

SULPHIDE MINERALOGY OF THE BROWN-MCDADE ZONE

Mt. Nansen Property, South-Central Yukon

**Diane Lister
December 18, 1988**

Only 6 specimens examined.
representing 4 assay intervals
in 4 DDHs from northern end of
deposit.
gold occurring with pyrite in two
samples.

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CHAPTER 1 - INTRODUCTION

1.1 SCOPE OF PROBLEM:

Using seven polished sections, and five hand specimens, some aspects of the ore mineralogy of the epithermal gold Brown-McDade Zone, situated on the Mt. Nansen Property in south-central Yukon will be established. Some conclusions will also be drawn pertaining to ore paragenesis and factors influencing its beneficiation.

1.2 LOCATION AND ACCESS

Consisting of 30 mineral leases and 181 mineral claims covering an area of approximately 30 square kilometres, the Mt. Nansen property is located about 44 km due west of Carmacks on NTS mapsheet 115I/3 at latitude 62°05' N and longitude 137°08' W. Road access to the property is possible during summer months via a 60 km gravel road from Carmacks. One hundred and ninety km of all weather and paved highway (the Klondike Highway), connect Carmacks with Whitehorse. There is an airstrip at the south end of the Mt. Nansen property, but it is in poor condition and has not been used for several years. Winter access is limited to helicopter use only.

1.3 AREA HISTORY

Prospectors Afe Brown and George McDade discovered the Brown-McDade showing in 1943, catalyzing four years of extensive exploration by different companies on the three major zones of the present Mt. Nansen property: the Huestis, the Webber, and the Brown-McDade. All work was abandoned in 1947.

Exploration resumed in 1957, and in 1962, the Brown-McDade, Webber, and Huestis properties were optioned by the Mt. Nansen Syndicate (Newmont, Noranda, Rio Tinto, Kerr Addison, Conwest, and Faraday) who continued the trenching, drilling, geophysics, and underground work until 1967.

A decision was made in 1967 to construct a 200 ton per day mining operation using froth flotation to produce a sulphide rich concentrate to be shipped out for smelting. The mine produced for only 8 months from September, 1968 to April, 1969, milling only 18,000 tons of ore from the Huestis underground workings, and recovering 2482 oz Au, 76,534 oz Ag, and 108,621 lb Pb. The mine briefly reopened for five months in 1976, but was closed once again due to poor gold recoveries. Some components of the mill were sold, and the rest abandoned. The mill and other buildings have subsequently been vandalized and scavenged.

The property was relatively inactive, passing through several

Figure 1

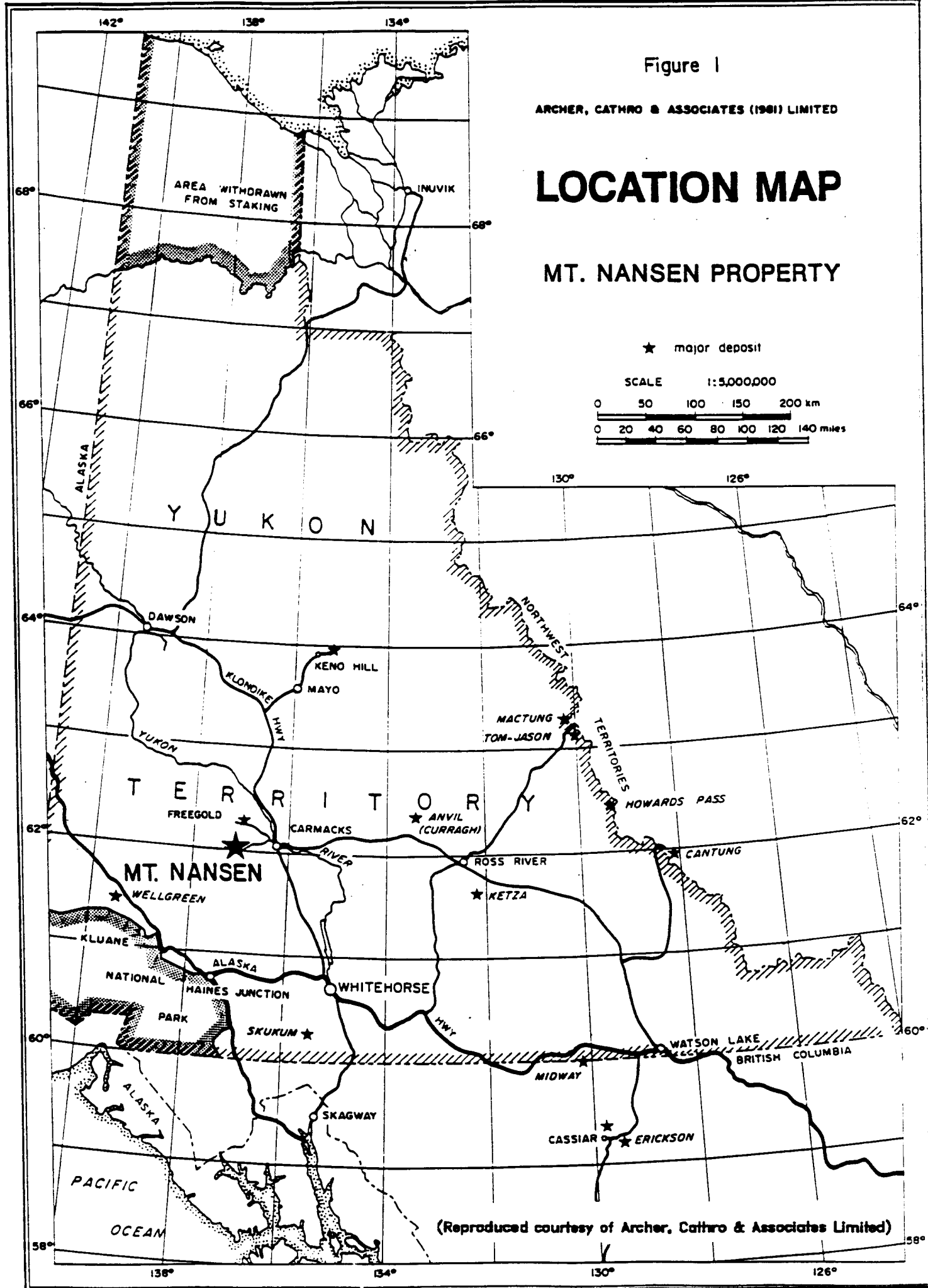
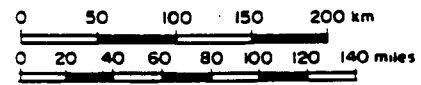
ARCHER, CATHRO & ASSOCIATES (1981) LIMITED

LOCATION MAP

MT. NANSEN PROPERTY

★ major deposit

SCALE 1:5,000,000



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owners until it was acquired by B.Y.G. Natural Resources in 1984. Chevron Canada Resources Limited then optioned the Mt. Nansen property in 1985, and since then the exploration has been managed by Archer, Cathro, & Associates (1981) Limited. Work has been directed towards evaluating potential for open pitable gold-silver ores amenable to cyanide extraction by either heap or vat leach techniques. Geochemistry, aerial photography, geophysics, mapping, trenching, drilling, and metallurgical, environmental and geotechnical studies have been conducted thus far. Extensive drilling and metallurgical studies were conducted on the Brown-McDade zone in the 1988 field season, in order to establish proven open pitable and underground reserves.

1.4 1988 BROWN-MCDADE DRILLING

In 1988, a total of 5060.7 m of diamond drilling in 73 holes was completed on the Brown McDade Zone, in order to establish tonnage and grade of ore suitable for open pit mining. All holes were inclined at -50°, and drilled along lines spaced 33m apart. Collars were spotted along section lines so as to intersect the vein footwall at vertical depth increments of approximately 20 m below the surface elevation of the fault for the shallow intersections, and 30 m for deeper intersections.

Geotechnical logging of the core and recovery measurements were conducted before detailed geological logging and sampling. Samples were fire assayed for Au and Ag using a one assay ton split. Rejects from selected samples were sent to a metallurgical laboratory for bottle leach tests.

1.5 PROVEN RESERVES AND PROPOSED MINE PLAN

Initial calculations based on 1988 drilling results and existing trench data indicate total reserves as listed below.

Table I. Initial Brown McDade Proven Reserves*

	Tons	Au (oz/ton)	Ag	Cutoff (oz/ton Au)
Total Reserves (surface & u/g)	356,776	0.390	2.92	0.200
Open Pitable Reserves**	143,255	0.332	2.92	0.060

* Subject to revision

** Uncut reserves based on 5 foot minimum mining width (Table I, cont...)

it is estimated that an average stripping ratio of 2.6:1 will be necessary in order to extract the Open Pittable reserves. This will be done from two separate pits; the North and South Pit. The outlines for these workings are shown in Fig. 2. The mine will operate at 300 tons per day, giving the two Brown McDade pits (at their present geometry) a mine life of 1.3 years, yielding approximately 35,700 ounces of gold (75% extraction), and 146,400 ounces of silver (35% extraction).

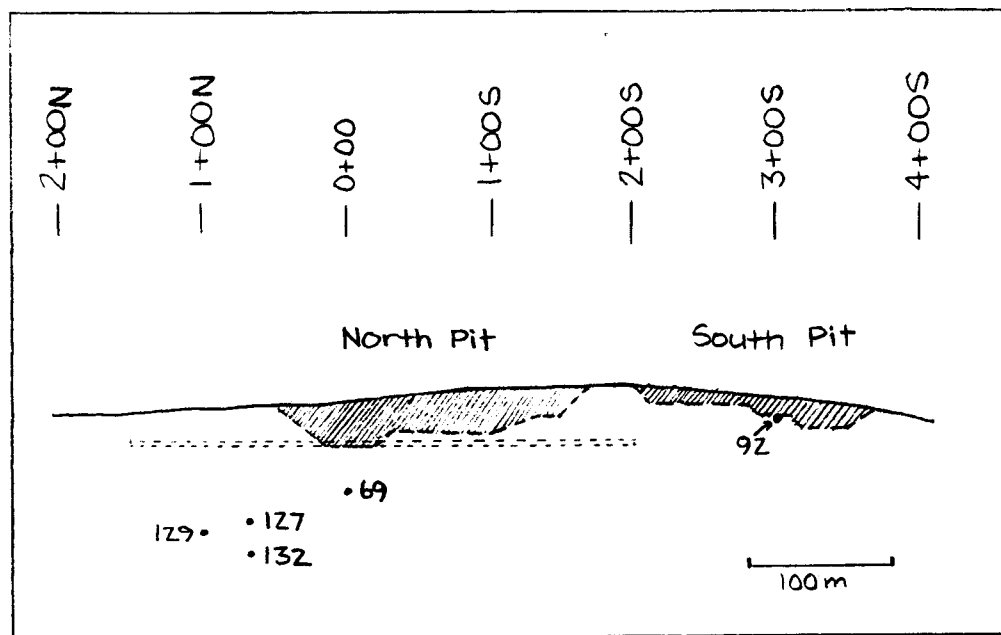


Figure 2. Longitudinal Section of the Brown-McDade Zone showing proposed pit outlines (shaded area), underground workings (dashed line), and location of samples used in this study.

Proposed milling will likely involve crushing and grinding the ore to approximately -100 mesh, thickening, carbon column cyanidation, followed by electrowinning the gold-silver alloy onto steel wool. The steel wool would then shipped out for smelting. Metallurgical analyses to date on the Brown McDade ore indicate that average recoveries will be 77.3% for gold, and 38.9% for silver, with cyanide and lime consumptions of 1.68 and 9.49 kg/tonne respectively.

In order to implement this process, the existing mill would

require considerable refurbishing. This would basically involve overhauling and restoring the ball mills back to working order, replacing the existing floatation tanks by a cyanidation circuit, and general repair and upgrading of the out of date and somewhat vandalised facilities.

CHAPTER 2 - GEOLOGY AND GEOMORPHOLOGY

2.1 GEOMORPHOLOGY

The Mt. Nansen property lies within the Dawson Range, a northwest trending series of peaks ranging in elevation from approximately 1600 to 2000 m. Local elevation on the property ranges from 1030 m in valley bottoms to 1500 m on ridge tops. Slopes are generally gentle, steepening only when contiguous to the major peaks.

The major streams, Victoria and Nansen Creek, are mature in geomorphic age, and flow in a meandering fashion in large valleys. Just south of the property Victoria Creek joins Nansen Creek which then flows westward into the Nisling River, part of the Yukon River watershed. Tributaries to the main streams typically flow in a dendritic pattern in narrow, V-shaped valleys.

Treeline occurs at approximately 1400 m elevation, below which spruce up to 10 m high grow on south-facing slopes. Above this altitude are various willows, shrubs, and the occasional stunted spruce. Permafrost occurs throughout the property, and is most extensive on north-facing slopes, where thick moss accumulations prevent appreciable thawing even in summer months.

A unique feature of the Mt. Nansen property and other areas in the Dawson Range is its lack of ice cover during the Wisconsin glaciation, approximately 10,000 years ago (See Fig. 3). This has resulted in deep, in-situ weathering of the terrain, relatively few bedrock outcroppings, and an abundance of felsenmeer boulders of the more resilient lithologies.

2.2 REGIONAL GEOLOGY

Lying within the Yukon Crystalline Terrane (Tempelman-Kluit, 1984), or Stikinia (Monger, 1984), the Mt. Nansen property is underlain by a basement of Upper Paleozoic or older schists, gneisses, amphibolites, and marbles intruded by foliated Upper Triassic and unfoliated Jurassic diorite, granodiorite, and syenite batholiths (See Fig. 4). The basement rocks are thought to belong to an island arc sequence accreted to the North American craton in mid-Jurassic time, while the intrusions are likely related to the Coast Plutonic Complex (Tempelman-Kluit, 1979). Unconformably overlying and cross-cutting the older rocks are volcanics associated with early Tertiary magmatism; these include intermediate to acid volcanic lavas, tuffs, and tuff breccias (Nansen Andesite in Fig. 4), basaltic plateau lavas (Carmacks Basalt), and porphyritic acidic rocks, commonly associated with mineralization in the area.

