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FALCONBRIDGE METALLURGICAL LABORATORIES

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Min Report No. 1285

TO: A. J. Davidson/D.H. Watkins

PROJECT No. 83302

FROM: R. Buchan

SAMPLE No. L#84-003

DATE: February 27th, 1984

SUBJECT: Mineralogical Examination of 11 DDH Core Samples from Rea Gold Property, B.C.

KEYWORDS: Arsenopyrite

DISTRIBUTION: RAB, MJK, Min file

DESCRIPTION OF SAMPLE: INFORMATION REQUESTED

Eleven drill core samples received on January 4th have been sectioned and examined. They represent footwall and ore horizon material from 8 holes on the property.

PROCEDURES:

- [ ] Spectrochem. Analysis
- [ ] Chemical Analysis
- [ ] X.R.D.
- [x] Optical Microscopy
- [ ] Electron Probe
- [ ]

RESULTS:

Brief descriptions of each section are given on the accompanying pages. The main features of the host rock and ore mineral assemblages are as follows:

1. All samples have similar silicate/carbonate assemblages. They consist of variable proportions of quartz and muscovite/sericite with traces only of dolomite.

2. The host rocks range from fragmented impure or argillaceous chert to felsic fragmentals of probable lapilli tuff origin.

3. No talc is present in the "soapy" argillaceous samples.

4. The semi-massive and massive sulphide/arsenide samples are all sulphide breccias with a granulated, cataclastic texture in polished section.

5. Ore minerals consist of blocky pyrite and arsenopyrite surrounded and partly replaced by sphalerite >galena >chalcopyrite. Minor amounts of tetrahedrite are present in four of the samples.

6. Two grains of a mineral tentatively identified as electrum and two grains of native gold were observed. The latter, measuring only approx. 3 x 8µm, are enclosed in arsenopyrite.

On the basis of rock classification the suite is considered to represent a tuffaceous exhalite of the type related to volcanogenic massive sulphide deposits. Scott et al [1] have recently described similar rocks as indicators of ancient hydrothermal activity on the sea floor. They cite several examples of the distinctive rock type and include the main contact Tuff, Millenbach Mine among Canadian occurrences. A copy of their extended abstract is appended.

Several 35mm colour slides have been taken to illustrate ore textures in the sample suite. These will be forwarded to you when the film has been developed.

R. Buchan

RB/kb
attachments

R. Buchan

1 Tuffaceous Exhalites as Exploration Guides for Volcanogenic Massive Sulphide Deposits. S.D. Scott et al. Jour. of Geochem. Expl. Vol. 19 - p500, 1983.

Location Rea Gold, B.C. Lab. No. 84-003

Sample Description RG3/35 "Felsic lapillistone with Py/Aspy stockwork" PTS No. 7472

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Quartz	45 - 50		
Muscovite/sericite	20 - 25		
Dolomite	1 - 2		
Pyrite	10 - 12		
Arsenopyrite	10 - 12		
Sphalerite	Tr		
Galena	~1		
Chalcopyrite	~1		
Electrum	Tr		

DESCRIPTION

The hand sample shows a pale creamy, very fine host rock cut by stockworks of sulphides/arsenides and late quartz. In pol-thin section the silicate textures are very confused and patchy with areas of very fine grained quartz and coarser granular quartz with rhombs of dolomite interspersed with quartz-muscovite-sericite. The latter is streaky and occasionally shows crenulations and dynamic flow textures around grains of quartz. The rock is tentatively classified as a fragmental felsic volcanic of probable rhyolite origin.

Pyrite and arsenopyrite are present in about equal proportions. They are concentrated along "stockwork" zones with coarse grained quartz and also occur as streaky disseminations within the quartz/sericite host. Pyrite is predominantly subhedral with only a few spheroidal grains present, usually enclosed in arsenopyrite. Aggregates of pyrite have intergranular galena and sphalerite. The latter also forms coarse patches enclosing arsenopyrite and blebs of chalcopyrite. In transmitted plane light the sphalerite is colourless, indicating a very low iron content. Arsenopyrite is coarser than the pyrite and occurs, surrounded by coarse quartz, in large subhedral twinned grains. Shattering and replacement of the arsenide by galena and to a lesser extent by chalcopyrite and sphalerite is common.

Two grains of a mineral tentatively identified as electrum occur in the section. The larger grain, measuring 60 x 20μm, occurs with galena at the contact of two coarse subhedral pyrite grains. The other is an elongate grain occurring in quartz between two grains of pyrite.

