PETROGRAPHIC REPORT ON EIGHT DRILL CORE SAMPLES FROM THE THURSDAY'S GOSSAN PROJECT, WESTERN VICTORIA

For

Stavely Minerals

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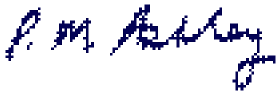

Introduction

A suite of eight drill core samples from the Thursday's Gossan project in the Cambrian age Stavely Belt in western Victoria was submitted for petrographic preparation, description and interpretation. Samples were from drill holes SMD016 (1 sample), SMD021 (1 sample), SMD044 (1 sample), SMD045 (1 sample), SMD045W2 (2 samples), SMD046 (1 sample) and SMD047 (1 sample) and were from downhole depths ranging from 336.8 m to 1148.8 m. They were fresh, and most had substantial proportions of sulphide minerals. Brief drill core descriptions and handspecimen photos for the samples were provided.

Petrographic sections were prepared at Petrographic International Pty Ltd in Brisbane, with polished thin sections (PTS) being prepared from each sample. Subsequently, PTS were examined microscopically in transmitted and reflected light. All samples were measured for magnetic susceptibility (all but one had very low susceptibility) and representative photomicrographs of textural and mineralogical characteristics were taken.

The purpose of the petrographic work was mainly to identify the sulphide mineral paragenesis, and specifically, the mineralogy and relationships of the Cu-bearing phases. There were also objectives of identifying primary rock types (where possible, as several samples were almost entirely the products of hydrothermal infill and/or intense replacement) and imposed alteration types.

Summary descriptions of the samples are listed following:

SMD016 336.8 m PTS

Summary: Semi-massive sulphide sample with a small zone of possible remnant host rock that has been intensely hydrothermally altered. The remainder of the sample could represent hydrothermal infill. The possible host rock domain has little recognised relict texture and was replaced by fine grained quartz, plus minor disseminated pyrite and chalcopyrite as well as veinlet chalcopyrite, plus a little bornite and tennantite-tetrahedrite. There is also minor sericite and a little rutile. Speculatively, the host rock was of igneous type. In the hydrothermal infill zone, abundant fine to medium grained, inequigranular quartz is intergrown with disseminated to massive zones of pyrite, with overprinting (paragenetically later) chalcopyrite, minor bornite and tennantite-tetrahedrite, and trace galena. It can be implied that tennantite-tetrahedrite was deposited prior to chalcopyrite (-bornite).

SMD021 460.1 m PTS

Summary: Semi-massive sulphide sample perhaps representing hydrothermal infill, as no vestiges of altered host rock are recognised. The rock is dominated by pyrite and quartz, with crudely banded coarser pyrite aggregates intercalated with those containing patchily abundant fine grained quartz, plus disseminated to semi-massive pyrite and subordinate Cu sulphides. Minor patchy aggregates and veinlets of sericite occur with quartz, textures of which are typical of formation in the shallow mesothermal to epithermal environment. Traces of Cu sulphides (bornite, chalcopyrite, chalcocite, digenite) occur in quartz, but Cu sulphides are most abundant in association with coarser pyrite. Here, they are paragenetically later than pyrite, tending to enclose and form fracture fillings in the mineral. Chalcocite is the dominant Cu sulphide phase, with minor chalcopyrite (mostly occurring as fracture fill in pyrite), and traces of bornite and colusite. No enargite is recognised in the sample.

SMD044 1024.7 m PTS

Summary: Strongly altered porphyritic microtonalite, with major veining by anhydrite, plus minor chalcopyrite and pyrite. There is moderately well preserved primary texture, indicating that the rock had scattered quartz and feldspar phenocrysts, with minor biotite and possibly amphibole, in a fine to medium grained inequigranular quartzofeldspathic groundmass. It is possible that there was an early, mild phase of potassic alteration, with development of minor hydrothermal biotite, mostly at former ferromagnesian sites, and accompanied by traces of pyrite, chalcopyrite and anhydrite. Subsequently, alteration evolved into strong propylitic type, with overprinted by fine grained chlorite and sericite. Major anhydrite veining appears to be bordered by strong chlorite development, with the veins also containing scattered chalcopyrite and pyrite (mostly adjacent to vein margins).

SMD045 1077.7 m PTS

Summary: Intensely hydrothermally altered rock, largely silicified, and containing scattered, mostly sub-parallel quartz-sulphide veins. No relict texture is recognised in altered protolith domains, which have been replaced by fine to medium grained quartz, minor disseminated sulphides, a little sericite and carbonate, and trace rutile. Veins are diffuse and contain medium grained quartz and disseminations and aggregates of pyrite, with paragenetically later Cu sulphides. These phases are disseminated in the altered protolith and tend to occur enclosing and invading pyrite aggregates in the veins. The Cu sulphides appear to be in equilibrium and include bornite and enargite, with minor chalcocite and digenite, and a trace of colusite. No chalcopyrite is recognised in the assemblage.

SMD045W2 1133.1 m PTS

Summary: Sulphide-quartz rock, with breccia texture and containing a few possible intensely hydrothermally altered host rock remnants. The latter are replaced by a silicic-phyllic assemblage of dominant quartz, with minor sericite, pyrite and trace rutile. The remainder of the rock probably represents hydrothermal infill, with early-formed pyrite showing brecciation and subsequent infill by abundant fine to medium grained quartz and patchy Cu sulphides. The latter locally occur surrounding pyrite and invading along grain boundaries and fractures. Cu sulphides include major enargite and bornite, with minor colusite in places, and a trace of digenite. The Cu sulphide minerals appear to be in equilibrium with each other and are paragenetically later than pyrite. No chalcopyrite is recognised.

SMD045W2 1148.8 m PTS

Summary: Strongly deformed and hydrothermally altered rock, with abundant sulphide mineralisation. Much of the rock has no preserved primary characteristics due to imposed processes, but local domains have some relict texture suggesting that the protolith was a fine grained sandstone, grading to siltstone, containing considerable detrital quartz. The protolith evidently experienced strong penetrative deformation, maybe attending low grade metamorphism, so as to form a foliated and locally micro-cataclastic to mylonitic texture, and with replacement by locally abundant sericite, recrystallised quartz and trace rutile. Subsequently, the rock was invaded by quartz, sulphides and minor anhydrite, in masses largely co-planar with the foliation. Early deposited coarse grained quartz was strained and partly recrystallised and pyrite was typically fractured. Pyrite, chalcopyrite and minor anhydrite were deposited in the adjacent altered host rock, and pyrite masses throughout were overprinted by paragenetically later chalcopyrite and minor tennantite-tetrahedrite. No bornite, chalcocite or enargite were observed in the sample.

SMD046 373.6 m PTS

Summary: Porphyritic intermediate igneous rock (e.g. of andesitic or microdioritic type), with indications of initial hydrothermal biotite (potassic) alteration and later retrograde (propylitic) alteration, maybe coincident with two phases of vein emplacement. The original rock contained feldspar and small ferromagnesian phenocrysts in a fine grained groundmass. Initial alteration led to considerable replacement by hydrothermal biotite, with patchy quartz and traces of chalcopyrite, pyrite and magnetite. Early veining was by quartz, with a little chalcopyrite, pyrite and carbonate and with patchy development of potassic alteration selvedges. Later alteration caused strong destruction of any prior feldspar, and most ferromagnesian material, including hydrothermal biotite, with replacement by abundant chlorite, sericite, subordinate carbonate, minor pyrite and trace rutile. This phase of alteration appear to be related to emplacement of a major vein of carbonate and pyrite, with a little quartz and trace chalcopyrite.

SMD047 636.9 m PTS

Summary: Intensely hydrothermally altered rock, with replacement by quartz and pyrite, minor anhydrite and sericite and traces of Cu sulphides and rutile, and hosting a sub-parallel array of diffuse veinlike masses of quartz, anhydrite, pyrite, Cu sulphides and trace carbonate. No relict characteristics from a protolith are recognised. The rock was evidently deformed, with disaggregation of pyrite masses, recrystallization of quartz (commonly to fibre-texture aggregates) and anhydrite, development of foliation in sericite. Paragenetically, pyrite is earlier than, and probably locally replaced by, Cu sulphides that are dominated by bornite, with minor associated chalcocite and digenite, and a trace of enargite. The Cu sulphide phases appear to be in equilibrium.

Interpretation and comment

Primary rock types

Only three samples in the suite have recognisable primary rocks, with the others having primary characteristics that are totally obscured by the intensity of hydrothermal alteration and/or overprinting by hydrothermal infill. Sample SMD044/1024.7 m has moderately well preserved primary texture suggesting that the protolith was a porphyritic microtonalite, and there is moderately preserved texture in SMD045W2/1148.8 m (possible sandstone, grading to siltstone, with relict detrital quartz grains) and in SMD046/373.6 m (possible porphyritic andesite or microdiorite).

The two samples with igneous protoliths have relict porphyritic texture, with SMD044/1024.7 retaining a few relict quartz phenocrysts, and having pseudomorphs after former feldspar (e.g. plagioclase) and ferromagnesian phenocrysts, set in a fine to medium grained quartzofeldspathic groundmass.

This rock has a "classic" porphyry texture. In SMD046/373.6 m, there are pseudomorphs after former feldspar (e.g. plagioclase) phenocrysts, and possibly after small ferromagnesian phenocrysts, in a finer grained groundmass. In SMD045W2/1148.8 m, possible relict detrital grain texture is apparent, with rather abundant small quartz grains in a finer grained altered and recrystallised matrix.

Samples SMD016/336.8 m, SMD021/460.1 m, SMD045/1077.7 m, SMD045W2/1133.1 m and SMD047/636.9 m have either protolith material whose original nature was totally obscured by imposed processes, or in the case of SMD021/460.1 m, has no evidence at all for the occurrence of protolith material (i.e. this sample could be totally composed of hydrothermal infill). In the samples that do have indications of having formerly contained some protoith material, the intensity of alteration has completely destroyed any primary characteristics.

Hydrothermal alteration

In the two rocks with definite igneous protoliths (SMD044/1024.7 m, SMD046/373.6 m), there are indications that early, mild potassic alteration was imposed. In both samples, it is apparent that hydrothermal biotite formed in the groundmasses and from former ferromagnesian material. In the former sample, biotite development was accompanied by a little pyrite, chalcopyrite and anhydrite, and in the latter it was accompanied by quartz and traces of magnetite, chalcopyrite and pyrite. Both samples then show evidence of strong retrograde alteration overprinting the initial potassic alteration, manifest in formation of a propylitic assemblage of phases including chlorite and sericite, plus local carbonate, pyrite, anhydrite and trace rutile. Most hydrothermal biotite was destroyed in this retrograde process. In the interpreted sandstone-siltstone sample SMD045W2/1148.8 m, a phyllic alteration overprint occurred, with development in the matrix of quartz and sericite, with a little anhydrite, pyrite, chalcopyrite and rutile. In the samples that could retain vestiges of intensely altered protolith, the alteration tends to be of silicic (-phyllic) type, with complete reconstitution into fine to medium grained quartz, plus minor disseminations and patches of sericite, pyrite, local anhydrite and small amounts of Cu sulphides and trace rutile.

Veining

Veining and/or diffuse hydrothermal infill have occurred in each samples in the suite. In rocks with recognisable igneous protoliths, there was early veining that could be related to the initial potassic alteration. These veins contain phases such as quartz and/or anhydrite, with minor pyrite, chalcopyrite, carbonate and trace hematite. Later veining in SMD046/373.6 m) is related to the subsequent propylitic alteration and contains carbonate and pyrite, with a little quartz and trace chalcopyrite. In other samples with silicic (-phyllic) alteration, or which are dominated entirely by vein infill, the veining contains dominant quartz and/or pyrite, minor to abundant Cu sulphide phases, a little anhydrite and traces of sericite and carbonate. Amongst the Cu sulphide phases, bornite and chalcopyrite can each be rather abundant and there are minor to trace amounts of chalcocite, digenite, tennantite-tetrahedrite, enargite and colusite.

In many vein infillings, quartz is fine through to medium grained and has textures that range from inequigranular to prismatic, typical of those found in epithermal to shallow mesothermal systems. In samples SMD045W2/1148.8 m and SMD047/636.9 m, quartz (± sericite) shows effects of imposed deformation, e.g. strain, recrystallization, foliation, suggesting that the rocks were deformed during or subsequent to mineralisation.

Mineralisation

All samples contain sulphide minerals, ranging from relatively minor (e.g. <10% in SMD044/1024.7 m and SMD046/373.6 m) up to largely massive, e.g. >50% in SMD016/336.8 m, SMD021/460.1 m and SMD045W2/1133.1 m. Largest concentrations of sulphides appear to be in the veins and related diffuse aggregates, but there are also considerable sulphides in places due to replacement of protolith. In less-mineralised material, there are disseminated sulphides in altered host rock and veins.

Pyrite is commonly the major sulphide (attaining up to 40-50%), but in a couple of samples, it is subordinate to chalcopyrite. Most pyrite is fine to medium grained, with anhedral to subhedral grains and having a paragenetic relationship with Cu sulphides indicating that it was deposited earlier. Locally, pyrite is strongly fractured and invaded by quartz, Cu sulphides and local anhydrite, as well as containing small inclusions of these phases. Textures suggest that pyrite was locally replaced by the Cu sulphides. The Cu sulphide phases include chalcopyrite, bornite and generally lesser amounts of chalcocite, digenite, enargite, tennantite-tetrahedrite and colusite. Total amounts of Cu sulphide phases range from a trace up to >30% (in SMD016/336.8 m). These phases, however, are not all present in the one sample and there appears to be two main groupings, with only minor mineralogical overlap. One group includes chalcopyrite ± tennantite-tetrahedrite ± bornite ± chalcocite (e.g. in SMD016/336.8 m, SMD044/1024.7 m, SMD045W2/1148.8 m, SMD046/373.6 m) and the other group has bornite and/or chalcocite, ± enargite, digenite and a little colusite. Examples of the latter group are in SMD021/460.1 m, SMD045/1077.7 m, SMD045W2/1133.1 m and SMD047/636.9 m. Each of the Cu sulphide minerals can form mono-mineralic aggregates up to a few millimetres across, but also show complex intergrowths on the small scale, e.g. chalcopyrite with tennantite-tetrahedrite, and bornite-chalcocite, or bornite-digenite. Enargite tends to have little intergrowth with the other phases. The rather rare mineral, colusite ($Cu_{13}VAs_3S_{16}$) tends to be closely associated with bornite, chalcocite and enargite. Most of the Cu sulphide phases appear to be largely in equilibrium, although locally, chalcopyrite deposition could post-date that of tennantite-tetrahedrite. The only other sulphide mineral observed in the sample suite is a trace of galena in SMD016/336.8 m, in association with the Cu sulphides. No discrete precious metal phase was recognised.

Affinities of mineralisation

The host rock textures and alteration types observed in samples SMD044/1024.7 m and SMD046/373.6 m are typical of those found in many porphyry Cu systems (e.g. early hydrothermal biotite development overprinted by propylitic alteration). The other samples, commonly with intense silicic to phyllic alteration of host rock (where recognised) and association with sulphide-rich (and commonly Cu sulphide-rich) veining and replacement, have analogies to lode style mineralisation (e.g. the Main Vein stage at Butte, Montana). These samples also show some affinity with high –sulphidation style mineralisation (e.g. occurrence of phases including bornite, chalcocite, enargite, tennantite-tetrahedrite and anhydrite). Perhaps the lode style mineralisation and associated alteration is superimposed on an already existing porphyry system, or alternatively, it might overlie a deeper porphyry system. If the latter option is considered, it leads to the question of whether the intrusive and hydrothermal system at Thursdays Gossan has remained upright during subsequent orogenic overprints, or could be significantly tilted?

Individual sample descriptions

SMD016 336.8 m PTS

Summary: Semi-massive sulphide sample with a small zone of possible remnant host rock that has been intensely hydrothermally altered. The remainder of the sample could represent hydrothermal infill. The possible host rock domain has little recognised relict texture and was replaced by fine grained quartz, plus minor disseminated pyrite and chalcopyrite as well as veinlet chalcopyrite, plus a little bornite and tennantite-tetrahedrite. There is also minor sericite and a little rutile. Speculatively, the host rock was of igneous type. In the hydrothermal infill zone, abundant fine to medium grained, inequigranular quartz is intergrown with disseminated to massive zones of pyrite, with overprinting (paragenetically later) chalcopyrite, minor bornite and tennantite-tetrahedrite, and trace galena. It can be implied that tennantite-tetrahedrite was deposited prior to chalcopyrite (-bornite).

Handspecimen: The drill core sample is composed of a semi-massive sulphides, with sulphide-rich and quartz-rich domains on a scale of up to 1.5 cm wide being intercalated and with banding being at a high angle to the core axis (Fig. 1). Pale grey, fine grained quartz contains minor disseminated pyrite and chalcopyrite and these zones grade relatively sharply into sulphide-rich zones containing fine to medium grained pyrite and abundant chalcopyrite, with the latter locally forming veinlike aggregates (Fig. 1). Traces of possible bornite and tennantite-tetrahedrite occur with chalcopyrite. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 1: Drill core sample of semi-massive, weakly banded sulphides, with zones rich in pyrite and pale grey quartz that are invaded by irregular to veinlike chalcopyrite aggregates.

