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Petrology of 14 samples from Western Tasmania for Stellar Resources Ltd

- M1181
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Summary

A suite of 14 rock samples from the Alpine Prospect, western Tasmania was examined in polished thin section and by XRD analysis.

The original lithologies comprise graphitic-muscovitic phyllite, chloritic phyllite, pelitic schist, chlorite schist, dolostone and calcareous-quartzite and also include mylonites and highly sheared, veined and silicified metasediments.

Alteration is difficult to distinguish from the metamorphism within the metasediments. The alteration is dominated by chlorite and carbonate alteration and replacement and by sulphide and oxide mineralisation and silicification.

Veining and brecciation are common throughout this rock suite, with carbonate veins cutting through most of the samples. Brecciation occurs as both polymict and monomict breccias and as localised brecciation around carbonate veining. The matrix minerals within the breccia are dominantly carbonate and quartz, indicating a hydrothermal origin.

The mineragraphy of the suite is dominated by pyrite, chalcopyrite and magnetite. Bornite and chalcocite occur as rare intergrowths with chalcopyrite, and hematite partly replaces magnetite in some samples. Mineralisation is closely associated with highly sheared and strained samples and with carbonate.

The dominantly metamorphic Alpine Prospect rock suite is mineralogically consistent with formation during retrograde metamorphism, although some of the magnetite may be of primary sedimentary origin. Much of the chalcopyrite appears to have formed at a late stage, and is associated with carbonate veins, some of which post-date all shearing and metamorphism.

1. Introduction

A suite of 14 samples from the Alpine Prospect in western Tasmania, Australia was submitted in May 2007 with a request for petrological analysis under covering letter. Instructions and information about these samples are reproduced in Appendix A.

The Alpine Prospect is hosted in the Arthur Metamorphic Complex, with metamorphism dominated by the greenschist metamorphic facies, reaching up to the blueschist and amphibolite facies before retrogressing to the greenschist facies. The complex is characterised by polyphase mylonitic deformation with isoclinal fold structures and segregation banding forming along a strong metamorphic fabric. Metamorphism and deformation is Cambrian in age with protolith lithologies, described as including siltstone, sandstone, tholeiitic dolerite, minor basalt and a felsic granitoid, probably Neoproterozoic in age.

Of these samples, all 14 were prepared as polished thin sections, and examined in transmitted and reflected light. One sample was prepared as a bulk powder for carbonate determination and three were prepared as oriented clay separates and analysed by XRD.

2. Lithologies

Lithologies, alteration and vein mineralogy of the samples are summarised in Table 1. This includes the results of XRD analyses. Full petrographic descriptions are given in Section 8.

Table 1 Summary of Lithologies and Alteration

Sample Numbers SKM	Stellar Resources Ltd	Lithology (and primary/metamorphic minerals)	Alteration and Veining
13788	1	Graphitic muscovitic phyllite (Q, Mus/Ser, Fe/Mg Crb, Gr, Chl*, Tur, Tt, Zrn)	Weak: Q, Py, Cpy Vein: Q, Fe/Mg Crb, Py, Cpy
13789	2	Brecciated Phyllite	Clasts: I/Ser, Dol, Q, Tt, Tur, Zrn Matrix/Vein: Dol, Q, Py, Cpy
13790	3	Pelitic Schist (Mus/Ser*, Q, Gr, Tur, Tt, Rt)	Moderate: Q, Dol, Py, FeO Vein: Q, Dol
13791	4	Dolostone (Dol, Q, Mus/Ser, Chl, Cal, Tt, Tur, Py)	Weak: Dol, Q Vein: Dol, Q
13792	5	Polymict Breccia (Ser*, Q, Tur, Crb, Chl*, Tt)	Matrix: Crb, Q, Ser*, Py, Tur Vein: Dol, Q, Tur, Py
13793	6	Silicified Sheared Metasediment (Q, Ser*, Py, Dol, Cpy, Chl*, Tt, Chc, Bn, Po?)	Vein: Dol, Q, Cpy
13794	7	Magnetite- Rich Metasediment	Intense: Q, Crb/Dol, Mt, Py, Cpy Chl*, Tur Vein: Dol, Q, Chl
13795	8	Sulphide-Rich Chlorite Schist (Q, Py, Chl*, Crb, Kfs, Cpy, Tt)	
13796	9	Calcareous Quartzite (Q, Fe/Mg Cal/Dol, Kfs, Ser*, Tt, Py, Cpy, Tur, Zr)	Vein: Dol, Py, {Cpy}, {Opq}
13797	10	Sheared Metasediment (Crb, Py, Q, Cpy, Mt, Ah, I/Ser, Ka, Tt, Po)	Vein: Cal, Py, Cpy, Q, Mt, I/Ser, Bn
13798	11	Silicified Metasediment (Q, Ab, Crb, Cpy, Pt, Tt, Ser*)	Vein: Ser*, Py, Tt
13799	12	Chloritic Phyllite (Q, Chl*, Dol, Py, Cpy, Mt, Tt, Hm)	Vein: Crb, Py, Cpy, Mt
13800	13	Mylonite - Semi Massive Sulphide and Oxide (Crb, Q, Py, Mt, Chl*, Hm, Cpy	Vein: Crb
13801	14	Mylonite - Semi Massive Sulphide and Oxide (Mt, Py, Crb, Q, Hm, Cpy)	Vein: Crb, Q

Mineral Abbreviations

Ab	Albite	Mn	Magnesite
Ah	Anhydrite	Mt	Magnetite
Ap	Apatite	Mus	Muscovite
Bn	Bornite	Opq	Unidentified opaque
Cal	Calcite	Po	Pyrrhotite
Chc	Chalcocite	Py	Pyrite
Chl	Chlorite	Q	Quartz
Cpy	Chalcopyrite	Rt	Rutile
Crb	Unidentified carbonate	Sd	Siderite
Dol	Dolomite	Ser	Sericite
FeO	Iron Oxides	Tt	Titanite
Gr	Graphite	Tur	Tourmaline
Hm	Hematite	Zrn	Zircon
I	Illite		
Ka	Kaolinite	*	Clay phase unconfirmed by XRD
Kfs	K-feldspar	{ }	Phase present only as inclusions

This rock suite is largely metamorphic including phyllite, schist and mylonitic metasediments. A dolostone may represent the protolith lithologies and the monomict and polymict breccia comprise clasts representative of the both protolith rock type and their metamorphic counterparts.

The dolostone is predominantly comprised of dolomite and includes mineralogical indicators of the low temperature greenschist facies. The sample is poorly crystalline and thus indicative of low grade metamorphism of a dolostone protolith. The calcareous quartzite mineralogy is indicative of recrystallisation of quartz-rich sandstone. The carbonate mineralisation appears to have formed as a replacement mineral as indicated by formation as interstitial minerals.

The phyllites are graphite-muscovitic and chloritic and are representative of the low temperature greenschist metamorphic facies with different parent rocks, the muscovite-rich phyllite having a pelitic carbon-rich origin and the latter more indicative of a basic or magnesian parent lithology. The two schists are pelitic and chloritic and probably represent increasing metamorphic grade as the mineralogy is similar to the phyllites described above although there is a marked increase in schistosity and segregation banding.

Many of the samples display sheared and strained textures. Two samples with significantly more intense shearing were named mylonites. These samples appear to have a metasedimentary origin, with mineralogy similar to the phyllitic samples and comprise massive sulphides and oxides. Strained deformation within the metasediments is indicated by textures such as undulose extinction and serrated grain margins in quartz and strain shadows within quartz around euhedral pyrite grains.

3. Alteration and Vein Mineralogy

Alteration is moderate to intense in many of the samples although it is difficult to distinguish the alteration mineralogy from the metamorphic assemblages.

The dominant alteration assemblage is carbonate-silica-sulphide which occurs largely in the highly sheared and strained samples and in particular, the mylonites. The carbonate generally forms in bands or interstitial to other minerals, and often with a poorly crystalline texture. Silicification occurs as quartz-rich patches around veining and within the matrix, and as intense replacement of the groundmass.

Hematite is found strongly replacing magnetite in Sample 14, which also has late stage carbonate. The occurrence of the hematite is closely correlated with the mylonites and is likely a function of the increased permeability of the highly sheared rocks.

The vein mineralogy is dominated by well crystalline carbonates with minor quartz. As in the host rocks, in places the carbonate appears to have replaced quartz. Chlorite occurs in a carbonate-rich vein in the magnetite-rich metasediment (Sample 7), and illite/sericite has formed within the sheared metasediment (Sample 10).

4. XRD Analyses

Four samples were prepared for bulk powder and three of those as oriented clay separates and analysed by XRD over the interval 2-38° for the clay and 2-62° for the carbonates. Where necessary, samples were glycolated and re-run from 2-18°, to assess the interlayered clays, and heated to 550°C for one hour, to distinguish the kandites (kaolinite and dickite) from one another and from chlorite. The glycolated and heated charts are combined with air-dried traces, and distinguished as a dashed line and a dotted line respectively, with labels in italic type for new peaks on the glycolated trace. XRD analysis confirmed the identification of sericite/mica, illite/sericite, chlorite, kaolinite, quartz, dolomite, magnesite, calcite, graphite, pyrite and chalcopyrite and tentatively siderite and Mg calcite and the results are incorporated in Table 1. XRD charts are presented in Section 9.

5. Brecciation and Veining

Dolomite veining is common within these samples and many have dolomite and quartz lenses. Two of the samples have been termed breccias (one monomict and one polymict) although localised brecciation does occur within a few of the metasediments.

The monomict breccia (Sample 2) contains fragmented metasedimentary clasts similar to the phyllitic samples within this rock suite. The matrix is carbonate and quartz-rich, with minor pyrite and chalcopyrite, which suggests that mineralisation occurred concomitantly with brecciation. The fragmental nature of this breccia suggests formation through shear strain, and the carbonate and quartz matrix indicates a hydrothermal origin. Strain shadows around cubic pyrite suggest a period of shear strain post dating mineralisation.

The polymict breccia (Sample 5) comprises both metasedimentary clasts and sedimentary clasts in a carbonate and quartz matrix, again probably hydrothermal in origin. Mineralisation is restricted to the matrix and to veins within the matrix, again suggesting mineralisation at the time of brecciation and in a later episode concomitant with shear strain causing veining and strain features.

Veining within this rock suite generally occurs crosscutting the fabric of the metasedimentary samples. The veins are composed of dolomite, calcite, illite/sericite and chlorite. Most of the quartz-rich veining appears to have formed prior to a shear deformation event which has caused much of the veining to be strained, whereas many of carbonate-rich veins are less sheared or deformed.

6. Mineragraphy

The opaque minerals within this rock suite are pyrite, chalcopyrite, magnetite, hematite, bornite and chalcopyrite. Pyrite is the dominant opaque mineral and is ubiquitous throughout the depth range of the samples. Chalcopyrite also occurs throughout most of the section and is most highly concentrated in the rocks named silicified or sheared metasediments and in the chloritic schist. Bornite has formed within the two sheared metasediments and chalcocite has also formed within the shallow sheared metasediment. Magnetite forms in samples deeper than 219.5 m and the highest concentrations are those contained within the mylonitic rocks.

Chalcopyrite typically forms space filling and within pyrite fractures. In the samples where chalcopyrite occurs in high concentration it is closely associated with dolomite veining and dolomite banding within a foliated and sheared groundmass. Bornite is a rare mineral in the rock suite (Sample 6 and Sample 10) and has formed closely associated with dolomite. Although chalcopyrite and pyrite dominantly form concomitantly fine veinlets within Sample 11 suggest that pyrite mineralisation has also occurred in a later episode.

The magnetite mineralisation occurs with chlorite and carbonate in the magnetite- rich metasediment, the chloritic phyllite and in the deeper mylonite. In the shallower mylonite, magnetite is associated with carbonate banding. The magnetite occurs with variable textures, as strongly hexagonal porphyroblastic, in fine grained granular masses and as massive fractured bands within this rock suite. Hematite is a minor replacement mineral within the mylonites and in the chloritic phyllite.

7. Discussion

Massive oxide and sulphide mineralisation in this rock suite is associated with the samples which are most highly deformed, including the sheared and silicified metasedimentary rocks and the mylonites. Those that were not sheared or silicified (the phyllites, schists, breccias and protolith rocks) are largely barren with only rare to minor pyrite.

Chalcopyrite and pyrite are co-deposited in all instances of chalcopyrite formation. Mineralisation that was considered to be chalcopyrite in crosscutting veinlets in Sample 11 has been determined as fine grained subhedral pyrite and chalcopyrite forms parallel to the rock foliation. To this end pyrite deposition has occurred both concomitantly with chalcopyrite and in a later episode.

Magnetite formation has largely occurred before the common intergrowths of chalcopyrite and pyrite. This is seen in Sample 7 where sigmoidal sulphide veining offsets the magnetite banding, suggesting pyrite and chalcopyrite formed in a later mineralising episode. This is also seen in Sample 12 where chalcopyrite and pyrite are filling spaces within the fractured euhedral (hexagonal) magnetite and in the muscovitic schist where pyrite appears to have replaced a pale grey hexagonal (probably magnetite) mineral. In the mylonites however, the magnetite is closely intergrown with pyrite and chalcopyrite which may suggest that they have formed within the same mineralising episode. Common hematite formation in Sample 13 may be a function of the increased permeability of the mylonite. It is possible that the magnetite formed within an iron-rich protolith, particularly in view of the correlation between the abundances of magnetite and chlorite in these samples.