Location	Rea Gold, B.C.	Lab. No. 84-003

Sample Description RG5/71 "Coarse banded chert with disseminations and matrix infilling of Cp, Py, Aspy" PTS No. 7467

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Quartz	60 - 65		
Muscovite/sericite	15 - 20		
Dolomite	~1		
Pyrite	4 - 5		
Arsenopyrite	4 - 5		
Sphalerite	3 - 4		
Galena	3 - 4		
Chalcopyrite	1 - 2		
Tetrahedrite	Tr		

DESCRIPTION Somewhat similar in appearance to the previous sample, the hand specimen is more siliceous and sulphides/arsenides follow along coarse and fine laminations rather than forming a stockwork texture. In pol-thin section, inclusions or fragments of coarse mosaic quartz occur throughout a finely laminated quartz/sericite schist. The rock is more siliceous than sample RG3/35 and is classified as a felsic volcanic fragmental of probable rhyolite composition. Individual laminations have variable degrees of sulphide/arsenide mineralization with one band consisting of massive sulphides (Py + Cp + Sphl + Gal). Arsenopyrite occurs mainly as euhedral crystals in fine and coarse disseminations. Base metal sulphides (Cp, Sphl and Gal) form a matrix to the Py and Aspy and also replace them locally. One small area of tetrahedrite is present in the section.

Location	Rea Gold, B.C.	Lab. No. 84-003
Sample Description	RG6/75 "Chert-Breccia, grey and graphitic"	PTS No. 7466

MINERALS	Est. % by Vol.	Grain Size Max.	(m.m.) Avg.
Quartz	80 - 85		
Muscovite/sericite	8 - 10		
Dolomite	<1		
Pyrite	5 - 6		
Graphite	Tr		

DESCRIPTION

In hand sample and pol-thin section sedimentary textures are predominant with very fine grained layers of granular quartz alternating with fine laminations of quartz/sericite. Sulphides, consisting of subhedral pyrite, are disseminated throughout, mainly in the argillaceous layers where the coarser grains have a halo of recrystallized quartz. As in other sections porous rhombs of dolomite have formed in the cherty matrix.

Classified as a mineralized chert with argillaceous laminations.

Location	Rea Gold, B.C.	Lab. No. 84-003
Sample Description	RG7/44 "Semi-massive sulphides"	PS No. 8597

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Pyrite	35 - 40		
Sphalerite	12 - 15		
Galena	4 - 6		
Chalcopyrite	Tr		
Gangue	40 - 45		

DESCRIPTION

In hand sample coarse grained and massive fine grained sulphides occur in a quartz/sericite host rock. The texture is that of brecciated massive sulphides. In polished section pyrite, the major sulphide, forms coarse porous anhedral grains and fine euhedral disseminations. Galena is prominent in the interstices of the coarse grains whereas sphalerite forms coarse patches enclosing pyrite of all types. Rare grains of coarse galena occur in areas of coarse quartz. No arsenopyrite is present in the section.

Location Rea Gold, B.C. Lab. No. 84-003

Sample Description RG8/46 "Massive Sulphides" PS No. 8598,99

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Pyrite	25 - 30		
Arsenopyrite	25 - 30		
Sphalerite	8 - 10		
Galena	8 - 10		
Chalcopyrite	3 - 5		
Tetrahedrite	1 - 2		
Native Gold	Tr		
Gangue	18 - 20		

DESCRIPTION

Brecciated massive sulphides show vague banding and segregation into different sulphide/arsenide associations in hand sample. Both polished sections display confused, brecciated, replacement textures with coarse and fine grained pyrite and arsenopyrite locally replaced by the base metal sulphides. Sphalerite forms the matrix to fragments and crystals of Py and Aspy and is coarser than the Cp or Gal. Several patches of tetrahedrite are also intergranular and form mutual boundary relationships with the Sphal, Cp and Gal. Excellent examples of replacement textures are present in both sections, especially of galena after pyrite and arsenopyrite. The latter sometimes occurs in twin crystals and rarely shows lamellar twin planes in cross polarized light. Overgrowths of pyrite on arsenopyrite are also present.

Two grains of native gold are enclosed in arsenopyrite in PS8598. Both measure about 3 x 8μm.

