PETROGRAPHIC REPORT ON TWENTY DRILL CORE SAMPLES FROM THE THURSDAY'S GOSSAN PROSPECT, WESTERN VICTORIA

For

Stavely Minerals

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Introduction

A suite of twenty drill core samples from the Thursday's Gossan prospect in the Cambrian age Stavely Belt in western Victoria was submitted for petrographic preparation, description and interpretation. Samples were from drill holes SMD013 (5 samples), SMD014 (1 sample), SMD015 (12 samples) and STRC019D (2 samples) and were from downhole depths ranging from 138 m to 497 m. Most samples were fresh, but it is possible that deep supergene alteration effects could have been imposed on some sulphide-rich rocks (e.g. from STRC019D). Brief drill core descriptions, handspecimen photos and comprehensive geochemical assay data for sample intervals were also provided.

Petrographic sections were prepared at Australian Petrographics Pty Ltd in Queanbeyan, with 17 polished thin sections (PTS) and 3 standard thin sections (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.

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:

<u>**SMD013 325.5 m PTS**</u>

<u>Summary</u>: Porphyritic quartz microdiorite showing strong propylitic alteration and an intense chlorite-altered zone associated with major veining. Relict texture is poorly to moderately preserved, but it is apparent that the rock originally had scattered feldspar (e.g. plagioclase) and ferromagnesian (e.g. hornblende) phenocrysts in a fine to medium grained groundmass of feldspar, ferromagnesian material and minor quartz. A major vein cuts the rock, containing chalcopyrite, pyrite and quartz, and it is bounded by an alteration selvedge rich in chlorite, with a little pyrite, chalcopyrite and rutile. This zone merges into an enclosing alteration zone of fine grained sericite, chlorite and quartz, with minor pyrite and trace rutile, and which hosts a few thin veins of quartz, pyrite and chlorite.

<u>**SMD013 330.8 m PTS**</u>

<u>Summary</u>: Porphyritic microtonalite or dacite with strong pervasive propylitic alteration and a few large aggregates of pyrite ± chalcopyrite. Relict texture is moderately preserved, with scattered altered plagioclase phenocrysts and pseudomorphs after a prismatic ferromagnesian phase (e.g. hornblende). There are also a few altered microphenocrysts of FeTi oxide and rare quartz, all enclosed in a former rather fine grained quartzofeldspathic groundmass. Imposed alteration caused initial albitisation of plagioclase phenocrysts, but with further replacement by abundant sericite and a little carbonate, quartz and trace chalcopyrite. Ferromagnesian material was replaced largely by chlorite and at these sites and former FeTi oxide locations, there is minor rutile along with traces of pyrite and chalcopyrite. The

groundmass was replaced by abundant inequigranular quartz, with subordinate sericite, minor chlorite and pyrite. Scattered sparsely in the groundmass are a few large pyrite masses, with some also being associated with chalcopyrite, quartz and chlorite.

SMD013 361.0 m PTS

Summary: Porphyritic microtonalite, gradational to quartz microdiorite, showing moderate preservation of relict texture, but having strong pervasive propylitic alteration and associated veining. The rock originally contained scattered plagioclase and a few ferromagnesian (e.g. hornblende) phenocrysts, in a generally medium grained groundmass of plagioclase, ferromagnesians (hornblende, biotite), with minor interstitial quartz and a little K-feldspar. Imposed alteration caused albitisation of plagioclase and further replacement by sericite and carbonate. Ferromagnesian material was replaced by chlorite, with local epidote and carbonate, pyrite and trace chalcopyrite, sphalerite and rutile. A major vein was emplaced, associated with a chlorite-rich alteration selvedge. The vein contains medium to coarse grained carbonate (calcite) abundant pyrite, minor chlorite, a little epidote and traces of chalcopyrite and sphalerite.

SMD013 412.8 m PTS

Summary: Quartz-galena-dominated vein, containing a few apparent fragments of intensely hydrothermally altered host rock. The latter have no recognised relict characteristics due to alteration and local micro-cataclasis and are now composed of fine to medium grained quartz and pyrite, with fine grained sericite, a little carbonate and traces of galena and rutile. Much of the sample is vein-dominated, with medium to coarse quartz hosting large interstitial masses of galena, and minor carbonate. In places, quartz hosts minor aggregates of pyrite and a trace of chalcopyrite, and within galena-rich masses, there are a few grains of Fe-poor sphalerite and fine grained pyrite. No discrete Ag-rich phase was observed.

SMD013 497.0 m TS

Summary: Massive porphyritic dacite, with moderate to strong and pervasive propylitic alteration. The rock contained abundant blocky plagioclase phenocrysts, scattered small prismatic ferromagnesian phenocrysts (probably mostly hornblende), rare quartz and a few microphenocrysts of apatite and FeTi oxide, all enclosed in a holocrystalline, fine grained quartzofeldspathic groundmass. The latter probably had plagioclase > K-feldspar and quartz. Imposed alteration caused albitisation of plagioclase and ferromagnesian material was altered to chlorite, with minor other alteration phases including epidote, prehnite, sericite, quartz and traces of actinolite, leucoxene and hematite. A few thin, discontinuous veins of albite ± quartz ± prehnite occur.

SMD014 219.5 m PTS

Summary: Porphyritic microtonalite, with indications of initial hydrothermal biotite development with subsequently imposed strong retrograde alteration of propylitic type and associated veining. The rock has moderately well preserved relict texture, with scattered blocky plagioclase phenocrysts (now altered) and pseudomorphs after possible hornblende phenocrysts, in a fine to medium grained groundmass that was probably rich in plagioclase and quartz, with minor K-feldspar, ferromagnesian material, a little FeTi oxide and trace apatite. It appears that minor hydrothermal biotite ± a little chalcopyrite developed from replacement of igneous ferromagnesian material. Later-imposed retrograde alteration caused replacement of hydrothermal biotite and any residual igneous ferromagnesian material by chlorite ± chalcopyrite and rutile. Plagioclase is largely albitised, with minor to abundant sericite development, plus minor chlorite and trace chalcopyrite. FeTi oxide was replaced by rutile and chlorite, with a little chalcopyrite. Several veins were emplaced, possibly with an early quartz-rich vein, followed by an array of veins including thin quartz-rich types, thin sericite ± chlorite ± chalcopyrite, and more prominent pyrite-quartz-chlorite ± chalcopyrite, with associated sericite (-chlorite-chalcopyrite) alteration selvedges.

SMD015 138.0 m PTS

Summary: Strongly altered and veined (tending to hydrothermal breccia) porphyritic dacite. The rock originally contained scattered phenocrysts of plagioclase and prismatic ferromagnesian material (e.g. hornblende) and a few smaller grains of quartz, in a fine grained granular quartzofeldspathic groundmass. The rock was cut by abundant network veining of quartz, with minor associated chlorite, magnetite and trace pyrite and chalcopyrite, and subsequently by a few thin chlorite (-sericite) veins. Pervasive alteration is of propylitic type and resulted in considerable replacement of phenocrystal and groundmass feldspar by albite, variable sericite and minor chlorite, with all ferromagnesian material being chloritised. Adjacent to the veins, the host rock also contains a little magnetite and traces of chalcopyrite and pyrite.

SMD015 162.6 m PTS

Summary: Porphyritic microtonalite, transitional to dacite, showing well preserved relict texture, and having moderate to strongly hydrothermal alteration and abundant veining by quartz (-magnetite-chlorite). The rock retains plagioclase phenocrysts, although these are partly altered, and original hornblende prisms are completely altered. The phenocrystal phases occurred in a finely inequigranular groundmass of plagioclase and quartz, with minor K-feldspar and altered ferromagnesian material. Veining is locally intersecting and is dominated by fine to medium grained quartz, with minor chlorite, irregularly distributed magnetite and a tiny trace of chalcopyrite and pyrite. About the veins, minor K-feldspar and magnetite developed, but most alteration in the rock is of retrograde, propylitic type, with albite, sericite and trace chlorite and epidote developed from plagioclase, and chlorite (-magnetite-rutile) from ferromagnesian material. A few thin chlorite veins cut the earlier quartz-rich veins.

SMD015 168.25 m PTS

Summary: Strongly hydrothermally altered porphyritic dacite, with a few veins that locally contain chalcopyrite and pyrite. The rock retains partly altered plagioclase phenocrysts and a few relict quartz phenocrysts. Former small grains of ferromagnesian material (e.g. hornblende) and FeTi oxide are completely altered and the original fine grained groundmass (probably containing plagioclase, alkali feldspar and quartz) was strongly altered. The alteration assemblage is dominated by fine grained sericite, with minor clay, albite and quartz (e.g. in groundmass), with traces of rutile, pyrite and chalcopyrite. In part of the sample, there is veining by quartz, sericite, pyrite and chalcopyrite, as well as scattered aggregates of pyrite and/or chalcopyrite. One chalcopyrite aggregate shows trace development of digenite and bornite (maybe a deep supergene alteration process).

SMD015 168.8 m TS

Summary: Massive porphyritic dacite with moderate to strong alteration of transitional propylitic to argillic type. The rock has well preserved relict texture and there is some preservation of plagioclase and quartz phenocrysts. Smaller phenocrystal grains of ferromagnesian material (e.g. prismatic hornblende) and FeTi oxide are completely altered. The fine grained groundmass was originally plagioclase-rich, with minor quartz, alkali feldspar and ferromagnesian material. Imposed alteration led to some albitisation of plagioclase, but also replacement by sericite and clay (e.g. kaolinite), with ferromagnesian material being replaced largely by chlorite and minor clay, and FeTi oxide by leucoxene-rutile. A few thin discontinuous veins of sericite and/or clay occur in the altered rock.

<u>SMD015 194.9 m PTS</u>

<u>Summary</u>: Strongly altered porphyritic andesite, with several veins. Due to imposed alteration, relict texture is poorly preserved, but it is likely that the rock originally contained scattered feldspar (e.g. plagioclase) phenocrysts as well as a ferromagnesian phase, enclosed in a fine grained groundmass. The rock experienced pervasive argillic-propylitic alteration, with replacement by fine grained chlorite, a clay phase (e.g. kaolinite), minor quartz, rutile and pyrite, and trace chalcopyrite. A paragenetically early array of intersecting quartz-rich veins was emplaced, with these also containing a little chlorite and trace pyrite and chalcopyrite, and the rock was later cut by pyrite-rich veining, with associated clay, chlorite, sericite and quartz, and having sericitic alteration selvedges.

<u>SMD015 196.6 m PTS</u>

<u>Summary</u>: Massive sulphide material, showing crude banding and composed largely of pyrite and chalcopyrite, with subordinate amounts of bornite, quartz and sericite. No relict texture after a protolith is recognised and the rock could be the product of complete hydrothermal replacement, or represent hydrothermal infill. Sulphides are intergrown with, and enclose irregular to elongate masses of fine to medium grained quartz, fine grained sericite and a trace of anhydrite. Abundant pyrite is paragenetically early and invaded by abundant chalcopyrite and associated bornite. Within chalcopyrite-bornite domains, there are uncommon small grains of galena, chalcocite and ?wittichenite.

<u>SMD015 198.0 m PTS</u>

<u>Summary</u>: Very strongly hydrothermally altered porphyritic dacite, containing probably two vein sets, one of which hosts abundant bornite. The rock has moderate preservation of primary texture, indicating that it contained scattered phenocrysts of feldspar (e.g. plagioclase), quartz and a prismatic ferromagnesian phase (e.g. hornblende) in a fine grained quartzofeldspathic groundmass. Phyllic alteration was imposed, with an assemblage of fine grained sericite and quartz, with minor pyrite, a little bornite and traces of rutile, chalcopyrite, chalcocite and digenite being formed. A couple of early sub-planar veins were emplaced, with these being quartz-rich and containing minor pyrite and trace bornite. These veins were cut by later veining with local extensional growth textures, containing quartz, bornite and pyrite, with local chalcocite and trace digenite and chalcopyrite. Textures in the Cu sulphides indicate that they are paragenetically later than pyrite and that they could be largely due to hypogene processes.

<u>SMD015 204.1 m PTS</u>

<u>Summary</u>: Strongly hydrothermally altered, porphyritic andesite, cut by a few quartz-sulphide veins. There is moderate preservation of primary texture, indicating that the original rock contained rather sparse phenocrysts of feldspar (e.g. plagioclase) and ferromagnesian material (e.g. hornblende, pyroxene) in a fine grained groundmass of feldspar and subordinate ferromagnesian material, a little FeTi oxide and possible quartz. Pervasive alteration is of transitional phyllic-propylitic type, with replacement by abundant sericite, subordinate quartz and chlorite, a little rutile, pyrite and chalcopyrite. Veining is dominated by quartz and pyrite, but there are zones with significant chlorite (in part as immediate alteration selvedges) and chalcopyrite (interstitial to pyrite and quartz).

<u>SMD015 240.0 m TS</u>

<u>Summary</u>: Fine to medium grained massive dolerite, with overprinting strong propylitic alteration (or simply the effects of low grade metamorphism). Original texture is moderately preserved suggesting that the rock formerly contained abundant plagioclase, intergrown with a subordinate amount of ferromagnesian material and a little FeTi oxide. There were also a few small amygdules. The alteration assemblage is dominated by albite (replacing original

plagioclase) and chlorite. Initially, it appears that a minor amount of acicular amphibole (e.g. tremolite-actinolite) developed, but it was mostly replaced by chlorite and sericite. Minor disseminated epidote, quartz, a little leucoxene-rutile and trace hematite occur throughout. The altered rock is cut by a couple of veins of epidote and/or chalcedonic quartz.