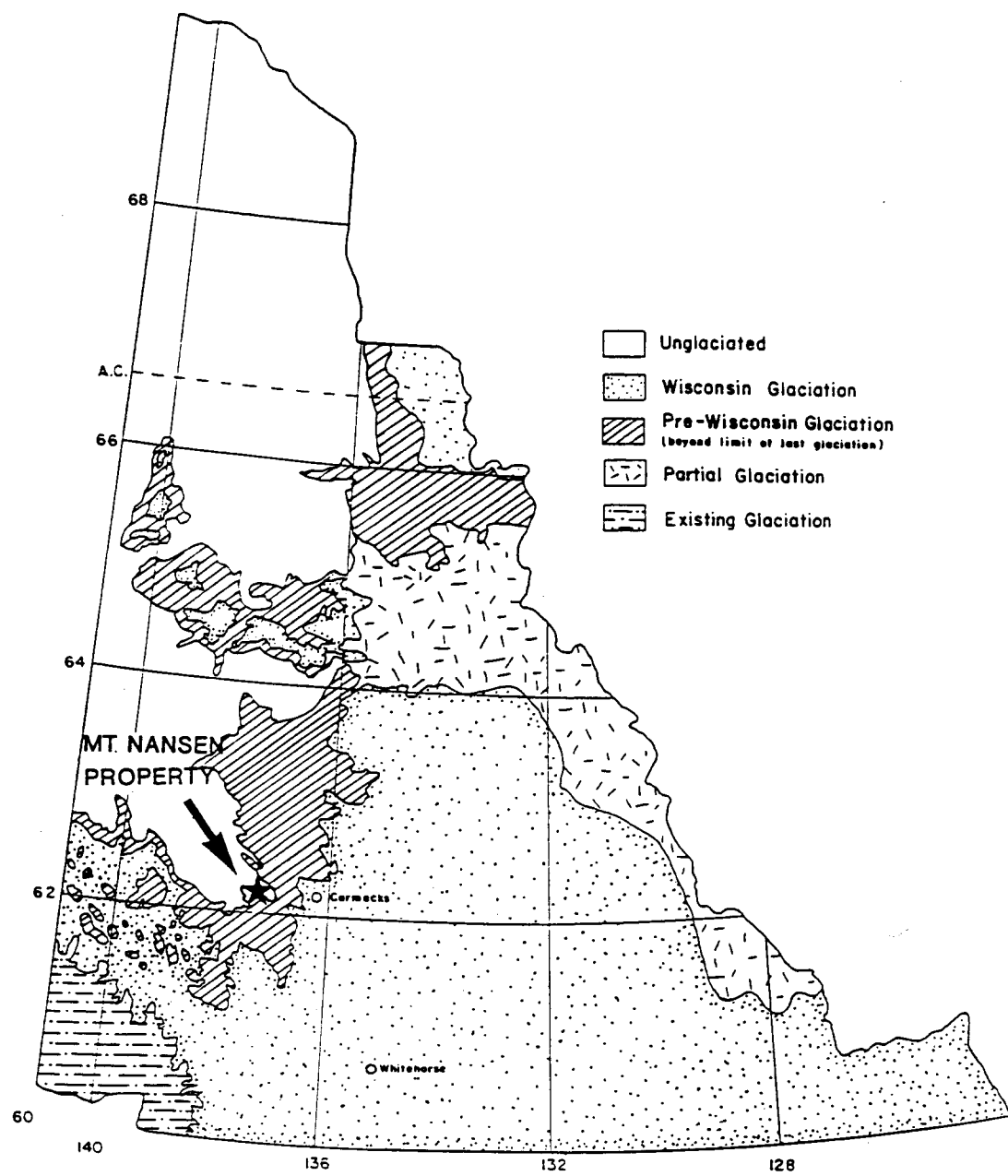


FIGURE 3: GLACIATION, DAWSON RANGE Y.T.

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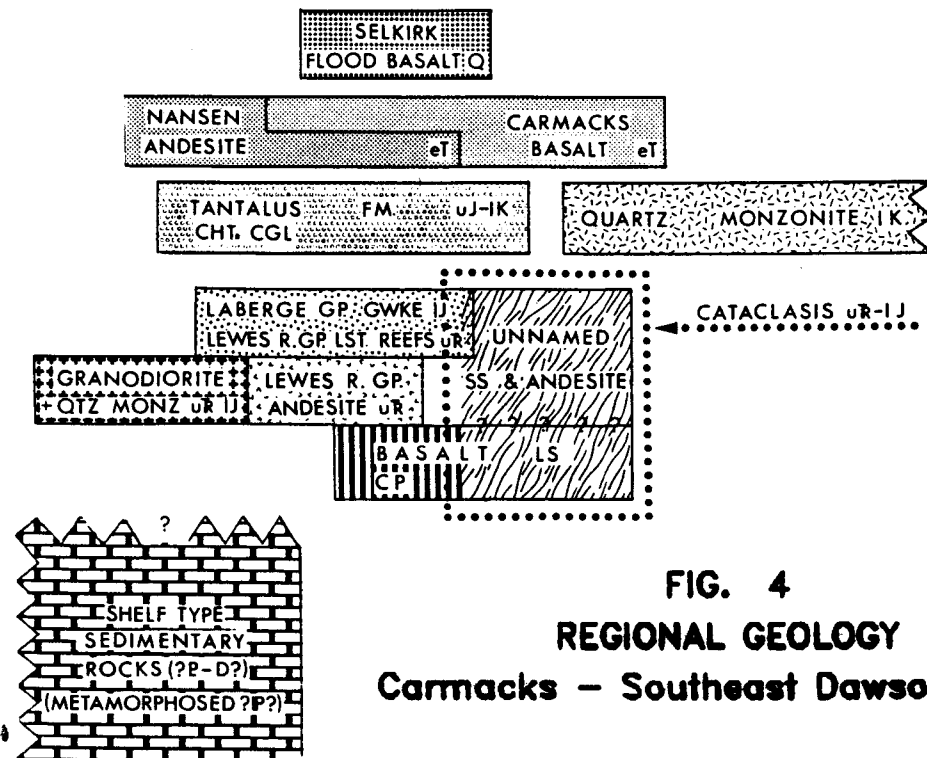
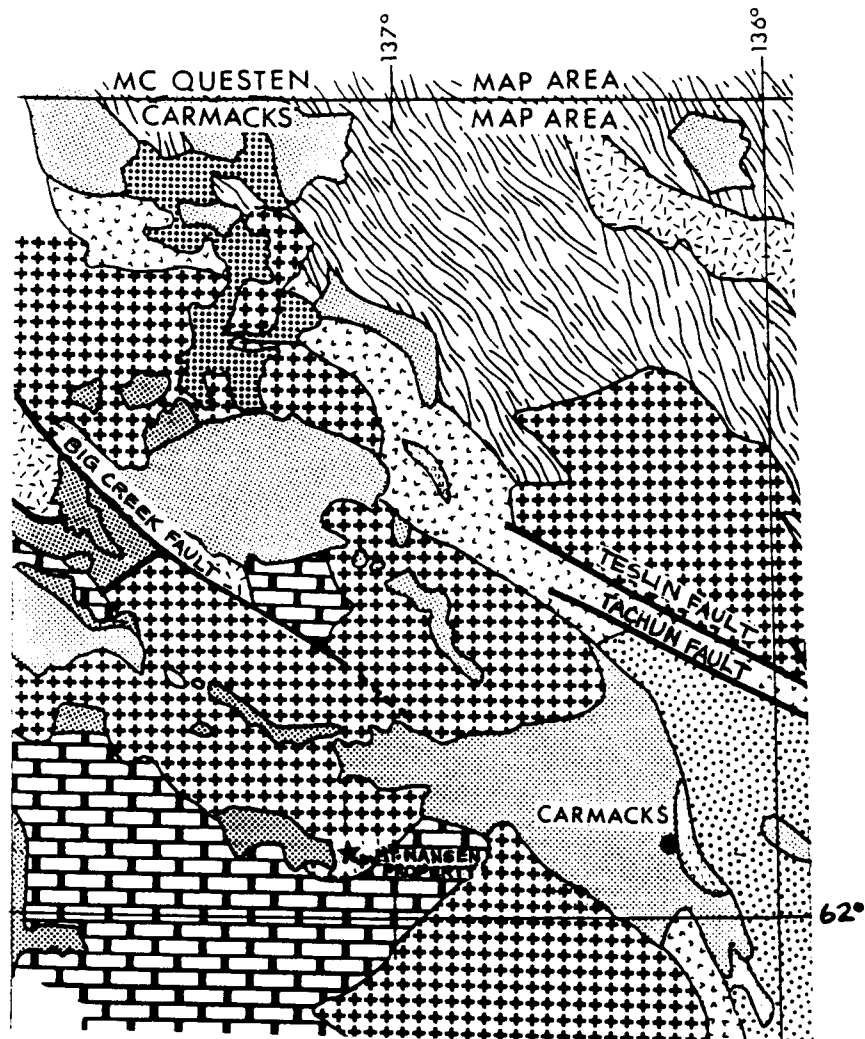


FIG. 4
 REGIONAL GEOLOGY
 Carmacks - Southeast Dawson Range

The main structural feature of the area is the Big Creek Fault, which marks the boundary of the island arc assemblage and the para-cratonic rocks of the Yukon Cataclastic Terrane. This feature is poorly understood, as parts of it are obliterated by post-faulting magmatism. In some areas, the fault appears as a steeply dipping, linear feature, and in other areas appears as a westward-dipping thrust.

In summary, it is thought that the region underwent compression and metamorphism during Jurassic time, followed by post-accretionary extension, giving rise to block faulting and magmatism.

2.3 PROPERTY GEOLOGY, MINERALIZATION AND ALTERATION

2.3.1 PROPERTY GEOLOGY

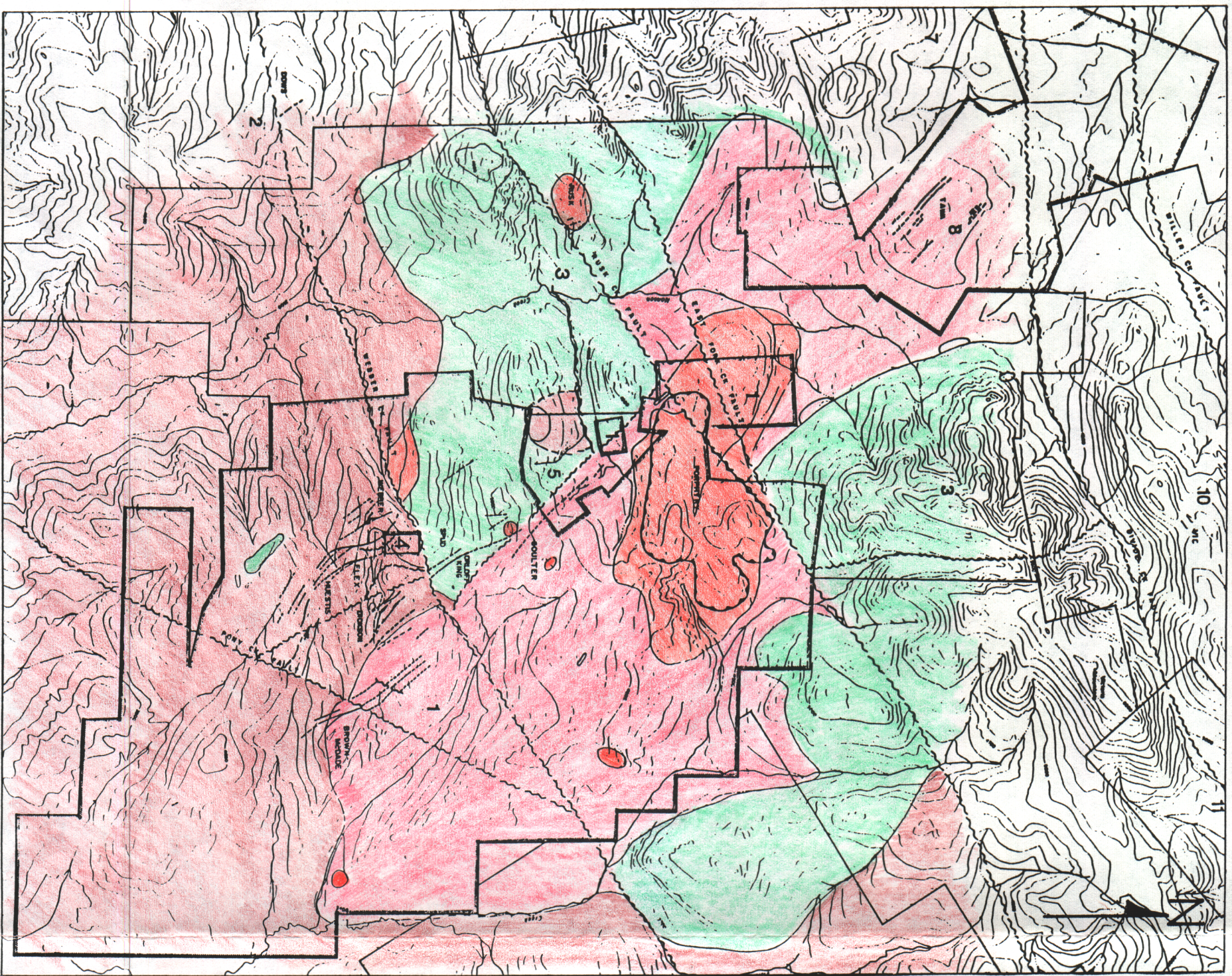
The Upper Paleozoic metamorphic assemblage forms the oldest unit in the Mt. Nansen area, and is the dominant wallrock at the Webber, Flex, and Huestis Zones (See Fig. 5). Intruding this is a northwest-trending belt of granodioritic to dioritic rocks of Late Triassic to Mid-Cretaceous age. Mineralization in or adjacent to this unit occurs in the Brown-McDade, Dickson, and Goulter Zones. The youngest unit on the property is the Early Tertiary Mount Nansen Group, consisting of two suites; one predominantly andesitic, and the other dacitic to rhyolitic flows, pyroclastics, feeder dykes, and plugs. The Orloff King and Spud Zones occur within the andesitic suite; the felsic volcanics are associated with porphyry copper mineralization at the north end of the property, as well as with the mineralization in the Brown-McDade Zone.

The property is cross-cut by several major northeast trending faults, offsetting the units by a few hundred metres. Associated with these faults are linears trending northwest which show varying displacement of lithologies.

2.3.2 MINERALIZATION

The two major types of mineralization known on the property are precious metal vein zones and disseminated and stockwork porphyry copper mineralization.

Precious metal vein zones occur in all rock types, striking between 130° and 180° , with a wide range of dips from 30° SW to 75° NE. The veins are offset by the major faults in the area, and can be further divided into narrow, simple vein systems (Webber, Huestis, Spud, and Dickson), and complex vein and breccia zones (Brown-McDade, Orloff King, Goulter). Narrow vein systems vary in width from a few centimetres to 5m; primary sulphides include, in order of abundance: pyrite, arsenopyrite, galena, sphalerite, chalcopyrite, sulphosalts, and stibnite. Silver to gold ratios are high, normally between 20 and 30:1. The complex zones are quite



- EARLY TERTIARY**
- Quartz feldspar porphyry
 - Andesitic flows, tuffs and agglomerates
- MID-CRETACEOUS**
- Granodiorite and diorite
- PALEOZOIC OR OLDER**
- Gneiss and schist
- Geological contact
 Vein fault
 Fault
 Mt. Nansen Property Boundary
- 1 0 0.5 1 2 3 Km

FIG. 5

GEOLOGY AND MINERALIZATION
Mt. Nansen Property
and Surrounding Area

similar in mineralogy, but show a lower silver to gold ratio (8:1 in the Brown-McDade, and 20:1 in the Orloff King Zone) and appear to have a spatial, and probably genetic link with feldspar porphyry dykes.

Porphyry copper mineralization is likely syngenetically related to the property's vein mineralization, possibly representing a deeper and hotter part of the system. The plug is approximately 3.5 km long by 1.5 km wide, and shows the typical alteration of a porphyry system with local potassic and silic cores surrounded by advanced argillic and phyllic halos, circumfurenced by weak argillic and propylitic regions. Copper mineralization is weak (average grade of less than 0.1% Cu), but covers and approximate area of 3000 by 1500 m; preliminary sampling indicates precious metal values of less than 0.005 oz/ton Au and 0.1 oz/ton Ag.