Petrographic description

a) Primary rock characteristics: In the section, much of the sample is composed of fine to medium sulphides and quartz, with either dominating, and in which there is no relict texture after protolith material. Much of the sulphide-quartz aggregate could represent hydrothermal infill. There is, however, a small domain occupying about 10% of the section that has less sulphides and a greater proportion of quartz, along with minor sericite and a little rutile. This domain is interpreted as being intensely altered host rock, with the rutile aggregates perhaps being pseudomorphic after former igneous FeTi oxide grains. If this is the case, it can be speculated that the host rock was igneous (e.g. volcanic or intrusive).

b) Alteration and structure: The small zone in the sample that is interpreted a former igneous host rock was intensely replaced by finely inequigranular quartz, with minor patchy sericite, disseminated and veinlet sulphides (pyrite, chalcopyrite, minor bornite, tennantite-tetrahedrite) and sparsely distributed rutile in aggregates up to 0.2 mm across. Alteration of the host rock is interpreted as silicic-phyllic type. The remainder of the sample is regarded as mostly hydrothermal infill and is composed of abundant fine to medium grained, inequigranular quartz (up to 0.3 mm), pyrite and chalcopyrite, with minor tennantite-tetrahedrite, bornite and traces of sericite and galena. Quartz is intergrown with disseminated to largely masses aggregates of pyrite (aggregates up to several millimetres), with paragenetically later chalcopyrite and associated tennantite-tetrahedrite and bornite (Figs 2, 3). Quartz textures are typical of deposition in the shallow mesothermal to epithermal environment and in one chalcopyrite-rich veinlike mass, there is crustiform texture infill of chalcedonic quartz and low-birefringent clay (e.g. kaolinite).

c) Mineralisation: The sample contains abundant sulphides, probably mostly representing hydrothermal infill and with a minority disseminated in the altered host rock. There is abundant, paragenetically early pyrite, ranging from disseminated to largely massive aggregates up to several millimetres across (irregular to elongate morphology). Pyrite has been invaded by abundant, paragenetically later chalcopyrite forming massive aggregates (some veinlike) and associated minor tennantite-tetrahedrite, bornite and trace galena (Figs 2, 3). Bornite occurs as intergrowths with chalcopyrite (perhaps formed by exsolution) and with associated trace galena (grains to 0.3 mm) appears to be largely in equilibrium (Fig. 2). Locally abundant tennantite-tetrahedrite forms masses up to several millimetres across and although later than pyrite, could be slightly paragenetically earlier than chalcopyrite (-bornite) (Fig. 3).

Mineral Mode (by volume): quartz (including chalcedony) 40%, chalcopyrite 30%, pyrite 20%, tennantite-tetrahedrite 5%, bornite 3%, sericite 2% and traces of clay (kaolinite), rutile and galena.

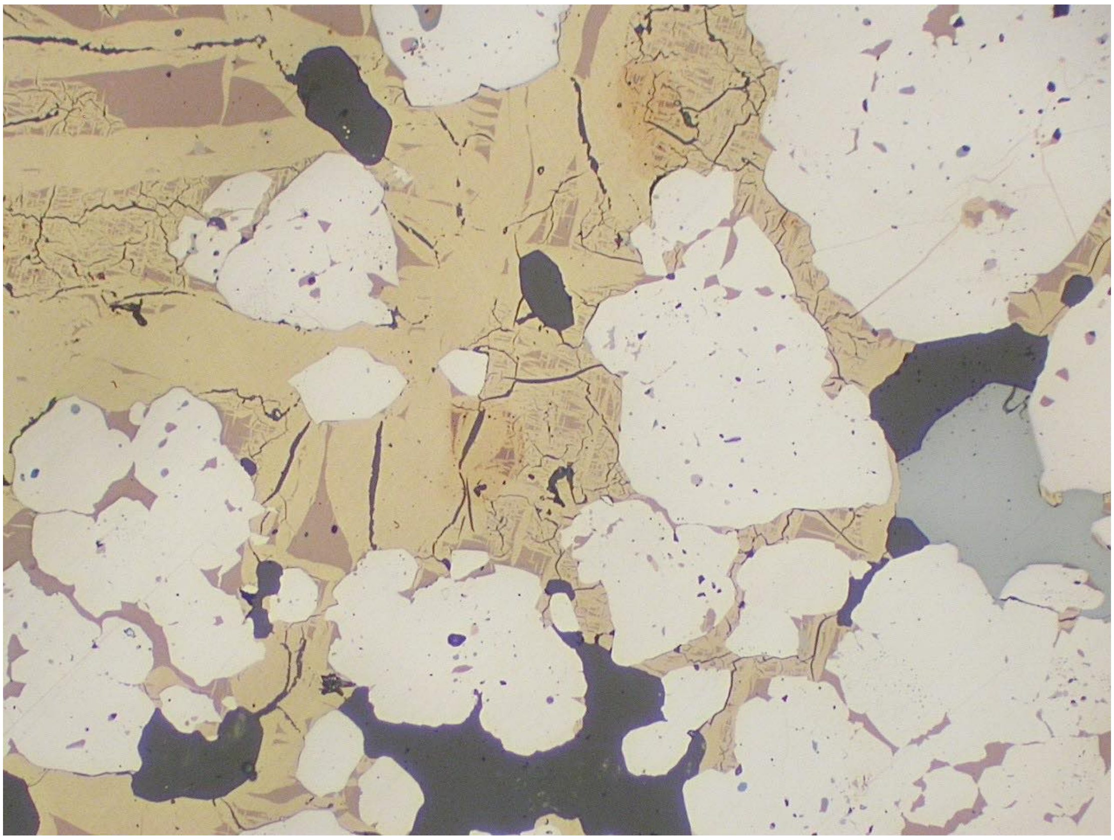

Fig. 2: Scattered pyrite grains (pale creamy) invaded by abundant chalcopyrite (yellow) containing minor exsolved bornite (pink-brown). The pale grey grain at right is tennantite-tetrahedrite. Plane polarised reflected light, field of view 1 mm across.

Interpretation and comment: It is interpreted that the sample represents a zone of semi-massive sulphides containing a small zone of possible remnant host rock that has been intensely hydrothermally altered. The remainder of the sample may be hydrothermal infill. Possible host rock has little recognised relict texture and was replaced by fine grained quartz, plus minor disseminated pyrite, chalcopyrite, plus a little bornite and tennantite-tetrahedrite. There is also minor sericite and a little rutile. Speculatively, the host rock was of igneous type. In the hydrothermal infill zone, abundant fine to medium grained, inequigranular quartz is intergrown with disseminated to massive pyrite, with overprinting (paragenetically later) chalcopyrite, minor bornite and tennantite-tetrahedrite, and trace galena. It can be implied that tennantite-tetrahedrite was deposited prior to chalcopyrite (-bornite).

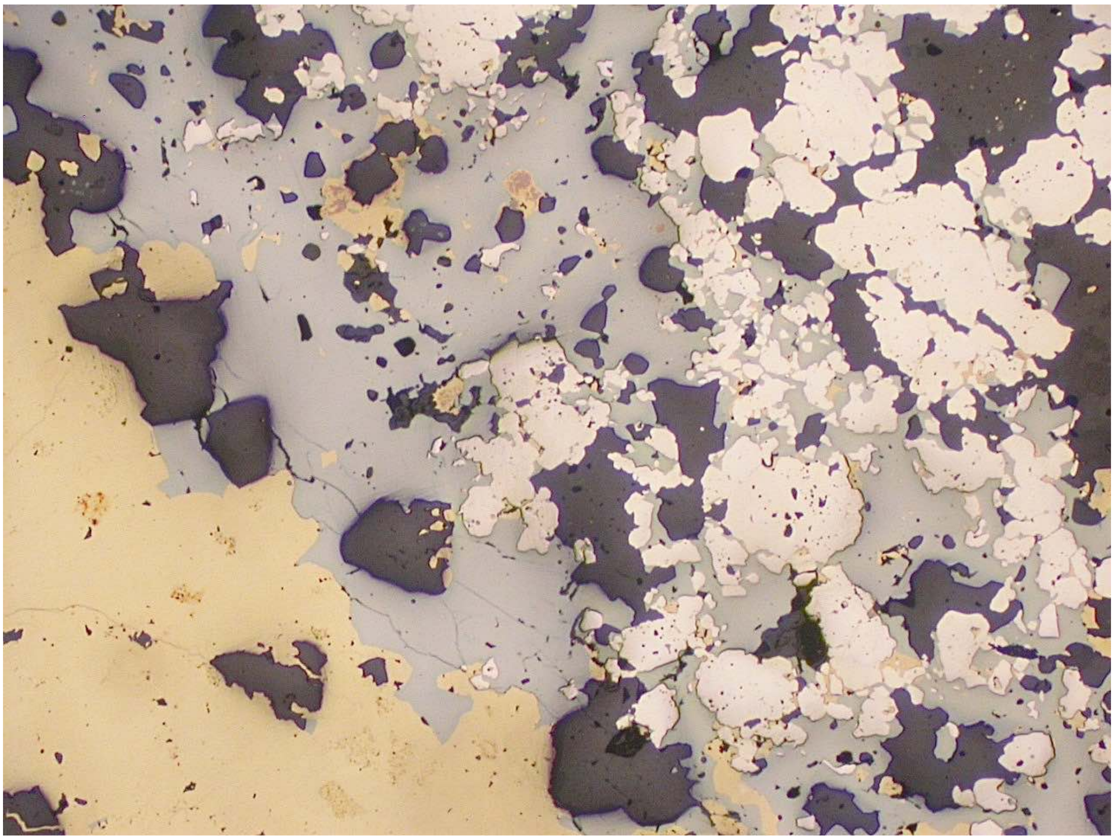

Fig. 3: Zone of strongly disseminated pyrite (pale creamy) and quartz (dark) that has been invaded by tennantite-tetrahedrite (pale grey) and chalcopyrite (yellow). It is possible that chalcopyrite is paragenetically later than tennantite-tetrahedrite. A trace of bornite is associated with chalcopyrite (upper centre). Plane polarised reflected light, field of view 2 mm across.

SMD021 460.1 m PTS

Summary: Semi-massive sulphide sample perhaps representing hydrothermal infill, as no vestiges of altered host rock are recognised. The rock is dominated by pyrite and quartz, with crudely banded coarser pyrite aggregates intercalated with those containing patchily abundant fine grained quartz, plus disseminated to semi-massive pyrite and subordinate Cu sulphides. Minor patchy aggregates and veinlets of sericite occur with quartz, textures of which are typical of formation in the shallow mesothermal to epithermal environment. Traces of Cu sulphides (bornite, chalcopyrite, chalcocite, digenite) occur in quartz, but Cu sulphides are most abundant in association with coarser pyrite. Here, they are paragenetically later than pyrite, tending to enclose and form fracture fillings in the mineral. Chalcocite is the dominant Cu sulphide phase, with minor chalcopyrite (mostly occurring as fracture fill in pyrite), and traces of bornite and colusite. No enargite is recognised in the sample.

Handspecimen: The drill core sample is composed of a pyrite-quartz rock, representing a zone of strong sulphide mineralisation in a zone of probable dominant hydrothermal infill. Strongly disseminated to massive pyrite is associated with minor amounts of silvery-grey chalcocite, and grades into, as well as containing apparent fragments of, pale grey, fine grained quartz and minor sericite (Fig. 4). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

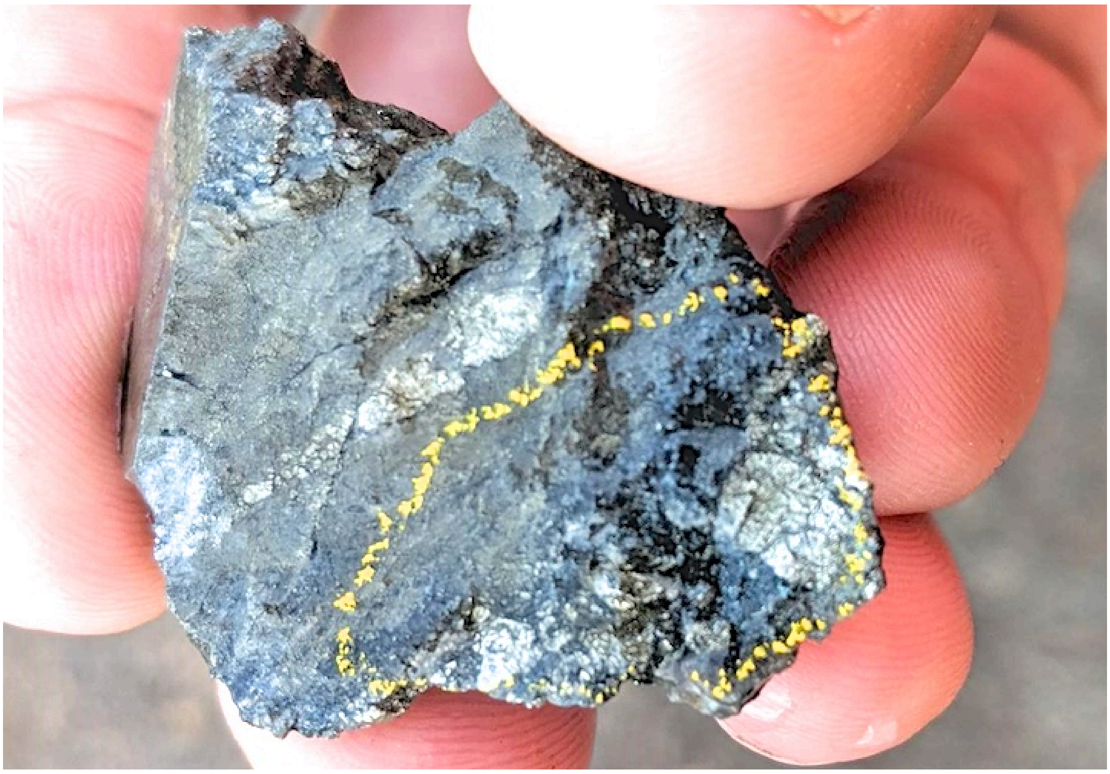

Fig. 4: Drill core sample of sulphides-rich aggregates (dark) that are intercalated with and enclose fragments of, fine grained quartz (-sericite) rock. Sulphides are dominated by pyrite, with minor chalcocite and other Cu sulphide phases.

Petrographic description

a) Primary rock characteristics: In the section, no relict texture from a protolith is recognised and the rock is considered to most likely represent the product of hydrothermal infill. No rutile, a refractory indicator of many types of protolth material, was recognised in the sample.

b) Alteration and structure: The sample is dominated by pyrite and quartz, with smaller amounts of fine grained sericite and Cu sulphides. Pyrite occurs as fine grained, strongly disseminated to semi-massive aggregates, intercalated with bands up to several millimetres wide of more massive, coarser grained pyrite and associated Cu sulphides (Fig. 5). Interstitial to pyrite grains and aggregates is locally abundant quartz, mostly finely inequigranular in texture, but grading in places to medium grainsize (up to 0.6 mm). Within quartz-rich zones are disseminated and aggregates up to 1.5 mm across of fine grained sericite. There are also a few irregular to sub-planar, discontinuous veins up to 0.4 mm wide of sericite and/or quartz cutting pyrite-quartz and pyrite-rich domains. Quartz textures in the sample are typical of those formed in the shallow mesothermal to epithermal environment. Small grains of Cu sulphides are sparsely distributed in the more quartz-rich domains (chalcocite, bornite, chalcopyrite, but most Cu sulphides tend to be associated with the coarser pyrite aggregates, occurring as aggregates enclosing pyrite, filling fractures in pyrite, and as small inclusions (Figs 5, 6). Chalcocite is the dominant Cu sulphide, but chalcopyrite is common as fracture filling, and small amounts of chalcopyrite, bornite and colusite occur in chalcocite (Figs 6, 7).

c) Mineralisation: The sample contains abundant sulphides, which along with quartz and minor sericite, are interpreted to be part of the hydrothermal infill assemblage. Pyrite is the dominant sulphide mineral occurring as strongly disseminated to semi-massive fine grained aggregates that are irregularly interlayered with bands of coarser grained, more massive pyrite (Fig. 5). Coarser pyrite is commonly fractured and locally micro-brecciated, with fractures filled mainly with chalcopyrite, but locally by chalcocite (Figs 5, 6). Where more disseminated, pyrite is hosted in quartz, and in which there also uncommon small individual grains and composites that have one or more of chalcocite, chalcopyrite, bornite and rare digenite. Chalcocite is the dominant Cu sulphide, occurring in a few parts of the sample in relative abundant, but very sparse elsewhere. Chalcopyrite forms semi-massive aggregates up to 4 mm across and also borders on to pyrite and occurs, along with chalcopyrite, as fracture fillings in pyrite. Within chalcocite aggregates, there are also small inclusions of chalcopyrite, bornite and uncommon grains of colusite up to 0.3 mm across (Fig. 7). Chalcopyrite mainly occurs in the sample as fracture fillings in coarser pyrite. Textures indicate that the Cu sulphides are paragenetically later than, and could locally replace, pyrite. No enargite is recognised in the sample.

Mineral Mode (by volume): pyrite 50%, quartz 40%, sericite 5%, chalcocite 4%, chalcopyrite 1% and traces of bornite, colusite and digenite.