SMD015 249.0 m PTS

Summary: Strongly hydrothermally altered porphyritic microdiorite. Due to alteration, relict texture is poorly to moderately preserved, but it is likely that the rock originally contained phenocrysts of feldspar (e.g. plagioclase) and a prismatic ferromagnesian phase (e.g. hornblende) and a few microphenocrysts of FeTi oxide, enclosed in a fine to medium grained groundmass of feldspar, ferromagnesian material and a little FeTi oxide and apatite. Pervasive alteration is of phyllic type, with replacement of the rock by abundant fine grained sericite, subordinate quartz, minor pyrite, a little rutile and trace chalcopyrite. A single thin quartz vein occurs, but in the handspecimen, minor quartz-pyrite veining is more prevalent.

SMD015 254.9 m PTS

Summary: Strongly mineralised hydrothermal breccia containing scattered intensely altered fragments and a matrix that is rich in sulphides and quartz. The rock has a matrix-supported texture, with fragments locally retaining possible relict porphyritic texture. The protolith is speculated to have been of andesite, but was replaced by abundant quartz, subordinate sericite and pyrite, a little bornite and chalcocite, and traces of rutile and apatite. In the breccia matrix, fine to medium grained quartz is intergrown with abundant sulphides and traces of sericite and anhydrite. In the sulphide aggregates, pyrite is paragenetically early and enclosed and replaced by bornite and chalcocite.

SMD015 335.8 m PTS

Summary: Strongly hydrothermally altered porphyritic microgranodiorite or dacite, with moderate preservation of original texture. Plagioclase phenocrysts were initially albitised, but later largely replaced by sericite, minor quartz and chlorite, and small amounts of sulphides. There are a few relict quartz phenocrysts, and a few pseudomorphs after former small ferromagnesian phenocrysts, that were originally set in a finely inequigranular quartzofeldspathic groundmass. Chlorite, quartz and sericite also formed at ferromagnesian sites and in the groundmass and sparsely disseminated sulphides (mostly occurring at former feldspar sites) are mostly pyrite and chalcopyrite, with a little Fe-poor sphalerite and a tiny trace of galena.

STRC019D 151.5 m PTS

Summary: Hydrothermal quartz-sulphide rock, representing the product of complete hydrothermal replacement of a protolith whose original nature is obscure, and/or representing hydrothermal infill. There is an intercalation of fine to medium grained quartz-rich domains, with sulphide-rich domains. A few aggregates of fine grained sericite occur in the quartz zones and these also have scattered irregular voids, in part lined by crystalline quartz. Pyrite is the dominant sulphide, locally semi-massive to massive and containing small inclusions of chalcopyrite and rare bornite and anhydrite. A little chalcopyrite also occurred interstitial to pyrite and hosted in quartz. The rock contains extensive chalcocite, apparently replacive towards chalcopyrite and pyrite. It is possible that chalcocite represents a deep supergene alteration product.

STRC019D 152.9 m PTS

Summary: Hydrothermal quartz-hematite rock, with minor disseminated sulphides and a little carbonate, representing the product of intense alteration of a former ultramafic protolith. Evidence for the latter is manifest in the presence of sparsely scattered relict chromite grains.

The protolith was replaced by abundant fine to medium grained quartz, characteristically with textures typical of formation in the epithermal environment, and patchily abundant disseminations and aggregates of fine grained acicular to prismatic hematite. Disseminated pyrite is relatively common hosted in quartz and hematite, and there is a little chalcopyrite, although it is commonly replaced by chalcocite. Local paragenetically later carbonate infill and narrow veins occur, with carbonate intergrown with chalcocite in places. It is possible that chalcocite represents a deep supergene alteration phase.

Interpretation and comment

The sample suite consists largely of felsic to intermediate, porphyritic igneous rocks that have experienced moderate through to intense hydrothermal alteration, with associated veining and sulphide mineralisation. A few samples do not accord with this generalisation, having mafic and ultramafic protoliths, as well as some in which no protolith material is recognised, e.g. due to the intensity of alteration or that the rock represents hydrothermal infill. Several of the samples are sulphide-rich and contain significant Cu mineralisation.

Primary rock types

The identification of primary rock types in the sample suite is based on the occurrence of diagnostic relict textures, the presence of relict igneous minerals, and in some examples, the use of geochemical signatures based on "immobile trace element" constitution. Several samples are classified as porphyritic dacite, grading into porphyritic microtonalite or microgranodiorite, depending on the grainsize of the groundmass component. There is also an evident gradation into porphyritic quartz microdiorite or microdiorite. Each of these interpreted rock types typically had plagioclase and ferromagnesian phenocrysts, with some also having quartz phenocrysts, and microphenocrysts of FeTi oxide. Although all ferromagnesian material is altered (in all samples), relict shapes of pseudomorphs infer that hornblende was the typical (and in most cases, the only) ferromagnesian phase. Dacites had a fine grained groundmass and the others in this group had slightly coarser groundmasses (but never more than a grainsize of ~0.2-0.5 mm), with this component probably being dominated by plagioclase, minor to abundant quartz, minor K-feldspar and ferromagnesian material, a little FeTi oxide and trace apatite.

Three samples (SMD015/194.9 m, SMD015/204.1 m, SMD015/254.9 m) are interpreted to have had andesitic protoliths. These were less strongly porphyritic compared to the group described above and had characteristically larger values of "mafic" immobile trace elements Ti, V, Cr and Ni. One sample (SMD015/240.0 m) is interpreted as a former dolerite, based on relict texture and trace element constitution, and sample STRC019D/152.9 m evidently had an ultramafic precursor, based on the presence of a little relict chromite and high values of Cr, Ni and Co. In a few samples, the nature of the protolith was completely obscured by the intensity of alteration or that much/all of the rocks was composed of hydrothermal infill (e.g. dominated by sulphides ± quartz). In this category are SMD013/412.8 m, SMD015/196.6 m and STRC019D/151.5 m.

Most of the felsic to intermediate composition igneous rocks could represent former shallow crustal level (sub-volcanic) intrusives, although the possible andesitic rocks could have been volcanics. The interpreted primary mineralogy suggests that this group of rocks were of I-type character and probably of relatively low-K, calc-alkaline affinity.

Hydrothermal alteration

There is a significant diversity of imposed hydrothermal alteration effects in the sample suite. Possible early, higher temperature potassic alteration is essentially not recognised, but there is some indication that hydrothermal biotite (and trace chalcopyrite) could have initially developed in SMD014/214.5 m, but was later retrogressed, and that minor K-feldspar + magnetite developed about early quartz-rich veining in SMD015/162.6 m. The main alteration types observed are phyllic through to propylitic, with some transition to argillic type. There are also assemblages that are sulphide-, quartz- and hematite-rich. Strong phyllic alteration is recognised in SMD013/412.8 m, SMD015/198.0 m, SMD015/249.0 m and in hydrothermal breccia fragments in SMD015/254.5 m. This type of alteration has replacement by sericite, quartz and pyrite, with varying amounts of other sulphides (e.g. chalcopyrite, bornite, chalcocite, galena) and trace rutile. There is transitional phyllic-argillic alteration in SMD015/168.25 m (incoming of kaolinite), a transition to silicic alteration in possible protolith remnants in STRC019D/151.5 m, and a transition to propylitic alteration in SMD015/204.1 m and SMD015/335.8 m (incoming of chlorite and local retention of albite). Propylitic alteration is commonly expressed in the suite. It has probably been imposed on earlier potassic alteration in SMD014/219.5 m and SMD015/162.6 m, but in other samples appears to have been directly imposed on the igneous precursors (e.g. SMD013/325.5 m, SMD013/330.8 m, SMD013/361.0 m, SMD013/497.0 m, SMD015/138.0 m, SMD015/240.0 m). Propylitic assemblages typically have two or more of chlorite, albite, sericite, carbonate, with local epidote, actinolite, prehnite, pyrite, leucoxene-rutile, chalcopyrite and hematite. In the altered dolerite sample SMD015/240.0 m, the apparent propylitic assemblage could have simply been formed by imposition of lower greenschist facies metamorphism. There is interpreted transitional propylitic-argillic alteration in SMD015/168.8 m and SMD015/194.9 m, with a clay phase (kaolinite) accompanying the typical propylitic alteration phases. Sulphide-and/or quartz-dominated assemblages occur in SMD015/196.6 m and STRC019D/151.5 m, but these could be largely hydrothermal infill as well as products of complete replacement. In STRC019D/152.9 m, the ultramafic protolith was replaced by an "epithermal texture" quartz-hematite assemblage, with minor sulphides and carbonate.

Several metre length intervals from where samples were obtained appear to contain geochemically high (anomalous) P contents (1770-4900 ppm P). In part, these higher values could relate to the primary rock type (e.g. interpreted andesite, dolerite, microdiorite) and/or to residual enrichment of P during strong hydrothermal alteration, e.g. phyllic type in SMD015/249.0 m and SMD015/254.0. Traces of apatite were recognised in some high-P samples, but no aluminium-phosphate-sulphate (APS) phases were found.

Vein and hydrothermal breccia fillings

Veins occur in most samples in the suite and in a few samples (SMD013/412.8 m, SMD015/196.6 m, STRC019D/151.5 m) much/all of each could be largely hydrothermal infill. The protolith in SMD015/254.9 m underwent hydrothermal brecciation with infill by quartz and sulphides. The majority of prominent veins (commonly sub-planar and up to several millimetres wide) range from sulphide-rich to quartz-rich, with abundant calcite occurring in one vein (in SMD013/361.0 m), with local occurrence of sericite and chlorite. Sulphide assemblages include pyrite and chalcopyrite most commonly, but there are also those with pyrite, chalcopyrite and/or bornite and/or chalcocite (e.g. SMD015/196.6 m, SMD015/198.0 m, STRC019D/151.5 m) and abundant galena (SMD013/412.8 m). Quartz-rich veins occur in several samples (e.g. SMD014/219.5 m, SMD015/194.9 m, STRC019D/192.5 m) and in SMD015/138.0 m and SMD015/162.6 m, quartz-rich veining also contains minor magnetite as well as small amounts of pyrite, chalcopyrite and chlorite. Traces of anhydrite are observed in a couple of sulphide-rich infill assemblages. The apparent breccia-fill assemblage in SMD015/254.9 m is dominated by quartz, pyrite, bornite and chalcocite, with a little sericite and trace anhydrite.

Paragenetically later veining occurs in several samples, with these veins being mostly narrow and cutting earlier quartz/sulphide veins and associated alteration assemblages. Later veining has phases including chlorite, quartz, carbonate, pyrite and rare occurrences of albite, epidote and prehnite.

Mineralisation

The majority of samples in the suite contain sulphides, ranging from traces, through to several percent, and into sulphide-rich rocks. Only a few samples appear to be devoid of sulphides (SMD013/497.0 m, SMD015/168.8 m, SMD015/240.0 m). There are also a couple of samples with a few % magnetite that only contain traces of pyrite and chalcopyrite (SMD015/138.0 m, SMD015/162.6 m). Pyrite and chalcopyrite are the most commonly observed sulphides (not always the most abundant), with bornite, chalcocite and galena being abundant in a few. Large quantities of sulphides (e.g. tens of %) are restricted to those samples that are either constituted largely by vein or breccia fill material, or represent products of complete hydrothermal replacement. These include SMD013/412.8 m (25% galena, 6% pyrite), SMD015/196.6 m (35% each of pyrite and chalcopyrite, 10% bornite), SMD015/254.9 m (18% chalcocite, 15% pyrite, 12% bornite) and STRC019D/151.5 m (40% pyrite, 12% chalcocite, 1% chalcopyrite). Many other samples contain a few % up to 15-20% sulphides (pyrite, chalcopyrite, bornite typically), with these occurrences being hosted in veins and as part of the pervasive alteration assemblages.

Pyrite is typically a paragenetically early phase; where occurring with other sulphides (chalcopyrite, bornite, chalcocite, galena) it is typically enclosed by, and in places, replaced by, the latter phases. Chalcopyrite and bornite where occurring together are mostly in equilibrium relationships, although locally chalcopyrite could replace bornite. Chalcocite occurs in a few samples in SMD015 where it appears to be a hypogene phase in equilibrium with bornite. It also occurs in the two samples from STRC019D, but in these it has textural relations indicating replacement of chalcopyrite and pyrite. Given the relatively shallow downhole depths of these two samples, it is possible that chalcocite could represent a deep supergene alteration product. A trace of a phase resembling wittichenite (Cu_3BiS_3) occurs with bornite and chalcopyrite in SMD015/196.6 m and this sample also has a trace of galena. Apart from the abundant galena in the vein assemblage in SMD013/412.8 m, the only other observation of galena is in SMD015/335.8 m, in association with a little pyrite, chalcopyrite and sphalerite. Traces of sphalerite were also noted in SMD013/361.0 m and SMD013/412.8 m. No discrete precious metal phase was observed (e.g. gold, electrum, Ag-rich phases) despite locally relatively high Au and Ag assay values. Ag could occur in phases such as chalcocite and galena. No molybdenite was observed in the sample suite, consistent with the low Mo values in assay data.

Sample STRC019D/152.9 m is distinctive in containing a substantial amount of finely acicular to prismatic, fine grained hematite as part of the intense alteration of an ultramafic protolith. This rock also contains a little relict chromite from the protolith, and as part of the hypogene alteration, minor pyrite and a little chalcopyrite.

