823437

MINNOVA INC.

DATE : May 20, 1990.

TO : I.D. Pirie

COPIES TO : B. Freisen, I. Piwek

FROM : A.R. Hill

SUBJECT : Petrography of selected rock samples, SAMATOSUM mine.

Nine samples were recently sent out for petrographic, scanning electron, and microprobe work, in an effort to solve some of the nagging geological questions at Samatosum. The sample descriptions follow:

No.	Method	Type	Location	Remarks
A-1	petro	core	RG258/336.5m	Intermediate xtl tuff or metased?
A-2	petro	"	RG258/549.6m	Lithic wacke. Is there a volcanic/tuffaceous component?
A-3	petro	"	RG258/349.8m	Intermediate xtl tuff?
A-4	petro	"	RG258/416.8m	Mafic tuff?
A-5	probe	"	RG254/314.0m	Strong yellow sericite alteration for probing. Compare to A-6.
A-6	probe	"	RG230/217.3m	Strong grey sericite alteration for probing. Is the grey colour due to the presence of clay? pyrite? or ?
A-7	petro	"	RG254/353.8m	Grey sericite altered lithic wacke?
A-8	sem	grab	pit	Barite from the Sam pit. Does it have fluid inclusions? What is the sulfide/sulfosalt mineralogy?
A-9	sem	grab	pit	High grade sample from the margin of the barite body. What is the red metallic mineral?

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Samples: A Series, 1 to 9

Summary:

Samples are of strongly metamorphosed volcanic and sedimentary rocks of intermediate to felsic composition. Several samples contain two distinct foliations representing two metamorphic events. Because of the strong deformation and recrystallization, the origin of several samples is uncertain. Some samples contain veins and replacement patches dominated by ankerite and quartz.

Sample A-1 is a **meta-tuff** containing fragments of very fine grained aggregates of quartz-(sericite-pyrite) in a groundmass of muscovite-quartz with abundant disseminated pyrite. A chert layer several mm thick is dominated by cherty quartz with much less pyrite and sericite.

Sample A-2 is a **metamorphosed lithic-crystal calcareous wacke** containing fragments of quartz grains, chert, cherty mudstone, and minor plagioclase grains in a foliated groundmass dominated by ankerite and quartz, with minor sericite. A post-metamorphic vein is dominated by ankerite with minor quartz.

Sample A-3 is a **metamorphosed porphyritic latite flow** (or crystal **tuff)** containing phenocrysts of plagioclase and minor ones of hornblende and quartz in a moderately foliated groundmass dominated by plagioclase, sericite, and calcite. The elongate nature of some of the plagioclase phenocrysts suggests that the rock is a flow rather than a crystal tuff. A major replacement vein and smaller patches are dominated by pyrite and chlorite with much less calcite and quartz.

Sample A-4 is a **metamorphosed andesitic tuff** containing lenses and patches of very fine grained plagioclase-ankerite in a well foliated groundmass dominated by chlorite, with much less ankerite, plagioclase, pyrite, and Ti-oxide. A few replacement(?) lenses are of quartz-ankerite or quartz-chlorite.

Sample A-5 is a **quartz-sericite-ankerite schist** after a **sedimentary** rock or **fine felsic tuff.** It is dominated by quartz and sericite, with less ankerite and minor pyrite. A strong foliation is contorted moderately to strongly into small kink folds, and cut by a second foliation axial planar to the kink folds and at a moderate to high angle to the primary foliation. Locally, sericite was recrystallized to muscovite along the second foliation direction. Kink folds are developed much more strongly in sericite-rich parts of the rock than in quartz-rich lenses. Veins and veinlets are dominated by ankerite and quartz.

Sample A-6 is a **muscovite-pyrite-quartz schist** after a **felsic tuff?** containing a few quartz phenocrysts(?) in a groundmass dominated by muscovite with much less quartz. Muscovite contains abundant disseminated pyrite and minor disseminated apatite. The grey color of the hand sample is because of the finely disseminated pyrite.

Sample A-7 is a **metamorphosed felsic lapilli tuff** containing a few equant fragments of latite in a strongly deformed groundmass dominated by quartz and muscovite. Pyrite occurs in two main modes. A layer or diffuse replacement vein up to 1.5 mm wide contains abundant ankerite.

Sample A-8 is a **barite vein(?) with** lenses and patches dominated by **tetrahedrite** or **pyrite,** with minor **bournonite, boulangerite, sphalerite, native gold, and quartz.** Sulfosalts are concentrated in one main band. **Native gold** forms disseminated grains associated with sulfosalts and pyrite. Coarser barite grains contain minor fluid inclusions, which were not studied further.

Sample A-9 is a vein containing **tetrahedrite/tennantite-sphalerite-galena-pyrite-(native gold)** in a gangue of quartz, calcite, and minor albite.

Sulfosalts in samples A-8 and A-9 were analysed by semi-quantitative S.E.M. examination.

Muscovite in samples A-5 and A-6 will be analysed by John Knight at U.B.C. on the electron microprobe, and results and billing forwarded by him directly to you.

John G. Payne

Sample A-1 **Meta-tuff with Cherty layer**

The rock contains fragments of very fine grained aggregates of quartz-(sericite-pyrite) in a groundmass of muscovite-quartz with abundant disseminated pyrite. A layer several mm thick is dominated by cherty quartz with much less pyrite and sericite.

fragments	
quartz-(sericite)	3- 4%
groundmass	
muscovite	40-45
quartz/plagioclase	17-20
pyrite	2- 3
chlorite	0.3
ankerite	minor
apatite	trace
cherty layer	25-30

The rock contains equant to lensy fragments(?) averaging 1-1.5 mm in size dominated by aggregates of slightly to moderately interlocking quartz grains averaging 0.03-0.1 mm in grain size. Sericite forms irregular patches of flakes averaging 0.02-0.03 mm long. A few fragments contain minor to moderately abundant disseminated pyrite. One contains a few ragged, skeletal grains of ankerite up to 0.2 mm in size. These patches may be secondary after plagioclase phenocrysts.