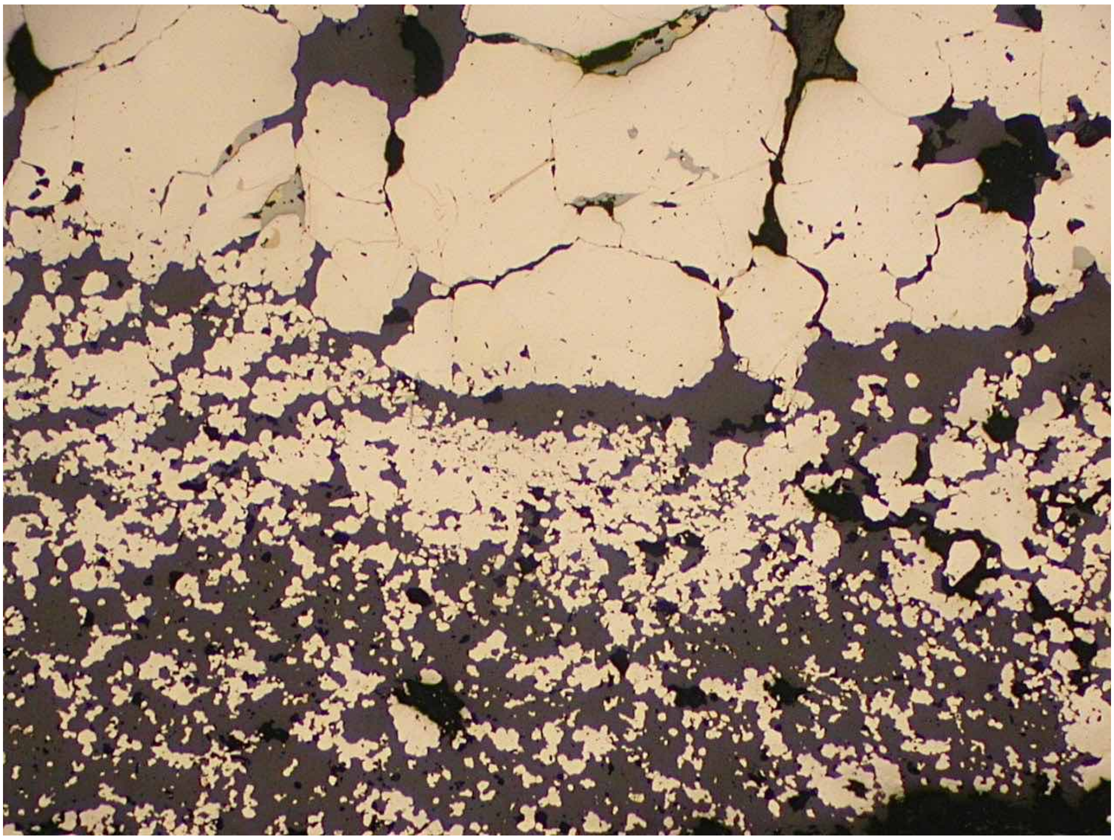

Fig. 5: Banding caused by intercalation of massive, coarser grained pyrite (upper) and semi-massive to disseminated pyrite and quartz (dark). Small amounts of pale grey chalcocite are visible as fracture filling in coarser pyrite. Plane polarised reflected light, field of view 2 mm across.

Interpretation and comment: It is interpreted that the sample is dominated by pyrite and quartz, being a zone of semi-massive sulphide mineralisation that probably represents hydrothermal infill. No vestiges of altered host rock are recognised. Crudely banded coarser pyrite aggregates are intercalated with those containing fine grained quartz, plus disseminated to semi-massive pyrite and subordinate Cu sulphides. Minor patchy aggregates and veinlets of sericite occur with quartz, textures of which are typical of formation in the shallow mesothermal to epithermal environment. Traces of Cu sulphides (bornite, chalcopyrite, chalcocite, digenite) occur in quartz, but Cu sulphides are most abundant in association with coarser pyrite where they are paragenetically later, tending to enclose and form fracture fillings in the mineral. Chalcocite is the dominant Cu sulphide phase, with minor chalcopyrite (mostly occurring as fracture fill in pyrite), and traces of bornite and colusite. No enargite is recognised in the sample.

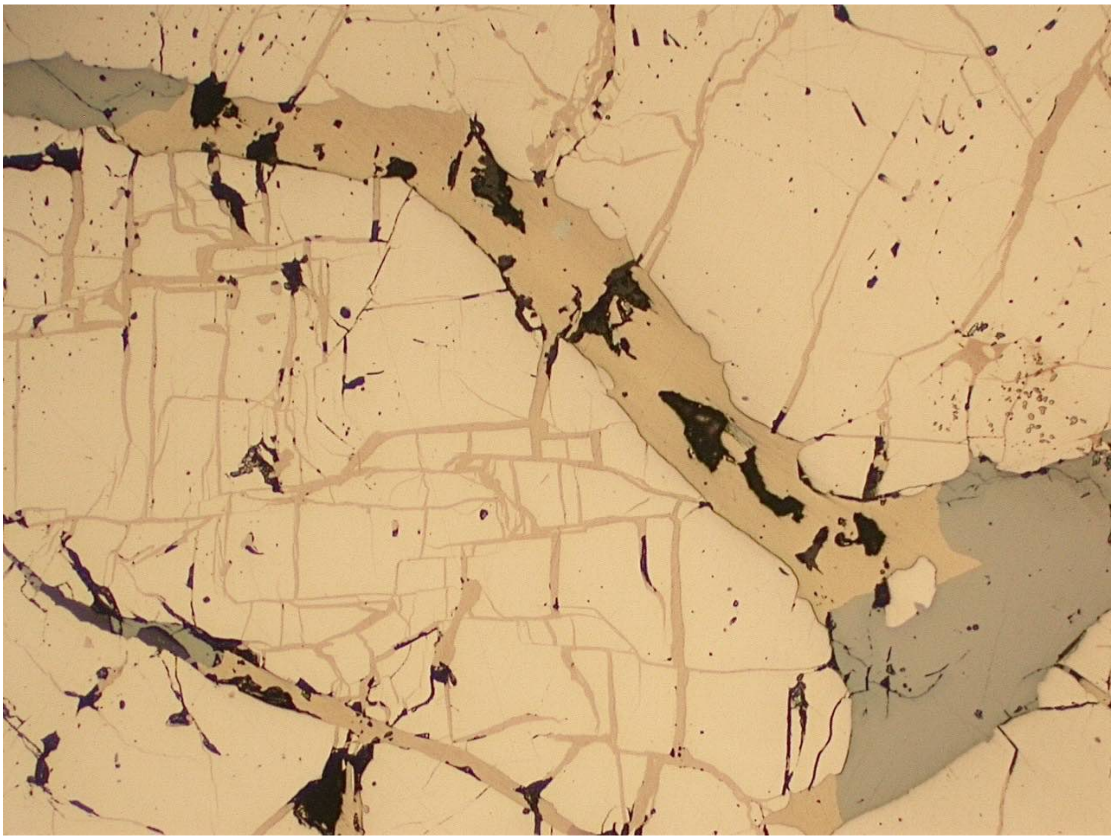

Fig. 6: Coarse pyrite showing fracturing and invasion by chalcopyrite (yellow) and chalcocite (pale grey). Plane polarised reflected light, field of view 1 mm across.

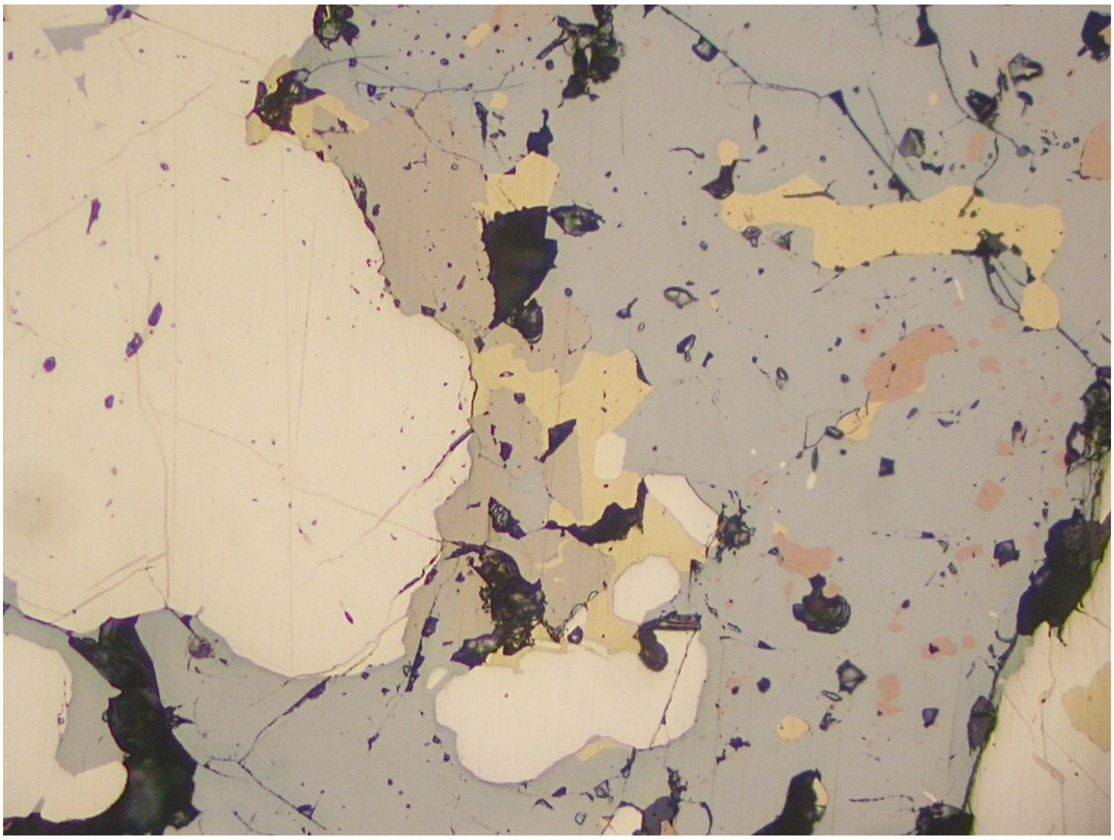

Fig. 7: Pyrite (left, pale creamy) adjacent to a composite aggregate of chalcocite (pale grey) containing inclusions of colusite (pale tan), chalcopyrite (yellow) and bornite (pink-brown). Plane polarised reflected light, field of view 0.5 mm across.

SMD044 1024.7 m PTS

Summary: Strongly altered porphyritic microtonalite, with major veining by anhydrite, plus minor chalcopyrite and pyrite. There is moderately well preserved primary texture, indicating that the rock had scattered quartz and feldspar phenocrysts, with minor biotite and possibly amphibole, in a fine to medium grained inequigranular quartzofeldspathic groundmass. It is possible that there was an early, mild phase of potassic alteration, with development of minor hydrothermal biotite, mostly at former ferromagnesian sites, and accompanied by traces of pyrite, chalcopyrite and anhydrite. Subsequently, alteration evolved into strong propylitic type, with overprinted by fine grained chlorite and sericite. Major anhydrite veining appears to be bordered by strong chlorite development, with the veins also containing scattered chalcopyrite and pyrite (mostly adjacent to vein margins).

Handspecimen: The drill core sample is composed of a strongly altered, porphyritic felsic igneous rock containing prominent veining up to 1.5 cm wide consisting of white to mauve anhydrite and bordering masses of chalcopyrite and minor pyrite (Fig. 8). Veining is commonly rimmed by dark grey-green chlorite alteration selvedges. Pervasive chlorite and sericite development has affected the host rock, which originally contained feldspar phenocrysts, as well as retaining a few quartz phenocrysts, in a fine grained groundmass (Fig. 8). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI. There is no evidence for any vein-hosted magnetite.

Fig. 8: Drill core pieces showing veining by white to mauve anhydrite, plus minor chalcopyrite, hosted in altered porphyritic microtonalite.

Petrographic description

a) Primary rock characteristics: In the section, about 40% of the sample is vein infill and the remainder is strongly altered igneous rock in which relict porphyritic texture is moderately well preserved. The rock originally contained scattered blocky feldspar phenocrysts (e.g.

plagioclase) up to 4 mm across and it retains scattered quartz phenocrysts up to 2.5 mm across (Fig. 9). There are also a few pseudomorphs after former biotite grains (up to 1 mm) and elongate bladed grains that were probably hornblende (up to 3 mm long). The phenocrystal phases occurred in a fine to medium grained, inequigranular groundmass containing quartz, feldspar, ferromagnesian material and trace FeTi oxide (Fig. 9). The preserved primary characteristics of the rock indicate that it represents an altered porphyritic microtonalite. The primary texture is that of "classic" porphyry type.

b) Alteration and structure: The igneous rock was strongly hydrothermally altered and cut by major veining. All original feldspar, ferromagnesian material and FeTi oxide were replaced. There is an indication that there was an initial mild phase of hydrothermal biotite development (e.g. at ferromagnesian sites and in the groundmass) and this might have been accompanied by formation of trace anhydrite, pyrite and chalcopyrite, and represents potassic alteration. It is the considered that major veining occurred, along with evolution of the alteration to strong propylitic type. Veining is up to 7 mm wide and dominated by medium grained anhydrite, but with concentrations of chalcopyrite, plus minor pyrite and quartz, towards the vein margins. Traces of blady texture hematite occur in anhydrite. About the veining, the immediate host rock was strongly replaced by chlorite, with minor anhydrite, quartz, pyrite and chalcopyrite. Further away, alteration effects are manifest in replacement of feldspar and ferromagnesian grains by fine grained chlorite and sericite, with a little anhydrite and trace rutile (Fig. 9).

c) Mineralisation: In the altered host rock, a little sparsely disseminated pyrite and chalcopyrite developed, forming aggregates up to 0.5 mm across. Speculatively, this could be part of the early potassic alteration, or be related to the later propylitic alteration. Major development of sulphides occurred with the emplacement of the anhydrite-rich veining. Chalcopyrite aggregates up to several millimetres across and associated minor pyrite (aggregates to 2 mm) tend to be concentrated towards the vein margins (Fig. 10). Pyrite is paragenetically earlier than chalcopyrite (Fig. 10).

Mineral Mode (by volume): quartz 30%, chlorite 25%, anhydrite 20%, sericite 17%, chalcopyrite 6%, pyrite 2% and traces of rutile and hematite.

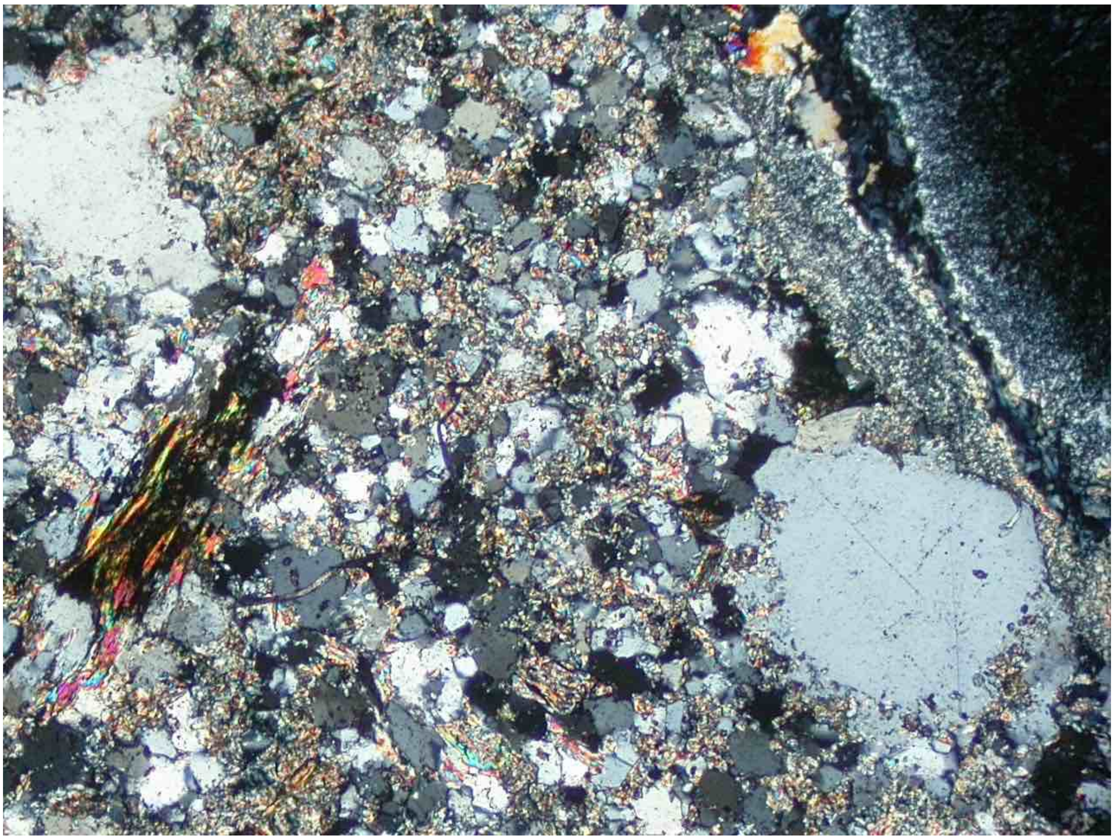

Fig. 9: Relict porphyritic texture, with quartz phenocrysts, an altered large feldspar phenocryst (upper right) and an altered biotite grain (left) in a finer grained groundmass. Alteration is dominated by sericite and chlorite, with trace anhydrite. Transmitted light, crossed polarisers, field of view 2 mm across.

