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REPORT ON THE MINERALOGY AND THE PARAGENESIS

OF THE LEAD AND SILVER CLAIMS

NTS 82J/4W

Lat 50 01 30N
Long 115 59 30

GOLDEN MINING DIVISION

FOR

OWNER/OPERATOR: Allan Ingelson

BY

Victor Q. Kakebeeke

GEOLOGICAL SURVEY BRANCH
TECHNICAL REPORT

November 30, 1999

26,145

TABLE OF CONTENTS

Introduction and Location.....	4
Property History.....	4
Regional Geology and Sample locations.....	5-6
Analytical Methods	7-8
Results.....	9-25
Paragenesis and Element Regression Values.....	26-38
Conclusion and Suggestions	39-40
References and Bibliography.....	41-42

APPENDICES

Appendix 1 Sample Locations.....	43
Appendix 2 XRD Results.....	44-46
Appendix 3 Sample Photographs.....	47-48
Appendix 4 Analysis, Scorodite and Pharmacosiderite.....	49
Appendix 5 Model analyses of sample 16.....	50
Appendix 6 Geology and Workings Map, Packrat Grid....	51
Appendix 7 Geological Map, Marmot Showings.....	52
Appendix 8 Geochemical Analysis.....	53-54
Appendix 9 Statement of Qualifications.....	55
Appendix 10 Costs.....	56

INTRODUCTION

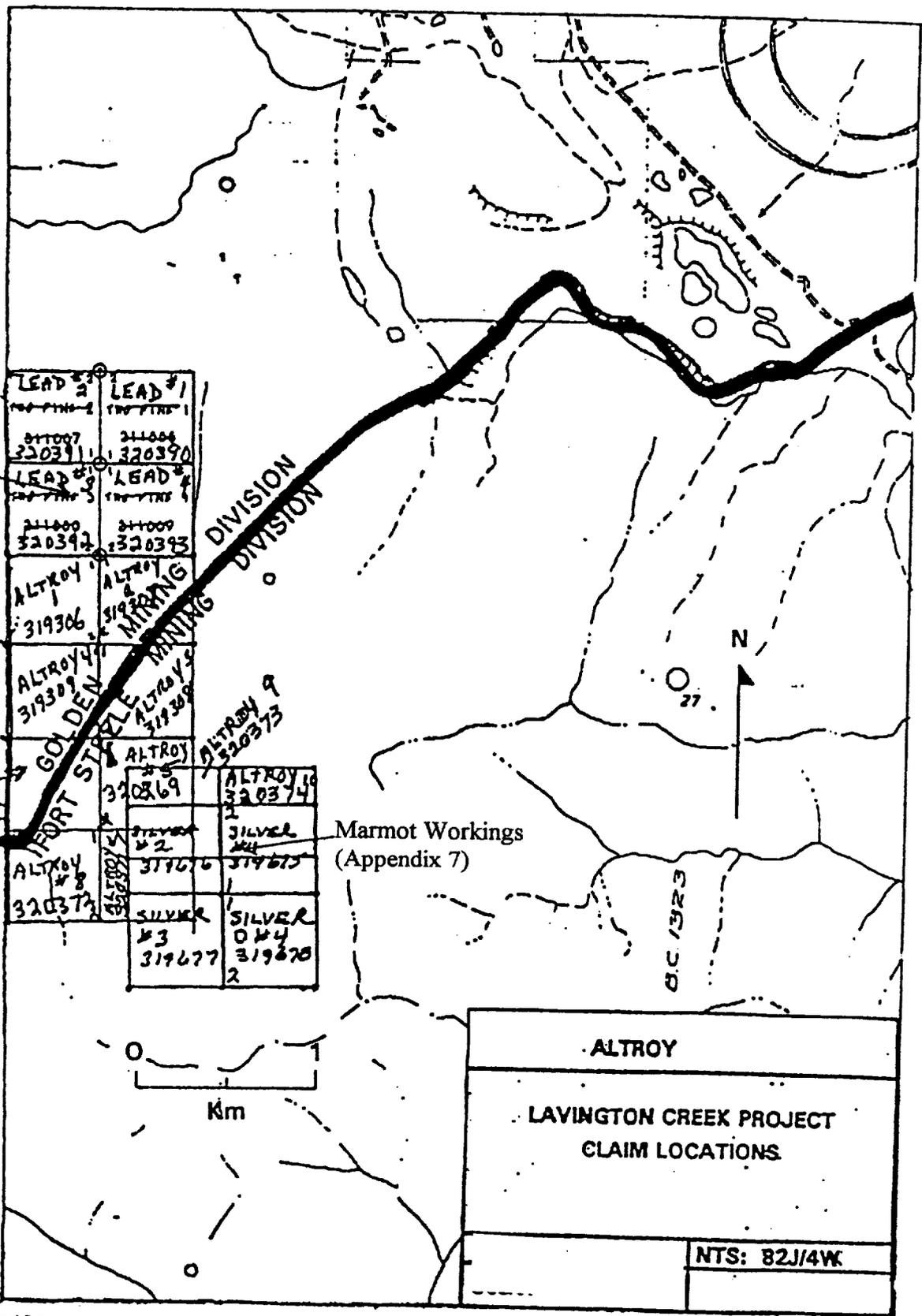
The Altroy Group consists nine claims and encompasses the "Lead" and "Silver" Prospects. The Lead prospect is located on a tributary of Lavington Creek, in the Purcell Mountains, on the west side of the Rocky Mountain Trench, twenty kilometres southwest of Canal Flats. Three adits are located on the Lead Prospect over which the Packrat grid has been established. Four kilometers north of the Lead Prospect is the Silver Prospect on which the Marmot grid has been established over a caved adit, trenches, and open cuts. The Altroy property is owned by Allan Ingelson. The area between the Lead and Silver prospects is forested and covered with talus boulders. The property is accessible by forestry road and trail from Lavington Creek or by helicopter from Invermere. This mineralogical study is to determine the minerals present and the paragenesis of the deposit.

PROPERTY HISTORY

During the period 1926 through 1934 three adits were driven along narrow quartz veins for sixty two metres, on the Lead Prospect (Packrat showings). Four kilometers north on the Silver Prospect (Marmot showings) during the same time period, trenching in the oxidized metasediments disclosed disseminated sulphide and oxide mineralization with silver values in the amount of 102 to 364 grams of silver/tonne, 0.7 to 1.4 grams of gold/tonne, 13 to 22% lead and 10 to 26% zinc. In 1993, D.Edwards and R. Falls mapped the adits on the Packrat Prospect and sampled the Marmot Showings. During 1995, Paul Whitby mapped the Marmot Prospect, and reconnaissance VLF-EM and magnetometer and geochemical surveys were completed.

5544000

North, Central and South Adits (Appendix 6)



50°00'00"
116°00'00"

REGIONAL GEOLOGY

The Altroy property is located 44 kilometers north of the Sullivan Mine a world class stratabound lead-zinc deposit. The mineralization in the metasediments on the Marmot Showings occurs in the Canadian lateral equivalent of the Revalli Group. A 58 million tonne stratabound copper-silver deposit (running 0.76% copper and 54 gm/tonne silver) is located at Spar Lake in the Middle Proterozoic Revett Formation, in northwestern Montana. (J.M. Hamilton and J. Balla, 1989 at p. 25). The Troy deposit is the largest concentration of copper within the Belt-Purcell rocks in the United States or Canada. Spar Lake is a complexly tongue-shaped deposit of parallel zones of copper and lead sulphides and authigenic gangue minerals. The ratio of silver to copper is consistently about 70 grams silver per tonne percent copper, throughout most of the Troy orebody. (Hamilton and Balla, 1989 at p. 30.) The zonal pattern consists of a northwest elongate tongue-shaped, chalcocite-bearing ore zone with fringing concentric zones of bornite, chalcopyrite, galena, and pyrite-bearing rock. (Hayes et al, 1989 at p. 322).

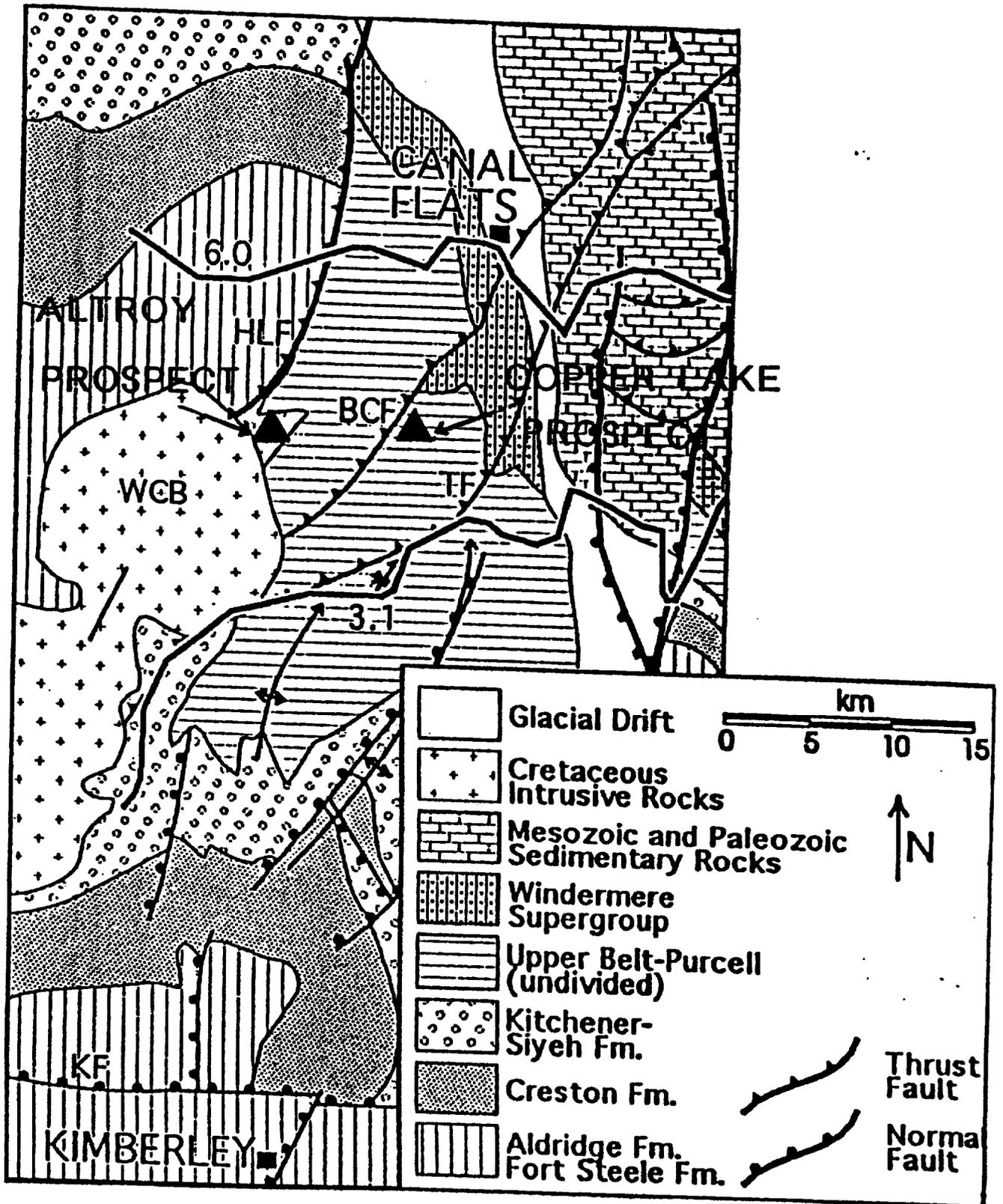
Edwards (1993) reported copper and lead sulphides in folded Creston and Kitchener metasediments on the Silver claims. Whitby (1995) noted current ripples, flaser bedding, scour and fill bedding on the Silver claims suggesting deposition in a shallow marine environment. In the Troy deposit two-thirds of the copper sulphides occur as blebs which parallel bedding, forset beds or layering in scour and fill structures. (Hamilton and Balla, at p. 30).

A second form of mineralization in the Troy Deposit consists of copper sulphides disseminated in 1 to 5 cm thick quartz veins. (Hamilton and Balla, at p. 30). In the adits mapped on the Packrat showings, lead, copper and zinc sulphides are disseminated in 1 to 5 cm thick quartz veins.

Recently D. A. Brown mapped the adjacent Findlay-Doctor Creek area, parts of 82F/16, 82K/1, (Geological Fieldwork 1997, Paper 1998-1). Brown notes that the Findlay-Doctor Creek area straddles in the central axis of the Purcell anticlinorium, a broad, gently north-plunging structural culmination cored by the Purcell Supergroup. The supergroup comprises a siliclastic and lesser carbonate sequence at least 12 kilometres thick, that initially accumulated in an intracratonic rift basin. Refer to figures one a two.

The Creston Formation in the Findlay-Doctor creek area consists of pale grey to green argillite with interlaminated greenish siltstone, and minor pale grey arenite. Lenticular and wavy bedforms, argillaceous rip-up clasts, and tectonically flattened mudcracks distinguish the Creston from the Aldridge Formation. The medium to thin bedded quartz wacke and argillite commonly displays a sericitic phyllitic foliation. Brown indicates that the formation was only examined around the Alpine showing and west of the Doc occurrence. In these areas discrete schistose shear zones and southeast-verging minor folds are common. Narrow (<10m thick), dark green mafic sills and dikes locally intrude the Creston Formation.

The Alpine/Rocky Top Property (Minfile 82KSE081) is hosted in rocks correlated with the Creston Formation, based on wavy bedforms, local abundant mudcracks, interbeds of argillite and faint green colour. It has been explored by Cominco Ltd. (Mawer 1986) and Tech Exploration Ltd. (Pautler, 1991). A moderately northwest-dipping sericitic phyllite shear zone hosts a shallow-dipping stratabound to slightly discordant zone of alteration comprising silicified, albitized and clay altered rocks with disseminated pyrite and lesser sphalerite and galena. A semi-concordant boudinaged quartz-ankerite vein in the shear zone with disseminated pyrite and irregular blebs of sphalerite and minor galena ranges from 20 cm to 2 m thick. The grade of the zone as reported by Mawer is 0.5% Pb and 0.6% Zn across a 3.5 m width and over the length, with a higher grade band containing 16 gm/T Ag, 2.2% Pb and 3.7% Zn (Mawer, 1986).



ALTROY PROSPECT

PROPERTY LOCATION
REGIONAL GEOLOGICAL MAP
OF CANAL FLATS - KIMBERLEY AREA
AREA, S.E. BRITISH COLUMBIA

NTS : 82J/4W
Fig. No.: 1

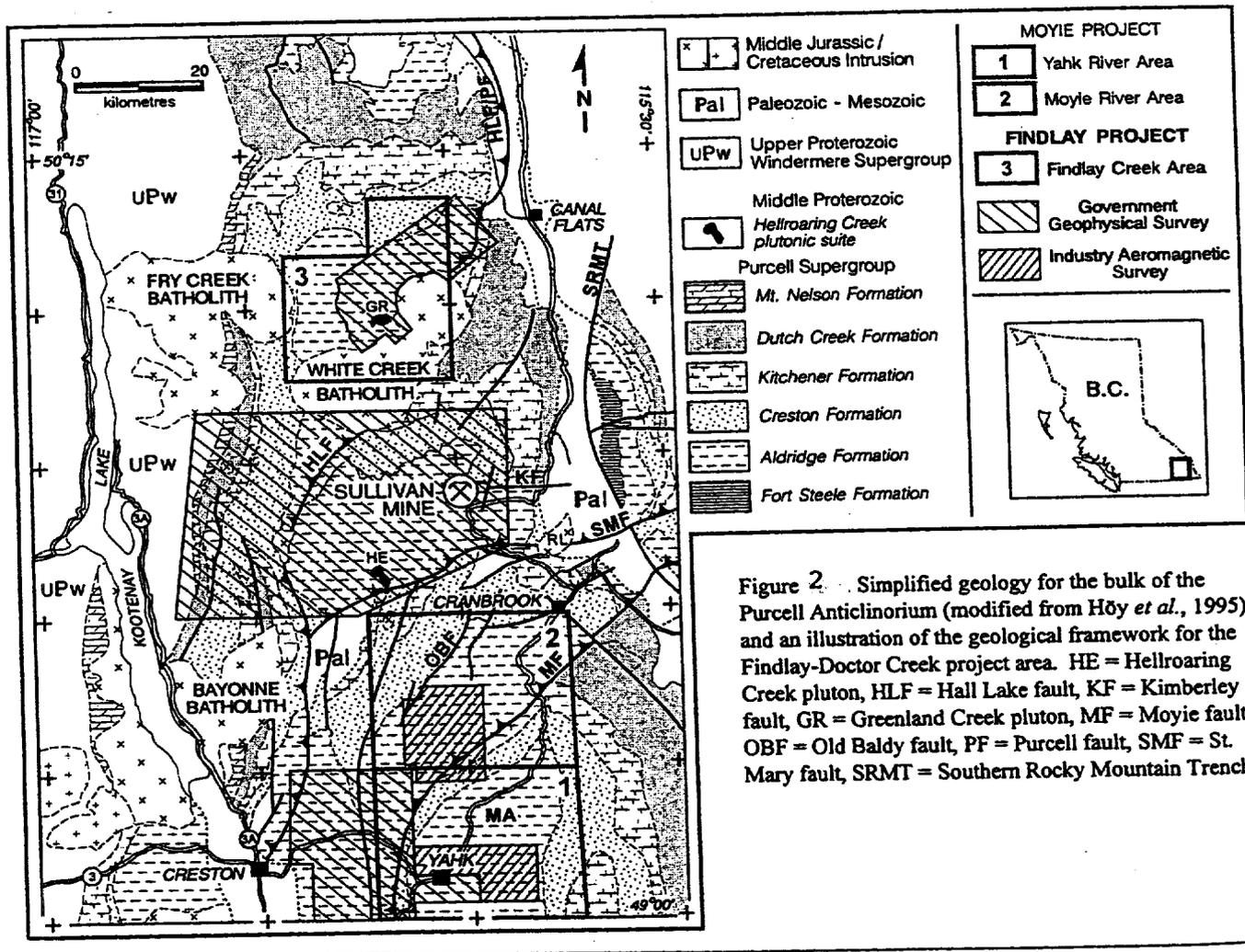


Figure 2. Simplified geology for the bulk of the Purcell Anticlinorium (modified from Höy *et al.*, 1995), and an illustration of the geological framework for the Findlay-Doctor Creek project area. HE = Hellroaring Creek pluton, HLF = Hall Lake fault, KF = Kimberley fault, GR = Greenland Creek pluton, MF = Moyie fault, OBF = Old Baldy fault, PF = Purcell fault, SMF = St. Mary fault, SRMT = Southern Rocky Mountain Trench.