Location Rea Gold, B.C. Lab. No. 84-003

Sample Description RG9/45 "Mixed lapilli tuff, flattened clasts of talc-sericite schist and sulphide fragments in Py-rich matrix" PTS No. 7469

MINERALS	Est. % by Vol.	Grain Size Max.	(m.m.) Avg.
Quartz	15 - 20		
Muscovite/Sericite	50 - 55		
Dolomite	<1		
Rutile	4 - 6		
Pyrite	15 - 20		
Sphalerite/chalcopyrite	Tr		

DESCRIPTION

Somewhat similar in appearance to sample RG10/61, both samples are sericitic and strongly schisted. In pol-thin section clasts of mosaic quartz are severely flattened in a sericite/muscovite/quartz matrix. The brownish colour of the hand sample is due to a high content of minute rutile disseminations. Pyrite is disseminated throughout in euhedral coarse and fine grains. It also occurs as granular replacements of a lath-shaped mineral, a texture not observed in any other section.

The rock is classified as a lapilli tuff, less siliceous but more intensely sheared than sample RG5/71.

Location	Rea Gold, B.C.	Lab. No. 84-003
Sample Description	RG9/48 "Semi-massive sulphides"	PS No. 8596

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Pyrite	35 - 40		
Arsenopyrite	15 - 20		
Sphalerite	4 - 6		
Galena	4 - 6		
Chalcopyrite	4 - 6		
Gangue	25 - 30		

DESCRIPTION

Brecciated massive sulphides in a matrix of quartz/sericite are similar to those described in sample RG7/44 (PS8597) except for the presence of arsenopyrite. Coarse and fine Py and Aspy fragments are cemented or replaced by Sphal, Gal or Cp. Excellent replacement textures, especially by galena,illustrate zoned pyrite and crystal plane orientations of arsenopyrite.

Two main types of pyrite are present, subhedral coarse aggregates and coarse porous anhedral fragments.

Location	Rea Gold, B.C.	Lab. No. 84-003

Sample Description	RG10/54 "Quartz-rich section veins with up to 50% sulphides with talc/sericite"	PTS No. 7470

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Quartz	45 - 50		
Muscovite/Sericite	15 - 20		
Pyrite	12 - 15		
Arsenopyrite	12 - 15		
Sphalerite	3 - 4		
Galena	<1		
Chalcopyrite	1 - 2		
Tetrahedrite	Tr		

DESCRIPTION

Semi-massive sulphides/arsenides occur in a felsic fragmental rock. Stretched rock fragments up to 1cm long occur with brecciated sulphide fragments in the laminated groundmass of quartz/sericite. In PTS7470, the rock fragments are seen to consist of fine and/or coarse grained mosaic patches. Pyrite and arsenopyrite show similar textures to other samples with the arsenopyrite generally coarser grained than the pyrite.

Location Rea Gold, B.C. | Lab. No. 84-003

Sample Description RG10/61 "Talc-rich mafic tuff. | PTS No. 7468

Angular siliceous fragments in talc-rich matrix"

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Quartz	40 - 45		
Muscovite/Sericite	40 - 45		
Pyrite	10 - 12		
Sphalerite	~1		
Galena	Tr		
Chalcopyrite	<1		

DESCRIPTION

The hand sample is strongly schistose with a high content of muscovite/sericite. No talc is present in the sample (confirmed as mica only by XRD). Textures in PTS7468 indicate that the host rock is a felsic fragmental, probably a felsic tuff, with stretched siliceous fragments in a micaceous matrix. One layer contains abundant pyrite in coarse euhedral crystals rimmed by recrystallized quartz. Otherwise the pyrite is very finely disseminated throughout the section.

Location Rea Gold, B.C. Lab. No. 84-003

PTS 7473

Sample Description RG11/112 "Chert breccia, dark grey PS No. 8595

with fine pyrite and chert clasts"

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Quartz	20 - 25		
Muscovite/Sericite	10 - 15		
Dolomite	<1		
Pyrite	25 - 30		
Arsenopyrite	20 - 25		
Sphalerite	6 - 8		
Galena	1 - 2		
Chalcopyrite	Tr		
Tetrahedrite	Tr		
Graphite	~1		

DESCRIPTION

The hand sample presents a brecciated appearance with light and dark siliceous fragments set in a pyrite/arsenopyrite-rich matrix. In pol-thin section, the rock fragments consist of chert, graphitic chert and felsic tuff. The latter is similar to others previously described with siliceous inclusions set in a quartz/sericite groundmass. Some areas consist of coarse mosaic recrystallized quartz and excellent examples of strained, lamellar quartz surrounding grains of sulphides or arsenopyrite are present.