<u>Interpretation and comment</u>: It is interpreted that the sample represents a porphyritic microtonalite that has experienced strong hydrothermal alteration and emplacement of major veining by anhydrite, plus minor chalcopyrite and pyrite. Primary textural remnants indicate that the rock had scattered quartz and feldspar phenocrysts, with minor biotite and possibly amphibole, in a fine to medium grained quartzofeldspathic groundmass. It is possible that there was an early phase of mild potassic alteration, with development of minor hydrothermal biotite, accompanied by traces of pyrite, chalcopyrite and anhydrite. Subsequently, alteration evolved into strong propylitic type, with overprinted by fine grained chlorite and sericite. Major anhydrite veining appears to be bordered by strong chlorite development, with the veins also containing scattered chalcopyrite and pyrite (mostly adjacent to vein margins).

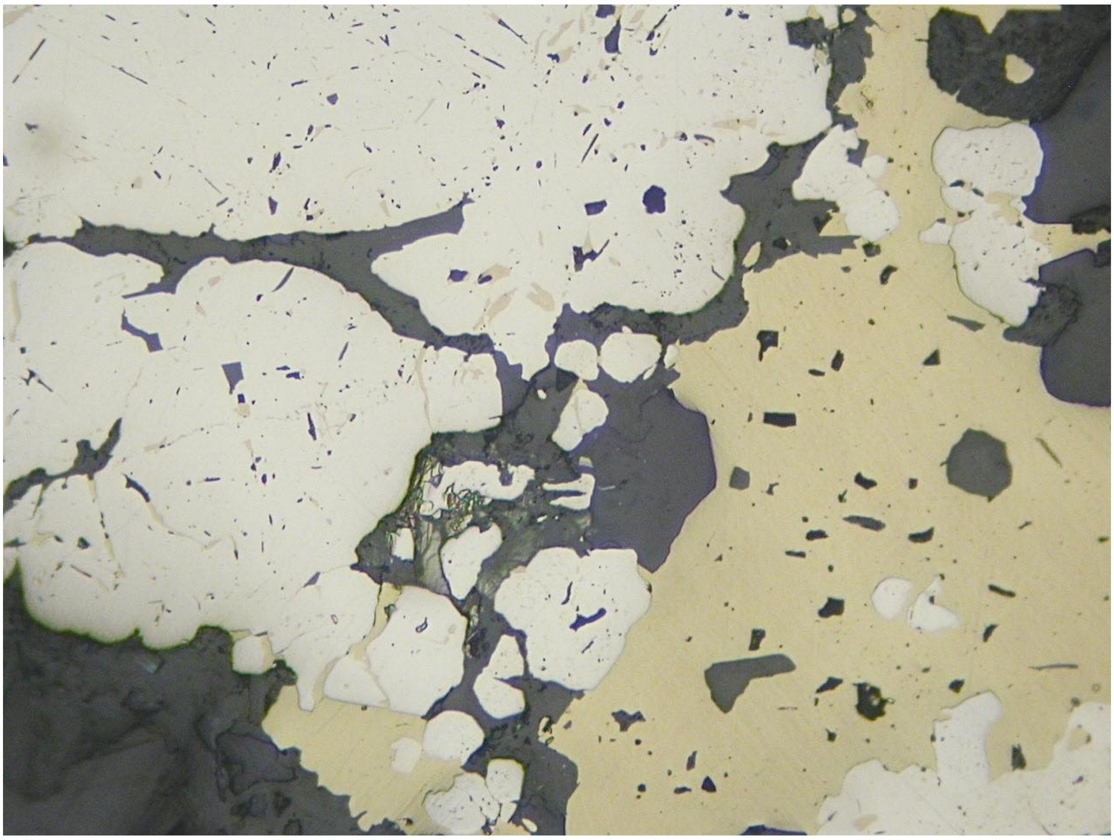

Fig. 10: Sulphide aggregate along the margin of anhydrite veining. Chalcopyrite (yellow) is paragenetically later than pyrite (pale creamy). Plane polarised reflected light, field of view 1 mm across.

SMD045 1077.7 m PTS

Summary: Intensely hydrothermally altered rock, largely silicified, and containing scattered, mostly sub-parallel quartz-sulphide veins. No relict texture is recognised in altered protolith domains, which have been replaced by fine to medium grained quartz, minor disseminated sulphides, a little sericite and carbonate, and trace rutile. Veins are diffuse and contain medium grained quartz and disseminations and aggregates of pyrite, with paragenetically later Cu sulphides. These phases are disseminated in the altered protolith and tend to occur enclosing and invading pyrite aggregates in the veins. The Cu sulphides appear to be in equilibrium and include bornite and enargite, with minor chalcocite and digenite, and a trace of colusite. No chalcopyrite is recognised in the assemblage.

Handspecimen: The drill core sample is composed of a crudely banded quartz-sulphide rock, with banding defined by varying abundance of disseminated sulphides and elongate sulphide aggregates in a white to grey fine to medium grained quartz matrix (Fig. 11). No definite relict texture from a protolith is recognised. Sulphides range from disseminated fine grained, to semi-massive and medium to coarse grained, especially pyrite, which occurs in aggregates up to several millimetres across (Fig. 11). Pyrite appears to form paragenetically early aggregates, perhas enclosed and veined by Cu sulphide minerals that include bornite, enargite (grey) and chalcocite (silvery blue-grey). Sulphide bands occur at a moderate angle to the core axis (Fig. 11). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

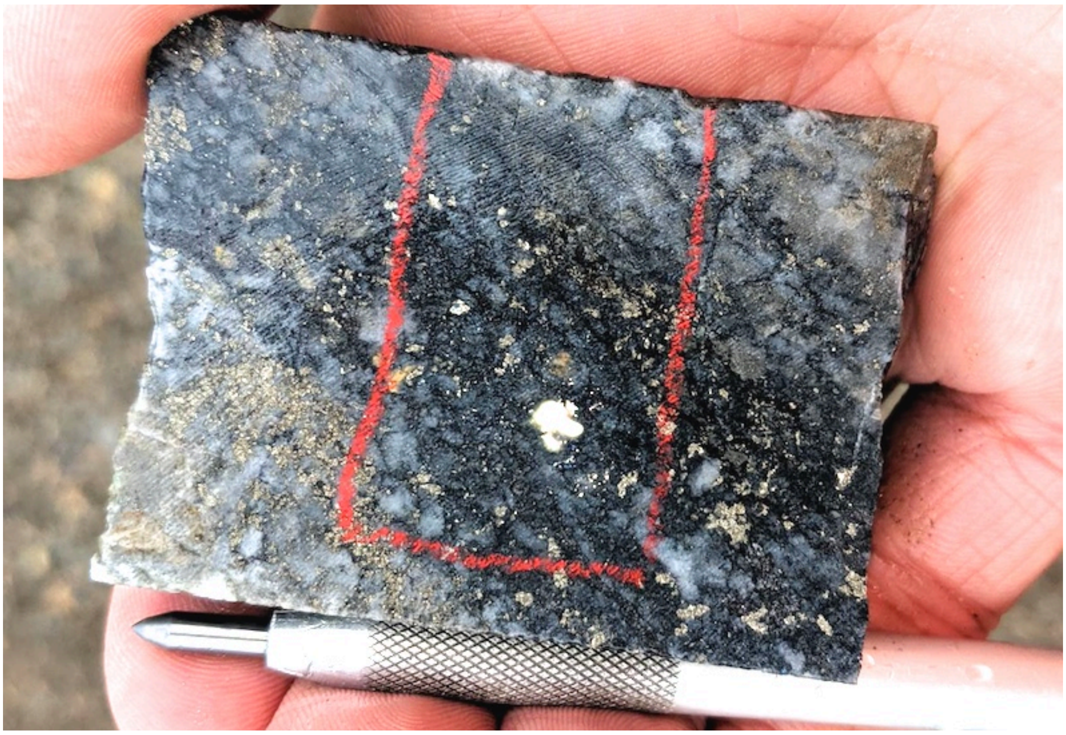

Fig. 11: Drill core sample of slightly banded quartz-sulphide rock. Disseminations and aggregates of pyrite are evident in quartz, with the dark grey zone containing considerable Cu sulphides that include bornite, enargite, chalcocite and digenite.

Petrographic description

a) Primary rock characteristics: In the section, the rock is dominated by quartz and sulphides. There are evidently coarser grained veinlike zones of quartz and sulphides up to several millimetres wide, with which the majority of sulphides are associated. These appear to constitute 50-60% of the sample and although some veinlike zones are sub-parallel, others are randomly oriented. The intervening domains contain abundant fine to medium grained quartz, are up to several millimetres across and could represent intensely hydrothermally altered protolith. No relict texture is recognised in these domains, however, due to the intensity of alteration, leading to complete reconstitution by quartz, minor sulphides, a little sericite and carbonate and trace rutile (Fig. 12). The nature of the protolith remains obscure.

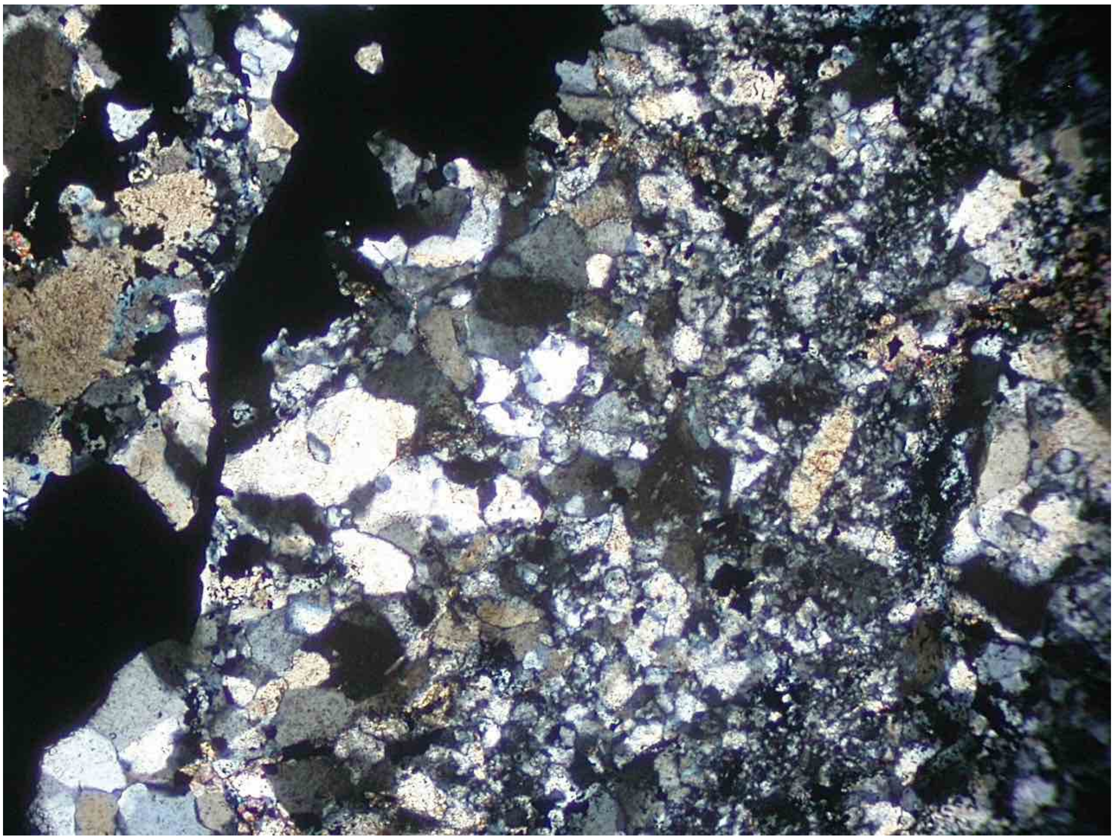

Fig. 12: Strongly silicified host rock (right), diffusely bordering on to a vein of medium grained quartz and sulphides (black). A trace of carbonate is visible at right, and the vein sulphides include bornite and enargite. Transmitted light, crossed polarisers, field of view 2 mm across.

b) Alteration and structure: It is interpreted that protolith material was intensely hydrothermally altered and diffusely veined by quartz and sulphides (Fig. 12). Domains of remnant altered host rock are up to several millimetres across and were completely replaced by fine to medium grained, inequigranular quartz, minor disseminated sulphides, a little patchy sericite and interstitial carbonate and a trace of rutile (Fig. 12). Disseminated sulphides are mostly fine grained and include chalcocite, digenite, bornite and pyrite. The alteration of the protolith is of silicic type. Diffuse veins are up to several millimetres wide and contain medium grained quartz (locally to 2.5 mm), intergrown with sulphides and trace carbonate (Fig. 12). In the veins, sulphides form semi-continuous aggregates up to several millimetres across as well as disseminated individual grains and composites. Pyrite is the dominant sulphide, accompanied by subordinate amounts of bornite and enargite, minor chalcocite and digenite and a trace of colusite (Figs 13, 14, 15).

c) Mineralisation: The sample contains rather abundant sulphides, as fine grained disseminations in the altered host rock, and disseminations and semi-massive aggregates in quartz-rich veins. Pyrite is the dominant sulphide, occurring in isolated grains, and medium grained, semi-massive aggregates up to several millimetres across (Figs 13, 14, 15). It is paragenetically earlier than associated Cu sulphides, which occur surrounding pyrite, as veinlike and irregular invasions and small inclusions in pyrite (Figs 13, 14, 15). Each of the Cu sulphide minerals appears to be in equilibrium with each other. Bornite is relatively abundant, forming irregular aggregates up to 4 mm across and occurring in composites with enargite, chalcocite and digenite (Figs 13, 14, 15). Enargite aggregates are up to 2 mm across, and less common chalcocite is up to 1 mm across (Fig, 14). Fine grained digenite is commonly intergrown with bornite (Figs 13, 14). Traces of colusite occur, in grains up to 0.4 mm across, typically in composites with the other Cu sulphides and pyrite (Fig. 15). No chalcopyrite was observed in the sample.

Mineral Mode (by volume): quartz 75%, pyrite 15%, bornite 4%, enargite 3%, sericite, chalcocite and digenite each 1% and traces of carbonate, colusite and rutile.

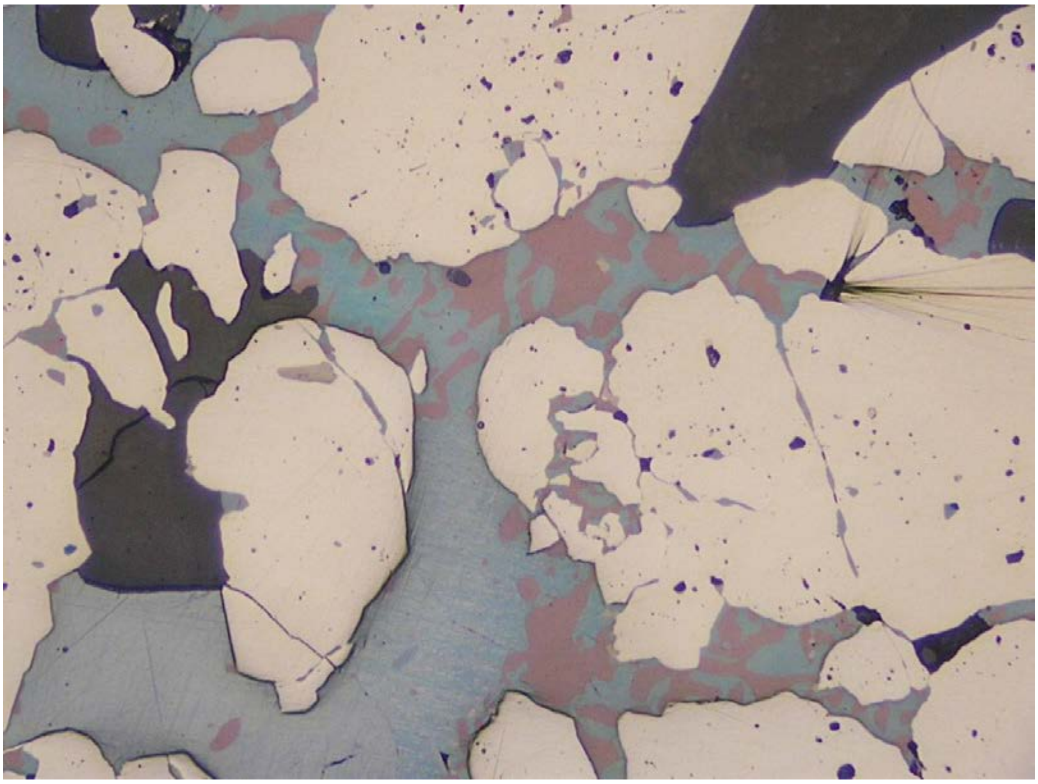

Fig. 13: Pyrite aggregate invaded by an intergrown mass of digenite (bluish) and bornite (pink-mauve). Plane polarised reflected light, field of view 1 mm across.