British Columbia Geological Survey Branch

2.2 Geological location:

The rock samples come from two different geological locations.

One group of samples is taken from quartz monzonite intrusives and metasediments of the Creston formation located on the Packrat grid. The other samples are all metasediments which are located on the Marmot grid, fig. 3.

The first group samples comes from the Packrat grid.

The quartz monzonite intrusives are part of the White Creek batholith which had the last emplacement and (or) consolidation of the marginal zones around 126 Ma and the final consolidation of the leucocratic quartz monzonite core at 111 +/- 5Ma. Fluid movements through the batholith went on to 65 Ma, Wanless *et al.* 1968. This batholith consists out of concentric rings ranging in composition from quartz diorite, granodiorite to leuco-quartz monzonite and granites.

Chemical and mineralogical data for whole rock samples indicate differentiation of a homogeneous source magma apart from the leuco-quartz monzonite in the core. This leuco-quartz monzonite has different trace and isotopic data indicating that the magma is derived from a separate source and was emplaced during a unique intrusive event, Wanless *et al* 1968.

The metasediments on the Packrat grid are from the Creston formation as described below.

The second group of samples comes from Marmot grid.

Mineralisation in the rocks from the Marmot grid mainly occurs in the metasediments of the Creston and the Kitchener formation.

The White Creek batholith and the surrounding metasediments were previously mapped by Reesor in 1958. He found two types of metasediments which he divided into two formations: the Creston formation and the Kitchener formation. These can be found at different localities in the Purcell Mountains.

The Creston formation was originally deposited as an impure sandstone in a shallow marine environment, Reesor 1958. This formation has now been metamorphosed into a siliceous rich metasediment and has been overlain by the Kitchener formation.

The Kitchener formation was originally deposited in a shallow marine environment like the Creston formation but the Kitchener formation is more calcareous.

In the western part of the Marmot grid the metasediments are intruded by quartz monzonite of the White Creek batholith.

2.3 Method:

Equipment used for identification of minerals and textures:

- Swift and Research microscope,
- Scanning Electron microscope (SEM),
- Back Scatter Electron (BSE),
- Cathode Luminescence (CL),
- X-ray diffraction (XRD).

2.4 Research Microscope

Most of the research work on polished section and polished blocks was done in reflected light on the research microscope.

The research microscope was very good to observe different textures and for identifying the major minerals present and therefore providing good evidence for paragenesis.

2.5 Scanning Electron Microscope

The Scanning Electron Microscope (SEM) was used on carbon coated sections. This allowed identification of minerals on their atomic number, the higher the atomic number the brighter the mineral would appear.

An Energy Dispersive X-ray analysis system (EDS) provided printouts giving an analysis of particular mineral phases.

Samples from the Marmot grid were too altered to get a good polished section from. Instead identification of minerals was done on chip samples that were mounted on a stobe and coated in carbon. These chips were then analysed with the Back Scatter Electron (BSE).

Work on the research microscope was done prior to the use of the SEM this allowed time spend on the SEM to be much more efficient.

2.6 Cathodoluminescence

Cathodoluminescence is the emission of visible light from solid materials when bombarded by electrons, Finch 1992. The emission of visible light depends on the chemical and or physical nature of the materials.

Cathodoluminescence work was used to pick out features that otherwise would be missed under the research microscope and with the SEM for example the different stages of fluid movement. When using this technique it was easier to spot small minerals that occur as small inclusions in other minerals like muscovite because of their bright luminescing colours.

2.7 X-ray diffraction

The X-ray diffraction data was obtained from assay data produced by ACME Analytical Laboratories Ltd.

3. Results

List of plates

Plate 1	10* galena, sphalerite and sericite. Sample 2.....	10
Plate 2	240* sphalerite and schultenite. Sample 6974.....	11
Plate 3	210* hematite - kidney stone. Sample 8.....	12
Plate 4	135* scorodite, beudantite, sericite. Sample 65726.....	15
Plate 5	500* close up of plate 4. Sample 65726	15
Plate 6	100* zoned pyrite. Sample 2	17
Plate 7	5* chalcopyrite in sphalerite. Sample 4	18
Plate 8	690* zoned rutile surrounding apatite. Sample 2	19
Plate 9	500* covellite, galena, hematite, and chalcopyrite. Sample 2.....	20
Plate 10	20* same as plate 9	20
Plate 11	10* strain shadow, sericite & quartz. Sample 4	21
Plate 12	10* regular fractures in quartz. Sample 7.....	22
Plate 13	10* brecciated quartz. Sample 8.....	23
Plate 14	same as plate 13, ppl	23
Plate 15	4* alteration of galena, hematite. Sample 6	24
Plate 16	same as plate 15, ppl	24
Plate 17	20* pyrite growing in cavity surrounded by galena. Sample 2	25
Plate 18	20* cavity fill, galena & arsenopyrite. Sample 2.....	25
Plate 19	20* pyrite growing on arsenopyrite. Sample 2.....	27
Plate 20	5* arsenopyrite, sphalerite. Sample 2	27
Plate 21	10* exsolution of sphalerite in arsenopyrite. Sample 2	28
Figure 4	EDS trace of quenselite	13
Figure 5	EDS trace of hemimorphite	14
Figure 6	Drawing of sample 7	22
Figure 7	Paragenesis graph on sample 2	29
Figure 8	Paragenesis graph on sample 4b	30
Figure 9	Paragenesis graph on sample 6,7 & 8	31
Figure 10	Cadmium - zinc regression	34
Figure 11	Silver - copper regression	35
Figure 12	EDS trace of covellite.....	36
Figure 13	Silver - antimony regression	36
Figure 14	Arsenic - gold regression.....	37
Figure 15	Gold - iron regression.....	37
Figure 16	Gold - lead regression	38

3. Results

In this chapter minerals found with the research microscope, SEM and CL will be described.

3.1 Packrat grid samples

Arsenopyrite FeAsS

The arsenopyrite occurs as subhedral to euhedral rhomb shaped crystals that are white and weakly anisotropy. Individual crystals of arsenopyrite are up to 7mm long. Appendix 2.1.

Pyrite FeS₂

The pyrite crystals are subhedral to euhedral, cubic and yellow.

Galena PbS

The galena is anhedral and has characteristic triangular polishing pits. Galena was easily recognised under the SEM by its bright colour due to the high atomic mass.

Sphalerite ZnS

Sphalerite is anhedral with a distinct dark grey colour. In the quartz veins the sphalerite is often fractured but in the wall rock the sphalerite is not altered. The sphalerite in the wall rock contains less inclusion of chalcopyrite.

Quartz SiO₂

Inequigranular anhedral to subhedral quartz with undulose extinction is found in the base metal veins and in the hosting quartz-monzonite rock.

Muscovite and Sericite $K_2Al_4Si_6Al_2O_{22}(OH,F)_4$

Muscovite is found partially and completely sericitised and only occurs in the quartz-monzonite and not in the veins. The small individual sericite crystals are subhedral to euhedral.

The sericite in the wall rock is often associated with galena and sphalerite, plate 1.

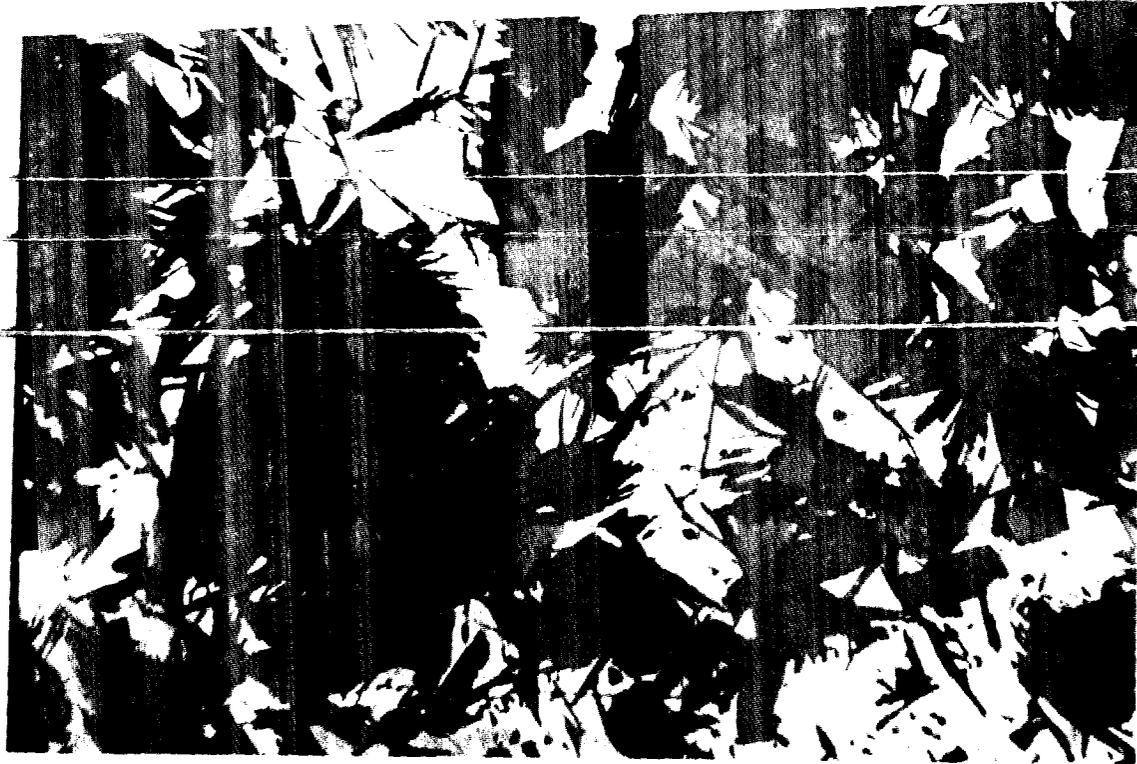


Plate 1.

Rutile TiO_2

The rutile was detected with the SEM and is found in the muscovite crystals that have undergone alteration. After the rutile was spotted with the SEM further microscope work in the quartz monzonite samples showed that rutile is very common in the muscovite crystals. But the rutile wasn't detected in the sericite. Appendix 2.2.

Apatite $Ca_5(PO_4)_3(OH,F,Cl)$

The apatite is often found in the muscovite as an inclusion but it is also seen as an inclusion in arsenopyrite. This is especially noted on the cathodoluminescence microscope where the apatite appears to be bright yellow and also shows zoning in some apatite crystals. Under the cathodoluminescent microscope there are also green and small blue/green minerals which could be apatite or tourmaline.

Monazite $(Ce,La,Y,Th)PO_4$

The monazite occurs as small inclusions in the muscovite. An EDS trace on the monazite indicates that there is also calcium (Ca), niobium (Nd) but no yttrium (Y), Appendix 2.3.

Zircon $ZrSiO_4$

Like the above three minerals the zircon is also found in the muscovite as a small inclusion.

Chalcopyrite CuFeS_2

The anhedral to euhedral chalcopyrite has a distinct dark yellow colour and is only found as an inclusion in the sphalerite.

Covellite CuS and Digenite Cu_{2-x}S

Both minerals have a distinct blue colour. Only one covellite mineral with strong anisotropic colours from orange to reddish brown was found. The isotropic blue mineral is digenite. Covellite and digenite are found in sphalerite as very small inclusions, appendix 3.1, and are probably supergene deposits.

Iron oxide ? hematite

This iron oxide was found in sample 6974 with the research microscope where the mineral appears violet to purple in colour. With the SEM an EDS trace was run on the mineral which showed that the mineral is an iron oxide and has minor inclusions of sulphur (S), lead (Pb) and trace amount of arsenic (As), plate 2 (dark grey lines in the fractures).

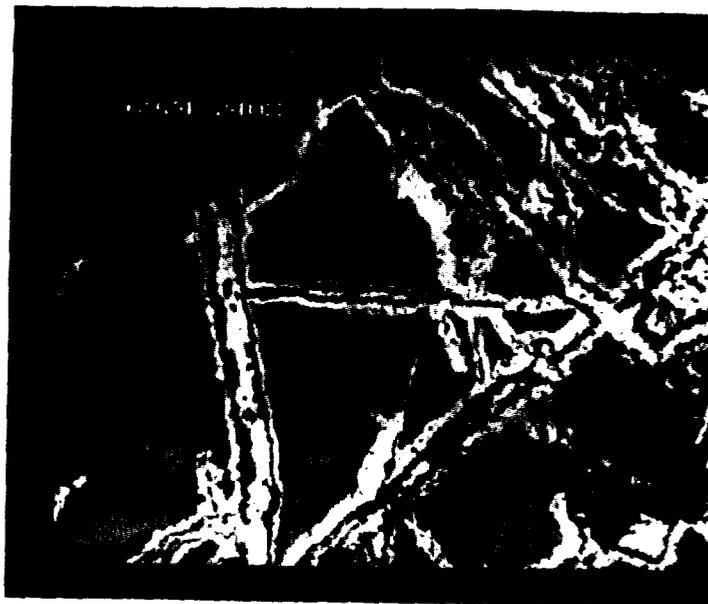


Plate 2.

Schultenite $\text{PbH}(\text{AsO}_4)$

The mineral is anhedral, appears grey under the research microscope. This mineral is found in association with arsenopyrite and in the fractures of the sphalerite, plate 2 (white mineral filling in fractures).

Angelsite PbSO_4

This mineral is brighter than the pyrite but duller than galena and is associated with galena which often appears as bright patches in the angelsite.

3.2 Marmot grid samples

Galena PbS

The galena found in the metamorphic samples is subhedral and always associated with hematite veins.

Quartz SiO₂

The quartz is inequigranular, allotriomorphic and occurs in aggregates of quartz which have a random orientation. Some of these aggregates are rounded and turned.

Muscovite and Sericite K₂Al₄Si₆Al₂O₂₂(OH,F)₄

The muscovite has been altered to sericite but in a greater extent than the muscovite crystals of the Packrat grid samples.

Hematite Fe₂O₃

The hematite is the main mineral in the metamorphic samples of the Marmot grid. From the EDS trace, appendix 2.4, it was found that there was a lot of iron present in this mineral which could indicate that this mineral is hematite or magnetite. The BS mode showed a typical kidney-stone shape, plate 3, and the red colour of the hematite veins on the CL indicates Fe²⁺, plate x. This proves that this mineral is hematite rather than magnetite.



Plate 3.

Quenselite $\text{PbMnO}_2(\text{OH})$

This mineral was detected with the SEM. On the BS mode an EDS trace was taken and it showed that there was lead (Pb), manganese (Mn) and minor amounts of zinc (Zn) present, fig. 4. A possibility is that this mineral could be magnetoplumbite $\text{Pb}(\text{Fe},\text{Mn})_6\text{O}_{16}$, but the amount of iron present in the analysed mineral is not enough for the mineral to be magnetoplumbite. This suggests that the mineral is quenselite.

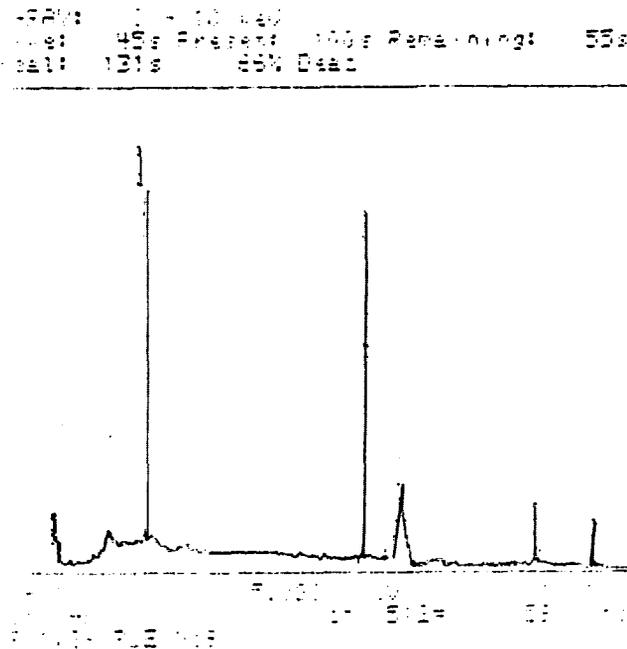


Figure 4.