The groundmass is dominated by subparallel aggregates of very fine to fine grained muscovite flakes. Quartz forms lenses and patches averaging 0.1-0.2 mm long of grains averaging 0.03-0.1 mm in size. Much of the muscovite is in subparallel orientation parallel to foliation. Grain size varies moderately from less than 0.03 mm long to up to 0.3 mm long. Wispy seams of muscovite define a second foliation at a low angle to the first foliation.

Chlorite forms equant, colorless porphyroblasts averaging 0.07-0.1 mm in size.

Pyrite forms disseminated anhedral to euhedral grains averaging 0.01-0.05 mm in size, with a few up to 0.1 mm across. A few pyrite rich lenses averaging 0.3-0.5 mm long contain abundant subhedral to euhedral pyrite cubes averaging 0.01 mm in size intergrown with less quartz and muscovite.

Ankerite forms a very few anhedral grains averaging 0.1-0.2 mm in size.

Apatite forms anhedral, equant grains averaging 0.02-0.03 mm in size.

The rock contains a lensy layer of chert up to several mm wide dominated by equant quartz grains averaging 0.01-0.015 mm in size, with much less disseminated sericite and pyrite. Pyrite grains average 0.01-0.02 mm in grain size. Ankerite forms a few disseminated grains averaging 0.05-0.08 mm in size. The layer appears to be incipiently boudinaged. Lenses rich in extremely fine grained pyrite form replacement veins up to 0.3 mm wide.

A few tight microscopic folds have amplitudes of about 0.5 mm and periods of about 1 mm.

Sample A-2 **Metamorphosed Lithic-Crystal Calcareous Wacke; Ankerite-(Quartz Vein)**

Fragments of quartz grains, chert, cherty mudstone, and minor plagioclase grains are set in a foliated groundmass dominated by ankerite and quartz, with minor sericite. A post-metamorphic vein is dominated by ankerite with minor quartz.

fragments		vein	
quartz grains	12-15%	ankerite-(quartz)	1- 2%
cherty mudstone	12-15		
chert	7- 8		
plagioclase	0.2		
opaque	minor		
apatite	trace		
tourmaline	trace		
zircon	trace		
groundmass			
ankerite	35-40		
quartz	20-25		
sericite	4- 5		
opaque	0.3		

Quartz forms single grains averaging 0.5-1.2 mm in size, and a few aggregates up to 1.8 mm across of anhedral grains averaging 0.1-0.7 mm. Many of the aggregates were formed by recrystallization of coarser single grains, and some show moderately strained extinction.

Cherty mudstone forms fragments up to 5 mm wide and 12 mm long. It is dominated by quartz grains averaging 0.005-0.01 mm in size and less sericite flakes. The latter are oriented moderately parallel to the length of the fragments (and the foliation in the rock). Larger fragments are cut by wispy seams of opaque, along which the rock was contorted slightly. An elongate fragment 6 mm long and a few smaller ones are foliated perpendicular to their length (foliation = orientation of sericite). This foliation is warped moderately in a series of small kink folds. A few seams of opaque are parallel to the kink-fold axes. In narrower parts of the large fragment and along its borders, and in some smaller fragments, sericite is recrystallized to very fine grained muscovite, which is oriented parallel to the length of the fragment. Other fragments contain less sericite, and grade in composition and texture towards the chert fragments. One of the latter contains patches with moderately abundant, disseminated, dusty carbonaceous opaque.

Chert fragments average 0.3-1.2 mm in size. They are dominated by equant quartz grains averaging 0.01-0.02 mm in size, with minor sericite and ankerite. Some fragments contain wispy sericite seams, along which quartz was recrystallized to slightly coarser grains in subparallel orientation. Ankerite locally forms subhedral porphyroblasts up to 0.15 mm in size. One fragment contains abundant subhedral to euhedral, rhombic ankerite porphyroblasts averaging 0.02 mm in size.

Plagioclase forms a few anhedral grains averaging 0.5 mm in size. One fragment 0.9 mm long consists of an intergrowth of a large quartz grain and a smaller plagioclase grain.

One equant opaque grain 0.4 mm across appears to be detrital; it may be hematite.

Apatite is concentrated in one lensy patch with opaque and sericite as equant anhedral grains averaging 0.02-0.03 mm in size.

Tourmaline forms an equant grain 0.15 mm in size. Pleochroism is from very pale to medium olive green.

Zircon forms a few rounded grains averaging 0.05-0.1 mm across; one of the larger grains is corroded slightly.

In the groundmass, ankerite forms anhedral, slightly interlocking grains averaging 0.05-0.15 mm in size and a few patches of much finer grains.

Quartz forms aggregates of slightly interlocking to submosaic grains averaging 0.02-0.05 mm in size. Grain size varies moderately from patch to patch. A few quartz patches contain subhedral to euhedral porphyroblasts of ankerite averaging 0.05-0.1 mm in size.

Sericite/muscovite is concentrated in wispy seams up to 0.1 mm wide and patches up to 1 mm across. Some of these are contorted strongly. Dusty to extremely fine grained opaque (carbonaceous?) is intergrown with sericite/muscovite flakes. Disseminated in ankerite and quartz are minor sericite/muscovite flakes averaging 0.03-0.07 mm long.

Opaque (possibly ilmenite/Ti-oxide) forms anhedral grains averaging 0.05-0.15 mm in size, mainly associated with seams of sericite.

A discontinuous vein up to 0.9 mm wide is dominated by medium grained ankerite with minor patches of cherty to very fine grained quartz.

