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

For

Stavely Minerals

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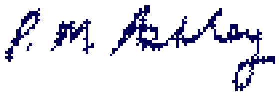

Introduction

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 SMD026 (1 sample), SMD031 (1 sample), SMD032 (1 sample), SMD036 (2 samples), SMD037 (1 sample) and SMD040 (2 samples) and were from downhole depths ranging from 80.2 m to 542.3 m. Samples were fresh, with no indications of supergene alteration. Brief drill core descriptions and handspecimen photos for the samples were provided.

Petrographic sections were prepared at Petrographic International Pty Ltd in Brisbane, with seven polished thin sections (PTS) and one standard thin section (TS) being produced. Subsequently, PTS were examined microscopically in transmitted and reflected light, and TS in transmitted and oblique reflected light. All samples were measured for magnetic susceptibility and representative photomicrographs of textural and mineralogical characteristics were taken. Six sample offcuts were treated with hydrofluoric acid and sodium cobaltinitrite to check for the presence of K-feldspar.

The purpose of the petrographic work was to identify the primary rock types, the nature of alteration, veining and mineralisation.

Summary descriptions of the samples are listed following:

SMD026 394.6 m PTS

Summary: Strongly mineralised rock consisting of scattered domains of intensely hydrothermally altered host rock and quartz-sulphide (-carbonate) veining. There is no diagnostic relict texture in the host rock domains and they were replaced by mostly fine grained aggregates of chlorite and quartz, with minor sulphide masses (chalcopyrite, pyrite) and traces of sericite, carbonate and rutile. Hydrothermal infill is dominated by fine to medium grained, inequigranular to prismatic quartz, with scattered aggregates of pyrite and/or chalcopyrite, minor interstitial carbonate and traces of barite, sphalerite and galena. Sphalerite is an Fe-poor variety and is associated with chalcopyrite and galena. Pyrite is paragenetically earlier than chalcopyrite, and is locally fractured and contains inclusions and fracture fillings of chalcopyrite and galena. At least five grains of electrum up to 10 µm across occur in association with chalcopyrite and galena in pyrite.

SMD031 80.2 m PTS

Summary: Coarse volcanic fragmental rock with a minor proportion of interstitial volcanic-derived siltstone (i.e. a coarse epiclastic), showing pervasive strong alteration, perhaps due to low grade metamorphism and also containing minor amounts of hydrothermal replacement aggregates and veins. Relict texture is moderately well preserved, with a clast- to matrix-supported texture and fragments of former porphyritic andesite. These contained phenocrysts of plagioclase and hornblende in a fine grained feldspathic groundmass. Enclosing subordinate siltstone matrix contains relict detrital grains of altered plagioclase and ferromagnesian material, as well as quartz. The rock was affected by almost complete replacement of the primary mineralogy and development of abundant albite, with subordinate K-feldspar, quartz, actinolite and chlorite, minor magnetite, epidote and traces of sericite, carbonate, titanite and sulphides. There are a few apparent metasomatic aggregates containing one or more of epidote, quartz, chlorite, magnetite and sulphides, as well as a few epidote-rich veins. Sulphides are sparse and include chalcocite (most common) and traces of bornite, digenite and chalcopyrite.

SMD032 542.3 m PTS

Summary: Intensely hydrothermally altered rock, with possible zones of hydrothermal infill, ranging from pyrite-rich to quartz-rich and being cut by an anastomosing to sub-planar array of veinlike aggregates of Cu sulphides, dominated by chalcocite. Some quartz-rich aggregates could represent zones of former protolith, subject to hydrothermal silicification and also containing disseminated pyrite, a few aggregates of sericite, a little chalcocite and traces of carbonate, digenite, bornite and covellite. The quartz-rich domains grade into pyrite-rich domains and also have interstitial masses of chalcocite and minor enargite and digenite. Chalcocite-rich veinlike masses also contain a little digenite and trace bornite. The alteration-mineralisation assemblage is consistent with development under high-sulphidation conditions.

SMD036 271.8 m TS

Summary: Contact between porphyritic andesite and a matrix-supported sedimentary rock, considered to be a quartz-lithic sandstone, grading to siltstone. Both rock types have undergone pervasive propylitic alteration and emplacement of a couple of carbonate-rich veins. The interpreted andesite was originally porphyritic, with feldspar (plagioclase) phenocrysts, a few ferromagnesian phenocrysts and a few microphenocrysts of quartz in a finer grained groundmass. The sandstone-siltstone has well-preserved relict detrital grain texture, as well as local bedding. In this rock type, detrital quartz is abundant, but there are also grains of altered lithics, feldspar and a trace of biotite. There is no evidence that this rock type was originally igneous (e.g. aplite). The relationship between the andesite and sandstone-siltstone is not established. Pervasive alteration led to considerable replacement and development of an assemblage that includes fine grained sericite, quartz, albite, carbonate and chlorite, with a little leucoxene-rutile and traces of pyrite and chalcopyrite. A few veins occur, mostly in the sandstone-siltstone and contain carbonate and local quartz.

SMD036 534.3 m PTS

Summary: Porphyritic andesite, showing strong pervasive propylitic to locally phyllic alteration and with considerable veining. There is no evidence for the occurrence of an aplitic rock in the sample. There is moderately well preserved relict texture in the andesite, indicating that it contained phenocrysts of plagioclase and a ferromagnesian phase (maybe hornblende) in a fine grained feldspathic groundmass. Two sets of veining were emplaced, with earlier and wider quartz-rich veins occurring, and cut by later veins of carbonate, quartz, pyrite and chalcopyrite. About the latter, phyllic alteration, with abundant sericite, is apparent. Elsewhere, pervasive alteration has led to formation of an assemblage with abundant albite, subordinate quartz and chlorite, plus a little sericite, pyrite and trace chalcopyrite and rutile.

SMD037 387.9 m PTS

Summary: Strongly porphyritic hornblende microtonalite, with pervasive alteration and emplacement of a few veins. The igneous rock contained abundant plagioclase phenocrysts and less common phenocrysts of hornblende and quartz, in a finely inequigranular groundmass that was dominated by plagioclase and quartz. There is evidence for minor early alteration with development of albite and magnetite, perhaps coeval with emplacement of prominent quartz-rich veins that also contains scattered magnetite aggregates and a tiny trace of chalcopyrite and bornite. Pervasive alteration affects the entire rock, with this being of propylitic type and resulting in moderate to strong development of albite and chlorite, with minor sericite, epidote and carbonate, a trace of hematite, and emplacement of a couple of thin, carbonate-rich veins.

SMD040 325.5 m PTS

Summary: "Skarn-like" metamorphic and slightly mineralised rock, likely derived from a former amygdaloidal mafic igneous (e.g. basaltic) protolith. The presence of scattered quartz (-plagioclase) aggregates that could represent former amygdules is the only vestige of relict texture, with the remainder of the protolith being replaced by dominant fine to medium grained garnet (e.g. andradite-grossular) and plagioclase (perhaps albitic), with a little magnetite. This assemblage was locally overprinted by epidote (± magnetite ± Cu sulphides) in irregular patches and local veins, with the rock subsequently being affected by retrograde alteration forming fine grained carbonate and chlorite. Cu sulphides tend to be associated with epidote and magnetite and include fine grained aggregates and individual grains of chalcocite and bornite, with trace chalcopyrite and digenite.

SMD040 427.1 m PTS

Summary: Porphyritic quartz andesite with strong pervasive alteration and emplacement of two vein sets. Relict texture is moderately well preserved, indicating that the rock contained abundant plagioclase phenocrysts and less common ferromagnesian (e.g. hornblende) phenocrysts and a few quartz microphenocrysts, set in a fine grained, locally fluidal texture, plagioclase-rich groundmass. It is possible that early hydrothermal alteration was imposed with development of biotite (e.g. at ferromagnesian sites) plus traces of fine grained chalcopyrite, pyrite and bornite. This alteration could have been related to emplacement of early quartz-rich veining that also could have contained a little biotite and trace chalcopyrite and bornite. Pervasive overprinting propylitic alteration was imposed, with significant replacement of the rock by albite and chlorite, with minor carbonate and sericite, and trace epidote and rutile. The latter alteration was accompanied by carbonate-chlorite veining.

Interpretation and comment

Samples in the suite represent a wide variety of protolith types including igneous (volcanic and intrusive) and sedimentary types, although in one sample the nature of the protolith is obscure. Similarly, effects of hydrothermal alteration and mineralisation are commonly diverse, with two samples containing significant sulphide mineralisation and alteration ranging from moderate to intense.

Primary rock types

These are quite diverse, given the small number of samples involved. Based on preservation of relict textural and mineralogical characteristics, it is possible to be relatively certain about the nature of protoliths for five samples, with the protoliths for two others being more equivocal and one being completely speculative, due to the intensity of alteration and hydrothermal infill.

In sample SMD031/80.2 m, it is interpreted that the protolith was a coarse volcanic fragmental rock with generally angular clasts of porphyritic andesitic rock, infilled by a smaller volume of finer grained interstitial siltstone. Ultimately this rock might represent a former coarse epiclastic. In sample SMD036/271.8 m, there is a sharp, rather irregular contact between porphyritic andesite and a clastic sedimentary rock with well preserved detrital grain texture and local bedding, being a quartz-lithic sandstone, transitional to siltstone. The nature of the contact between the two rock types is not established. Samples SMD036/534.3 m and SMD040/427.1 m are rather similar, being originally porphyritic andesite and containing phenocrysts of plagioclase and hornblende, and with a few quartz microphenocrysts in the latter. Both samples display a fine grained, formerly plagioclase-rich groundmass in which relict flow foliation is locally observed. All of the porphyritic andesite occurrences in the sample suite are considered to represent products of original volcanism.

These rocks contrast with sample SMD037/387.9 m, which is interpreted as an intrusive of porphyritic hornblende microtonalite composition. It originally contained phenocrysts of plagioclase, quartz and hornblende, set in a finely inequigranular groundmass rich in plagioclase and quartz. Sample SMD040/325.5 m is more equivocal in terms of primary rock type. It does contain abundant quartz-rich aggregates that are interpreted as representing sites of former amygdules and the bulk mineralogical constitution of the rock is consistent with an original mafic igneous (e.g. basaltic) composition. The protolith for SMD026/364.9 m is more obscure, with remnant domains of intensely altered rock being enclosed in mineralogical domains that represent the products of hydrothermal infill and replacement. The bulk mineralogical constitution of the remnant rock domains contain considerable chlorite and a trace of rutile, and are therefore speculated to have been of possible mafic igneous character. The protolith for SMD032/542.3 m is also obscure, but as the rock contains a few small pseudomorphic aggregates of rutile after former igneous-appearing FeTi oxide grains, it is possible that the protolith was a type of igneous rock.

No aplitic intrusive rock was recognised in any samples. Specifically, aplite dykes, as inferred from logging information, were not recognised in samples SMD036/271.8 m and SMD036/534.3 m.

Alteration

Effects of hydrothermal alteration in the sample suite might include local occurrences of relatively high temperature, early alteration, ranging through to more widespread retrograde alteration, typically of propylitic type.

Examples of potentially early alteration include: (a) possible development of minor hydrothermal biotite (from former ferromagnesian grains) and traces of chalcopyrite, pyrite and bornite in SMD040/427.1 m, with this being associated with quartz-rich veining, (b) minor albite-magnetite alteration in SMD037/387.9 m, with this also associated with quartz-rich veining containing minor magnetite, and (c) development of a skarn-like replacement assemblage of garnet (andradite-grossular), plagioclase, quartz and minor magnetite in interpreted amygdaloidal basalt host rock in SMD040/325.5 m. This assemblage could have initially developed as a consequence of medium grade thermal metamorphism (and was later followed by a hydrothermal overprint). More intense alteration, leading to complete replacement (and textural destruction) of primary rock material took place in SMD026/364.9 m and SMD032/542.3 m. In the former rock, alteration was to (d) quartz and chlorite, plus chalcopyrite, pyrite and minor sericite, whereas in the latter it was to (e) quartz and pyrite, with minor sericite. These assemblages could represent the products of intense replacement and infill, with the latter having affinities to those in high-sulphidation alteration systems, and with both rocks having rather sulphide-rich subsequent infilling.

In SMD036/534.3 m, minor phyllic alteration (sericite-rich) is locally apparent adjacent to a mineralised vein, and in SMD040/325.5 m, there is minor occurrence of veining containing epidote, quartz, magnetite and carbonate, with traces of Cu sulphides that are associated with epidote-rich alteration patches and which clearly post-date the prograde garnet-plagioclase-quartz (-magnetite) assemblage. Likely retrograde propylitic alteration has developed, in part as subsequently imposed overprints, in the andesite (± sedimentary) protolith, as well as in the microtonalite (SMD037/387.9 m) and in the skarn-like assemblage in SMD040/325.5 m. Typical minerals in these assemblages include chlorite, albite and carbonate, with smaller amounts of sericite, epidote, actinolite, titanite, rutile, quartz and K-feldspar.

Veins and possible breccia infillings

All samples in the suite contain veins, with some samples probably being largely the product of hydrothermal infill and replacement, maybe of material that had experienced hydrothermal brecciation (SMD026/364.9 m, SMD032/542.3 m). The latter two samples have minority amounts of intensely altered interpreted host rock, but much represents quartz- and sulphide-rich infill. In SMD026/364.9 m, these components are dominated by quartz, pyrite and chalcopyrite, with a little carbonate, barite, sphalerite, galena and a few tiny grains of electrum. In SMD032/542.3 m, initial quartz and pyrite deposition was paragenetically followed by abundant chalcocite (commonly in veinlike masses), with minor enargite and digenite and trace bornite and covellite.

Veins in some other samples include paragenetically early quartz-rich types (e.g. in SMD036/534.3 m, locally with magnetite (in SMD037/387.9 m) and ?biotite + Cu sulphides (in SMD040/427.1 m). As mentioned above, there is minor veining of the skarn-like assemblage in SMD040/325.5 m by epidote, quartz, magnetite and carbonate, plus traces of Cu sulphides, and an epidote vein occurs in SMD031/80.2 m. In other samples, apparently later veining tends to be carbonate-rich, locally with pyrite, chalcopyrite and quartz, or with chlorite.

Mineralisation

All samples in the suite contain sulphide minerals, ranging from traces to abundant (i.e. semi-massive), with a few samples also containing minor magnetite. Cu-bearing sulphides are the most common sulphide phases, but there are also significant occurrences of pyrite (especially in SMD026/364.9 m and SMD032/542.3 m) and traces of galena and sphalerite (in SMD026/364.9 m).

Sample SMD032/542.3 m is composed of semi-massive sulphides, with abundant, paragenetically early pyrite (estimated at ~35%), with later infilling and veining dominated by abundant chalcocite (estimated at 10%). Associated with chalcocite are smaller amounts of enargite and digenite, with traces of bornite and covellite, and a single small grain of possible stannite. This sulphide assemblage formed under hypogene conditions and conforms to high-sulphidation type. Its occurrence is consistent with the largely silicic type of alteration evident in the host rock. Another sample with significant sulphides is SMD026/364.9 m, with an estimated 6% of paragenetically early pyrite, and an estimated 6% of later chalcopyrite, occurring as hydrothermal infill, and associated with traces of sphalerite (Fe-poor), galena and electrum. The last phase is found several small (up to 10 µm) grains associated with the base metal sulphides.