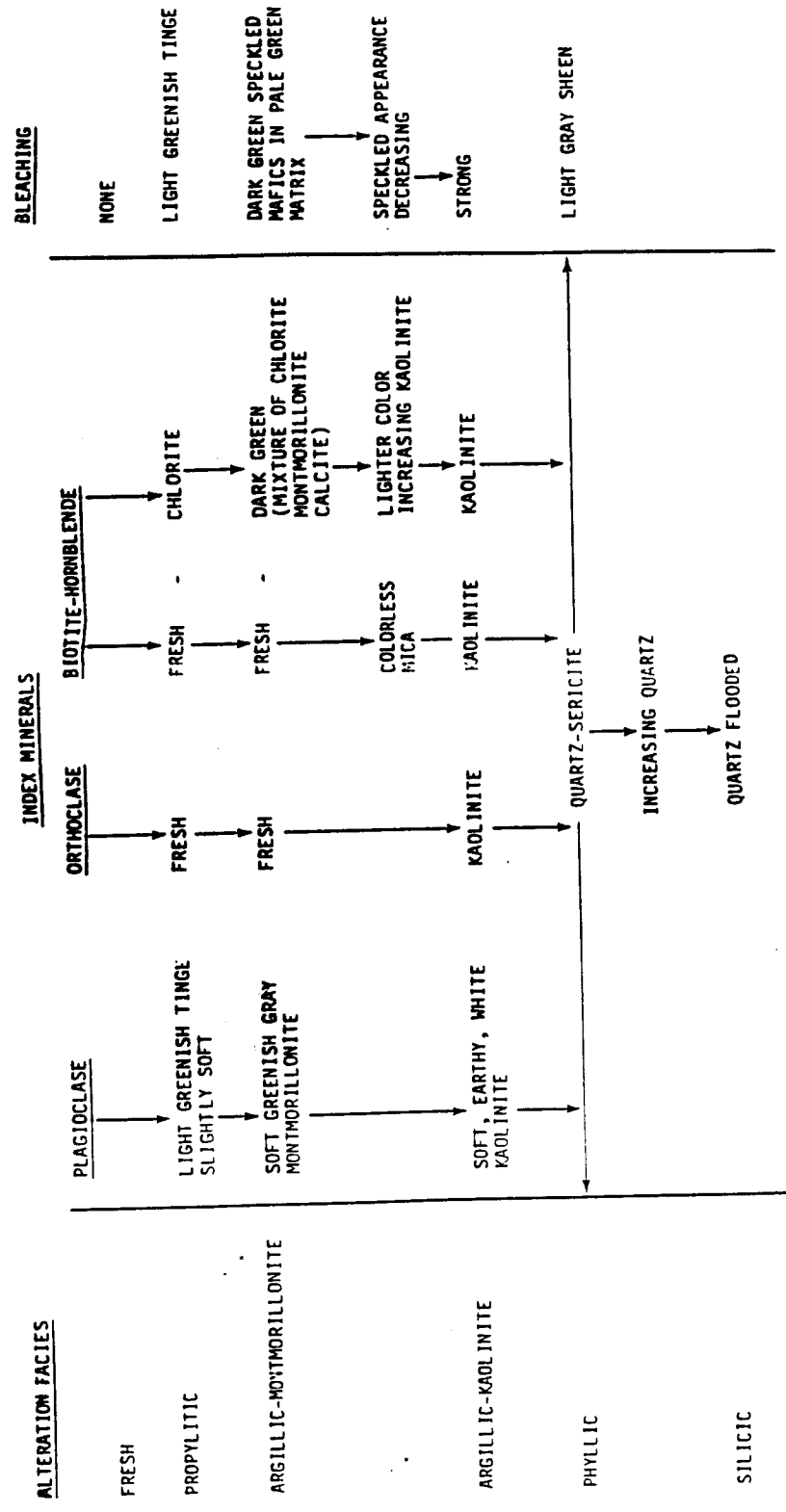
2.3.3 ALTERATION

Observation of hypogene alteration facies can be a useful tool in delineating mineralization on the Mt. Nansen property. Table III lists the five major facies observed in trenches and drill core, with key minerals used in their identification.

Being unglaciated, the region shows considerable supergene overprinting on the hypogene alteration. This has a tendency to upgrade the weakly altered (propylitic to argillic-montmorillonite) facies.

Steeply dipping systems such as the Huestis and Webber tend to show symmetric alteration about the veins, while the more moderately dipping Brown McDade and Flex Zones exhibit much more extensive alteration in the hanging wall. Silic alteration of the wallrock is relatively rare and usually occurs immediately adjacent to the mineralized quartz veins, while phyllic alteration is more widespread, and depending on the steepness of the vein, may develop only in the hanging wall. Argillic-kaolinite and montmorillinite facies vary in extent depending mainly on wallrock lithology and dip of vein. Propylitic alteration is generally quite widespread on both sides of the vein.

TABLE II. HYPOGENE ALTERATION FACIES



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3.1 BROWN-MCDADE GEOLOGY AND VEIN STRUCTURE

The Brown-McDade mineralization is spatially and possibly genetically related to the swarms of northwest trending feldspar porphyry dykes which crosscut both the Mid-Cretaceous granodiorite and the Upper Paleozoic metamorphic suites of the zone (See Fig. 6). The dykes are irregular in width and appear to stem from the major stock situated along the Footwall Fault. This main stock also hosts the most impressive mineralization of the zone.

The Footwall Fault strikes concordant with the veins at approximately 155° , dipping between 60° and 70° to the southwest. The footwall of this feature consists of propyliticized granodiorite, which, in nearly all cases, contains no economic mineralization. The location of the footwall is easily seen on surface and in the drillholes; in the granodiorite host it is characterized by 5 to 10 cm of clay gouge at the boundary, and by a strongly sheared and altered hangingwall in both the metamorphic and granodiorite units. The widest mineralization typically occurs adjacent to the Footwall Fault in widths from 1 to 5 m. At depth, the vein appears to split into two, one part remaining concordant to the fault, the other splaying off at a shallower angle. Narrower veins also occur a distance off the fault, and are again associated with the porphyry dykes.

The vein appears truncated by the Pony Creek Fault to the north, but remains open to the south, and at depth.

Extensive surface oxidation penetrates the Brown-McDade Zone to an estimated depth of 40 m below surface.

3.2 BROWN-MCDADE MINERALOGY

3.2.1 STUDY PROCEDURE

Twenty samples of core from the Brown-McDade zone were obtained for the purposes of the mineralogical research; due to the small scale of this study it was necessary to limit the specimens to those listed below in Table III.

With the exception of sample 92, all specimens were from drill holes at the north end of the zone. This was in part due to the lower degree of oxidation of the ore samples from this region; as well, it was thought that a study of this size would produce more meaningful results if it were concentrated on one specific area of the zone.

All laboratory work was performed using the available facilities at the UBC Geology Department. Sample preparation

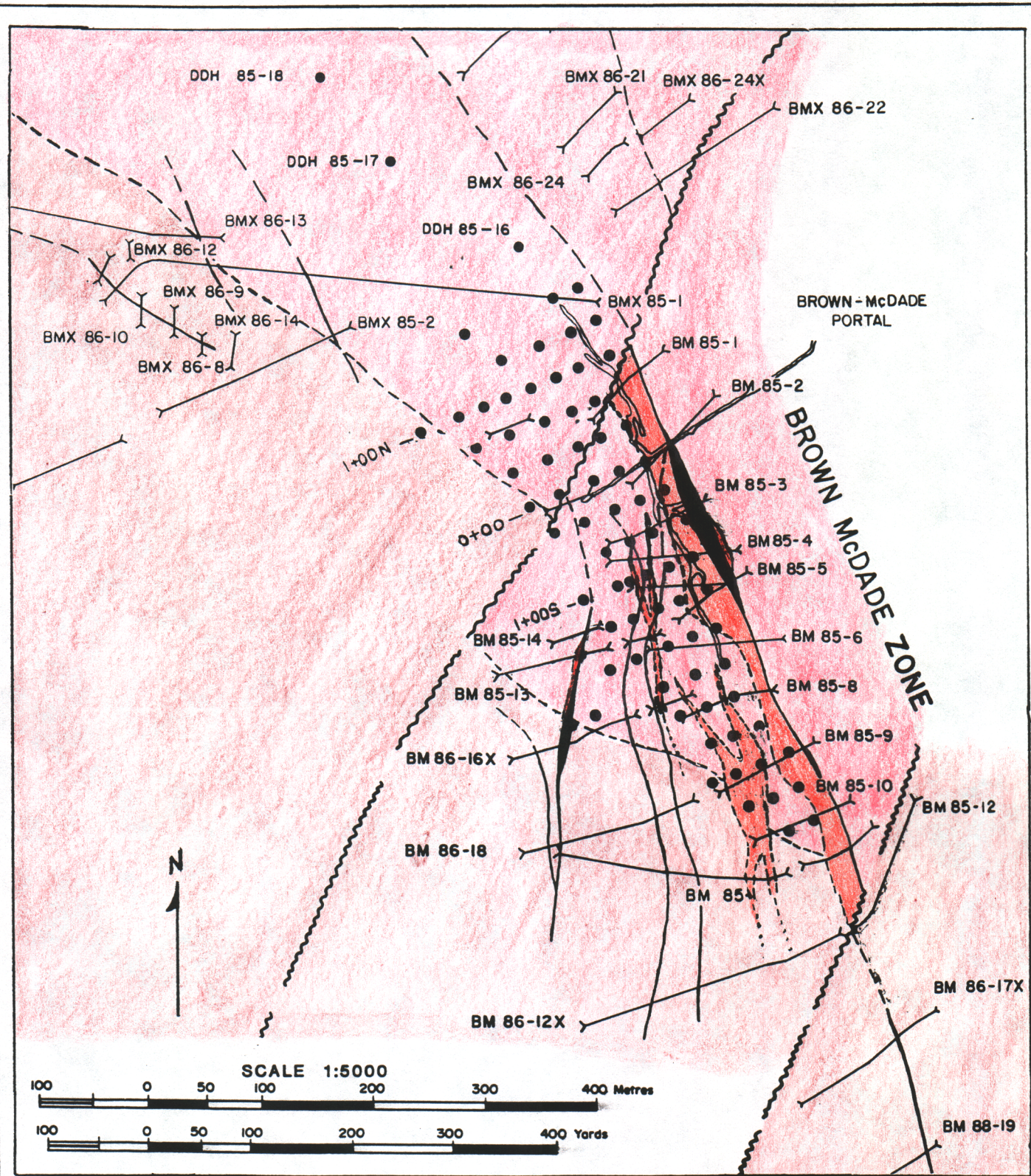


FIG. 6 BROWN McDADE ZONE
Geology, Mineralization and Workings

- | | | |
|----------------------------|-------|--------------------|
| EARLY TERTIARY | --- | Geological contact |
| □ Feldspar porphyry | ~ ~ ~ | Fault |
| MID-CRETACEOUS | — | Vein Trace |
| □ Granodiorite and diorite | ● | Drill hole |
| PALEOZOIC OR OLDER | ↔ | Trench |
| □ Gneiss and schist | | |

involved cutting a thin slab of rock from a piece of core showing high a degree of mineralization and alteration. Smaller pieces were then taken from the slab, pressed into 1 1/4" disks, and carefully polished. The complementary piece of core was also polished to reveal its macroscopic features.

Table III. Samples Examined in Study

Spec. #	Hole #	Line #	Interval (m)	Width (m)	Assay (opt)	
					Au	Ag
69IA	88-69	0+00	62.79-63.75	0.96	0.762	0.51
69IB	88-69	0+00	62.70-63.75	0.96	0.762	0.51
92*	88-92	3+00S	11.04-11.30	0.26	0.304	0.70
127A	88-127	0+66N	89.93-90.53	0.60	1.046	3.35
127B	88-127	0+66N	89.93-90.53	0.60	1.046	3.35
129	88-129	1+00N	115.12-115.77	0.65	0.365	0.80
132A	88-132	0+66N	120.40-121.92	1.52	0.883	21.00

* Sample 92: hand specimen only

Due to the high quartz content of the ore, a satisfactory polish could not usually be obtained on the standard polishing wheels. If, after this stage, examination of a specimen under reflecting microscope revealed the presence of gold or other minerals of interest, the sample was given to the lab technician for fine diamond polishing.

The mineralogy and textural relationships in each of the polished sections were then described in detail on forms which can be found in Appendix II. As well, the features of its complementary peice of core were also noted in the "Hand Specimen" section of the form. Photographs were taken of certain aspects of the specimens deemed to typify the principal mineralogy and textural relationships of the ore. Photographs of all hand specimens were taken as well, to illustrate both the source of each of the polished sections, and the ore's macroscopic character.

Scanning electron microscope (SEM) analyses were performed on specimens 127, 129, and 132A, primarily to positively identify grains thought to be gold. Other objectives were to identify elements present in two adjacent phases that were thought to be sulphosalts, and to scan for sub-microscopic gold in an area of the ore that was typically sulphide rich, but contained no microscopic gold (See Appendix III for results).

3.2.2 MACROSCOPIC FEATURES OF THE ORE

The Brown-McDade ore can be described as being a highly silicified and sulphide rich breccia. The matrix of the unoxidized ore is a dark to medium grey silica, mottled with lighter angular wallrock fragments (approx. 40% total rock



Photo 1 (left). Typical ore breccia, with silicified wallrock or vein fragments in grey-black matrix.

Photo 2 (right). Euhedral quartz infilling a cavity (88-92).



volume) 0.5 to 8 cm in size.

Fragments vary in alteration from phyllic to strongly silic; the siliceous areas are highly enriched in pyrite and are light grey in colour. The phyllic altered fragments are generally more white in colour, and have blebs of pyrite concentrated along fractures.

The petrology of the ore matrix is more complex than the fragments; for the most part it is a dark grey to almost black colour and strongly silicified, mottled with approximately 20% (of matrix volume) white, unmineralized quartz nodules 1 to 2 mm in size. Pyrite, arsenopyrite, and occasional sphalerite, galena, and sulphosalts are visible in the matrix.

Euhedral quartz is relatively infrequent in the zone, though samples from hole 88-132 have 0.5 mm stubby crystals growing on some fractures, and larger crystals grow into a vug in a sample from 88-92 (See Photo 2). Dark brown gypsum is commonly present in fractures along with limonite. Calcite is occasionally seen in narrow veins that have been slightly offset by movement along microfractures.

3.2.3 SILVER AND GOLD OCCURENCES

GOLD

Five occurrences of gold were observed in the specimens examined; 3 were within sample 129, and 2 were within sample 132A. All gold seen was in contact with pyrite, and generally, more than one grain was observed in a given occurrence. Both samples 129 and 132A were taken from pyrite-rich silic altered fragments ~~present~~ of the silicified breccia ore. No microscopic gold was seen in samples taken from other areas of the breccia.

Typically, the gold grains range in size from 0.008 to 0.04 mm, and are subangular to rounded inclusions within pyrite. Post-depositional cataclasis seems to have broken up some of the pyrite grains, thus exposing gold on grain edges. The pyrite-gold relationship implies a ~~syngenetic~~ syngenetic association of the two, however, Photo 6, taken with the SEM, clearly shows gold invading a fracture in pyrite.

All of the gold occurrences were examined under the SEM, and were found to contain both gold and silver. The amplitudes and ratios of gold to silver peaks were very similar among the occurrences, and the proportion of gold is estimated to be $80 \pm 10\%$. This apparent uniformity in composition implies that only one gold mineralizing event has occurred; however a much greater number of samples taken from throughout the zone will be required to confirm this.