Sample A-3 **Metamorphosed Porphyritic Latite Flow** (or Crystal Tuff); **Replacement Pyrite-Chlorite-Calcite-Quartz**

Phenocrysts of plagioclase and minor ones of hornblende and quartz are set in a moderately foliated groundmass dominated by plagioclase, sericite, and calcite. The elongate nature of some of the plagioclase phenocrysts suggests that the rock is a flow rather than a crystal tuff. However, the evidence is not conclusive, and the alternate origin as a crystal tuff is possible. A major replacement vein and smaller patches are dominated by pyrite and chlorite with much less calcite and quartz.

	phenocrysts	groundmass	replacement vein, patches
plagioclase	15-17%	50-55%	
hornblende(?)	0.5		
quartz	trace	0.3	1- 2%
sericite		8-10	
calcite		8-10	2- 3%
pyrite		1- 2	5- 7
chlorite		1- 2	2- 3
Ti-oxide		0.3	
apatite		trace	
zircon		trace	
fragments(?)			
quartz-(pyrite)	1- 2%		

Plagioclase forms subhedral to euhedral phenocrysts averaging 0.5-1.2 mm in size. Shapes range from equant to moderately elongate prismatic. Some clusters contain aggregates of a few plagioclase grains. Alteration is slight to moderate to disseminated flakes of sericite and patches of calcite.

A few elongate patches up to 1 mm long are dominated by very fine grained calcite with locally minor quartz and pyrite. Shapes of these patches suggest that they may represent altered hornblende phenocrysts.

Quartz forms a very few, angular grains up to 0.4 mm long, which may represent original phenocrysts.

Several patches averaging 0.2-0.7 mm in size are dominated by aggregates of fine to very fine grained quartz. Some contain minor to moderately abundant pyrite and/or calcite. The origin of these is uncertain.

In the groundmass, plagioclase forms anhedral grains averaging 0.02-0.1 mm in size. Alteration is moderate to sericite and calcite.

Sericite forms disseminated flakes and clusters of a few flakes averaging 0.01-0.03 mm in size, and is intergrown intimately with plagioclase. Locally it is concentrated in wispy seams parallel to foliation.

Calcite forms disseminated, irregular grains and clusters of grains averaging 0.05-0.1 mm in size, with a few patches containing grains up to 0.3 mm across.

Pyrite forms disseminated grains and clusters of grains averaging 0.02-0.1 mm in grain size.

Quartz forms a few equant grains averaging 0.1-0.2 mm in size.

Ti-oxide forms anhedral lenses averaging 0.1-0.15 mm long and equant patches averaging 0.05 mm across. These are secondary, probably after ilmenite; most have a delicate concentric texture.

Apatite forms a few subhedral, stubby prismatic grains up to 0.15 mm in length.

The main replacement vein and smaller replacement patches are dominated by pyrite and chlorite, with less calcite or quartz. A few patches are Chlorite forms anhedral aggregates of grains averaging 0.02-0.08 mm in grain size. Quartz forms equant to elongate grains averaging 0.05-0.15 mm in size. Commonly elongate grains are oriented perpendicular to crystal faces of pyrite, and are intergrown with irregular flakes of chlorite. Calcite forms a few grains up to 1.5 mm in size; more commonly it forms irregular aggregates of grains averaging 0.05-0.15 mm in size intergrown with chlorite and quartz.

One quartz grain contains a patch 0.06 mm across consisting of a grain of galena containing a smaller grain of pyrite and one of chalcopyrite.

Sample A-4 **Metamorphosed Andesitic Tuff; Replacement Lenses of Quartz-Ankerite and Quartz-Chlorite**

Lenses and patches of very fine grained plagioclase-ankerite are set in a well foliated groundmass dominated by chlorite, with much less ankerite, plagioclase, pyrite, and Ti-oxide. A few replacement(?) lenses are of quartz-ankerite or quartz-chlorite.

chlorite	50-55
plagioclase	25-30
ankerite	10-12
pyrite	3- 4
quartz	1- 2
Ti-oxide	1

Lenses and patches up to 2 mm long consist of submosaic aggregates of plagioclase and ankerite averaging 0.03-0.1 mm in grain size. These grade down in size to much smaller lenses and single grains of plagioclase and ankerite. Plagioclase locally shows simple or weakly developed albite twins; this distinguishes it from quartz. A small percentage of the untwinned grains classified as plagioclase may actually be quartz.

The groundmass is dominated by chlorite, which forms extremely fine to very fine grained flakes, commonly in subparallel orientation parallel to a prominent foliation. Finer grained lenses of chlorite commonly contain abundant prismatic grains and irregular aggregates of rutile averaging 0.005-0.01 mm in grain size and equant grains of pyrite up to 0.02 mm in size; these commonly are concentrated in seams and lenses parallel to foliation. A few recrystallized patches up to 1 mm in size contain chlorite flakes averaging 0.07-0.25 mm in size in random orientation.

Pyrite also forms disseminated grains and aggregates of grains averaging 0.05-0.5 mm in size. Surrounding most coarser grains are recrystallized patches of chlorite.

One lens 5 mm long and up to 1.3 mm wide consists of quartz and less abundant ankerite. Quartz forms anhedral grains averaging 0.1-0.5 mm in size, many of which show strained extinction. Ankerite forms anhedral grains averaging 0.07-0.1 mm in size.

One lens 1.5 mm long consists of patches of very fine grained quartz coarsely intergrown with patches of very fine grained recrystallized(?) chlorite.

Sample A-5 **Quartz-Sericite-Ankerite Schist (Meta-sedimentary Rock or Metamorphosed Fine Felsic Tuff)**

The rock is dominated by quartz and sericite, with lesser ankerite and minor pyrite. A strong foliation is contorted moderately to strongly into small kink folds, and cut by a second foliation axial planar to the kink folds and at a moderate to high angle to the primary foliation. Locally, sericite was recrystallized to muscovite along the second foliation direction. Kink folds are developed much more strongly in sericite-rich parts of the rock than in quartz-rich lenses. Veins and veinlets are dominated by ankerite and quartz.

sericite	45-50%
quartz	35-40
ankerite	7- 8
muscovite	3- 4
pyrite	0.5
Ti-oxide	0.1
chlorite	minor
veins	
ankerite-quartz	2- 3

Sericite forms subparallel flakes averaging 0.01-0.05 mm in length, oriented parallel to the primary foliation. It was recrystallized locally to braided strands of aggregates of subparallel muscovite flakes up to 1 mm in length oriented along the second foliation.