General comment

The felsic to intermediate composition porphyritic igneous rocks, imposed hydrothermal alteration, veining and local hydrothermal brecciation characteristics appear to be consistent with the sample suite being derived from a mineralised porphyry Cu system. Sulphide-rich, high-Cu intervals are probably structurally controlled and have some affinities with oxidised, high-sulphidation systems (e.g. occurrence of assemblages of bornite-pyrite-hypogene chalcocite, and locally, hematite). However, no advanced argillic alteration is recognised in association. Similarly, there is little (preserved) indication of an early, potassic alteration phase, with the majority of alteration and related veining occurring at the retrograde stage (e.g. phyllic to propylitic alteration).

Individual sample descriptions

SMD013 325.5 m PTS

Summary: Porphyritic quartz microdiorite showing strong propylitic alteration and an intense chlorite-altered zone associated with major veining. Relict texture is poorly to moderately preserved, but it is apparent that the rock originally had scattered feldspar (e.g. plagioclase) and ferromagnesian (e.g. hornblende) phenocrysts in a fine to medium grained groundmass of feldspar, ferromagnesian material and minor quartz. A major vein cuts the rock, containing chalcopyrite, pyrite and quartz, and it is bounded by an alteration selvedge rich in chlorite, with a little pyrite, chalcopyrite and rutile. This zone merges into an enclosing alteration zone of fine grained sericite, chlorite and quartz, with minor pyrite and trace rutile, and which hosts a few thin veins of quartz, pyrite and chlorite.

Handspecimen: The drill core sample is composed of a strongly altered, dark grey-green, fine to medium grained igneous rock, perhaps of intermediate composition, and cut by several sub-planar to irregular veins up to a few millimetres wide that are at varying angles to the core axis (Fig. 1). The rock appears to have relict porphyritic texture, with a few chloritised ferromagnesian phenocryst sites up to 2.5 mm across. The original rock probably contained abundant feldspar and ferromagnesian material, but has been strongly replaced by chlorite, quartz, possible sericite, and minor disseminated pyrite. About a major vein, there is a dark zone of intense chlorite alteration up to several millimetres wide (Fig. 1). Veins contain pyrite, chalcopyrite and quartz, and are up to 2-3 mm wide (Fig. 1). The sample is very weakly magnetic, with susceptibility up to 30 x 10^{-5} SI.

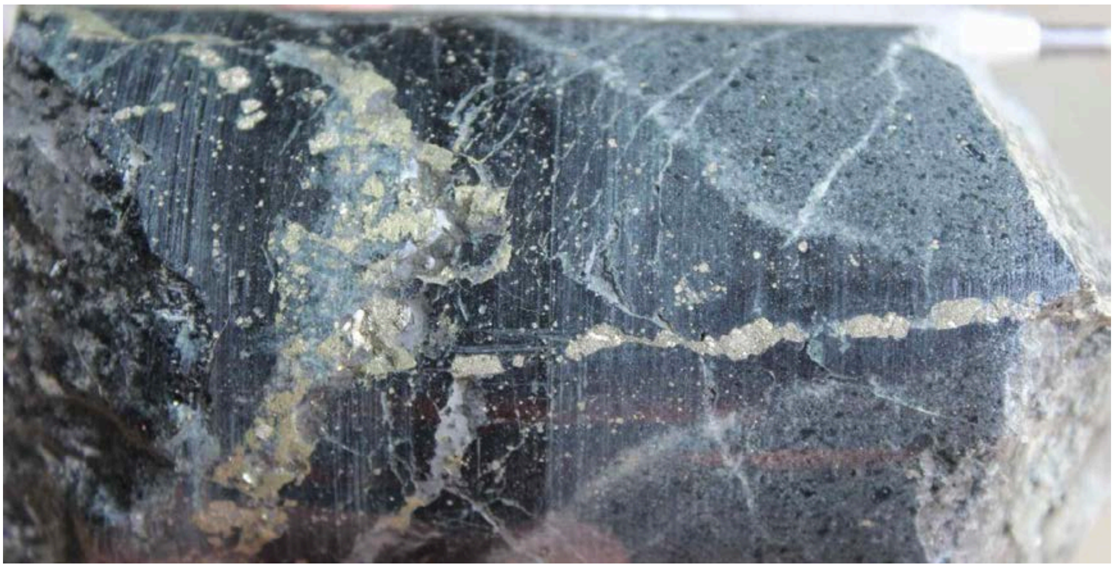

Fig. 1: Drill core sample showing sulphide-quartz veins associated with dark greenish-black chlorite alteration and adjacent zones (right) of paler alteration (sericite-chlorite-quartz) in which relict texture is partly preserved.

Petrographic description

a) Primary rock characteristics: In the section, approximately two-thirds of the sample has some preservation of relict porphyritic texture (albeit only poor to moderate preservation), with the remainder having had complete textural and mineralogical destruction. The latter zone is associated with a major vein. Away from this vein it is apparent that the rock originally contained scattered blocky feldspar (e.g. plagioclase) phenocrysts up to 2 mm across and ferromagnesian phenocrysts (e.g. hornblende) up to 3 mm long (but mostly <1 mm) set in a fine to medium grained groundmass consisting of feldspar, ferromagnesian material, minor quartz and trace FeTi oxide (Fig. 2). From the preserved primary characteristics, the rock is interpreted as an altered porphyritic quartz microdiorite.

b) Alteration and structure: The original igneous rock was subject to strong and locally intense hydrothermal alteration, leading to significant textural destruction. The alteration is feldspar-destructive and away from the major vein is characterised by fine grained sericite, subordinate chlorite (e.g. replacing ferromagnesian material), minor quartz, disseminated pyrite and trace rutile (Fig. 2). This alteration is considered to be of strong propylitic type and it merges over a couple of millimetres into an intense chlorite-alteration zone about the major vein. The latter alteration zone is up to ~5 mm wide and contains abundant pale green chlorite, with a little pyrite, fine grained rutile, a couple of aggregates of chalcopyrite and trace quartz and apatite. The enclosed vein is up to 2 mm wide, sub-planar and contains medium to coarse grained chalcopyrite and pyrite, with subordinate quartz and trace sericite and apatite (Fig. 3). In the sericite-chlorite-quartz alteration domains, there are also a few sub-planar veins, up to 1 mm wide and containing quartz, pyrite and minor chlorite.

c) Mineralisation: In the sericite-chlorite-quartz alteration domains, there are sparsely distributed pyrite grains up to 0.6 mm across, in places concentrated at altered ferromagnesian sites. These domains also host a few veins containing scattered pyrite grains and a trace of chalcopyrite. Pyrite is also present in the intense chlorite alteration domains and there are also a couple of chalcopyrite aggregates. The major vein contains medium to coarse masses of chalcopyrite and pyrite (up to a few millimetres across), with textures indicating that pyrite is paragenetically earlier than chalcopyrite (Fig. 3). One pyrite mass is strongly fractured and invaded by chalcopyrite.

<u>Mineral Mode (by volume)</u>: chlorite 45%, sericite 30%, quartz 19%, pyrite 4%, chalcopyrite 2% and traces of rutile and apatite.

<u>Interpretation and comment</u>: It is interpreted that the sample is a strongly altered porphyritic microdiorite, cut by several veins. Relict texture is poorly to moderately preserved, with the rock originally having scattered feldspar (e.g. plagioclase) and ferromagnesian (e.g. hornblende) phenocrysts in a finer grained groundmass of feldspar, ferromagnesian material and minor quartz. A major vein cuts the rock, containing chalcopyrite, pyrite and quartz, and it is bounded by an alteration selvedge rich in chlorite, with a little pyrite, chalcopyrite and rutile. Away from this vein, there is an enclosing alteration zone of sericite, chlorite and quartz, with minor pyrite and trace rutile, and which hosts a few thin veins of quartz, pyrite and chlorite.

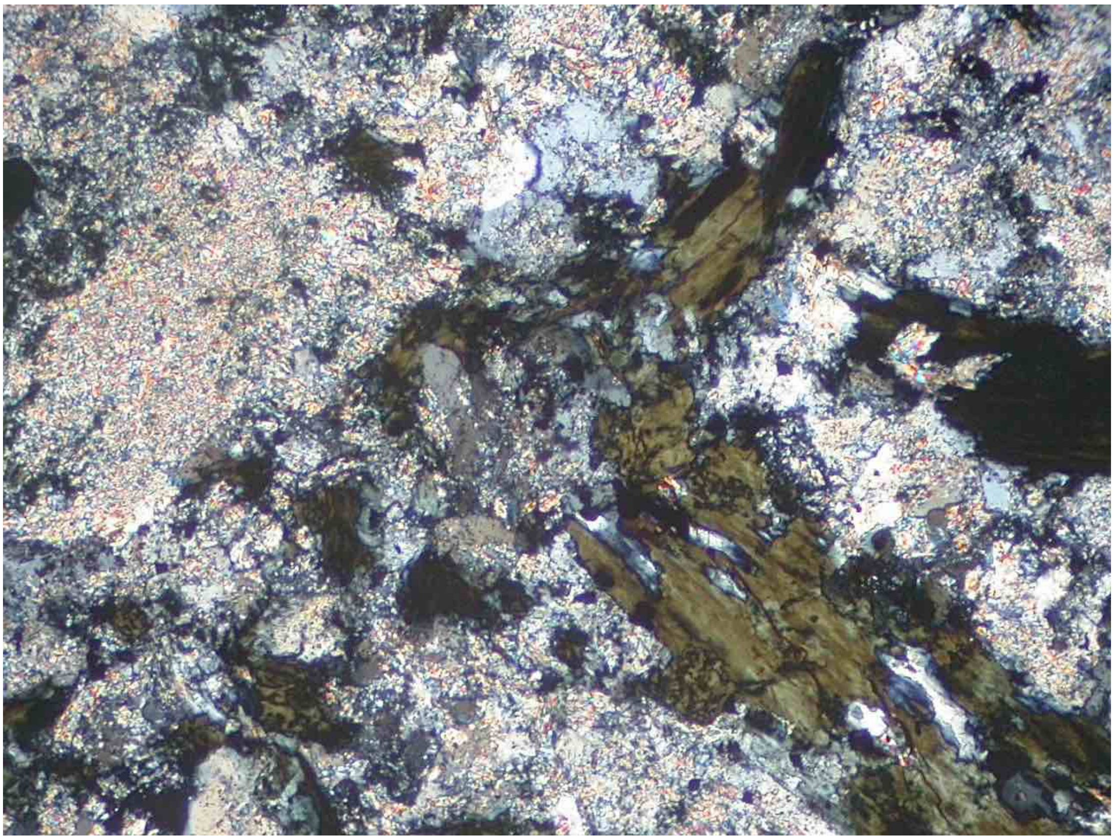

Fig. 2: Strongly sericite-chlorite-quartz altered microdiorite showing pseudomorphs after former feldspar (plagioclase) at left (replaced by sericite) and after ferromagnesian material (replaced by khaki coloured chlorite). Transmitted light, crossed polarisers, field of view 2 mm across.

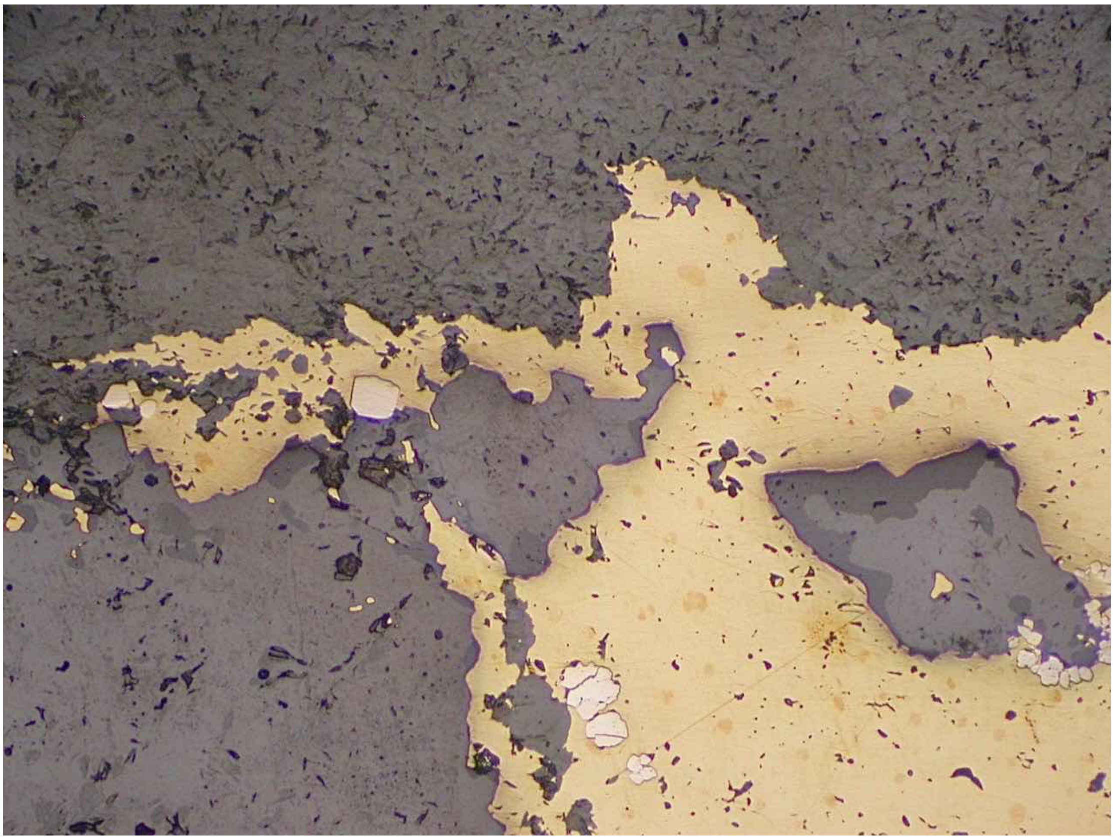

Fig. 3: Part of a major vein containing chalcopyrite (yellow), with small enclosed pyrite grains (pale creamy) and quartz (lower left) abutting intensely chlorite-altered rock (upper). Plane polarised reflected light, field of view 2 mm across.