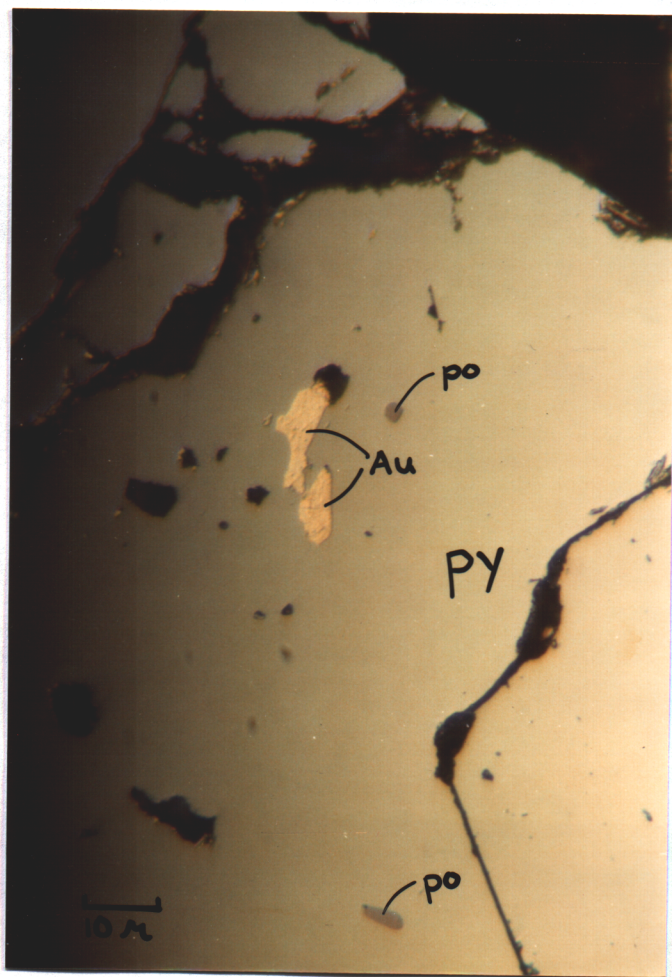
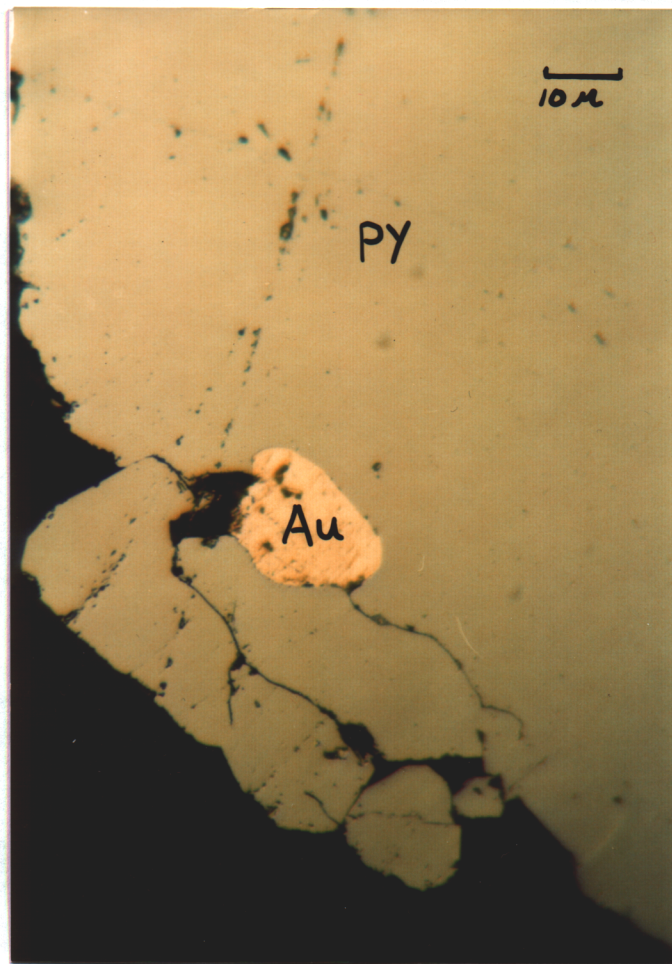


Photo 3 (left). Gold (Au #1) in 132A, with rare pyrrhotite inclusions.

Photo 4 (right). Gold (Au #2) in 132A.



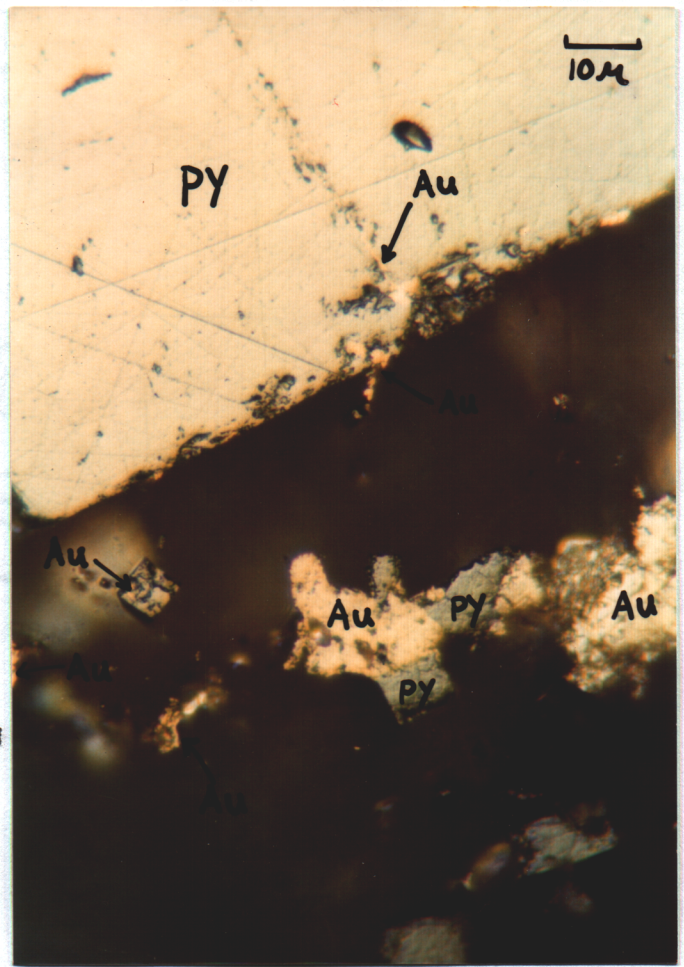
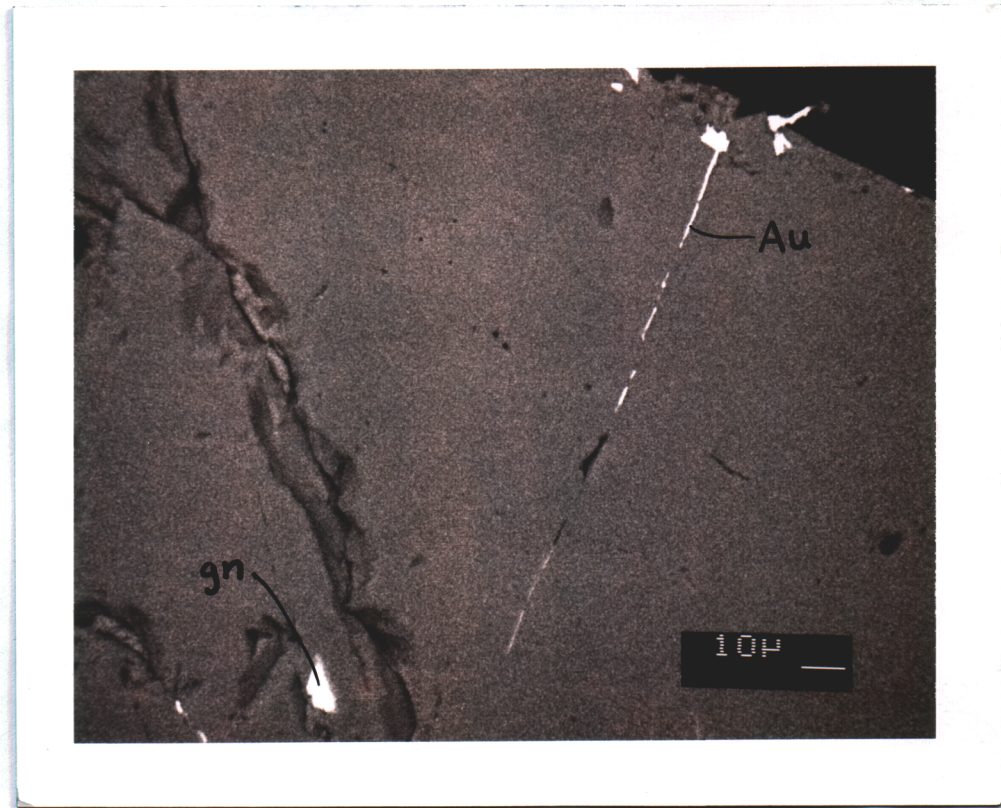


Photo 5 (right). Gold (Au #2 in 129 (see also Photo 6)).

Photo 6 (below). SEM photograph showing gold penetrating pyrite fracture, also galena inclusion in pyrite. (Au #2, 129)



SILVER

Silver occurs in solid solution with gold at an estimated proportion of $20 \pm 10\%$, but this does not nearly account for the average gold to silver ratio of approximately 8:1 in the Brown-McDade Zone. No native silver was observed in any of the specimens; it is assumed that most silver is present in the form of Ag-sulphides, Ag-Fe-sulphides, or Ag-sulphosalts. Reliable identification of many of these minerals is difficult without the aid of the SEM or electron probe; scanning of two possible silver-bearing minerals did not produce a silver response. A more thorough analysis of the specimens using the electron probe or SEM is necessary in order to establish silver mineralogy.

3.2.4 ASSOCIATED MINERALOGY

PYRITE

Pyrite is the most abundant ore mineral in the zone, accounting for about 55% of total sulphides. In the silicified altered wallrock fragments it represents between 80 and 85% of the sulphides, while the amount present in the breccia matrix is lower, varying from 10 to 60%.

A marked difference in pyrite within specimen 132A could indicate two events of pyritization in the zone. The major type of pyrite, seen in all specimens, is relatively large (1 to 3 mm) grains. These grains are generally fractured and pitted, and are ragged and irregularly shaped, possibly indicating some epigenetic catclasis. Inclusions of quartz, galena, sphalerite, pyrrhotite, tetrahedrite (?), boulangerite or geocronite, and gold (listed in descending order of abundance) are a distinguishing feature of this generation of pyrite. A second type of pyrite, seen in specimen 132A along gangue fractures, is fine (0.2 to 0.4 mm), relatively euhedral and inclusionless; it appears to have formed after any cataclasis that may have occurred.

In specimens of the breccia matrix, arsenopyrite appears to be invading both along fractures and into actual grains of pyrite (See photo 8***). Sulphosalts are also seen to penetrate pyrite fractures.

ARSENOPYRITE

Arsenopyrite accounts for an average of 25% of total sulphides in the specimens. It is seen only in trace amounts in the breccia fragments, but in the matrix varies in amounts

Photo 7 (right). Gold (Au #1
in 129.

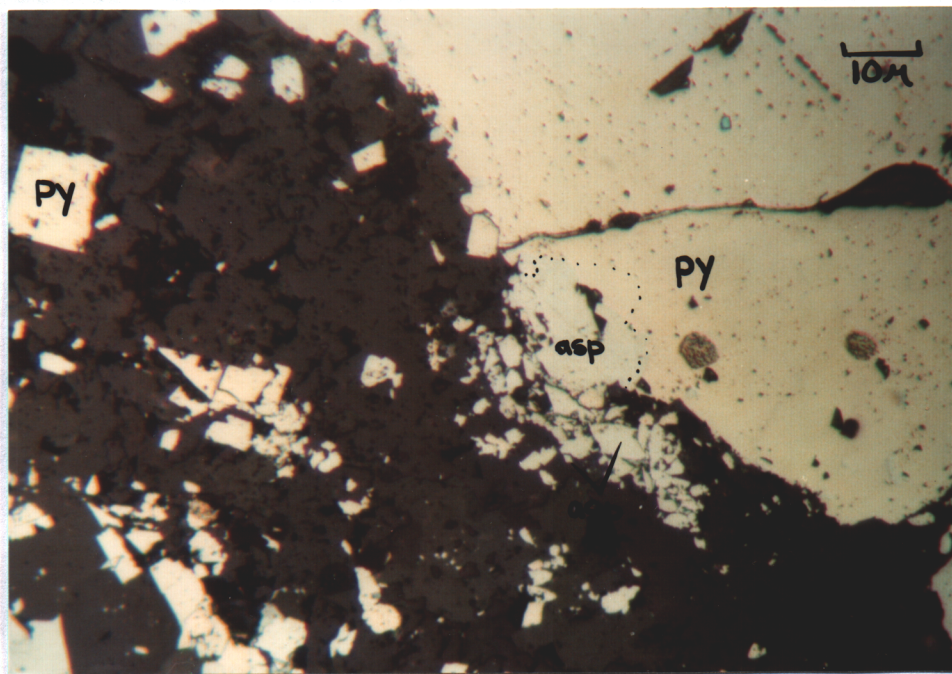
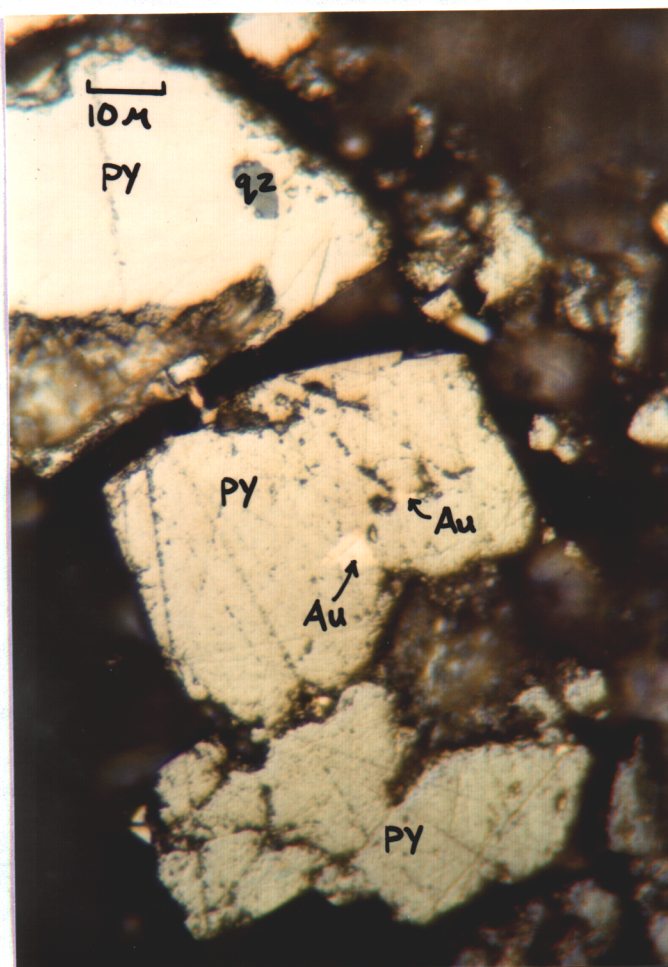


Photo 8 (left). Arsenopyrite and pyrite (127).

from 10 to 50% of the ore minerals.