Hemimorphite $\text{Zn}_4\text{Si}_2\text{O}_7(\text{OH})_2 \cdot \text{H}_2\text{O}$

Figure 5 indicates that there is a high silica and zinc peak and minor amounts of iron which is probably in solid solution with the zinc. From this information the mineral could also be willemite, Zn_2SiO_4 . But the crystals have a tabular habit and by leaving the electron beam of the SEM on the mineral for some time it creates a bright spot on the mineral surface indicating that this mineral might be a hydrate.

X-ray diffraction results from a sample collected from the open cut in the Upper Marmot Showings indicated that there is possibly hemimorphite present, Whitby 1996.

Argentite Ag_2S or Acanthite Ag_2S

These minerals are anhedral and are also the brightest minerals present under the SEM. Appendix 2.5.

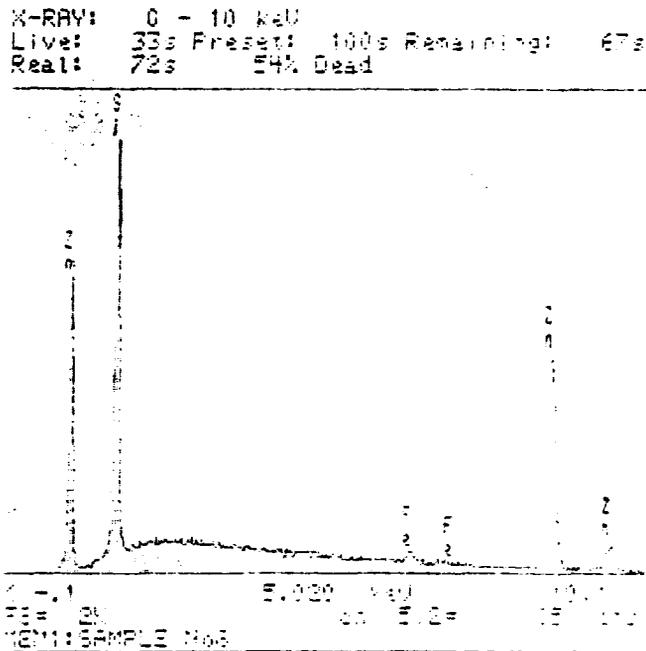


Figure 5.

Scorodite $\text{Fe}(\text{AsO}_4) \cdot 2\text{H}_2\text{O}$

This mineral is only detected in sample 65726 the mineral was picked up with the SEM, plate 4 (Centre, grey mineral). The EDS trace picked up iron, arsenic and oxygen suggesting that this mineral is a oxide. By leaving the electron beam of the SEM on the mineral for some time it creates a bright spot on the mineral surface indicating that this mineral might be a hydrate.

The handspecium of sample 65726 has light green to greyish-green patches which is typical for scorodite.

Scorodite is often found associated with pharmacosiderite but the average atomic number of pharmacosiderite is 19.38, appendix 4, and for scorodite it is 20.35 suggesting that the two different minerals have different brightness under the SEM. This is not the case in the sample analysed so scorodite is the only mineral present.

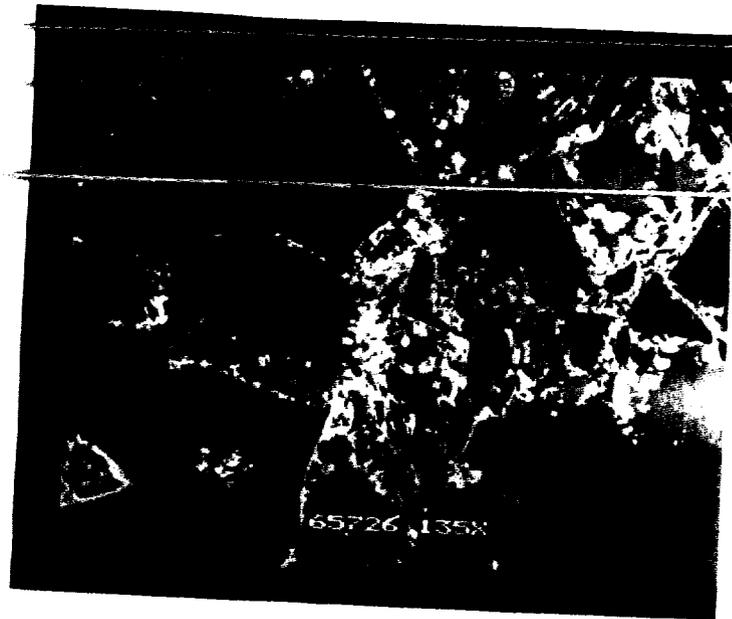


Plate 4.

Beudantite $\text{PbFe}(\text{AsO}_4)(\text{SO}_4)(\text{OH})_6$

This mineral is often associated with the scorodite and appears white under the SEM see plate 4 and 5. An EDS trace, appendix 2.6, showed that the mineral contains sulphur, lead and in some smaller quantities iron arsenic and aluminium suggesting that this mineral is beudantite.

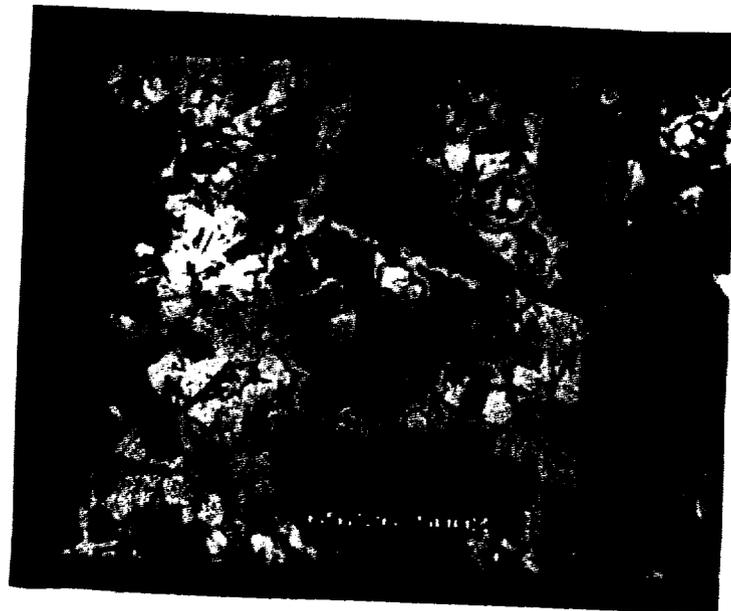


Plate 5.

Monazite (Ce,La,Y,Th)PO₄

In sample 65726 are about 5 anhedral monazite crystals that are up to 100μ long.

4. Textures

This chapter explains the textural relationship between individual crystal grains and groups of crystals. These textural relationships are used in the following chapter which is on the paragenesis of the ore mineralisation.

~~Both the Packrat and the Marmot samples will be described under different headings because of the large difference in texture between the samples.~~

4.1 Packrat grid

Zoning

Zoning in the pyrite was only recognised with the SEM. The pyrite was zoned with a brighter outer rim and a darker centre, plate 6. An EDS trace showed that the brighter outer rim was more enriched in arsenic, appendix 2.7.1 & 2.7.2.

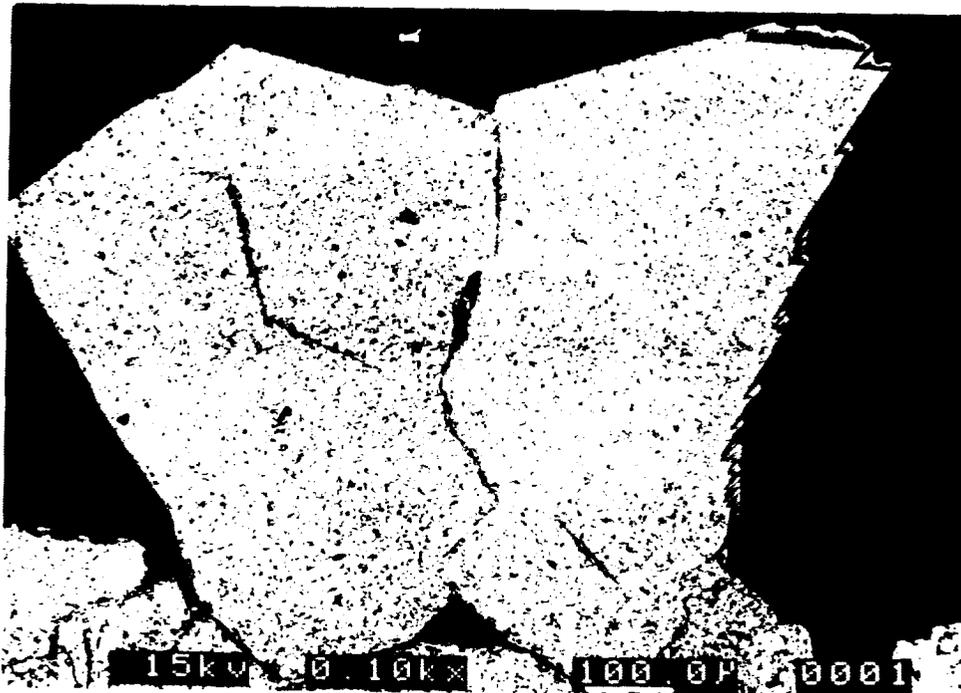


Plate 6.

The chalcopyrite inclusions in the sphalerite occur as lines which are sometimes at 90° to each other, plate 7. This could indicate the cubic growth of sphalerite. Another possibility is the exsolution of chalcopyrite along the cleavage plane of sphalerite during the cooling from a higher temperature ZnS-CuFeS₂ solid solution, Deer *et al* 1962. Both theories are possible but there is no evidence to support or disprove one of the theories.

The cubic growth zoning could be observed with both the microscope and the research microscope.



Plate 7.

Under the CL apatite crystals sometimes showed zoning. These apatite crystals are often found in the cleavage plane of the muscovite crystal.

Zoning also occurs in rutile crystals, plate 8, which is caused by the inclusions like neodymium (Nd) and iron (Fe), appendix 2.2.1 & 2.2.2. Observation with the SEM was the only way that the zoning could be detected. The zones in the rutile are not as regular as the ones observed in chalcopyrite, pyrite and the apatite.

Zoning is also observed in the beudantite, plate 5, where the bright outer zone and the centre are beudantite and the dark rim is sericite. This sericite rim has an unusual high aluminium peak compared with the silica, appendix 2.8, suggesting that substitution is taking place with the Fe³⁺ of the beudantite.

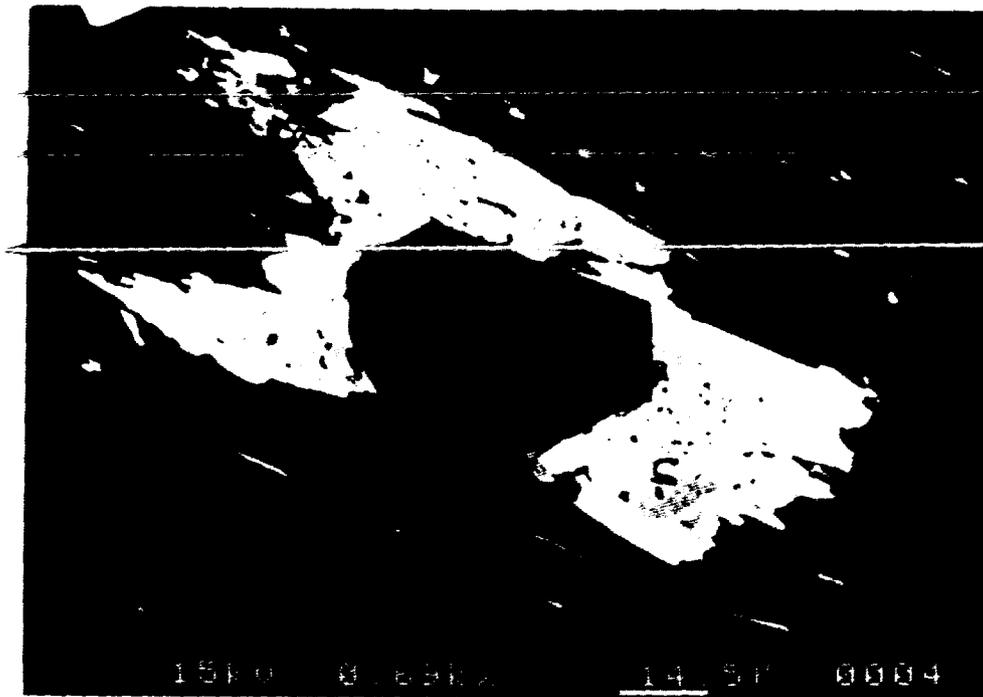


Plate 8.

Fracturing/Crustification

The sphalerite occurring in the quartz vein, sample 2, is highly fractured and in places filled in with different minerals at subsequent stages. This infilling of the fracture was first observed with the research microscope and later work on the SEM emphasised this fracture filling, plate 9 and 10.

The black hematite rim in the centre has been crystallised during the last stages of fracture filling, SEM photo (plate 9). Going out from the black hematite rim into the grey (that appears blue on the research microscope, plate 10) is a covellite rim. The brightest zone with the wavy texture on the SEM photo is galena. Chalcopyrite is found furthest away from the fracture and if the chalcopyrite is associated with the fracture filling then it was deposited first i.e. when the fracture opened.



Plate 9.



Plate 10.

The sphalerite in the vein deposits are fractured and the sphalerite in the wall rock is not fractured. In sample 6974 the sphalerite is fractured and filled in by three different stages of fluid movement. The first phase is associated with the precipitation of the schultenite, bright rim on plate 2, and the second stage is the iron oxide, dark rim, and the final stage is the precipitation of schultenite again.

Foliation

Foliation is seen in the muscovite crystals which are present in sample 5. The small elongated rutile crystals in the muscovite have been foliated with the muscovite.

Strain shadow

~~Plate 11, appendix 3.3, is an example of strain shadow. The quartz crystals are~~ surrounded by blue luminescing minerals which is sericite. All the sericite laths are parallel to each other indicating the strain direction.

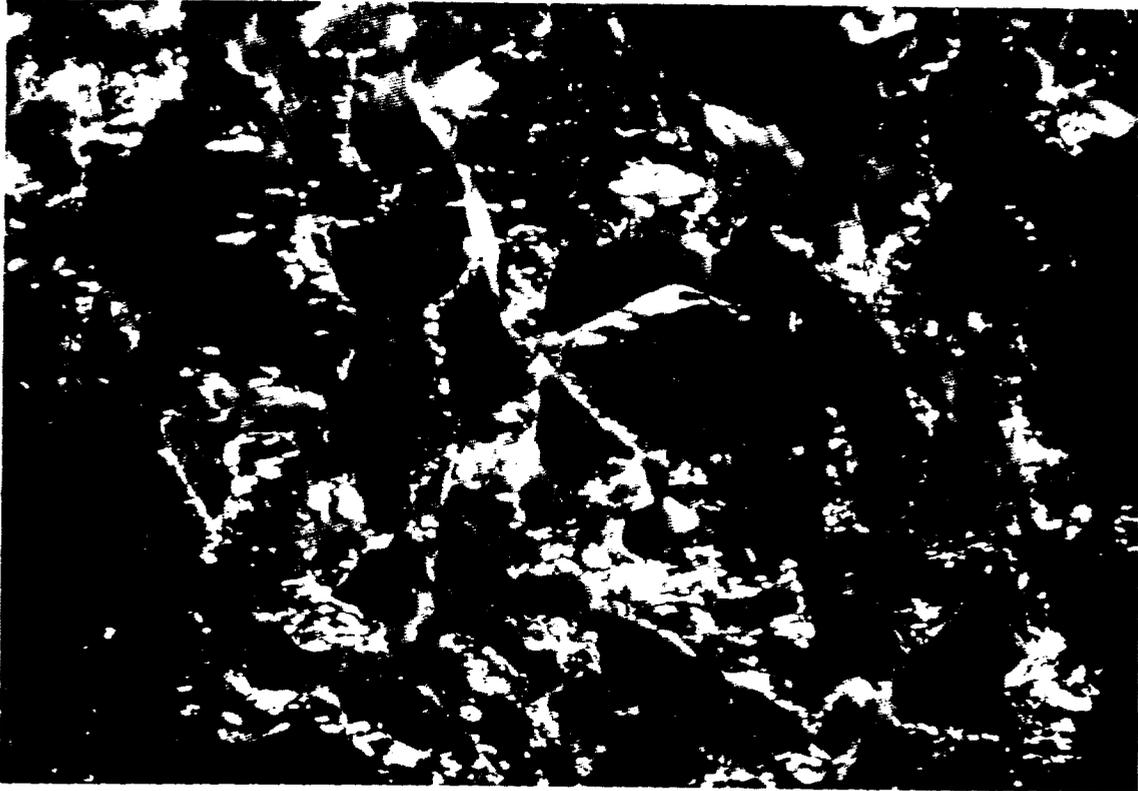


Plate 11.