Quartz forms equant, slightly interlocking grains averaging 0.005-0.02 mm in size. It also is concentrated in a few quartz-rich lenses parallel to foliation up to 0.2 mm wide and 1.5 mm long.

Ankerite forms disseminated, anhedral to euhedral grains averaging 0.02-0.03 mm in size, with a few grains up to 0.15 mm across. It is concentrate moderately in certain layers and patches, and with sericite accounts for the buff color of the rock.

Pyrite forms disseminated grains averaging 0.05-0.1 mm in size, with a few up to 0.4 mm across. A few have partial to complete rims of quartz grains averaging 0.05 mm in size, and one has minor chlorite intergrown with quartz in the halo.

Chlorite forms equant grains averaging 0.03-0.07 mm in size bordering a few pyrite grains.

Ti-oxide forms irregular patches up to 0.2 mm long.

One discontinuous vein up to 1 mm wide is dominated by medium to fine grained ankerite and less fine grained and minor very fine grained, disseminated flakes of chlorite. A few irregular veinlets from 0.1-0.2 mm wide are dominated by very fine grained quartz and ankerite.

Sample A-6 **Muscovite-Pyrite-Quartz Schist (Metamorphosed Felsic Tuff?)**

A few quartz phenocrysts(?) are set in a groundmass dominated by muscovite with much less quartz. Muscovite contains abundant disseminated pyrite and minor disseminated apatite. The rock probably is a metamorphosed and altered felsic tuff. The grey color of the hand sample is because of the finely disseminated pyrite.

phenocrysts and vein(?)	
quartz	2- 3%
groundmass	
muscovite	77-82
pyrite	7- 8
quartz	10-12
apatite	0.3
zircon	trace

Quartz forms a few single grains averaging 0.3-0.7 mm in size. Most of these are anhedral, and a few are subhedral. Some have textures typical of phenocrysts. However, one discontinuous, quartz-rich lens or vein zone up to 1 mm wide contains similar quartz grains up to 3 mm long.

Muscovite forms aggregates of flakes averaging 0.1-0.5 mm in length; these are in parallel orientation and define the strong foliation in the rock. Foliation is contorted slightly into wavy folds.

Quartz is concentrated in lenses and patches, mainly as aggregates averaging 0.02-0.05 mm in grain size, and locally in coarser grained patches averaging 0.1-0.2 mm in grain size. Along borders of coarser pyrite grains, it is recrystallized into aggregates oriented perpendicular to pyrite crystal faces.

Pyrite is concentrated in certain bands parallel to foliation, and generally is intergrown with muscovite. A few layers are dominated by pyrite and quartz. Pyrite-rich bands average 0.1-0.2 mm wide. Grain size of pyrite averaged 2 microns up to 0.2 mm. A few pyrite patches are up to 0.5 mm across; some of these are rimmed by aggregates of recrystallized quartz.

Ti-oxide (after ilmenite?) forms equant, subhedral grains averaging 0.07-0.2 mm in size.

Apatite forms disseminated, ragged, anhedral to subhedral grains averaging 0.1-0.2 mm in length.

Zircon forms anhedral to subrounded grains up to 0.15 mm long.

Sample A-7 **Metamorphosed Felsic Lapilli Tuff; Ankerite-rich Layer or Replacement Vein**

The rock contains a few equant fragments of latite in a strongly deformed groundmass dominated by quartz and muscovite. Pyrite occurs in two main modes. A layer or diffuse replacement vein up to 1.5 mm wide contains abundant ankerite.

fragments	
latite/chert	3- 4%
quartz	45-50%
muscovite/sericite	35-40
pyrite	7- 8
ankerite	2- 3
apatite	0.1
chlorite	0.1
Ti-oxide	minor

Subrounded fragments average 0.7-1.2 mm in size. One latite fragment is dominated by anhedral grains of plagioclase averaging 0.02-0.07 mm in size. It also contains moderately abundant disseminated flakes of sericite, disseminated pyrite, and abundant clusters of equant grains of apatite(?) averaging 0.01 mm in size. Another fragment contains plagioclase in a similar texture, with disseminated clusters of pyrite and one subhedral prismatic apatite grain 0.08 mm long. Some fragments are dominated by quartz averaging 0.005-0.01 mm in size and much less sericite. Some of these contain moderately abundant, disseminated, extremely fine grained pyrite.

Quartz forms anhedral grains averaging 0.005-0.02 mm in size intergrown intimately with sericite.

Sericite forms wispy flakes averaging 0.02-0.05 mm in length intergrown with quartz. These probably defined an original metamorphic foliation. Sericite was contorted along closely spaced seams, and recrystallized strongly to coarser grained muscovite flakes along some of these seams to produce a second foliation. One lensy patch 1.2 mm long consists of unoriented flakes of muscovite averaging 0.1-0.2 mm in length intergrown with minor grains of ankerite of similar size.

Pyrite is concentrated in irregular lenses and patches, commonly elongated parallel to foliation. In these, pyrite forms anhedral grains averaging 0.01-0.03 mm in size, and is intergrown intimately with sericite and less commonly with quartz. Pyrite also forms single grains and clusters of grains averaging 0.1-0.5 mm in size. Most of these are surrounded by recrystallized quartz grains, which grew in wavy, flamelike, subparallel aggregates extending outwards from the pyrite crystal faces which are subperpendicular to the second foliation.