SMD013 330.8 m PTS

Summary: Porphyritic microtonalite or dacite with strong pervasive propylitic alteration and a few large aggregates of pyrite ± chalcopyrite. Relict texture is moderately preserved, with scattered altered plagioclase phenocrysts and pseudomorphs after a prismatic ferromagnesian phase (e.g. hornblende). There are also a few altered microphenocrysts of FeTi oxide and rare quartz, all enclosed in a former rather fine grained quartzofeldspathic groundmass. Imposed alteration caused initial albitisation of plagioclase phenocrysts, but with further replacement by abundant sericite and a little carbonate, quartz and trace chalcopyrite. Ferromagnesian material was replaced largely by chlorite and at these sites and former FeTi oxide locations, there is minor rutile along with traces of pyrite and chalcopyrite. The groundmass was replaced by abundant inequigranular quartz, with subordinate sericite, minor chlorite and pyrite. Scattered sparsely in the groundmass are a few large pyrite masses, with some also being associated with chalcopyrite, quartz and chlorite.

Handspecimen: The drill core sample is composed of a massive, porphyritic intermediate to felsic igneous rock, with strong pervasive alteration. It contains scattered creamy-coloured altered feldspar (e.g. plagioclase) phenocrysts up to 7 mm across and a few small dark grey-green altered ferromagnesian phenocrysts in a fine to medium grained, grey-green altered groundmass (Fig. 4). Feldspar phenocrysts could have been variably sericitised and the groundmass evidently contains significant chlorite, as well as sericite, quartz, and several porphyroblastic pyrite aggregates up to 7 mm across (Fig. 4). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

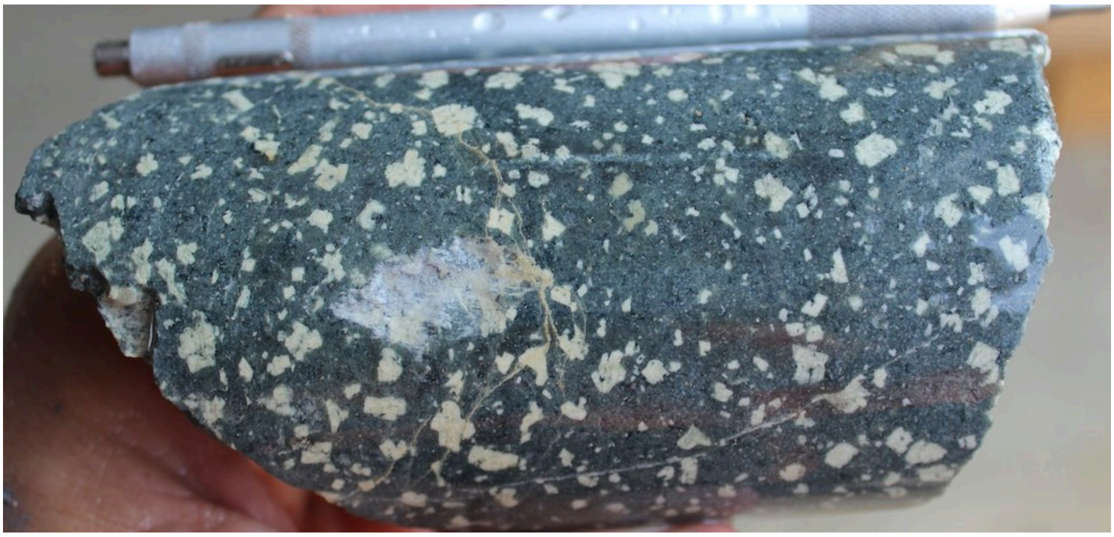

Fig. 4: Drill core sample showing pale creamy, altered plagioclase phenocrysts and a couple of dark grey-green chloritised hornblende phenocrysts in a grey-green altered groundmass (now containing quartz, sericite and chlorite, plus a few pyrite aggregates).

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved, despite strong pervasive hydrothermal alteration. There are scattered, altered blocky plagioclase phenocrysts up to 4 mm across and pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 2 mm long. A single quartz microphenocryst ~0.5 mm across is observed and the rock also contained sparse microphenocrysts of FeTi oxide, now completely altered, and rare prisms of apatite up to 0.4 mm long. A finer grained groundmass component could have formerly occupied ~70% of the rock and although strongly altered, it appears to have contained abundant feldspar, minor ferromagnesian material and quartz, and a little FeTi oxide and apatite. Due to the imposed alteration, classification of the protolith is problematic, but it is speculated from the preserved primary characteristics that it was a porphyritic hornblende microtonalite or dacite.

b) Alteration and structure: The original igneous rock underwent strong, pervasive hydrothermal alteration of propylitic type. Original plagioclase phenocrysts were initially replaced by albite, followed by abundant fine grained sericite and a little carbonate, quartz and trace chalcopyrite (Fig. 5). Former ferromagnesian grains were replaced largely by chlorite, with a little sericite, quartz, pyrite, rutile and trace chalcopyrite (Fig. 5) and FeTi oxide was replaced by rutile ± chlorite, pyrite and chalcopyrite. In the groundmass, there was replacement by abundant inequigranular quartz, with subordinate fine grained sericite, minor chlorite and a little rutile, and with sparse pyrite and trace chalcopyrite, but grading into large aggregates (up to 7 mm) of pyrite ± chalcopyrite ± quartz ± chlorite (Fig. 6).

c) Mineralisation: The most obvious sulphide mineralisation in the sample is the occurrence of apparently replacive large aggregates of medium to coarse grained pyrite (from ~0.5 to 7 mm across), mainly in the altered groundmass. Associated with some pyrite aggregates are irregular chalcopyrite masses up to 2 mm across (Fig. 6), but there is also discrete chalcopyrite in the altered groundmass and at several altered plagioclase sites. Similarly, a little pyrite tends to be disseminated through. In the large pyrite aggregates, there is local fracturing, in which a little chalcopyrite was emplaced.

Mineral Mode (by volume): quartz 40%, sericite 30%, chlorite 15%, pyrite 7%, albite 5%, chalcopyrite, rutile and carbonate each 1% and a trace of apatite.

Interpretation and comment: It is interpreted that the sample represents a strongly altered, porphyritic microtonalite or dacite. From moderately preserved relict texture it is apparent that the rock formerly contained plagioclase and hornblende phenocrysts as well as microphenocrysts of FeTi oxide and rare quartz, all enclosed in a rather fine grained quartzofeldspathic groundmass. Strong alteration was of propylitic type, leading to initial albitisation of plagioclase phenocrysts, and further replacement by abundant sericite and a little carbonate, quartz and trace chalcopyrite. Ferromagnesian material was replaced largely by chlorite and at these sites and former FeTi oxide locations, there is minor rutile along with traces of pyrite and chalcopyrite. The groundmass was replaced by abundant inequigranular quartz, subordinate sericite, minor chlorite and pyrite. Scattered sparsely in the groundmass are a few large pyrite masses, with some also being associated with chalcopyrite, quartz and chlorite.

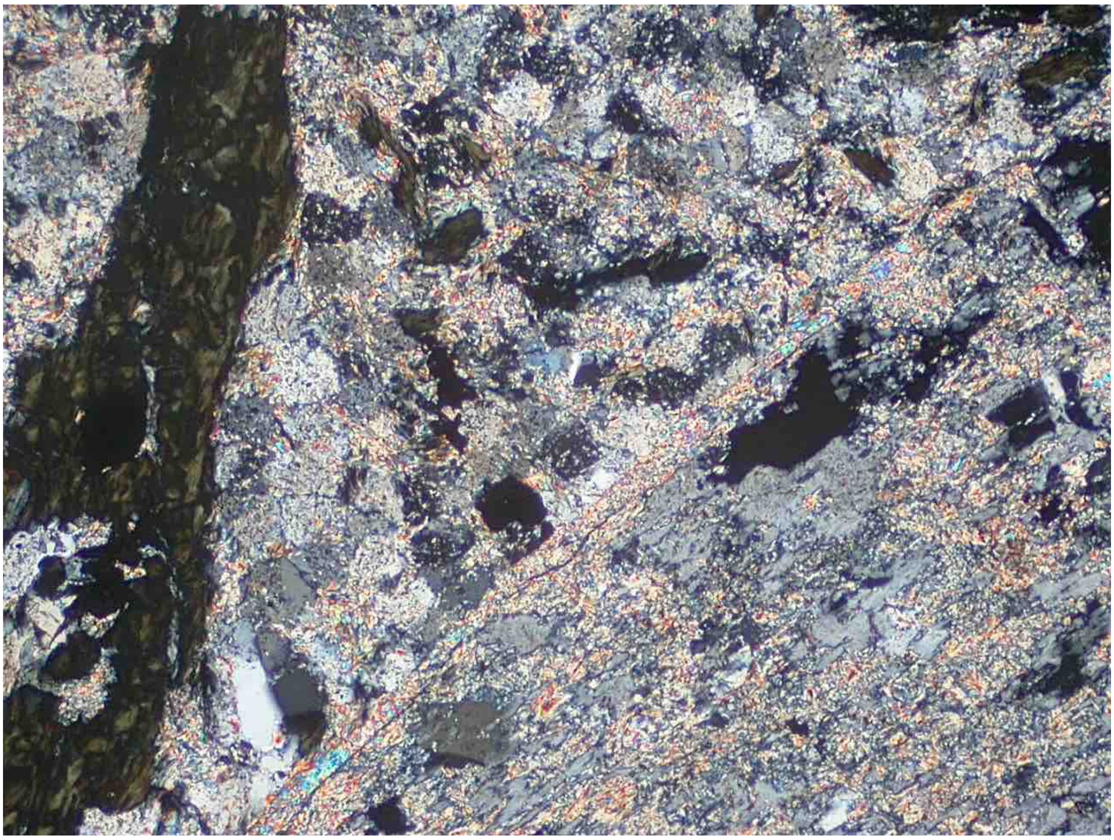

Fig. 5: Part of an altered plagioclase phenocryst (right), replaced by albite (pale grey) and overprinting sericite. At left is a chlorite-altered hornblende phenocryst. The intervening groundmass is replaced by quartz and subordinate sericite and chlorite. Transmitted light, crossed polarisers, field of view 2 mm across.

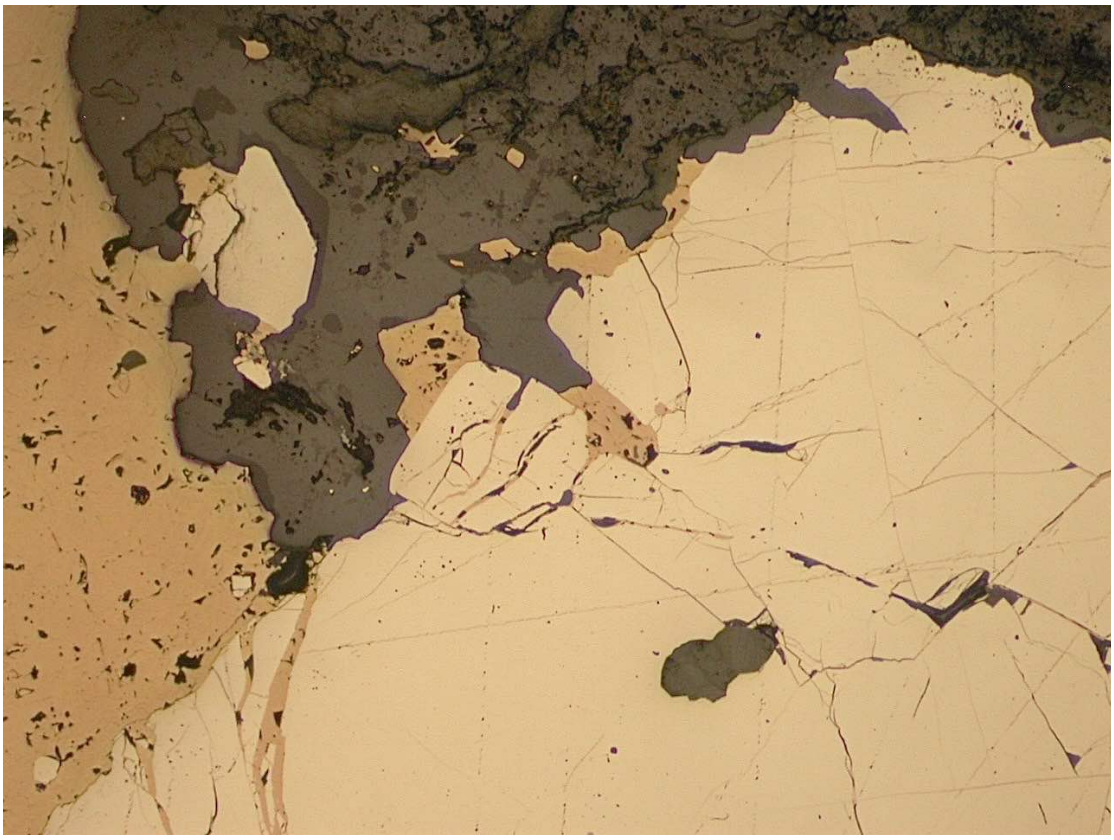

Fig. 6: Part of a large pyrite mass (pale creamy) with adjacent chalcopyrite (yellow), in places invading pyrite along fractures. Plane polarised reflected light, field of view 2 mm across.