Another strain feature was observed in the quartz crystals forming regular fractures, plate 12.

Evidence for strain is also seen in the quartz crystals, this is described under the heading of brecciation of the Marmot samples.

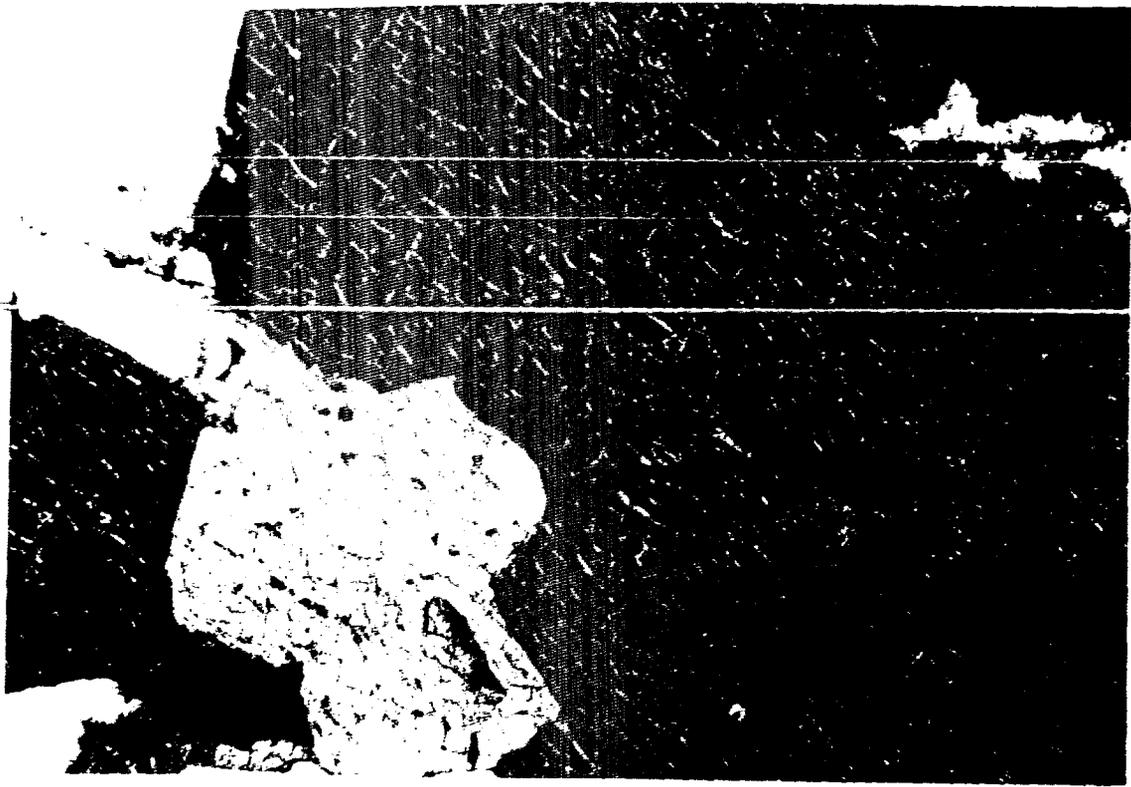


Plate 12.

4.2 Marmot grid

Brecciation

The brecciation is best seen in the handspecimen where it occurs in the hematite veins. The clasts in the veins are quartz clasts and have different shapes. In some clasts the quartz has got crystal boundaries and in others clasts the quartz has no crystal boundaries at all and appears to be sheared, appendix 3.2.1 & 3.2.2. The quartz crystals in the clasts do not show any overgrowth indicating that the quartz has not been formed during the fluid movements.

The clasts in the hematite veins range from rounded to angular and are in general up to 7 mm long and only 1 to 2% of the total number of the clasts are up to 31mm long, fig. 6.



Figure 6.

Under the CL brecciation occurs very clearly in the individual quartz crystals, plate 13 & 14, where quartz crystals with overgrowth have been fractured and are still optically the same. The space between the fractured fragments has been filled in with quartz again. This fracturing indicates that there has been a lot of strain.

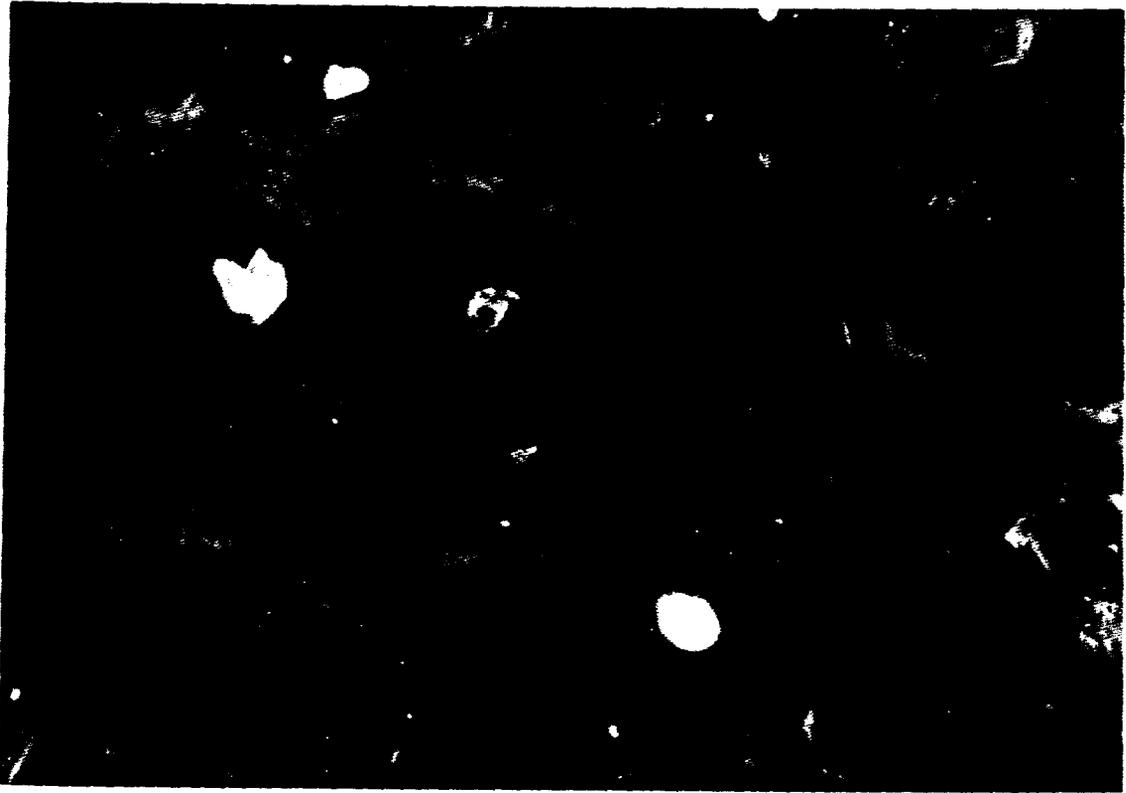


Plate 13.



Plate 14.

Alteration

Alteration of the galena crystals in the metasedimentary rocks appears bright blue on the CL, plate 15 & 16. The alteration product of the galena is always associated with hematite, red coloured under the cathodoluminescence microscope.

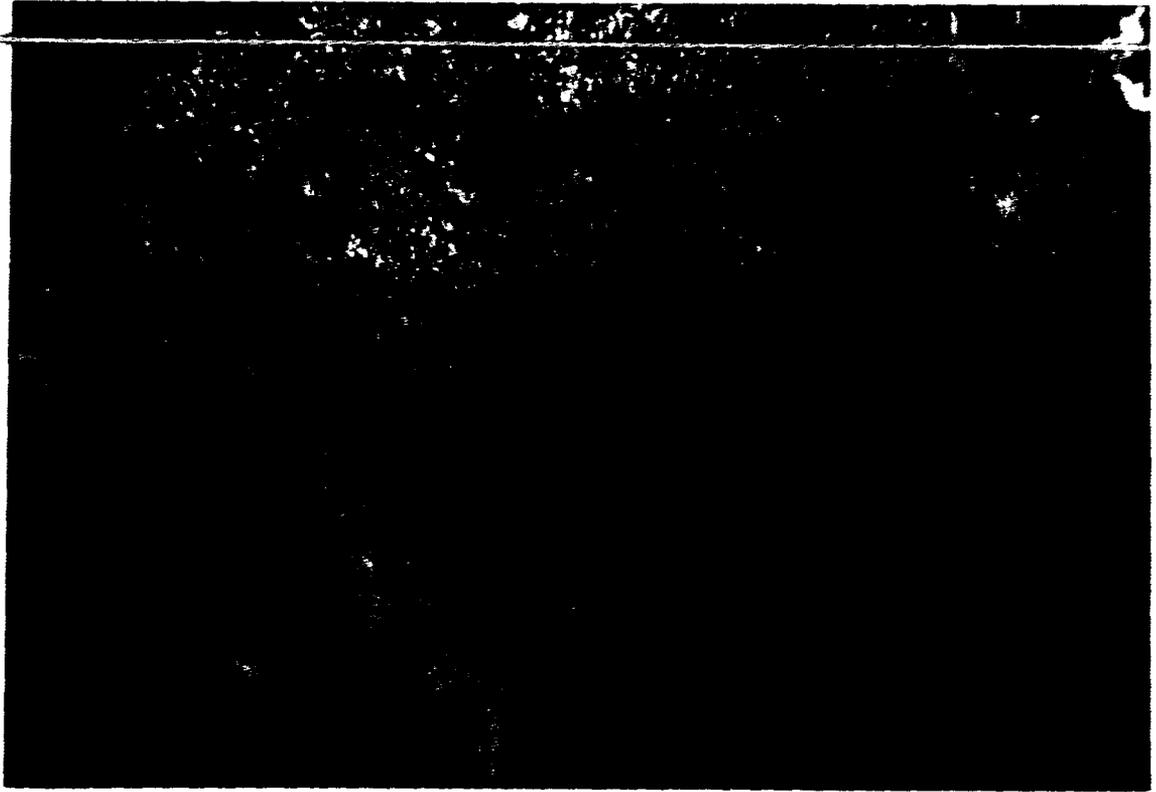


Plate 15.



Plate 16.

Cavity infill

Cavity infill is common in the vein mineralisation. The minerals that fill a cavity have an irregular crystal face often in contact with quartz and the crystal face that grows into the cavity forms euhedral crystal faces, plate 17.

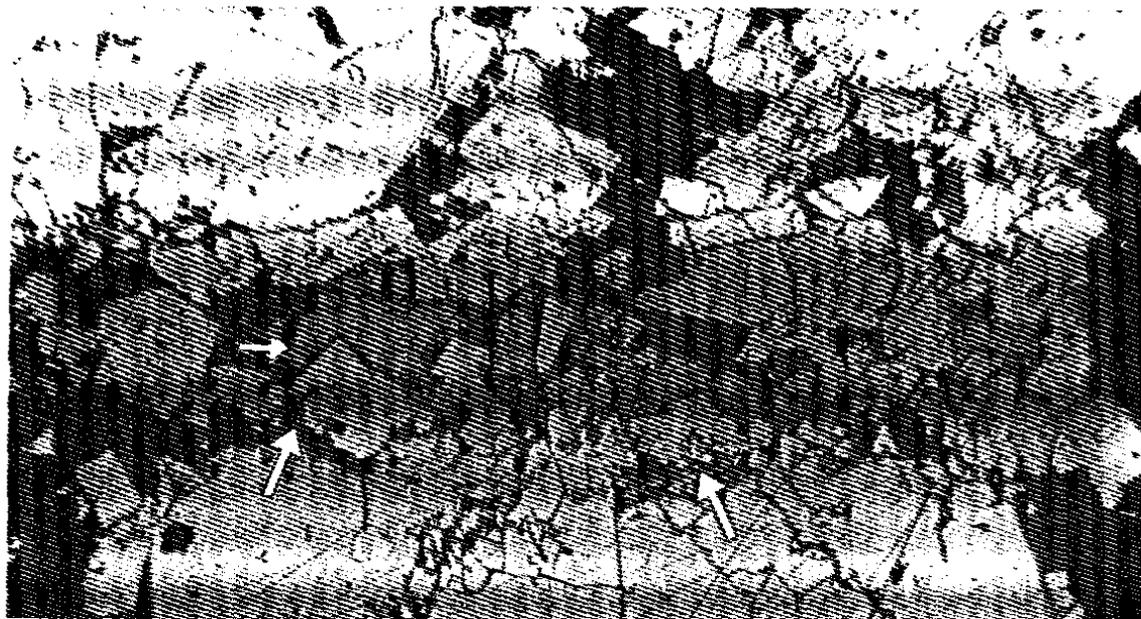


Plate 17.

Cavity infill is also seen in arsenopyrite crystals where the cavities have been filled with galena, plate 18.



Plate 18.

5. Paragenesis

This chapter will explain the stages of mineralisation by describing different samples of three different types of mineralisation which are: the vein mineralisation, mineralisation in the wall rock and the mineralisation in the metasediment.

The first type of mineralisation occurs in samples with vein deposits which have undergone different stages of mineralisation, sample 2 and 4, appendix 1.

The first stage of major vein mineralisation.

This first stage of mineralisation is associated with white, euhedral to subhedral rhomb shaped arsenopyrite crystals that are up to 7 mm long. Small sphalerite inclusions with irregular crystal faces are found in the arsenopyrite.

The sphalerite has also an irregular contact with the crystal edges of the arsenopyrite crystal itself. This texture might indicate an exsolution feature and not the early crystallisation of sphalerite because in that case the crystal faces of sphalerite would have been more euhedral.

The large arsenopyrite crystals have inclusions of apatite suggesting that the apatite was present before the crystallisation of arsenopyrite

The second stage of major vein mineralisation.

This stage is associated with the mineralisation of the small arsenopyrite crystals.

The third stage of major vein mineralisation.

This stage is mainly associated with the crystallisation of small anhedral to euhedral pyrite crystals which overprint the large arsenopyrite crystals on the crystal edges. The pyrite is often growing on the crystal edges of the arsenopyrite crystals, plate 19.



Plate 19.

In general arsenopyrite doesn't have any inclusions of pyrite indicating that there was no pyrite present when the arsenopyrite crystallised.

In plate 17 there is a pyrite crystal with an irregular edge in contact with the quartz. The perfect crystal faces of the pyrite are surrounded by galena which suggest that the pyrite grew into a cavity and the galena crystallised at a later stage.

Inclusions of subhedral to euhedral arsenopyrite crystals in sphalerite indicates that the arsenopyrite crystallised before the sphalerite, plate 20.

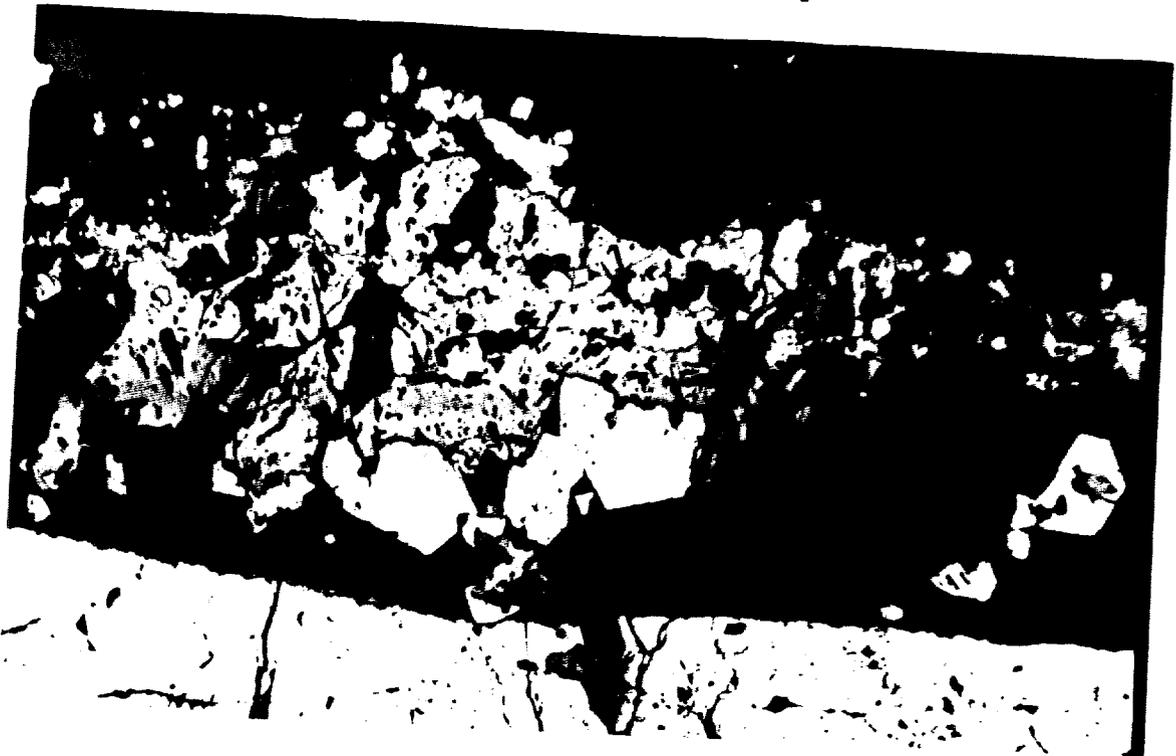


Plate 20.

