mesh and this fraction used for heavy liquid separations using methylene iodide (sp. gr. 3.3). The heavies or sink fractions were fashioned into polished sections to assist in the identities of the opaque minerals by ore microscopy and electron microprobe analyses.

Deposit Geology

The Kerr Sulphurets property was designated by Western Canadian Mining as consisting of three zones, namely the "A", "B" and "C". The "B" zone is the main copper-gold porphyry deposit with a gold-silver-copper "A" zone located on the western margin and a gold-silver "C" zone on the eastern margin. In 1990, the Kerr Sulphurets property became the focus of a MASc. thesis by D. J. Bridge of the Mineral Deposits Research Unit, the University of British Columbia and a preliminary report was published by Bridge and Godwin (1991). This report was based on geological mapping across the deposit and core logging of drill holes during August to September 1990 and the interpretation of the deposit geology given in this publication is open for debate. A more detailed property examination has been underway by Placer Dome

and final release of these results as well as the completed thesis by D.J. Bridge with more laboratory observations and the information in this report mainly on the "B" zone should give a clearer understanding of the deposit.

The Kerr Sulphurets Cu - Au porphyry deposit is hosted in an potassic altered pyrite-rich sericite-chlorite schist. The altered zone and the location of the drill holes examined in this study are shown in Figure 1. The intense alteration and deformation has obscured all the original lithologies, at least within the "B" zone examined in this study. The zone dips approx. 45 to 50 degrees to the west and is probably fault bounded both on its hanging wall and footwall as well as many faults within the zone. The present rock unit apppears to be altered volcanic tuffs. Numerous unaltered barren feldspar porphyry dykes or sills occur throughout the zone. The copper mineralization occur within the pyrite-rich chlorite-sericite schist and within higher grade silicified intervals.

Mineralogy

The minerals identified in the deposit are listed in Table 2. The main copper mineral in the pyrite-rich chlorite-sericite schist host rock is chalcopyrite whereas within several silicified intervals, chalcopyrite and tennantite, in places of equal quantities, are the principal copper minerals. One distinctive silicified interval contains a unique mineral assemblage of bornite-tennantite-enargite-chalcocite-colusite that has been identified intermittently in three locations over a length of 1100 metres as shown in Figure 1. Because of its unique mineral assemblage, this interval labelled as the bornite interval should serve as a marker horizon within the "B" zone. The analyses of the colusite are given in Table 3. The presence of the tennantite-rich intervals are readily distinguished by the higher arsenic contents of the samples.

Another occurrence of bornite on the property is the Bornite Showing within the Tedray Claim (Figure 1). At this locality, the host rock is an altered intrusive and bornite has only been identified in surface samples. Bornite occurs concentrated along fracture planes associated with chalcopyrite, tetrahedrite, electrum, magnetite-hematite and rare clausthalite, merenskyite, chalcocite, covellite and malachite. The gangue minerals are albite, kfeldspar, quartz, titanite, rutile, calcite and chlorite.

Minor supergene alteration is prevalent throughout the altered ore zone and appears to be localized within the sericitic schist, the faults and/or the highly fractured zones commonly referred to as a "rubble" zone in the field. No alteration is present in the more silicified bornite interval or the chalcopyrite-tennantite intervals. The supergene alteration is represented by the chalcopyrite being altered to a bluish Cu-S, normally as rims no more than 20 micrometres and rare covellite. Because of its thin rims, it is difficult to correctly identify

the Cu-S, but electron microprobe analysis indicates that the composition is closer to digenite $Cu_{1.8}S$ than chalcocite Cu_2S to which it is frequently named. Limonite and malachite are commonly found in the altered zones with rare native copper. Clay minerals have not been identified. Anhydrite with lesser secondary gypsum has been identified as a major constituent in the lower portion of drill holes K89-4 and K89-19 at line 10550N. The anhydrite is of hypogene orgin, but further studies would be required to determine its distribution within the deposit. This anhydrite-rich rock occurs within the B-zone where extensive regions of a "rubble" zone exists from which core recoveries were very poor. This rubble zone probably represents previous anhydrite-rich host rock that have been leached. Two rare aluminium phosphate sulfate minerals, namely kribergite and sasaite occur as white, chalk-like powders on drill core. Kribergite was identified from drill hole 89-6, 159.2m and sasaite from drill hole 89-7, 70.5m. Both minerals are nearly identical in appearance and their identity was determined by X-ray diffraction.