SMD013 361.0 m PTS

Summary: Porphyritic microtonalite, gradational to quartz microdiorite, showing moderate preservation of relict texture, but having strong pervasive propylitic alteration and associated veining. The rock originally contained scattered plagioclase and a few ferromagnesian (e.g. hornblende) phenocrysts, in a generally medium grained groundmass of plagioclase, ferromagnesians (hornblende, biotite), with minor interstitial quartz and a little K-feldspar. Imposed alteration caused albitisation of plagioclase and further replacement by sericite and carbonate. Ferromagnesian material was replaced by chlorite, with local epidote and carbonate, pyrite and trace chalcopyrite, sphalerite and rutile. A major vein was emplaced, associated with a chlorite-rich alteration selvedge. The vein contains medium to coarse grained carbonate (calcite), abundant pyrite, minor chlorite, a little epidote and traces of chalcopyrite and sphalerite.

Handspecimen: The drill core sample is composed of a massive, grey-green to creamy-grey, altered medium grained and apparently porphyritic, intermediate to felsic igneous rock. It is rich in feldspar and probably contains significant ferromagnesian material and perhaps minor quartz (Fig. 7). A major vein array cuts the rock at a low to moderate angle to the core axis, containing white carbonate and pyrite, and bordered by a dark grey-green chlorite-rich alteration selvedge (Fig. 7). The rock probably has moderate to strong alteration to sericite and chlorite, with a few epidote-rich aggregates up to 5 mm across and a little disseminated pyrite. Testing of the section offcut with dilute HCl gave a strong reaction on vein carbonate, indicating that it is calcite. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 7: Drill core sample of altered porphyritic microtonalite/microdiorite, with carbonate-pyrite veining bordered by a dark, chlorite-rich alteration selvedge.

Petrographic description

a) Primary rock characteristics: In the section, relict texture is moderately preserved. The rock was evidently porphyritic, containing scattered blocky plagioclase phenocrysts up to 5 mm across and a few ferromagnesian phenocrysts (e.g. hornblende) up to 4 mm long, but now completely altered. The phenocrysts occur in a largely medium grained (~0.2-1.5 mm) aggregate consisting of abundant plagioclase, subordinate altered ferromagnesian material (would have included hornblende and biotite, judging by relict textures), interstitial quartz and a little associated turbid K-feldspar (Fig. 8). The preserved primary characteristics suggest that the rock was a porphyritic microtonalite, transitional to quartz microdiorite.

b) Alteration and structure: The original igneous rock experienced pervasive strong hydrothermal alteration, emplacement of a major vein and a couple of narrow, subsidiary veins. All original plagioclase was albitised, with subsequent further partial replacement by fine grained sericite and local carbonate (Fig. 8). All ferromagnesian material was altered, mainly to chlorite (Fig. 8), but there are also occurrences of epidote, carbonate, pyrite and traces of rutile, sphalerite and chalcopyrite. About the major vein, there is an increase in chlorite replacement of the host rock, with reduction in amounts of sericite and quartz, and absence of albite. The major vein is sub-planar, up to 4 mm wide and contains abundant medium to coarse grained carbonate (calcite) and pyrite (disseminated to semi-massive), with subordinate chlorite, minor fine to medium grained epidote (partly replaced by carbonate and traces of sphalerite and chalcopyrite (Fig. 9). A couple of other narrow (<0.2 mm) sub-planar veins rich in carbonate also occur. The overall alteration assemblage is consistent with propylitic type.

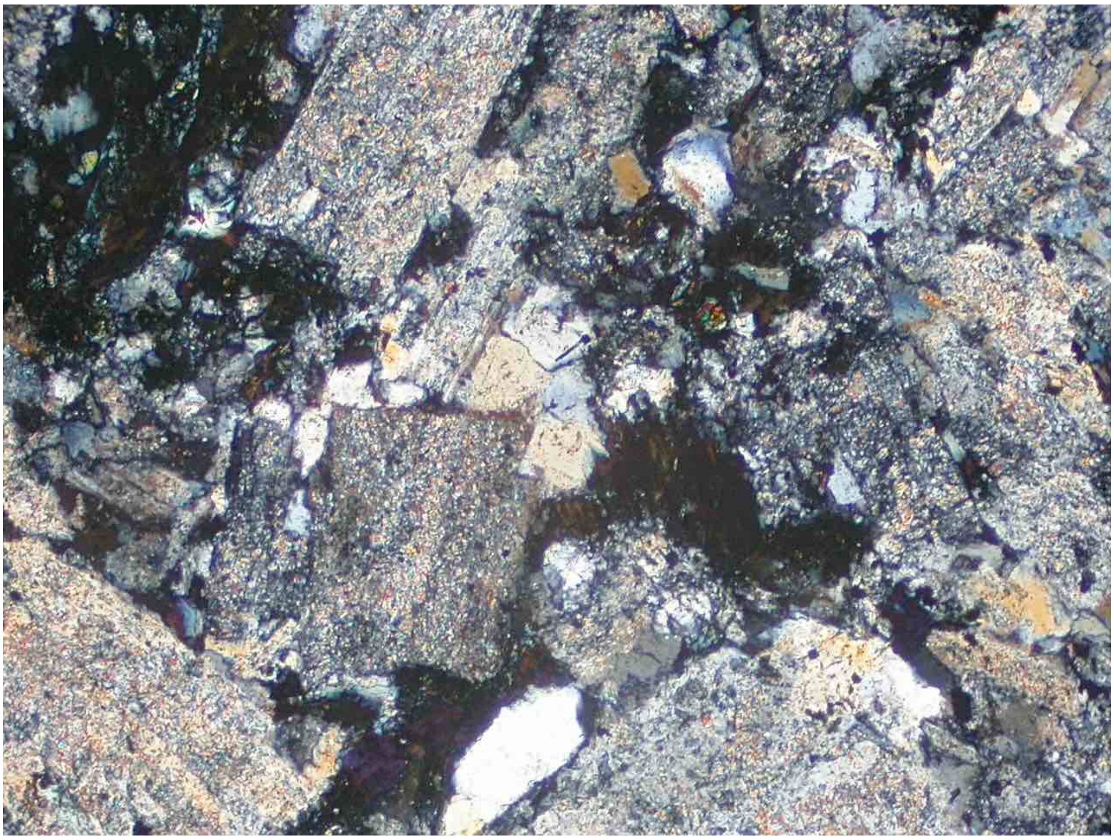

Fig. 8: Typical texture of rock with blocky plagioclase grains, replaced by albite and minor sericite, with dark aggregates being chlorite, after former ferromagnesian material. Interstitial quartz could, in part, be a primary igneous phase. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: In the host rock, there is minor disseminated pyrite (up to 0.8 mm) as part of the pervasive alteration and there are also traces of chalcopyrite and sphalerite (locally in composites with pyrite and concentrated at former ferromagnesian sites). A major vein contains disseminated to semi-massive, medium grained pyrite (aggregates to several millimetres), with traces of associated chalcopyrite and sphalerite (Fig. 9).

<u>Mineral Mode (by volume)</u>: plagioclase (albite) 45%, chlorite 17%, sericite and carbonate each 10%, quartz 8%, pyrite 6%, epidote 2%, K-feldspar 1% and traces of rutile, chalcopyrite and sphalerite.

Interpretation and comment: It is interpreted that the sample is a strongly hydrothermally altered and locally veined, porphyritic microtonalite, transitional to quartz microdiorite. The rock has moderate preservation of relict texture, indicating that it contained plagioclase and a few ferromagnesian (e.g. hornblende) phenocrysts, in a medium grained groundmass of plagioclase, ferromagnesians (hornblende, biotite), with minor interstitial quartz and a little K-feldspar. Alteration is of strong propylitic type and led to albitisation of plagioclase and further replacement by sericite and carbonate. Ferromagnesian material was replaced by chlorite, with local epidote and carbonate, pyrite and trace chalcopyrite, sphalerite and rutile. A major vein was emplaced, associated with a chlorite-rich alteration selvedge. The vein contains medium to coarse grained carbonate (calcite) abundant pyrite, minor chlorite, a little epidote and traces of chalcopyrite and sphalerite.

Fig. 9: Part of the large vein, with an assemblage of coarse carbonate (dark), abundant subhedral pyrite (pale creamy) and at upper left, a grain of sphalerite (pale grey) with tiny chalcopyrite inclusions. Plane polarised reflected light, field of view 2 mm across.

SMD013 412.8 m PTS

Summary: Quartz-galena-dominated vein, containing a few apparent fragments of intensely hydrothermally altered host rock. The latter have no recognised relict characteristics due to alteration and local micro-cataclasis and are now composed of fine to medium grained quartz and pyrite, with fine grained sericite, a little carbonate and traces of galena and rutile. Much of the sample is vein-dominated, with medium to coarse quartz hosting large interstitial masses of galena, and minor carbonate. In places, quartz hosts minor aggregates of pyrite and a trace of chalcopyrite, and within galena-rich masses, there are a few grains of Fe-poor sphalerite and fine grained pyrite. No discrete Ag-rich phase was observed.

Handspecimen: The drill core sample is composed largely of quartz-galena vein filling, but there are a few elongate fragments of strongly altered host rock up to 3.5 cm long, incorporated into the vein. The fragments are greenish-grey in colour, fine grained, and contain quartz, sericite and pyrite, but have no recognised relict texture (Fig. 10). The vein material is crudely banded, with the banding being at a low to moderate angle to the core axis (Fig. 10), and banding defined by varying proportions of quartz and galena. In quartz-rich zones, there is minor interstitial carbonate. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

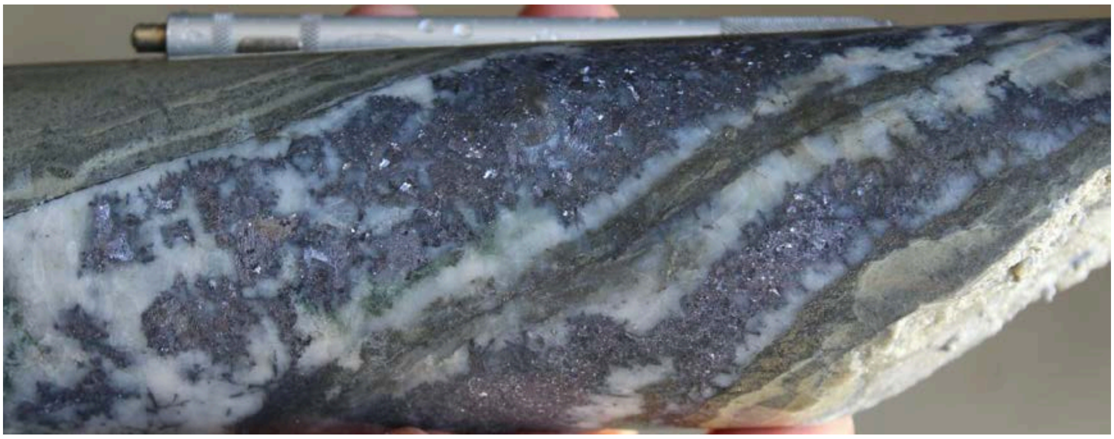

Fig. 10: Drill core sample of quartz-galena-dominated banded vein at a moderate angle to the core axis and showing a screen and bordering zones of grey-green, strongly altered host rock.

Petrographic description

a) Primary rock characteristics: In the section, 90-95% of the sample represents vein material, with the remainder being apparently highly altered fragments of host rock up to several millimetres across and locally showing micro-cataclastic textures. Due to imposed deformation and strong hydrothermal alteration effects, the original nature of the host rock remains obscure.

b) Alteration and structure: A few elongate to irregular, strongly hydrothermally altered host rock fragments occur, but the sample is dominated by vein infill. The host rock fragments are up to a few millimetres across and are composed of abundant quartz (in places showing micro-cataclastic texture), with locally abundant pyrite and sericite (Fig. 11), a little carbonate and traces of galena and rutile. Alteration in the fragments is interpreted to range from phyllic to silicic type. Much of the sample is dominated by vein infill, with this being characterised by medium to coarse grained quartz (individual elongate grains up to several millimetres), with commonly abundant interstitial galena (aggregates to ~1 cm), with minor interstitial carbonate, pyrite (as irregularly scattered grains and aggregates) and traces of chalcopyrite and Fe-poor sphalerite (the last phase occurring in galena) (Fig. 12). Quartz-rich vein infill is locally cut by minor carbonate veining.

c) Mineralisation: In the vein infill, there is patchily abundant medium to coarse galena in aggregates up to 1 cm across, interstitial to quartz. Galena encloses rare small grains of pyrite (up to 0.2 mm), with one galena mass hosting ~3 grains of Fe-poor sphalerite up to 0.7 mm across (Fig. 12). Elsewhere in vein quartz, there is a trace through to locally common aggregates and individual grains of pyrite up to 1 mm across (Fig. 11) as well as a few small grains of chalcopyrite. In the strongly altered host rock fragments, strongly disseminated pyrite is common (grains up to 0.6 mm) and there is also a trace of galena (Fig. 11). No discrete Ag-rich mineral has been observed on the scale of the section. It is possible that at least some Ag values are hosted in solid solution in galena.