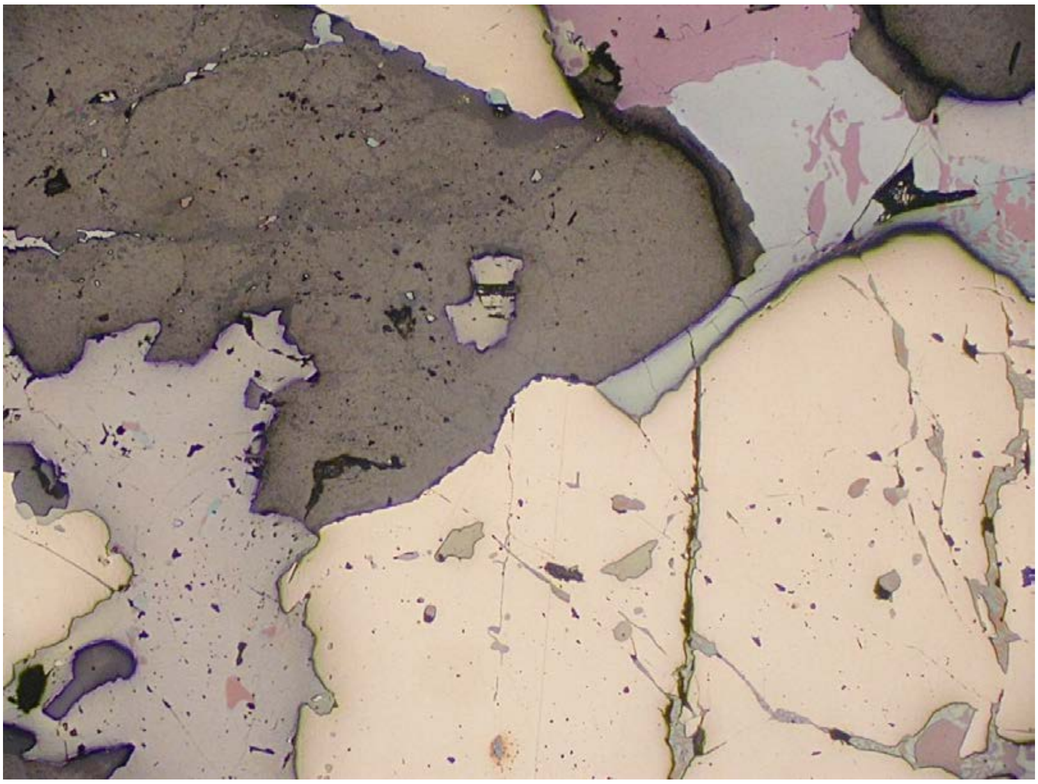

Fig. 14: Pyrite aggregate with nearby quartz (dark) showing associated paragnetically later grains of enargite (pale grey at left) and intergrown bornite, chalcocite (pale blue-grey) and digenite at right. Plane polarised reflected light, field of view 2 mm across.

<u>Interpretation and comment</u>: It is interpreted that the sample is a quartz-sulphide rock contains domains of intensely hydrothermally silicified host rock and quartz-sulphide veining. No relict texture is recognised in altered protolith domains, which have been replaced by quartz, minor disseminated sulphides, a little sericite and carbonate, and trace rutile. Veins are diffuse and contain medium grained quartz and disseminations and aggregates of pyrite, with paragenetically later Cu sulphides. These phases are also disseminated in the altered protolith and in the veins, tend to occur enclosing and invading pyrite aggregates in the veins. The Cu sulphides appear to be in equilibrium and include bornite and enargite, with minor chalcocite and digenite, and a trace of colusite. No chalcopyrite is recognised in the assemblage.

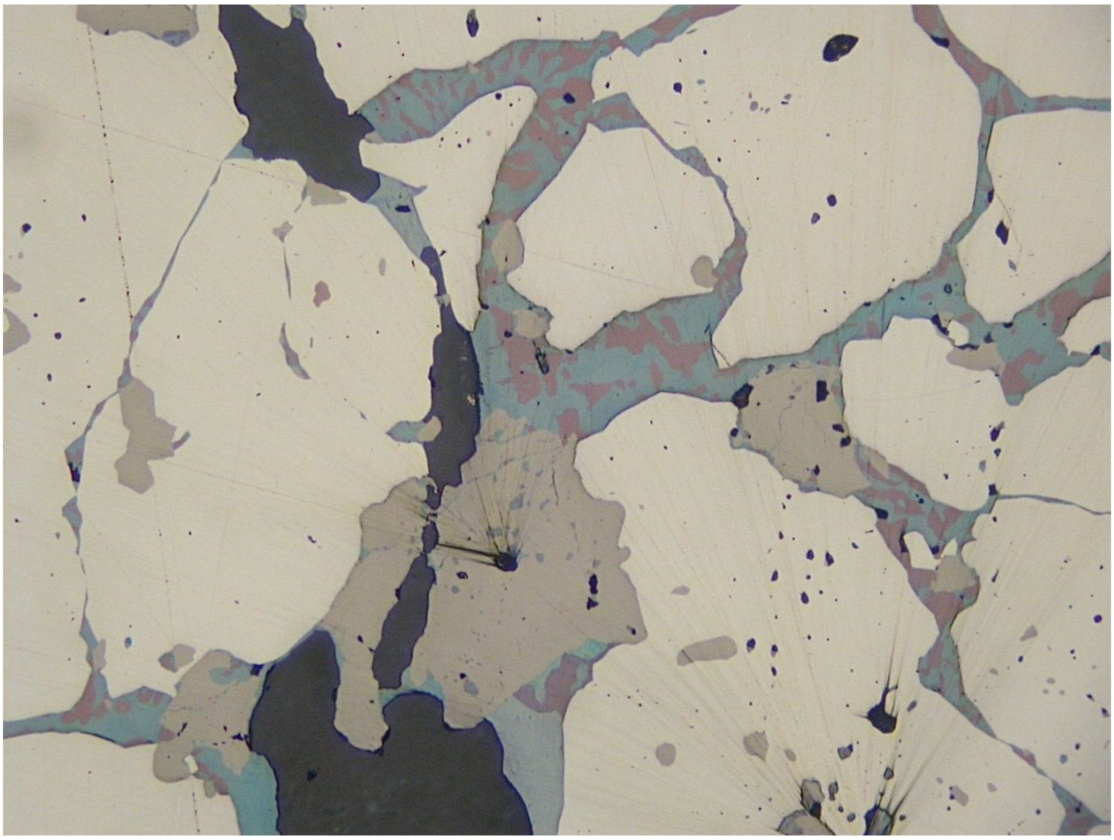

Fig. 15: Pyrite aggregate with invasion by colusite (pale grey-tan), digenite (blue) and a little intergrown bornite. Plane polarised reflected light, field of view 1 mm across.

SMD045W2 1133.1 m PTS

Summary: Sulphide-quartz rock, with breccia texture and containing a few possible intensely hydrothermally altered host rock remnants. The latter are replaced by a silicic-phyllic assemblage of dominant quartz, with minor sericite, pyrite and trace rutile. The remainder of the rock probably represents hydrothermal infill, with early-formed pyrite showing brecciation and subsequent infill by abundant fine to medium grained quartz and patchy Cu sulphides. The latter locally occur surrounding pyrite and invading along grain boundaries and fractures. Cu sulphides include major enargite and bornite, with minor colusite in places, and a trace of digenite. The Cu sulphide minerals appear to be in equilibrium with each other and are paragenetically later than pyrite. No chalcopyrite is recognised.

Handspecimen: The drill core sample is composed of a sulphide-rich breccia, containing disseminated pyrite, grading to massive fragments up to a few centimetres across, enclosed by pale grey, fine to medium grained quartz and minor, patchy aggregates of Cu sulphides that include bornite and a grey phase that is possibly enargite (Fig. 16). Pyrite-rich fragments are angular and fine to medium grained, with small amounts of included Cu sulphides and quartz. No obvious host rock is recognised and the rock could be the product of hydrothermal infill (including subsequent brecciation) and perhaps, hydrothermal replacement. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

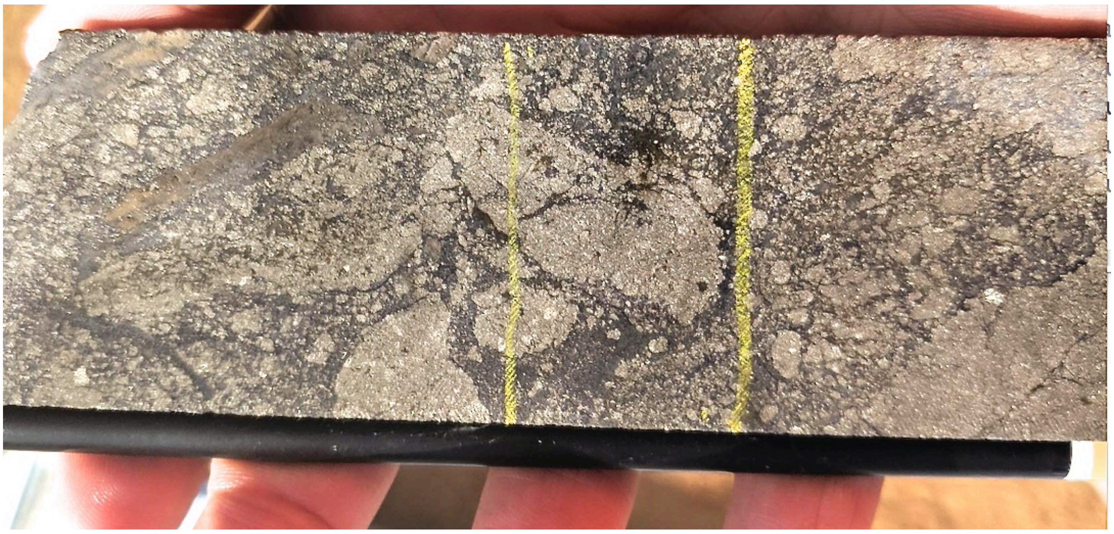

Fig. 16: Drill core sample of sulphide-quartz rock, with apparent breccia fragments of massive pyrite enclosed by grey quartz and minor amounts of dark Cu sulphides (dominated by enargite and bornite).

Petrographic description

a) Primary rock characteristics: In the section, the rock is dominated by sulphides and quartz. There are a couple of zones up to a few millimetres across that could be interpreted as representing intensely hydrothermally altered host rock, but the remainder has no relict characteristics or alteration assemblages that would indicate replacement of protolith and hence is likely to be the product of hydrothermal infill. Possible former host rock occurs in a few rather diffuse masses in which no relict texture is recognised, but they are texturally different to the enclosing aggregate of quartz and sulphides (Fig. 17). The possible host rock domains were replaced by quartz, minor sulphides and sericite and a trace of rutile. The actual nature of the protolith remains obscure.

b) Alteration and structure: Possible protolith material was intensely hydrothermally altered to a silicic-argillic assemblage of fine to medium grained, inequigranular to prismatic quartz, with minor sulphides (mostly pyrite) and sericite and trace rutile (Fig. 17). The remainder of the rock appears to represent hydrothermal infill. It contains abundant pyrite, as disseminated grains, grading to massive aggregates up to a few centimetres across (in part as apparent breccia fragments), with interstitial fine to medium grained, inequigranular to prismatic quartz, minor to locally abundant Cu sulphides and trace sericite (Figs 17, 18, 19). Cu sulphides include enargite and bornite, with minor colusite and a trace of digenite

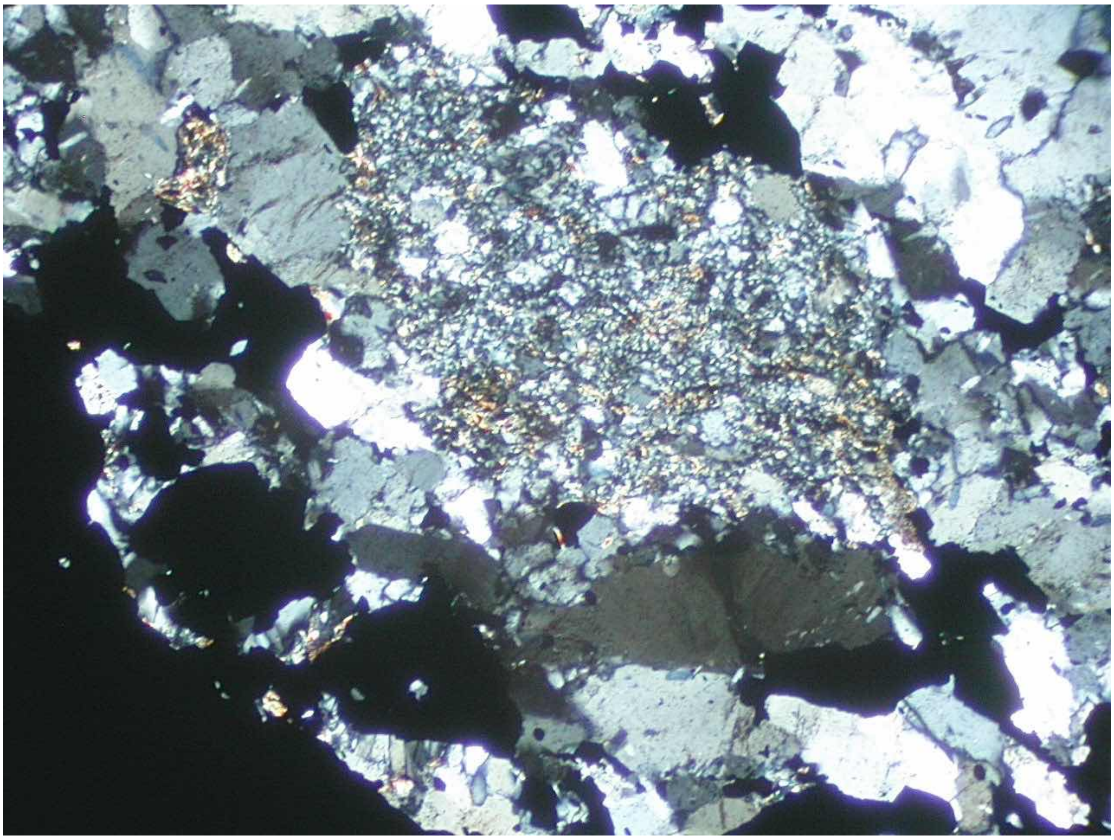

Fig. 17: Small fragment of intensely hydrothermally altered host rock (replaced by quartz and minor sericite), enclosed by inequigranular texture infill of quartz and sulphides (black, mainly pyrite). Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The sample contains abundant sulphides. These are dominated by pyrite, occurring as disseminated small grains, grading to large (few centimetres) massive aggregates. Grains are anhedral and individually up to 2 mm across. Pyrite is enclosed by quartz and variable amounts of Cu sulphides, with the latter also invading pyrite along grain boundaries and fractures and occurring as small inclusions in pyrite (Figs 18, 19). Cu sulphides are also disseminated in quartz and are dominated by enargite and bornite, each forming aggregates up to a few millimetres across (Figs 18, 19). Locally, there are scattered grains and aggregates up to 2 mm across of colusite, mainly hosted in enargite, but also intergrown with bornite and occurring in pyrite (Fig. 19). A trace of digenite is observed in association with enargite and bornite. The Cu sulphide minerals all appear to be in equilibrium and are paragenetically later than pyrite (Figs 18, 19). No chalcopyrite or chalcocite were observed in the sample.

<u>Mineral Mode (by volume)</u>: quartz and pyrite each 45%, enargite 5%, bornite 3%, sericite and colusite each 1% and traces of digenite and rutile.

Interpretation and comment: It is interpreted that the sample represents a sulphide-quartz rock, with breccia texture and containing a few possible intensely hydrothermally altered host rock remnants, but with most of the rock probably being the product of hydrothermal infill. Possible host rock fragments are replaced by a silicic-phyllic assemblage of quartz, with minor sericite, pyrite and trace rutile. The remainder of the rock contains abundant early-formed pyrite showing brecciation and subsequent infill by abundant quartz and patchy Cu sulphides. The latter locally occur surrounding pyrite and invading along grain boundaries and fractures. Cu sulphides include major enargite and bornite, with minor colusite in places, and a trace of digenite. The Cu sulphide minerals appear to be in equilibrium with each other and are paragenetically later than pyrite. No chalcopyrite is recognised.