Table 1. Drill Holes Studied in the Kerr Sulphurets Property

Zone	Drill Hole	Core	Rejects	Geochemical
A	K88-04	x		
	K88-05	x	x	x
C	K88-12	x	x	x
B	K87-08	x		
	K88-01	x	x	x
	K88-02		x	x
	K88-11	x	x	x
	K88-18	x	x	x
	K88-14	x		
	K89-02		x	x
	K89-04		x	x
	K89-06		x	x
	K89-19	x		
	T89-08		x	x
	T89-11	x		
	T89-12	x		
	T89-13	x		
	KS90	x		
	KS98	x		
	KS99		x	
	KS111		x	
	KS112*		x	
	KS114		x	
Bornite	T88-02		x	x

K = Sulphurets Gold Claims
T = Tedray Claims
KS = Holes drilled by Placer Dome
* = Tedray Claims

Table 2. Mineralogy of the Kerr Sulphurets Deposit

Ore Minerals

	Major	Minor	Trace	Rare
"B" Zone	Pyrite Chalcopyrite Tennantite	Bornite Enargite	Chalcocite Sphalerite Galena Molybdenite Tetrahedrite Arsenopyrite	Colusite Gold
"A" Zone	Pyrite	Chalcopyrite		Tetrahedrite Pyrargyrite Hessite Altaite Mercurian silver Electrum Galena
"C" Zone	Pyrrhotite Pyrite	Chalcopyrite Galena	Gold Sphalerite Tennantite	Molybdenite
Bornite Zone	Chalcopyrite Bornite Hematite	Magnetite	Arsenopyrite Gold	Merenskyite Clausthalite