In contrast, pyrite and chalcopyrite are generally more abundant where carbonates are more abundant, including in carbonate veins and carbonate-rich breccias. This indicates that the copper was deposited at a later stage during the waning stages of metamorphism and unroofing of a metamorphic complex. The concentration of sulphides, carbonates and silica along the metamorphic fabric of some samples indicates that the deposition of these minerals was influenced by the host rock chemistry. This is consistent with the observation that there is a relationship between copper mineralisation and the mafic schists and banded magnetite-pyrite-carbonate-silicate, despite much of the copper mineralisation being hosted in veins and breccias.

8. Petrographic Descriptions

Sample Numbers:	**Stellar Resources Ltd**	**:**	**1**
	Sinclair Knight Merz	**:**	**13788**
Rock Name:	**Graphitic-Muscovite Phyllite**		

Petrographic Description

Lithology: In hand specimen, the sample is a fine grained medium to dark grey strongly foliated metasedimentary rock with dark and pale grey wavy banding. The sample is cut by a white vein (<4 mm) which has formed semi-perpendicular to the rock fabric and contains a large carbonate and quartz xenolith. Coarse grained pyrite has formed as clots in the vein.

In thin section, the rock has a strong planar fabric formed by foliations of muscovite/sericite, quartz, graphite and carbonates (Mg calcite, dolomite and siderite/magnesite from XRD). Muscovite/sericite is a major mineral constituent of the rock, occurring in sinuous foliations in the rock fabric, as bent mica flakes and intergrown with graphite. Quartz occurs finely intergrown with the muscovite/sericite and as coarser, slightly elongate crystals forming along foliations in the very fine grained quartz-muscovite/sericite matrix. Iron and magnesium-rich carbonates have formed interbedded with white mica along the rock fabric and as irregular patches within the foliated minerals. Colourless to very pale green chlorite also occurs as foliations. Minor tourmaline occurs as fine hexagonal to rounded porphyroclasts and titanite occurs as minor subhedral crystals throughout the foliated groundmass. Zircon has formed as rare rounded crystals within the fine grained quartz. A series of folds within the micro-fabric suggests a period of ductile deformation which post-dates the rock fabric formation.

Alteration: Alteration is difficult to distinguish from metamorphism in this sample. The coarse quartz crystals within the muscovite-quartz matrix may be secondary through partial silicification of the phyllite.

Veining: There is one substantial vein and two minor veins. The large vein is comprised of coarsely crystalline iron and magnesium-rich carbonates and quartz with minor opaques, and branches into two thin (<2 mm thick) veins. The carbonates occur in a patchwork texture with irregular grain boundaries, and the quartz has a strained appearance, with sutured margins and undulose extinction. Two minor bands (up to 0.2 mm) of strained quartz with minor highly birefringent carbonate have formed as splays from the major vein, and are partially offset by the strong foliations in the rock.

Mineragraphy:	The mineragraphy of the sample comprises pyrite and chalcopyrite. Pyrite occurs as very fine grained and subhedral, often elongate along the muscovite foliation, and rarely in the carbonate-quartz vein as fine subhedral grains. The chalcopyrite occurs solely in the vein, as anhedral space filling interstitial to the carbonate and quartz. In addition, there are thin bands of fine graphite within the host rock.	
Proportions (%):	Primary:	Quartz (37), muscovite/sericite (29), Fe/Mg carbonate (10), graphite (8), chlorite* (2), tourmaline (1), titanite (1), zircon (<1)
	Secondary:	Quartz (5), Fe/Mg carbonate (6), pyrite (<1), chalcopyrite (<1)
XRD:	Sericite/Mica, Quartz, Graphite, Dolomite, Siderite/Magnesite?, Mg Calcite?	

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Sample Numbers:	**Stellar Resources Ltd**	**:**	**2**
	Sinclair Knight Merz	**:**	**13789**
Rock Name:	**Brecciated Phyllite**		

Petrographic Description

Lithology: In hand specimen, the sample has a brecciated texture. The breccia is comprised of dark grey highly fractured phyllosilicate clasts in a matrix of coarsely crystalline carbonate and quartz. The breccia has strong sulphide mineralisation which is closely spatially associated with the matrix carbonate and quartz.

In thin section, iron-stained illite/sericite occurs in strongly foliated clasts with quartz, dolomite, titanite, tourmaline and rare zircon. The clay is fine grained with a preferred mineral orientation, and with some clasts having a vague segregation banding. Quartz has formed as elongate porphyroclasts within the clast fabric and forms pressure shadows around subhedral opaque inclusions. Some of the sericite flakes are coarse and birefringent, and could be muscovite. Tourmaline forms rounded crystals and titanite forms irregular fine crystals within the phyllosilicate foliations. The clasts are supported within a fine to medium grained dolomite-quartz matrix. The mineralogy suggests that this was originally a muddy limestone or calcareous mudstone.

Alteration: The original clast mineralogy and textures have been modified by metamorphism, alteration and brecciation, but it is difficult to distinguish what minerals have formed by alteration. Some silicification may have formed the coarse quartz patches and lenses within the clasts and along the clast matrix boundary.

Veining: Veining is not readily distinguished within this sample although the clay-rich clasts have been highly cut through by millimetre scale, fine to medium grained quartz lenses. The quartz has serrated grain margins with undulose extinction. The lenses mostly occur parallel to the foliation in the phyllosilicates and are not continuous into the matrix. In addition, there are some patches of medium to coarse quartz with undulose extinction, which appear to be brecciated quartz-rich vein clasts.

Mineragraphy: Pyrite is the major opaque phase in this sample and has formed crystals with anhedral to euhedral habit. The mineralisation is strongly associated with the matrix dolomite and quartz, although pyrite is also found scattered throughout

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the clasts and within quartz- rich lenses in the clasts. High concentrations of mineralisation occur along grain boundaries between the clasts and the matrix. Chalcopyrite has formed as a rare mineral within fractures in pyrite crystals.

Brecciation: The sample is a monomict breccia. The clasts are phyllites, comprised of illite/sericite, quartz, dolomite, titanite, tourmaline and rare zircon. The clasts are angular, irregular and highly fractured and range from millimetre to centimetre size. The matrix is composed dominantly of dolomite and quartz. The dolomite is coarsely crystalline ranging from fine to medium grained and the quartz appears highly strained. Rather than being coeval and intergrown, the quartz appears to have formed earlier, and so is more deformed, brecciated, and appears to have been partially replaced by the coarser and generally undeformed carbonate.

Proportions (%): Clasts: Illite/sericite (40), dolomite (10), quartz (6), titanite (2), tourmaline (1), zircon (<1)
Vein/matrix: Dolomite (27), quartz (10), pyrite (2), chalcopyrite (<1)

XRD: Illite/Sericite, Quartz, Dolomite, Graphite

Sample Numbers:	Stellar Resources Ltd	:	3
	Sinclair Knight Merz	:	13790
Rock Name:	Pelitic Schist		

Petrographic Description

Lithology: In hand specimen, the sample is a light grey and pale green segregation banded metasedimentary rock. The sample has a distinct wavy foliation with coarse quartz banding and shears along pale green micaceous banding. Fine sulphides are disseminated throughout the sample. This sample has a higher schistosity and coarser grain size relative to Sample 1.

In thin section, the sample is comprised of muscovite/sericite, quartz, graphite and dolomite. The muscovite/sericite occurs as coarse flakes in sinuous bands interbedded with graphite, and intergrown with coarse quartz and dolomite crystals. Micro-folds within the foliated mica indicate ductile deformation. The quartz has formed as medium to coarse grained bands with irregular grain boundaries and as micro quartz interbedded within the mica. The quartz has a strained appearance as indicated by undulose extinction and sutured margins, and by the formation of quartz shadows around subhedral opaque (pyrite) crystals. Tourmaline and rutile have formed subhedral rounded crystals within the groundmass and titanite occurs with a subhedral habit with irregular grain boundaries. The mineralogy points to a pelitic protolith.

Alteration: Alteration is difficult to distinguish in this sample, though much of the quartz, carbonate and opaques could be secondary. Dolomite occurs in lensoidal bands semi-parallel to the rock fabric as coarse crystals and intergrown with quartz. The rock has been partially silicified with quartz forming coarse polycrystalline grains within the muscovite/sericite matrix. Opaque (pyrite) crystals have formed replacing a hexagonal pale grey opaque mineral, probably magnetite.

Veining: The rock is cut by discontinuous veins and irregular patches of quartz and carbonate (dolomite). In places the two are intergrown, though generally the carbonate appears to be replacing or cutting across earlier formed quartz. Several patches of quartz appear to be brecciated vein fragments, and many of these are bounded by shear fractures.

Mineragraphy: The mineragraphy of the sample is comprised of pyrite. Pyrite is pervasively disseminated as subhedral to euhedral cubic, hexagonal and pyritohedral crystals up to 0.6 mm in length. The pyrite also occurs partially fractured, with the elongate fracture axis semi-parallel to the foliation, indicative of deformation post-dating the pyrite formation. Fine fractures in the sample have been filled with iron oxide proximal to the coarser pyrite.

Proportions (%): Primary: Muscovite/sericite (46), quartz (5), graphite (5), tourmaline (1), titanite (<1), rutile (<1)

Secondary: Quartz (27), dolomite (12), pyrite (2), iron oxides (<1)

Sample Numbers:	Stellar Resources Ltd	:	4
	Sinclair Knight Merz	:	13791
Rock Name:	Dolostone		

Petrographic Description

Lithology: In hand specimen, the sample is a very fine grained pale grey to green highly indurated sedimentary rock. The sample has a distinct foliation which may be sedimentary bedding or a metamorphic fabric. A white-pink coarsely crystalline carbonate vein and several fine white-grey quartz veins transect the sample.

In thin section, the sample is fine grained and equigranular, composed dominantly of carbonates (dolomite, magnesite and calcite) with quartz, sericite/white mica, tourmaline, and titanite. Dolomite/magnesite is the dominant mineral in the sample, has formed with irregular grain boundaries and is poorly crystalline. Quartz occurs as medium to fine grained anhedral crystals that are intergrown with fine sericite and chlorite. Minor titanite occurs as fine grained anhedral crystals, tourmaline occurs as minor fine equant rounded crystals and there are rare coarse sericite/muscovite flakes. Chlorite was tentatively identified by XRD.

Alteration: Alteration is difficult to distinguish in this sample. Secondary quartz and carbonate have formed within veins, and in both veins and the host rock, the carbonate is replacing quartz.

Veining: In hand specimen the sample is cut by two generations of veining. The first generation is a series of coarsely crystalline (up to 3 mm thick) grey-blue bands which are oblique to the later stage veins, and parallel to the fine foliation evident in the rock. The bands are composed of coarse grained dolomite and quartz. These are crosscut by one fine (less than 1 mm) and one more substantial (over 6 mm) white-pink vein transecting the sample. These veins are composed of fine grained dolomite with minor coarse grained quartz. Both the quartz and dolomite have strain features such as undulose extinction, and dolomite has clearly formed at the expense of quartz. The thin section also contains a thin dolomite vein. Its relationship to the other veins is not seen, but the lack of shear features indicates that it is younger.

Mineragraphy:	The mineragraphy of the sample is comprised of pyrite which is disseminated throughout the dolomitic groundmass and within the dolomite veins. The pyrite is euhedral to subhedral and fine grained (up to 0.05 mm).	
Proportions (%):	Primary:	Dolomite/magnesite (48), quartz (26), sericite/muscovite (5), chlorite (3), calcite (2), titanite (1), tourmaline (1), pyrite (1)
	Vein:	Dolomite (8), quartz (5)
XRD:	Dolostone:	Sericite/Mica, Quartz, Dolomite, Magnesite, Calcite, Chlorite?
	Vein:	Quartz, Dolomite, Siderite/Magnesite, Illite/Sericite, Kaolinite?/Chlorite?

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Sample Numbers:	**Stellar Resources Ltd**	**:**	**5**
	Sinclair Knight Merz	**:**	**13792**
Rock Name:	**Polymict Breccia**		

Petrographic Description

Lithology: In hand specimen, the sample is a medium grey hard silicified rock with a brecciated texture. The rock is cut through by a creamy white carbonate vein up to 5 mm thick. Sulphides are disseminated throughout the matrix and have formed millimetre size veinlets.

In thin section, the sample is a polymict breccia. The clasts are predominantly clay-rich pelitic metasediments, together with calcareous sediments and polycrystalline quartz grains. The pelitic metasediment clasts comprise dense masses of birefringent sericitic clay with minor quartz, chlorite and fine granular tourmaline and titanite. Rare clasts consist of fine granular calcite with minor intergrown quartz and clay. Other metasedimentary (?) clasts consist largely of very fine tourmaline that encloses quartz, sericite, calcite and scattered zircon, titanite and opaque grains. The polycrystalline quartz encloses pale green or yellow to colourless tourmaline, sericite, and calcite inclusions, which are concentrated in particular crystal growth zones.

Alteration: Alteration is obscure in this sample, though there appears to be partial clay replacement of carbonate proximal to veining, and replacement of carbonate crystals within the vein. The quartz extinction is undulose and the grain boundaries are irregular. The quartz is also rich in secondary fluid inclusions, colouring the grains slightly brown.

Veining: The sample is cut through by a large coarse grained equigranular dolomite vein which is partially clay altered. Opaque minerals form along the dolomite vein boundary and as inclusions within the dolomite crystals. The quartz rich clasts within the breccia appear to be vein fragments. The common tourmaline inclusions in some of this quartz indicate that both quartz and tourmaline were deposited from solution.

Mineragraphy: The mineragraphy of this sample is comprises only subhedral pyrite which occurs disseminated throughout the carbonate and quartz matrix, along the contact between the matrix and the carbonate vein, and in veinlets in the matrix.