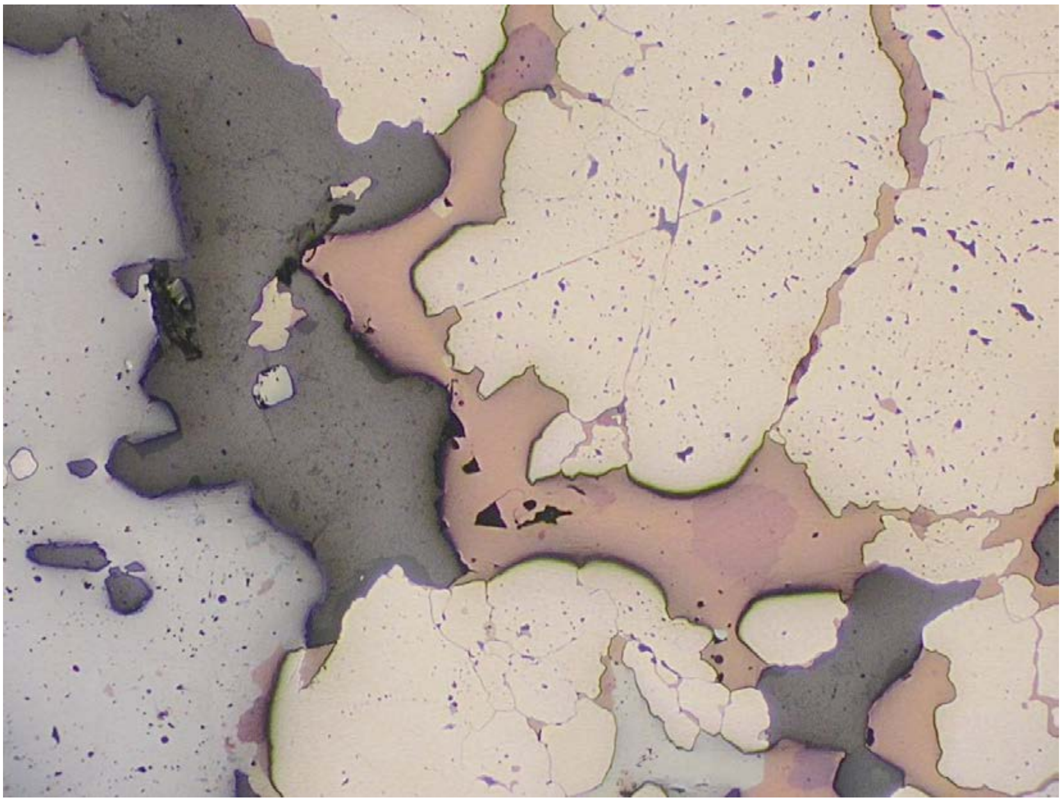

Fig. 18: Pyrite aggregates with enclosing bornite (pinkish), enargite (pale grey) and quartz (dark grey). Plane polarised reflected light, field of view 2 mm across.

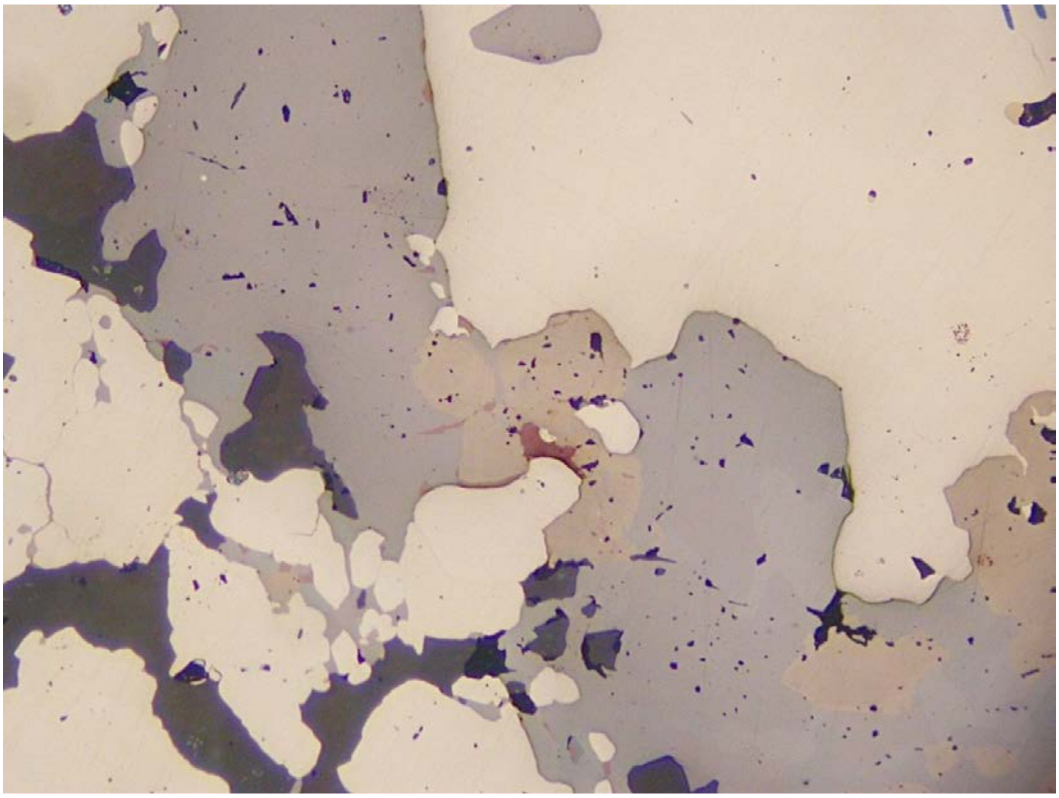

Fig. 19: Pyrite aggregates with interstitial masses of enargite (pale grey) and intergrown colusite (pale grey-tan) and with a small tarnished grain of bornite near centre (dark red-brown). Plane polarised reflected light, field of view 1 mm across.

SMD045W2 1148.8 m PTS

Summary: Strongly deformed and hydrothermally altered rock, with abundant sulphide mineralisation. Much of the rock has no preserved primary characteristics due to imposed processes, but local domains have some relict texture suggesting that the protolith was a fine grained sandstone, grading to siltstone, containing considerable detrital quartz. The protolith evidently experienced strong penetrative deformation, maybe attending low grade metamorphism, so as to form a foliated and locally micro-cataclastic to mylonitic texture, and with replacement by locally abundant sericite, recrystallised quartz and trace rutile. Subsequently, the rock was invaded by quartz, sulphides and minor anhydrite, in masses largely co-planar with the foliation. Early deposited coarse grained quartz was strained and partly recrystallised and pyrite was typically fractured. Pyrite, chalcopyrite and minor anhydrite were deposited in the adjacent altered host rock, and pyrite masses throughout were overprinted by paragenetically later chalcopyrite and minor tennantite-tetrahedrite. No bornite, chalcocite or enargite were observed in the sample.

Handspecimen: The drill core sample is composed of a strongly sulphide-mineralised, grey to whitish, strongly deformed rock. There is a moderate foliation at ~60° to the core axis, defined by mineralogical banding (quartz-rich and sericite-rich) on a scale of up to a few millimetres (Fig. 20). No relict texture is recognised in these zones. The deformed rock appears to be overprinted by masses of sulphides and quartz up to a few centimetres wide (Fig. 20). These are possibly veinlike and contain grey quartz and disseminated to locally massive pyrite, with apparently paragenetically later chalcopyrite (Fig. 20). Locally, chalcopyrite occurs in thin veinlets, accompanied by white to pale brown anhydrite and a silvery-grey sulphide mineral. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

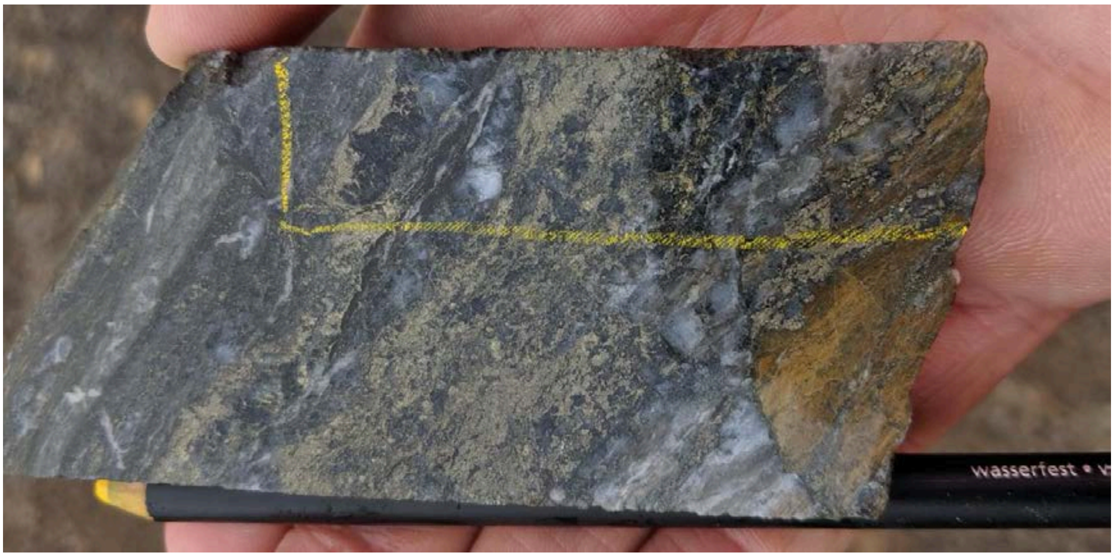

Fig. 20: Drill core sample of sheared host rock (possibly sandstone) with intercalated quartz- and sericite-rich bands, overprinted by largely co-planar quartz-sulphide veining. Quartz and abundant pyrite are overprinted by paragenetically later chalcopyrite.

Petrographic description

a) Primary rock characteristics: In the section, much of the sample is composed of hydrothermal masses of quartz and sulphides, perhaps being the products of infill and locally intense replacement. Most of the rock does not have any recognisable vestige of protolith material, but a small proportion of the sample, towards one end of the section does retain probably relict detrital grain texture. In this domain, there are apparent relict detrital quartz grains up to 0.3 mm across in an altered and deformed matrix (Fig. 21). The preserved primary characteristics of this rock suggest that it represent a fine grained sandstone, grading to siltstone.

b) Alteration and structure: The possible protolith material experienced deformation, perhaps associated with low grade metamorphism and subsequent hydrothermal alteration. Although relict quartz grains are preserved, the former matrix material was replaced by abundant fine grained sericite, lesser quartz, disseminated pyrite and chalcopyrite, a little anhydrite and trace rutile (Fig. 21). Sericite is commonly concentrated into foliae up to 1-2 mm thick. In much of the rock, however, any remnants of primary texture in the protolith were destroyed by intense deformation, manifest in zones up to several millimetres wide of micro-cataclasis and mylonitisation, with these zones containing fine grained sericite and quartz, with sericite preferred orientation defining the foliation (Fig. 22). The deformed and altered rock was overprinted by veining up to several millimetres wide of coarse grained quartz and sulphides, minor anhydrite and trace carbonate, with veining largely co-planar with foliation. Continued deformation occurred, with development of strain and recrystallization phenomena in quartz, strong fracturing of pyrite and recrystallization of anhydrite. Chalcopyrite is abundant and was evidently deposited in, and replacing, fractured pyrite and it also forms veinlike masses up to a few millimetres wide, in places with associated tennantite-tetrahedrite and anhydrite (Figs 22, 23, 24). Overall alteration in the host rock is interpreted as of phyllic type.

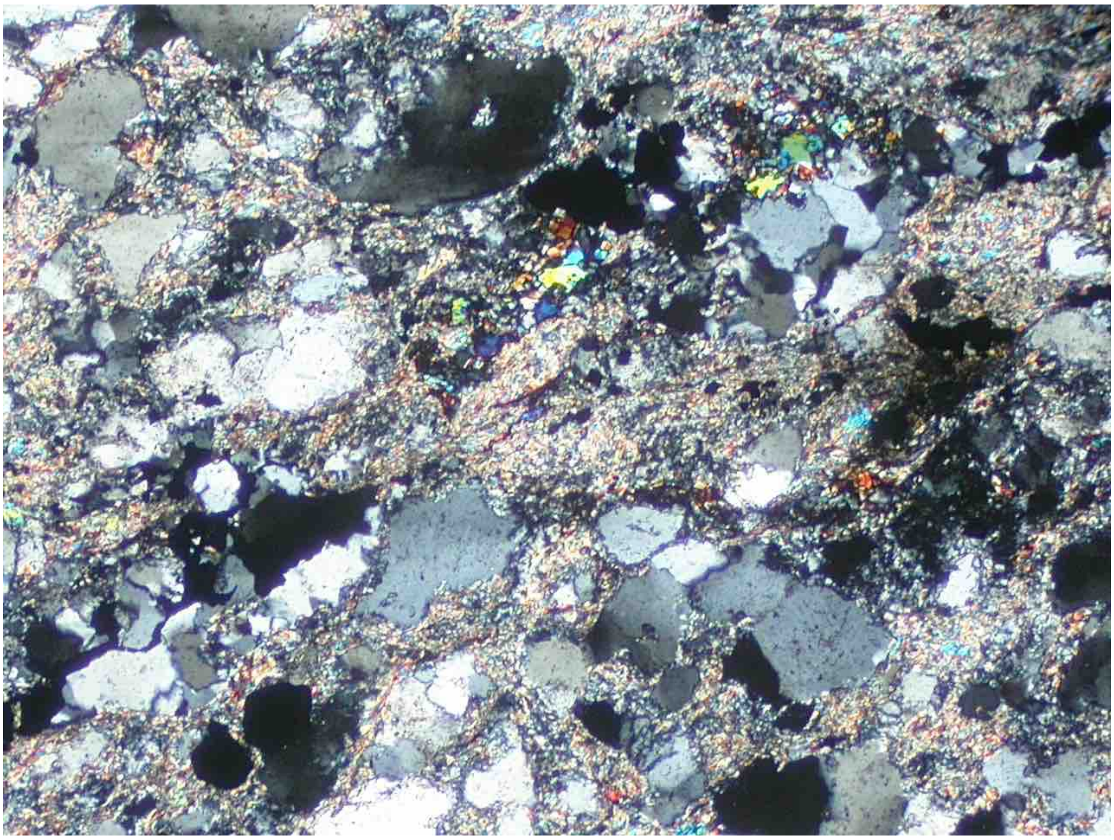

Fig. 21: Domain of partly preserved relict texture inferring that the host rock was a fine grained sandstone, grading to siltstone, containing detrital quartz grains. Matrix material was replaced by a foliated aggregate of sericite, quartz and a little anhydrite (bright colours) and disseminated sulphides (black: pyrite and chalcopyrite). Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The sample contains abundant sulphides. There is minor disseminated pyrite and chalcopyrite in the strongly altered host rock, but most sulphides are associated with deformed coarse quartz as part of veinlike masses. Pyrite is patchily abundant, forming aggregates up to several millimetres across and with individual, mostly anhedral, grains up to 2 mm across, with these typically being fractured and in many places, invaded by chalcopyrite and minor tennantite-tetrahedrite (Figs 23, 24). Chalcopyrite is also abundant, forming disseminated grains and semi-continuous masses up to several millimetres, with some being veinlike, co-planar with foliation and associated with anhydrite (Fig. 22). Chalcopyrite and tennantite-tetrahedrite appear to be in textural equilibrium and are later than pyrite. Tennantite-tetrahedrite forms masses up to 1.5 mm across, almost always in association with chalcopyrite (Figs 23, 24). No bornite, chalcocite or enargite were observed.

<u>Mineral Mode (by volume)</u>: quartz 50%, sericite, pyrite and chalcopyrite each 15%, anhydrite 3%, tennantite-tetrahedrite 2% and traces of carbonate and rutile.

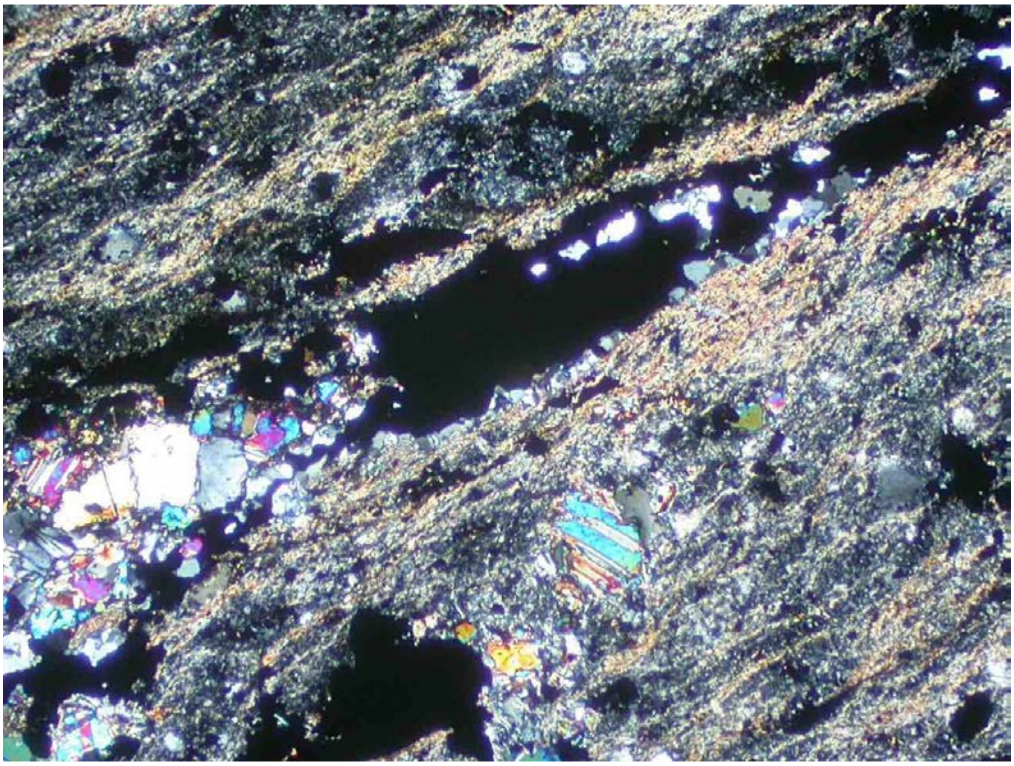

Fig. 22: Mylonitic zone in host rock, composed of foliated fine grained sericite, minor quartz, anhydrite (bright colours) and chalcopyrite (black) and invaded by a foliation-parallel vein of anhydrite and chalcopyrite. Transmitted light, crossed polarisers, field of view 2 mm across.