Ore minerals show the same brecciated appearance as in other sections. Fragments and grains of pyrite and arsenopyrite are replaced by the base metal sulphides. Sphalerite, the iron-free colourless variety, forms a coarse matrix to the Py and Aspy. Occasional patches are filled with exsolution blebs of chalcopyrite.

The sample is classified as a sulphide/arsenide breccia with lithic fragments of various types.

Location Rea Gold, B.C. Lab. No. 84-003

Sample Description RG11/125 "Chert breccia with sulphides" PTS No. 7471

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Quartz	45 - 50		
Muscovite/Sericite	40 - 45		
Dolomite	~1		
Pyrite	6 - 8		
Sphalerite	Tr		
Galena	Tr		

DESCRIPTION

The hand sample is milky-white, brittle, very fine grained and fractured with quartz/sulphide veinlets filling the brittle fractures. In PTS7471 the host rock is seen to consist of microcrystalline quartz and muscovite/sericite in about equal proportions. As such it is classified as an impure or argillaceous chert. The stockwork of brittle fracture fillings consists of coarser grained quartz, pyrite and carbonate. The pyrite is in the form of grain aggregates with porous interiors and subhedral crystal rims.

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TUFFACEOUS EXHALITES AS EXPLORATION GUIDES FOR VOLCANOGENIC MASSIVE SULPHIDE DEPOSITS

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(Received June 16, 1983)

EXTENDED ABSTRACT

Ancient hydrothermal activity on the sea floor not only resulted in economic accumulations of copper, lead and zinc sulphides but, in some volcanogenic massive sulphide (v.m.s.) districts, it also produced an associated, distinctive, thin, iron- and silica-rich sediment with geochemical and mineralogical anomalies which can provide stratigraphically-controlled lithogeochemical exploration guides. The distinctive rock type is referred to in Japan, as *tetsusekiei* (literally iron-quartz) and, in North America, as ferruginous chert, graphitic chert, cherty tuff, tuffite, sulphide iron formation, etc. The term we prefer is "tuffaceous exhalite" which denotes a rock consisting of a mixture of two very different components: (1) tuff which is commonly chemically and texturally indistinguishable from that of the indigenous environment; and (2) chemical contributions from the exhalative plume in the form primarily of silica, iron (oxide and/or sulphide), sulphur and various trace elements, and graphite or kerogen of uncertain origin. Of the two components, the latter is expected to reflect best any chemical or isotopic anomalies in sea water adjacent to metalliferous hydrothermal discharge, and therefore to provide the more useful lithogeochemical information in the search for v.m.s. deposits. On this basis, we have carefully separated the two components, either physically or statistically, in our analyses in order to avoid the problem caused by their variable ratios from sample to sample, which might mask real trends in the distribution of trace elements. In some cases, however, we have found that chemical interaction between the two components during penecontemporaneous alteration or subsequent metamorphism precluded the clean separation we were seeking. We have studied the following areas of tuffaceous exhalites of contrasting age and metamorphism as part of an ongoing research program on lithogeochemical exploration for v.m.s. deposits:

(1) Sturgeon and Savant Lakes, NW Ontario, Archean age, low grade metamorphism;

(2) the iron formation hosting Willroy no. 4 orebody, Manitouwadge district, Ontario, Archean age, high-grade metamorphism;

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.. Savant Lakes, NW Ontario, Archean age, low grade

..ion hosting Willroy no. 4 orebody, Manitouwadge dis- ..n age, high-grade metamorphism;

(3) the Main Contact Tuff, Millenbach mine, Noranda, Quebec, Archean age, low-grade metamorphism;

(4) Austin Brook iron formation, Bathurst district, New Brunswick, Ordovician age, moderate metamorphism; and

(5) *tetsusekiei* of Fukazawa mine, Hokuroku district, Japan, Miocene age (13Ma), not metamorphosed.

The Sturgeon-Savant Lakes area contains both small isolated sulphide-rich tuffaceous exhalites and thick laterally continuous oxide-rich tuffaceous exhalites. The latter are normal magnetite-bearing iron formations. Our study was not sufficiently well controlled stratigraphically with respect to known ore horizons to test the tuffaceous exhalites systematically for lithogeochemical prospecting. However, spatial associations here are significant. The sulphide-rich rocks were formed at higher submarine elevations within pyroclastic piles and closer to ore-forming and barren hydrothermal fumaroles than were the oxide-rich rocks. In this respect, the iron formations at Sturgeon-Savant differ from the Ordovician magnetite-rich Austin Brook iron formation which immediately overlies large v.m.s. deposits at Bathurst, although even the Austin Brook has a regionally persistent sulphide-rich basal portion. The geochemistry (pyrite/carbon ratios, S/Se and Co/Ni in pyrite, S and C isotopes) of the Sturgeon-Savant sulphide-rich tuffaceous exhalite is consistent with mixing a small amount of hydrothermal fluid with excess sea water in an otherwise normal, low-temperature marine, sedimentary environment. Biogenic activity is permissible but not proven by the isotopic data. Abundance and distribution of base metals relative to the orebodies is erratic and nondiagnostic.