The samples from SMD031/80.2 m and SMD040/325.5 m have some similarities with respect to mineralisation. Both have irregularly distributed, generally finely disseminated amounts of chalcocite, with a little associated bornite (commonly forming intergrowths with chalcocite) and traces of digenite and chalcopyrite. The dominant chalcocite in these samples is of hypogene origin, particularly demonstrated with its complex intergrowth with bornite, and again attests to mineralisation having high-sulphidation affinities. In other samples (andesite-dominated and microtonalite), there are trace to small amounts of chalcopyrite, with local bornite and pyrite. Magnetite occurs as a disseminated and local vein-hosted phase up to a few % in SMD031/80.2 m, SMD037/387.9 m and SMD040/325.5 m. Magnetite is locally associated with sulphides (and is paragenetically early, as in SMD040/325.5 m) and also shows retrograde replacement by hematite in places.

Individual sample descriptions

SMD026 394.6 m PTS

Summary: Strongly mineralised rock consisting of scattered domains of intensely hydrothermally altered host rock and quartz-sulphide (-carbonate) veining. There is no diagnostic relict texture in the host rock domains and they were replaced by mostly fine grained aggregates of chlorite and quartz, with minor sulphide masses (chalcopyrite, pyrite) and traces of sericite, carbonate and rutile. Hydrothermal infill is dominated by fine to medium grained, inequigranular to prismatic quartz, with scattered aggregates of pyrite and/or chalcopyrite, minor interstitial carbonate and traces of barite, sphalerite and galena. Sphalerite is an Fe-poor variety and is associated with chalcopyrite and galena. Pyrite is paragenetically earlier than chalcopyrite, and is locally fractured and contains inclusions and fracture fillings of chalcopyrite and galena. At least five grains of electrum up to 10 µm across occur in association with chalcopyrite and galena in pyrite.

Handspecimen: The drill core sample is composed dominantly of a dark grey-green, strongly altered fine grained rock, cut by several quartz-sulphide veins that are up to 2 cm wide, occurring at low through to high angles to the core axis (Fig. 1). The grey-green rock does not have diagnostic relict texture, although it could be implied that it was originally an amygdaloidal and/or porphyritic mafic volcanic, but now replaced by fine grained chlorite and quartz, with small amounts of chalcopyrite and/or pyrite (Fig. 1). Veins are dominated by pale grey quartz, with splashy infill aggregates of pyrite and/or chalcopyrite up to several millimetres across, and a couple of grains of pale brown sphalerite up to 2 mm across (Fig. 1). A little carbonate also occurs, mostly as thin, late stage veins. The sample is weakly magnetic, with susceptibility up to 50 x 10^{-5} SI.

Fig. 1: Drill core sample showing paler grey quartz (-chalcopyrite-pyrite) veining in dark grey-green, intensely altered host rock (probably originally basaltic).

Petrographic description

a) Primary rock characteristics: In the section, approximately a quarter of the sample is interpreted as representing intensely hydrothermally altered host rock, with the remainder being the product of complete hydrothermal replacement and more commonly, infill. No diagnostic relict texture is preserved in the interpreted host rock domains, which are irregular in shape and up to 2 cm across. The alteration mineral assemblage is dominated by chlorite and quartz, with minor chalcopyrite and pyrite, a little sericite and traces of carbonate and rutile (Fig. 2). This assemblage is tentatively interpreted as indicating that the protolith was of mafic igneous type, e.g. basaltic.

b) Alteration and structure: The protolith was evidently intensely hydrothermally altered and cut by major veining and associated sulphide mineralisation. The protolith was replaced by varying amounts of mostly fine grained chlorite and quartz (Fig. 2), with a few aggregates of pyrite and/or chalcopyrite up to several millimetres across, a little sericite and traces of rutile and carbonate. The domains of altered host rock appear to merge into vein infill, with the latter dominated by fine to medium grained, inequigranular to prismatic quartz (up to 2.5 mm), with scattered aggregates and intergranular masses of pyrite and/or chalcopyrite (up to 8 mm across), local carbonate (aggregates to 2 mm) and traces of sphalerite, galena and barite (couple of grains to 1 mm associated with a chalcopyrite-quartz aggregate). Sulphide aggregates show that pyrite is paragenetically earlier than chalcopyrite (and associated traces of sphalerite and galena) (Fig. 3). The altered host rock and quartz-sulphide (-carbonate) infill zones are cut by a couple of narrow carbonate-rich veins.

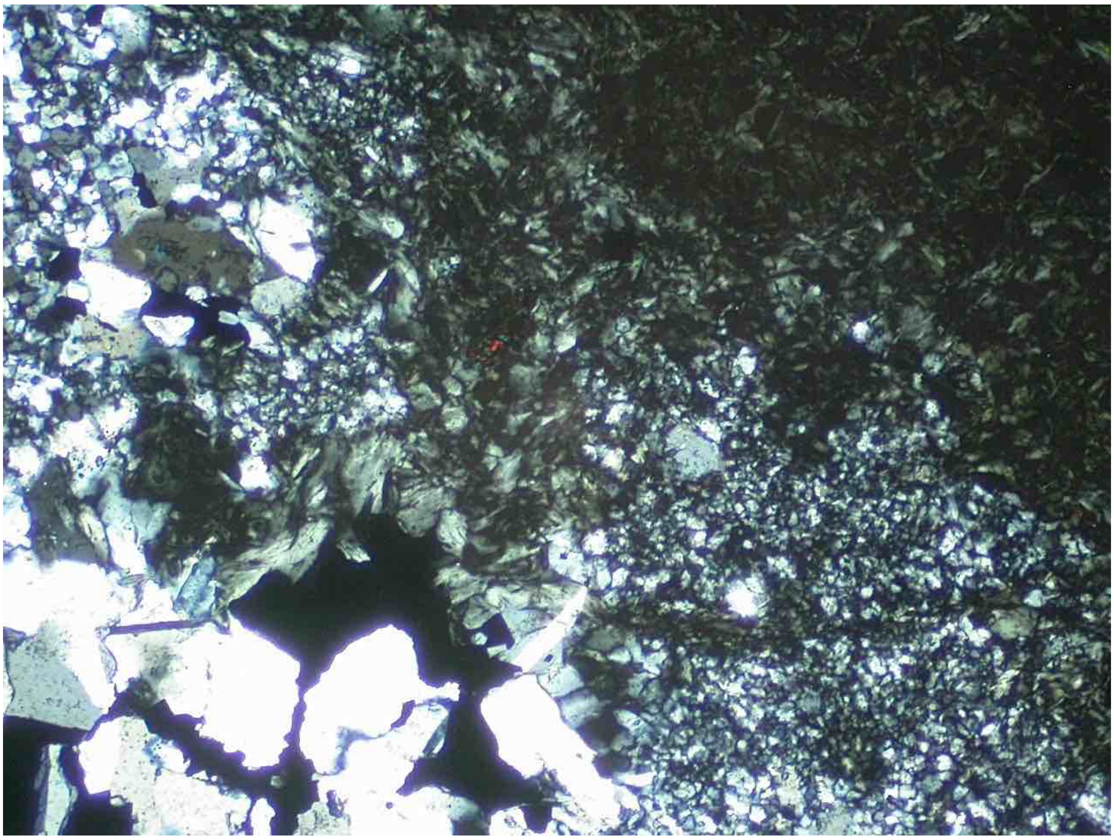

Fig. 2: Domain of intensely altered host rock (right), replaced by chlorite (dark grey-khaki) and fine grained quartz, and abutting on to hydrothermal infill of quartz and chalcopyrite (black). Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: Minor, but locally prominent medium to coarse grained aggregates of pyrite and/or chalcopyrite occur in the altered host rock domains and in quartz-rich veining (Figs 2, 3). Sulphide aggregates are up to 8 mm across, with these ranging from pyrite- to chalcopyrite-rich. One composite aggregate ~3 mm across contains Fe-poor sphalerite showing intergrowth with chalcopyrite and minor galena (Fig. 4). Pyrite is paragenetically early and is commonly fractured. It also contains a few composite inclusions of chalcopyrite ± galena. In fractures and inclusions in pyrite, chalcopyrite and galena occur, with at least five inclusions of electrum up to 10 μm across being observed in association (Fig. 5).

<u>Mineral Mode (by volume)</u>: quartz 65%, chlorite 20%, pyrite and chalcopyrite each 6%, carbonate 2% and traces of sericite, rutile, barite, sphalerite, galena and electrum.

<u>Interpretation and comment</u>: It is interpreted that the sample represents a strongly mineralised rock that retains scattered domains of intensely hydrothermally altered host rock and abundant quartz-sulphide (-carbonate) veining. No diagnostic relict texture is recognised in the host rock domains, but as they were replaced by chlorite and quartz, with minor sulphide masses (chalcopyrite, pyrite) and traces of sericite, carbonate and rutile, it is speculated that the protolith could have initially been of basaltic type. Hydrothermal infill is dominated by inequigranular to prismatic quartz, with scattered aggregates of pyrite and/or chalcopyrite, minor interstitial carbonate and traces of barite, sphalerite and galena. Sphalerite is an Fe-poor variety and is associated with chalcopyrite and galena. Pyrite is paragenetically earlier than chalcopyrite, and is locally fractured and contains inclusions and fracture fillings of chalcopyrite and galena. At least five grains of electrum up to 10 μm across occur in association with chalcopyrite and galena in pyrite.

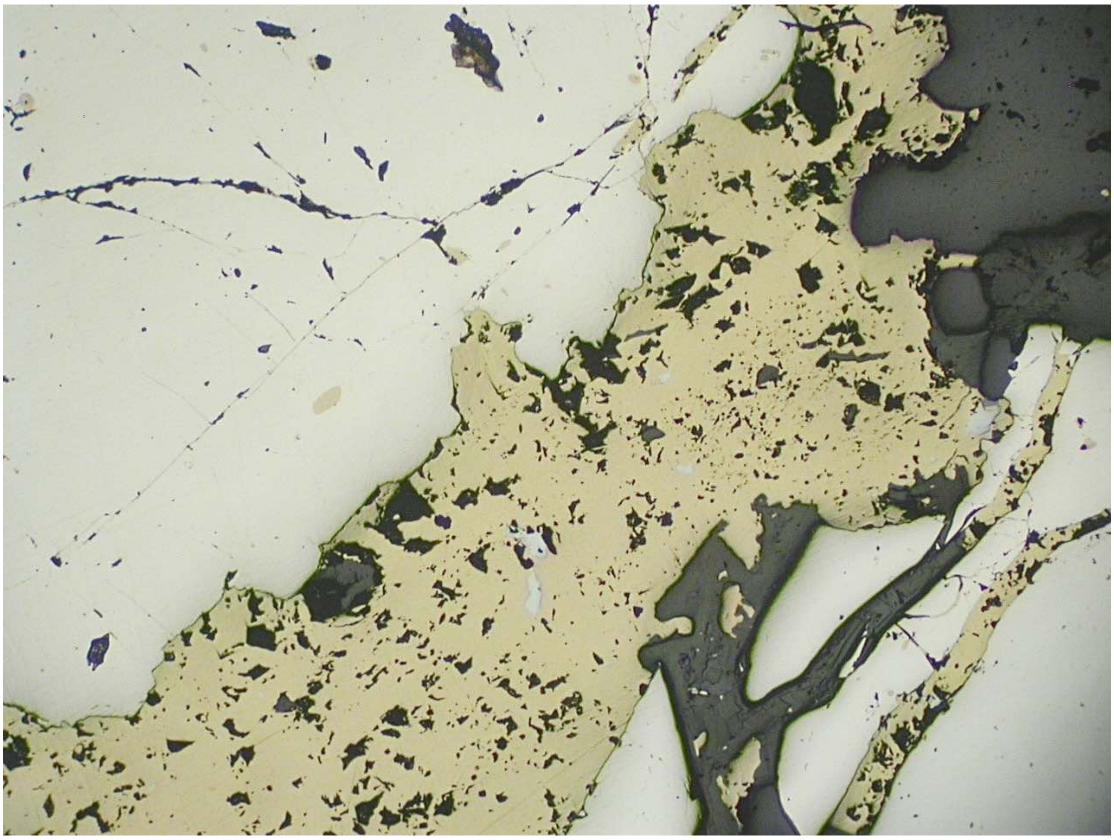

Fig. 3: Part of a vein assemblage showing rather coarse pyrite (pale creamy) with fracturing and invasion by chalcopyrite (yellow). Tiny whitish grains in chalcopyrite are galena. Plane polarised reflected light, field of view 2 mm across.

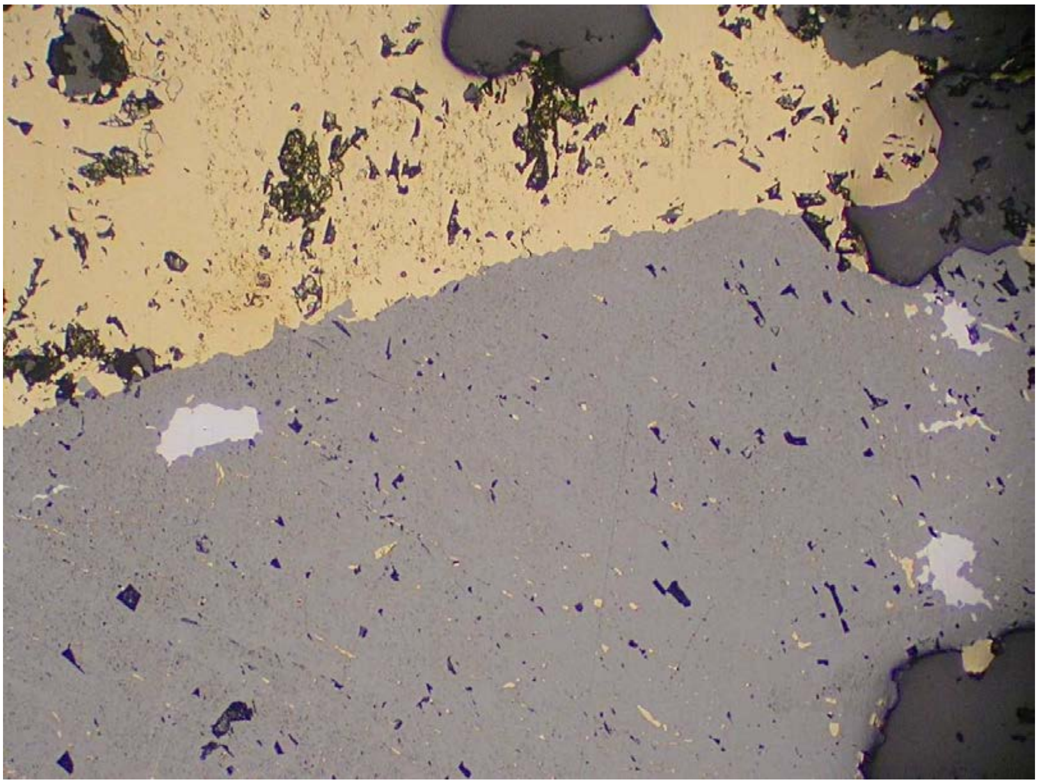

Fig. 4: Composite aggregate of sphalerite (grey) and chalcopyrite (yellow), with small inclusions of galena (whitish) and chalcopyrite in sphalerite. Plane polarised reflected light, field of view 1 mm across.