Brecciation: This sample is a matrix supported polymict breccia. The matrix comprises around 60 per cent of the sample and is composed dominantly of carbonate (dolomite?) and quartz. The clasts are subrounded to subangular, millimetre to centimetre sized pelitic metasediments, calcareous sediments and vein clasts. In addition to dolomite and quartz, the matrix contains lesser white mica/sericite, tourmaline, titanite and opaques. Dolomite occurs as fine equigranular crystals in a patchwork texture intergrown with quartz. Tourmaline is quite common and occurs as euhedral hexagonal crystals throughout the carbonate and quartz. Many of the tourmaline crystals have a pale green tint and are almost colourless. Titanite has formed rounded crystals closely associated with and as inclusions in pyrite.

Proportions (%):	Primary:	Sericite/white mica* (12), quartz (4), tourmaline (5), carbonate (5), chlorite* (<1), titanite (<1)
	Matrix:	Carbonate (43), quartz (26), sericite* (5), pyrite (4), tourmaline (1)

Sample Numbers:	Stellar Resources Ltd	:	6
	Sinclair Knight Merz	:	13793
Rock Name:	Silicified Sheared Metasediment		

Petrographic Description

Lithology: In hand specimen, the sample is a pale to dark grey, highly indurated, moderately foliated sulphide-rich rock. The sample is cut by two generations of coarse white-pink carbonate veining and several finer veins. Sulphide mineralisation occurs as fine to medium grained chalcopyrite and pyrite along the rock fabric and as coarse clots within the carbonate veining.

In thin section, the sample is highly sheared and much of the primary metasedimentary foliation has been lost by intense deformation and brecciation. The rock is comprised of quartz, sericite/mica and dolomite, with minor chlorite, titanite and opaques. Some areas consist almost entirely of quartz, and others of sericite/mica, though most parts contain quartz, sericite/mica and dolomite. The quartz occurs in ribbons and as coarse grained crystals, and has formed a foliation in the rock with flaky coarse and fine grained sinuous sericite/mica flakes. Quartz shadows have formed around some of the opaque (pyrite) crystals, indicating ductile deformation of the quartz around the pyrite.

Alteration: There are quartz-rich patches, but it is uncertain whether these are entirely primary. The presence of quartz-carbonate-sulphide veining indicates that at least some of the quartz and dolomite is secondary, though there is little evidence of alteration in the sample.

Veining: The thick (up to 6 mm in width) white-pink vein is composed of coarse grained (on average 0.8 mm) dolomite crystals enveloping a fine grained dolomite vein core. This vein crosscuts a dolomite vein of the same thickness with massive chalcopyrite and some prismatic quartz. Two fine carbonate veins also transect the rock fabric and form envelopes along fractures in the rock. Other veins comprise a mixture of dolomite, quartz and opaques. In some, the quartz forms euhedral prismatic crystals, and in others it is anhedral, has undulose extinction, and is interstitial to quartz.

Mineragraphy: The mineragraphy of the sample is comprised of pyrite, chalcopyrite, chalcocite and bornite. The subhedral pyrite is the dominant sulphide. Most grains are highly fractured and intergrown with sheared sericite and quartz groundmass. Chalcopyrite has formed both within the host rock and in the dolomite vein.

The chalcopyrite occurs as coarse (up to 5 mm), massive, highly pitted grains interstitial to the vein dolomite, and filling fractures and forming inclusions within the fractured pyrite. Chalcopyrite has also formed fine grained intergrowths with rare chalcocite and bornite. These intergrowths occur closely associated with the carbonate veining. Chalcocite and bornite have also formed rims around massive chalcopyrite in contact with quartz and dolomite. A very fine grained, unidentified grey-white anhedral mineral occurs as inclusions in the pyrite and possible pyrrhotite forms as fine inclusions within the pyrite.

Brecciation: Brecciation within the sample is seen with large, rounded quartz-rich patches in a sheared sericite-rich pyritic matrix. Some of the quartz-carbonate veins are sheared and fragmented, though most of the more carbonate-rich veins are less intensely sheared. The textures indicate that shear deformation was accompanied by deposition of quartz and pyrite, and later chalcopyrite and dolomite.

Proportions (%): Quartz (36), sericite/mica (22), pyrite (17), dolomite (18), chalcopyrite (5), chlorite (2), titanite (<1), chalcocite (<1), bornite (<1), pyrrhotite? (<1)

Sample Numbers:	**Stellar Resources Ltd**	**:**	**7**
	Sinclair Knight Merz	**:**	**13794**
Rock Name:	**Magnetite- Rich Metasediment**		

Petrographic Description

Lithology: In hand specimen, the sample is a fine grained, medium grey metasedimentary rock. Sulphide mineralisation has formed along the wavy rock foliation and in an extensive network of sulphide veining. Carbonate veins crosscut the sample oblique to the rock fabric. The sample has dark grey bands which follow the sinuous foliation, which are highly magnetic.

In thin section, the sample comprises segregation banded quartz, chlorite and carbonate and opaques. The primary rock fabric is still partially evident and the sinuous nature and crenulated textures indicate an initial metasedimentary foliation. Quartz forms massive bands that are fractured along the wavy fabric of the rock. Rare fine tourmaline is included within quartz.

Alteration: This sample has been intensely recrystallised, though it is uncertain to what degree it is altered. The primary mineralogy of the metasedimentary rock has been replaced by the chlorite-carbonate-quartz-opaque assemblage. Chlorite and carbonate occur interstitial to the fractured quartz in bands with opaque minerals. The carbonate, which has also formed in patchwork textures, is a pale brown colour suggesting it is either dolomite or an iron-magnesium-rich carbonate. The quartz is elongate along the rock fabric although there is little evidence for strain within most crystals. In places there are strain shadows within quartz surrounding dolomite rhombs, and sutured margins are common in the coarser quartz.

Veining: The sample is cut through by a medium grained 3 mm thick vein containing dolomite with minor quartz and chlorite. Chlorite also occurs as a fine envelope partially rimming the carbonate. Quartz has also filled open spaces within the vein, locally bleaching the surrounding carbonate. Perpendicular to this vein, another carbonate vein cuts through the sample, although this vein has considerably more chlorite. This veining occurs as an en echelon structure. The sample is also offset by a large fracture running oblique to the rock fabric which is the same orientation as fine sigmoidal sulphide veinlets, indicating formation through brittle-ductile deformation.

Mineragraphy: The mineragraphy of the sample is comprised of magnetite, pyrite and chalcopyrite. The magnetite occurs as fine grained granular masses densely packed in bands. The magnetite is strongly associated with the foliated chlorite and to a lesser extent carbonate, pyrite and chalcopyrite. The pyrite is coarser grained and occurs as anhedral to euhedral cubic crystals, some of which are fractured. Chalcopyrite occurs in the fractures in pyrite, as inclusions within pyrite and interstitial to quartz. The pyrite and chalcopyrite are generally younger than the magnetite, and occur closely associated with the late stage carbonate, which is evidenced by sigmoidal pyrite veinlets off-setting the magnetite banding.

Proportions (%): Secondary: Quartz (31), dolomite/Fe-Mg carbonate (23), magnetite (21), pyrite (15), chalcopyrite (6), chlorite (4), tourmaline (<1)

Sample Numbers:	**Stellar Resources Ltd**	**:**	**8**
	Sinclair Knight Merz	**:**	**13795**
Rock Name:	**Sulphide-Rich Chlorite Schist**		

Petrographic Description

Lithology: In hand specimen, the sample is a dark green to grey, coarse grained metamorphic rock. The sample is sinuously foliated with sulphide mineralisation forming along the rock fabric. A white-pink carbonate mineral occurs in large (up to 6 mm) clots in sulphide-rich quartz bands. Brecciation and veining are not apparent in this sample.

In thin section, there is a distinct foliation comprised of bands of quartz, K-feldspar, chlorite and carbonate (iron or magnesium-rich carbonate, possibly dolomite). The quartz is fine to medium grained and occurs as elongate quartz ribbons along the foliation axis. The quartz occurs with serrated margins, undulose extinction and quartz shadows indicating strain. It is intergrown with some slightly coarser K-feldspar (orthoclase with simple twinning and quartz inclusions). Chlorite forms coarse bands along the rock foliation, intergrown with carbonate and interstitial to the quartz. The anomalous blue birefringence indicates Mg-rich chlorite. Titanite occurs as a minor mineral and forms elongate wedge shaped inclusions within chlorite and carbonate.

Alteration: The carbonate forms with a patchwork texture in lenses within the rock. It does not appear strained or follow the fabric of the rock, suggesting formation as a secondary mineral.

Mineragraphy: The mineragraphy of the sample is dominated by pyrite. The pyrite is largely anhedral with few euhedral cubic crystals remaining. Chalcopyrite is a minor constituent occurring within fractures in the pyrite. This sulphide mineralisation occurs largely in association with the carbonate and chlorite and rarely with the quartz.

Proportions (%): Quartz (35), pyrite (22), chlorite (17), carbonate (14), K-feldspar (6), chalcopyrite (2), titanite (1)

Sample Numbers:	**Stellar Resources Ltd :**		**9**
	Sinclair Knight Merz	**:**	**13796**
Rock Name:	**Calcareous Quartzite**		

Petrographic Description

Lithology: In hand specimen, the sample is a pale grey to green fine grained highly indurated rock. The sample is cut through by many fine carbonate veins and lenses. Sulphides occur very finely disseminated and in veinlets.

In thin section, the sample has a moderate foliation with quartz, K-feldspar, calcite/dolomite, and sericite/mica forming a preferred mineral orientation. The quartz is etched and shows evidence of strain, with undulose extinction, sutured grain boundaries and elongation along the mineral foliation. Iron stained calcite/dolomite and flaky sericite/white mica occur interstitial to the strained quartz. The carbonate minerals have also formed equant subhedral crystals within the quartz-rich matrix. Titanite forms in random orientations within the rock and as inclusions in pyrite, and zircon forms subhedral inclusions within the quartz. The K-feldspar (orthoclase) is slightly coarser and more elongate than the quartz, and some crystals have simple twinning. Rare plagioclase with polysynthetic twinning is also present, and there are rare small zircon and tourmaline inclusions in quartz.

Alteration: At least some of the calcite has formed at a late stage as it forms an interstitial mineral that has partly replaced quartz and K-feldspar grains. Similarly, the irregular distribution of opaque minerals suggests that these were mostly introduced at a late stage.

Veining: Iron stained calcite/dolomite fills fractures and veinlets both parallel and perpendicular to the rock foliation. The most substantial (0.8 mm thick) is a calcite vein which coarsens outwards with a very fine grained Fe/Mg calcite/dolomite core.

Mineragraphy: The mineragraphy of the sample is pyrite and chalcopyrite. The pyrite has formed as fine grained subhedral rounded crystals, and slightly coarser crystals within fractures. Chalcopyrite forms very fine grained inclusions within the pyrite. The sample is peppered with unidentified very fine bright white flecks, which may be pyrite but are too fine to discern.

Proportions (%): Quartz (74), Fe/Mg calcite/dolomite (18), K-feldspar (3), sericite/white mica* (2), titanite (1), pyrite (1), chalcopyrite (<1), zircon (<1), tourmaline (<1),

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Sample Numbers:	Stellar Resources Ltd	:	10
	Sinclair Knight Merz	:	13797
Rock Name:	Sheared Veined Metasediment		

Petrographic Description

Lithology: In hand specimen, the sample is a pale grey crudely foliated and banded quartz-rich rock. Large quartz and carbonate lenses and veins cut through the sample. Sulphide mineralisation occurs as bands of fine grained crystals which have formed along foliations and boundary contacts.

In thin section, the sample is a sheared, foliated and weakly segregation banded rock. The rock is dominated by vein material. Within the host rock, quartz shows undulose extinction, sutured grain margins and quartz shadows around opaque minerals and has a strongly planar sheared texture. Fine grained kaolinite and illite/sericite have formed along the rock fabric and dolomite and magnesite/siderite form equant and elongate minerals within the foliation. Both dolomite and magnesite/siderite were identified by XRD though they could not be optically distinguished.

Alteration: The host rock is strongly deformed, although the original banding remains largely intact. It is uncertain what minerals formed during metamorphism, and what may be of alteration origin, although much of the carbonate appears to have formed at the expense of quartz.

Veining: The large (up to 17 mm thick) dolomite/magnesite/siderite vein comprises subhedral coarse carbonate crystals with undulose extinction and enclosing minor quartz, illite/sericite and titanite. Quartz occurs as a coarse grained lens and as inclusions within the carbonate vein, and appears to have been partly replaced by carbonate. The illite/sericite may have formed as clasts of sheared metasediment within the vein.

Mineragraphy: The deformed matrix is highly mineralised whereas the coarse carbonate vein is largely barren. The mineragraphy of the sample comprises pyrite, chalcopyrite, magnetite and bornite. The pyrite is anhedral to subhedral and occurs throughout the rock, where it is closely associated with the carbonates. Chalcopyrite has formed interstitial to the carbonate crystals and as inclusions within pyrite. Rare pyrrhotite inclusions were also observed in pyrite. Bornite occurs as intergrowths with chalcopyrite largely as inclusions in pyrite. Magnetite occurs as subhedral inclusions in pyrite and as very fine to fine granular crystals disseminated within a dolomite-rich band. Chalcopyrite, magnetite and pyrite also occur within the carbonate vein, but are much less abundant.

Brecciation: There was no obvious brecciation within this sample aside from the shear deformation and the formation of quartz lenses within the large carbonate vein described above.

Proportions (%): Carbonate (dolomite, magnesite/siderite) (34), pyrite (22), quartz (19), chalcopyrite (7), magnetite (4), anhydrite (6), illite/sericite (4), kaolinite (2), titanite (<1), pyrrhotite (<1)

XRD: Illite/Sericite, Quartz, Dolomite, Pyrite, Chalcopyrite, Siderite/Magnesite?, Kaolinite?