The Willroy no. 4 orebody is enclosed within a quartz-(formerly chert ?) and sulphide-rich (predominantly pyrite and pyrrhotite) tuffaceous exhalite which grades laterally into normal magnetite-rich banded iron formation extending several hundred metres from ore. Three fractions (silicate, magnetite, sulphide) of drill core samples analyzed by INAA for Cu, Zn, Sn, Co, Ag, Au, V, Se, As, Sb, Mn, S, Ni and In give similar distribution patterns but, not unexpectedly, the pattern in the sulphide fraction is most sharply defined. Most elements are obviously anomalous only very close (a few metres) to ore. Silver and As give good haloes up to 200 m. Results are enhanced by factor analysis and mapping of factor scores. Haloes extend for several hundred metres from ore for factors Cu-Au-Ag-As and Zn-Sb-As-Sn. An anomalous zone of unknown origin was located within the tuffaceous exhalite about 400 m from the orebody.

The tuffaceous exhalites in the immediate hanging wall of the Japanese Kuroko v.m.s. deposits (e.g., *tetsusekiei* of Fukazawa mine) and of the Noranda v.m.s. deposits (e.g., Main Contact Tuff, MCT, Millenbach mine) are remarkably similar rocks despite the very large difference in their ages (Miocene vs. Archean). The main mineralogical difference is the presence of pyrrhotite in MCT and of hematite, imparting a deep red colour, in *tetsusekiei*, both in an assemblage consisting predominantly of chlorite, sericite, quartz and sulphides. Their chemical differences are restricted to elements that characterize the immediate ore environment. For example, Pb and Ba in Kuroko ores and *tetsusekiei* are absent in Noranda ores and MCT. Texturally, the MCT is coarse grained due to recrystallization during low grade regional and contact metamorphism whereas the unmetamorphosed *tetsusekiei* is very fine grained. Typically, *tetsusekiei* is discontinuous and covers an area about four times that of the ore deposit whereas MCT is laterally continuous over hundreds of metres. In addition to locating a horizon of fossil hydrothermal discharge and therefore possible ore, both tuffaceous exhalites display cryptic variations which provide explorational guides at different scales:

(1) Fe/(Fe + Mg) ratio of chlorites in the Noranda MCT decreases by 0.32 (from 0.63 to 0.31) over a distance of 0.3 km approaching ore from the N, and by 0.4 (from 0.72 to 0.32) over 1.5 km from the S. This trend is somewhat parallel to that of the whole-rock FeO/(FeO + MgO) ratio (from 0.8 to 0.37) but the chlorite variation is more sensitive for sulphur-rich samples.

(2) Ilmenite is altered within 0.3 km of ore to assemblages containing (a) rutile + hematite + pyrite (Kuroko), (b) rutile + pyrrhotite + pyrite (Noranda) and (c) rutile + sphene + pyrrhotite (Noranda).

(3) The most manganiferous ilmenites (up to 18 wt % MnO) are found closest to Millenbach ore.

(4) Whole-rock oxygen isotopic values decrease from +9 ‰ (Kuroko ore horizon tuff) to 5.1 ± 0.8 ‰ (*tetsusekiei*) over a distance of 0.5 km from ore.

(5) $(K_2O+MgO)*100/(K_2O+MgO+Na_2O+CaO)$ for the tuffaceous component of *tetsusekiei* and correlative ore horizon tuff increases from about 50 to 90% over 2-3 km approaching ore.

(6) Trace metals of exhalative origin are enriched in *tetsusekiei* and in MCT relative to normal pelagic rocks but their distributions are erratic and seem to be controlled by multiple sources, most of which did not produce ore.

In summary, not only are tuffaceous exhalites good indicators of ancient hydrothermal activity on the sea floor, but they contain a variety of geochemical and mineralogical changes relative to ore which hold promise for lithogeochemical prospecting. Unfortunately, trace-element distributions, which are relatively inexpensive to obtain by whole-rock analyses, are commonly very erratic and are inconsistent from district to district so are not a panacea for exploration.