Typically, arsenopyrite occurs as euhedral rhomb-shaped sections and irregular grains ranging from 0.01 to 0.07 mm in size. It is easily distinguished from pyrite by its pale colour, anisotropy, and euhedral shape.

The majority of arsenopyrite occurs near or in direct contact with pyrite. Several textures observed in the various specimens suggest that arsenopyrite is replacing, or is at least epigenetic to pyrite. These textures include rimming and fracture invasion of pyrite by arsenopyrite, and arsenopyrite "streaked" with pyrite, as seen in specimen 69IB. The two minerals often occur in the same bleb, and the boundary between them is very irregular.

Arsenopyrite also occurs adjacent to sphalerite, galena, and sulphosalts, and was enclosed by sphalerite in specimen 69IA.

SPHALERITE

About 12% of total sulphides observed in the specimens consisted of sphalerite, the amount varying in each sample between 0 and 70%. Except as inclusions in pyrite, sphalerite is present only in the dark grey to black siliceous matrix of the breccia ore. The irregular grains are 0.01 to 1 mm and commonly show few internal reflections, indicating a high iron content. They are stippled with fine chalcopyrite inclusions which often occur in clusters. Sphalerite appears to surround arsenopyrite in some of the samples; in turn, its fractures are filled with secondary digenite and covellite.

GALENA

Galena accounts for about 4% of the sulphides observed; it ranges in size from 0.05 to 0.5 mm, and commonly exhibits diagnostic triangular cleavage pits. When isolated, galena occurs as irregular grains with jagged boundaries (cleavage-controlled fracture), but typically shows a straight or curving boundary adjacent to associated sphalerite and sulphosalts. Slivers of sphalerite seen in one galena grain likely indicate recrystallization of galena after cataclasis rather than an epigenetic relationship between the two.

SULPHOSALTS

Sulphosalts are estimated to account for about 3% of the ore sulphides. There are over 80 known sulphosalt minerals in existence, some of which differ only slightly from each other in chemical composition, and absolute diagnosis is not usually

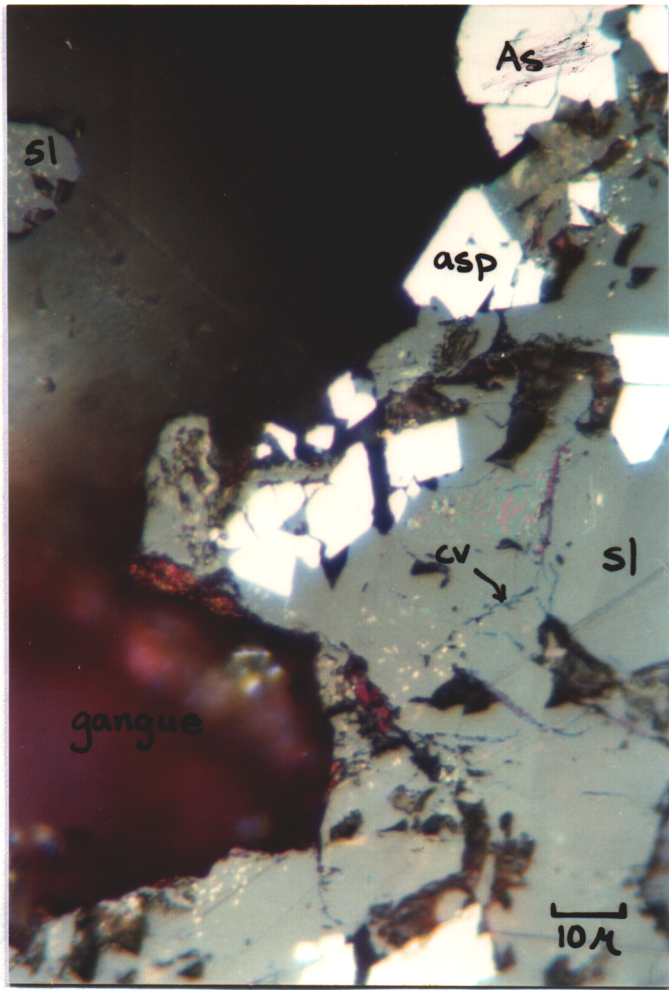


Photo 9. Sphalerite grain with arsenopyrite and secondary covellite (69IA).

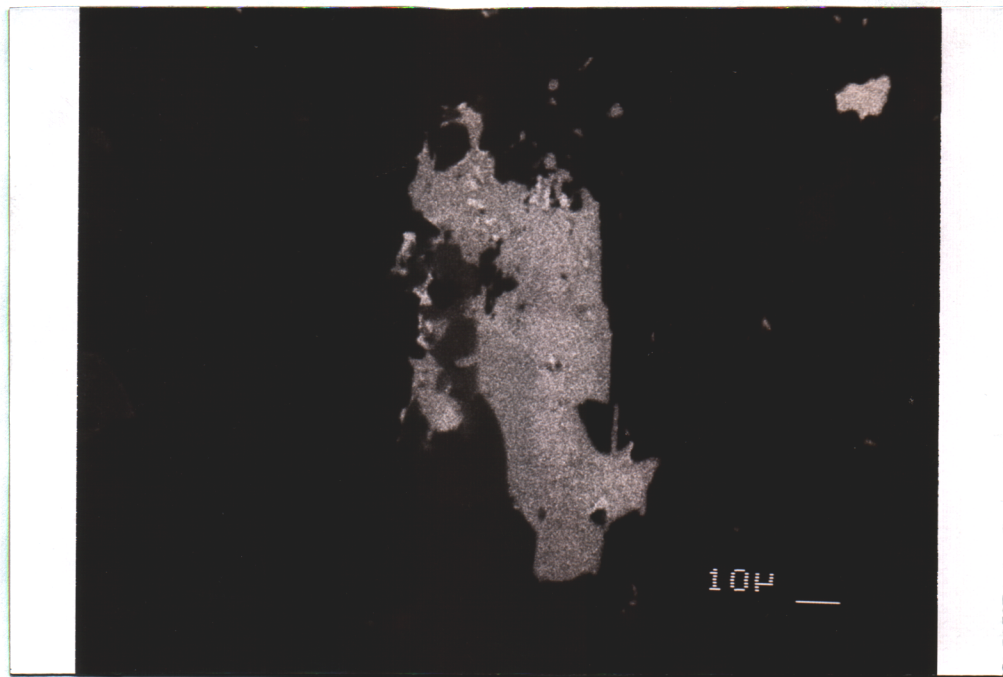


Photo 10. Two phases of sulphosalts; bournonite (dark grey), and boulangerite/geocronite (lighter grey). Small bright phases at top of grain are galena (127B).

possible by using only optical methods. In order to gain a complete understanding of sulphosalt mineralogy in the specimens, it would be necessary to undertake extensive electron probe analysis. The diminutive amount of SEM examination performed on sulphosalt grains in sample 127B revealed one phase containing copper, lead, antimony and sulphur, and a second phase with lead, antimony and sulphur (See Appendix III). This information, combined with some of the minerals' optical characteristics, enabled a relatively confident diagnosis of bournonite for the first phase, and a conjecture of boulangerite or geocronite for the second phase. Other minerals thought to be sulphosalts were seen in other samples; they appear to share similar characteristics to the above minerals, but that in itself is not conclusive.

Bournonite is seen in anhedral grains 0.1 mm in size in the breccia matrix, is associated with other sulphosalt phases, and is occasionally present as inclusions in pyrite. A mineral sharing bournonite's optical properties was seen in specimen 132B; this grain had chalcopyrite inclusions, a trait common in both bournonite and tetrahedrite.

Boulangerite or geocronite has a slightly higher reflectivity than bournonite, and is anisotropic. Bornite occurs exclusively with this mineral in sample 127B, and this association was noted in sample 132A as well. This occurrence of a sulphosalt in significant quantities in a pyrite-rich wallrock specimen is unusual with respect to the rest of the specimens examined in this study.

Huss (1965) proposed the presence of several different sulphosalt minerals in the Brown-McDade Zone; they are listed below:

Andorite	$Pb(Ag, Cu)Sb_3S_6$
Freibergite	(Ag-tetrahedrite)
Ruby Silver	$Ag_2(As, Sb)_2S_3$

Huss does not elaborate on the methods used for diagnosis of these minerals, and it is assumed that his conclusions were drawn based on the assay grades of silver. Although the presence of silver bearing sulphosalts in the ore is likely, the findings of this study do not support the presence of the above listed minerals in particular.

BORNITE

Bornite is seen only in exclusive association with boulangerite/geocronite; in sample 132A it is noted to be in well-formed tetragonal crystals growing on the edge of a pyrite grain into what is assumed to be boulangerite or geocronite. It occurs as more anhedral grains in combination with the lead-antimony sulphosalt in specimen 127B, where it forms both as isolated masses and inclusions in pyrite.

Clumps of secondary digenite occasionally forms on the bornite.

CHALCOPYRITE

Chalcopyrite is seen only as fine (0.005 mm) inclusions in both sphalerite and bournonite.

DIGENITE AND COVELLITE

These copper minerals occur as secondary mineralization in association with sphalerite, bornite, and bournonite in relatively small (less than 0.5% of sulphides). They are light blue under reflected light, and generally inhabit fractures of the primary ore minerals.

CHAPTER 4 - SUMMARY AND RECOMMENDATIONS

4.1 ORE MINERALOGY SUMMARY

The major features of the ore mineralogy studied are summarized below in Table IV.

TABLE IV. Summary of Mineralization

Phase	% of Ore Minerals	Occurrence*				
		M	F	I	Fr	O
Major Phases:						
pyrite	55	2	1			
arsenopyrite	25	1				
sphalerite	12	1		2		
galena	4	1				
sulphosalts	3	1	2	3		
bornite	1	1	3	2		
Minor Phases:						
chalcopyrite	trace					1
covellite	trace				1	
digenite	trace			1		
gold	trace					

* M=Matrix, F=Fragments, I=Inclusions in pyrite, Fr=fractures, O=Other(incl. in sl,ss), 1,2,3=most common (1) to least common (3) mode of occurrence

4.2 PARAGENESIS

Both the fragments and matrix of the breccia ore are mineralized quite distinctly; the fragments are mainly pyrite with inclusions of gold, sulphosalts, and pyrrhotite, while the matrix has significant amounts of pyrite (with inclusions of sphalerite, bornite, and sulphosalts), arsenopyrite, sphalerite, galena, sulphosalts (bournonite, boulangerite or geocronite, ± Ag-sulphosalts?), and bornite. This suggests two separate mineralization events; an Au, Fe, and Ag phase followed by an Fe, Ag, Pb, Zn, Cu, and As phase. According to Buchanan's epithermal deposit model, the first phase came from higher up in the model horizon (100 to 300 m below the spring orifice) than the second base metal phase (350 to 550 m depth).

The only obvious paragenetic relationship is in the breccia matrix where pyrite is being replaced by arsenopyrite. Since almost all other minerals present in the matrix are also seen as inclusions in pyrite, it is likely that they were formed

simultaneously. This is also true for the breccia fragments. The apparent consistency in gold composition indicates one mineralizing event for gold, apparently coincident with the other mineralization. There is much evidence for later cataclasis, but it was not accompanied by any significant ore deposition. Fine, euhedral pyrite in gangue fractures may be deposited by meteoric waters or later hydrothermal fluids.

4.3 FACTORS AFFECTING BENEFICIATION

Post-depositional cataclasis has fractured many pyrite grains, thus exposing some of the gold inclusions. Three out of ^{five} five gold grains observed were locked in the pyrite, and fine grinding to approximately -1200 mesh is apparently necessary to liberate at least one face of the gold grain in order that it may be leached. In the designated pit area, however, significant oxidation of sulphides has alleviated this problem, and gold appears to be recoverable at a much coarser grind.

Poor silver recoveries are likely due to most of the silver likely being bound in sulphosalt compounds, making them less amenable to cyanidation.

Arsenopyrite present will not likely cause problems in a cyanide circuit, as only realgar and orpiment commonly form thio-arsenides which consume oxygen.

Copper minerals such as bornite, digenite, covellite, chalcocite, and some sulphosalts may cause excessive cyanide consumption. The estimated percent of copper minerals in the specimens is about 0.2%.

4.4 RECOMMENDATIONS

While this study may have answered some fundamental questions about the Brown-McDade mineralogy, some aspects still require further investigation.

Silver mineralogy is still poorly understood. Sources of silver in the ore should be found in order to determine if it is economically extractable. A thorough investigation of silver mineralization would likely require extensive electron probe and microscopic analyses of sulphosalt occurrences.

It should be kept in mind that only a small number of specimens from a select area of the Brown-McDade Zone were examined in this study, and that a larger, more uniform study of the zone is recommended in order to thoroughly understand the mineralization and its applications to metallurgy and further exploration in the area.

APPENDICES

APPENDIX I. ABBREVIATIONS USED
APPENDIX II. SAMPLE DESCRIPTIONS
APPENDIX III. SCANNING ELECTRON MICROSCOPE DATA

APPENDIX I. ABBREVIATIONS USED

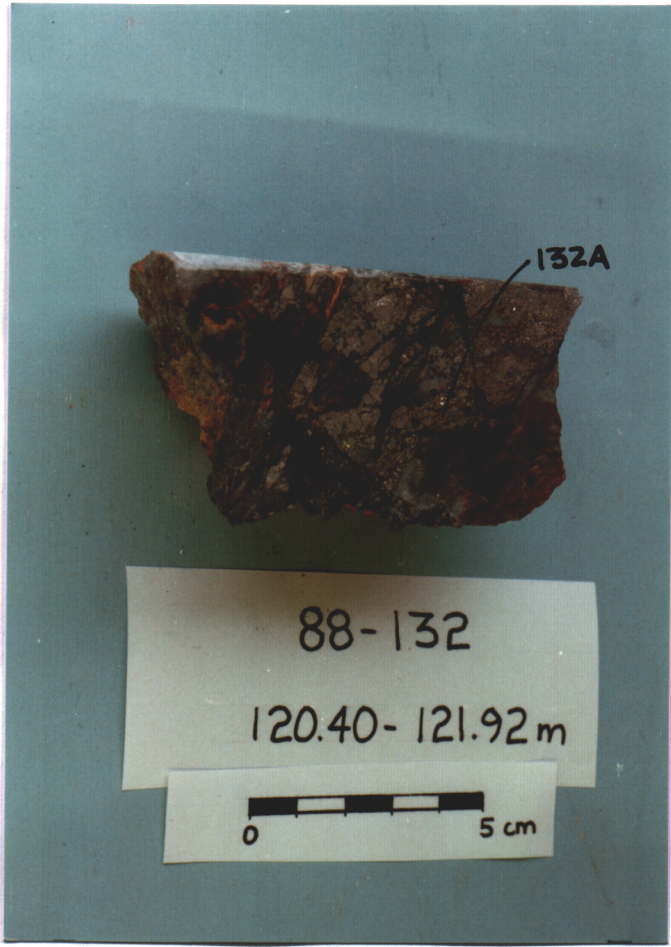
Au	Gold	py	pyrite
asp	arsenopyrite	po	pyrrhotite
bx	breccia	qz	quartz
bn	bornite	sl	sphalerite
cp	chalcopyrite	ss	sulphosalts
cv	covellite	sx	sulphides
dg	digenite	tt	tetrahedrite
gn	galena		
gyp	gypsum		
li	limonite		

APPENDIX II. SAMPLE DESCRIPTIONS

HAND SPECIMEN PHOTOGRAPHS

Where possible, the location of polished section specimens is indicated. Photos for samples 127 and 132 are in the body of the report.