Sample Numbers:	Stellar Resources Ltd	:	11
	Sinclair Knight Merz	:	13798
Rock Name:	Silicified Metasediment		

Petrographic Description

Lithology: In hand specimen, this sample is a pale grey foliated and banded siliceous rock. Sulphide minerals have formed in bands along the rock foliation and within fine white veins.

In thin section, the sample appears bedded which may suggest a primary sedimentary texture or metamorphic foliation. The quartz has formed in a mosaic texture with a roughly equigranular fine grain size, and is intergrown with plagioclase (with a composition ranging from albite to oligoclase) which has been stained a pale brown colour. The carbonates are fine to medium grained anhedral to euhedral commonly rhombic crystals with high relief, slight brown staining and some crystals with extreme birefringence. The carbonates are scattered throughout the quartz-albite mosaic. Titanite occurs as a minor mineral lineation along foliation within the rock and intergrown with chalcopyrite. In this sample there is little evidence of shear deformation, as the quartz lacks undulose extinction and quartz shadows. The distinct elongation within the quartz along the rock fabric indicates it has formed through replacement of a foliated or bedded precursor.

Veining: Sericite, opaques (pyrite) and titanite have formed veinlets interstitial to the quartz and albite mosaic perpendicular to the rock fabric. Proximal to these veinlets the rock has cloudy etched appearance.

Mineragraphy: The mineragraphy of the sample is chalcopyrite and pyrite. The chalcopyrite has formed interstitial to the quartz-carbonate-albite along the rock fabric and has also formed intergrowths with pyrite and titanite in the groundmass. Pyrite has formed intergrown with and as inclusions in chalcopyrite and in fine veinlets crosscutting the rock fabric.

Proportions (%): Quartz (38), albite (26), carbonate (17), chalcopyrite (8), pyrite (6), titanite (3), sericite* (2)

Sample Numbers:	Stellar Resources Ltd	:	12
	Sinclair Knight Merz	:	13799
Rock Name:	Chloritic Phyllite		

Petrographic Description

Lithology: In hand specimen, the sample is a medium to coarse grained dark green to black indurated rock. The sample is sulphide rich, with highly magnetic dark grey clots around some of which the rock is stained red. Carbonate and quartz occur in lenses in the rock with sulphides. Fine white veinlets crosscut the rock oblique to the vague foliation in the sample.

In thin section, the sample has a strong mineral alignment but is only crudely segregation banded as the quartz, chlorite and dolomite are largely interwoven. The quartz occurs both as fine grained mosaic crystals with an elongate axis along the rock fabric and with a porphyroclastic texture within foliated chlorite. The fine grained quartz has highly sutured margins and many have formed quartz shadows around cubic opaque minerals. The chlorite has formed as sinuous bands interstitial to the quartz and as medium grained flakes. The chlorite is Mg-rich as evidenced by the strong blue birefringence. The dolomite occurs rarely in bands and more commonly as fine equigranular crystals in large patchwork clots with minor quartz and chlorite. Minor titanite occurs as tabular inclusions in the chlorite.

Alteration: The carbonate largely forms within fractures and irregular lenses along the rock fabric indicating that its formation post dates deposition of the primary minerals. Hematite is found to be partially replacing magnetite porphyroblasts. However, with most of these minerals, it is difficult to tell whether they are of metamorphic or alteration origin.

Veining: Although no major veining occurs, carbonate fills minor fractures and lenses in the sample, cutting across the rock fabric. These fractures are also partially infilled by opaque minerals (pyrite, chalcopyrite and magnetite).

Mineragraphy: The mineragraphy comprises magnetite, pyrite and chalcopyrite. Magnetite occurs with a strong porphyroblastic texture as large (up to 2 mm) euhedral crystals. The crystals are highly fractured and pitted, with pyrite and chalcopyrite forming in the fracture spaces. Pyrite is dominantly anhedral with grain sizes up to 0.3 mm. Chalcopyrite occurs intergrown with the pyrite as anhedral fine grained space-filling crystals along the rock fabric and crosscutting the foliation. Minor hematite is found replacing magnetite. The mineragraphy is very closely spatially associated with carbonate with opaque minerals, commonly forming along the contact between chlorite groundmass and carbonate lenses, and along carbonate rich foliations in the rock.

Proportions (%): Quartz (36), chlorite* (28), dolomite (14), pyrite (8), chalcopyrite (6) magnetite (5), titanite (2), hematite (1)

Sample Numbers:	Stellar Resources Ltd	:	13
	Sinclair Knight Merz	:	13800
Rock Name:	Mylonite - Semi Massive Sulphide and Oxide		

Petrographic Description

Lithology: In hand specimen, the sample is a medium to dark grey to green, dense rock. The sample is medium grained and foliated with prominent segregation banding. The bands are composed of dark grey highly magnetic lineations and lenses, highly sinuous white bands and medium grained sulphide-rich bands. Dark red and oxidative stains follow lineations in the rock.

In thin section, the sample has a strong planar fabric and is banded with an intensely sheared texture composed of fine grained quartz, carbonate and chlorite. The primary textures and minerals are no longer evident. This sample appears intensely sheared and has undergone strong ductile deformation and is thus termed a mylonite.

Alteration: Carbonate has formed as equigranular very fine grained (0.05 mm) crystals in bands along the rock fabric and along rock fractures. The carbonate is medium brown with high relief commonly with a rhombic habit indicating is an iron or magnesium-rich type. The carbonate is intergrown with quartz and appears in places to be replacing the quartz. The quartz occurs with a strongly planar mosaic texture along the rock foliation, with many crystals exhibiting sutured margins and undulose extinction. Chlorite has formed as randomly oriented crystals interstitial to quartz with acicular and flaky textures. Quartz has also formed replacing the chlorite, with primary textures still evident. Alteration in this sample is also seen in the common replacement of magnetite with hematite. As with the previous sample, the carbonate in this rock appears to have formed secondary to the quartz and probably in the same episode as the sulphide mineralisation.

Veining: Veining is not distinguished in this sample although carbonate occurs in very fine branching veinlets cutting across the rock foliation.

Mineragraphy: The opaque minerals in the sample are magnetite, pyrite, chalcopyrite and hematite. Magnetite has formed as massive highly fractured bands commonly replaced by acicular to massive very fine grained hematite. The hematite has caused localised deep red staining of the gangue minerals. Pyrite occurs as fine to medium grained subhedral crystals. The pyrite is commonly elongate along the rock fabric and highly fractured suggesting it has undergone both ductile and shear deformation. Anhedral chalcopyrite is a minor mineral in the sample. Chalcopyrite occurs closely associated with the pyrite and has dominantly formed along carbonate and pyrite grain boundaries. The sulphide mineralisation is spatially associated with carbonate. Magnetite formation is more commonly associated with the mosaic quartz, although hematite replacement is found dominantly proximal to carbonate mineralisation.

Proportions (%): Carbonate (26), quartz (21), pyrite (20), magnetite (17), chlorite* (8), hematite (6), chalcopyrite (2)

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Sample Numbers:	Stellar Resources Ltd	:	14
	Sinclair Knight Merz	:	13801
Rock Name:	Mylonite - Semi Massive Sulphide and Oxide		

Petrographic Description

Lithology: In hand specimen, this sample is a foliated and segregation banded medium grey rock. The sample is very dense, and some of the bands are strongly magnetic. Coarse white carbonate veins cut through the sample perpendicular to the foliation and these veins are crosscut by a finer carbonate vein. Sulphide minerals form in bands along the foliation of the rock.

In thin section, the sample is fine grained and intensely sheared and altered, with no primary textures or minerals evident. The primary texture has been lost due to intense shearing of this rock and as such the rock has been labelled a mylonite.

Alteration: The rock is highly sheared with a strong foliation and crude segregation banding. Carbonate and quartz comprise the mineralogy of the sample. The quartz is elongate along the rock foliation with sutured margins and undulose extinction. The iron or magnesium-rich carbonate is patchy and occurs interstitial to the quartz and in crude bands elongate along the rock fabric. Deep red internal reflections suggest a partial replacement of magnetite by hematite.

Veining: The veining is perpendicular and oblique to the rock fabric. The thick (up to 3 mm) vein comprises fine grained equigranular carbonate crystals with minor quartz inclusions. The vein is branching and irregular and is crosscut by a fine (0.5 mm) carbonate vein. A third fine carbonate vein which fines inwards to a very fine grained centre crosscuts the major vein.

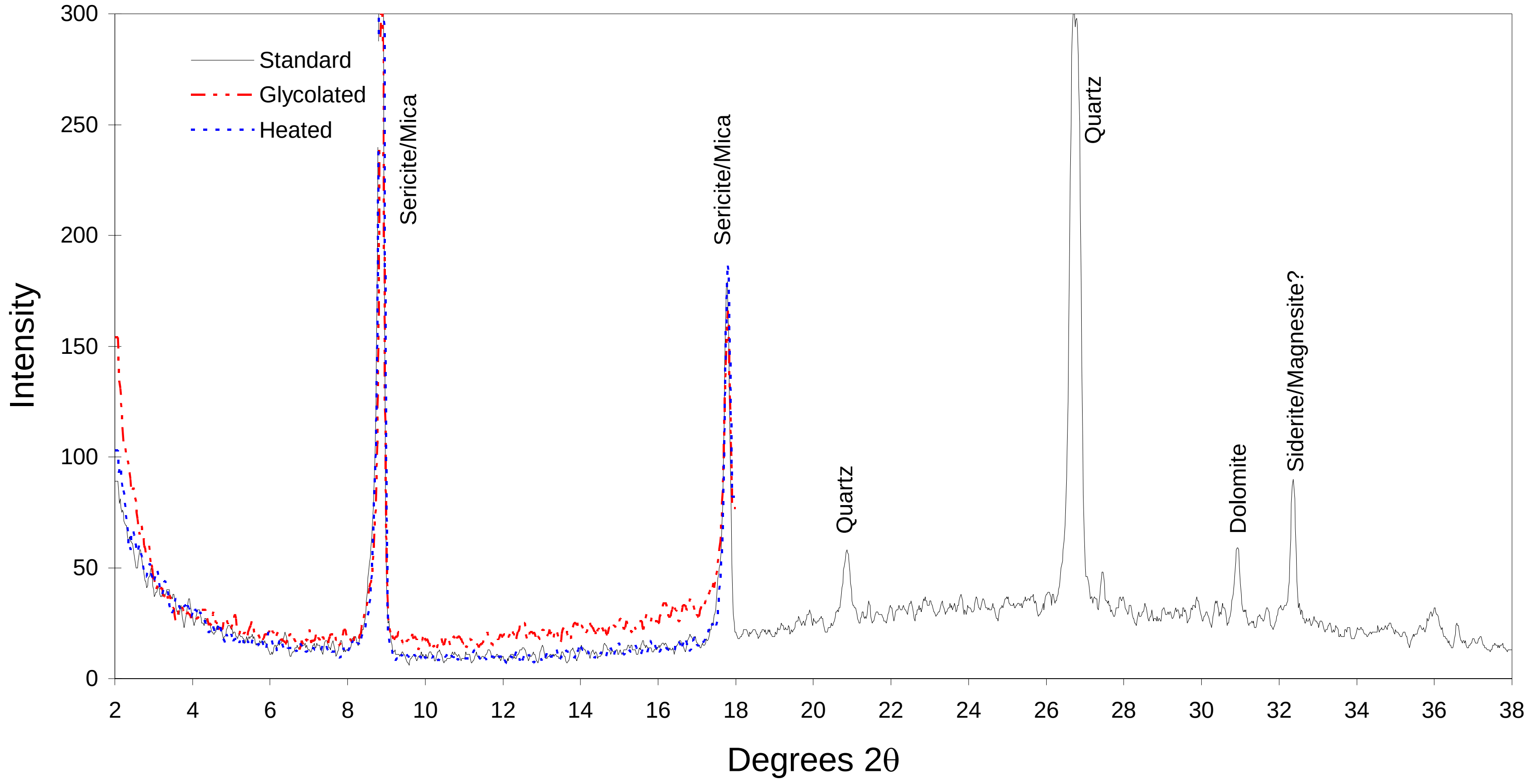
Mineragraphy: The mineragraphy of the sample is dominantly magnetite and pyrite with minor chalcopyrite. The magnetite is massive, highly fractured and pitted and is elongate along the rock fabric. The pyrite is fine grained and subhedral and the anhedral chalcopyrite is intergrown with pyrite and disseminated in the carbonate. Pyrite also forms as very fine grained inclusions within the magnetite. The chalcopyrite also forms rarely within the crosscutting carbonate veins. Although the opaques are intergrown with one another they have formed magnetite-rich and pyrite-rich banding.

Brecciation: No brecciation was seen in this sample other than the intense shearing and fracturing commented on above.