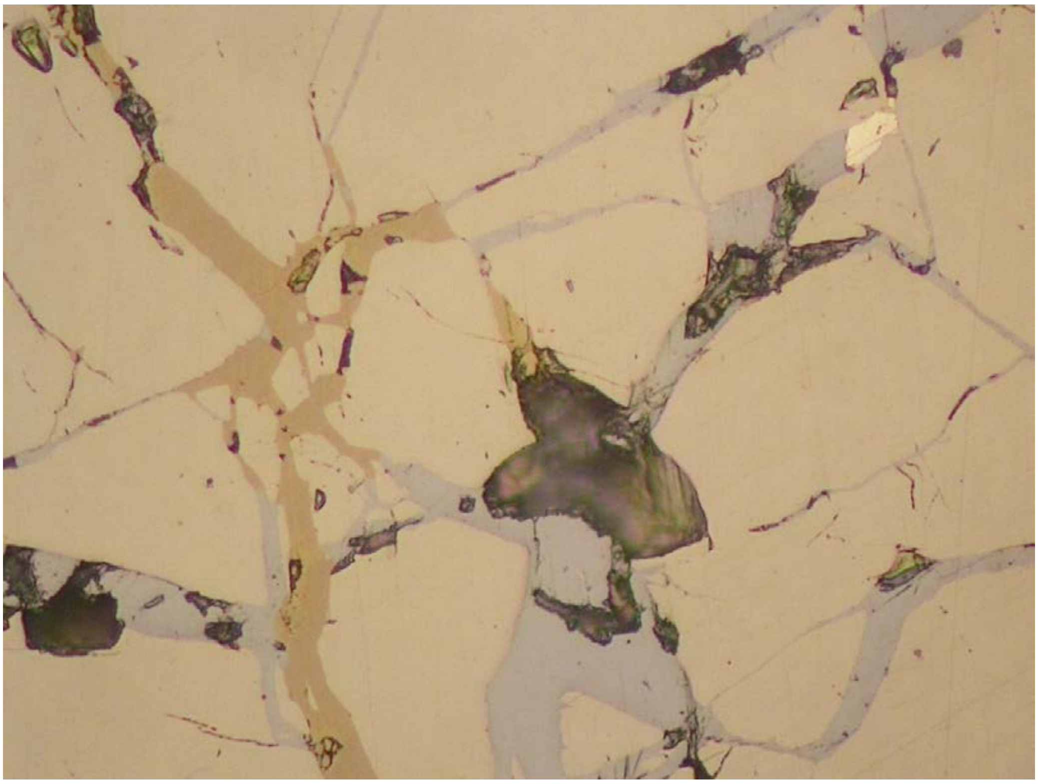

Fig. 5: Fractured pyrite (pale creamy) showing invasion along fractures by chalcopyrite (yellow) and galena (pale silvery grey). A grain of electrum occurs at upper right. Plane polarised reflected light, field of view 0.25 mm across.

SMD031 80.2 m PTS

Summary: Coarse volcanic fragmental rock with a minor proportion of interstitial volcanic-derived siltstone (i.e. a coarse epiclastic), showing pervasive strong alteration, perhaps due to low grade metamorphism and also containing minor amounts of hydrothermal replacement aggregates and veins. Relict texture is moderately well preserved, with a clast- to matrix-supported texture and fragments of former porphyritic andesite. These contained phenocrysts of plagioclase and hornblende in a fine grained feldspathic groundmass. Enclosing subordinate siltstone matrix contains relict detrital grains of altered plagioclase and ferromagnesian material, as well as quartz. The rock was affected by almost complete replacement of the primary mineralogy and development of abundant albite, with subordinate K-feldspar, quartz, actinolite and chlorite, minor magnetite, epidote and traces of sericite, carbonate, titanite and sulphides. There are a few apparent metasomatic aggregates containing one or more of epidote, quartz, chlorite, magnetite and sulphides, as well as a few epidote-rich veins. Sulphides are sparse and include chalcocite (most common) and traces of bornite, digenite and chalcopyrite.

Handspecimen: The drill core sample is composed of a coarse, apparently volcanic fragmental rock. It contains pale grey-green to brown, red-brown, pink and dark grey-green angular to sub-rounded fragments up to 4 cm across, forming a largely clast-supported texture (Fig. 6). Fragments are fine grained, porphyritic (plagioclase-phyric) and could be of intermediate composition. The small amount of matrix component is fine grained and could represent tuffaceous or sedimentary material. The rock is strongly pervasively altered, with at least some of the pink to red-brown zones containing K-feldspar, as indicated by staining of the section offcut with sodium cobaltinitrite. Other alteration products could include epidote, chlorite and actinolite, and there are a few aggregates of magnetite and a trace of silvery-grey chalcocite. The rock is cut by a couple of thin epidote veins at a high to moderate angle to the core axis. The sample is strongly magnetic, with susceptibility up to 4990 x 10^{-5} SI, confirming the occurrence of magnetite.

Fig. 6: Drill core sample showing relict fragmental texture. Altered andesitic fragments show replacement by phases including albite, K-feldspar, quartz, chlorite, actinolite, epidote and minor magnetite and sulphides.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock represents a type of volcanic fragmental, with angular to sub-rounded fragments of altered porphyritic volcanic rock and uncommon lithic-quartz-feldspar siltstone, enclosed by a subordinate amount of fine grained siltstone as a matrix (Fig. 7). Volcanic fragments are up to 4 cm across, with siltstone fragments being considerably smaller. In the volcanic fragments, there are pseudomorphs after former plagioclase phenocrysts up to 2 mm across and less common, partly altered, hornblende phenocrysts (up to 1.5 mm long) in a fine grained feldspathic groundmass. The texture and mineralogy of the volcanic fragments indicate that they were originally hornblende andesite. Interstitial siltstone domains are up to several millimetres across and include scattered detrital quartz and altered plagioclase and ferromagnesian grains and a finely recrystallised, altered quartzofeldspathic matrix. From the preserved primary characteristics, it is considered that the original rock was a coarse epiclastic, e.g. volcanic conglomerate or breccia, containing a subordinate amount of interstitial volcanic siltstone.

b) Alteration and structure: The original fragmental rock evidently experienced pervasive strong low grade alteration, perhaps due to metamorphism, together with indications of local hydrothermal veining and development of a few metasomatic replacement aggregates. The rock was replaced by dominant albite (e.g. from phenocrystal plagioclase and in groundmass and matrix material), with lesser amounts of actinolite (e.g. from hornblende), chlorite, K-feldspar (patchy), quartz, epidote, plus a little sericite (at plagioclase sites), magnetite, pumpellyite, chalcocite and traces of titanite, carbonate, chalcopyrite, bornite and digenite (Figs 7, 8). The rock contains a few fine to medium grained aggregates up to several millimetres across of epidote, quartz, magnetite and chlorite, with small amounts of Cu sulphides, with the sulphides mostly associated with epidote (± a little actinolite) (Figs 7, 8). A few sub-planar to irregular veins cut the altered rock, with these being up to 0.4 mm wide and although generally epidote-rich, locally contain actinolite and carbonate (Fig. 7).

c) Mineralisation: It is interpreted that as part of the alteration assemblage, a few aggregates up to 2 mm across and isolated discrete smaller grains of magnetite formed, in places associated with epidote aggregates (Fig. 7). Small amounts of Cu sulphides also formed, again commonly in association with epidote and/or magnetite, actinolite. Sulphide aggregates are up to 1 mm across and include chalcocite, with less common bornite, chalcopyrite and digenite (Fig. 8).

Mineral Mode (by volume): albite 65%, K-feldspar 8%, quartz 7%, actinolite (+ hornblende), epidote and chlorite each 5%, magnetite 2%, pumpellyite and chalcocite each 1% and traces of titanite, carbonate, sericite, chalcopyrite, bornite and digenite.

Interpretation and comment: It is interpreted that the sample is a pervasively altered, coarse volcanic fragmental rock with a minor proportion of interstitial volcanic-derived siltstone (i.e. a coarse epiclastic). Alteration could be due to low grade metamorphism and there is also formation of a few hydrothermal replacement aggregates and veins. The protolith has a clast- to matrix-supported texture, with fragments of altered porphyritic andesite that formerly contained phenocrysts of plagioclase and hornblende in a fine grained feldspathic groundmass. Enclosing subordinate siltstone matrix contains relict detrital grains of altered plagioclase and ferromagnesian material, as well as quartz. Almost complete replacement of the primary mineralogy occurred, with development of abundant albite, subordinate K-feldspar, quartz, actinolite and chlorite, minor magnetite, epidote and traces of sericite, carbonate, titanite and sulphides. There are a few apparent metasomatic aggregates containing one or more of epidote, quartz, chlorite, magnetite and sulphides, as well as a few epidote-rich veins. Sulphides are sparse and include chalcocite (most common) and traces of bornite, digenite and chalcopyrite.

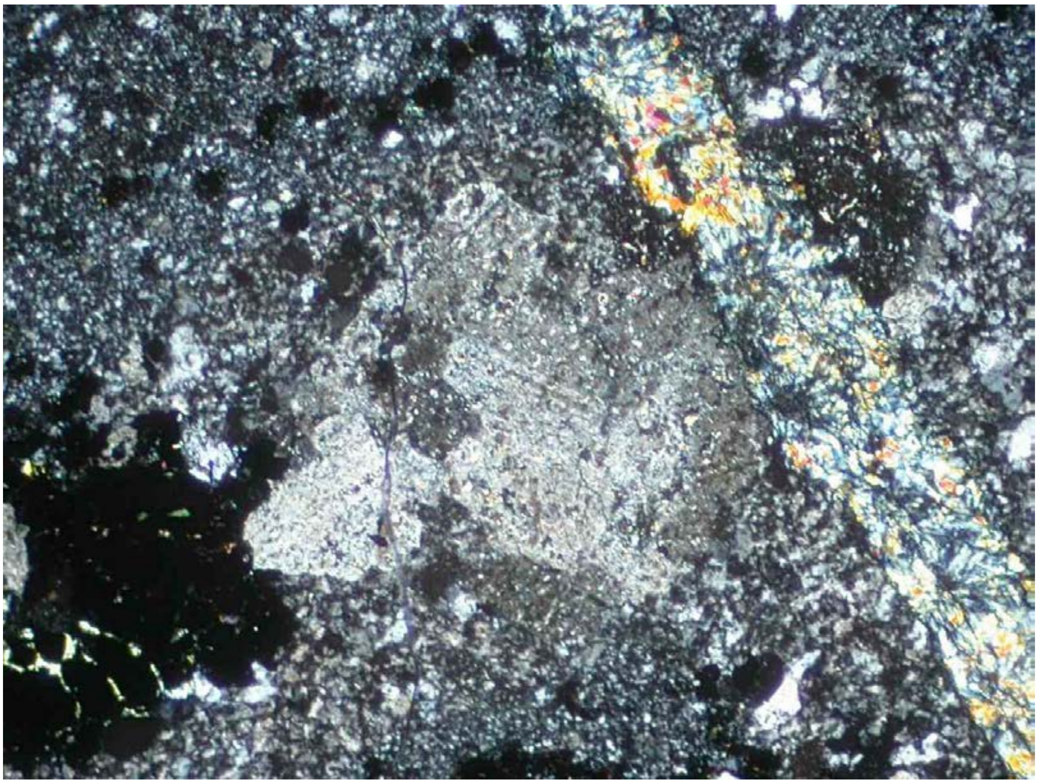

Fig. 7: Part of an altered porphyritic andesite fragment (lower), with an albitised plagioclase phenocryst, and a replacement aggregate of magnetite (black), bordering on to altered fine grained siltstone matrix (upper). The rock is cut by an epidote vein. Transmitted light, crossed polarisers, field of view 2 mm across.

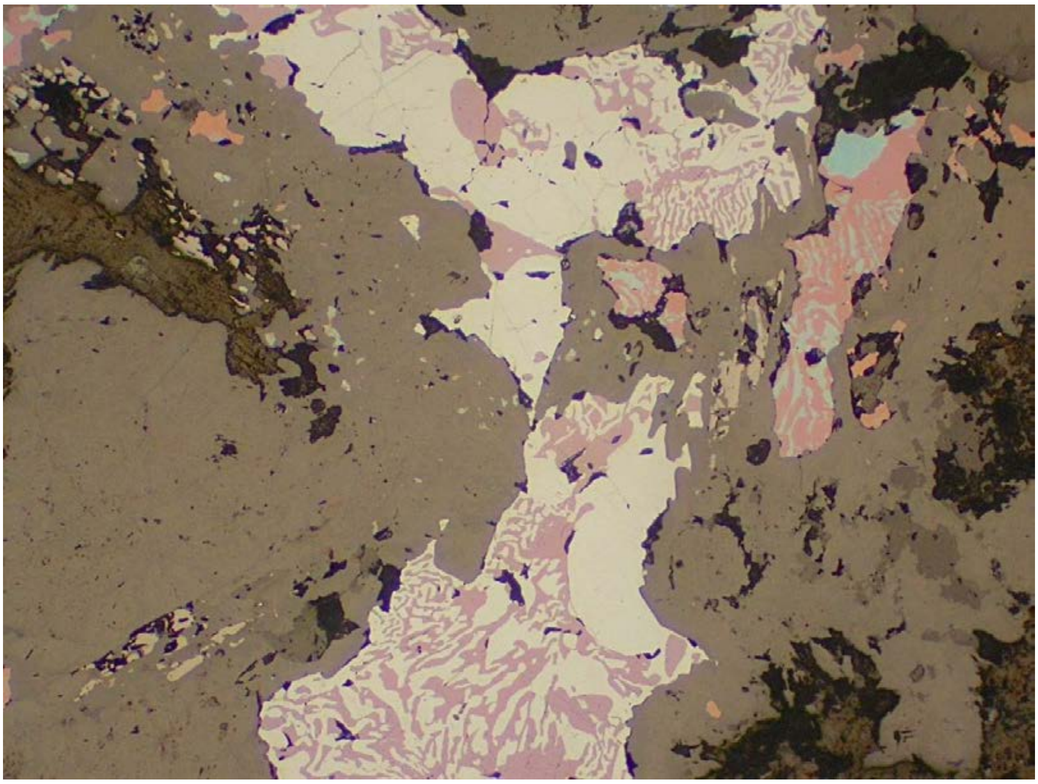

Fig. 8: Epidote-rich metasomatic replacement aggregate containing a composite aggregate of chalcocite (pale grey), intergrown with bornite (mauve-pink) and digenite (blue). Plane polarised reflected light, field of view 1 mm across.

SMD032 542.3 m PTS

Summary: Intensely hydrothermally altered rock, with possible zones of hydrothermal infill, ranging from pyrite-rich to quartz-rich and being cut by an anastomosing to sub-planar array of veinlike aggregates of Cu sulphides, dominated by chalcocite. Some quartz-rich aggregates could represent zones of former protolith, subject to hydrothermal silicification and also containing disseminated pyrite, a few aggregates of sericite, a little chalcocite and traces of carbonate, digenite, bornite and covellite. The quartz-rich domains grade into pyrite-rich domains and also have interstitial masses of chalcocite and minor enargite and digenite. Chalcocite-rich veinlike masses also contain a little digenite and trace bornite. The alteration-mineralisation assemblage is consistent with development under high-sulphidation conditions.