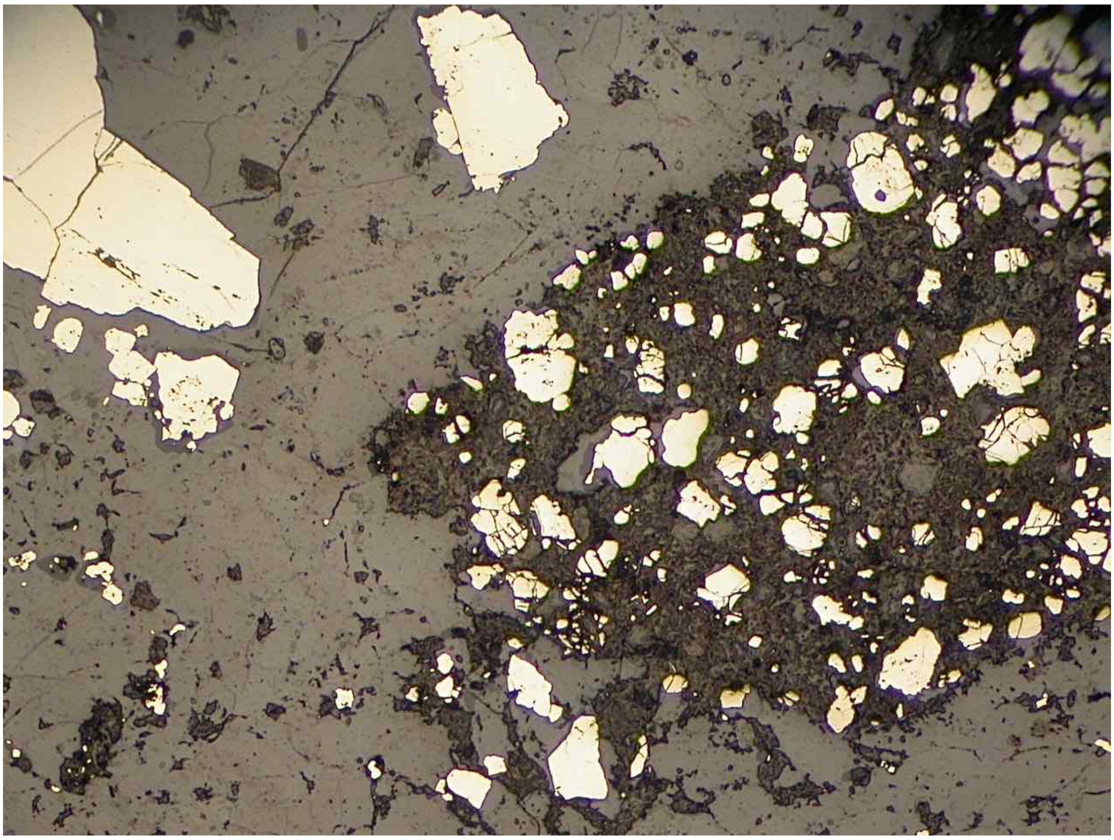

Fig. 11: Part of a strongly altered host rock fragment at right, with abundant disseminated pyrite, enclosed in quartz-rich vein material with a few isolated larger pyrite grains. Plane polarised reflected light, field of view 2 mm across.

<u>Mineral Mode (by volume)</u>: quartz 55%, galena 25%, carbonate (calcite) 12%, pyrite 6%, sericite 2% and traces of chalcopyrite, sphalerite and rutile.

<u>Interpretation and comment</u>: It is interpreted that the sample represents a quartz-galena vein, containing a few fragments of intensely hydrothermally altered host rock that have no recognised relict characteristics due to alteration and local micro-cataclasis. The host rock fragments contain quartz, pyrite and sericite, a little carbonate and traces of galena and rutile. Much of the sample is vein-dominated, with medium to coarse quartz hosting large interstitial masses of galena, and minor carbonate. In places, quartz hosts minor aggregates of pyrite and a trace of chalcopyrite, and within galena-rich masses, there are a few grains of Fe-poor sphalerite and fine grained pyrite. No discrete Ag-rich phase was observed.

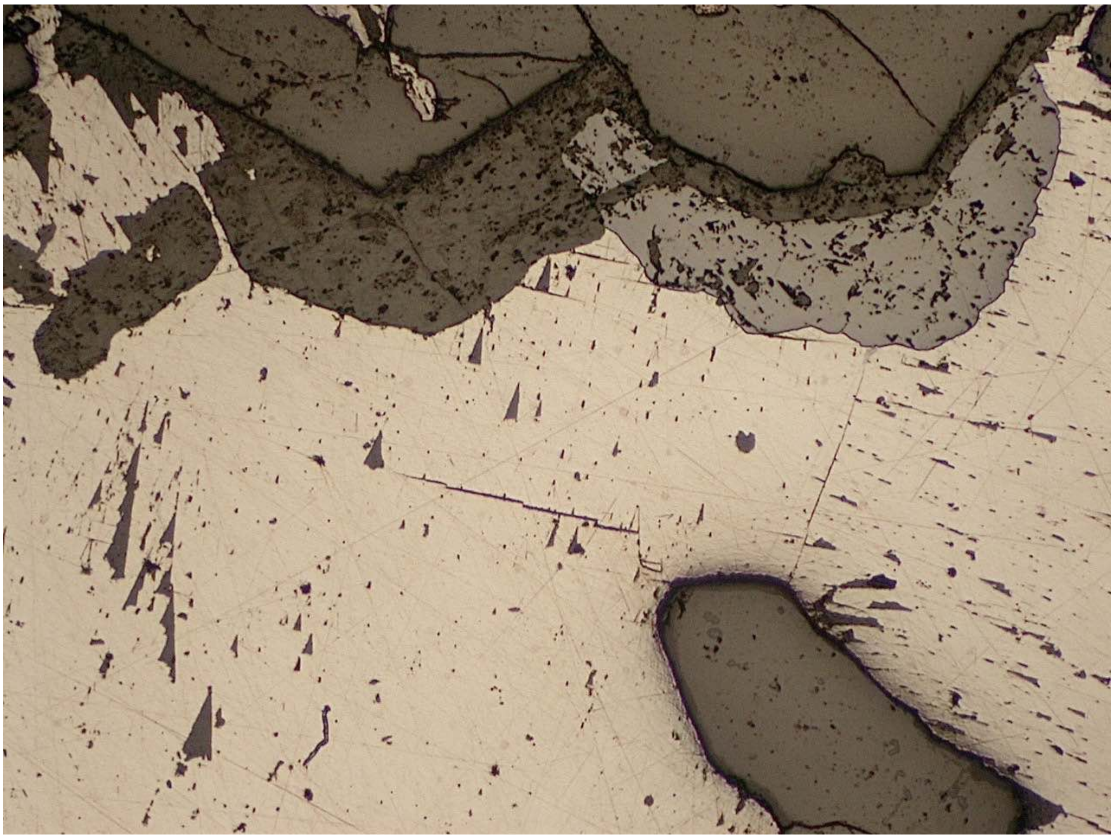

Fig. 12: Large mass of galena infill (pale silvery-grey) interstitial to quartz and minor carbonate (upper left). The mid grey aggregate (upper right) is sphalerite. Plane polarised reflected light, field of view 2 mm across.

SMD013 497.0 m TS

Summary: Massive porphyritic dacite, with moderate to strong and pervasive propylitic alteration. The rock contained abundant blocky plagioclase phenocrysts, scattered small prismatic ferromagnesian phenocrysts (probably mostly hornblende), rare quartz and a few microphenocrysts of apatite and FeTi oxide, all enclosed in a holocrystalline, fine grained quartzofeldspathic groundmass. The latter probably had plagioclase > K-feldspar and quartz. Imposed alteration caused albitisation of plagioclase and ferromagnesian material was altered to chlorite, with minor other alteration phases including epidote, prehnite, sericite, quartz and traces of actinolite, leucoxene and hematite. A few thin, discontinuous veins of albite ± quartz ± prehnite occur.

Handspecimen: The drill core sample is composed of a massive, strongly porphyritic intermediate to felsic igneous rock, with a fine grained groundmass. It contains abundant blocky whitish feldspar phenocrysts (e.g. plagioclase) up to 1 cm across and less common dark grey-green altered ferromagnesian phenocrysts (e.g. originally hornblende) up to 2 mm long. The groundmass is grey-green in colour and could be of quartzofeldspathic composition. Pervasive alteration has occurred, but is probably only moderate, with development of chlorite and perhaps sericite. No veining is evident. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 13: Drill core sample of strongly porphyritic, moderately altered dacite. The white phenocrysts are plagioclase and small dark grey-green grains are chloritised hornblende. The fine grained groundmass is of quartzofeldspathic composition.

Petrographic description

a) Primary rock characteristics: In the section, strongly porphyritic texture is well preserved. The rock contains abundantly scattered blocky plagioclase phenocrysts up to 6 mm across and a few clusters of plagioclase ± ferromagnesian material up to 8 mm across. There are also scattered altered ferromagnesian phenocrysts of prismatic form and up to 2 mm long, with relict shapes indicating that most were probably hornblende (Fig. 14). The rock also hosts rare quartz phenocrysts (up to 3 mm) and microphenocrysts of apatite (up to 0.4 mm) and FeTi oxide (up to 0.6 mm, now altered), all occurring in a holocrystalline groundmass (grainsize generally <0.2 mm) dominated by plagioclase, but with subordinate quartz and K-feldspar, and minor altered ferromagnesian material (Fig. 14). Rare small grains of zircon are observed in altered plagioclase and at FeTi oxide sites. The primary characteristics of the rock indicate that it represents an altered porphyritic hornblende dacite.

b) Alteration and structure: Moderate to strong, pervasive alteration was imposed on the igneous rock. All plagioclase phenocrysts, and probably much of the groundmass feldspar, was albitised, with development also of a little sericite, prehnite and epidote. All former ferromagnesian material was replaced by chlorite, in places accompanied by minor prehnite, epidote, quartz and actinolite (Fig. 14). Igneous FeTi oxide was replaced by fine grained aggregates of leucoxene and hematite. A few thin, discontinuous veins (<0.2 mm wide) of albite ± quartz and trace prehnite were emplaced. The alteration assemblage is consistent with propylitic type (but could simply be caused by very low grade metamorphism).

c) Mineralisation: No sulphide minerals were observed. All former igneous FeTi oxide grains were replaced by fine grained aggregates of leucoxene and hematite.

Mineral Mode (by volume): plagioclase (albite) 60%, quartz and chlorite each 13%, K-feldspar 10%, sericite, prehnite and epidote each 1% and traces of apatite, zircon, leucoxene, hematite and actinolite.

Interpretation and comment: It is interpreted that the sample is a pervasively altered porphyritic dacite. It contained abundant plagioclase phenocrysts, scattered small prismatic ferromagnesian phenocrysts (probably mostly hornblende), rare quartz and a few microphenocrysts of apatite and FeTi oxide, enclosed in a holocrystalline, fine grained quartzofeldspathic groundmass, with plagioclase > K-feldspar and quartz. Imposed alteration of propylitic type caused albitisation of plagioclase, with ferromagnesian material being replaced by chlorite. Other minor alteration phases formed include epidote, prehnite, sericite, quartz and traces of actinolite, leucoxene and hematite. A few thin, discontinuous veins of albite ± quartz ± prehnite occur.

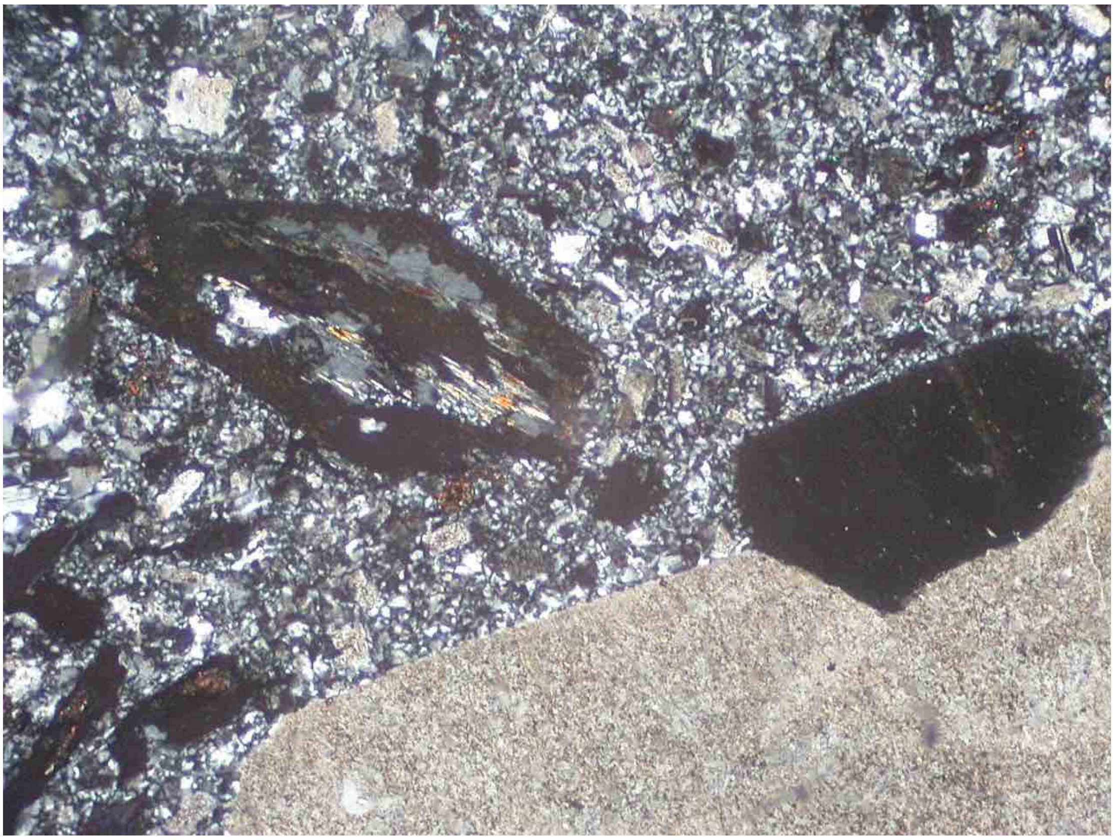

Fig. 14: Part of a phenocrystal cluster of albitised plagioclase (lower right) and altered hornblende (left) replaced by chlorite ± quartz and actinolite, set in a finely inequigranular plagioclase (-K-feldspar-quartz) groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD014 219.5 m PTS