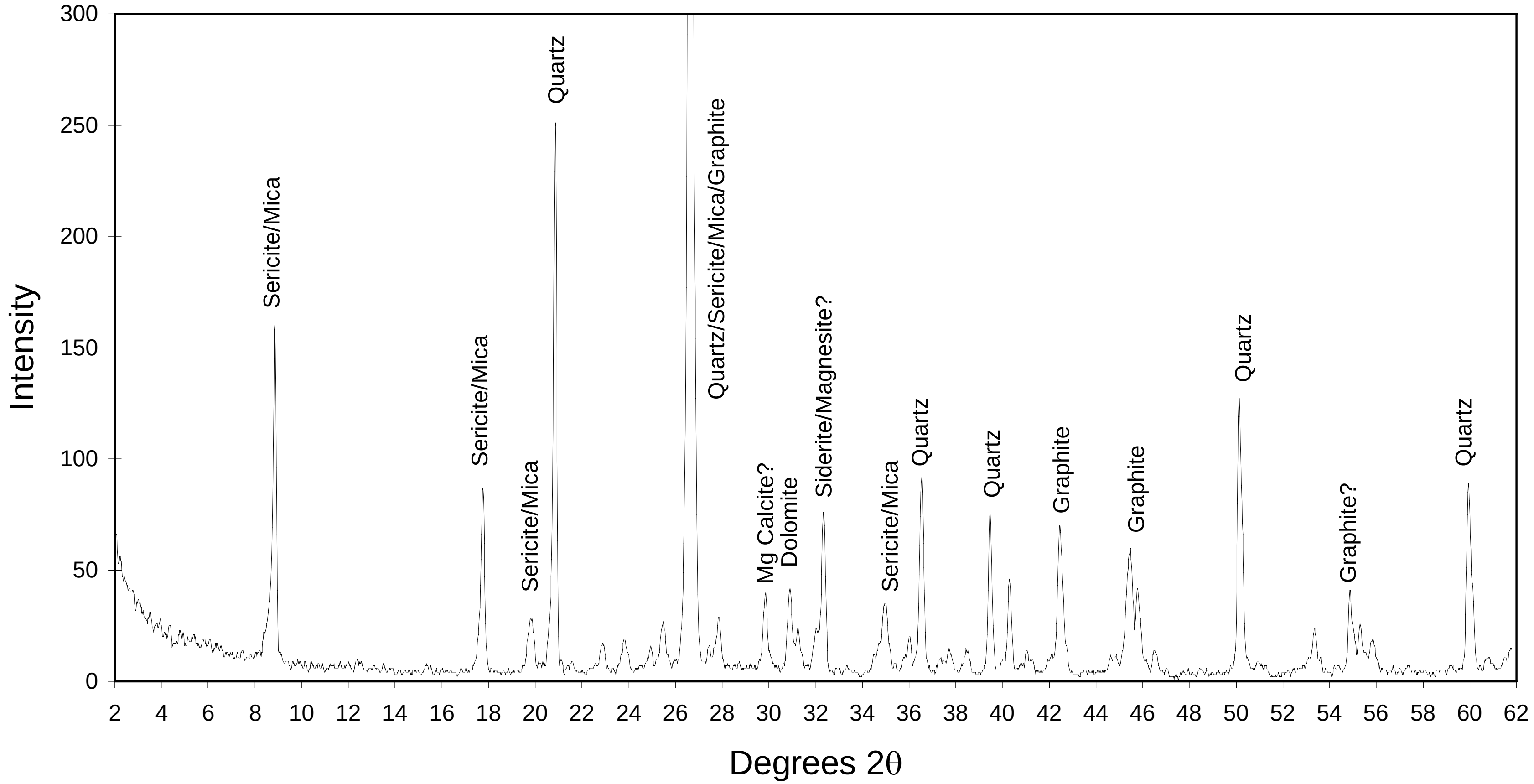
Proportions (%): Magnetite (32), pyrite (25), Fe/Mg carbonate (24), quartz (16), hematite (2), chalcopyrite (1)

9. XRD Charts

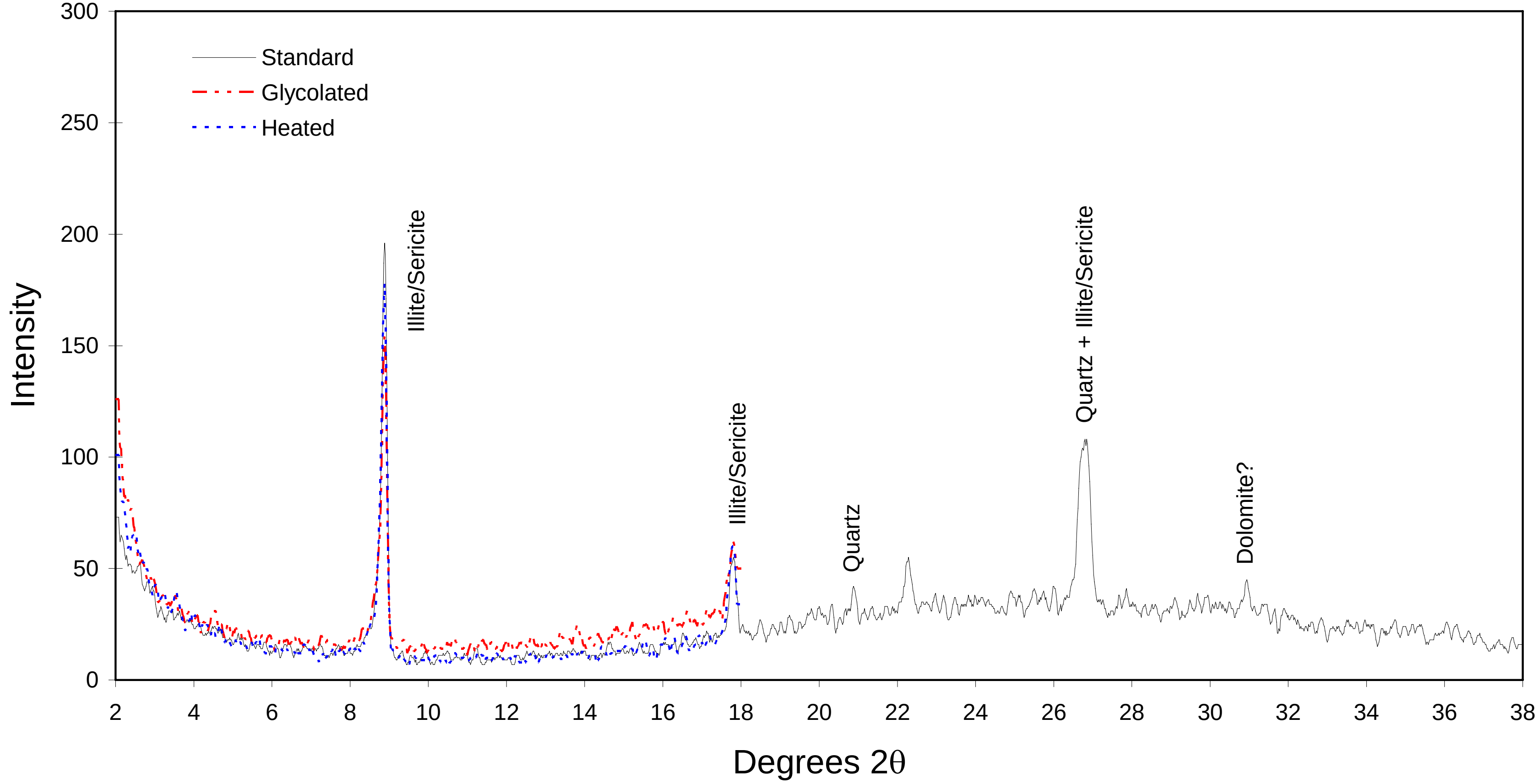
XRD: Sample 13788. Clay separate, smoothed



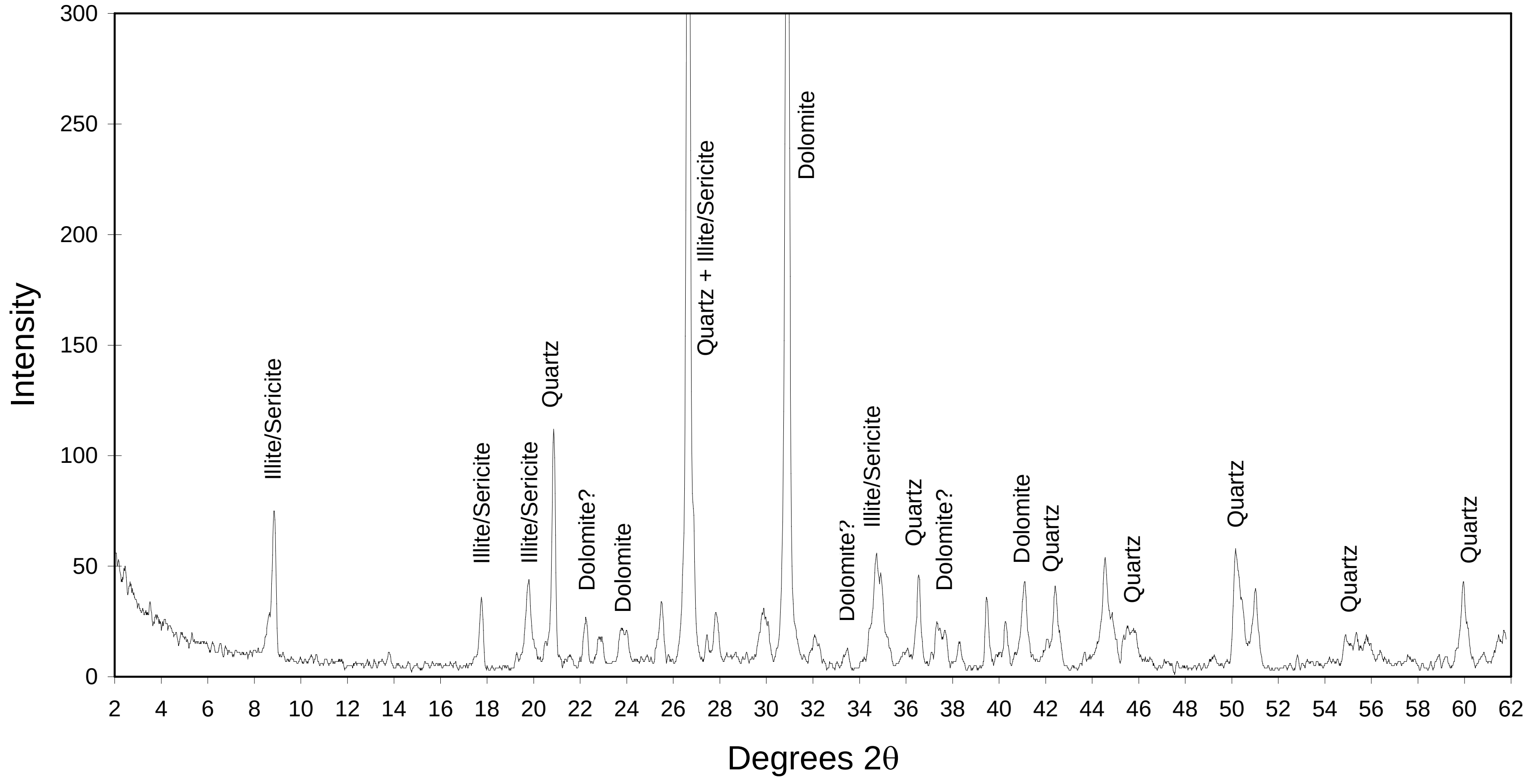
XRD: Sample 13788. Powder, smoothed



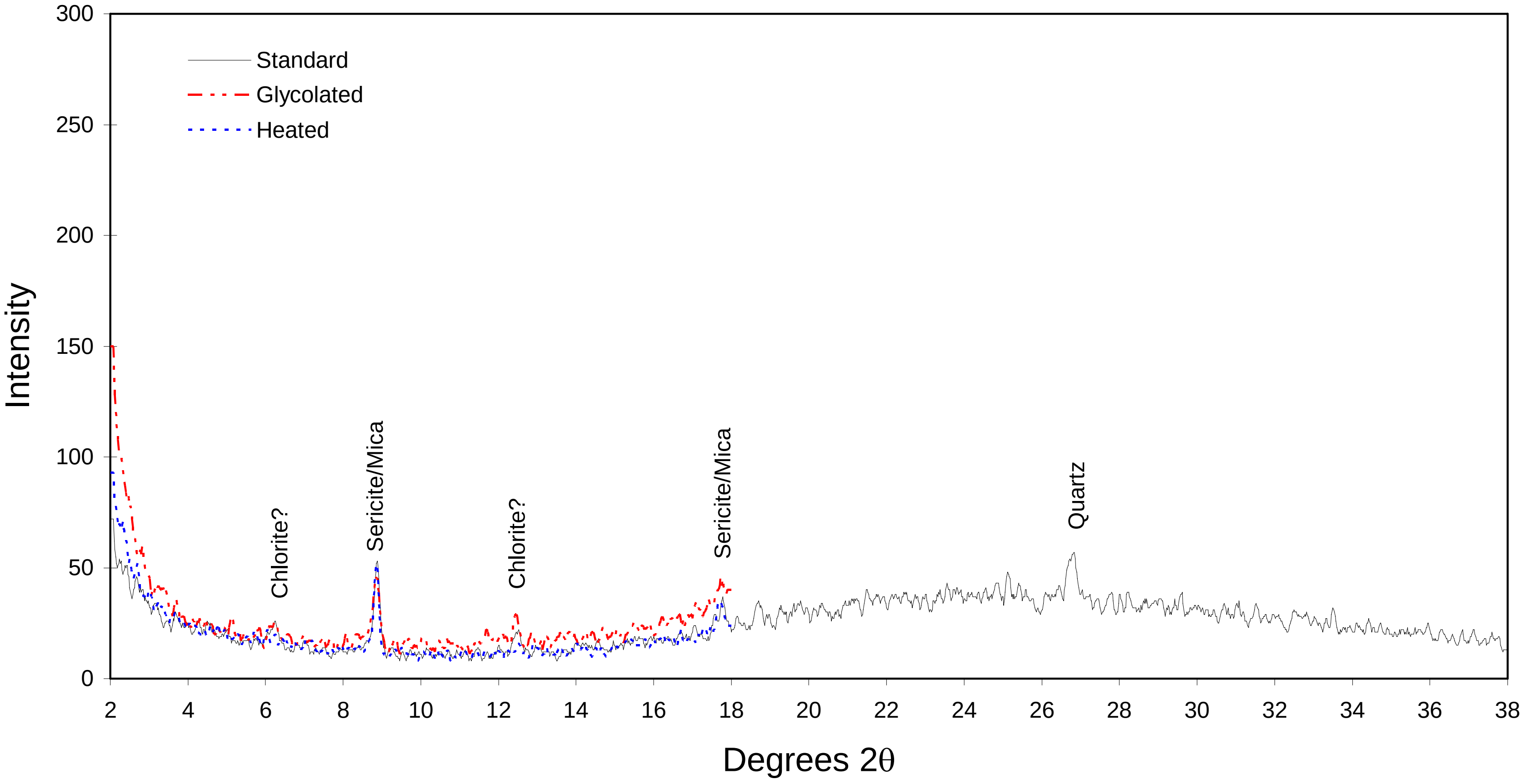
XRD: Sample 13789. Clay separate, smoothed