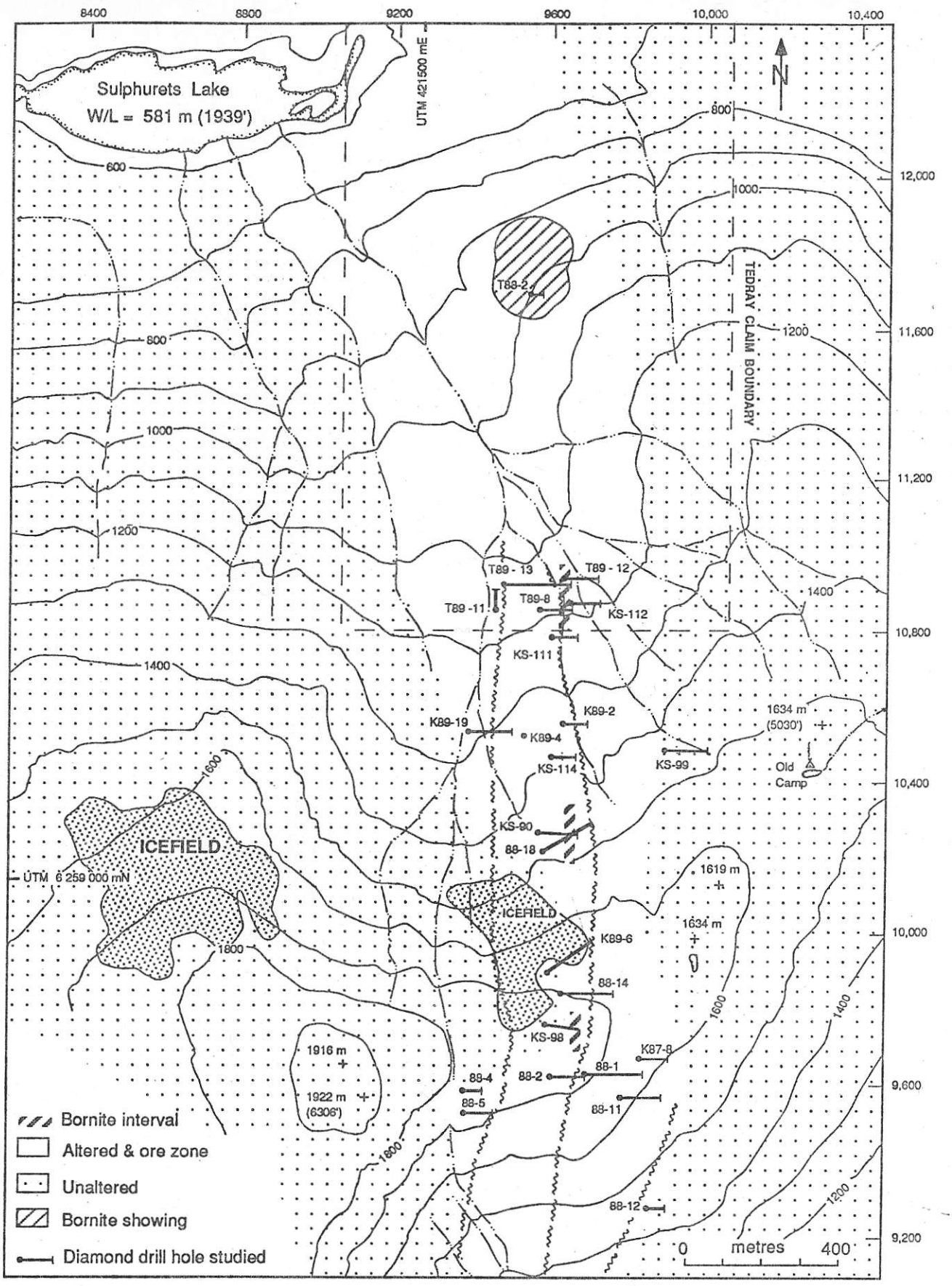
Gangue Minerals

Quartz Sericite Chlorite	Rutile Albite+ Kfeldspar+ Titanite* Anhydrite	Calcite Barite Apatite Talc

Secondary Minerals

"B" Zone	Cu-S Malachite Limonite	Covellite Native Copper	Kribergite Sasaite

* Occur in the Bornite Showing, Tedray Claim.
\+ Occur in the andesitic dykes, the Bornite Showing and unaltered rocks.


8400
8800
9200
9600
10,000
10,400
Sulphurets Lake
W/L = 581 m (1939')
UTM 421500 mE
N
600
800
1000
1200
1400
1600
1800
12,000
11,600
11,200
10,800
10,400
10,000
9,600
9,200
TEDRAY CLAIM BOUNDARY
T88-2
T89 - 13
T89 - 12
T89-8
T89 -11
KS-112
KS-111
K89-19
K89-2
K89-4
KS-114
KS-99
1634 m
(5030')
Old
Camp
KS-90
88-18
ICEFIELD
UTM 6 259 000 mN
1619 m
1634 m
K89-6
88-14
KS-98
K87-8
88-1
88-2
88-4
88-5
88-11
1916 m
1922 m
(6306')
88-12
0
metres
400
Bornite interval
Altered & ore zone
Unaltered
Bornite showing