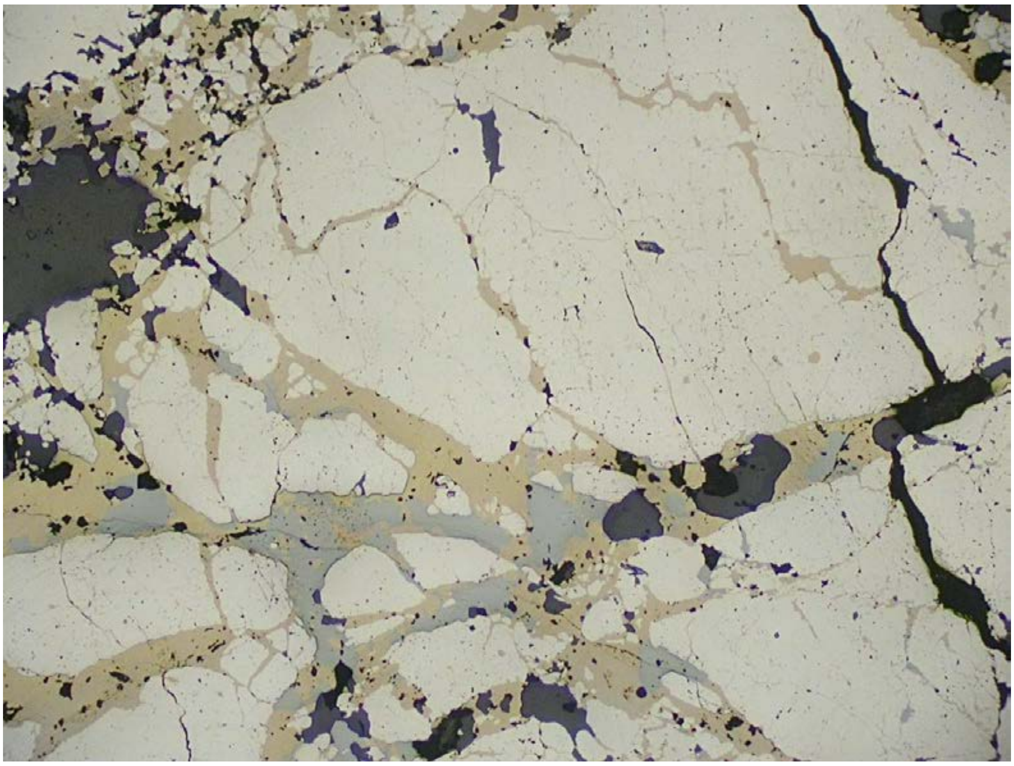

Fig. 23: Fractured pyrite invaded by chalcopyrite (yellow) and minor tennantite-tetrahedrite (pale grey). Plane polarised reflected light, field of view 2 mm across.

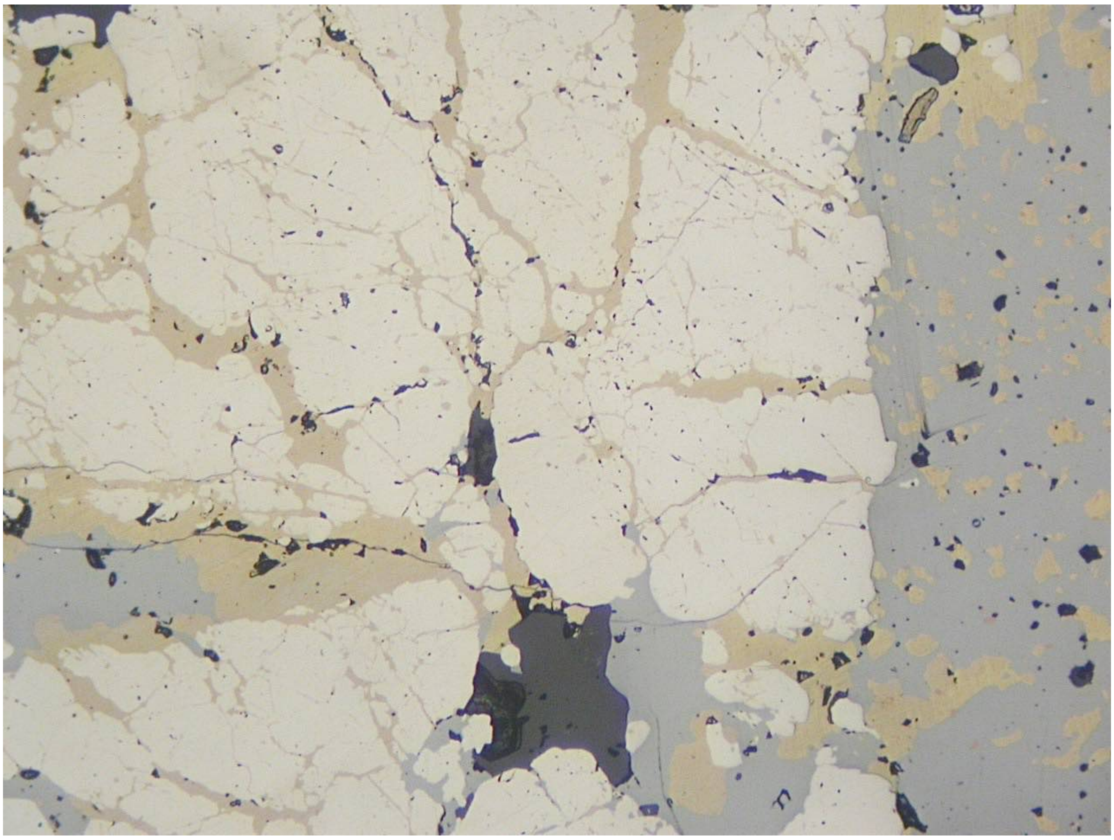

Fig. 24: Detail of fractured pyrite and invasion by chalcopyrite (yellow) and tennantite-tetrahedrite (pale grey). Note eutectic-like intergrowth of tennantite-tetrahedrite and chalcopyrite at right. Plane polarised reflected light, field of view 1 mm across.

Interpretation and comment: It is interpreted that the sample is a fine grained sandstone, grading to siltstone, containing considerable detrital quartz that experienced strong deformation, hydrothermal alteration and sulphide mineralisation. Mostly, primary characteristics of the protolith were destroyed, but there are local domains with relict texture. Penetrative deformation was imposed, maybe associated with low grade metamorphism and subsequent hydrothermal alteration, forming a foliated and locally micro-cataclastic to mylonitic texture, and with replacement by locally abundant sericite, recrystallised quartz and trace rutile. The rock was then invaded by quartz, sulphides and minor anhydrite, in veinlike masses largely co-planar with the foliation. Early deposited coarse grained quartz was strained and partly recrystallised and pyrite was typically fractured. Pyrite, chalcopyrite and minor anhydrite were deposited in the adjacent altered host rock, and pyrite masses throughout were overprinted by paragenetically later chalcopyrite and minor tennantite-tetrahedrite. No bornite, chalcocite or enargite were observed in the sample.

<u>SMD046 373.6 m PTS</u>

Summary: Porphyritic intermediate igneous rock (e.g. of andesitic or microdioritic type), with indications of initial hydrothermal biotite (potassic) alteration and later retrograde (propylitic) alteration, maybe coincident with two phases of vein emplacement. The original rock contained feldspar and small ferromagnesian phenocrysts in a fine grained groundmass. Initial alteration led to considerable replacement by hydrothermal biotite, with patchy quartz and traces of chalcopyrite, pyrite and magnetite. Early veining was by quartz, with a little chalcopyrite, pyrite and carbonate and with patchy development of potassic alteration selvedges. Later alteration caused strong destruction of any prior feldspar, and most ferromagnesian material, including hydrothermal biotite, with replacement by abundant chlorite, sericite, subordinate carbonate, minor pyrite and trace rutile. This phase of alteration appear to be related to emplacement of a major vein of carbonate and pyrite, with a little quartz and trace chalcopyrite.

Handspecimen: The drill core sample is composed of a strongly hydrothermally altered and veined rock, with it originally being apparently porphyritic and maybe of intermediate type (e.g. andesitic). It could have contained scattered feldspar phenocrysts in a fine grained groundmass. Initial pervasive alteration produced fine grained hydrothermal biotite, manifest in a dark grey-brown colour (Fig. 25). The rock was cut by two sets of veins, with early milky quartz (up to 7 mm wide, but with local wider patches) and later sub-planar veining up to 4 mm wide by white carbonate and infill pyrite (Fig. 25). About the veins, there are diffuse, paler grey-green alteration selvedges that probably have retrograde phases such as chlorite and sericite developed (Fig. 25). In parts of the sample where there is hydrothermal biotite, the rock is moderately magnetic, with susceptibility up to 490 x 10^{-5} SI, indicating the presence f a little magnetite, but in veined zones, susceptibility is much lower.

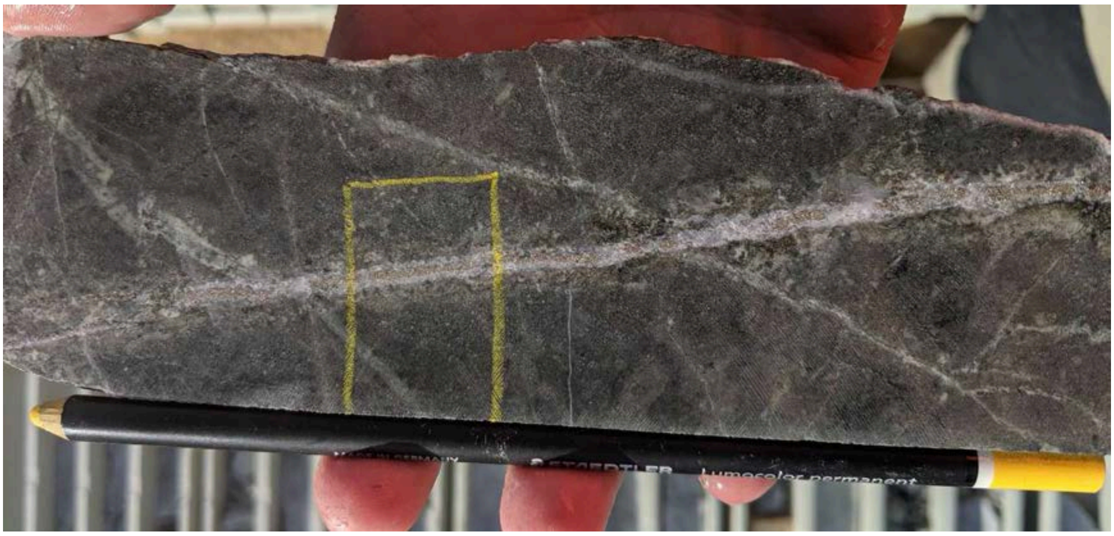

Fig. 25: Drill core sample of possible andesitic or microdioritic rock with initial biotite alteration, cut by early quartz-rich veins and by a later, major vein of carbonate and pyrite. Retrograde propylitic alteration, forming chlorite-sericite-carbonate is overprinting biotite alteration and is commonly vein-controlled.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved in places, but elsewhere it is destroyed due to the intensity of alteration and veining. The rock originally contained scattered blocky feldspar phenocrysts up to 2.5 mm across (mostly smaller and probably being composed of plagioclase) and ferromagnesian phenocrysts up to

1 mm long that could have included hornblende and biotite, all enclosed in a finer grained groundmass (Fig. 26). It is possible that the groundmass contained feldspar and ferromagnesian components, with a little quartz and FeTi oxide. The preserved primary characteristics indicate that the protolith was of intermediate type, e.g. porphyritic andesite or microdiorite.

b) Alteration and structure: The protolith was subject to strong hydrothermal alteration and veining with probably two episodes of each. There are indications that initial alteration developed considerable hydrothermal biotite (e.g. from igneous ferromagnesian phases and in the groundmass), along with patchy quartz (in the groundmass) and traces of finely disseminated chalcopyrite, pyrite and magnetite (Fig. 26). This phase of alteration could have been related to the emplacement of a few sub-planar quartz-rich veins up to 2 mm wide, with these also containing a little chalcopyrite, pyrite and carbonate (Fig. 27) and in places having biotite-quartz alteration selvedges. Subsequently, strong retrograde alteration of propylitic type was imposed, probably related to the emplacement of a major, sub-planar vein up to 4 mm wide. This vein contains abundant fine to medium grained carbonate and a central zone of medium grained pyrite, along with a little quartz and trace chalcopyrite associated with pyrite. The carbonate-pyrite vein appears to overprint earlier quartz-rich veining. The associated retrograde alteration was destructive of all feldspar and most ferromagnesian phases were overprinted, including hydrothermal biotite. The retrograde alteration formed abundant chlorite, sericite and subordinate carbonate, with trace rutile and about the carbonate-pyrite vein, disseminated pyrite.

c) Mineralisation: The early quartz-rich veining contains a little chalcopyrite and pyrite in small aggregates (Fig. 27) and the biotite alteration adjacent hosts traces of fine grained chalcopyrite, pyrite and magnetite. The major vein hosts a central zone of medium grained pyrite, with which is associated a trace of chalcopyrite. About this vein, these is also minor disseminated pyrite.

<u>Mineral Mode (by volume)</u>: chlorite 35%, quartz and sericite each 25%, carbonate 8%, pyrite 5%, biotite 1% and traces of magnetite, chalcopyrite and rutile.

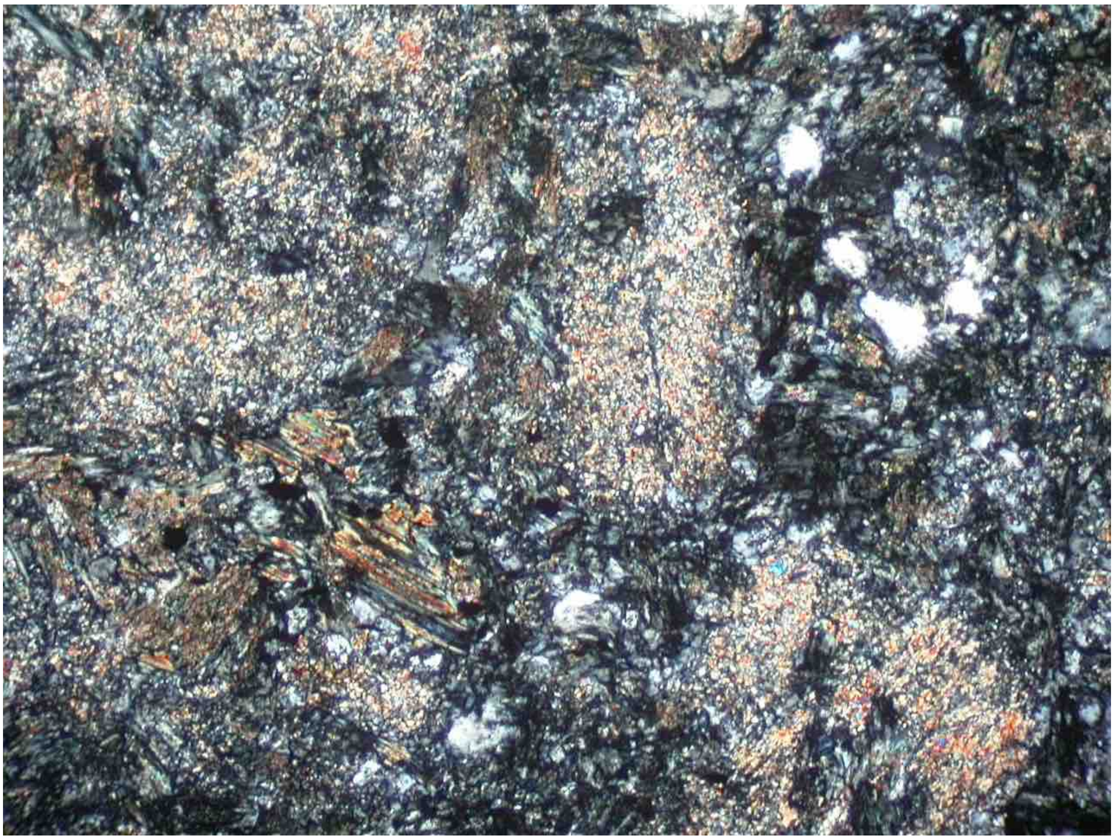

Fig. 26: Relict porphyritic texture showing diffuse, sericite-replaced feldspar phenocrysts, in an altered groundmass that contains chlorite and minor sericite and quartz, but which retains a little hydrothermal biotite (brownish at left). Transmitted light, crossed polarisers, field of view 2 mm across.

Interpretation and comment: It is interpreted that the sample represents a former porphyritic intermediate composition igneous rock (e.g. of andesitic or microdioritic type) that sustained initial hydrothermal biotite (potassic) alteration and later retrograde (propylitic) alteration, and emplacement of two vein phases. The protolith contained feldspar and small ferromagnesian phenocrysts in a fine grained groundmass. Initial alteration caused development of hydrothermal biotite, with patchy quartz and traces of chalcopyrite, pyrite and magnetite. Early veining was by quartz, with a little chalcopyrite, pyrite and carbonate and with associated potassic alteration selvedges. Later alteration caused strong destruction of any prior feldspar, and most ferromagnesian material, including hydrothermal biotite, with replacement by abundant chlorite, sericite, subordinate carbonate, minor pyrite and trace rutile. This phase of alteration appear to be related to emplacement of a major vein of carbonate and pyrite, with a little quartz and trace chalcopyrite.