Plate 21 show irregular contacts between the arsenopyrite crystals and sphalerite crystals this is because the arsenopyrite has been exsolved away.



Plate 21.

A similar relation is seen on plate 7 (left of the centre) where the cubic growth of the sphalerite replaces the arsenopyrite.

Galena is found as irregular inclusions in the pyrite suggesting exsolution of pyrite by galena. This textural relationship between the galena and the pyrite indicates that the galena crystallised late during this third stage of mineralisation.

Galena is also found in the arsenopyrite, filling in cavities. This texture shows that the galena came later as it surrounds euhedral crystal faces, plate 18.

The fourth stage of major vein mineralisation

This stage is associated with the crystallisation of digenite, covellite and chalcopyrite.

Between crystals of pyrite and arsenopyrite the chalcopyrite and digenite are filling in the remaining space indicating that they crystallised at a later time than the pyrite and arsenopyrite. This is also observed in the cavities that are present in the sphalerite which are filled with digenite and covellite, plate 9 & 10, indicating that they are late stage crystallisation.

Figure 7 summarises the different stages of mineralisation.

Paragenesis graph.

Sample 2 with vein

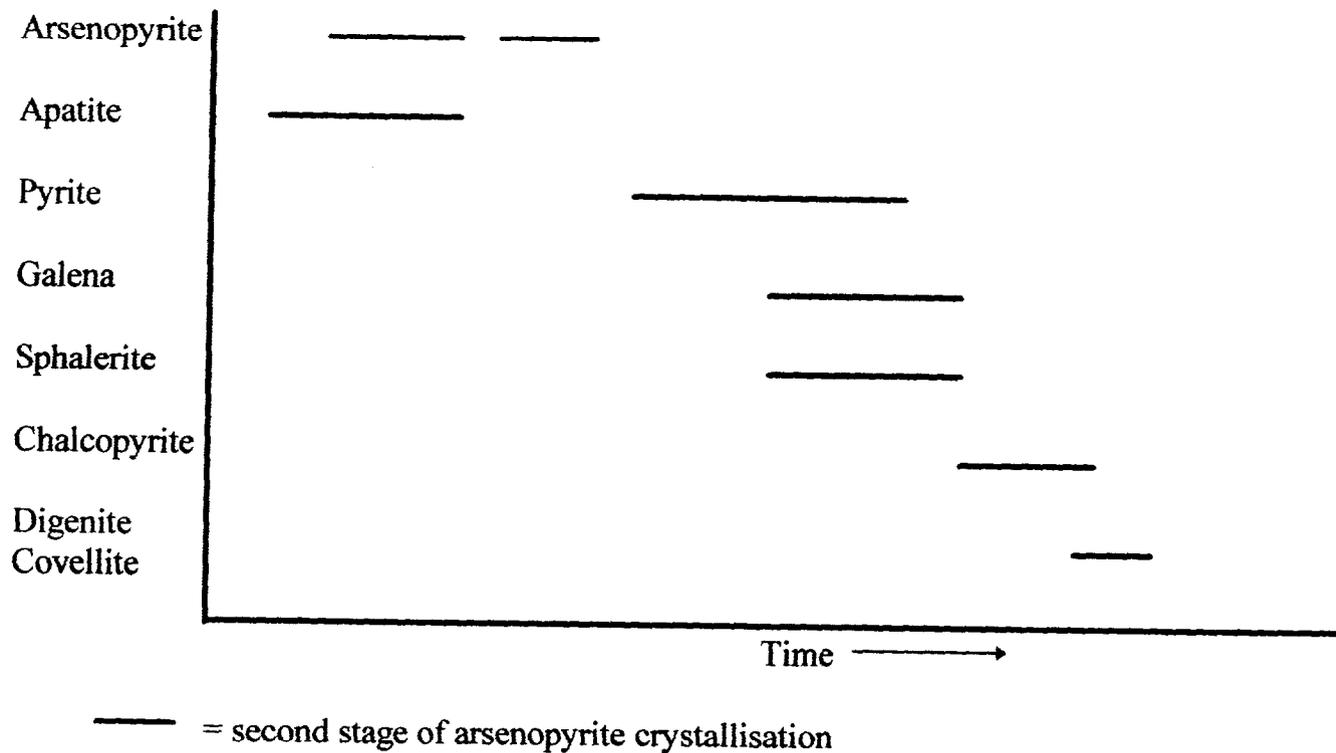


Figure 7.

The second type of mineralisation occurs in the wall rock of the quartz monzonite samples e.g. sample 4b, appendix 1.

The main ore minerals in sample 4b are galena and sphalerite, plate 1. There are also pyrite and some minor amounts of chalcopyrite, rutile and apatite present. The chalcopyrite occurs as an exsolution mineral in the sphalerite and as single anhedral crystals in the secondary quartz.

Some apatite crystals are surrounded by rutile. These rutile crystals are pre-sericitisation (as described in chapter 5) indicating that the apatite was present before the sericitisation.

Pyrite crystals have been replaced by galena and sphalerite suggesting that the pyrite crystallised first. This is similar to the vein deposits in the samples studied. The pyrite crystals are surrounded by sericite but don't have inclusions of sericite indicating that the pyrite was present before the sericitisation.

The galena and the sphalerite crystals crystallised during the sericitisation, plate 1.

In the wall rock samples there is no arsenopyrite and no minor late stage minerals like digenite and covellite as observed in the vein mineralisation.

Figure 8 summarises the different stages of mineralisation.

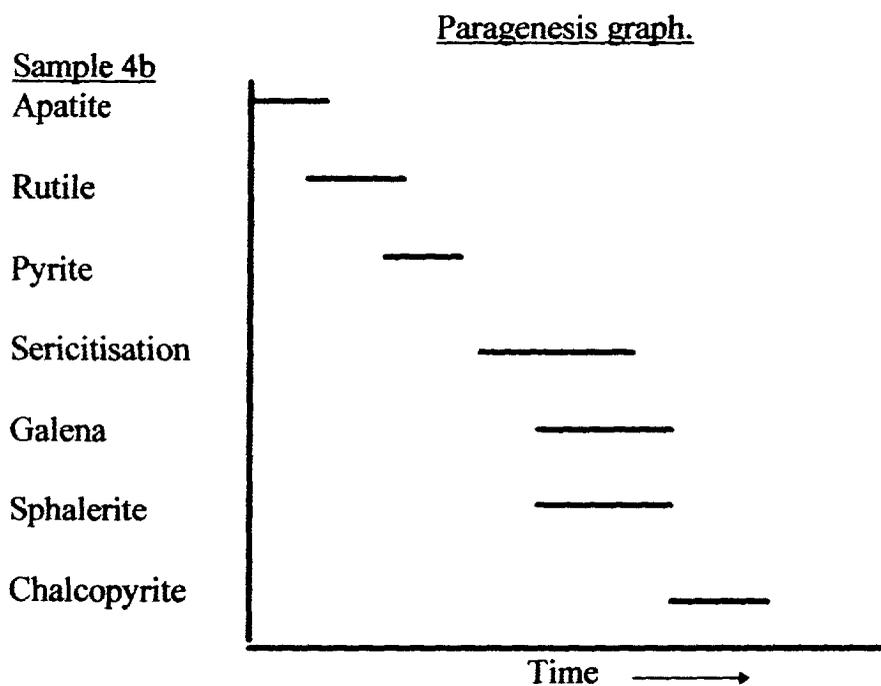


Figure 8.

The third type of mineralisation occurs in the metasediments of the Marmot grid which are highly altered, sample 6, 7 and 8. Appendix 1.

The main sulphide mineral present in the metasediments is galena. This must have been one of the earlier minerals to crystallise but has now largely been replaced. The replacement of the galena is best observed on the cathodoluminescence microscope, plate 15.

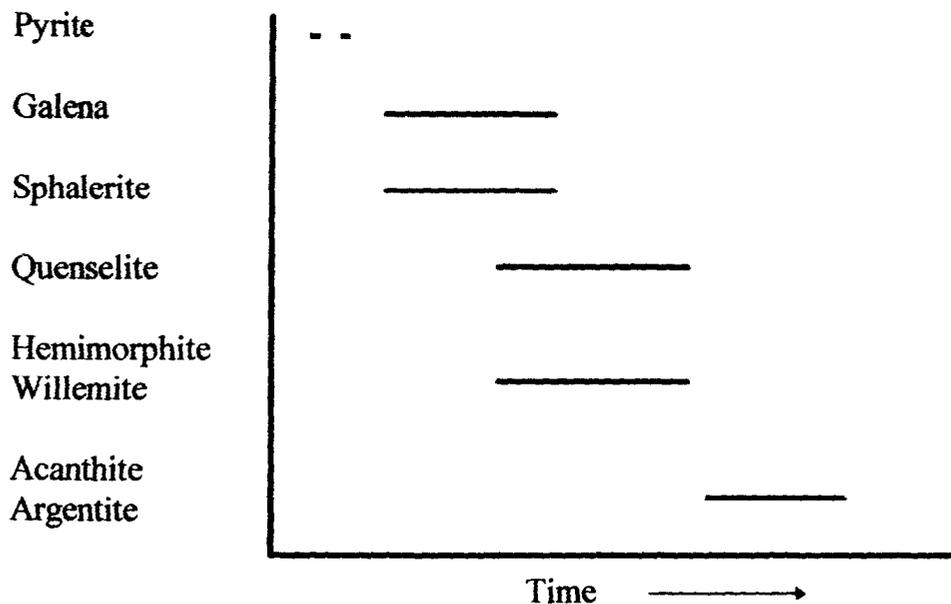
Other minerals present are quenselite, hemimorphite and argentite or acanthite. The quenselite and hemimorphite are oxides that might suggest that the original sulphides were galena and sphalerite which have undergone oxidation. This indicates that the quenselite and the hemimorphite are late alteration minerals. Hemimorphite is a common alteration product of sphalerite and with the presence of iron oxide like hematite it suggests that the oxidation occurred. In sample 6 and 7 small square holes were found which are filled with an light orange material. This square hole could be a pseudomorph after pyrite indicating that pyrite was present prior to the oxidation.

The oxidation of the sulphides happened during the hematisation which brought oxidising fluids into the metasediments.

Figure 9 summarises the different stages of mineralisation.

Paragenesis graph.

Sample 6,7 and 8



- - - = Mineral not present anymore.

Figure 9.

6. Conditions for crystallisation and alteration

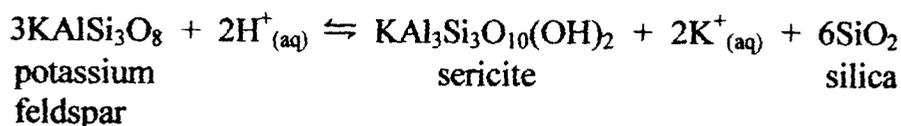
This chapter will look what the time relation is between the wall rock mineralisation and the vein mineralisation and processes acting on the ~~crystallisation and alteration~~ of certain minerals.

The alteration in the wall rock of the quartz monzonite is associated with the third and fourth stage of the vein mineralisation because of the presence of pyrite, galena and sphalerite.

The wall rock was probably cold when the vein got emplaced and no fluids could enter the wall rock because no arsenopyrite (which is associated with the initial emplacement of the vein) could be found in the wall rock. The initial intrusion associated with the arsenopyrite warmed the rock up making it easier for the next stage of fluids to move through, precipitating pyrite, galena and sphalerite.

Sericitisation is common during the early stages of hydrothermal alteration of the wall rock along with pyrite and other sulphides like galena and sphalerite. Rutile is always associated with muscovite but muscovite itself doesn't have a lot of titanium in its crystal lattice. This suggests that the muscovite is an alteration product of biotite and that the rutile has been formed when titanium was released from the biotite lattice.

All the quartz monzonite samples for this project have undergone sericitisation and comprise mainly of quartz, sericite and muscovite. Rutile has not been found in the sericite indicating that sericite does not replace the biotite or muscovite but another mineral. According to Reesor 1958 the unaltered quartz monzonite, appendix 5, contains microcline (a low temperature potassium feldspar, Klein 1993). During the sericitisation process the microcline alters to sericite as shown below, Deer *et al.* 1962.



The by-product of this reaction is silica indicating that the sericitisation reaction is accompanied by some silicification; examples of this are seen in plates 13.

The wall rock in the quartz monzonite only contains quartz, muscovite and sericite indicating that the alteration has been very extensive. The alteration grade compares with the phyllic zone of Evans 1993 (modified from Meyer *et al.* 1967) and is close to the argillic zone because some of the muscovite start to show some alteration.

The metasediments have undergone more alteration than the quartz monzonite samples because the muscovite crystals have been altered to a carbonaceous material indicating that the rock has undergone argillic alteration. This higher grade of alteration in metasediments could be due to a higher permeability created by the brecciation of the rock.

Digenite and acanthite are alteration minerals of the sulphides on this property and are often deposited below the water table as supergene minerals. Meteoric water leaches the silver from the veins at the surface and precipitates the silver as acanthite just below the water table, Guilbert *et al.* 1986.

Sample 65726, appendix 1, is an altered intrusive of the Marmot grid. The assay value for the arsenic is up to 99999 ppm but SEM analysis shows that the arsenic values are greater than 10%.

The minerals in this sample are pseudomorphs after arsenopyrite. The alteration minerals are scorodite and beudantite. Both these minerals are oxides and formed in gossans by oxidation of the arsenopyrite minerals.

Sample 6974, appendix 1, is an altered quartz vein intrusive of the Packrat grid. This sample has arsenic values up to 2.9% most of the arsenic is in relics of arsenopyrite and in the alteration product of the arsenopyrite which is schultenite.

Angelsite is also present in this sample which has small bright patches of galena. This suggests that the galena has been oxidised to angelsite.

The fractures in the sphalerite are filled in with schultenite and an iron oxide possibly hematite, plate 2, indicating three stages of fluid movement as describe in 3.1- fracturing.

7. Occurrence of the elements

This chapter will explain where minor elements such as gold, silver and cadmium might occur. To find out in which minerals the minor elements were present a regression line has been drawn between the major element of the mineral and the minor element.

If the data of the minor element and the major element of the mineral are closely associated with the regression line (mean between two variables) then the regression values are close to one and a poor fit lead to values close to zero. Values close to one indicate that both elements crystallised at the same time.

These regression values and lines have been drawn with a computer software package called IGPET.

7.1 Cadmium

Cadmium is found in sphalerite as an inclusion which can be seen from the regression line, fig. 10.

Cadmium in solid solution with sphalerite

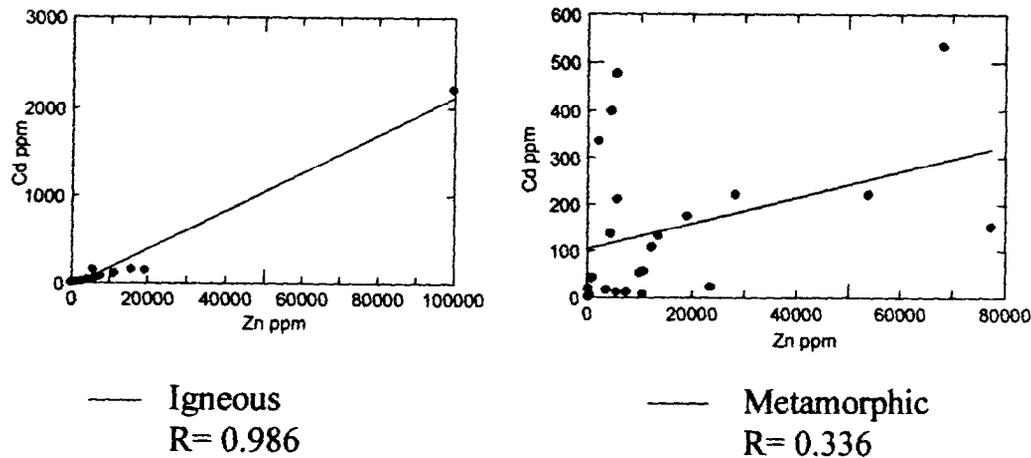


Figure 10.

The solid solution between the Cd and the sphalerite is only observed in the igneous samples from the Packrat grid and not in the Marmot grid samples because sphalerite doesn't occur in the metamorphosed samples.

7.2 Silver

A regression between the silver and copper of the igneous samples gave a regression value of 0.854, fig. 11, indicating that the silver is found in a copper bearing mineral. This mineral could be chalcopyrite or covellite.