Summary: Porphyritic microtonalite, with indications of initial hydrothermal biotite development with subsequently imposed strong retrograde alteration of propylitic type and associated veining. The rock has moderately well preserved relict texture, with scattered blocky plagioclase phenocrysts (now altered) and pseudomorphs after possible hornblende phenocrysts, in a fine to medium grained groundmass that was probably rich in plagioclase and quartz, with minor K-feldspar, ferromagnesian material, a little FeTi oxide and trace apatite. It appears that minor hydrothermal biotite ± a little chalcopyrite developed from replacement of igneous ferromagnesian material. Later-imposed retrograde alteration caused replacement of hydrothermal biotite and any residual igneous ferromagnesian material by chlorite ± chalcopyrite and rutile. Plagioclase is largely albitised, with minor to abundant sericite development, plus minor chlorite and trace chalcopyrite. FeTi oxide was replaced by rutile and chlorite, with a little chalcopyrite. Several veins were emplaced, possibly with an early quartz-rich vein, followed by an array of veins including thin quartz-rich types, thin sericite ± chlorite ± chalcopyrite, and more prominent pyrite-quartz-chlorite ± chalcopyrite, with associated sericite (-chlorite-chalcopyrite) alteration selvedges.

Handspecimen: The drill core sample is composed of a strongly hydrothermally altered, porphyritic intermediate to felsic igneous rock. It is creamy to pale grey in colour and contains scattered feldspar (e.g. plagioclase) phenocrysts up to 3 mm across and small, dark grey altered ferromagnesian grains (e.g. hornblende), up to 1.5 mm long. These phases occur in a finer grained, probably quartzofeldspathic composition groundmass. The rock appears to have pervasive alteration to sericite, perhaps with minor chlorite (e.g. at former ferromagnesian sites), quartz and traces of finely disseminated chalcopyrite and pyrite (Fig. 15). A few sub-planar veins up to 1 mm wide occur at a moderate angle to the core axis, with these apparently containing variable amounts of quartz, pyrite and sericite, and with some having dark grey alteration selvedges (Fig. 15). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 15: Drill core sample of altered porphyritic microtonalite, showing scattered plagioclase phenocrysts and a few veins with pyrite, quartz, sericite, chlorite and trace chalcopyrite.

Pervasive alteration in the rock has produced sericite, minor chlorite and quartz, a little finely disseminated chalcopyrite.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock is strongly altered, but relict porphyritic texture is moderately well preserved. The rock originally contained scattered blocky plagioclase phenocrysts up to 4 mm across and there are less common pseudomorphic aggregates after a former ferromagnesian phase (probably hornblende) up to 1.5 mm long, with the phenocrystal phases occurring in a fine to medium grained groundmass that was evidently dominated by plagioclase and quartz, but probably with minor K-feldspar and ferromagnesian material, a little disseminated FeTi oxide and trace apatite (Fig. 16). From the preserved primary characteristics, the rock is interpreted as a porphyritic microtonalite.

b) Alteration and structure: Strong pervasive hydrothermal alteration was imposed on the igneous rock and a few veins emplaced. There is an indication that there was an initial phase of hydrothermal biotite development (i.e. potassic alteration) with possibly a little associated chalcopyrite at former ferromagnesian sites, but all biotite was later retrogressed. The biotite alteration might have been accompanied by emplacement of a single quartz-rich vein up to 1.5 mm wide. The rock shows evidence of strong retrograde alteration that led to albitisation of plagioclase and minor to abundant replacement by sericite, minor chlorite and trace chalcopyrite. Ferromagnesian material (including hydrothermal biotite) was replaced by pale green chlorite, with a little sericite in places, chalcopyrite and trace rutile. All igneous FeTi oxide was replaced by rutile, chlorite and a little chalcopyrite, and in the groundmass, minor quartz, chlorite and sericite have developed. The retrograde alteration assemblage conforms to propylitic type. Several veins were probably emplaced coeval with the retrograde alteration. These include a few thin (<0.5 mm) veins that have variable amounts of quartz, chlorite and sericite, with a little chalcopyrite, and a more prominent sub-planar vein up to 1 mm wide that contains pyrite, quartz, chlorite and a little sericite and chalcopyrite, and is bordered by an alteration selvedge of abundant sericite, minor chlorite and a little chalcopyrite (Fig. 17).

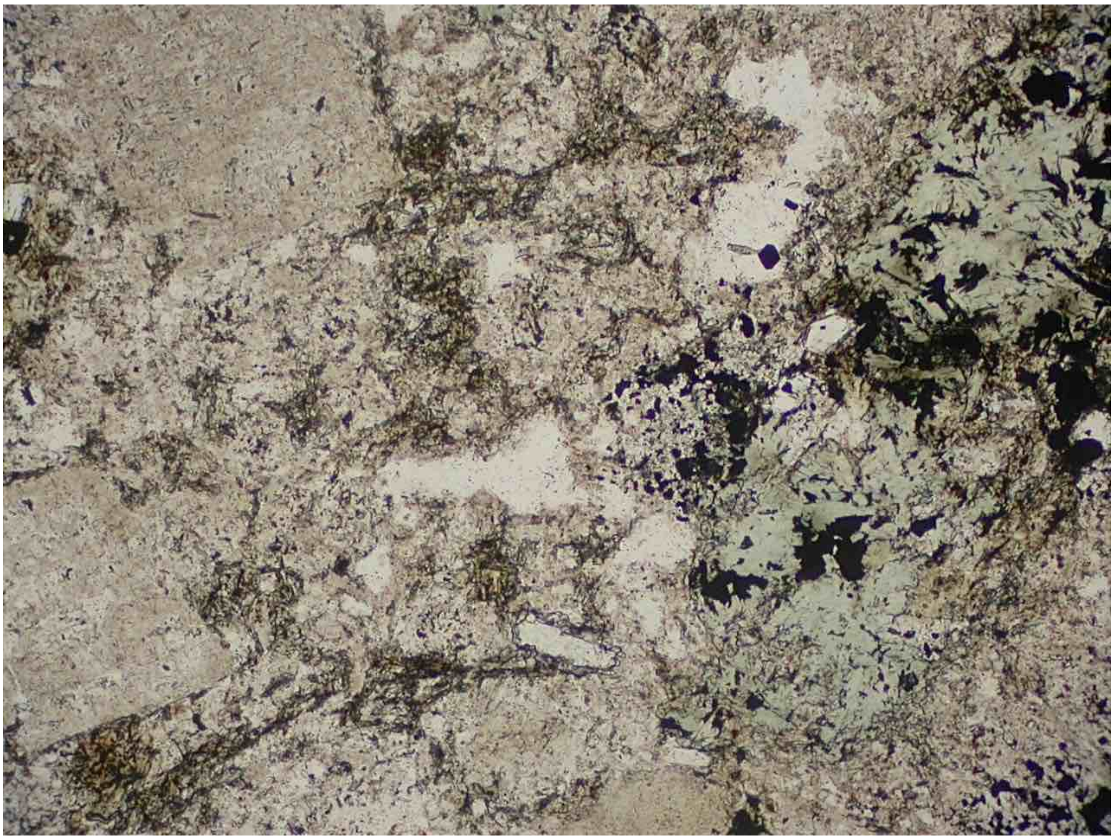

Fig. 16: Albitised blocky plagioclase phenocrysts at left and a former ferromagnesian grain (e.g. hornblende) at right, initially replaced by hydrothermal biotite and subsequently replaced by pale green chlorite (small black grains are chalcopyrite). Remainder of rock is a fine to medium grained groundmass of feldspars, quartz (clear) and small chlorite alteration aggregates. Plane polarised transmitted light, field of view 2 mm across.

c) Mineralisation: Throughout the altered rock, but mostly at former ferromagnesian sites and in some narrow sericite and/or chlorite veins, there is a little disseminated chalcopyrite (grains up to 0.3 mm). There is a prominent vein up to 1 mm wide containing considerable medium grained pyrite, as well as a little chalcopyrite (aggregates up to 0.5 mm) (Fig. 17).

<u>Mineral Mode (by volume)</u>: plagioclase (probably albite) 40%, quartz and sericite each 20%, chlorite 11%, K-feldspar 5%, pyrite 2%, rutile and chalcopyrite each 1% and a trace of apatite.

<u>Interpretation and comment</u>: It is interpreted that the sample is a strongly altered and locally veined porphyritic microtonalite. There is moderately well preserved relict texture, with scattered blocky plagioclase phenocrysts and pseudomorphs after possible hornblende phenocrysts, in a finer grained groundmass that was probably rich in plagioclase and quartz, with minor K-feldspar, ferromagnesian material, a little FeTi oxide and trace apatite. An early phase of hydrothermal biotite replacement of igneous ferromagnesian material apparently occurred, but followed by pervasive retrograde alteration of propylitic type that caused replacement of ferromagnesian material (including biotite) by chlorite ± chalcopyrite and rutile. Plagioclase is largely albitised, with minor to abundant sericite development, plus minor chlorite and trace chalcopyrite. FeTi oxide was replaced by rutile and chlorite, with a little chalcopyrite. Several veins were emplaced, possibly with an early quartz-rich vein, followed by an array of veins including thin quartz-rich types, thin sericite ± chlorite ± chalcopyrite, and more prominent pyrite-quartz-chlorite ± chalcopyrite, with associated sericite (-chlorite-chalcopyrite) alteration selvedges.

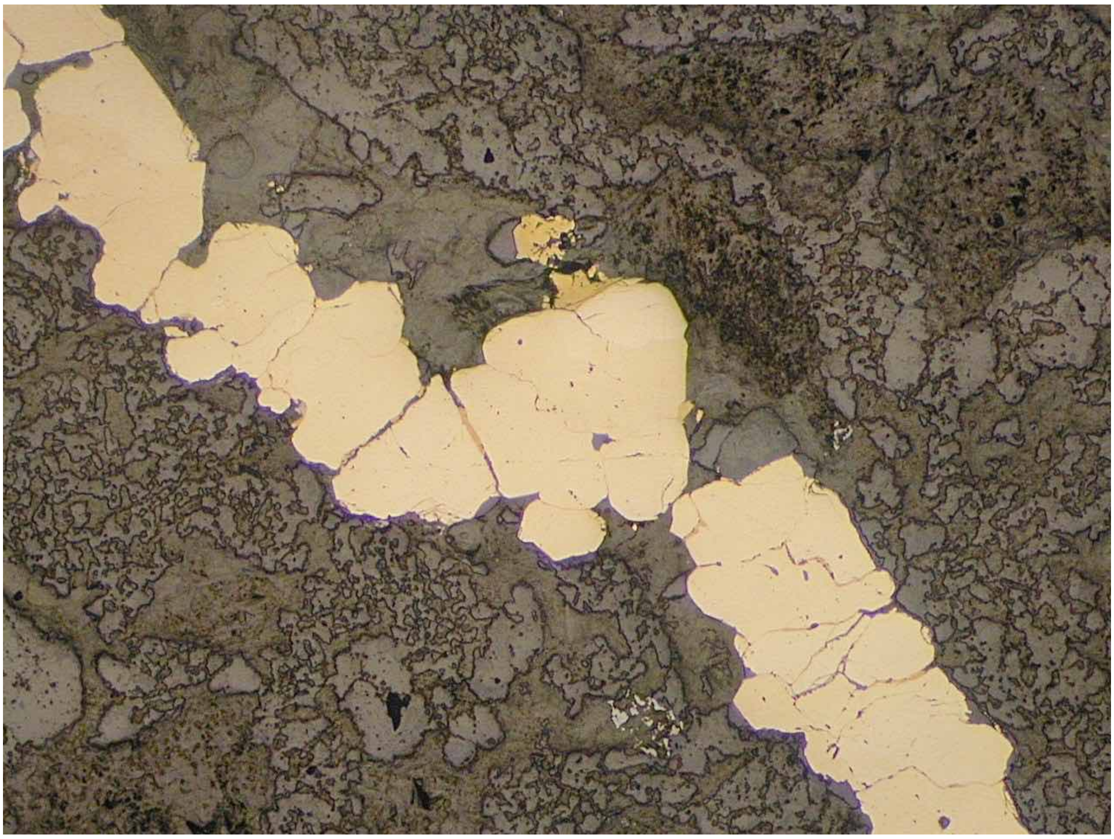

Fig. 17: Part of a vein containing pyrite (pale creamy) with a little associated quartz, chlorite and chalcopyrite (yellow) cutting strongly sericite-altered microtonalite. Plane polarised reflected light, field of view 2 mm across.