Handspecimen: The drill core sample is composed of semi-massive sulphides (Fig. 9). The rock is dominated by rather fine grained aggregates up to 2-3 cm across of brassy pyrite that are intercalated with grey domains of quartz up to 1 cm across, with both of these components being cut by an irregular to crudely sub-parallel array of diffuse veins up to 5 mm wide containing silvery-grey-blue Cu sulphides (e.g. chalcocite, digenite) (Fig. 9). The veins are aligned largely at a high angle to the core axis. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

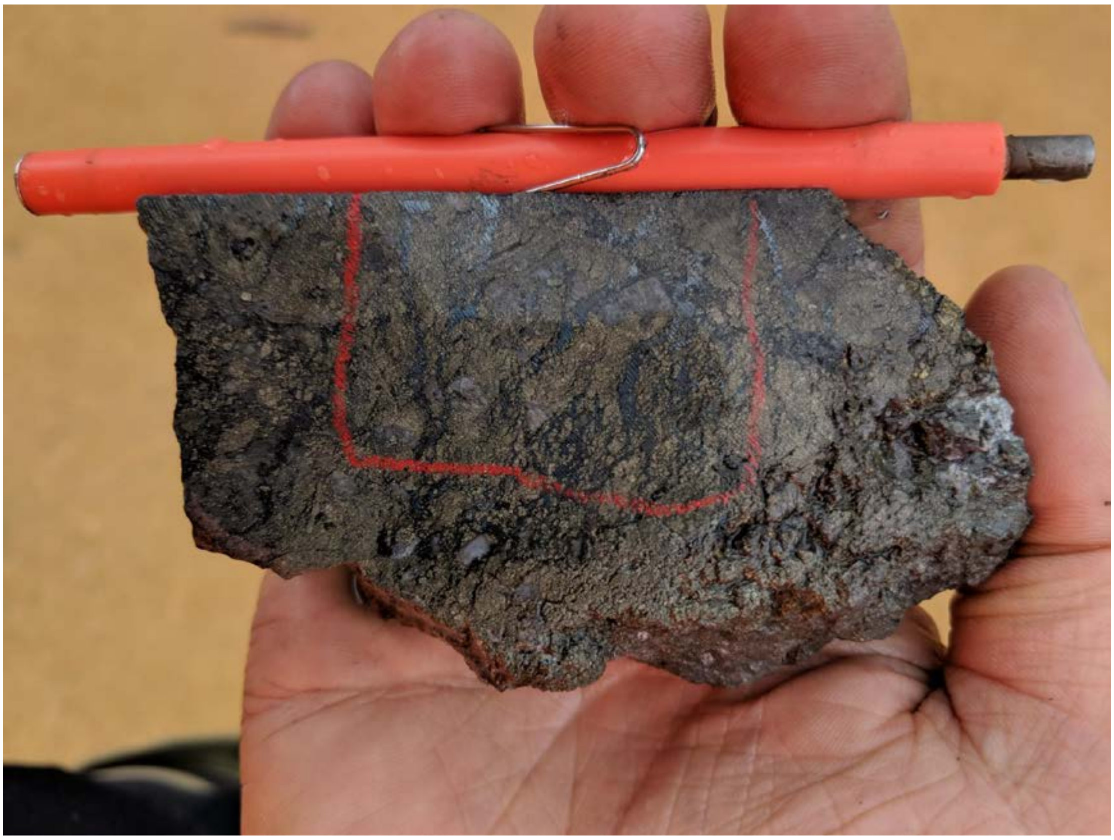

Fig. 9: Drill core sample containing semi-massive pyrite (brassy) intergrown with domains of rather fine grained grey quartz and cut by an array of anastomosing to sub-planar veins of Cu sulphides (mostly chalcocite).

Petrographic description

a) Primary rock characteristics: In the section, the sample is dominated by fine to medium grained quartz-rich domains that are intercalated with and grade into sulphide-rich domains (Fig. 10) and which are likely to be the product of intense hydrothermal replacement and local infill. It is possible that quartz-rich domains (that are up to 1 cm across) in part represent intensely replaced remnants of host rock, but generally, no diagnostic relict texture is preserved. However, there are a few small aggregates of fine grained rutile that could represent former sites of igneous FeTi oxide grains, with these hosted in quartz and locally associated with sericite ± sulphides. The nature of a possible igneous protolith remains obscure.

b) Alteration and structure: A possible igneous protolith was intensely hydrothermally altered and replaced by a new mineral assemblage, as well as possibly being brecciated or having dissolution cavities develop, resulting in local hydrothermal infillings. Interpreted irregular remnants of host rock are up to 1 cm across and were replaced by fine to medium grained, inequigranular quartz, grading to zones of fine to medium grained semi-massive pyrite, together with formation of local aggregates of sericite up to 2.5 mm across, a little carbonate and trace rutile (Fig. 10). In addition, quartz-rich domains typically contain disseminated pyrite, Cu sulphides (chalcocite, trace digenite, bornite, covellite). The quartz-rich domains grade into, and are intercalated with, irregular aggregates of semi-massive sulphides (pyrite, with interstitial chalcocite and minor digenite, enargite and trace bornite) (Figs 11, 12), with a little sericite and trace carbonate. The overall alteration of interpreted host rock is of silicic type and the alteration-mineralisation assemblage is consistent with development under high-sulphidation conditions.

c) Mineralisation: The sample contains abundant sulphides, mostly as semi-massive aggregates, but being disseminated in the quartz-rich domains. Paragenetically early, fine to medium grained pyrite is abundant, with individual irregular aggregates up to several millimetres across (Figs 10, 11). Pyrite was deposited prior to commonly abundant chalcocite, forming irregular to veinlike masses up to several millimetres across, commonly with trellis-type twinning and associated locally with minor enargite (aggregates to 1.5 mm), digenite and trace bornite and possible stannite (one grain ~0.2 mm across (Figs 11, 12). In quartz-rich domains, there is minor to locally common pyrite, with minor chalcocite and trace of digenite, bornite and covellite. The sulphide mineralogy accords with high-sulphidation type.

Mineral Mode (by volume): quartz 50%, pyrite 35%, chalcocite 10%, sericite 2%, digenite and enargite each 1% and traces of carbonate, rutile, bornite, covellite and ?stannite.

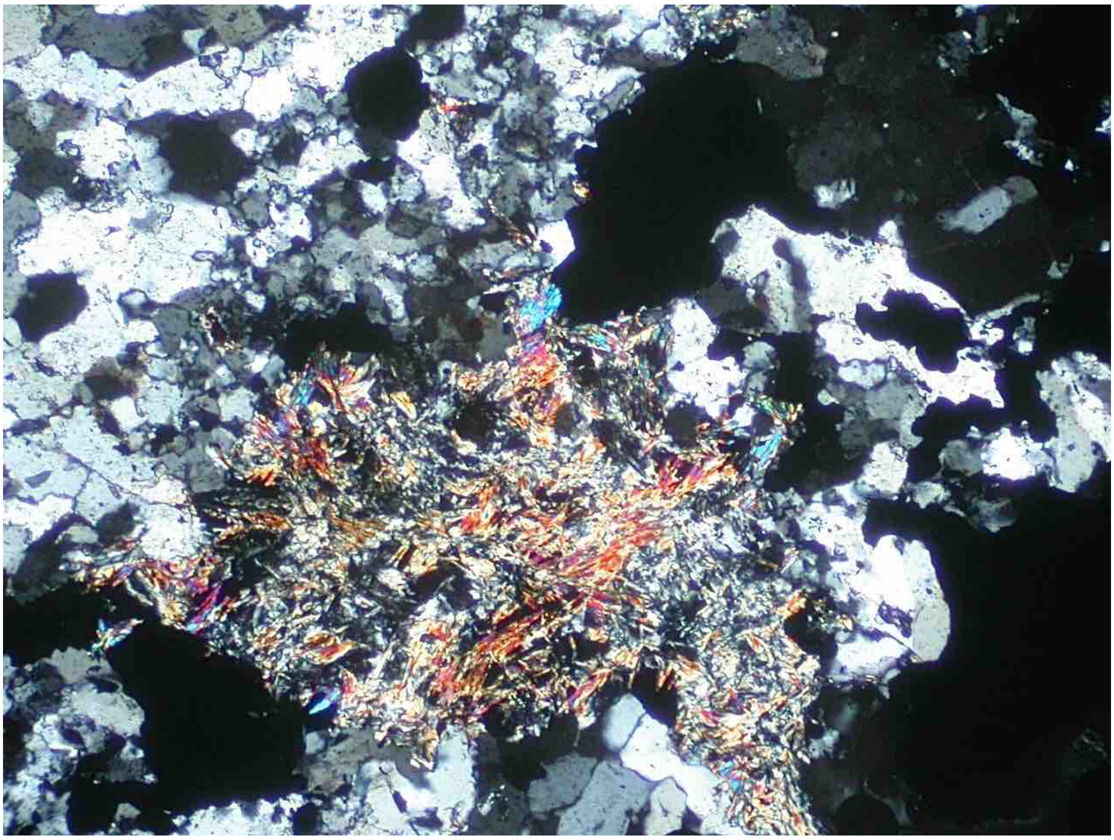

Fig. 10: A quartz-rich alteration domain containing an aggregate of sericite (bright colours) and scattered grains and aggregates of sulphides (black) including pyrite and chalcocite. Transmitted light, crossed polarisers, field of view 2 mm across.

Interpretation and comment: It is interpreted that the sample represents an intensely hydrothermally altered and mineralised rock, with possible zones of hydrothermal infill. It ranges from quartz- to pyrite-rich, with an array of chalcocite-dominated veins cross-cutting. Some quartz-rich aggregates could represent zones of intensely silicified protolith, replaced by quartz, disseminated pyrite, a few aggregates of sericite, a little chalcocite and traces of carbonate, digenite, bornite and covellite. Quartz-rich domains grade into pyrite-rich domains and also have interstitial masses of chalcocite and minor enargite and digenite. Chalcocite-rich veinlike masses also contain a little digenite and trace bornite. The alteration-mineralisation assemblage is consistent with development under high-sulphidation conditions.

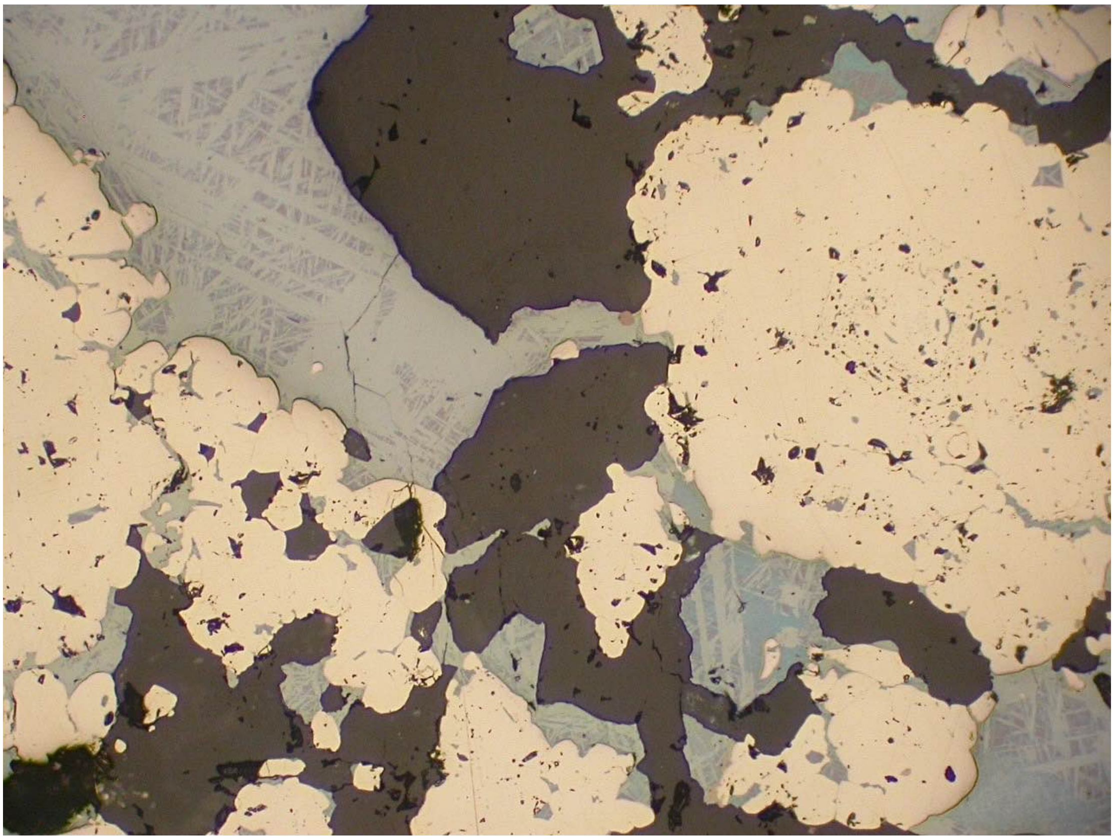

Fig. 11: Sulphide-rich domain containing aggregates of paragenetically early pyrite (pale creamy) and quartz (dark grey), with interstitial aggregates of chalcocite (pale bluish-grey, not local trellis-type twinning) and a little digenite (more blue). Plane polarised reflected light, field of view 1 mm across.

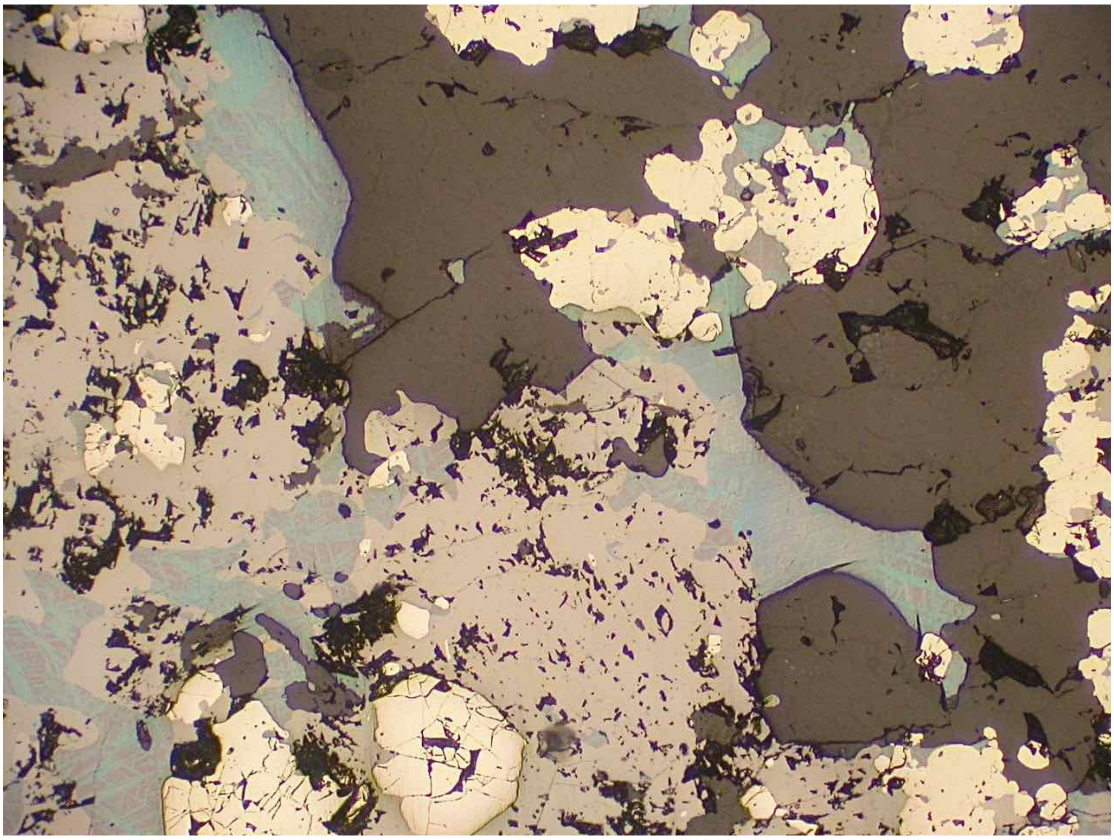

Fig. 12: Sulphide-rich domain containing paragenetically early pyrite (pale creamy) and quartz (dark grey), with interstitial enargite (paler grey) and digenite (blue). Plane polarised reflected light, field of view 1 mm across.