The ankerite-rich layer or replacement vein averages 0.7-1.5 mm in width. In places it is dominated by prismatic grains of ankerite oriented perpendicular to the walls of the vein. Elsewhere, ankerite is intergrown with minor to moderately abundant quartz-sericite. Elsewhere in the rock, ankerite forms scattered grains averaging 0.07-0.1 mm in size.

Chlorite forms single, equant porphyroblasts and aggregates of a few flakes averaging 0.07-0.12 mm in size, with a few up to 0.2 mm across. Most grains are very pale green in color, and a few are light olive green.

Apatite forms anhedral to subhedral, prismatic grains averaging 0.07-0.1 mm in length. Some are granulated moderately.

Ti-oxide forms a few irregular patches up to 0.15 mm in size of extremely fine grained aggregates.

Sample A-8 **Barite Vein with minor Tetrahedrite, Bournonite, Boulangerite, Sphalerite, Native Gold, Pyrite and Quartz**

Although textures are not conclusive, the rock is interpreted as a barite-rich vein containing lenses, patches, and disseminations of pyrite with less tetrahedrite and minor sphalerite, boulangerite, bournonite, and quartz. Sulfosalts are concentrated in one main band. **Native gold** forms disseminated grains associated with sulfosalts and pyrite. The section is much thicker than normal (for fluid inolusion study), and thus the composition of the silicates was difficult to determine. Coarser barite grains contain minor fluid inclusions, which were not studied further.

barite	85-87%	
pyrite	5- 7	
quartz	2- 3	
quartz/plagioclase	1- 2	
tetrahedrite	3- 4	
sphalerite	Ø.3	
boulangerite	Ø.3	(?)
bournonite	Ø.1	(?)
sericite/muscovite	Ø.1	
native gold	**trace**	

Barite forms anhedral grains averaging Ø.1-Ø.5 mm in size, with a few prismatic grains up to 1.7 mm long. Some coarser grains contain patches with minor fluid inclusions of unknown composition less than Ø.Ø1 mm in size.

Quartz forms disseminated, anhedral grains averaging Ø.Ø5-Ø.Ø8 mm in size. Quartz or plagioclase forms a few subhedral, stubby prismatic grains up to 1.5 mm long.

Muscovite forms scattered, slender flakes and clusters of a few flakes averaging Ø.Ø7-Ø.1 mm in length.

Pyrite forms clusters averaging Ø.2-Ø.7 mm in size of anhedral to euhedral grains averaging Ø.Ø1-Ø.Ø5 mm in grain size.

Tetrahedrite forms anhedral grains averaging Ø.Ø5-Ø.5 mm in size, with a few coarser grains up to 1.5 mm across. The S.E.M. analysis shows its composition to be a compound of Cu, Zn, Sb, and S with minor As and a trace of Ag. Boulangerite (Pb,Sb,S) and bournonite (Pb,Cu,Sb,S) forms grains averaging Ø.Ø3-Ø.Ø7 mm in size intergrown with tetrahedrite. Their optical properties are similar, with boulangerite having a slightly greater anisotropism.

Sphalerite forms anhedral grains averaging Ø.Ø2-Ø.Ø3 mm in size, mainly intergrown with tetrahedrite.

A few grains of **native gold** from Ø.ØØ3-Ø.ØØ7 mm long occur on the border of pyrite grains and boulangerite. A few others averaging Ø.ØØ3-Ø.ØØ5 mm in size occur occur within larger grains of boulangerite and tetrahedrite. Grains are light yellow in color, suggesting a composition similar to that of the coarser native gold grain in Sample A-9.

Sample A-9 **Tetrahedrite/Tennantite-Sphalerite-Galena-Pyrite-(Native Gold) in Gangue of Quartz-Calcite-(Albite)**

The rock is a vein containing tetrahedrite/tennantite, sphalerite, galena, minor pyrite, and a trace of **native gold** in a gangue of quartz, calcite, and albite.

quartz	35-35%	tetrahedrite/tennantite	12-15%
calcite	30-35	sphalerite	7- 8
albite	7- 8	galena	2- 3
sericite	0.1	pyrite	1- 2
		native gold	**trace**

Quartz forms anhedral aggregates averaging 0.1-0.5 mm in grain size.

Calcite forms equant grains averaging 0.3-0.8 mm in size, and locally up to 1.5 mm across. A few coarser calcite grains contain moderately abundant, tiny inclusions of sphalerite.

Albite forms equant grains averaging 0.7-1.3 mm in size. Some grains are intergrown with and may be replaced partly by much finer grained quartz.

Sericite forms disseminated flakes averaging 0.03-0.05 mm long, commonly intergrown with sulfides along borders of sulfide patches.

Tetrahedrite/tennantite forms anhedral grains averaging 0.1-0.5 mm in size, and locally up to 2 mm in size. In thinner parts of the section it shows a deep red internal reflection. This is characteristic of intermediate members of the tetrahedrite-tennantite solid solution series. The S.E.M. analysis shows abundant Cu, S, and Sb>As, with less Zn and minor Fe and Ag. The fact that Ag was identified by the S.E.M. indicates that it is moderately abundant.

Sphalerite forms anhedral grains averaging 0.05-0.2 mm in size, intergrown with tetrahedrite/tennantite and with quartz and calcite.

Galena forms anhedral grains averaging 0.07-0.2 mm in size, mainly intergrown with tetrahedrite/tennantite.

Pyrite occurs in irregular, clusters of equant, disseminated, subrounded to irregular grains averaging 0.02-0.05 mm in size. It also forms a few subhedral grains up to 0.15 mm across.

Light yellow **native gold** forms one irregular, elongate grain 0.02 mm long in tetrahedrite/tennantite near galena. The S.E.M. analysis indicates that it has a gold/silver ratio of about 80/20.

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Barriere,
B. C.
V0E 1E0

Dear Al,

Enclosed are the results of SEM-EDS investigation you requested on the samples provided by J. Payne. The bill for $90 will follow.