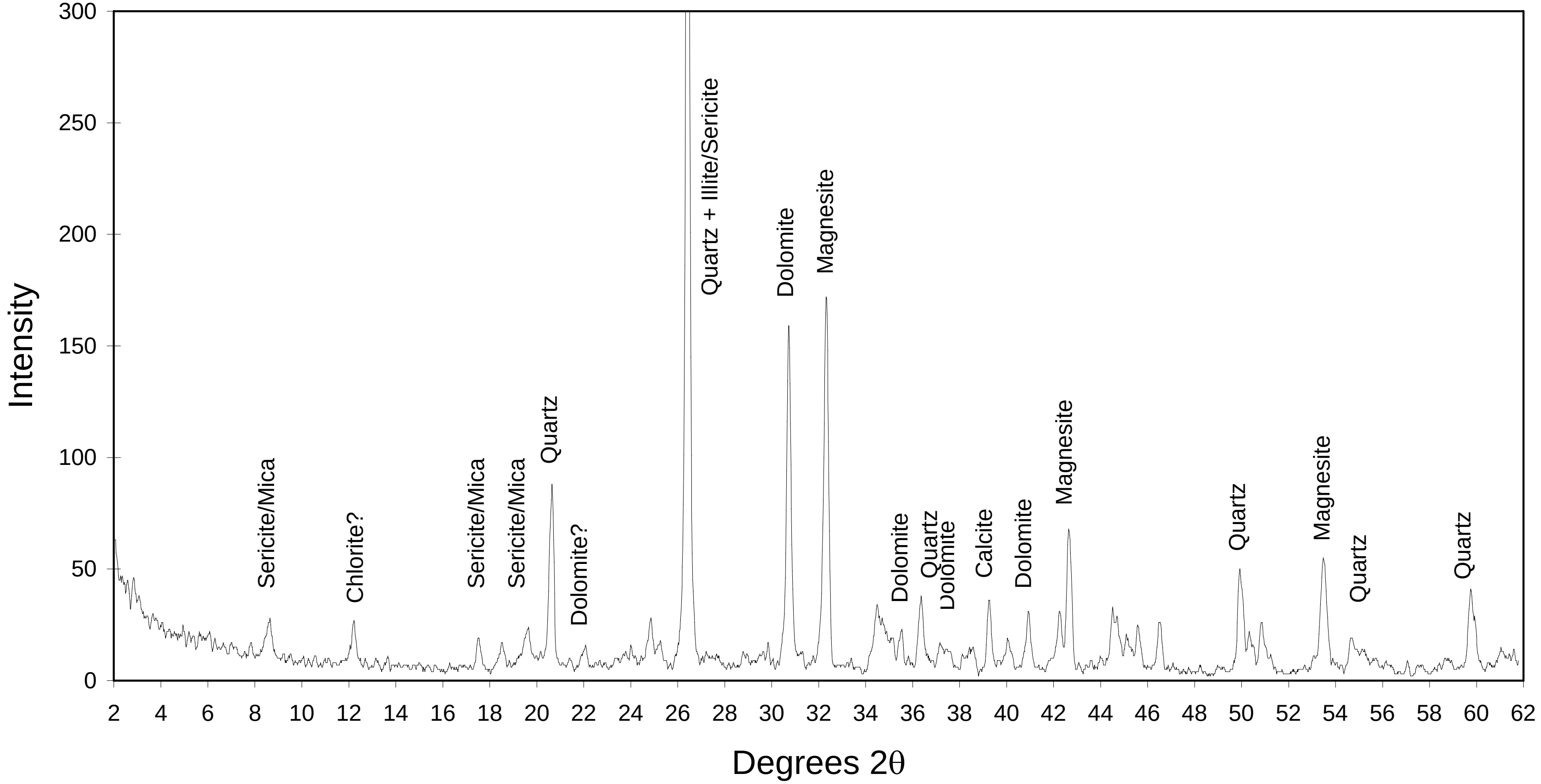
XRD: Sample 13789. Powder, smoothed



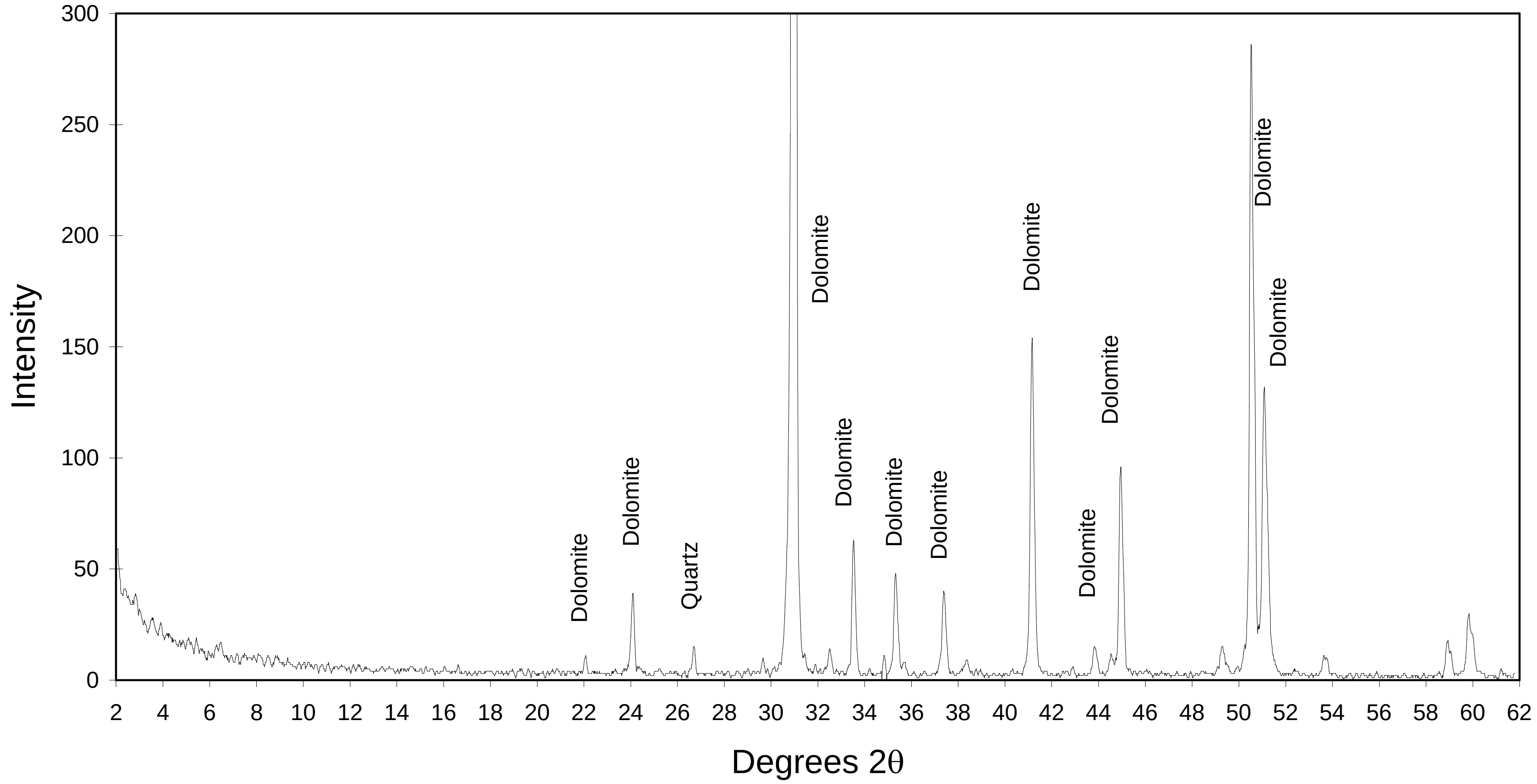
XRD: Sample 13791. Clay separate, smoothed