SMD036 271.8 m TS

Summary: Contact between porphyritic andesite and a matrix-supported sedimentary rock, considered to be a quartz-lithic sandstone, grading to siltstone. Both rock types have undergone pervasive propylitic alteration and emplacement of a couple of carbonate-rich veins. The interpreted andesite was originally porphyritic, with feldspar (plagioclase) phenocrysts, a few ferromagnesian phenocrysts and a few microphenocrysts of quartz in a finer grained groundmass. The sandstone-siltstone has well-preserved relict detrital grain texture, as well as local bedding. In this rock type, detrital quartz is abundant, but there are also grains of altered lithics, feldspar and a trace of biotite. There is no evidence that this rock type was originally igneous (e.g. aplite). The relationship between the andesite and sandstone-siltstone is not established. Pervasive alteration led to considerable replacement and development of an assemblage that includes fine grained sericite, quartz, albite, carbonate and chlorite, with a little leucoxene-rutile and traces of pyrite and chalcopyrite. A few veins occur, mostly in the sandstone-siltstone and contain carbonate and local quartz.

Handspecimen: The drill core sample is largely composed of a massive, dark grey-green, homogeneous rock, but with a domain of paler grey rock showing a sharp, rather irregular contact at ~70° to the core axis (Fig. 13). The dark grey-green rock could be a volcanic as it has an apparent porphyritic texture, with altered small feldspar phenocrysts in a fine grained groundmass (Fig. 13). The pale grey rock appears to have a relict clastic texture, with probable detrital grains, including significant quartz, up to 1 mm across. This rock could be a type of sandstone. Moderate to strong pervasive alteration has affected both rock types, probably with replacement by fine grained phases including chlorite, sericite and carbonate, and cut by a couple of white carbonate veins up to 1 mm wide at low to moderate angles to the core axis (Fig. 13). Staining of the section offcut with sodium cobaltinitrite showed that there is a little K-feldspar in the altered volcanic rock. The sample is weakly to moderately magnetic, with susceptibility up to 120 x 10^{-5} SI.

Fig. 13: Drill core sample showing a sharp contact between dark grey-green altered andesite at right and paler grey, quartz-lithic sandstone-siltstone at left. White veining is by carbonate.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that there are two distinctly different rock types present, with a relatively sharp, rather irregular contact in-between, the nature of which is not established (i.e. it could be depositional (sedimentary) or intrusive. The majority rock type, occupying ~60% of the sample, has moderately preserved relict porphyritic texture (Fig. 14). It contains a few pseudomorphs after former blocky feldspar phenocrysts (e.g. plagioclase) up to 2 mm across, after a couple of pseudomorphs after former ferromagnesian grains, as well as there being sparsely scattered relict quartz microphenocrysts in what could have been a fine grained, holocrystalline groundmass, probably containing abundant feldspar and minor ferromagnesian material (Fig. 14). The original rock type is interpreted, from relict characteristics, to have been a porphyritic quartz andesite. The minority rock type has a well preserved relict detrital grain texture and local bedding laminations, defined by variation of proportions of detrital grains versus matrix, as well as size of detrital grains (Fig. 15)> Overall, this rock type had a matrix-supported texture and ranges from siltstone to fine to medium grained sandstone, containing abundant detrital quartz, as well as minor altered feldspar, fine grained volcanic lithics and rare biotite, with largest detrital grains up to 1 mm across, and enclosed in a fine grained, recrystallised quartzofeldspathic matrix (Fig. 15). There is no evidence that this rock type represents igneous material (i.e. it is not an aplite).

b) Alteration and structure: Both rock types experienced moderate to strong pervasive alteration. In the interpreted andesite, groundmass and phenocryst phases were replaced (except quartz) and in the sandstone-siltstone, matrix material, lithic and feldspar grains were replaced (Figs 14, 15). The alteration assemblage is fine grained and includes considerable sericite (more in the andesite), albite, quartz, carbonate and chlorite, with a little K-feldspar (in the andesite), leucoxene-rutile and trace pyrite and chalcopyrite (sulphides mostly in the sandstone-siltstone). Alteration is consistent with propylitic type. A couple of veins occur, mostly in the sandstone-siltstone, and are up to 0.6 mm wide, containing abundant carbonate and local quartz.

c) Mineralisation: A trace of pyrite and chalcopyrite, forming aggregates up to 0.2 mm across, occur as part of the alteration, mostly in the sandstone-siltstone component.

Mineral Mode (by volume): sericite 30%, quartz 25%, albite 20%, carbonate 15%, chlorite 8%, K-feldspar and leucoxene-rutile each 1% and traces of biotite, pyrite and chalcopyrite.

Interpretation and comment: It is interpreted that the sample shows a contact between porphyritic andesite and a matrix-supported quartz-lithic sandstone, grading to siltstone. The nature of the contact relationship is not established. Both rock types have undergone pervasive propylitic alteration and emplacement of a couple of carbonate-rich veins. The andesite was porphyritic, with feldspar (plagioclase) phenocrysts, a few ferromagnesian phenocrysts and a few microphenocrysts of quartz in a finer grained groundmass. The sandstone-siltstone has well-preserved relict detrital grain texture, as well as local bedding. It contains abundant detrital quartz, with minor grains of altered lithics, feldspar and a trace of biotite. There is no evidence that this rock type was originally igneous (e.g. aplite). Pervasive alteration of propylitic type caused replacement by an assemblage including sericite, quartz, albite, carbonate and chlorite, with a little leucoxene-rutile and traces of pyrite and chalcopyrite. A few veins occur, mostly in the sandstone-siltstone and contain carbonate and local quartz.

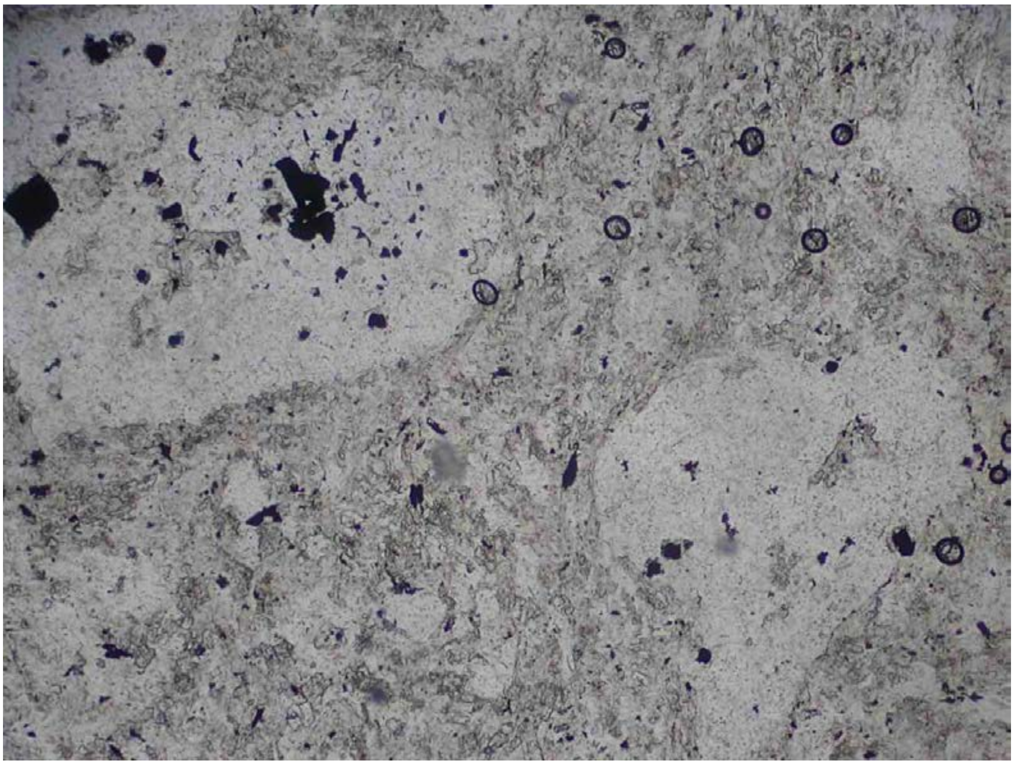

Fig. 14: Relict porphyritic texture in altered andesite, with pseudomorphs after former feldspar phenocrysts. The alteration assemblage includes albite, quartz, sericite, carbonate and chlorite, with the small black grains being pyrite and leucoxene-rutile. Plane polarised transmitted light, field of view 2 mm across.

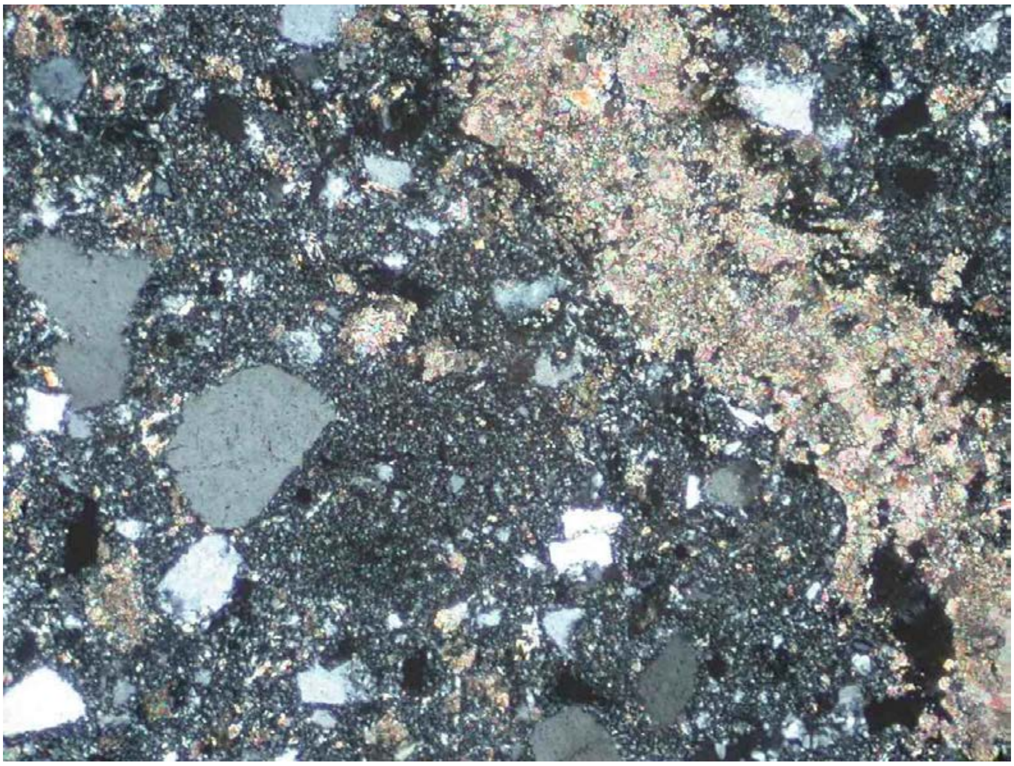

Fig. 15: Matrix-supported fine grained sandstone with scattered detrital quartz grains, cut at right by a carbonate vein. The sandstone matrix is replaced by fine grained quartz, albite, chlorite and minor carbonate. Transmitted light, crossed polarisers, field of view 2 mm across.

<u>SMD036 534.3 m PTS</u>

<u>Summary</u>: Porphyritic andesite, showing strong pervasive propylitic to locally phyllic alteration and with considerable veining. There is no evidence for the occurrence of an aplitic rock in the sample. There is moderately well preserved relict texture in the andesite, indicating that it contained phenocrysts of plagioclase and a ferromagnesian phase (maybe hornblende) in a fine grained feldspathic groundmass. Two sets of veining were emplaced, with earlier and wider quartz-rich veins occurring, and cut by later veins of carbonate, quartz, pyrite and chalcopyrite. About the latter, phyllic alteration, with abundant sericite, is apparent. Elsewhere, pervasive alteration has led to formation of an assemblage with abundant albite, subordinate quartz and chlorite, plus a little sericite, pyrite and trace chalcopyrite and rutile.

<u>Handspecimen</u>: The drill core sample is composed of a grey-green, strongly altered porphyritic igneous rock, cut by at least two generations of veins. There are altered, pale grey feldspar phenocrysts in a fine grained altered groundmass, probably with pervasive alteration to chlorite and quartz, and trace pyrite (Fig. 16). Paragenetically early pale grey quartz veins up to 1 cm wide occur at a low angle to the core axis, with these being apparently cut by a few creamy white veins up to several millimetres wide at a moderate angle to the core axis (Fig. 16). The latter veins are carbonate-rich, with local quartz and pyrite, and are bordered in part by pale alteration selvedges that could contain sericite and quartz. Testing of the section offcut with sodium cobaltinitrite did not detect any K-feldspar. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 16: Drill core sample of dark grey-green altered porphyritic andesite, with early veining by pale grey quartz and later veining by carbonate-rich aggregates (paler grey to white) that also contain quartz, pyrite and chalcopyrite.

<u>Petrographic description</u>

a) Primary rock characteristics: In the section, about two-thirds of the sample is interpreted as altered host rock, with the remainder being vein infill. In the host rock domain, relict porphyritic texture is moderately well preserved. There are pseudomorphs after former tabular to blocky plagioclase phenocrysts up to 4.5 mm long and a few pseudomorphs after a former ferromagnesian phase (possibly hornblende) up to 2.5 mm long, set in a fine grained altered feldspathic groundmass that locally preserves vestiges of flow foliation, and in which there were originally small amounts of ferromagnesian material and trace FeTi oxide (Fig. 17). From the preserved primary characteristics, the original rock is interpreted as a porphyritic andesite. There is no evidence for any other igneous rock type (e.g. aplite) to have occurred in the sample.

b) Alteration and structure: Strong pervasive alteration was imposed on the host rock, with emplacement of several veins. Primary minerals in the andesite were completely replaced. Phenocrystal plagioclase was replaced by albite, with local sericite, quartz and chlorite, and in the groundmass, abundant fine grained albite formed, with subordinate chlorite, minor quartz and traces of sericite, rutile (from FeTi oxide), pyrite and chalcopyrite (Fig. 17). Former ferromagnesian phenocrysts were replaced by chlorite, with minor quartz and trace rutile, pyrite and rare magnetite (Fig. 17). The alteration is largely of propylitic type, but about the veins containing considerable carbonate ± quartz and sulphides, there are alteration selvedges up to a few millimetres wide with abundant fine grained sericite, i.e. phyllic type. Two generations of veining appear to occur. Earlier veining is sub-planar, up to 1 cm wide and dominated by fine to medium grained, inequigranular quartz, and locally incorporating a couple of elongate "screens" of intensely altered host rock. These veins also contain a little interstitial chlorite, sericite, carbonate and traces of pyrite, chalcopyrite and rutile. Apparently later veining is cross-cutting, up to 2.5 mm wide and composed of fine to medium grained carbonate ± quartz, with scattered grains and aggregates of pyrite (up to 2 mm) and chalcopyrite (up to 2.5 mm) (Fig. 18).

c) Mineralisation: In the altered andesite, there is a little disseminated pyrite and trace chalcopyrite, with the sulphides being more common in the altered screens in the quartz-rich veins. The latter also contain traces of pyrite and chalcopyrite. Most mineralisation in the sample occurs in the later, carbonate-bearing veins, where there are scattered aggregates and individual grains of pyrite up to 2 mm across, and a few aggregates of paragenetically later chalcopyrite up to 2.5 mm across (Fig. 18).