BROWN MCDADE ZONE

SAMPLE NO.: 69IA

HOLE NO.: 88-69A OC: 69-A

Au (oz/ton): 0.762 (63.9% extr.)

COORDINATES: 0400/103.5W

Ag (oz/ton): 0.51 (42.3% Au)

AZIMUTH: 067°45'

WIDTH: 0.96

ANGLE: -50°

INTERVAL (m):

62.79-63.75

I. HAND SPECIMEN DESCRIPTION:

SILICIFIED BRECCIA - wallrock? Unrotated.

mottled dk gy, str. silicified w/unmin. qz nodules/frags, wht to li-brn 1-5mm (~30%).
 Irrag. band/bleb trending thru cut spec, ~2cm wide, pale gy-grn (digested wall-rock frag?). Some nodules alt → lt. brn clay ... fsp grains? lt. brn soft calcite around some qz frags or isolated blebs in matrix
 trend ± 90°. Spec. ox around frc 1-2mm, frc infill red brn qyp, some li.
 Min: py-asp: in dk gy silic, mostly, also in gy-grn band, none seen in qz nodules/frags.
 0.1-1mm ~ 5%
 -also a // banding of wallrock/matrix seen in one spec ± 80°
 69IA:

II. MICROSCOPIC DESCRIPTION:

approx % sulfides: 10%

A. PHASES PRESENT:

AREAL PERCENT:

py - in qz, not us. assoc. w/other sulf. 45%
 asp. 50%
 ① cov - in frc. in sl. <1%
 sl - in qz, ② frc. in py. 4%
 tt? - R 30-40, not reil. enough for gn., grey, isotropic, n>sl?
 - subangular grains in sl, no inclusions 1%
 cp - incl. in sl. <1%
 ?gn: incl. in sl, w/tt?

Au⁰? - search under med. pwr., none found.

B. TEXTURES:

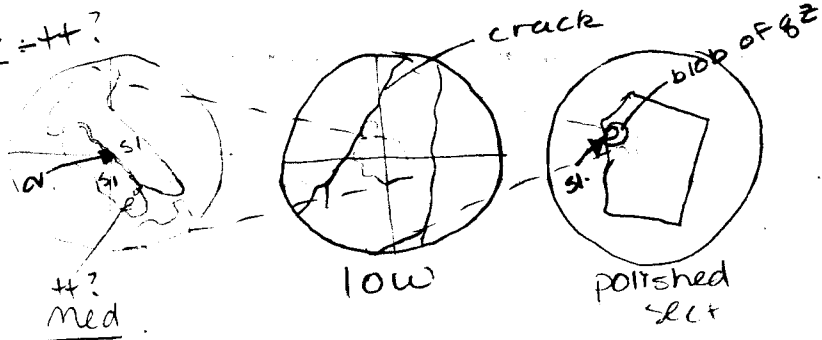
py: euhedral cubic, ~0.1-0.5mm, in qz, some cataclastic textures.
 occ. sl on frc (②), or as incl. Asp. quartz on them, then fracturing. incl. in asp. (③).
 sl: strong mt. refl, clusters minute cp incl., group mainly around other sulf. grains in sl, frc in py.
 asp: irreg. shaped grains (ang. frags), .05-0.3mm, irreg. anis. over grains. larger clusters have a clear qz halo around them.
 stands on its own, w/oth. sulf, w/py.
 qz: ① lt, li tex, pitted + irreg. ② dk gy, pitted, irreg. ③ clear gy blobs, gen adj to min.
 ?tt: both subang. + irreg. blebs in sl.

C. FACTORS AFFECTING BENEFICIATION:

- no Au⁰ in med. pwr. - where is it?

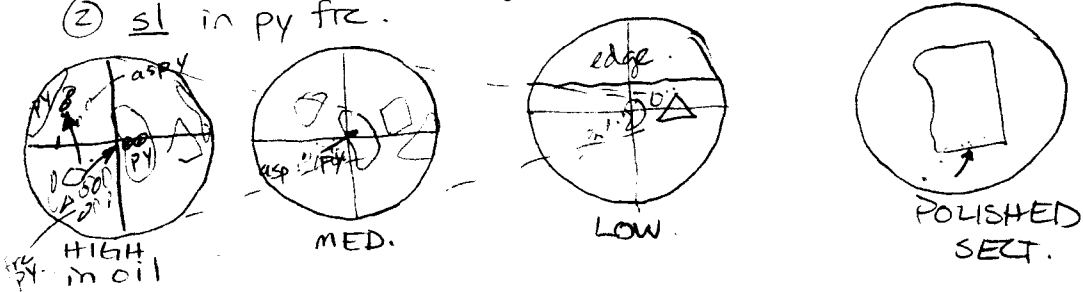
NOTES: - seems to be no assoc. of py with min. other than qz. and asp.
 asp is seen in close assoc. w/other sulf. in section, though.

① CV = ++?

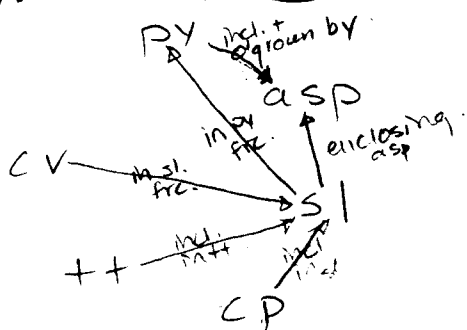
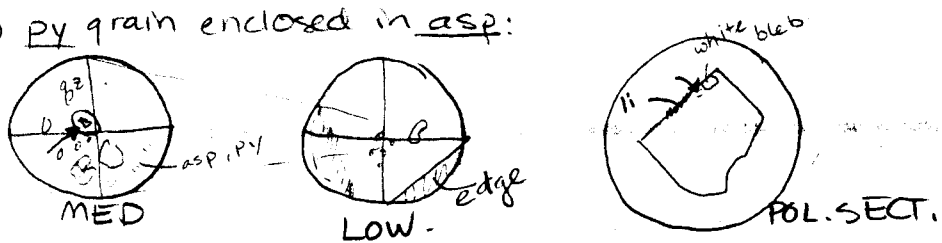


- sitting in a halo of relatively clear βZ .

② sl in py frz.



③ py grain enclosed in asp:



PV way ahead
 asp } closer together
 ++ }
 sl-cp }
 CV way after

BROWN McDADE ZONE

SAMPLE NO.: 69IB

HOLE NO.: 88-69

Au (oz/ton): 0.762

COORDINATES: 0+00 / 103.5W

Ag (oz/ton): 0.51

AZIMUTH: 067° 45'

WIDTH: 0.96 m.

ANGLE: -50°

INTERVAL (m): 62.79-63.75

I. HAND SPECIMEN DESCRIPTION:

see 69IA description

II. MICROSCOPIC DESCRIPTION:

% Sulphides ≈ 10%

A. PHASES PRESENT:

AREAL PERCENT (of sulphides)

py - large grains 1-2mm, broken up, cataclased, all. gn. inclusions.	60%
asp - well formed rhombs + cubes - 0.03-0.06mm.	36%
li in frz., pervading 2-3mm.	5%
sl v.f.g ~ 0.02mm in blob of dk. gy qz on spec. - irregular shape.	1%

B. TEXTURES:

asp: gran w streaks of py → asp after py?
 - mottled texture under x'd polars against partial cube of py
 - could be an annealing texture.

C. FACTORS AFFECTING BENEFICIATION:

order of x. py asp
 cataclasm: cataclasm
 pptn of inclusions of gn.

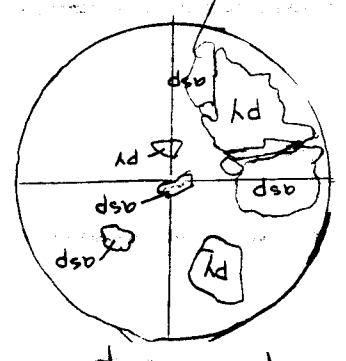
Q1. Explain the following terms: (10 marks)

1. Polished section
2. Mottled texture under X-polarisers

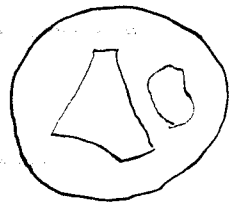
Q2. Explain the following terms: (10 marks)

1. Polished section
2. Mottled texture under X-polarisers

mottled texture under X-polarisers.



py-asp - med power



Polished section

BROWN McDADE ZONE

SAMPLE NO.: 92

HOLE NO.: 28-92

Au (oz/ton): 0.304

COORDINATES: 3100S

Ag (oz/ton): 0.70

AZIMUTH: 067° 45'

WIDTH: 0.26 m

ANGLE: -50°

INTERVAL (m): 11.04-11.30

I. HAND SPECIMEN DESCRIPTION:

VUGGY QUARTZ BRECCIA.

qu. wht, mottled, ~5% gy-blk sulfide rich blebs in irreg. pattern. ⇒ v. fine asp, py in blebs.
 Alteration: patchy silic, pervasive phyllic. Remnant fsp. phen 1-2 mm ⇒ cy-ser.
 Fractures - li clay on frc (sample ~ 8m below ground surface) ⇒ SUP.
 - sparse brn. gyp on frc.

MAIN FEATURE: 1.5 x 0.5 cm vug w/ euhedral qz growing cavity.

II. MICROSCOPIC DESCRIPTION:

NO POLISHED SECTION MADE.
 (INSIGNIFICANT MINERALIZATION)
 AREAL PERCENT:

A. PHASES PRESENT:

B. TEXTURES:

C. FACTORS AFFECTING BENEFICIATION:

BROWN MCDADE ZONE

SAMPLE NO.: 127A

HOLE NO.: 88-127

Au (oz/ton): 1.046

COORDINATES: 0T66N/151W

Ag (oz/ton): 3.35

AZIMUTH: 067° 45'

WIDTH: 0.60 m

ANGLE: -50°

INTERVAL (m): 89.93 - 90.53

I. HAND SPECIMEN DESCRIPTION:

BRECCIATED QZ VEIN: lt gy-wht qz vn, brecciated (w/some rotation of frags), infilled w/ dk gy silicified matrix. Z events silicification?

dk gy to white bx, str qs to str. silic alt. FRAGS: angular 0.5cm to 3cm, wht-gy in a zone ~ 70° .3cm wide. Resembles vn on core side, shattered bx frag on cut side. Py 0.5-3mm (avg. 1mm) (29%), streaked w/ dk gy fine py-(asp?) ribbons ~ 5mm x 0.5mm. Frags 50%.

MATRIX: dk gy, sl. mottled w/ wht. qz nodules, unmin. (20%). Fine (1%) py 0.1-1mm (avg. 0.2mm). Bleb in one corner of cut specimen had ~ 20% syl asp (avg. ~ 0.5mm), red-brn gypsum infill on frz, infrequent ca vn (0.5cm wide), continuity appears to be cut by microfrc.

127A:

II. MICROSCOPIC DESCRIPTION:

A. PHASES PRESENT:

AREAL PERCENT:

py.
asp.
gn.
sl.
* + ? see sketches,
over...

B. TEXTURES:

py: healed w/ + ? weak to med. anis.

- euhedral to subhedral, 0.01 - 0.5mm

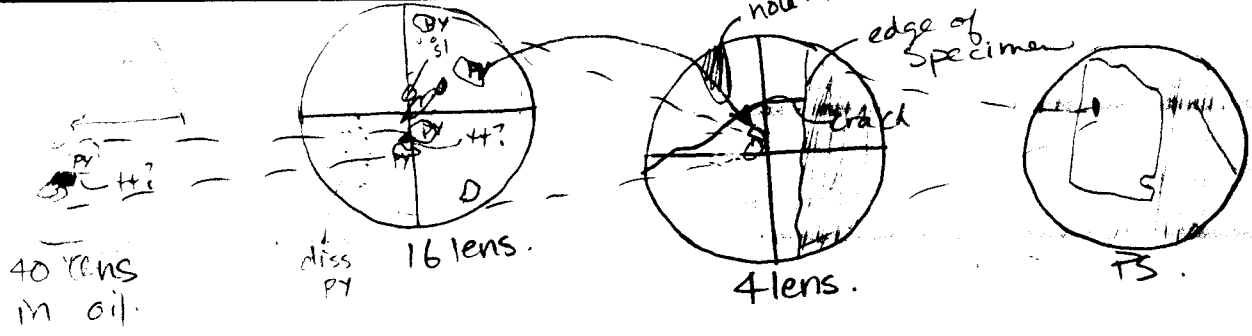
asp: euh to subh, sl. lighter colour than py, 0.01 - 0.5mm

sl: shapeless blebs, adjacent to py, assoc. w/ gn, cp inclusions irregularly distributed

C. FACTORS AFFECTING BENEFICIATION:

med pow. fov ≈ 1.3mm

11?



BROWN McDADE ZONE

SAMPLE NO.: 127B.

HOLE NO.: 88-127

Au (oz/ton): 1.046

COORDINATES: 0+66N /151W.

Ag (oz/ton): 3.35

AZIMUTH: 067° 45'

WIDTH: 0.60 m.

ANGLE: -50°

INTERVAL (m): 89.93-90.53

I. HAND SPECIMEN DESCRIPTION:

see description for sample 127A

127B: Frag-matrix boundary

II. MICROSCOPIC DESCRIPTION:

76 sulphides ≈ 15%

A. PHASES PRESENT:

AREAL PERCENT: OF sulphides.

Py	-broken up, anhedral 0.1-1mm.	60%
asp	-anhedral □, 0.05-0.1mm, and broken up -growing on py rims.	30%
gn	: irreg. grains w/ang. frs, assoc w/py, asp,	3%
sl	: irreg. sp. incl. 0.05-0.1mm. assoc w gn, ss ②, dg.	4%
① ss	: H? gy, isotropic R ₂ asp, & ss ②. -irreg. grains, look chewed up.	7 ss ① < ss ② 1%
② ss	: H? gy, anisotropic, irregular grains ~0.1mm R ₂ & gn. incl. in py - appears to alt to Cu-ss in assoc w/py.	1%
③ Cu-ss?	: as in 132A, w/ ss ② + grn bintl - dg. R: 25-30.	Cu-ss x ss ① 1%
prob. bn	: supergene, adjacent to sl, & ss.	< 1%

B. TEXTURES:

C. FACTORS AFFECTING BENEFICIATION:

@Cu-ss assoc. only w/ ②ss (Pb, Sb, sulphide) → also this combo seen in 132A.

37 - many sulfides much finer than microscopic texture.

two phases: ++ and ?

- see looseleaf sheet @ front for PIC.

BROWN McDADE ZONE

SAMPLE NO.: 129

HOLE NO.: 88-129

Au (oz/ton): 0.365

COORDINATES: 1400N / 1169W

Ag (oz/ton): 0.80

AZIMUTH: 067° 45'

WIDTH: 0.65m

ANGLE: -50°

INTERVAL (m): 115.12-115.77m

I. HAND SPECIMEN DESCRIPTION:

SILICIFIED PYRITE BRECCIA: wall rock frag.