Diamond drill hole studied

Colusite $(Cu,Fe)_{26}V_2(As,Ge)_6S_{32}$

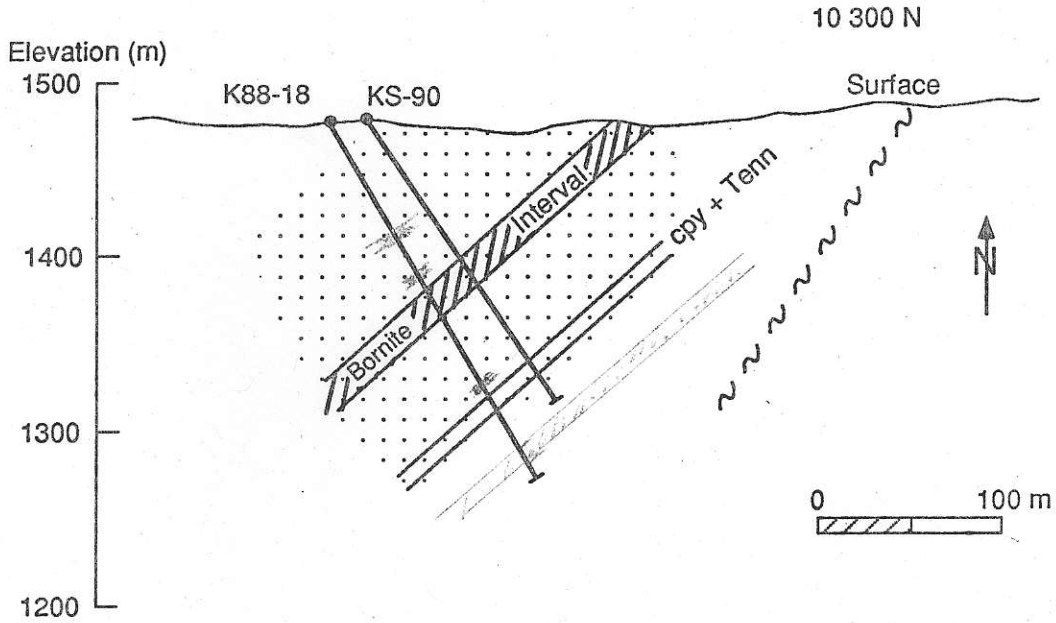
		Weight Percent						Atomic Proportions Based on 66 Atoms					
DDH	Metres	Cu	Fe	V	Ge	As	S	Cu	Fe	V	Ge	As	S
K88-18	118.87	49.8	2.4	3.1	1.3	11.9	32.8	24.78	1.36	1.92	0.57	5.02	32.35
KS-98	355.7	50.2	1.9	3.1	1.4	10.5	31.8	25.60	1.10	1.97	0.62	4.54	32.15
KS-90	87.5	51.4	0.3	3.2	3.7	9.7	31.9	26.01	0.17	2.02	1.64	4.16	32.00
	88.5	50.5	1.2	3.0	2.5	11.3	32.2	25.40	0.69	1.88	1.10	4.82	32.11
	89.8	50.4	1.9	3.1	2.7	10.8	32.5	25.13	1.08	1.93	1.18	4.57	32.12
	91.4	50.1	0.4	3.3	2.7	11.4	31.8	25.49	0.23	2.09	1.20	4.92	32.07
	91.5	50.0	1.0	3.3	2.9	11.0	32.7	25.01	0.57	2.06	1.27	4.67	32.42
	ave.	50.5	1.0	3.2	2.9	10.8	32.2	25.40	0.55	2.00	1.28	4.63	32.14
KS-112	42.7-45.7	49.0	1.6	3.3	1.1	12.3	32.7	24.66	0.92	2.07	0.48	5.25	32.62
T89-8	97.0-100.0	49.8	1.4	3.1	1.1	12.6	32.9	24.88	0.80	1.93	0.48	5.34	32.58