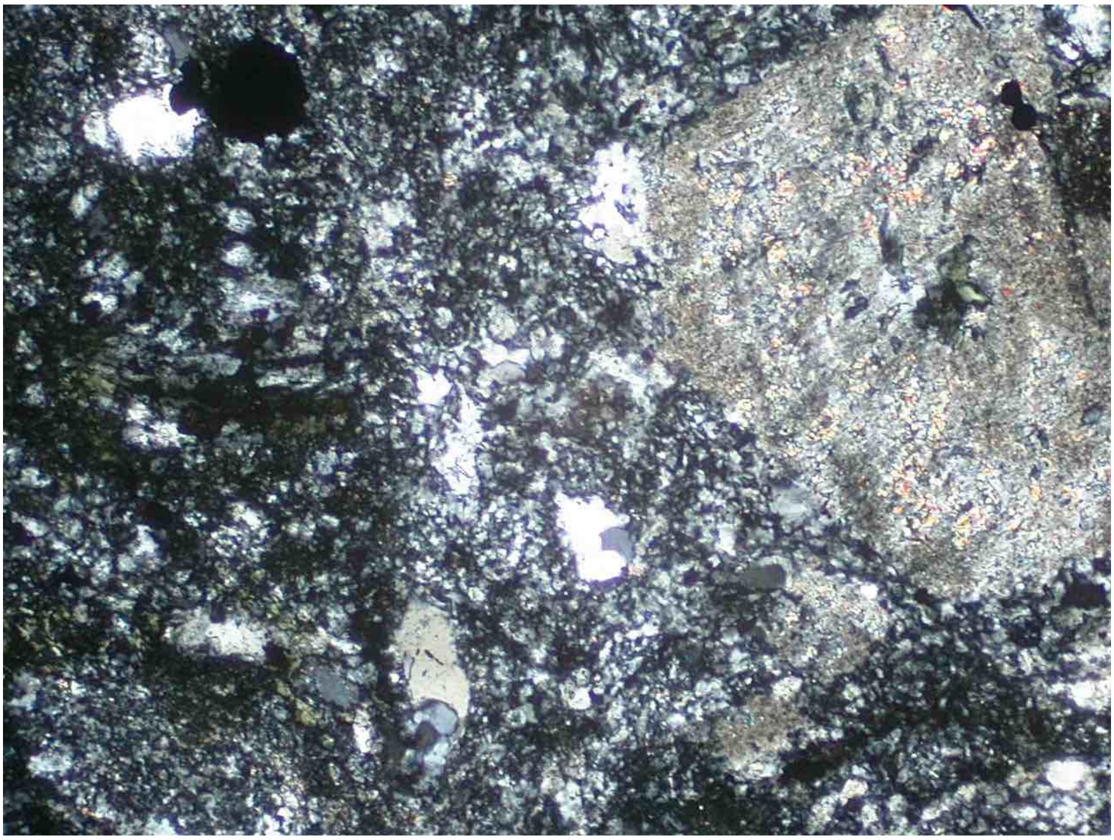

Fig. 17: Relict porphyritic texture in altered andesite, with pseudomorphs after a plagioclase phenocryst at right (now albite and minor sericite) and after a ferromagnesian phenocryst at left (dark chlorite mostly). Fine grained groundmass is replaced by albite, chlorite and quartz. Transmitted light, crossed polarisers, field of view 2 mm across.

Mineral Mode (by volume): albite 40%, quartz 35%, chlorite 10%, carbonate 6%, sericite 5%, pyrite 3%, chalcopyrite 1% and traces of rutile and magnetite.

Interpretation and comment: It is interpreted that the sample is a strongly altered porphyritic andesite, with considerable veining. There is no evidence for the occurrence of an aplitic rock in the sample. There is moderately well preserved relict texture showing that it formerly contained phenocrysts of plagioclase and a ferromagnesian phase (maybe hornblende) in a fine grained feldspathic groundmass. Pervasive alteration is largely of propylitic type, with formation of an assemblage containing abundant albite, subordinate quartz and chlorite, plus a little sericite, pyrite and trace chalcopyrite and rutile. Sericitic (phyllic) alteration is locally developed about the later, mineralised, carbonate-bearing veins. An earlier vein set Is typically quartz-rich and it is cut by the later veins of carbonate, quartz, pyrite and chalcopyrite.

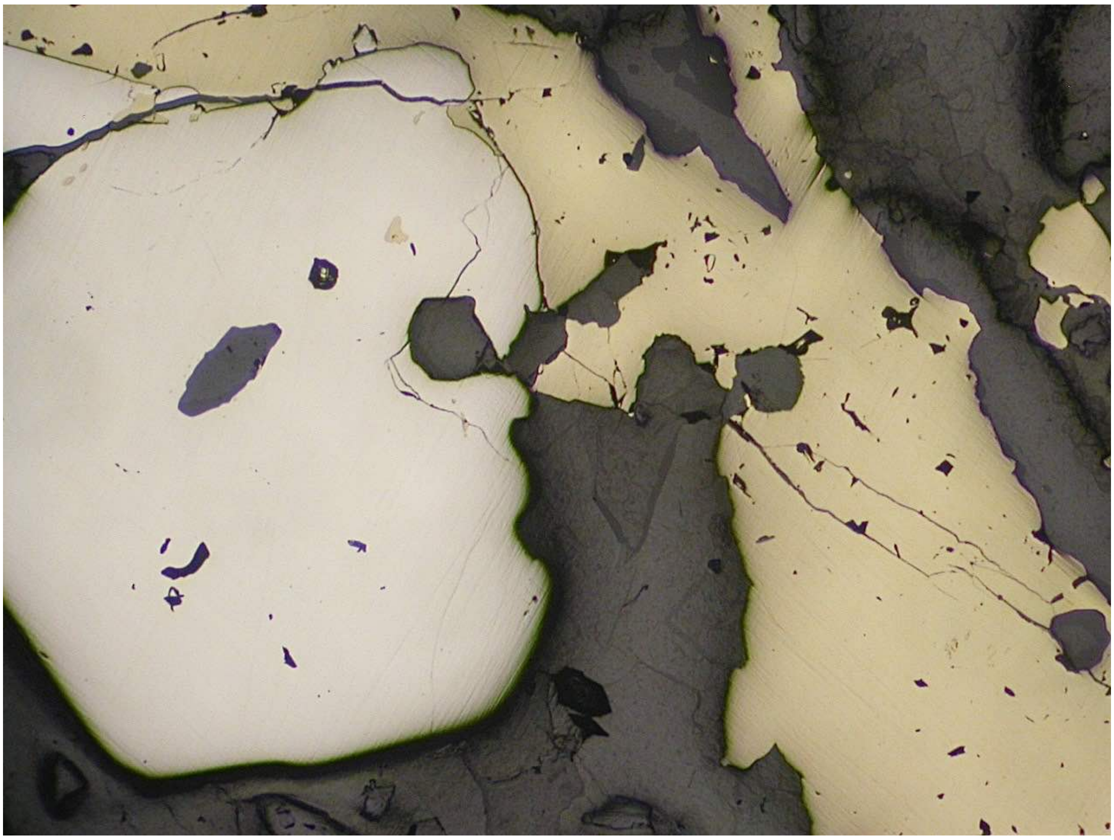

Fig. 18: Vein fill of the later vein type, showing abundant pyrite (pale creamy) and chalcopyrite (yellow) intergrown with dark grey carbonate and quartz. Plane polarised reflected light, field of view 2 mm across.

<u>SMD037 387.9 m PTS</u>

<u>Summary</u>: Strongly porphyritic hornblende microtonalite, with pervasive alteration and emplacement of a few veins. The igneous rock contained abundant plagioclase phenocrysts and less common phenocrysts of hornblende and quartz, in a finely inequigranular groundmass that was dominated by plagioclase and quartz. There is evidence for minor early alteration with development of albite and magnetite, perhaps coeval with emplacement of prominent quartz-rich veins that also contains scattered magnetite aggregates and a tiny trace of chalcopyrite and bornite. Pervasive alteration affects the entire rock, with this being of propylitic type and resulting in moderate to strong development of albite and chlorite, with minor sericite, epidote and carbonate, a trace of hematite, and emplacement of a couple of thin, carbonate-rich veins.

<u>Handspecimen</u>: The drill core sample is composed of a massive, strongly porphyritic felsic igneous rock. It contains abundant pale creamy to pale grey-green blocky feldspar phenocrysts up to 8 mm across, as well as less common altered, dark green-grey ferromagnesian phenocrysts (e.g. hornblende) and pale grey quartz phenocrysts up to 2 mm across, set in a fine grained pink-grey quartzofeldspathic groundmass (Fig. 19). A couple of sub-planar quartz-rich veins up to 8 mm wide occur at ~60° to the core axis and there are a couple of later, thin veins/fractures containing carbonate and chlorite (sheared). In the quartz-rich veins, there are a few dark grey magnetite aggregates up to 1 cm across (Fig. 19). Testing of the section offcut with sodium cobaltinitrite did not detect any K-feldspar. Much of the sample is moderately to strongly magnetic, with susceptibility up to 1290 x 10^{-5} SI, but over the veined zoned, susceptibility is strong at 3570 x 10^{-5} SI, confirming the presence of magnetite.

Fig. 19: Drill core sample of moderately altered porphyritic microtonalite, showing a vein at right of quartz and magnetite.

Petrographic description

a) Primary rock characteristics: In the section, about 30% of the sample is occupied by quartz-rich veining, with the remainder being moderately to strongly altered host rock. In the latter, primary texture is well preserved (Fig. 20). The rock contains abundant, variably altered blocky plagioclase phenocrysts up to 6 mm across, locally forming clusters up to 1 cm across. There are also scattered pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 2.5 mm long and a few quartz phenocrysts up to 2 mm across are retained (Fig. 20). The phenocrystal phases occur in a finely inequigranular groundmass of plagioclase and quartz, minor altered ferromagnesian material and trace disseminated FeTi oxide (e.g. titanomagnetite) and apatite (Fig. 20). The rock has a classic porphyry texture and is interpreted as an altered porphyritic hornblende microtonalite.

b) Alteration and structure: Moderate to strong pervasive hydrothermal alteration was imposed and several veins emplaced. A couple of major, quartz-rich veins occur and these might be related to local development of interpreted early alteration, manifest as minor development of albite (from phenocrystal and groundmass plagioclase) and disseminated magnetite. The quartz-rich veins are up to 7 mm wide and contain fine to medium grained, inequigranular quartz, plus scattered aggregates of magnetite up to 3 mm across, with traces of albite, epidote, carbonate, chalcopyrite and bornite (Fig. 21). Pervasive alteration elsewhere in the rock is of propylitic type, with variable replacement of plagioclase by albite, minor sericite, carbonate, epidote and chlorite, replacement of ferromagnesian material by chlorite, with local carbonate, epidote and trace titanite, development of a little patchy carbonate, chlorite and epidote in the groundmass, and local replacement of magnetite by hematite (Fig. 21). The altered rock and quartz-rich veining are cut by a couple of thin, late veins containing carbonate, with a little albite and chlorite.

c) Mineralisation: Minor disseminated fine grained magnetite occurs locally in the host rock, with some of this possibly being primary (maybe igneous titanomagnetite) and some being hydrothermal and related to quartz-magnetite vein emplacement. There are scattered magnetite aggregates up to 3 mm across in the veins, with magnetite being associated with tiny traces (grains <0.1 mm) of chalcopyrite and bornite (Fig. 21). There was also minor local replacement of magnetite by retrograde hematite (Fig. 21).

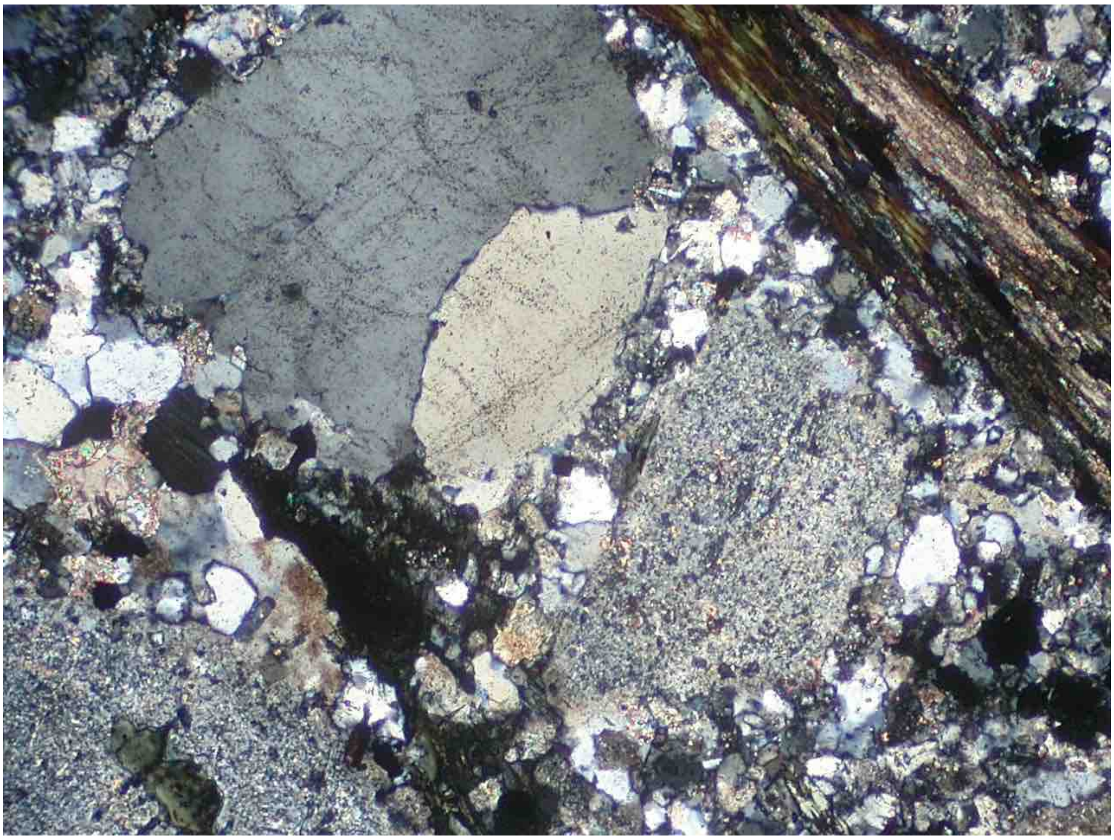

Fig. 20: Porphyritic texture in microtonalite with phenocrysts of quartz, altered hornblende (upper right, now replaced by chlorite and carbonate) and plagioclase (partly replaced by albite and sericite), in a finely inequigranular plagioclase-quartz groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.