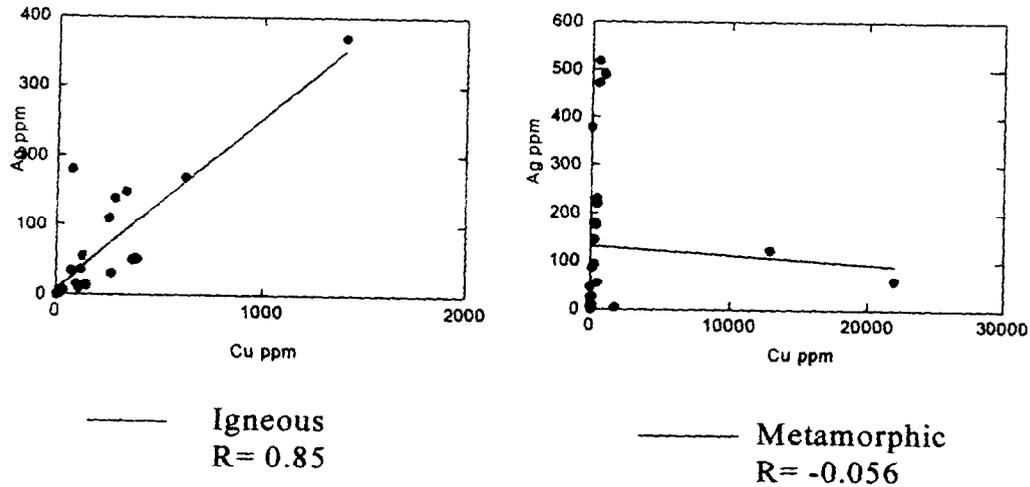


Figure 11.

A regression between the silver and copper of the metamorphic samples gives a regression value of -0.056. This shows that silver doesn't occur in a copper bearing mineral of the metamorphic samples from the Marmot grid.

It was suggested by Uytendogaardt 1971 that digenite may contain some silver. Figure 12, is an EDS from a covellite mineral. The EDS shows that there is some silver present in the copper bearing mineral which in this case is covellite. Since there is only one mineral that has the optical properties of covellite and the other blue minerals are digenite most of the silver is likely to be present in the digenite.

EDS trace

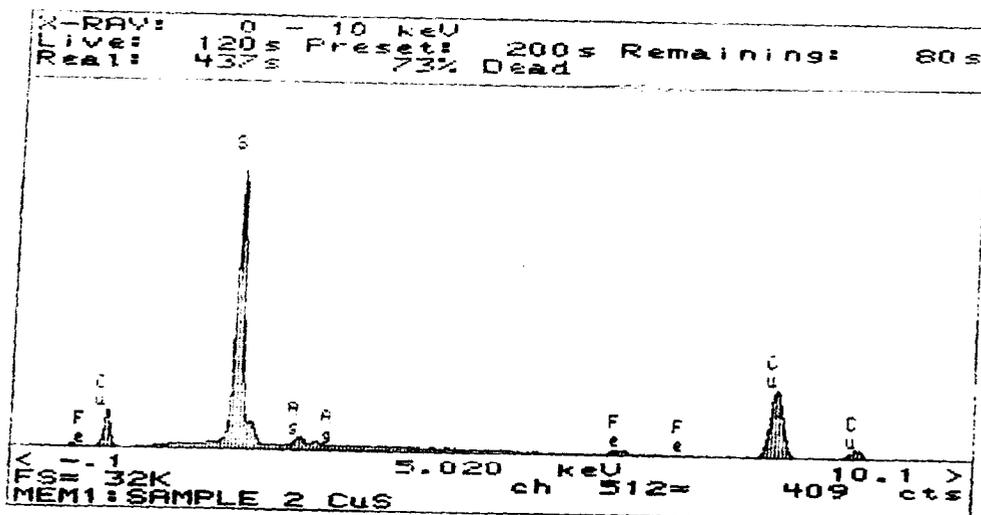


Figure 12.

A regression between antimony (Sb) and silver (Ag) gave a value of 0.943 and 0.785 for the igneous samples of the Packrat grid and the metamorphic samples of the Marmot Grid respectively, fig. 13.

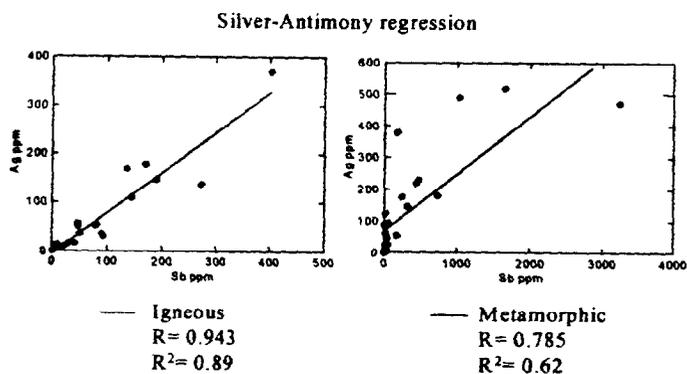


Figure 13.

The high regression values between the antimony and the silver suggest that the silver might be associated with tetrahedrite, $Cu_3SbS_{3.25}$. Tetrahedrite is not found in the samples analysed for this project but is known to be present in highly sheared zones and altered rocks, Whitby 1996. The tetrahedrite admixtures and sometimes is in solid solution with galena, Klein 1985. This would suggest that silver occurs in tetrahedrite which is located in the galena.

EDS and regression graphs indicate that silver occurs in covellite and tetrahedrite. Silver can also occur in the digenite as suggested by Uytenbogaardt 1971.

7.3 Gold

For the metamorphic samples of the marmot grid, figure 14 shows a regression value between arsenic and gold of 0.916 indicating that the gold is closely associated with the arsenic.

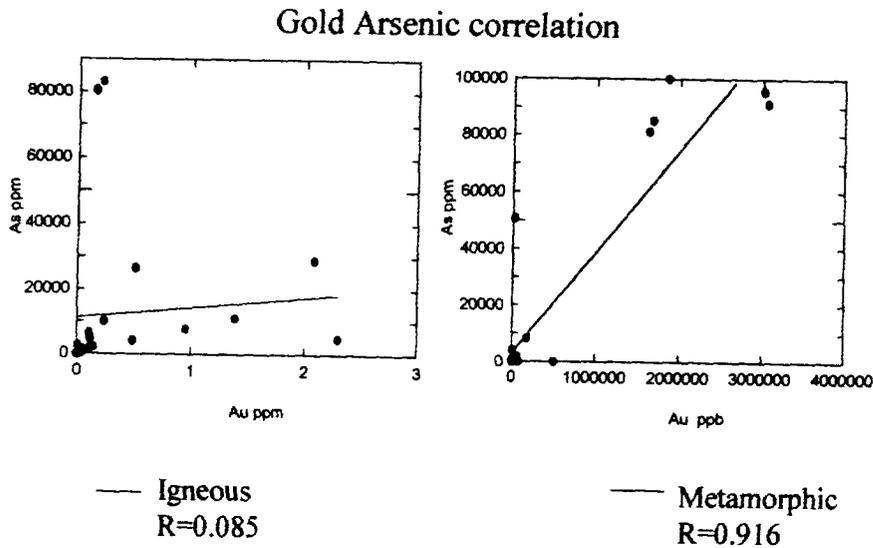


Figure 14.

A regression, figure 15, between gold (Au) and iron (Fe) in the metamorphic samples gave a value of 0.86.

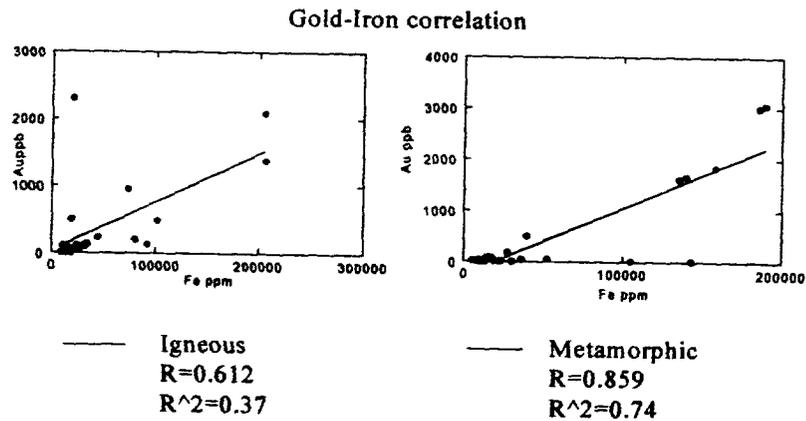


Figure 15.

For the igneous samples the regression values between the gold and the arsenic is low, 0.085, fig. 14 (with the two top left data points *eliminated* from the graph the regression value is 0.587). The low regression values between arsenic and gold and the high regression values for iron and gold suggests that the gold is probably located in the zoned pyrite.

The gold in the metasediments has high regression values with arsenic and iron. There are two possibilities for the gold to be associated with: scorodite and beudantite but low regression values between lead and gold, fig. 16, suggests that gold is associated with scorodite.

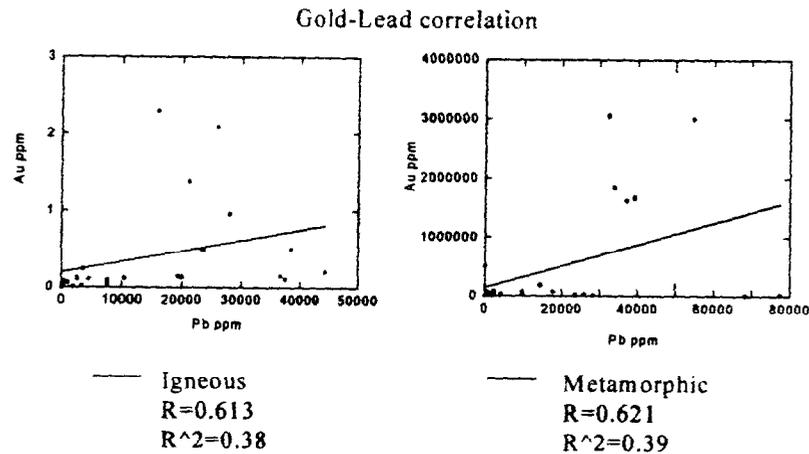


Figure 16.

8. Conclusion

The mineralisation in the quartz monzonite of the Packrat grid is mainly associated with vein deposits. Mineralisation in the wall rock occurred simultaneously with sericitisation and is accompanied with a lot of fluid movement. This is similar to studies on the Butte mine, Montana, where veins also demonstrated that the sericitisation took place at the same time as the mineralisation, Guilbert *et al.* 1986. This type of wall rock alteration and vein emplacement is common for Cordilleran vein deposits.

The ore minerals in the metasediments of the Marmot grid are mainly oxides. The presence of some relics of galena might indicate that the original metasediment contained hypogene sulphides. This could suggest that the sulphides were oxidised by oxidising fluids which could have been of a meteoric origin.

Silver occurs in the metasediments and vein deposits as the supergene minerals acanthite and covellite respectively. Regression graphs indicate that silver also occurs in tetrahedrite, in both the metasediments and the vein deposits.

No gold was detected with the research microscope or the SEM but the regression graphs suggest that the gold is associated with the pyrite in the vein deposits and scorodite of the metasediments.

In this mineralogical study the copper sulphides chalcopyrite, covellite, and digenite, have been identified on the Lead prospect along with galena, sphalerite, pyrite and arsenopyrite. Schultenite and anglesite occur with the sulphides. Cadmium is present in the sphalerite. The gold values are associated with the arsenopyrite. This analysis indicates that the silver is found in the copper-bearing minerals such as chalcopyrite, covellite or digenite. There are four stages of vein mineralization indicated in the samples collected from the adits on the Lead prospect.

On the Silver prospect there is more alteration of the metasediments than on the Lead Prospect. The minerals Hematite, Quenselite, Hemimorphite, Argentite (or Acanthite), Scorodite, Beudantite, were identified in this study. The main ore minerals in the metasediments are oxides and the main sulphide mineral present is galena. The identification of argentite (or acanthite) on the Silver claims explains the significant silver values reported in grab samples during early exploration (102 to 364 grams per tonne) and by Whitby in 1995. XRD confirmation of the presence of hemimorphite on the Silver prospect in conjunction with the resinous sphalerite previously reported can explain the zinc values reported during early exploration (10-26% zinc) and in grab samples by Whitby (6.95% to 15.10%).

9. Suggestions

The presence of supergene minerals and iron oxides in the metasediments of the Marmot grid might indicate that at lower depth there might be primary sulphide deposits and it would be worth drilling this part of the property.

Further studies on the property with more samples would give a better idea of the types of minerals present in which elements such as gold and silver occurs. Isotope and fluids inclusion studies will also give a good idea of the origin of the fluids and consequently the ore minerals.

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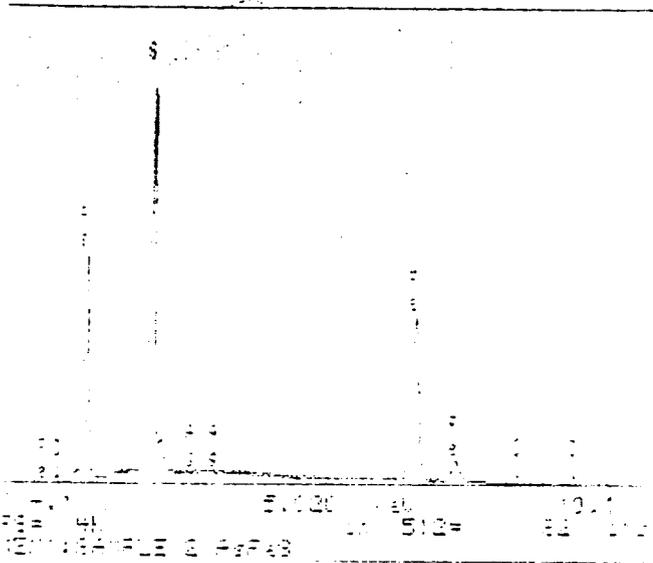
Appendix 1

Sample	Location	Description
1	Central Adit - Appendix 6	Altered quartz monzonite with pyrite, galena and sphalerite mineralisation and quartz vein mineralisation.
2	Central Adit Dump - Appendix 6	Altered quartz monzonite with pyrite, galena and sphalerite mineralisation and quartz vein mineralisation including arsenopyrite.
3	Central Adit Dump - Appendix 6	Altered quartz monzonite with pyrite, with minor amounts of galena and sphalerite.
4	North Adit - Appendix 6	Altered quartz monzonite with pyrite, galena and sphalerite mineralisation and quartz vein mineralisation including arsenopyrite. Polished section 60 μ
5	Central Adit - Appendix 6	Altered quartz monzonite with pyrite, galena and sphalerite mineralisation and quartz vein mineralisation including arsenopyrite. Polished section 60 μ
6	Near sample loc. 65807 Lower Marmot Trench - Appendix 7	Highly altered, brecciated metasediment with hematite veining and galena.
7	Between 65769 & 65768 - Lower Marmot Trench - Appendix 7.	Highly altered, brecciated metasediment with hematite veining and galena.
8	Near 65745 Appendix 7	Highly altered, brecciated metasediment with hematite veining and minor amounts of galena and acanthite (black)
9	Unknown	Moderately altered metasediment with pyrite and galena
10	Near sample 65771 & 65770 - Appendix 7	Altered metasediment
11	Near 95688 Upper Marmot Trench - Appendix 7	Altered metasediment with altered pyrite crystals and bright green mineral possibly tetrahedrite.
6974	Southern Adit 11.7 m	Grab sample Quartz vein 1-2 cm with pyrite, galena and arsenopyrite.
65726	Trench at 6+70N, 1 + 35E	Altered float from trench with over 10% of arsenic and limonite