XRD: Sample 13791. Powder, smoothed

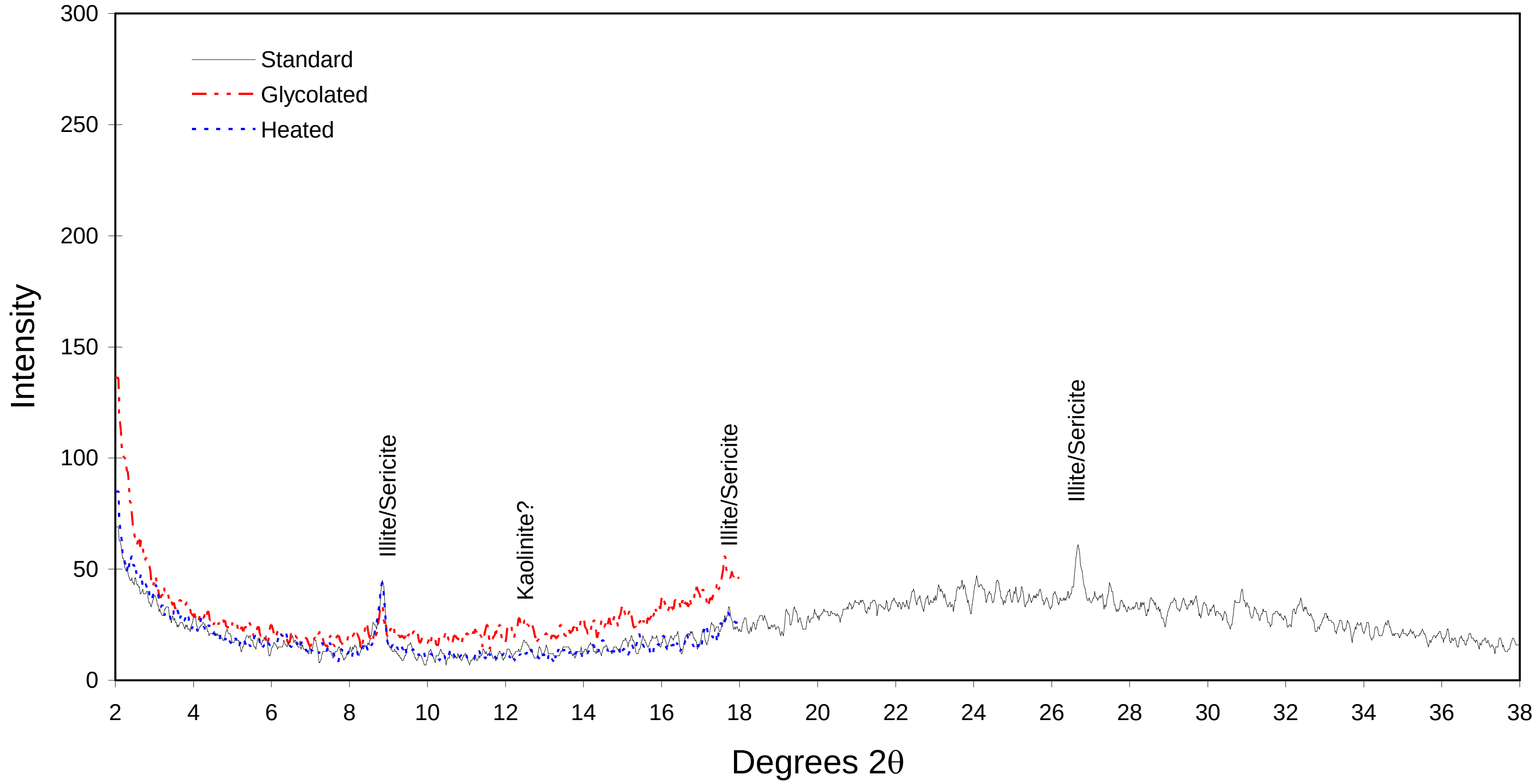


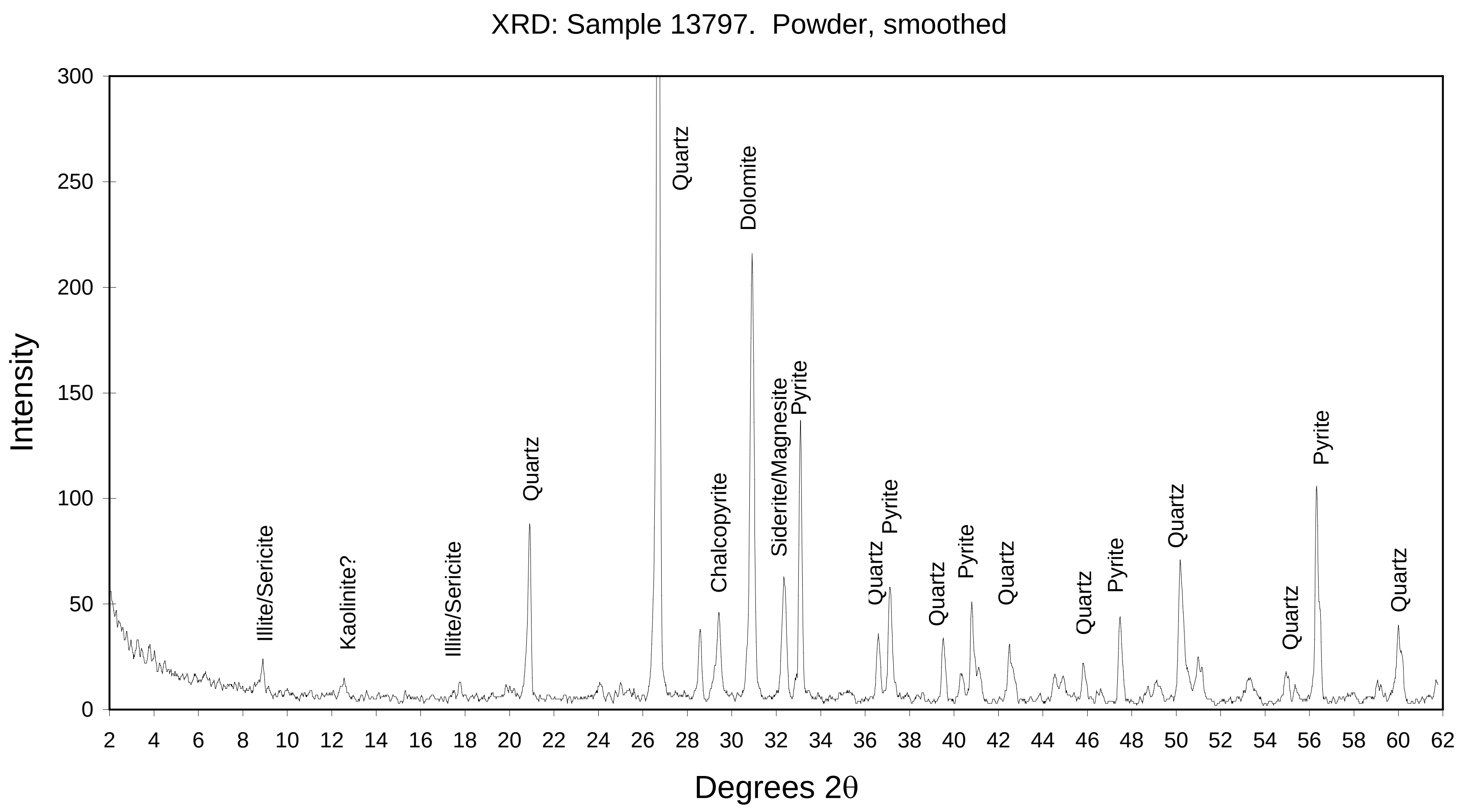
XRD: Sample 13791 - Vein. Powder, smoothed



SKM

XRD: Sample 13797. Clay separate, smoothed




XRD: Sample 13797. Powder, smoothed
Intensity
Degrees 2θ
0
50
100
150
200
250
300
2
4
6
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12
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54
56
58
60
62
Illite/Sericite
Kaolinite?
Illite/Sericite
Quartz
Quartz
Chalcopyrite
Dolomite
Siderite/Magnesite
Pyrite
Quartz
Pyrite
Quartz
Pyrite
Quartz
Quartz
Pyrite
Quartz
Quartz
Pyrite
Quartz

Appendix A   Client Instructions

Phil,

An associate of mine Nic Turner, will be forwarding to you in the near future some samples of drill core for petrological-mineralogical examination.

The samples come from the Alpine project, operated by Stellar Resources, just north of Zeehan on the west coast of Tasmania.

Alpine is shaping up as a substantial shallow Cu-magnetite deposit developed in a Proterozoic host formation. Several styles of mineralisation appear to be present including some late stage silicification events. Nic will undoubtedly provide you with additional info when he forwards the samples.

Would you please invoice this work to:

Stellar Resources Limited,

c/- Newnham Exploration and Mining Services

PO Box 183,

EXETER, TASMANIA, AUSTRALIA 7275

I will also be sending to you in the next few weeks some further samples from Allegiance's Melba Flats project which you have worked on previously. Will correspond with you separately on that matter.

Regards,

Lindsay Newnham

N.J. TURNER GEOLOGICAL SERVICES PTY. LTD.
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Mapping and mineral exploration in complicated terrains

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West Hobart | **Email nicturner@bigpond.com** | **Fax. (03) 6236 9599**
Tasmania 7000
Priv. (03) 6234 2652

8.5.07

To: Phil White
Geoscience Manager
Sinclair Knight Mertz Ltd
25 Tweed St, Newmarket
Auckland, New Zealand

Reference: Email to Philip J ((SKM)) White from Lindsay Newnham dated 7.4.07.

Subject: Core samples from drill hole AP13 at Stellar Resources Ltd's Alpine prospect, western Tasmania.

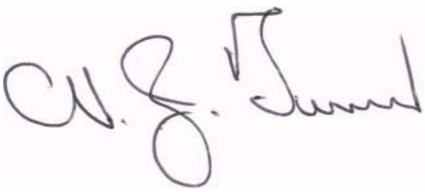
Dear Phil,

Fourteen samples of drill core were dispatched from Hobart today (8.5.07) per TNT Express. Please provide petrological descriptions of the samples. I have attached some notes on the regional setting of the Alpine prospect. There are also some notes on the samples that are aimed at highlighting aspects about which I would appreciate getting your particular comments.

ETA Auckland for the samples is 14.5.07. The consignment note number is 961638555. Please email confirmation of your receipt of the samples. Kindly return the material to the above address when your assessment is complete.

Thank you.

Regards,



Nic Turner
Stellar Resources Ltd
Samples for petrology, DDH AP13, Alpine Prospect, western Tasmania
Nic Turner, 8.5.07

Regional

Diamond drill hole AP13 tested chalcopyrite and magnetite mineralization in rocks located in the Arthur Metamorphic Complex in western Tasmania. The Arthur Metamorphic Complex is characterized by polyphase mylonitic deformation and is predominantly of greenschist facies though relict mineral assemblages indicate that some rocks in the complex reached blueschist facies before re-equilibrating to amphibolite facies, then retrogressing to greenschist facies. Folding was isoclinal and compositional banding is generally parallel to a strong, metamorphically differentiated foliation.

The mylonitic deformation and associated metamorphism are of Cambrian age while the protolith age is probably Neoproterozoic. Protolith lithologies included siltstone, sandstone, tholeiitic dolerite with some basalt, and rare felsic rocks (granitoid). The Savage River Iron Ore Mine (magnetite-pyrite-silicate) is located some 35 km along strike from the Alpine rocks, at about the same structural/stratigraphic level.

The rocks of the Arthur Metamorphic Complex were deformed again during the Devonian. This Devonian deformation preceded an episode of granitoid emplacement that was widespread in western Tasmania though no intrusions or metamorphic effects have been recognised in the Alpine area. Tin, tungsten, lead, zinc, copper, nickel, iron, gold and silver are associated with Devonian granitoids elsewhere in western Tasmania.

Alpine Prospect

Much of the copper mineralization at the Alpine prospect post-dates the Cambrian deformation and metamorphism, occurring as chalcopyrite in cross-cutting veinlets with carbonate and quartz. However, some chalcopyrite occurs as trains of fine grains that are parallel to compositional banding/foliation and thus, there may also have been an earlier episode of copper mineralization. Microtextures may assist in making this determination.

As well, there seems to be a relationship between more abundant copper mineralization and a lithological association of mafic schist and banded magnetite-pyrite-carbonate-silicate. In drill hole AP13 this lithological association appears to have been partly silicified. Above and below the mafic schist and banded magnetite-pyrite-carbonate-silicate there are metasedimentary phyllite and schist that were derived from a turbiditic assemblage of mudstone, siltstone, quartzwacke sandstone and uncommon carbonate.

Samples

Samples 1, 2 and 3: Sample 1 is a fairly typical graphitic, muscovite phyllite (metasedimentary) while Sample 3 is a less abundant, pale olive, muscovite phyllite.

Boundaries between the two types of phyllite may be sharp and parallel to foliation or they may be diffuse and cross cutting. These boundary relationships seem to be consistent with the pale olive phyllite being an alteration product of the graphitic phyllite. Sample 2 is partly brecciated and may also be an altered variant of the graphitic phyllite.

Sample 4: This is a fine grained carbonate (? dolomite) that is interlayered with the metasedimentary rocks. It is regarded as a primary rock type though probably recrystallised.

Sample 5: This is a breccia from one of several similar intervals in AP13 that have thicknesses of up to several metres. These breccia intervals may have boundaries parallel to foliation or have irregular boundaries where the breccia occupies spaces bounded by fractures in the adjacent metasedimentary rocks. However, the clasts in the breccia are unlike the adjacent metasedimentary rocks, being very fine grained and massive. The clasts have a silicified appearance.

Sample 6: Chalcopyrite in a siliceous or silicified, metasedimentary rock.

Samples 7 and 8: Sample 7 is banded magnetite-pyrite-?carbonate-silicate with substantial chalcopyrite in cross cutting carbonate-quartz veinlets. This material is transitional into banded mafic schist represented by Sample 8, which contains common chalcopyrite on the foliation surfaces.

Samples 9, 10, 11 and 14: These samples may all have been affected by silicification though Sample 9 may have been a quartzite. Speculatively, some of the other samples may have had precursors like Samples 7 and 8. Sample 9 lacks chalcopyrite whereas Sample 10 contains common chalcopyrite. Sample 11 also contains common chalcopyrite, both as trains of grains parallel to the foliation and in cross cutting veinlets. Sample 14 consists of banded magnetite-pyrite-carbonate-quartz, but occurs within a siliceous or silicified interval. Again, there are two modes of occurrence of chalcopyrite.

Samples 12 and 13: These are similar to Samples 8 and 7 respectively. Sample 12 is a crudely banded mafic schist with disseminated magnetite. It contains chalcopyrite as fine grains in the body of the rock and as blebs in cross cutting veinlets. Sample 13 is representative of a banded magnetite-red hematite-pyrite-carbonate-silicate interval that is within the mafic schist. Chalcopyrite in Sample 13 occurs as trains of grains parallel to foliation and in cross cutting veinlets.

Metal associations

Comments would be appreciated on the possible metal associations that might be expected in this suite of rocks. We currently recognize copper mineralization and iron mineralization, but there is some uncertainty about relative ages. Much copper is clearly younger than the iron, but the trains of fine grained chalcopyrite that are parallel to the compositional banding and foliation may be of similar age to the iron mineralization.

Analytical results for AP13 are not yet to hand. However, gold values to 1 gpt have been returned from a silicified interval in a nearby drill hole. Anomalous, vein style, lead-zinc mineralization has been encountered up-hole of iron and copper mineralization in some holes while anomalous platinum is present in unsilicified rocks in other holes.

Appendix B Glossary and Definitions

ALTERATION ASSEMBLAGES

Argillic:	Clay-rich assemblages dominated by low-temperature clays such as kaolinite, smectite, and interlayered illite-smectite. These are formed by low temperature (<230°C), acid to neutral, low salinity hydrothermal fluids.
Phyllic:	Dominated by illite or sericite and quartz, together with pyrite and possibly anhydrite. May also contain minor chlorite, calcite, titanite and rutile. Formed in the presence of moderate to high temperature (approx. 230-400°C), acid to neutral fluids at a range of salinities, commonly in permeable zones and adjacent to veins.
Propylitic:	Characterised by chlorite, with some of illite/sericite, epidote, quartz, albite, calcite, and anhydrite. Formed at moderate temperatures (mostly 200-300°C), in the presence of near-neutral pH fluids with a range of salinities, commonly in low permeability areas.
High-temperature propylitic:	Contains secondary actinolite and/or garnet in addition to the above assemblage. Forms under similar conditions, but higher temperatures (>290°C) than propylitic assemblages.
Potassic:	Major secondary minerals are biotite, orthoclase, quartz, and magnetite. Anhydrite is a common accessory, and minor albite and titanite or rutile can also develop. Potassic alteration is caused by near-intrusive, hot fluids (>300°C) with a strong magmatic character and high salinity.
Advanced argillic:	Contains alunite, diaspore, and/or pyrophyllite, together with one or more of quartz, chalcedony, kaolinite, and dickite. These assemblages occur as tabular near-vertical zones formed from condensed acid magmatic vapours in the porphyry environment, and as near-horizontal blankets at shallow epithermal levels, where acid-sulphate fluids form from oxidised steam condensates.
Skarn:	May contain garnet, clinopyroxene, vesuvianite, scapolite, wollastonite, epidote, amphibole, magnetite and calcite as major components. Minor amounts of biotite, K-feldspar, quartz and chlorite may also be present. Minerals present are similar to those found in potassic, high temperature propylitic and propylitic

assemblages of porphyry systems. Developed in the presence of calcium-rich, high salinity fluids over a wide temperature range with early anhydrous minerals forming in the range 300 - 700°C. Occurs near the contact between calcareous lithologies and intrusives.

MINERALISATION

Carlin-type:	Precious metal mineralisation, usually with the gold occurring submicroscopically, associated with the silicification of calcareous rocks in continental settings. Also broadly applied to any carbonate replacement deposit; evidence is mounting that this may be erroneous.
Epithermal:	Mineralisation produced by near-surface hydrothermal fluids related to igneous activity; originally defined as having formed in the range 50-200°C, though 150-300°C is perhaps more commonly accepted now.
Epigenetic:	Mineralisation which was later introduced into older rocks
Gold fineness:	A measure of the gold content of native gold or silver grains, determined by the equation 1000 x Au/(Au + Ag), where Au and Ag are determined by weight.
High-sulphidation:	Originally referred to opaque minerals which contain sulphur in a high oxidation state, but now used in a broader sense for deposits which contain them; for example "enargite-gold" (or quartz-alunite, or acid-sulphate) systems, in which the mineralising hydrothermal fluids have a major magmatic component, and produce acid alteration, with base metal mineralisation at shallow levels.
Hypogene:	Formed by processes occurring within the earth, especially mineralisation associated with ascending hot fluids.
Hypothermal:	Mineralisation associated with high temperature hydrothermal fluids; originally defined as forming at 300-500°C, today it commonly applies to temperatures over about 500°C.
Intermediate-sulphidation:	Deposits that are intermediate between high and low sulphidation. These deposits are characterised by a moderate magmatic component,

and a substantial base metal sulphide content, and commonly contain Mn minerals within the gangue.