Mineral Mode (by volume): plagioclase (includes albite) 45%, quartz 38%, chlorite 10%, magnetite 3%, sericite, carbonate and epidote each 1% and traces of titanite, hematite, apatite, chalcopyrite and bornite.

Interpretation and comment: It is interpreted that the sample represents an altered and veined, strongly porphyritic hornblende microtonalite, The rock contained plagioclase phenocrysts and less common phenocrysts of hornblende and quartz, in a finely inequigranular groundmass, dominated by plagioclase and quartz. There is evidence for minor early alteration and development of albite and magnetite, perhaps coeval with emplacement of prominent quartz-rich veins that host scattered magnetite aggregates and a tiny trace of chalcopyrite and bornite. Pervasive propylitic alteration affects the rock, resulting in moderate to strong development of albite and chlorite, with minor sericite, epidote and carbonate, a trace of hematite, and emplacement of a couple of thin, carbonate-rich veins.

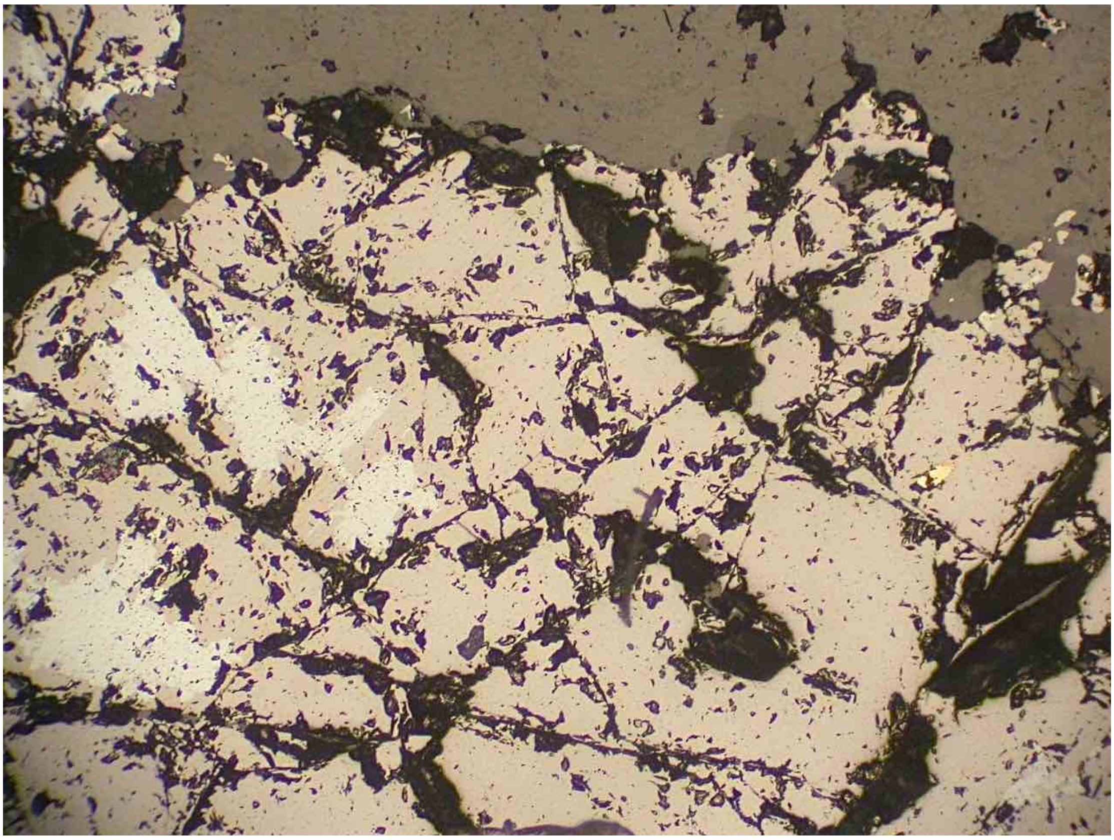

Fig. 21: Magnetite aggregate in vein quartz, with minor replacement of magnetite by hematite (pale bluish-grey at left) and with magnetite containing a tiny composite inclusion of chalcopyrite and bornite (right). Plane polarised reflected light, field of view 1 mm across.

SMD040 325.5 m PTS

Summary: "Skarn-like" metamorphic and slightly mineralised rock, likely derived from a former amygdaloidal mafic igneous (e.g. basaltic) protolith. The presence of scattered quartz (-plagioclase) aggregates that could represent former amygdules is the only vestige of relict texture, with the remainder of the protolith being replaced by dominant fine to medium grained garnet (e.g. andradite-grossular) and plagioclase (perhaps albitic), with a little magnetite. This assemblage was locally overprinted by epidote (± magnetite ± Cu sulphides) in irregular patches and local veins, with the rock subsequently being affected by retrograde alteration forming fine grained carbonate and chlorite. Cu sulphides tend to be associated with epidote and magnetite and include fine grained aggregates and individual grains of chalcocite and bornite, with trace chalcopyrite and digenite.

Handspecimen: The drill core sample is composed of a massive, although rather compositionally heterogeneous metamorphic rock, containing grey to pale brown, and scattered pale yellow-green domains, perhaps reflecting varying proportions of quartz, garnet and epidote respectively (Fig. 22). Sparsely distributed are a few black magnetite aggregates up to 3 mm across and rare aggregates up to 0.5 mm across of a silvery-blue-grey Cu sulphide phase (e.g. chalcocite). A couple of thin sub-planar veins rich in epidote, or in carbonate occur at a low angle to the core axis. The rock does not have a diagnostic relict texture. Testing of the section offcut with sodium cobaltinitrite did not detect any K-feldspar. The sample is strongly magnetic, with susceptibility up to 6540 x 10^{-5} SI, confirming the presence of magnetite.

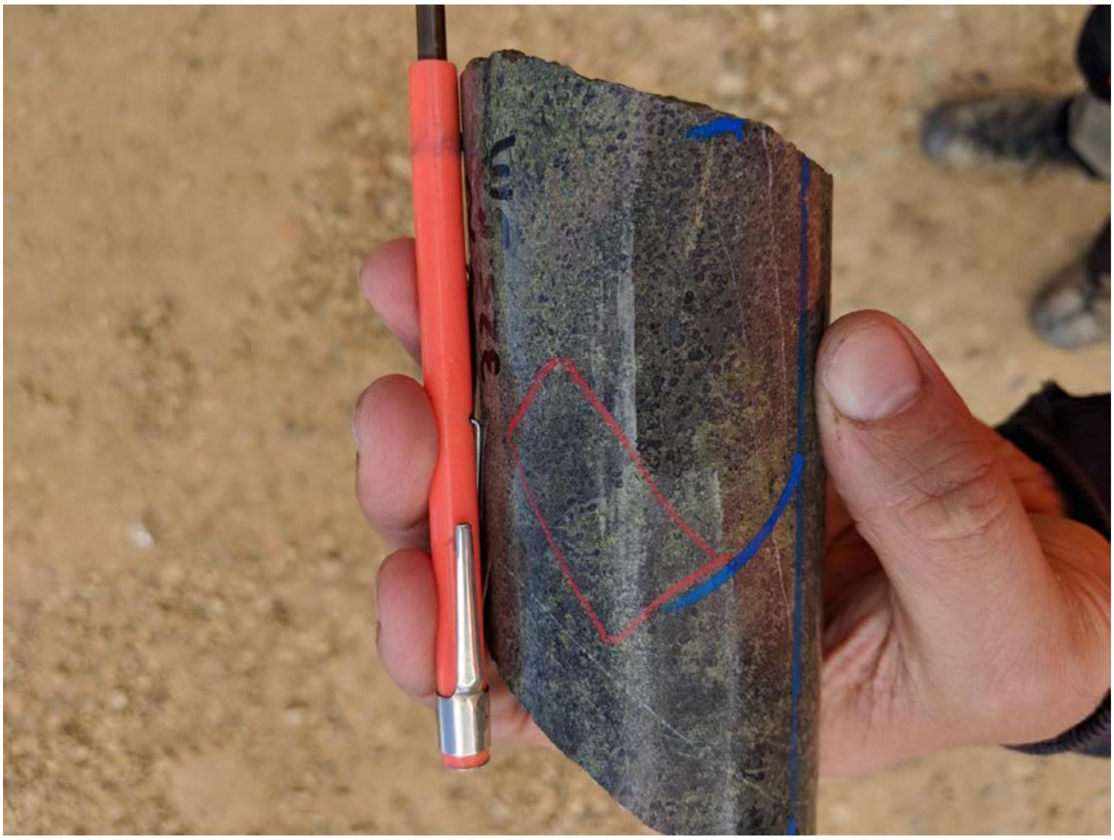

Fig. 22: Drill core sample of "skarn-like" rock derived by metamorphism and probable metasomatism of an originally amygdaloidal basalt. There is an initial assemblage of garnet-plagioclase-quartz, overprinted by epidote, and subsequently by retrograde chlorite and carbonate.

Petrographic description

a) Primary rock characteristics: In the section, unequivocal relict texture from a protolith is not recognised. The rock, however, contains abundantly scattered irregular to spheroidal aggregates, initially of quartz ± minor plagioclase (perhaps albitic), up to a few millimetres across that are speculated to represent former amygdules (Fig. 23). The bulk metamorphic mineral constitution of the remainder of the rock is dominated by garnet (e.g. andradite-grossular) and plagioclase (maybe albite), with minor epidote and magnetite, and considerable retrograde carbonate and chlorite, with this assemblage considered to be consistent with an originally mafic igneous protolith. Perhaps the protolith might have been an amygdaloidal basalt.

b) Alteration and structure: It is interpreted that initial protolith material experienced early alteration, maybe due to diagenesis, followed by medium grade metamorphism and concurrent minor mineralisation. Metamorphism of a possibly earlier altered mafic rock led to development of abundant medium grained quartz and local plagioclase in interpreted amygdules, with these commonly lined by fine to medium grained, pale brown-orange garnet (andradite-grossular), adjacent to abundant domains with varying proportions of garnet and plagioclase, with local aggregates of magnetite (Fig. 23). In places, the garnet-plagioclase assemblage is overprinted by a few aggregates of fine to medium grained epidote (and local magnetite) up to 3 mm across and cut by a few sub-planar veins up to 0.5 mm wide containing one or more of epidote, quartz, magnetite and carbonate, with traces of chalcopyrite and bornite. Also associated with epidote ± magnetite aggregates are small discrete aggregates and disseminated grains of chalcocite and/or bornite, with trace digenite and chalcopyrite (Fig. 24). The skarn-like, mineralised assemblage appears to be overprinted by retrograde alteration, with significant development of fine grained carbonate and chlorite from garnet and plagioclase, as well as overprinting quartz ± plagioclase in apparent amygdules (Fig. 23). Magnetite was also locally retrogressively replaced by hematite.

c) Mineralisation: The sample contains sparse through to locally common aggregates of magnetite up to 2.5 mm across, with this phase also occurring in a couple of discontinuous veins up to 0.5 mm wide. Magnetite was also locally retrogressively replaced by hematite, and is associated with fine grained Cu sulphides (Fig. 24). The latter also occur in epidote aggregates and veins, dominated by chalcocite masses up to 1 mm across, commonly intergrown with bornite (Fig. 24), also associated with a few small grains of chalcopyrite and digenite.

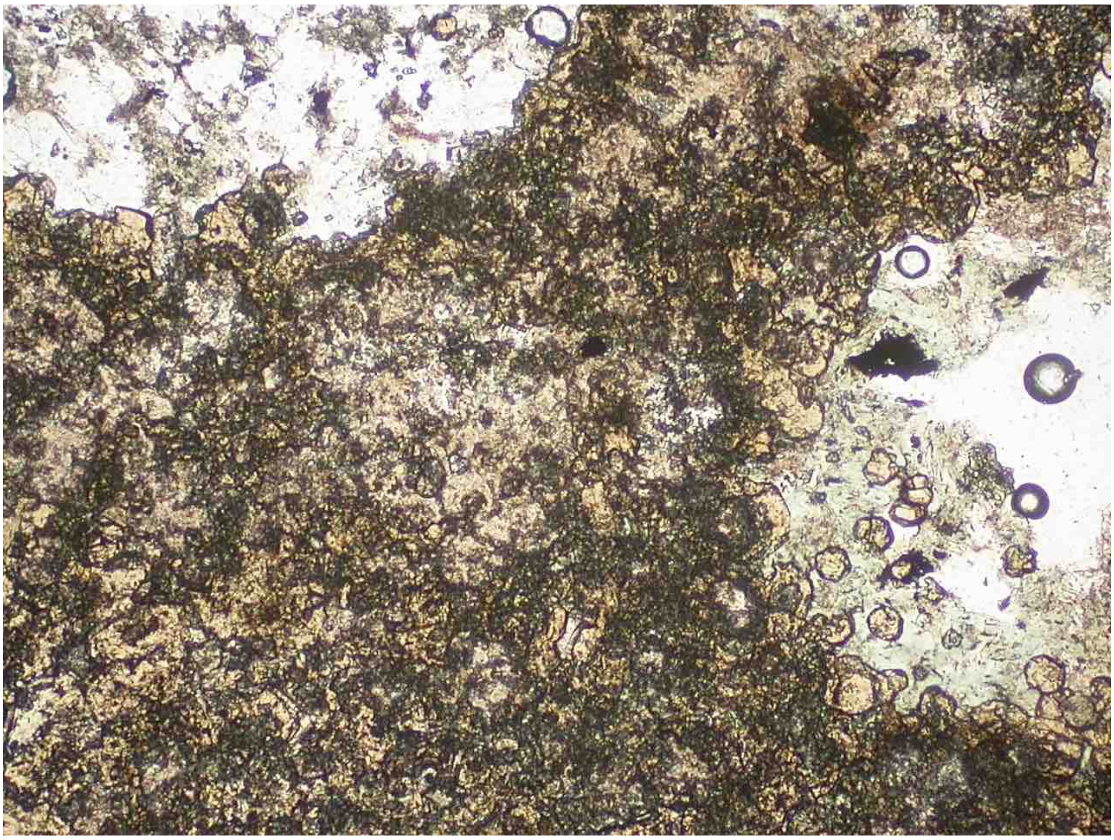

Fig. 23: Quartz-filled possible amygdular aggregates, with a little overprinting pale green chlorite, bordering on to an assemblage with abundant garnet (pale brown) and plagioclase, showing minor retrogression to turbid carbonate and chlorite. Plane polarised transmitted light, field of view 2 mm across.

Mineral Mode (by volume): quartz 35%, garnet (andradite-grossular) 20%, plagioclase (possibly albitic) 15%, carbonate 12%, chlorite 8%, epidote 5%, magnetite 4% and traces of hematite, chalcocite, bornite, chalcopyrite and digenite.