Appendix 2

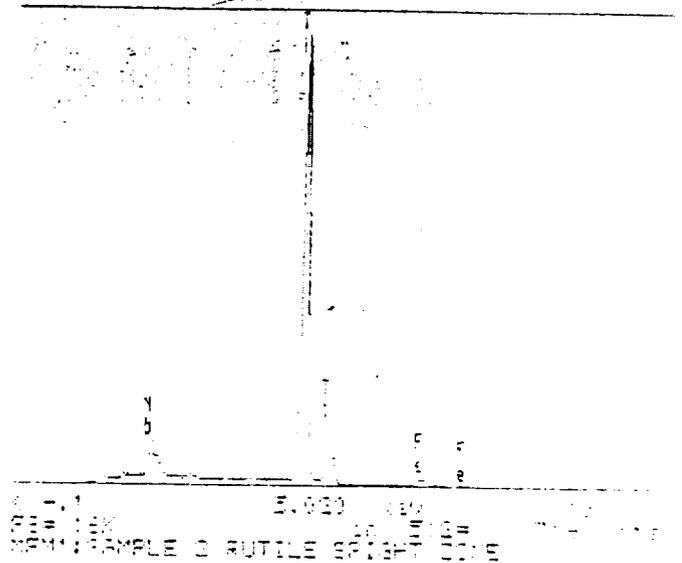
2.1 Arsenopyrite

X-RAY: 0 - 10 keV
Live: 23s Preset: 200s Remaining: 178s
Real: 96s 74% Dead



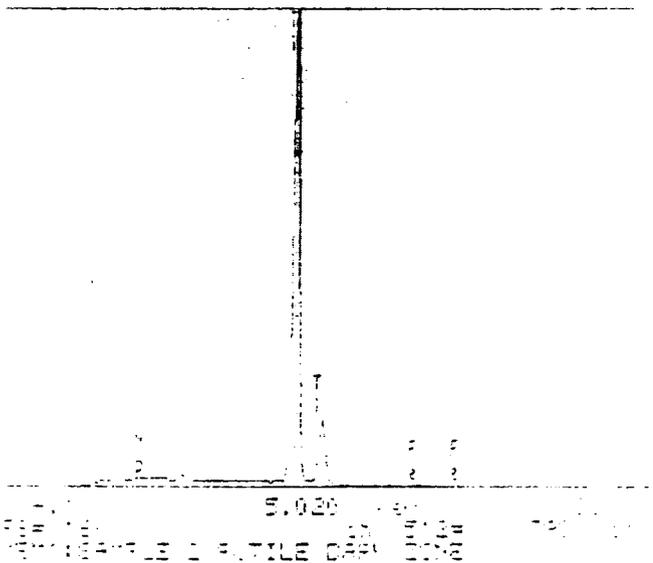
2.2.1 Rutile Bright Zone

X-RAY: 0 - 10 keV
Live: 62s Preset: 200s Remaining: 138s
Real: 233s 73% Dead



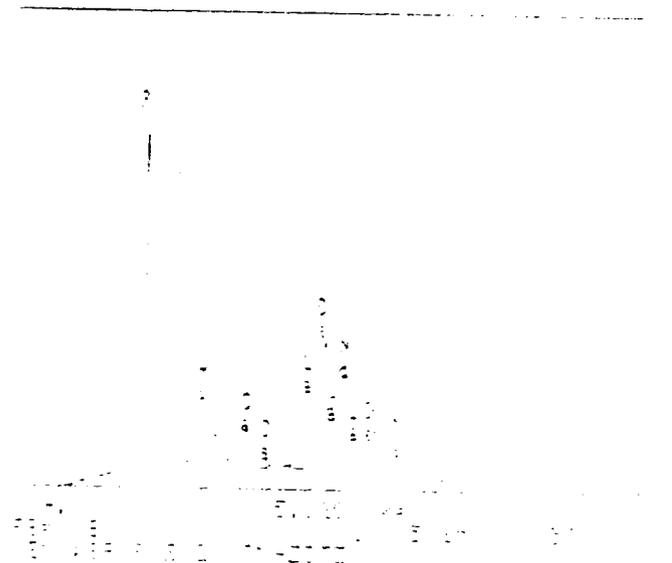
2.2.2 Rutile dark zone

X-RAY: 0 - 10 keV
Live: 62s Preset: 200s Remaining: 138s
Real: 233s 73% Dead



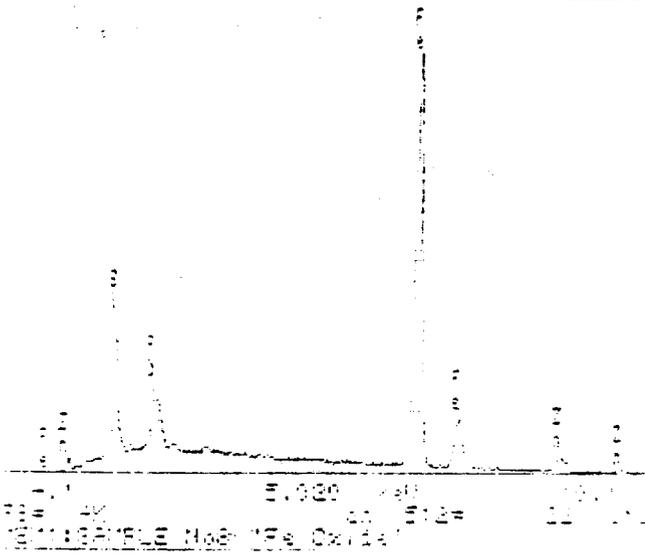
2.3 Monazite

X-RAY: 0 - 10 keV
Live: 71s Preset: 200s Remaining: 129s
Real: 238s 72% Dead



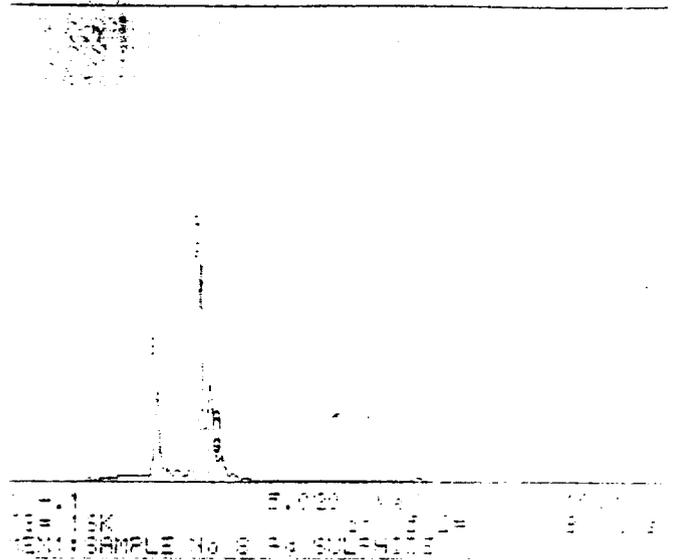
2.4 Hematite

X-RAY: 0 - 10 keV
Live: 49s Preset: 100s Remaining: 51s
Real: 113s 57% Dead



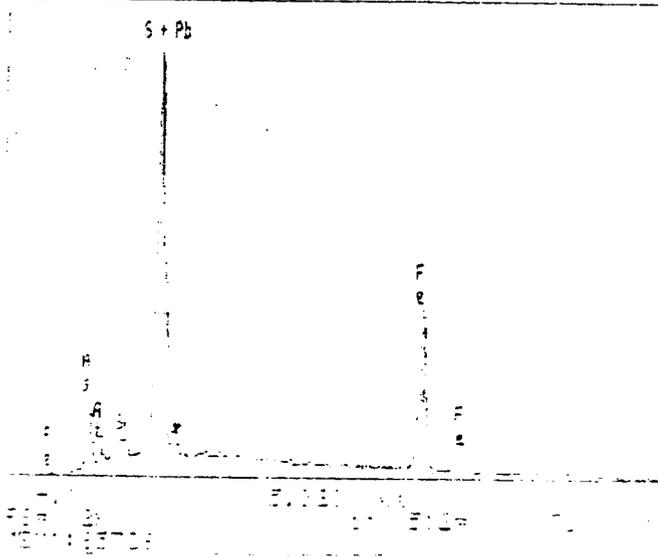
2.5 Acanthite

X-RAY: 0 - 10 keV
Live: 32s Preset: 100s Remaining: 68s
Real: 189s 83% Dead



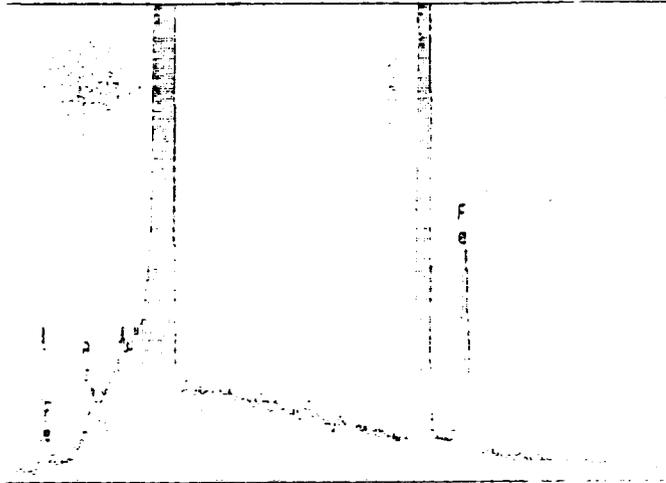
2.6 Beudantite

X-RAY: 0 - 10 keV
Live: 100s Preset: 100s Remaining: 0s
Real: 143s 50% Dead



2.7.1 Pyrite - bright rim

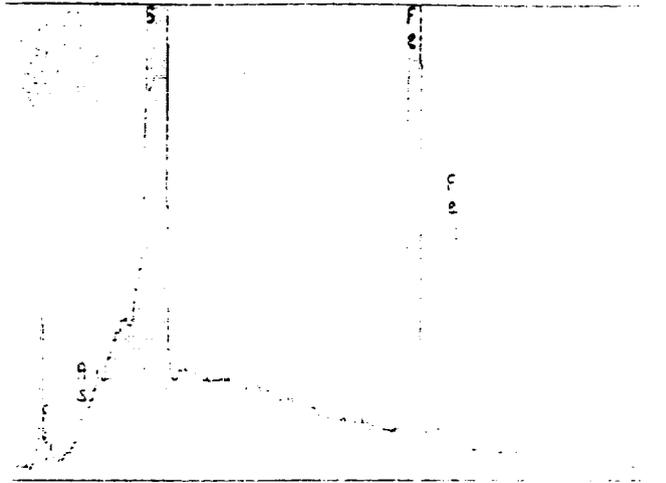
X-RAY: 0 - 10 keV
Live: 100s Preset: 100s Remaining: 0s
Real: 229s 56% Dead



5.000 keV
Si = 1k Fe = 1k
MEM: SAMPLE 2 PYRITE BRIGHT DONE

2.7.2 Pyrite dark rim

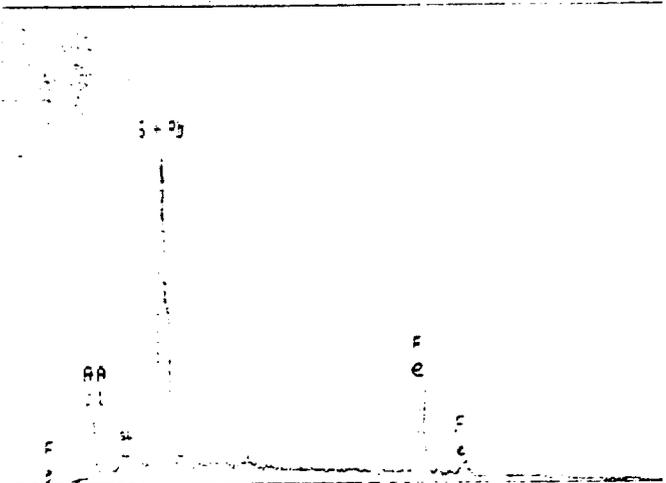
X-RAY: 0 - 10 keV
Live: 4s Preset: 100s Remaining: 96s
Real: 258s 82% Dead



5.000 keV
Si = 1k Fe = 1k
MEM: SAMPLE 2 PYRITE DARK DONE

2.8 Sericite with more Al than Si

X-RAY: 0 - 10 keV
Live: 100s Preset: 100s Remaining: 0s
Real: 139s 28% Dead



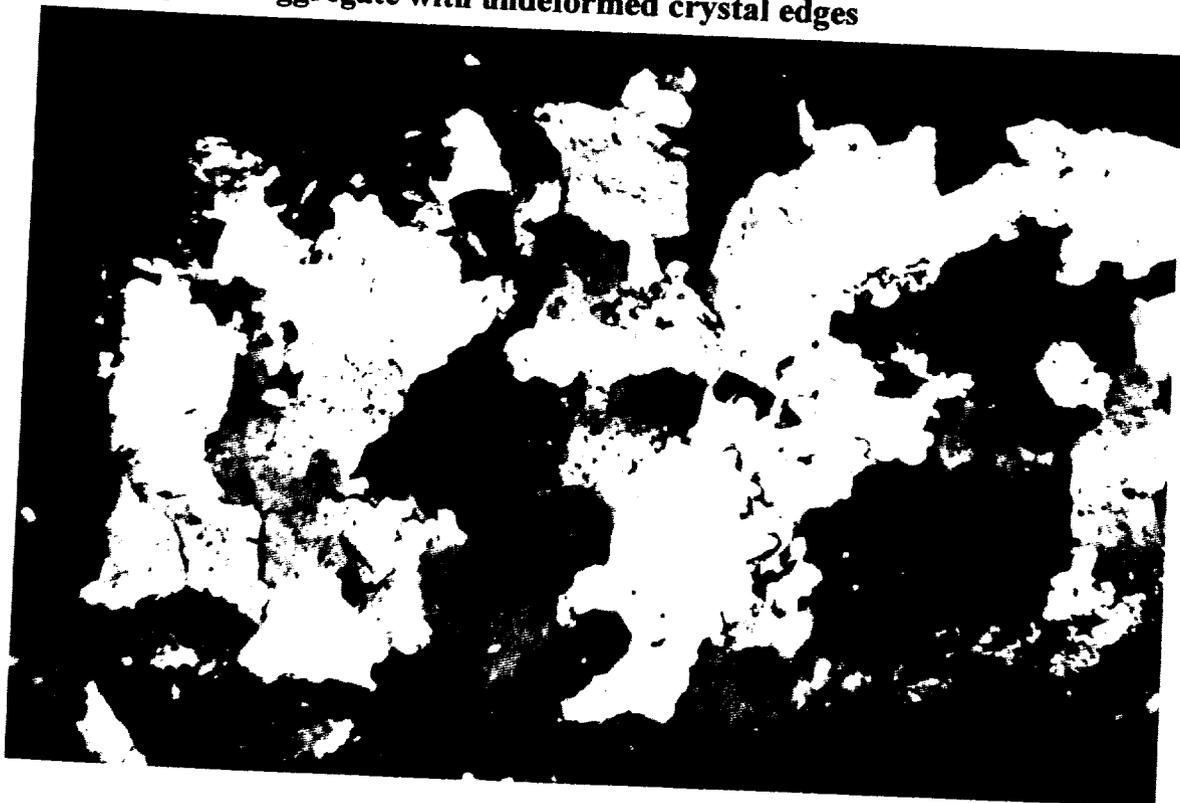
5.000 keV
Si = 1k Al = 1k Fe = 1k
MEM: SAMPLE 2 SERICITE DONE

Appendix 3

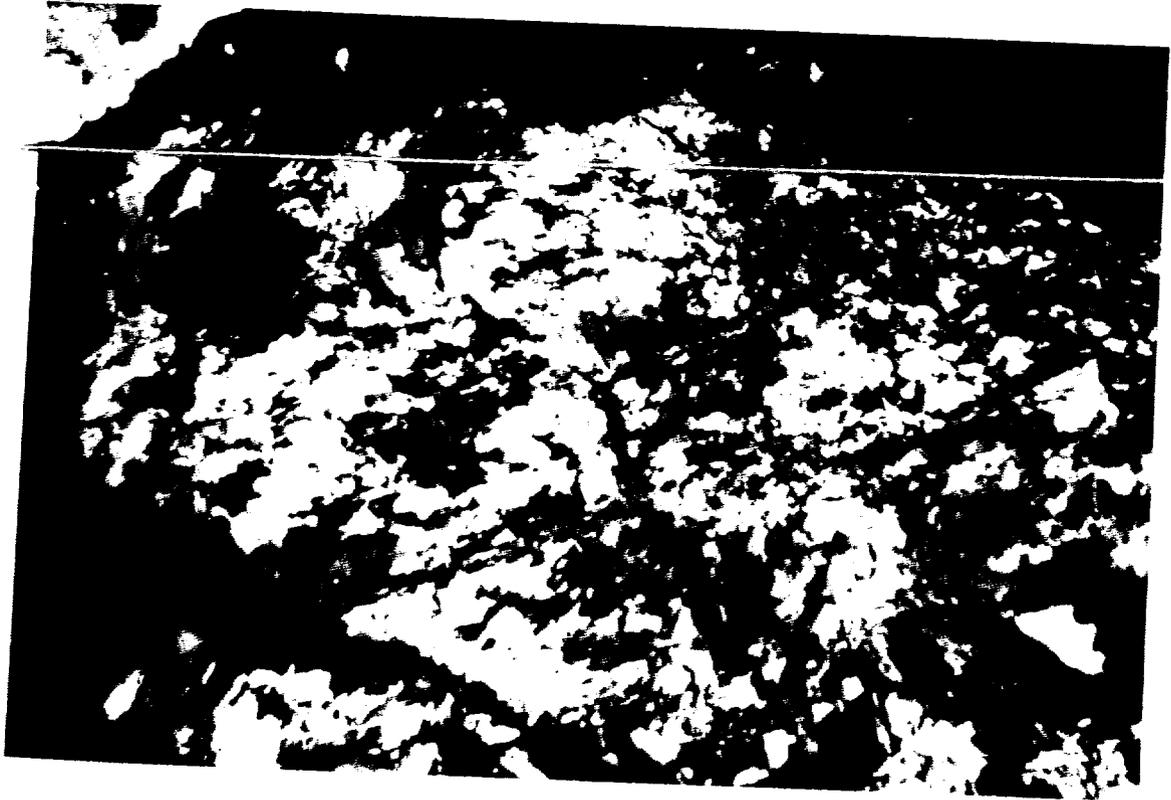
3.1 Inclusion of chalcopyrite and digenite in sphalerite