The pictures are all Backscattered electron images and the X-Ray traces were all collected using an EDS detector. Note that all work should be considered preliminary, because it was confined to the areas selected by Dr. Payne and may not be totally representative of the sample. Please integrate these results with Dr. Payne's observations.

The mica in A-5 has a higher K content that that in A-6. As the photo shows the mica in A-5 has numerous small inclusions of a TiO mineral (rutile). On the other hand the A-6 mica has numerous pyrite inclusions of varying size and a few rutile inclusions. The presence of a significant amount of pyrite inclusions (or its oxidation product) may account for the brown colour reported for the A-6 mica.

Monazite was identified in A-5 and Galena in A-6. Both are present in trace amounts.

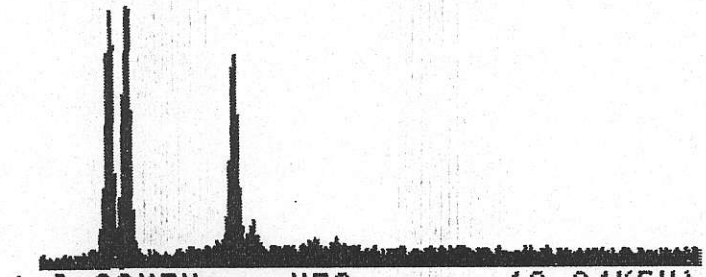
Although it can be said that A-6 has a higher S content than A-5, the significance of this is not clear from the samples. For example both have a well developed tectonic fabric. It is possible that either bulk chemistry or detailed mineralogy may be able to indicate if the S is primary or was introduced during alteration.

Hopes this helps. Call if you want to discuss the results further.

Yours sincerely,

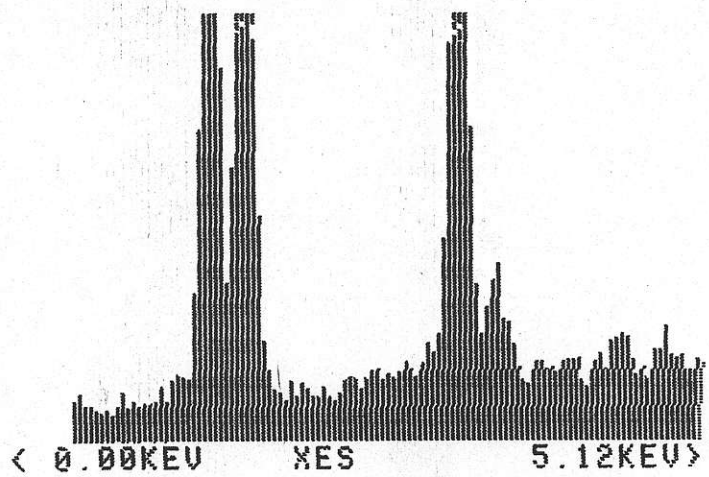
John Knight.