Interpretation and comment: It is interpreted that the sample is a "skarn-like" metamorphic and slightly mineralised rock, probably representing a replacement of an amygdaloidal basaltic protolith. Former amygdules could be represented by scattered quartz (-plagioclase) aggregates, with the remainder of the protolith being replaced by garnet (e.g. andradite-grossular) and plagioclase (perhaps albitic), with a little magnetite. This assemblage was locally overprinted by epidote (± magnetite ± Cu sulphides) in irregular patches and local veins, with the rock subsequently being affected by retrograde alteration forming considerable carbonate and chlorite. Cu sulphides tend to be associated with epidote and magnetite and include fine grained aggregates and individual grains of chalcocite and bornite, with trace chalcopyrite and digenite.

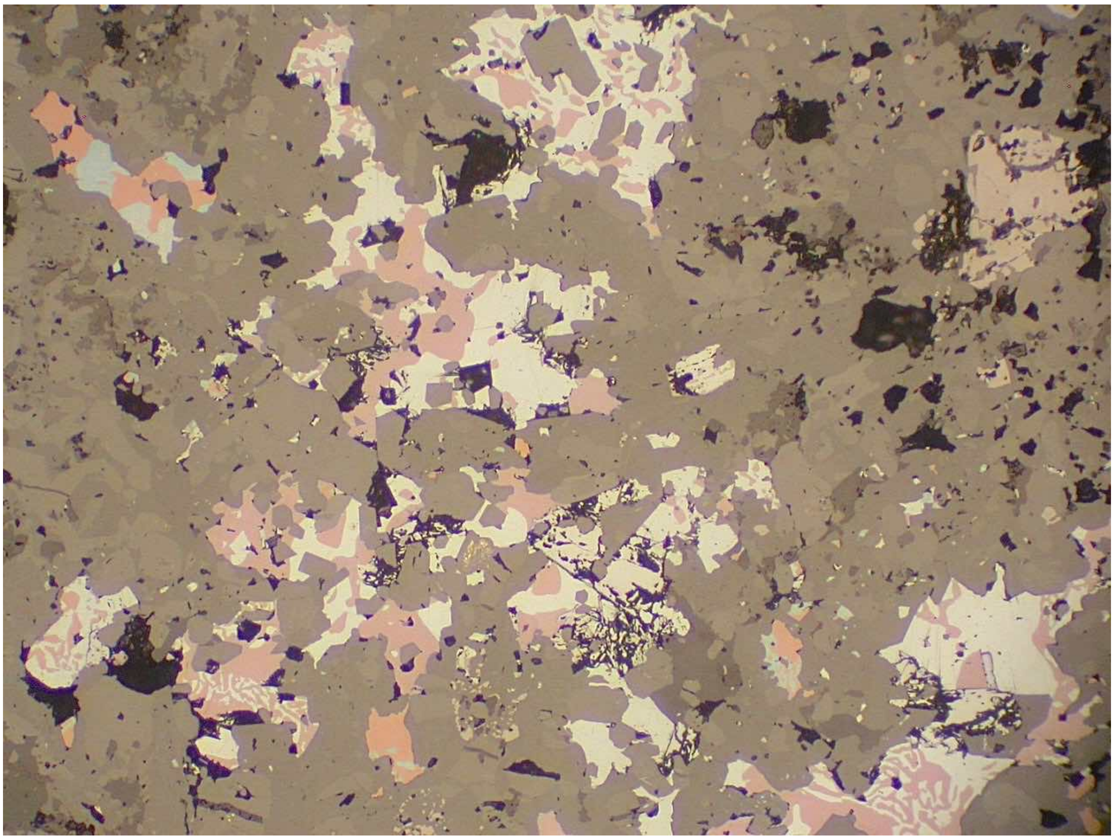

Fig. 24: Intergrowth of fine grained chalcocite (pale bluish-grey) and bornite (pink-orange) with trace digenite (bluish at upper left) in epidote, with a magnetite grain at upper right. Plane polarised reflected light, field of view 1 mm across.

SMD040 427.1 m PTS

Summary: Porphyritic quartz andesite with strong pervasive alteration and emplacement of two vein sets. Relict texture is moderately well preserved, indicating that the rock contained abundant plagioclase phenocrysts and less common ferromagnesian (e.g. hornblende) phenocrysts and a few quartz microphenocrysts, set in a fine grained, locally fluidal texture, plagioclase-rich groundmass. It is possible that early hydrothermal alteration was imposed with development of biotite (e.g. at ferromagnesian sites) plus traces of fine grained chalcopyrite, pyrite and bornite. This alteration could have been related to emplacement of early quartz-rich veining that also could have contained a little biotite and trace chalcopyrite and bornite. Pervasive overprinting propylitic alteration was imposed, with significant replacement of the rock by albite and chlorite, with minor carbonate and sericite, and trace epidote and rutile. The latter alteration was accompanied by carbonate-chlorite veining.

Handspecimen: The drill core sample is composed of an altered and veined, fine grained dark brown-grey to green-grey, porphyritic igneous rock. It contains scattered paler grey feldspar (e.g. plagioclase) phenocrysts up to a few millimetres across in a fine grained, probably feldspathic, groundmass (Fig. 25). Pervasive alteration appears to have produced a minor amount of chlorite and sericite, with rare tiny grains of bornite and chalcopyrite. At least two sets of veining were emplaced, with early, pale grey quartz veins up to 7 mm wide being cut by later, thin carbonate veins (Fig. 25). Veins are commonly at moderate angles to the core axis. Testing of the section offcut with sodium cobaltinitrite did not detect any K-feldspar. The sample is weakly magnetic, with susceptibility up to 80 x 10^{-5} SI.

Fig. 25: Drill core sample of altered porphyritic quartz andesite that has pervasive propylitic alteration, with early quartz-rich veining cut by later thin carbonate-chlorite veins.

Petrographic description

a) Primary rock characteristics: In the section, about 25% of the rock represents vein infill, with the remainder being moderately to strongly altered host rock. The latter has moderately well preserved relict porphyritic texture, with variably altered blocky plagioclase phenocrysts up to several millimetres across, scattered pseudomorphs after former ferromagnesian prismatic phenocrysts up to 3 mm long (e.g. hornblende) and a few quartz microphenocrysts, set in a fine grained, locally fluidal texture groundmass that was evidently rich in plagioclase, plus minor ferromagnesian material, quartz, FeTi oxide and apatite (Fig. 26). The preserved primary characteristics of the rock indicate that it was a porphyritic hornblende-quartz andesite.

b) Alteration and structure: The igneous rock shows pervasive moderate to strong alteration and emplacement of two sets of veining. It is possible that there was an early alteration event that led to formation of a minor amount of hydrothermal biotite (e.g. at former ferromagnesian sites) along with traces of finely disseminated chalcopyrite, pyrite and bornite. This pervasive alteration might be related to the emplacement of a few quartz-rich veins in the rock, with these being up to 7 mm wide and containing fine through to coarse, inequigranular quartz, with traces of chalcopyrite and bornite (Fig. 27). It is likely that minor biotite also occurred in the quartz-rich veins. Subsequently, the rock was affected by pervasive retrograde alteration of propylitic type (Fig. 26). This led to variable replacement of plagioclase by albite and minor sericite and carbonate, and trace epidote. All former ferromagnesian material (including possibly earlier-formed hydrothermal biotite) was replaced by chlorite, with local carbonate and trace epidote and rutile. FeTi oxide was replaced by rutile. Propylitic alteration was accompanied by emplacement of a few sub-planar carbonate-chlorite veins up to 0.4 mm wide, with these also cutting quartz-rich veins (Fig. 27)

c) Mineralisation: The rock contains traces of finely disseminated chalcopyrite, pyrite and bornite, perhaps formed as part of the interpreted early alteration. There are also rare grains of chalcopyrite and bornite in the quartz-rich veining. All sulphide grains are small, mostly <0.3 mm across.

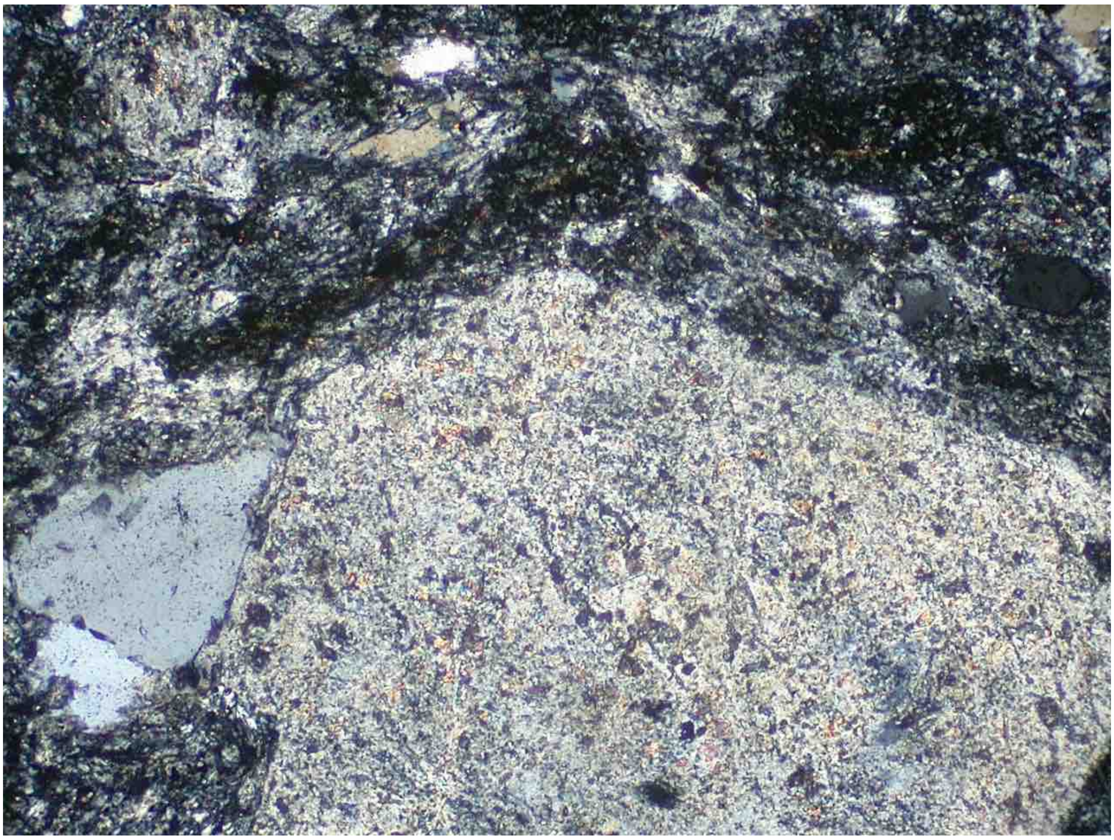

Fig. 26: Relict porphyritic texture, with a large plagioclase phenocryst, replaced by albite and minor sericite, associated with small dark altered hornblende phenocrysts (now mostly chlorite) and a quartz microphenocryst (left) in a slightly fluidal texture, formerly plagioclase-rich groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.

Mineral Mode (by volume): plagioclase (includes albite) 50%, quartz 30%, chlorite 12%, carbonate 5%, sericite 2% and traces of epidote, rutile, apatite, chalcopyrite, pyrite and bornite.

Interpretation and comment: It is interpreted that the sample represents an altered and veined porphyritic quartz andesite. Moderately well preserved relict texture indicates that the rock contained abundant plagioclase phenocrysts and less common ferromagnesian (e.g. hornblende) phenocrysts and a few quartz microphenocrysts, set in a fine grained, locally fluidal texture, plagioclase-rich groundmass. Early hydrothermal alteration could have occurred, with development of biotite (e.g. at ferromagnesian sites) plus traces of chalcopyrite, pyrite and bornite. This alteration may be related to emplacement of early quartz-rich veining containing a little biotite and trace chalcopyrite and bornite. Pervasive overprinting propylitic alteration was imposed, with significant replacement of the rock by albite and chlorite, with minor carbonate and sericite, and trace epidote and rutile. The latter alteration was accompanied by carbonate-chlorite veining.

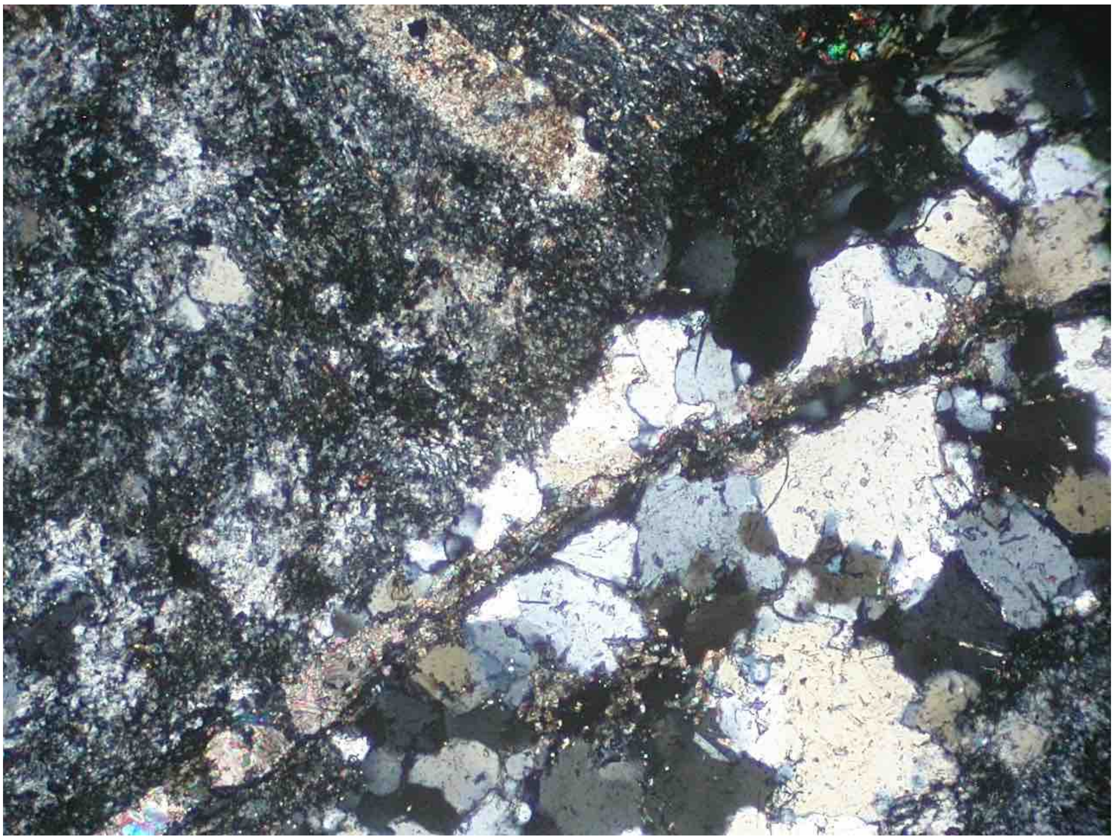

Fig. 27: Altered porphyritic host rock (left), cut by a quartz-rich vein and subsequently by a thin carbonate veins. In the quartz-rich vein, there are dark aggregates containing chlorite, carbonate and epidote that might have replaced earlier biotite. Transmitted light, crossed polarisers, field of view 1 mm across.