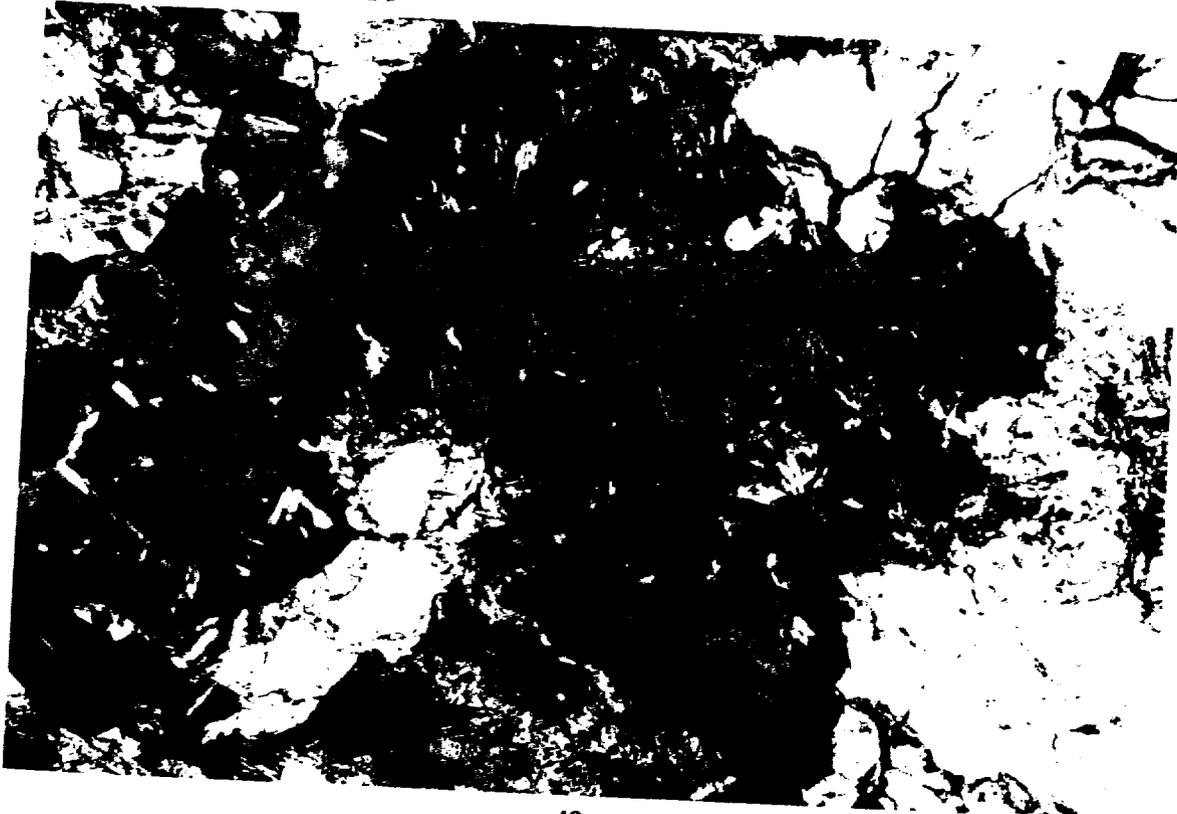
3.2.1 Quartz aggregate with undeformed crystal edges



3.2.20 quartz aggregate with sheared crystal edges



3.3 Strain shadows in ppl



Appendix 4

Formula for working out the atomic number of the mineral.

$$Z = \frac{\Sigma(\text{NAZ})}{\Sigma(\text{NA})}$$

N = number of atoms of each element.

A = at weight of each element.

Z = at number of each element.

Element	A	Z
As	74.922	33
Fe	55.847	26
O	15.999	8
H	1.008	1

Scorodite $\text{Fe}(\text{AsO}_4) \cdot 2\text{H}_2\text{O}$

Element	N	NA	NAZ
As	1	74.922	2472.426
Fe	1	55.847	1452.022
O	6	95.994	767.952
H	4	4.032	4.032
		Σ 230.795	Σ 4696.432

$$Z = 4696.432/230.795$$

$$= 20.35$$

Pharmacosiderite $\text{Fe}_3(\text{AsO}_4)_2(\text{OH})_3 \cdot 5\text{H}_2\text{O}$

Element	N	NA	NAZ
As	2	149.844	4944.852
Fe	3	167.541	4356.066
O	16	255.984	2047.872
H	13	13.104	13.104
		Σ 586.473	Σ 11361.894

$$Z = 11361.894/586.473$$

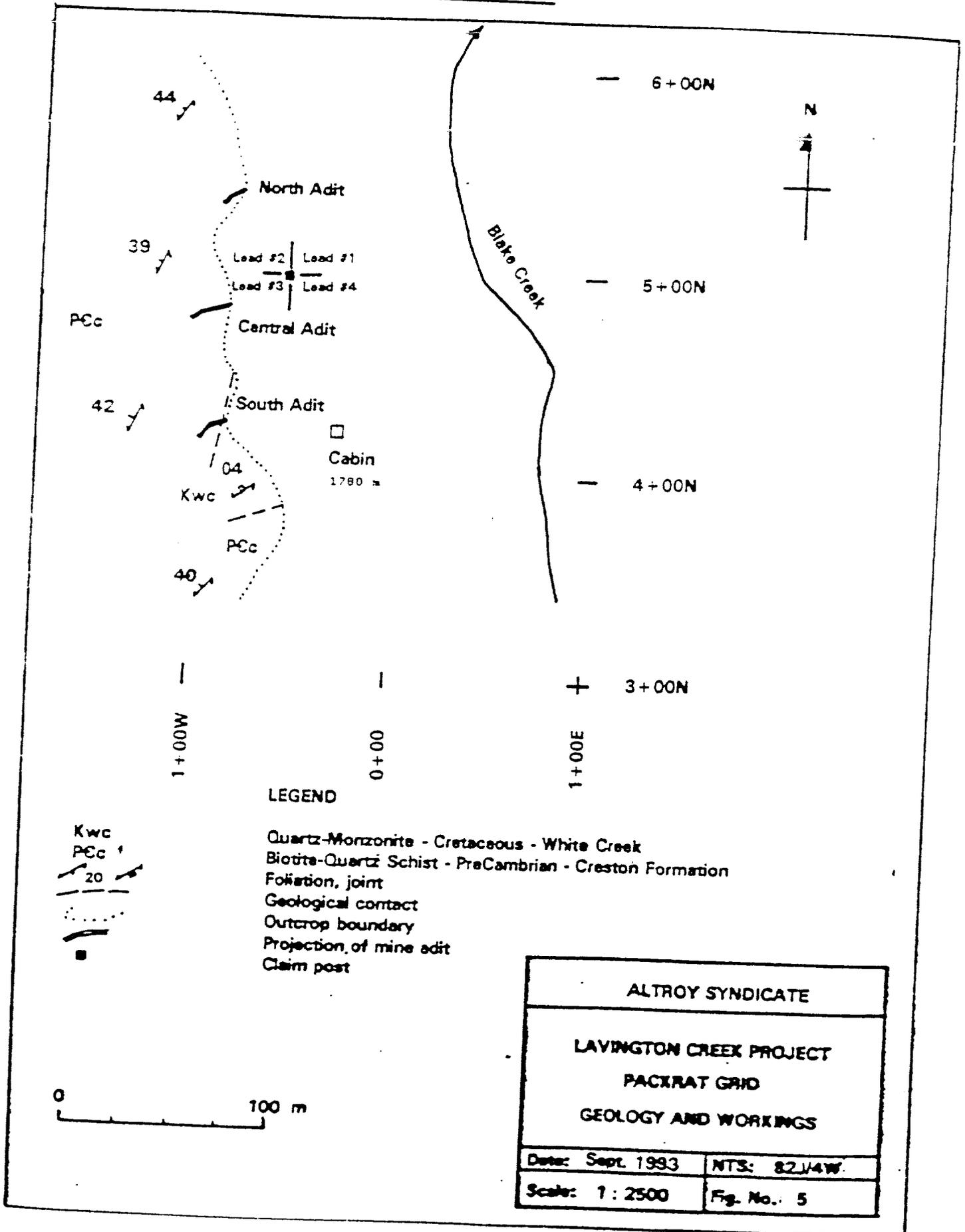
$$= 19.38$$

Appendix 5

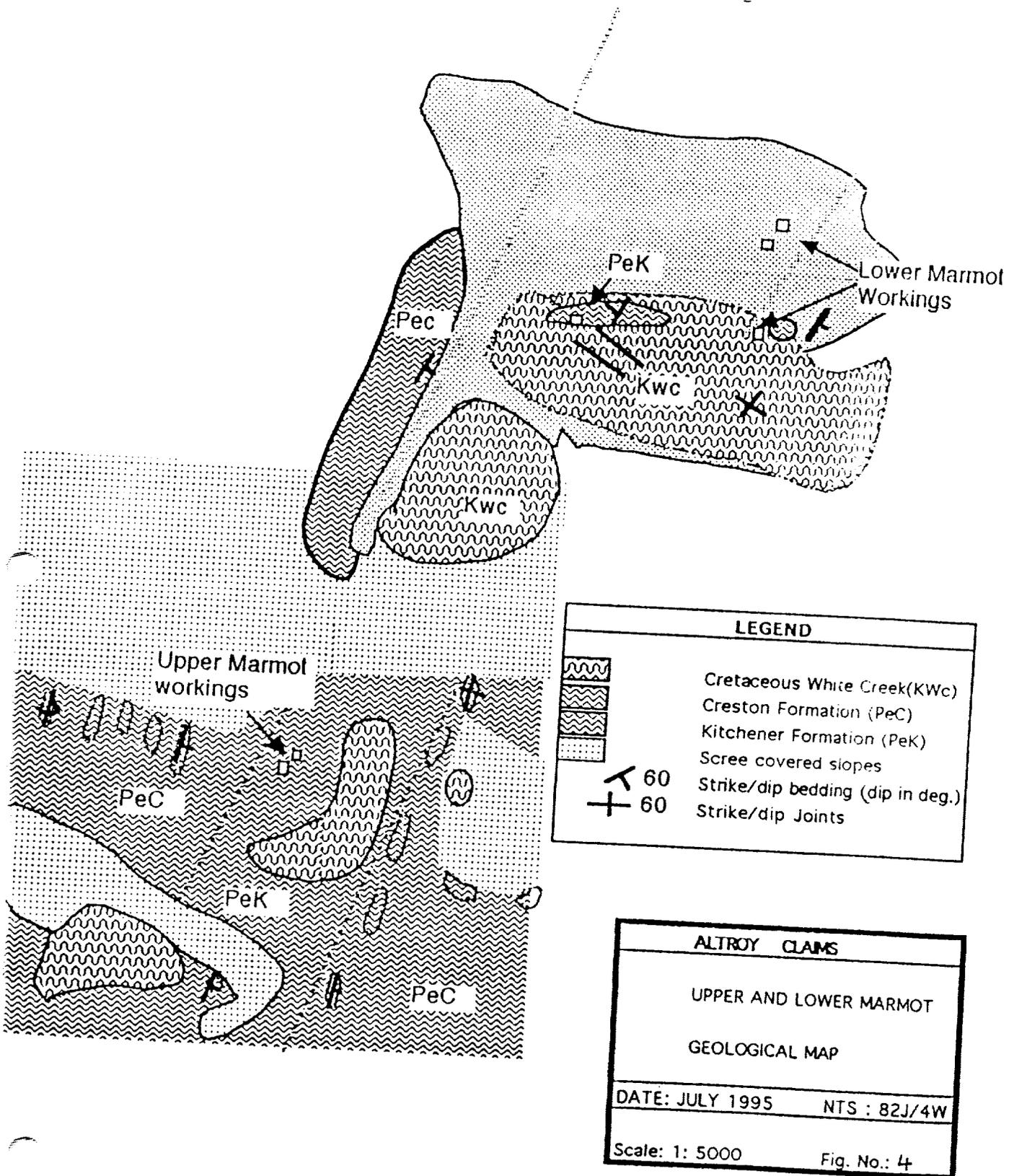
Model analyses of sample 16, after Reesor 1958.

Minerals	Sample 16
Plagioclase	37
Microcline	28
Quartz	25
Biotite	7
Hornblende	1
Total Accessories	2

Appendix 6



Appendix 7



Appendix 8

Altroy Resources FILE # 93-2018

Page 2

SAMPLE #	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Au*
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppm
65762	21	9	136	425	.4	9	25	260	1.97	44	<5	<2	12	31	3.0	<2	<2	10	.82	.057	13	33	.43	75	.05	<2	.45	.03	.28	<1	5
65763	16	398	20080	15983	53.8	6	4	140	3.43	2205	17	<2	10	7	156.8	82	<2	<2	.19	.054	7	5	.01	30	<.01	3	.22	<.01	.15	1	140
RE 65763	14	386	19496	15499	52.0	6	4	133	3.36	2156	22	<2	9	7	152.1	80	<2	<2	.18	.053	7	5	.01	30	<.01	2	.20	<.01	.16	1	150
65764	9	165	7688	7970	13.7	8	5	657	2.38	1228	14	<2	11	41	79.3	10	<2	<2	.69	.058	9	6	.15	32	<.01	4	.23	<.01	.18	<1	93
65765	6	148	14357	13484	25.0	9	4	384	2.71	8214	14	<2	12	28	131.3	17	<2	<2	.65	.055	8	26	.15	25	<.01	4	.26	<.01	.21	1	180
65768	4	18	25822	23485	378.0	7	5	2803	1.42	28	6	<2	3	13	23.5	173	<2	5	.09	.024	9	10	.05	13	<.01	4	.11	<.01	.06	2	7
65769	2	296	24862	28207	145.1	9	7	1916	1.91	50	5	<2	2	30	220.1	317	<2	14	12.00	.013	9	10	.34	52	<.01	2	.17	<.01	.10	2	5
65770	5	412	12035	77314	175.5	8	7	1501	2.34	292	<5	<2	3	4	151.9	242	<2	52	.51	.014	13	22	.07	13	<.01	3	.14	<.01	.09	3	9
65771	4	262	33277	68263	179.9	8	8	2461	2.22	33	<5	<2	22	532.3	729	3	7	8.94	.011	4	8	.16	54	<.01	2	.09	<.01	.06	1	4	
65801	1	143	294	412	2.3	16	14	445	.96	9	<5	<2	7	55	3.0	5	<2	5	7.13	.034	17	12	.97	26	.08	2	1.71	.28	.32	<1	2
65802	3	8	25833	369	46.0	9	4	2015	.94	16	<5	<2	4	73	6.2	38	8	2	11.06	.016	3	21	.19	21	<.01	2	.25	.01	.14	<1	30
STANDARD C/AU-R	19	60	39	127	7.4	68	33	1045	3.96	41	22	8	35	52	18.7	14	18	55	.49	.087	37	60	.93	183	.09	33	1.88	.06	.14	11	500

Sample type: ROCK. Samples beginning 'RE' are duplicate samples.

Assay recommended for Sb > 1000 ppm



GEOCHEMICAL ANALYSIS CERTIFICATE

Altroy Resources File # 93-2018 Page 1
48 Strathroy Bay S.W., Calgary AB T3H 1J5 Submitted by: Dave Edwards



Table with columns: SAMPLE #, Mo, Cu, Pb, Zn, Ag, Ni, Co, Mn, Fe, As, U, Au, Th, Sr, Cd, Sb, Bi, V, Ca, P, La, Cr, Mg, Ba, Ti, B, Al, Na, K, W, Au*. Rows contain numerical data for various elements across multiple samples.

ICP - .500 GRAM SAMPLE IS DIGESTED WITH 3ML 3-1-2 HCL-HNO3-H2O AT 95 DEG. C FOR ONE HOUR AND IS DILUTED TO 10 ML WITH WATER. THIS LEACH IS PARTIAL FOR MN FE SR CA P IA CR MG BA TI B W AND LIMITED FOR NA K AND AL. ASSAY RECOMMENDED FOR ROCK AND CORE SAMPLES IF CU PB ZN AS > 1%, AG > 30 PPM & AU > 1000 PPB. SAMPLE TYPE: P1 TO P2 ROCK P3 TO P6 SOIL. Samples beginning 'RE' are duplicate samples. AA* ANALYSIS BY ACID LEACH/AA FROM 10 GM/SAMPLE.

DATE RECEIVED: AUG 17 1993 DATE REPORT MAILED: Aug 25/93 SIGNED BY: [Signature] D. TOYE, C. LEONG, J. WANG; CERTIFIED B.C. ASSAYERS

APPENDIX 9

AUTHOR'S QUALIFICATIONS

I, Victor Q. Kakebeeke of Aberdeen, Scotland, hereby certify that:

1. I am a consulting geologist.
2. I am a graduate of the University of Aberdeen, holding a Bachelor of Science degree (Hons.) in Geology (1996).
3. I have currently work in mineral exploration for Rio Tinto Mining Exploration Ltd., Bristol, United Kingdom and have practised my profession since my graduation.
4. I have no interest, direct or indirect, in the herein described property.

Signed: 

Victor Q. Kakebeeke
November 30, 1999

APPENDIX 10

STATEMENT OF EXPENDITURES:

4 S.E.M. analysis @ \$10.00 each	\$ 40.00
20 thin sections @ \$43.00 each	\$860.00
7 polished sections @ \$67.00 each	\$469.00
Color Photographs	\$ 59.00
Microscopic examination of 120 rock samples and to prepare the report	\$1572.00
Total	\$3,000.00