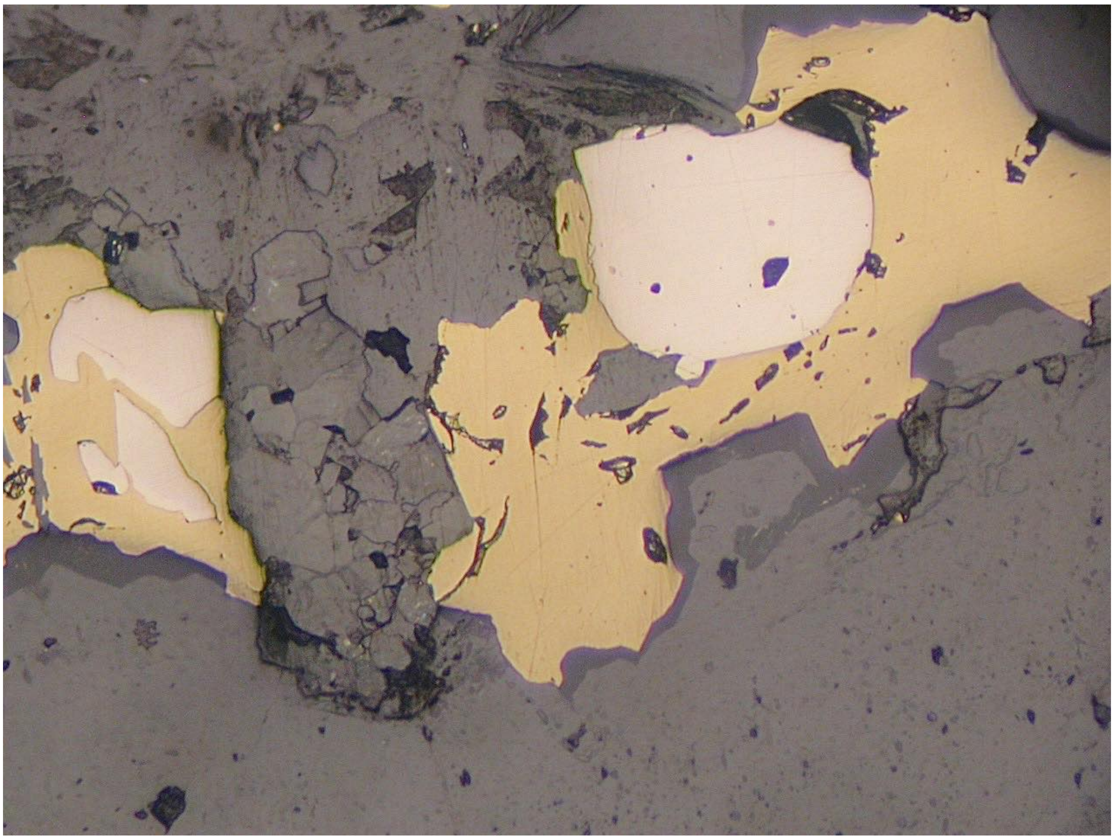

Fig. 27: Part of an early quartz-rich vein that hosts an aggregate of chalcopyrite (yellow) enclosing earlier pyrite (pale creamy). Plane polarised reflected light, field of view 1 mm across.

SMD047 636.9 m PTS

Summary: Intensely hydrothermally altered rock, with replacement by quartz and pyrite, minor anhydrite and sericite and traces of Cu sulphides and rutile, and hosting a sub-parallel array of diffuse veinlike masses of quartz, anhydrite, pyrite, Cu sulphides and trace carbonate. No relict characteristics from a protolith are recognised. The rock was evidently deformed, with disaggregation of pyrite masses, recrystallization of quartz (commonly to fibre-texture aggregates) and anhydrite, development of foliation in sericite. Paragenetically, pyrite is earlier than, and probably locally replaced by, Cu sulphides that are dominated by bornite, with minor associated chalcocite and digenite, and a trace of enargite. The Cu sulphide phases appear to be in equilibrium.

Handspecimen: The drill core sample is composed of an intensely hydrothermally altered and probably deformed rock, containing disseminated through to massive sulphides, with the latter defining a crudely banded texture, and with banding being at a moderate angle to the core axis (Fig. 28). The rock has varying proportions of fine to medium grained pale grey quartz and pyrite, with a few diffuse bands and small aggregates of bornite, with a little associated chalcocite up to a few millimetres wide in pyrite-rich zones (Fig. 28). The rock also hosts a few elongate aggregates (co-planar with banding) of white, medium to coarse grained anhydrite up to a few millimetres wide, with these locally containing bornite. No relict texture is recognised and the rock could be the product of hydrothermal infill and/or complete hydrothermal replacement. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 28: Drill core sample showing crudely banded pyrite-rich sulphides and quartz. Darker bands in sulphides tend to be bornite-rich. White patches at top include anhydrite and quartz.

Petrographic description

a) Primary rock characteristics: In the section, no primary characteristics are preserved and the rock appears to be the product of complete hydrothermal replacement as well as infill. Perhaps a third to half the sample is finer grained and dominated by quartz, with minor sericite, sulphides, a little anhydrite and trace rutile, and these domains are likely to represent intensely altered protolith.

b) Alteration and structure: Possible protolith was intensely hydrothermally altered and invaded by an array of largely sub-planar, diffuse veinlike masses with varying proportions of quartz, sulphides and anhydrite. Although no relict characteristics are preserved, there are domains in the sample that are interpreted to represent former host rock, with these being subject to intense alteration of silicic to phyllic type. There was evident complete replacement by fine to medium grained quartz and pyrite, minor disseminated through to local massive aggregates of sericite (up to 2 mm across), a little anhydrite and Cu sulphides, and a trace of rutile. The diffuse veinlike masses are up to several millimetres wide and contain varying proportions of fine to medium grained quartz and pyrite, patches of locally coarse anhydrite up to 3 mm across and paragenetically later infill of Cu sulphides and trace carbonate. The rock was evidently deformed, with this process occurring during or following the hydrothermal alteration and veining. Large pyrite aggregates were variably dismembered and invaded by quartz and Cu sulphides, quartz was recrystallised in places, commonly forming fibre-textured aligned aggregates, with sericite locally showing foliation (Fig. 29). The Cu sulphide phases occur in a couple of diffuse veinlike masses interstitial to quartz and pyrite, in places associated with coarse anhydrite aggregates. Bornite is the dominant Cu sulphide, with it being locally associated with chalcocite, digenite and trace enargite (Figs 30, 31).

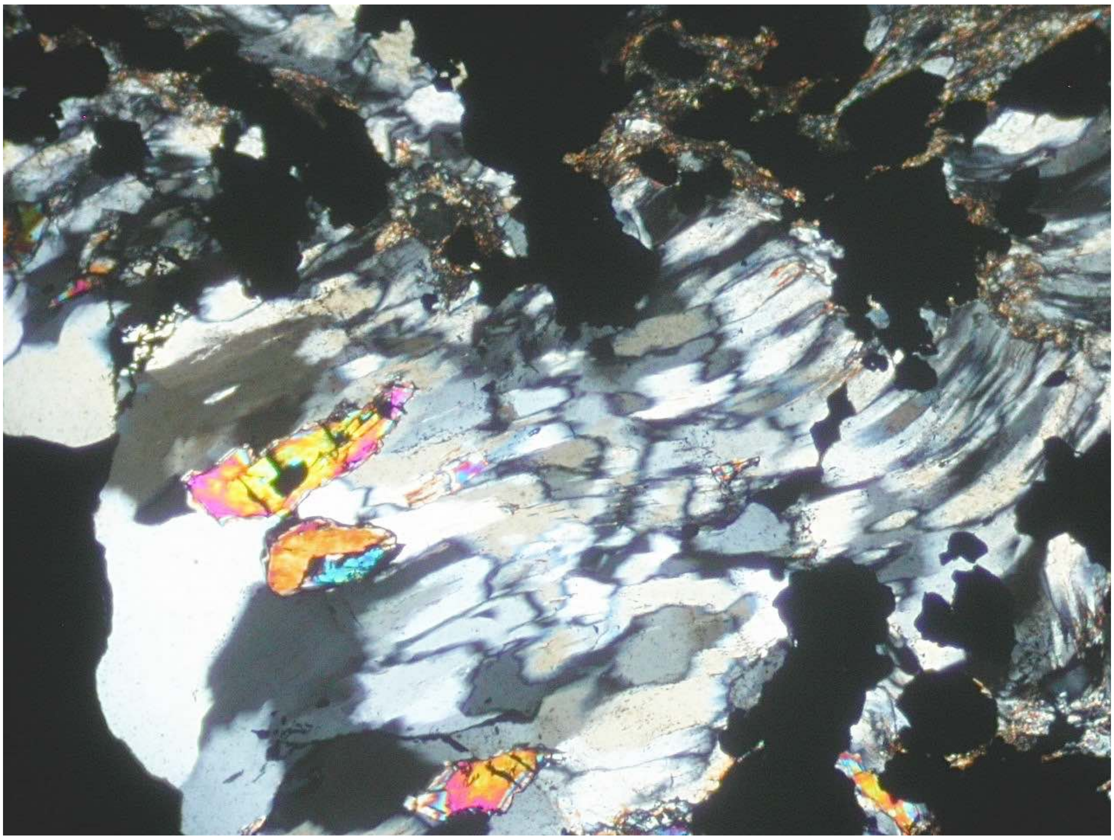

Fig. 29: Zone of fibre-texture infill quartz, intergrown with sulphides (black, mostly pyrite, with minor bornite), minor anhydrite (bright colours) and a little sericite (turbid, brownish, upper). Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The sample contains abundant sulphides. There is considerably paragenetically early pyrite that ranges from disseminated to massive aggregates. It is mostly rather fine grained, but larger individual grains are up to 0.5 mm across. Pyrite aggregates were variably dismembered by deformation and infilled by quartz (commonly fibre texture), anhydrite and Cu sulphides, and with pyrite perhaps being replaced by the Cu sulphides (Figs 29, 30). Irregular to elongate and veinlike Cu sulphide aggregates are up to 3 mm across, enclosing and veining pyrite aggregates (Figs 30, 31). Bornite is the major Cu sulphide, with minor intergrown aggregates of chalcocite (one aggregate 4 mm across, but others are smaller) and digenite (up to 0.5 mm) and a couple of grains of enargite (Figs 30, 31). The Cu sulphide minerals appear to be in textural equilibrium. No chalcopyrite was recognised.

Mineral Mode (by volume): quartz 45%, pyrite 40%, anhydrite and bornite each 5%, sericite 3%, chalcocite and digenite each 1% and traces of carbonate, enargite and rutile.

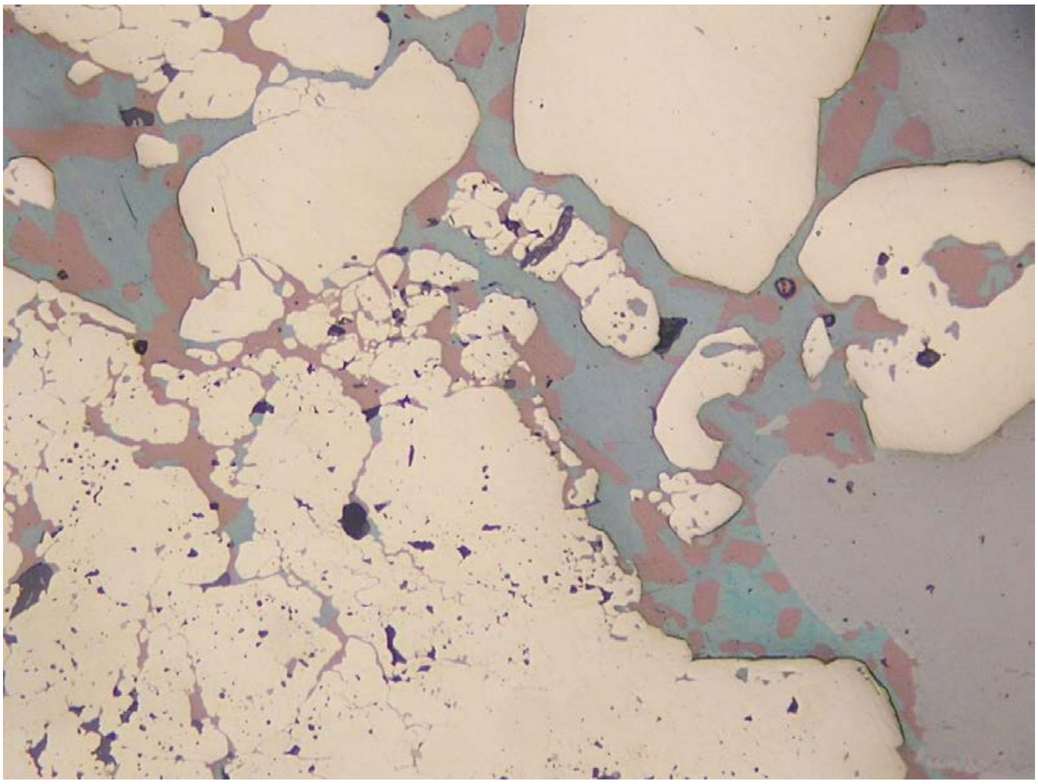

Fig. 30: Pyrite aggregates and individual grains (pale creamy) invaded by composite aggregates of Cu sulphides that include bornite (mauve-pink), digenite (bluish) and a pale grey grain of enargite (lower right) . Plane polarised reflected light, field of view 1 mm across.

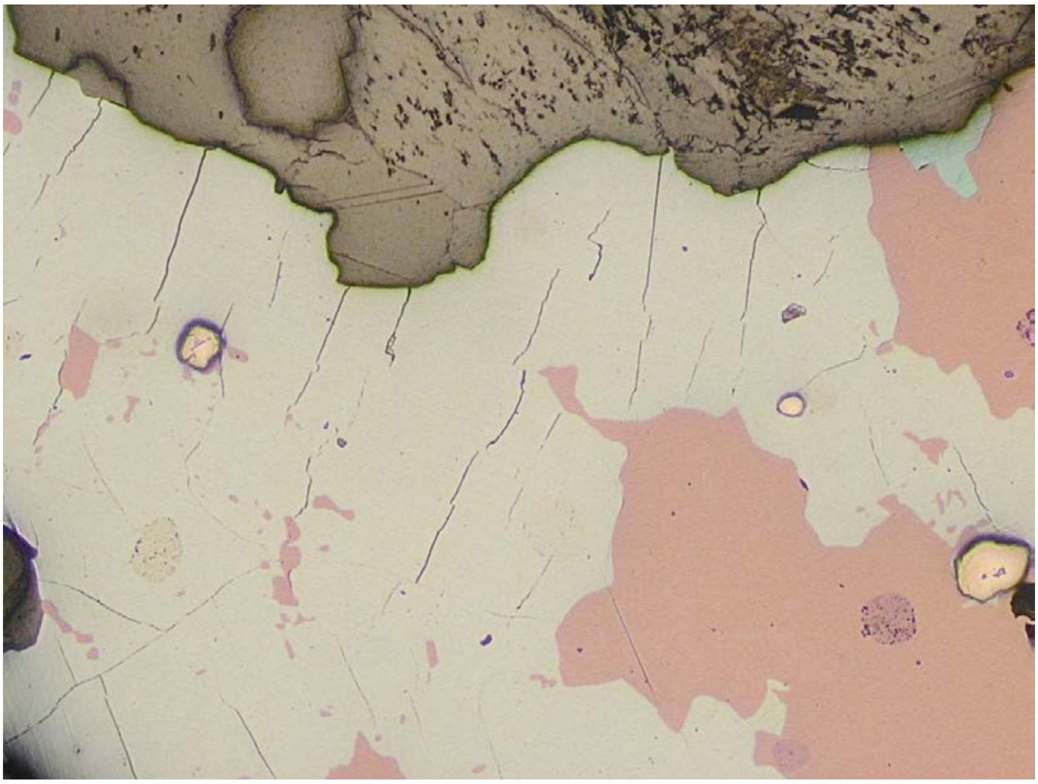

Fig. 31: Composite aggregate of chalcocite (pale bluish-grey) and bornite, abutting against anhydrite (upper). Note small inclusions of pyrite (pale creamy) and digenite (pale blue) in bornite and chalcocite. Plane polarised reflected light, field of view 2 mm across.

Interpretation and comment: It is interpreted that the sample is a quartz-sulphide-dominated rock, being the product of intense hydrothermal replacement and veinlike infill. No relict texture from a protolith is recognised, with replacement by quartz and pyrite, minor anhydrite and sericite and traces of Cu sulphides and rutile. There is a sub-parallel array of diffuse veinlike masses of quartz, anhydrite, pyrite, Cu sulphides and trace carbonate. The rock was evidently deformed during or following the hydrothermal phase, with disaggregation of pyrite masses, recrystallization of quartz (commonly to fibre-texture aggregates) and anhydrite, development of foliation in sericite. Paragenetically, pyrite is earlier than, and probably locally replaced by, Cu sulphides that are dominated by bornite, with minor associated chalcocite and digenite, and a trace of enargite. The Cu sulphide phases appear to be in equilibrium.