Low-sulphidation:	Originally referred to opaque minerals containing sulphur in a low oxidation state, but now used in a broader sense for the deposits which contain them; for example “adularia-sericite” type systems in which meteoric-dominated fluids produce phyllic, propylitic, and argillic alteration zones.
Mesothermal:	Mineralisation produced at deep levels in the crust, from high temperature hydrothermal fluids (250-400°+), at near lithostatic pressures. The fluids can be meteoric and/or magmatic and/or metamorphic in origin; where the latter is significant, this mineralisation is normally termed metamorphogenic.
Porphyry:	Hypothermal deposits occurring as stockworks or disseminations intimately associated with porphyritic intrusives, with mineralisation associated with potassic alteration, although this is frequently overprinted.
Skarn:	Mineralisation associated with moderate to high temperature, hydrothermally altered/metasomatised rocks near the contact between intrusive bodies and carbonate rocks.
Supergene:	Formed by surficial processes, particularly oxidation, hydration, solution, and deposition.
Syngenetic:	Mineralisation which formed at the same time as the enclosing rocks.
Volcanic-Hosted Massive Sulphide (VHMS)	Mineralisation associated with hydrothermal systems developed in volcanic and volcano-sedimentary rocks in a submarine setting.

GENERAL DESCRIPTIVE TERMS

Sinter:	Surficial chemically deposited precipitate, that is in the strictest sense of the term, siliceous. May be diagnosed on the basis of recognisable plant fragments (leaves, stems), near-horizontal planar lamination, and/or low-temperature mineralogy (*eg.* opal and chalcedony).

Travertine:	Calcareous (usually $CaCO_3$) sinter deposit.
Vein:	Material which was chemically deposited by fluids within a rock fracture. Veins exhibit a range of textures and minerals, depending primarily on the temperature, depth, and composition of both the fluid and the host rock. Veins may contain a small amount (<10%) of entrained host rock and/or vein clasts.
Breccia:	Coarse (usually >2 mm) fragmental rock, consisting of generally angular clasts of one or more lithologies. A complexly veined rock can have a brecciated appearance (if veins are multi-generational and/or branching), but it is important to differentiate between the two. Veins are generally linear or sinuous, whereas a breccia matrix is highly irregular.

TEXTURAL TERMS FOR VEINS AND BRECCIAS

Matrix: The interstitial material between clasts in a breccia, of which there are two main types. Some breccias may contain a proportion of both types:

Clastic matrix: composed of finely ground clast material; and

Chemically deposited matrix (cement): composed of chemically deposited material (usually similar to veins).

If the matrix encloses and separates clasts, the breccia is *matrix-supported*; if clasts are in contact and support each other, it is described as *clast-supported*.

Vug (druse):	Open cavity within a rock, usually in a vein or breccia cement, which is lined by euhedral prismatic crystals that project into the cavity.
Pseudomorph:	A mineral or minerals occurring in the crystal form of another, usually due to alteration or replacement of the original mineral (*eg.* limonite after pyrite, alunite + pyrophyllite after feldspar, quartz after calcite).
Prismatic:	Crystals which exhibit elongate euhedral shapes and have prismatic terminations are common in veins and cements, where they are considered to form by slow crystallisation. Prismatic crystals may be

zoned by bands of different composition (*e.g.* amethyst bands in quartz) or with abundant fluid inclusions.

Colloform:	A botryoidal type of texture commonly observed in vein chalcedony, where radiating aggregates of chalcedony have a grape-like outer surface. Banding within this material produces agate.
Comb:	Masses of parallel long, thin crystals growing inwards from the vein margins produce a texture like that of a comb.
Saccharoidal:	Granular aggregates of equant crystals having the appearance of sugar in hand specimen.
Crustiform:	Banding texture produced by differences of mineralogy, texture, and/or colour away from the vein margins. Crustiform banding is commonly produced by alternating chalcedony and saccharoidal quartz layers.
Cockade:	Concentric crustiform banding in the cement surrounding matrix-supported breccia clasts.
Imbrication:	A fabric found within some breccias where there is a subparallel alignment of clasts, similar to that observed within some fluvial gravels.
Vein breccia:	Rock consisting predominantly of vein fragments (<10% host rock clasts) in a chemically-deposited matrix. Clasts are generally subangular, and matrix-supported in a matrix of generally similar vein minerals (*eg.* quartz, chalcedony), which may be banded and enclose open cavities.
Polymict vein breccia:	Rock consisting of altered host rock ± vein clasts in a chemically deposited matrix, where the matrix, rock, and vein clasts each comprise at least 10% of the rock volume. Clasts are generally subangular, and enclosed by a matrix of vein minerals (*eg.* quartz, chalcedony).
Polymict breccia:	Rock consisting of various altered host rock ± lesser (<10%) vein clasts. These may occur in a chemically-deposited matrix, or in a clastic matrix. Clasts range from subangular to subrounded, and may be either clast or matrix-supported.

Monomict breccia:	Similar to a polymict breccia, but containing only a single clast type. Jigsaw breccias and crackle breccias are special types of monomict breccia.
Brecciated rock:	A rock which consists largely (>90%) of fragments of a single lithology. Clasts are commonly angular, and are usually surrounded by matrix material.
Brecciated vein:	Similar to a brecciated rock, but consisting largely (>90%) of vein clasts.
Matrix breccia:	A breccia which consists largely (>80%) of clastic matrix material.
Crackle breccia:	A type of brecciated rock that has been fractured, but with little or no matrix material. Clasts are still essentially in place. These have been called hydrofractured breccias, but "crackle breccia" is preferred.
Jigsaw breccia:	A type of brecciated rock that has been fractured, and has minor matrix material separating clasts. There has been minimal transport and rotation of the clasts, which can be visually fitted together by removal of the matrix.

GENETIC TERMS FOR BRECCIAS

Hydrothermal breccia:	A general term for breccias that formed primarily as a result of hydrothermal activity, including phreatic and magmatic-phreatic breccias. These range from brecciated rocks to vein breccias and polymict breccias, and include both erupted (*Hydrothermal eruption breccias*) and subsurface rocks. Diagnostic features include the presence of altered host rock clasts, hydrothermal vein clasts, and hydrothermal minerals within the matrix cement, though not all will exhibit all of these features. Plant fragments may occur in hydrothermal eruption breccias.
Phreatic breccia:	A more specific term for breccias which form due to the expansion of steam and gas in a water-dominated hydrothermal fluid where there is no direct association of brecciation with magmatic activity.

Magmatic-phreatic breccia: A specific term for breccias formed due to flashing of hydrothermal fluids following intrusion of magma, but which do not contain juvenile magmatic material.

Phreatomagmatic (diatreme) breccia: A breccia formed by the explosive interaction of magma and groundwater. Diatremes are near-vertical pipe-like bodies up to 1 km across. The breccias are generally polymict, with rounded, matrix-supported clasts. The matrix contains finely ground wallrock clasts and juvenile magmatic material, but lacks chemically deposited minerals (unless deposited later).

Tectonic breccia: Breccia formed by the mechanical disruption of rocks in response to tectonic stress. These generally occur in identifiable fault planes, which are commonly steeply dipping. They typically exhibit a planar fabric, imbrication, slickensides, and strain textures such as undulose extinction in quartz crystals.

Sedimentary breccia: Breccia emplaced at the Earth's surface by predominantly sedimentary processes. These breccias are generally polymict and exhibit sedimentary textures (*eg*. planar fabric, graded bedding). They include talus breccias, debris flows, turbidites, landslide deposits, solution breccias, reef breccias, and glacial deposits (tillites).

Intrusive breccia: A breccia which forms at the margins of an intrusive body during emplacement. Clasts include early-crystallised intrusive material and wallrock fragments.

Volcaniclastic breccia: Breccia formed at or near the surface due to fragmentation on release of magmatic volatiles to produce deposits which include vent breccias, crumble breccias, flow breccias, tuffs, lapilli tuffs, ignimbrites, and lahar deposits. Clasts are mostly unaltered volcanic material in a matrix of fine volcanic detritus.

HYDROTHERMAL SYSTEMS

Boiling zone: Zone of two-phase (*ie*. boiling) fluid, generally within a hydrothermal upflow.

Conductive:	Transmitted through a rock or liquid.
Convective:	Transmitted by movement of a fluid.
Hydrofracturing:	Fracturing of rocks when fluid pressure exceeds the minimum compressive stress plus the effective tensile strength of the rock.
Hydrostatic:	Where pressures are determined by the amount of overlying liquid.
Hydrothermal breccia:	A general term for a rock which was brecciated by fluid processes within a hydrothermal system, without being specific as to whether energy transfer was convective or conductive, or directly magmatic.
Hydrothermal eruption:	An eruption which reaches the surface and is caused by hydrothermal processes.
Lithostatic:	Where fluid pressures are determined by the confining rock pressure
Magmatic:	Water of magmatic origin, that is derived from the loss of volatiles from magma.
Meteoric:	Water of surficial origin, including near-surface groundwaters.
Outflow:	Area where water is flowing laterally away from an upflow zone.
Paleowatertable:	The level within the rock mass below which groundwaters were formerly present.
Permeability:	The ability of fluid to flow through the rock, which depends on the porosity and the degree of interconnection of pores.
Piezometric surface:	A surface of equal fluid pressure within the rock mass.
Porosity:	Degree of pore space within a rock.
Single phase zone:	A zone in which the pressure gradient corresponds to a single-phase liquid.
Two-phase fluid:	Fluid consisting of two separate phases (*ie*. liquid (water) and gas (steam)).
Upflow:	Area where hot water is flowing more or less vertically upwards within a geothermal system.

FLUID INCLUSIONS

Daughter crystal:	Solid crystal which has been precipitated within a fluid inclusion after trapping.
Equivalent salinity:	An estimate of salinity, expressed as wt% NaCl, calculated from melting temperature determinations.
Necking:	Post-entrapment reshaping of an inclusion to a more equant shape, during which an inclusion may be divided into two or more separate inclusions, which can have different vapour/liquid ratios.
Primary:	Trapped during primary crystal growth from a fluid.
Pseudosecondary:	Trapped on a microfracture during growth of the crystal.
Secondary:	Trapped after growth of the crystal, generally on a healed microfracture.

PETROGRAPHIC TEXTURAL TERMS

Aphanitic:	Fine-grained igneous rocks in which individual crystals are not visible to the naked eye.
Amygdaloidal:	Containing vesicles which have been infilled by a secondary mineral.
Equigranular:	Composed of crystals of approximately equal grain size.
Holocrystalline:	Composed entirely of crystals (*ie*., no glass).
Hyaline:	Containing volcanic glass.
Ophitic:	Coarse pyroxene crystals partly or wholly enclosing plagioclase laths.
Pilotaxitic:	Felted mass of acicular or lath-like crystals.
Porphyritic:	Igneous rock containing coarse crystals (phenocrysts) in a fine groundmass.
Porphyry:	Medium-grained subvolcanic rock containing phenocrysts.
Trachytic:	Parallel, flow-aligned feldspars, with sparse phenocrysts.

Vesicular:	Containing spherical/ellipsoidal cavities of gas bubbles trapped in a cooling lava.
Vitric:	Glassy; dominated by volcanic glass.

ALTERATION INTENSITY

Unaltered:	No secondary minerals.
Weak:	Minor (<25 vol.%) secondary minerals.
Moderate:	25-75 vol.% secondary minerals.
Strong:	>75 vol.% secondary minerals.
Intense:	Completely altered (except for primary quartz, zircon, and apatite), but primary textures remain visible.
Total:	Completely altered (except for primary quartz, zircon, and apatite), and primary textures lost.

GRAIN SIZE (AS USED IN IGNEOUS/HYDROTHERMAL PETROLOGY)

Very fine	<0.05 mm
Fine	0.05-1 mm
Medium	1-5 mm
Coarse	5-30 mm
Very coarse	>30 mm

MINERAL PROPORTIONS

Rare	<1%
Minor	1-5%

Moderate	5-10%
Major	10-50%
Predominant	>50%

MINERAL AND ROCK TERMS

Rock classification follows that given in the Australasian Institute of Mining and Metallurgy, Field Geologists' Manual. Mineral nomenclature is that of the IMA.

Some terms that have been found to be used elsewhere in different senses are defined below:

Illite:	Colourless, birefringent clay which is characterised by having the largest XRD peak at about 10.0A (8.8°). This peak should not shift on glycolation, but is not sufficiently sharp to be termed sericite.
Illite-smectite:	Pale green or brownish fine-grained clay, which has a major XRD peak between 15.4 and 10.0A (5.7 - 8.8°) that shifts on glycolation.
Sericite:	Colourless birefringent clay which commonly forms coarse flakes. It is characterised by very sharp XRD peaks at 10.0A (8.8°), 4.98 (17.8) and 3.33A (26.6°).
Obsidian:	Volcanic rock composed of >80% glass with well developed conchoidal fracturing and vitreous lustre.
Pitchstone:	Volcanic rock composed of >80% glass with poorly developed conchoidal fracturing and a resinous lustre. Contains >4% water and more crystallites than obsidian.
Perlite:	Weakly anisotropic, hydrous volcanic glass usually with spherical fractures.