Bx w/str silic alt. mainly dk gy str. silic. matrix (~60%), w/ lighter gy, ang. fragment ≥ 4 cm ~ QS alt. (portion of clast seen on spec.). FRAGMENT: ppyr? li vugs 1-3mm w/ fine remnant py (1%). MATRIX: mottled dk gy w/ lt. gy & z. nodules (~40%) 1-5mm. Poss two stages py?: coarser grained ~1mm (2%), v.f.g. py (0.1mm), neither follow any obvious pattern. %OX: wk to mod li plus pitting \Rightarrow ~30% ox.

li, gy \rightarrow coarser on fr

II. MICROSCOPIC DESCRIPTION:

A. PHASES PRESENT:

PY

AREAL PERCENT: (of sulfides)

80%

? - gy, R \approx 35, isotropic, no IR's, irreg. blebs in py, h < py. - numerous incl. in grains throughout section.

? Au⁰ - R \gg py, grain incl. in py, ~ 1/40 of high pur. ϕ . (~0.01mm?). Three grains seen in one field of view. Subang, yellow-wht. 1 grain seen on edge of smaller (py grn ~ 1/25 hi pur ϕ , other 2 grains in py grn ~ 1/6 of hi pur ϕ).

B. TEXTURES:

Au #1 occurrence: different from the other four:

- Au invading crack in py - others have been inclusions
- clumping around fine py grains

\rightarrow if you looked at this sample alone, would say that Au did not occur w/ py.

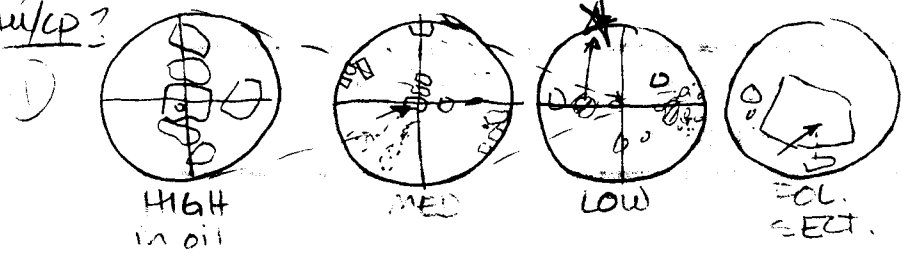
but - one small hb Au included in py - small ~~etc~~ square

C. FACTORS AFFECTING BENEFICIATION:

Au⁰ incl. in py - poor rec. grain off of large one.

R77 PY : Au

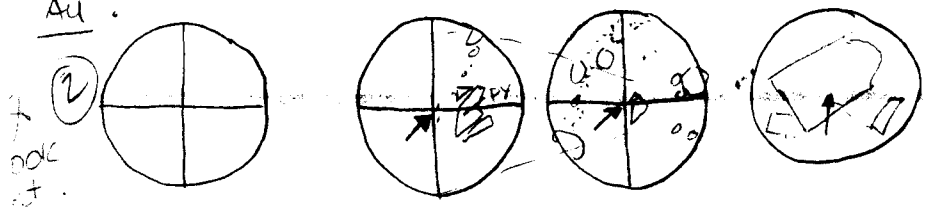
Au/cp?



Size: 0.01mm

small blobs
- in
could be...

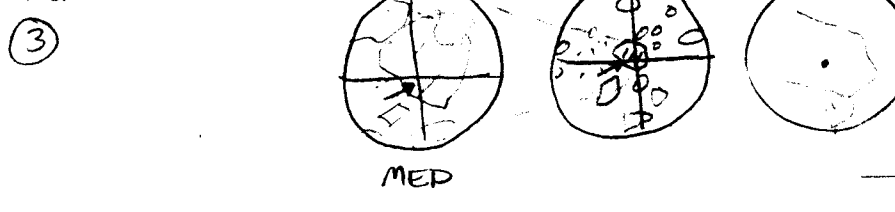
Au⁰?



Found...
NO

Size: 0.04mm

Au⁰



→ quite close to Au⁰, towards Au⁰

Size: 0.03mm

Phase in py grain adjacent to Au⁰ (see photos)

~~R~~ ⇒ qz.

- Bi, Pb phase (re: SEM work) could not be found

BROWN MCDADE ZONE

SAMPLE NO.: 132 A

HOLE NO.: 88-132

Au (oz/ton): 0.883

COORDINATES: 0+66N/180.5W

Ag (oz/ton): 21.00

AZIMUTH: 067°45'

WIDTH: 1.52 m

ANGLE: -50°

INTERVAL (m): 120.40 - 121.92

I. HAND SPECIMEN DESCRIPTION:

ALTERED Gd / POLYMETALLIC SULPHIDE BRECCIA.

For the most part, interval appears to be QS to silic alt gd, w/ small zone of polymetallic sulphides. Gd (?) QS to silic alt, py in elongate blobs in matrix, v. heavy, coarse py in fr, likely incr towards poly met. S. zone. Euhedral gz 1-2 mm, heavily infilling fr. in one spec.
 Polymetallic sulphide species: Bx? It. gy swirly gz (w/v. heavy py (25%) frags, rotten matrix (~25% of spec) w/ heavy sl (40% of matrix), gn (30%) w/ anglesite, ss (15%), py (10%), qyp, li. (5%). ~10% ox. Euh. gz on some fr faces ~1-2 mm.

II. MICROSCOPIC DESCRIPTION:

A. PHASES PRESENT:

AREAL PERCENT: (of sulfides)

Pv		85%
PROBE X ss? anis, Px 40 HcPy irreg. blobs		20%
interstit. to py & mo		5
- no cleavage or twinning.		
Au°		<1%
li		

B. TEXTURES:

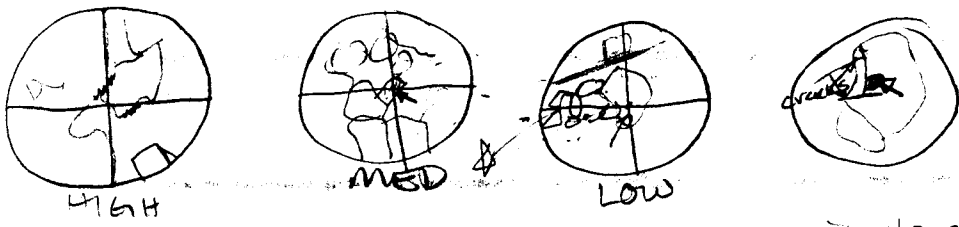
Au°: 1 grain, interstitial in gz ~0.02 mm, proximal to py-sl.
 ① pale yellow - could be cp - but none seen yet on Brown McAdade.
 (see location diagram, over)
 - also 2nd grain w/ gn? or asp (see over) ~0.2 mm
 - both grains sl. anisotropic.

S S Mystery phase: soft, mod - strong anisotropism R 25-35. (likely 730%), some annealing textures, anisotropy gy to pinkish gy-brn, invades fr in py and is interstitial to it.
 Barroisite or Meneghite - grey in colour - no obvious cleavage or fracture.
 → may be same as It gy anisotropiz min in 127B → SEE SEM. Pb, Cu, Sb.

C. FACTORS AFFECTING BENEFICIATION:

in sufficient cataclasm & gold has not been sufficiently exposed for good Au rec.

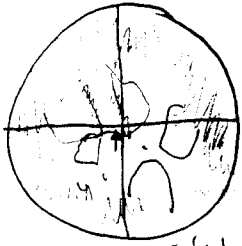
Summary: two events of pyritization ① - large, euh-sub grains 1-3 mm assoc w/ gn and Au min, ② finer, euh grains 0.5 mm along fr in ga no assoc w/ other min.



Phase 1: grn-bm R ≈ 25-30, mod axis to qy-grn.
 minute grains on edge of PY, growing into Phase 2.
 Danite: - Cu-ss? - p. 90, 98, ore tables.

Phase 2: mystery mineral, over

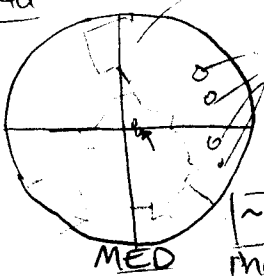
③ Au°



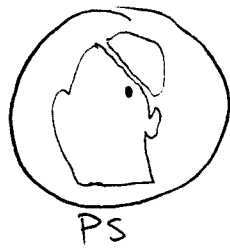
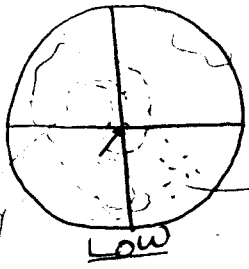
Don edge of grain
 ① in PFC to left of ①
 ② in PFC to right of ①

Low in D's lab.

① Au°

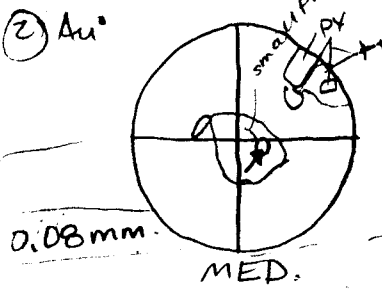


coarse PY
 fine PY
 2 v. small chunks
 ~ 0.02 mm
 mel in PY



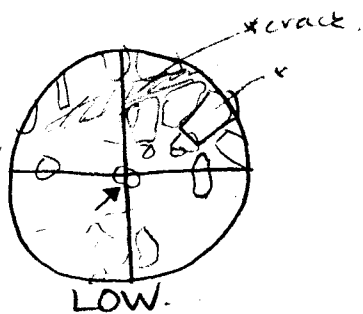
Size ≈ 0.008 mm

② Au°

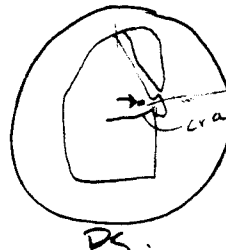


0.08 mm

MED.



LOW.



PS.

~ 3 mm from section edge

Size ≈ 0.02 mm

by 6 two points - ① large gr
 ② sm. gr along qz fr

BROWN McDADE ZONE

SAMPLE NO.: 132 B

HOLE NO.: 88-132

Au (oz/ton):

COORDINATES:

Ag (oz/ton):

AZIMUTH: 067° 45'

WIDTH:

ANGLE: -50°

INTERVAL (m):

I. HAND SPECIMEN DESCRIPTION:

see 132A description.

II. MICROSCOPIC DESCRIPTION: 70 sulf & 20%.

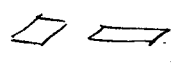
A. PHASES PRESENT:

AREAL PERCENT (sulf)

sl - large grains + broken frags	70%	
gn - w/++ sl, str. body's w/sl. - incl. in ++?	7%	
py - in frags. - cubic + irreg. grains infrz. in gangue, incl. ++	10%	
cp - incl. in sl, minor incl. in ++	<1%	
++ - irregular grains 0.1-0.4mm inclusions of gn? cp, silver of sl.	10%	
asp - angular grains in gangue w/py, inclusions smaller than py.	2%	- also seen as angular frags in ++ grains.
covellite - blue, red anis. infrz. in ++ sl.	<1%	

digonite - sl.

B. TEXTURES:

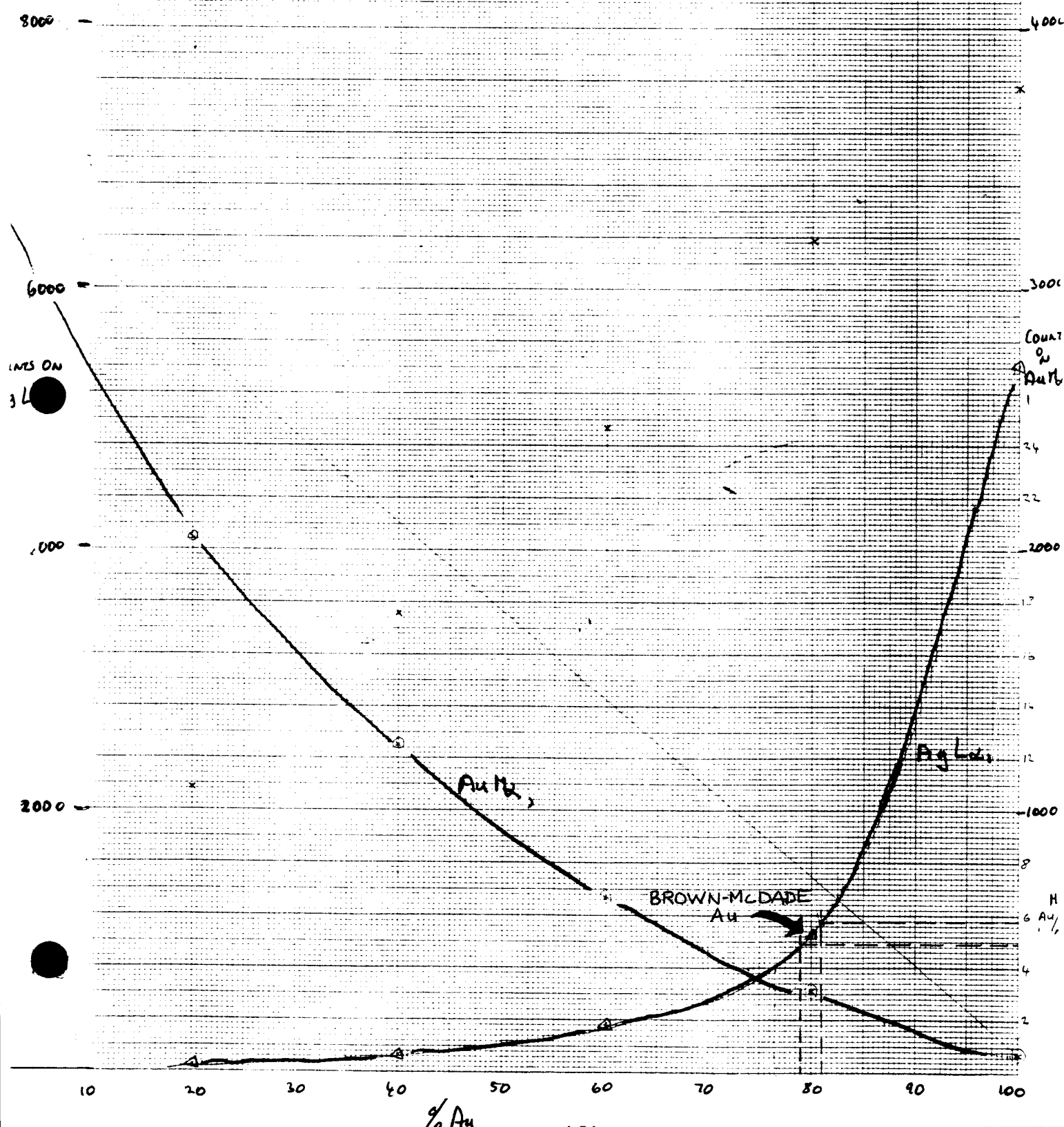
- ++: grains 0.1-1mm, irreg. shape, irreg. cracks throughout, infill w/dg. being repl. by py? ang. gr. asp in some grains, occ. cp inclusions
- sl: bulk of specimen, stippled w/cp, boundaries w/other sulphides mostly highly irreg, frz infill w/gz. cp incl generally irreg, but show occ. linear trending.
- py: some sl incl. 0.1-1mm, irreg. + cubic, some grains quite rounded.
- asp: angular and tabular grains 

C. FACTORS AFFECTING BENEFICIATION:

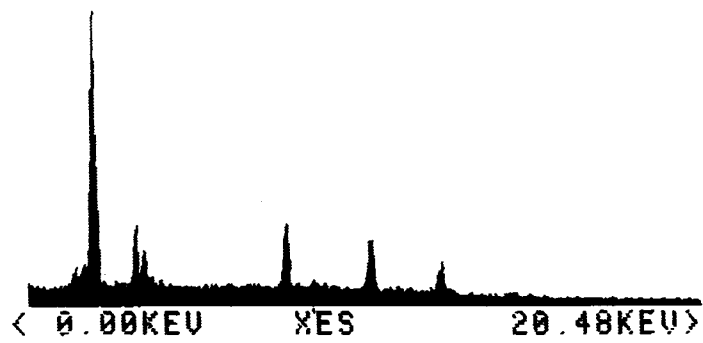
No Au⁰ seen.