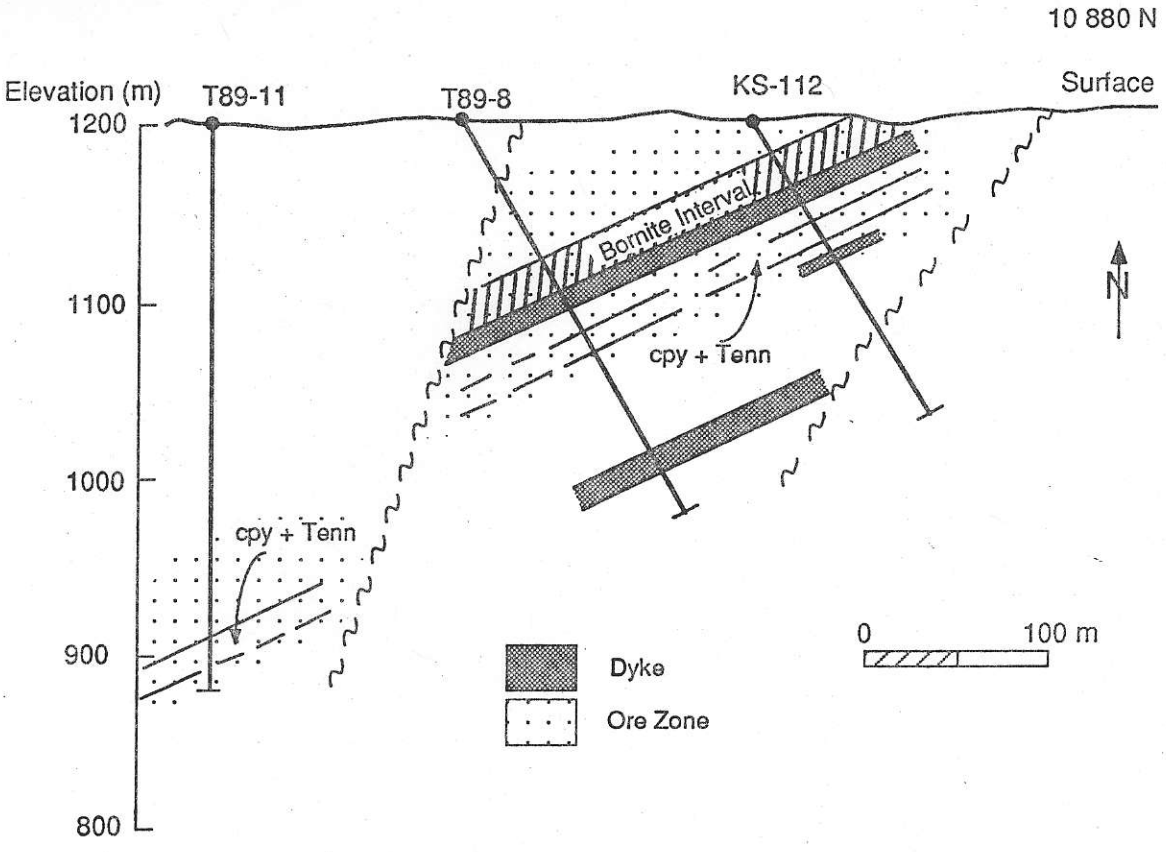
KERR SULPHURETS HOLE K88-18

x - Major, m - Minor, t.- Trace, i - Inclusion, a - Alteration

KERR/GSC #	DEPTH	Qtz	Chl	Mica	Carb	Plag	Rut	Lim	Py	Cpy	Sph	Ten	Enar	Bor	Chc	Gal	Moly	Col	Gold	
3144/887231	3.05-6.0	x		x			t		x	m										
3147/887232	12.0-15.0	x	m	x			t		t	m										
3150/887233	21.0-24.0	x	m	x	m		t		m	t										pmvl
3153/887234	29.6-32.6	x	m	x	m		t	t	t	m-a										+
3156/887235	38.8-40.8	x	m	m			t	t	m	m-a										rbvl
3159/887236	45.4-48.0	x	m	m	t		t		x	x				i	i					
3162/887237	54.0-57.0	x		x	t				x	x										
3165/887238	63.0-66.0	x	t	t	t		t		x	m		i		i	i					
3168/887239	70.0-72.0	x		t					x	x		m		i	i					cpy+ten
3170/ -	74.0-75.85								x	m-a		t								rbvl
3171/887240	75.85-77.7	x	x	t	m	m	t		t											dyke
3174/887241	83.7-85.7	x		x				t	m	t-a										rbvl
3177/887242	89.28-91.9	x		x					m	t-a										rbvl
3180/887243	98.0-101.0	m	m			x			t	t-a										dyke
3183/887244	106.0-109.0	m	m		m	t			m	m-a	t									rbvl
3186/887245	114.9-117.6	x	m	m			t	t	m	m-a										rbvl
3187/ -	117.6-120.0	x		x			t		x	x		m	m	x	t			t	t	
3189/887246	122.0-124.0	x		m					x	x		t								bornite
3192/887247	128.0-130.0	x		m	t		t		x	x		x		m	t					interval
3195/887248	134.0-136.0	x		m					x	x		x		i	i					
3198/887249	140.0-142.0	x		m			t		x	x										pmvl
3202/887250	146.27-147.27	x		m	m				m	x										pmvl
3205/887251	150.0-152.0	x		m	t		t		x	x		x		i	i					cpy+ten
3208/887252	156.0-158.0	x		m	t				x	m										
3210/ -	160.0-162.0	x		x					x	x						t	t		t	
3211/887253	162.0-164.0	x		m	t		t		m	m							t			pmvl
3214/887254	168.0-169.9	x		m	t		t		m											
3217/887255	173.35-176.0	x	m	m	m	x	t													dyke
3220/887256	180.9-183.9	x		m	t		t		x	m				i			t			pmvl
3223/887257	188.7-191.8	x	m	m	t		t		m	m										pmvl
3226/887258	194.25-196.45	x		m	m		t		x	x		x								cpy+ten
3229/887259	199.06-200.5	x	x		t		t		t	t										pmvl
3232/887260	204.5-206.5	x	m	m	t		t		x	m							t			pmvl
3235/887261	210.5-213.5	x	x			x	t		t											
3238/887262	218.65-221.0	x	m		t	x	t		t											dyke
3241/887263	227.0-229.1	x	m	m	m	m			t											
3244/887264	235.0-238.0	x		x					x	t		i		i						
3247/887265	244.0-247.0	x		x			t		x	t										volc
3250/887266	253.0-255.42	x		x			t		x	t										

Legend: Qtz-Quartz; Chl-Chlorite; Carb-Carbonate; Plag-Plagioclase; Rut-Rutile; Lim-Limonite; Py-Pyrite; Cpy-Chalcopyrite; Sph-Sphalerite; Ten-Tennantite; Enar-Enargite; Bor-Bornite; Chc-Chalcocite; Gal-Galena; Moly-Molybdenite; Col-Colusite.
pmvl = potential mineralized volcanics; rbvl = rubble volcanics; volc = unmineralized volcanics.


10 300 N
Elevation (m)
1500
1400
1300
1200
K88-18
KS-90
Surface
Interval
cpy + Tenn
Bornite
N
0
100 m


10 880 N
Elevation (m)
T89-11
T89-8
KS-112
Surface
1200
1100
1000
900
800
Bornite Interval
cpy + Tenn
cpy + Tenn
N
0
100 m
Dyke
Ore Zone