A-6 MICA Z=00
PR= S 17SEC 17627 INT
V=1024 H=40KEV 1:1H AQ=40KEV 1H



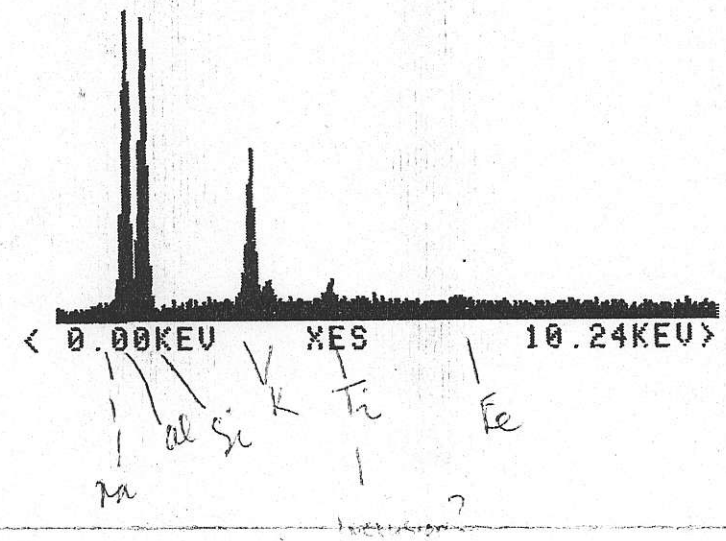
Ka Si K "No" Ti

A-6 MICA Z=00
PR= S 17SEC 17627 INT
V=256 H=40KEV 1:1H AQ=40KEV 1H

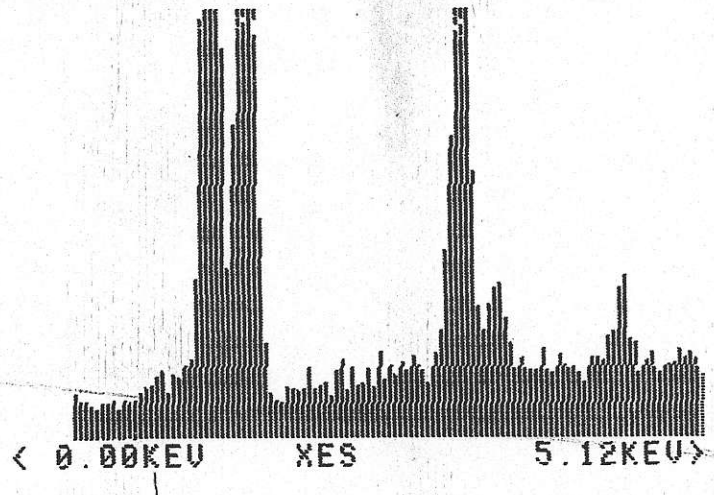


Na

MLK MODE! SELECT ELEMENT 00
A-5 1 MICA Z=00
PR= S 38SEC 17789 INT
V=1024 H=40KEV 1:1H AQ=40KEV 1H



MLK MODE! SELECT ELEMENT 0
A-5 1 MICA Z=00
PR= S 38SEC 17789 INT
V=256 H=40KEV 1:1H AQ=40KEV 1H



MLK MODE! SELECT ELEMENT 00

A-6 Z=00

PR= S 17SEC 17627 INT

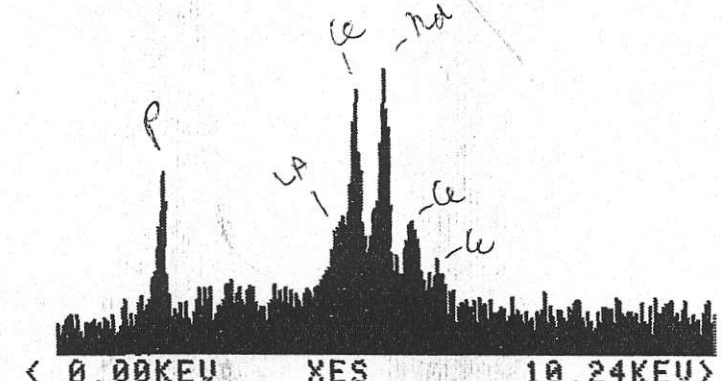
V=1024 H=40KEV 1:1H AQ=40KEV 1H

< 0.00KEV XES 10.24KEV>

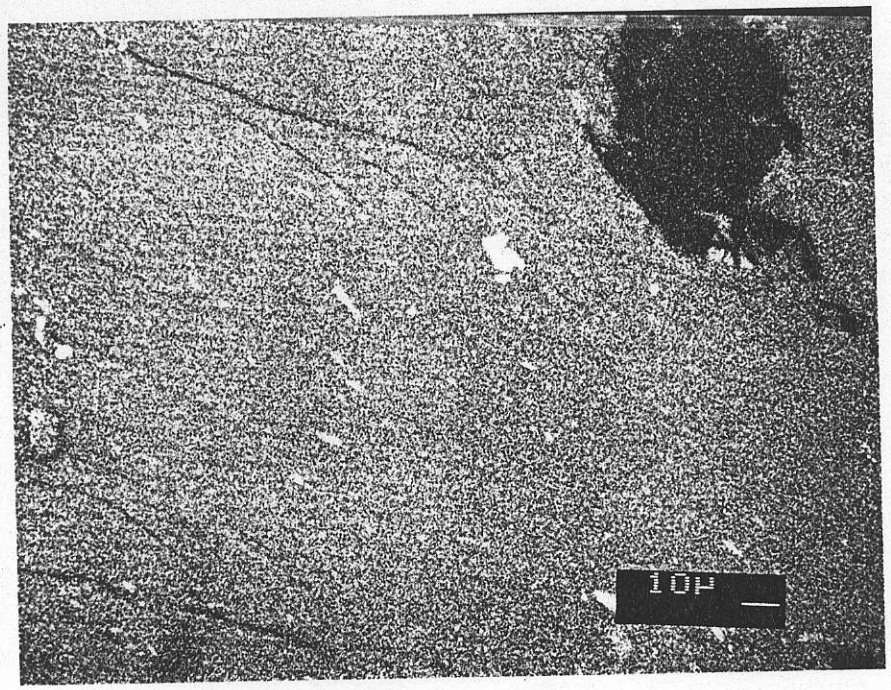
A-5 1 MONOZITE Z=00

PR= S 9SEC 11532 INT

V=256 H=40KEV 1:1H AQ=40KEV 1H



< 0.00KEV XES 10.24KEV>

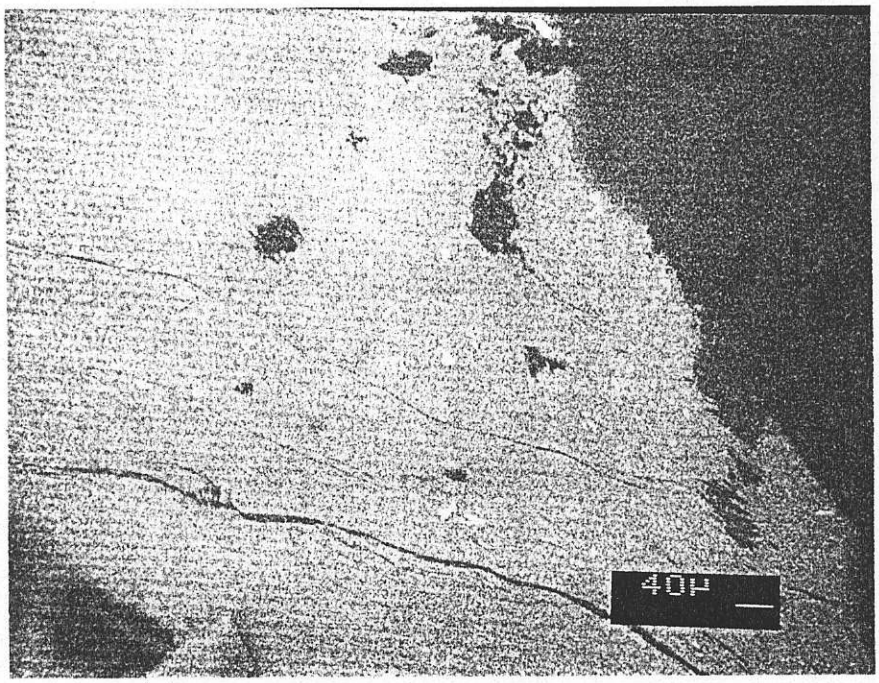


(2)