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File
Rea Gold

MINERALOGRAPHY OF SAMPLE R-1

November 10, 1983

Peter B. Read

GEOTEX CONSULTANTS LIMITED CONSULTING GEOLOGISTS

MINERALOGRAPHY OF SAMPLE R-1

1. INTRODUCTION:

Sample R-1 was submitted by C. D. Spence, Western Canada Manager of Riocanex, 800 W. Pender Street, Vancouver, B.C. The accompanying letter stated that assays of similar material have yielded 0.1 to 3% Cu, 0.6 to 6% Zn, 0.2 to 7% Pb, 11 to 220 ppm Ag and 1.5 to 42 ppm Au, and that ICP analysis of similar rock gave 13% As, 25 ppm Sr, 1500 ppm Sb and 100 ppm Ba (Ba and Sr will be only partial extraction).

2. PROCEDURE:

The mineralogy of a part of the sample containing visible galena and pyrite was determined using a Philips X-ray generator set at 40kV and 20mA which produced Ni-filtered monochromatic $CuK_{\bar{\alpha}}$ radiation. Goniometer and electronic circuit panel settings were: $2^{o}2\theta$ /minute at a chart speed of 1200 mm/hr with a ratemeter setting of 1×10^3 cps and a time constant of 1 second. A small part of the sample was powdered in a mortar by means of a pestle and spread on a glass slide as a slurry of ore minerals and acetone. A 2.5 cm square polished section was examined under reflected light microscopy and ore mineral identification made by comparison with polished sections of known minerals. Some etch tests were done where noted in the following description. The identification of ore minerals by mineralography, and by X-ray diffraction gave similar results although pyrite and sphalerite have overlappping X-ray diffraction peaks and tetrahedrite is present in such minor amounts that it does not appear on the X-ray diffractogram (Appendix A).

3. MINERALOGRAPHY OF THE SAMPLE:

The sample is a fine grained mixture of sulphides ranging in size from 0.05 to 0.3 mm in diameter and composing approximately 92% of the sample. The translucent mineralogy was not determined.

(a) Arsenopyrite (major mineral):

A creamy white mineral, in distinction to pyrite which is creamy yellow against it, with characteristic elongate rhomb-shaped prisms. The mineral has a strong bluish to purplish brown anisotropy under slightly uncrossed nicols. Hardness F and similar to that of pyrite. Some rhombs show partial internal replacement by galena No gold seen but the specimen was not studied under oil immersion.

(b) Pyrite (major mineral):

Pale yellow anisotropic grains which are yellower than arsenopyrite and range from anhedral to euhedral square outlines which range in size from 0.01 to 0.2 mm in diameter. Hardness F and similar to arsenopyrite.

(c) Galena (1 to 2%):

Galena white, hardness B but with no trace of triangular pits and only a rare hint of cleavage. It hosts anhedral to euhedral pyrite and euhedral arsenopyrite grains, and forms clots up to 0.3 mm in diameter. It appears to replace chalcopyrite and sphalerite, and hosts anhedral blebs of tetrahedrite. HNO_3 blackens, and $FeCl_3$ and HCl tarnish irridescent.

(d) Sphalerite (3%):

Medium grey, anhedral grains up to 0.3 mm in diameter which have minute exsolution or replacement blebs of chalcopyrite along crystallographic planes. The mineral powders white and does not have any intermal reflection.

(e) Chalcopyrite (1%):

Strong brass yellow anhedral grains up to 0.2 mm in diameter which contain anhedral to euhedral pyrite and arsenopyrite grains. Hardness approximately C and similar to that of galena. Forms minute replacement or exsolution blebs along crystallographic planes of sphalerite.

(f) Tetrahedrite (very rare):

Small areas of about 0.02 mm in diameter which are brownish grey relative to the surrounding galena. Hardness about C and shows no relief against the surrounding galena. Although with the high As assays tennantite might be expected, the colour of the mineral against galena is not the bluish grey expected of tennantite. The identification of the mineral as tetrahedrite provides an explanation for the Sb assay of 1500 ppm and it probably is the carrier of the silver values.

(g) Covellite (½%):

Deep blue to whitish blue bireflectance with fiery red anistropy colours. The mineral forms zones up to 0.05 mm wide along some galena grain boundaries and fills fractures cutting galena and chalcopyrite.