APPENDIX III. SCANNING ELECTRON MICROSCOPE DATA

FIGURE FOR ESTIMATE OF PERCENT COMPOSITION OF GOLD
 (Accuracy considered to be $\pm 1\%$)



127 A — dark grey phase Z=00
 PR= S 19SEC 38490 INT
 U=2048 H=40KEV 1:1H AQ=40KEV 1H



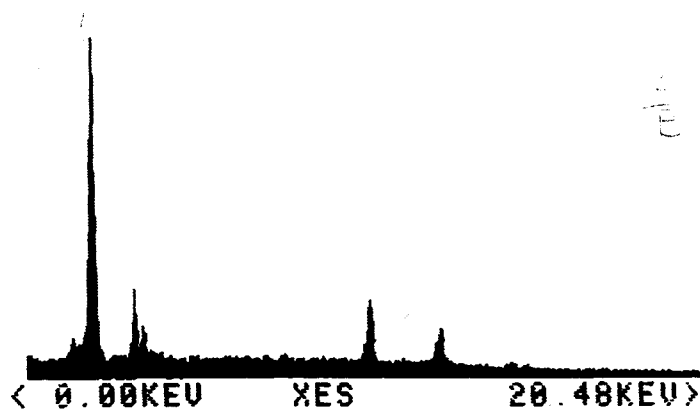
\downarrow
 Cu Pb Cu Sb Bournonite?
 PbCuSbS₃
 S Most Likely Present?

Minerals Meeting Elemental Criteria

Mineral Name	Formula
Bournonite	Cu Pb Sb S ₃
Mammothite	Cu₄ Pb₆ As Sb O₂ (Sb₂)₂ S₁₄ (OH)₁₆
Meneghinite	Cu Pb ₁₃ Sb ₇ S ₂₄
Nakaseite	As₃ Cu Pb₄ Sb₁₂ S₂₄
Senadorite	Ag₂₄ Cu₂ Pb₂₀ Sb₇ S₁₄
Unnamed	(Cu,Fe) ₄ Pb ₂ (Sb,As) ₂ S ₉

Sample 127A: The dark grey, isotropic phase was determined to have unknown amounts of Pb, Sb, Cu, and likely S. The mineral is very likely bournonite, as meneghinite is quite strongly anisotropic, and the other named minerals listed also have Ag in their composition.

127 B - light grey phase. Z=00
 PR= S 17SEC 39011 INT
 U=2048 H=40KEV 1:1H AQ=40KEV 1H

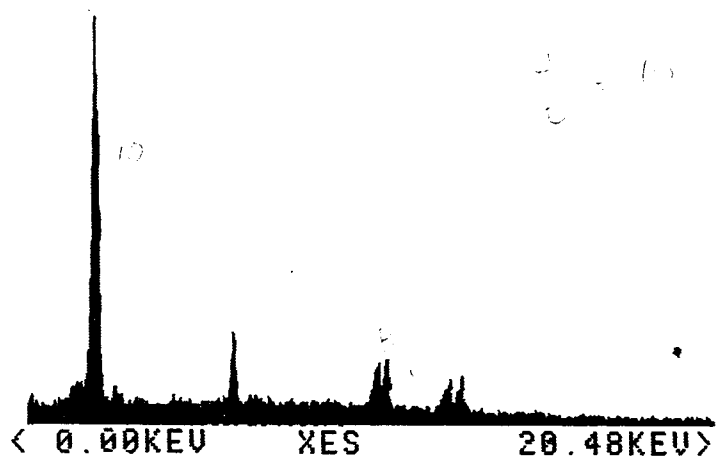


Handwritten marks: A circled 'S', 'Sb', and 'Pb' with checkmarks, and a circled 'Ar' with a checkmark.

Mineral Name	Formula
Ardaite	Pb19-20 Sb12-24 S24-36 Cl6-8
<u>Boulangerite</u>	Pb5 Sb4 S11
Chabourneite	Tl21-x Pb2x (Sb,As)91-x S147
Dadsonite	Pb21 Sb23 S55 Cl
Falkmanite	Pb5.4 Sb3.6 S11
Franckeite	Pb5 Sn3 Sb2 S14
Fulcopite	Pb3 Sb8 S15
<u>Geocronite</u>	Pb14 (Sb,As)6 S27
Guettardite	Pb (Sb,As) S7
Heteromorphite	Pb7 Sb8 S19
Jordanite	Pb14 (As,Sb)6 S27
Launayite	Pb22 (Sb,As)26 S61
Madocite	Pb17 (Sb,As)15 S41
Nacvanite	Pb5 (Te,Sn)4 S9-9
Placidonite	Pb5 Sb8 S17
Playfairite	Pb16 (Sb,As)19 S47
Robinsonite	Pb4 Sb6 S13
Serrevite	Pb7 Sb8 S13
Sorbyite	Pb19 (Sb,As)10 S49
Tammnite	Pb (Sb,As) S7
Unnamed	Pb Sb S S S S S S
Unnamed	Pb2 Sb20 As8 S18
Veenite	Pb1 (Sb,As) S7
Zinkenite	Pb8 Sb22 S57

Sample 127A: The light grey, anisotropic phase was determined to have unknown amounts of Pb, Sb and likely S. Little information is available on some of the minerals listed above. As this mineral is closely associated with bornite, boulangerite and geocronite were chosen as the most likely minerals because of their known association with Cu-sulphides.

MLK MODE! SELECT ELEMENT 0
 129 Au @ site Z=00
 PR= S 10SEC 23954 INT
 U=1024 H=40KEV 1:1H AQ=40KEV 1H



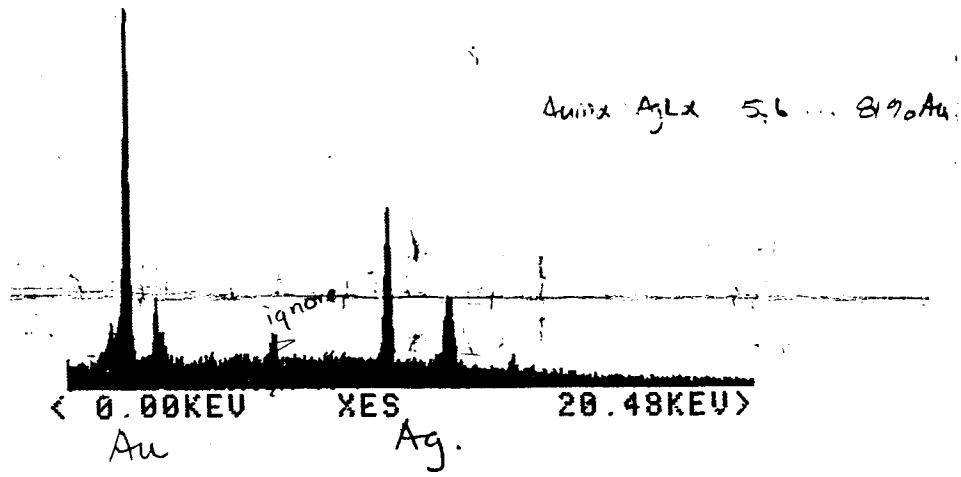
Handwritten notes:
 10
 1 2?
 SPURIOUS
 Bi Bi

Minerals Meeting Elemental Criteria

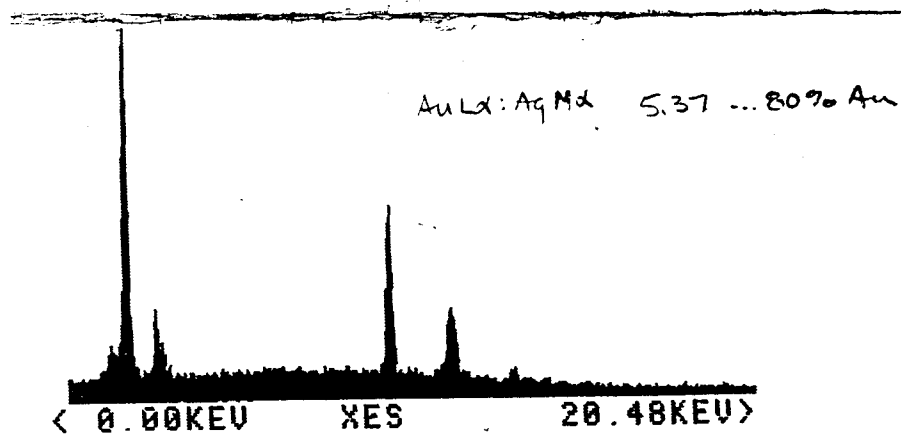
Mineral Name	Formula
Aschamalmite -	Pb6 Bi2 S9
Bonchevite -	Pb Bi4 S7
Bursaite -	Pb5 Bi4 S11
Cannizzarite -	Pb46 Bi54 S127
Cosalite -	Pb2 Bi2 S5
Galenobismutite -	Pb Bi2 S4
Kirkiite	Pb10 Bi2 As2 S19
Lillianite -	Pb3 Bi2 S6
Parkerite	4Bi (Bi,Pb)2 S2
Platynite	Pb4 Bi7 Se7 S8
Sakharovaite	(Pb,Fe) (Bi,Sb)2 S4
Unnamed	Pb2 Bi2 S7
Unnamed	Pb3 Bi4 S9
Unnamed	Pb4 Bi2 S9
Unnamed	Pb4 Bi5 S12
Unnamed	Pb4 Bi5 S13
Ustarasite	Pb (Bi, Sb)6 S9
Weibullite	Pb6 Bi8 (S, Se)18
Xilingolite	Pb5+x Bi2-2/3x S3

Sample 129: An inclusion in pyrite adjacent to Au #1 was seen during SEM work and was found to contain Pb, Bi, and likely S. The inclusion was not seen during subsequent examination under the microscope.

129 Au⁰ ① Z=00
PR= S 10SEC 31146 INT
U=1024 H=40KEV 1:1H AQ=40KEV 1H

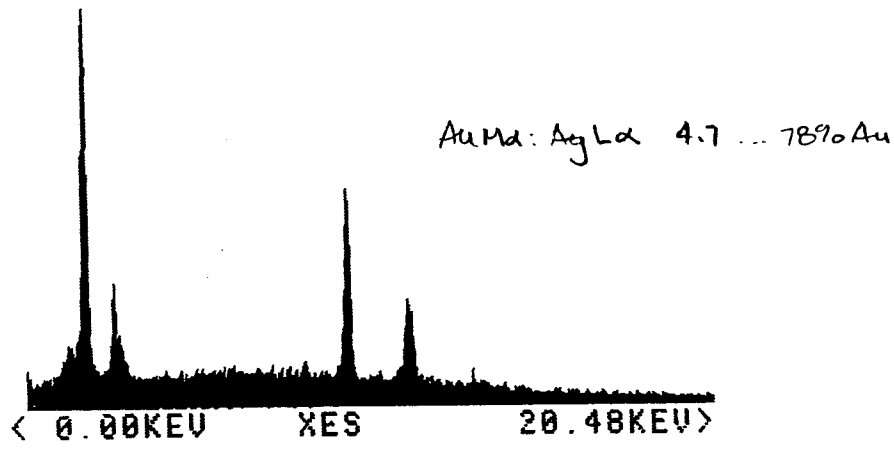


129 Au⁰ ② Z=00
PR= S 9SEC 29228 INT
U=1024 H=40KEV 1:1H AQ=40KEV 1H



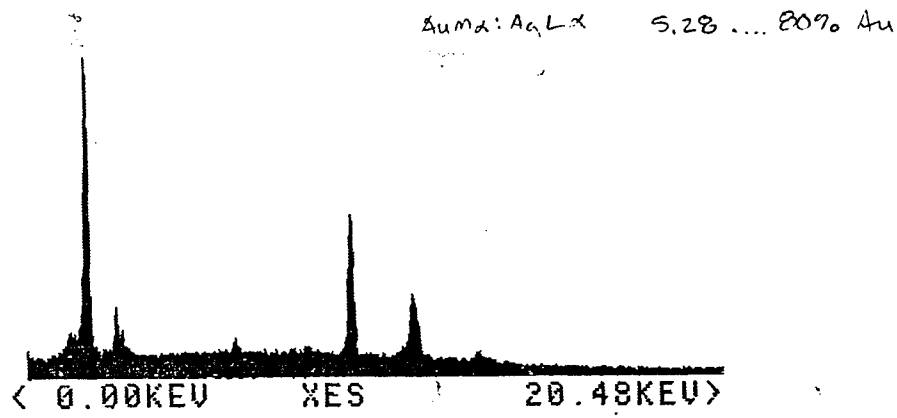
Sample 129: Gold grains.
Estimated Au Compositions: Au #1 - 81%
Au #2 - 80%

129 Au^o ③ Z=00
PR= S 11SEC 34490 INT
U=1024 H=40KEV 1:1H AQ=40KEV 1H

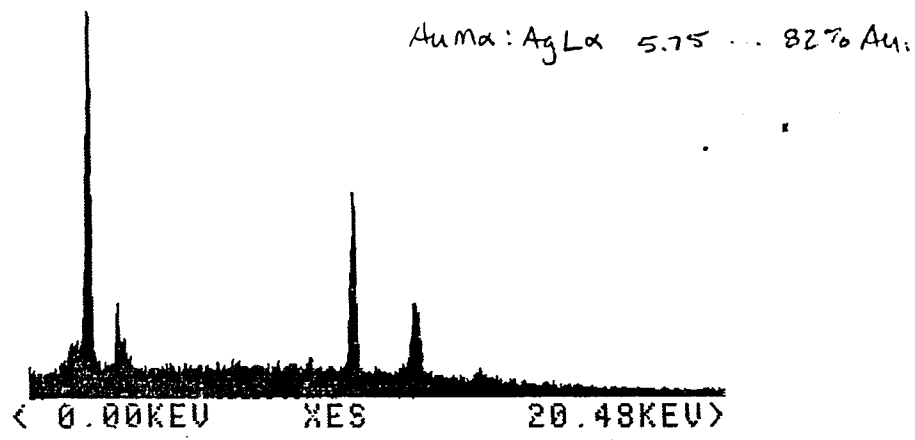


Sample 129: Gold grains.
Estimated Au Composition: Au #3 - 78%

MLK MODE! SELECT ELEMENT 0
132A Au^o ① Z=00
PR= S 36SEC 103678 INT
U=4096 H=40KEV 1:1H AQ=40KEV 1H



MLK-MODE! SELECT ELEMENT 0
132A Au^o ② Z=00
PR= S 21SEC 63169 INT
U=2048 H=40KEV 1:1H AQ=40KEV 1H



Sample 132A: Gold grains.
Estimated Au Composition: Au #1 - 80%
Au #2 - 82%

REFERENCES

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- Sawyer, J.B.P., and Dickinson, R.A. (1976): Mount Nansen, C.I.M. Special Volume 15, pp.336-343.
- Templeman-Kluit, D.J. (1984); Geology, Laberge (105E) and Carmacks (115I), Yukon Territory; G.S.C. Open File 1101.

Huss (1965) ref. p. 24