AS-2

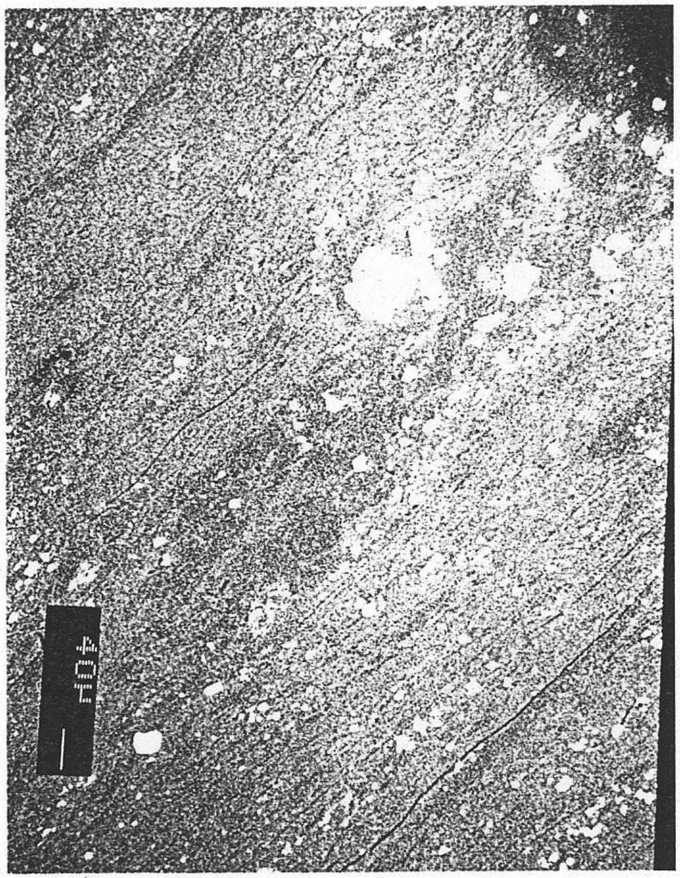
(2) 2 = TiO_2

(1)

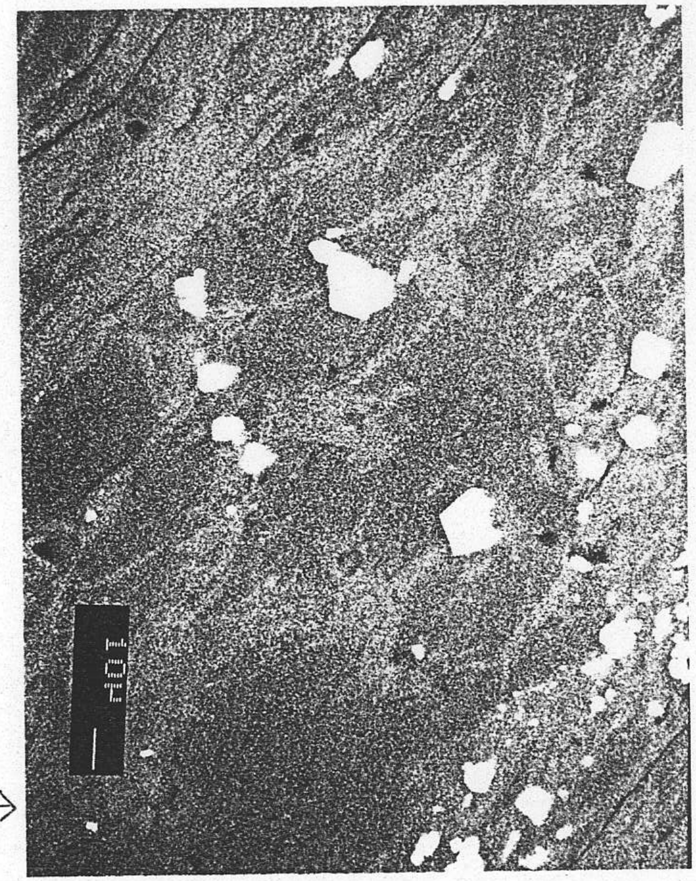


AS-1 (1)

(1) = Monozito

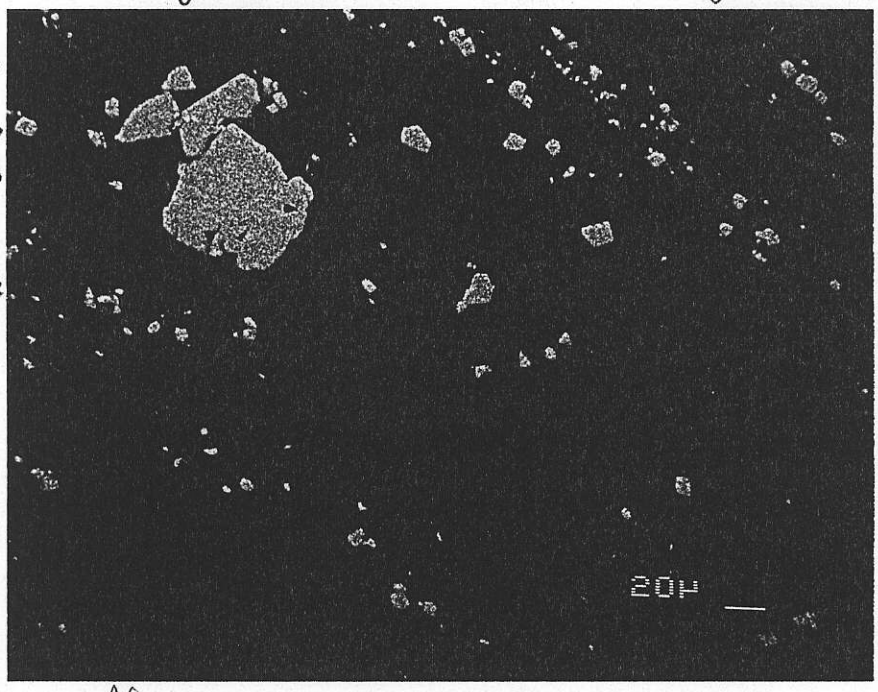


A6



A6

QT2



A6