SMD015 138.0 m PTS

Summary: Strongly altered and veined (tending to hydrothermal breccia) porphyritic dacite. The rock originally contained scattered phenocrysts of plagioclase and prismatic ferromagnesian material (e.g. hornblende) and a few smaller grains of quartz, in a fine grained granular quartzofeldspathic groundmass. The rock was cut by abundant network veining of quartz, with minor associated chlorite, magnetite and trace pyrite and chalcopyrite, and subsequently by a few thin chlorite (-sericite) veins. Pervasive alteration is of propylitic type and resulted in considerable replacement of phenocrystal and groundmass feldspar by albite, variable sericite and minor chlorite, with all ferromagnesian material being chloritised. Adjacent to the veins, the host rock also contains a little magnetite and traces of chalcopyrite and pyrite.

Handspecimen: The drill core sample is composed of a strongly hydrothermally altered and strongly veined porphyritic felsic igneous rock. The intensity of veining is such that the texture of the rock tends to equate to a hydrothermal breccia. Domains of altered host rock are up to a few centimetres across and have scattered phenocrysts of pale creamy feldspar (e.g. plagioclase) up to a few millimetres, uncommon quartz and smaller, dark grey-green altered ferromagnesian grains (e.g. former hornblende) up to 2.5 mm long, in a fine grained creamy-coloured altered fine grained groundmass (Fig. 18). Abundant network veining is up to 1.5 cm wide, dominated by grey quartz that contains a little finely dispersed magnetite and traces of pyrite and chalcopyrite (Fig. 18). The host rock appears to be pervasively altered, with development of chlorite, sericite and trace pyrite. The sample is strongly magnetic, with susceptibility up to 2180 x 10^{-5} SI, confirming the presence of minor magnetite.

Fig. 18: Drill core sample showing strong network vein development in altered porphyritic dacite. Veins are quartz-rich, but darker colour is due to fine grained magnetite and trace pyrite and chalcopyrite. The host rock domains have sericite-chlorite alteration.

Petrographic description

a) Primary rock characteristics: In the section, approximately half of the sample is composed of quartz-rich veining, with the remainder being angular fragments of altered host rock in which relict porphyritic texture is well preserved. It is apparent that the rock contains scattered blocky plagioclase phenocrysts up to 4 mm across, as well as pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 2 mm long (Fig. 19). There are also uncommon quartz phenocrysts up to 1 mm across and altered FeTi oxide grains up to 0.6 mm across, with traces of associated apatite and zircon. The phenocrystal phases occur in a fine grained granular texture groundmass, evidently containing considerable plagioclase and quartz, and probably minor K-feldspar and altered ferromagnesian material (Fig. 19). The primary characteristics of the rock indicate that it represents an altered porphyritic hornblende dacite.

b) Alteration and structure: The igneous rock was strongly hydrothermally altered and cut by a network array of quartz-rich veins so as to produce (on the scale of the section) a matrix-supported hydrothermal breccia. Pervasive alteration was imposed on the host rock, causing considerable replacement of plagioclase phenocrysts (and probably some of the groundmass feldspar) by albite, and minor to abundant sericite, as well as a little chlorite and trace pyrite. All ferromagnesian material was replaced by chlorite, with traces of magnetite (adjacent to veins), chalcopyrite and rutile (Fig. 20) and all FeTi oxide was replaced by rutile and chlorite. In the groundmass, it is apparent that minor sericite and chlorite formed, and adjacent to the veins, a little magnetite and pyrite. Quartz-rich veins are up to 6 mm wide, with fine to medium grained, inequigranular quartz, minor chlorite and irregularly distributed fine grained magnetite and traces of chalcopyrite and pyrite (Fig. 20). A few thin, sub-planar veins of chlorite ± sericite cut the quartz-rich veins and host rock domains. The alteration assemblage in the sample conforms to propylitic type.

Fig. 19: Typical texture of altered porphyritic dacite, showing part of an altered (sericitised) plagioclase phenocryst at top, a relict quartz grain, dark, chlorite-altered hornblende grains and at far left an altered FeTi oxide grain (black), note the finely granular quartzofeldspathic groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: Traces of fine grained pyrite, chalcopyrite and magnetite occur in the altered host rock domains, commonly adjacent to quartz-rich veins (Fig. 20). In the veins, there is a little patchily distributed fine grained magnetite (grains up to 0.3 mm) and uncommon small grains of chalcopyrite and pyrite (Fig. 20).

Mineral Mode (by volume): quartz 55%, plagioclase (includes albite) 25%, chlorite 10%, sericite 5%, K-feldspar and magnetite each 2% and traces of rutile, apatite, zircon, pyrite and chalcopyrite.

Interpretation and comment: It is interpreted that the sample represents a porphyritic dacite that has experienced strong hydrothermal alteration and veining (tending to hydrothermal breccia). It formerly contained scattered plagioclase phenocrysts, prismatic ferromagnesian material (e.g. hornblende) and a few smaller grains of quartz, in a finely granular quartzofeldspathic groundmass. Pervasive alteration of propylitic type was imposed, causing considerable replacement of phenocrystal and groundmass feldspar by albite, variable sericite and minor chlorite, with all ferromagnesian material being chloritised. Abundant network veining occurs, containing quartz, with minor associated chlorite, magnetite and trace pyrite and chalcopyrite. Adjacent to the veins, the host rock also contains a little magnetite and traces of chalcopyrite and pyrite. There was minor later emplacement of a few thin chlorite (-sericite) veins.

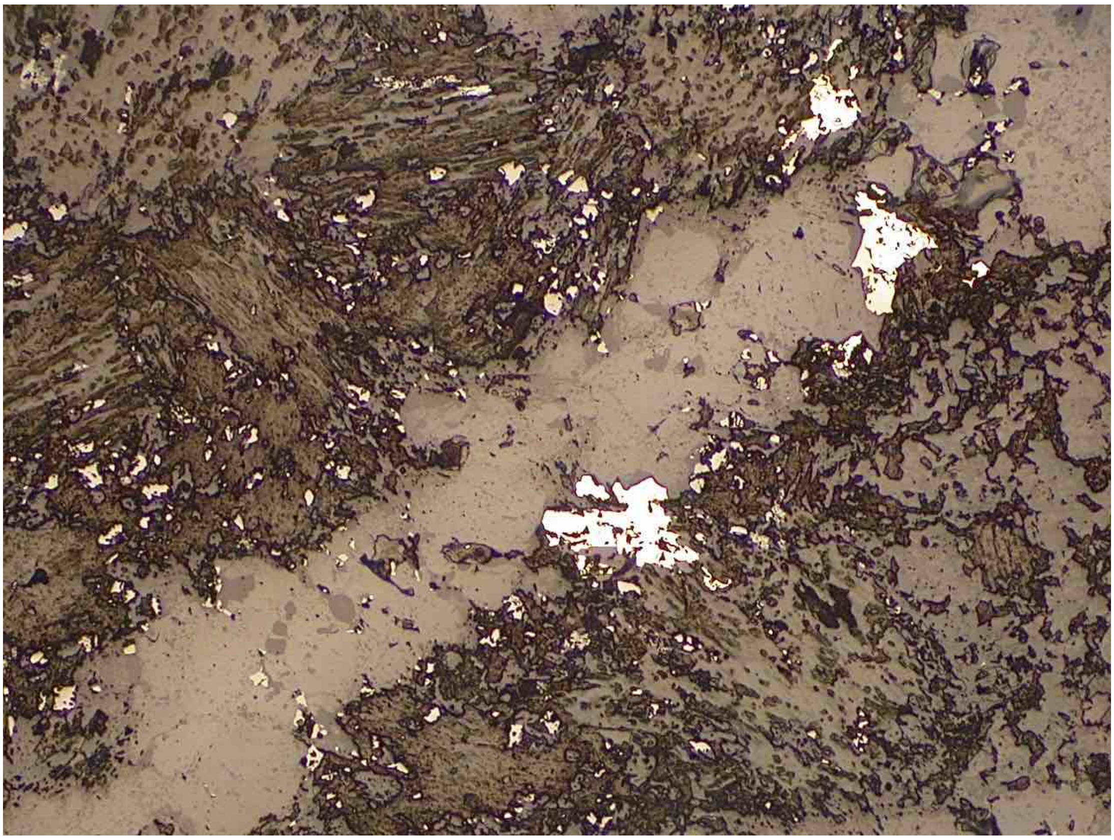

Fig. 20: Quartz vein containing a few aggregates of chalcopyrite ± pyrite (bright) and cutting altered host rock. At left are a few chlorite pseudomorphs after former hornblende, with these sites also containing a little fine grained disseminated magnetite (pale grey) and chalcopyrite. Plane polarised reflected light, field of view 2 mm across.

SMD015 162.6 m PTS

Summary: Porphyritic microtonalite, transitional to dacite, showing well preserved relict texture, and having moderate to strong hydrothermal alteration and abundant veining by quartz (-magnetite-chlorite). The rock retains plagioclase phenocrysts, although these are partly altered, and original hornblende prisms are completely altered. The phenocrystal phases occurred in a finely inequigranular groundmass of plagioclase and quartz, with minor K-feldspar and altered ferromagnesian material. Veining is locally intersecting and is dominated by fine to medium grained quartz, with minor chlorite, irregularly distributed magnetite and a tiny trace of chalcopyrite and pyrite. About the veins, minor K-feldspar and magnetite developed, but most alteration in the rock is of retrograde, propylitic type, with albite, sericite and trace chlorite and epidote developed from plagioclase, and chlorite (-magnetite-rutile) from ferromagnesian material. A few thin chlorite veins cut the earlier quartz-rich veins.

Handspecimen: The drill core sample is composed of a strongly veined porphyritic intermediate to felsic igneous rock, displaying abundant white, blocky feldspar (e.g. plagioclase) phenocrysts up to 6 mm across and smaller, dark grey-green, altered prismatic ferromagnesian grains (e.g. hornblende) up to 3 mm long, in a fine grained, grey quartzofeldspathic groundmass (Fig. 21). It is likely that the rock has moderate pervasive alteration to chlorite and sericite. An array of generally sub-parallel veins occur at a high angle to the core axis, but there are also other veins at differing orientations, so as to make a network (Fig. 21). Veins are up to 1 cm wide, are locally banded and contain abundant quartz, with variable amounts of fine grained dark magnetite. Due to the presence of magnetite, the sample is strongly magnetic, with susceptibility up to 9090 x 10^{-5} SI.

Fig. 21: Drill core sample displaying porphyritic texture in microtonalite, with network veining by quartz and fine grained magnetite (dark grey). Host rock has moderate chlorite-sericite alteration.

Petrographic description

a) Primary rock characteristics: In the section, approximately 40% of the sample constitutes quartz-rich veins, with the remainder being porphyritic host rock. The latter has well-preserved primary texture, with abundantly scattered blocky plagioclase phenocrysts up to 5 mm across, and pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 2 mm long, enclosed in a generally finely inequigranular groundmass (Fig. 22). Grainsize of the groundmass is mostly <0.2 mm, with abundant plagioclase and quartz, minor K-feldspar and (altered) ferromagnesian material, a little FeTi oxide (now altered) and trace apatite. The primary characteristics of the rock indicate that it represents a porphyritic hornblende microtonalite, transitional to dacite.

b) Alteration and structure: Moderate to strong hydrothermal alteration was imposed and abundant veining occurred. It is possible that there was an early phase of alteration associated with emplacement of the major quartz-rich veins, indicated by a little finely disseminated magnetite, as well as K-feldspar, adjacent to the veins. Fine to medium grained, inequigranular quartz dominates the veins, but there is also irregularly distributed fine grained magnetite (Fig. 22), a little chlorite and a tiny trace of chalcopyrite and pyrite. The rock was evidently affected by moderate to strong retrograde alteration of propylitic type, indicated by complete replacement of ferromagnesian material by chlorite, with a little magnetite and trace rutile. Although some fresh plagioclase remains, there has also been variable replacement by albite and sericite, with a little chlorite and trace epidote and magnetite. Igneous FeTi oxide was completely replaced by chlorite and rutile, and in the groundmass, there was minor development of sericite and chlorite. Probably related to the retrograde alteration, a couple of thin, sub-planar chlorite veins occur, cutting the earlier quartz-rich veins.

c) Mineralisation: The sample contains minor fine grained magnetite, mostly in the quartz-rich veins, where it locally forms aggregates up to 0.5 mm across (Fig. 22). The veins also host a tiny trace of fine grained chalcopyrite and pyrite. A little magnetite also occurs in the adjacent altered host rock, e.g. at former ferromagnesian sites.

Mineral Mode (by volume): quartz 50%, plagioclase (includes albite) 30%, chlorite 8%, K-feldspar 5%, magnetite 4%, sericite 2% and traces of rutile, apatite, epidote, pyrite and chalcopyrite.

Interpretation and comment: It is interpreted that the sample is an altered and veined porphyritic microtonalite, transitional to dacite. It retains plagioclase phenocrysts, but original hornblende prisms are completely altered, and a finely inequigranular groundmass of plagioclase and quartz, with minor K-feldspar and altered ferromagnesian material. Veining is dominated by quartz, with minor chlorite, magnetite and trace chalcopyrite and pyrite. About the veins, minor K-feldspar and magnetite developed, but most alteration is of retrograde, propylitic type, with albite, sericite and trace chlorite and epidote developed from plagioclase, and chlorite (-magnetite-rutile) from ferromagnesian material. A few thin chlorite veins cut the earlier quartz-rich veins.

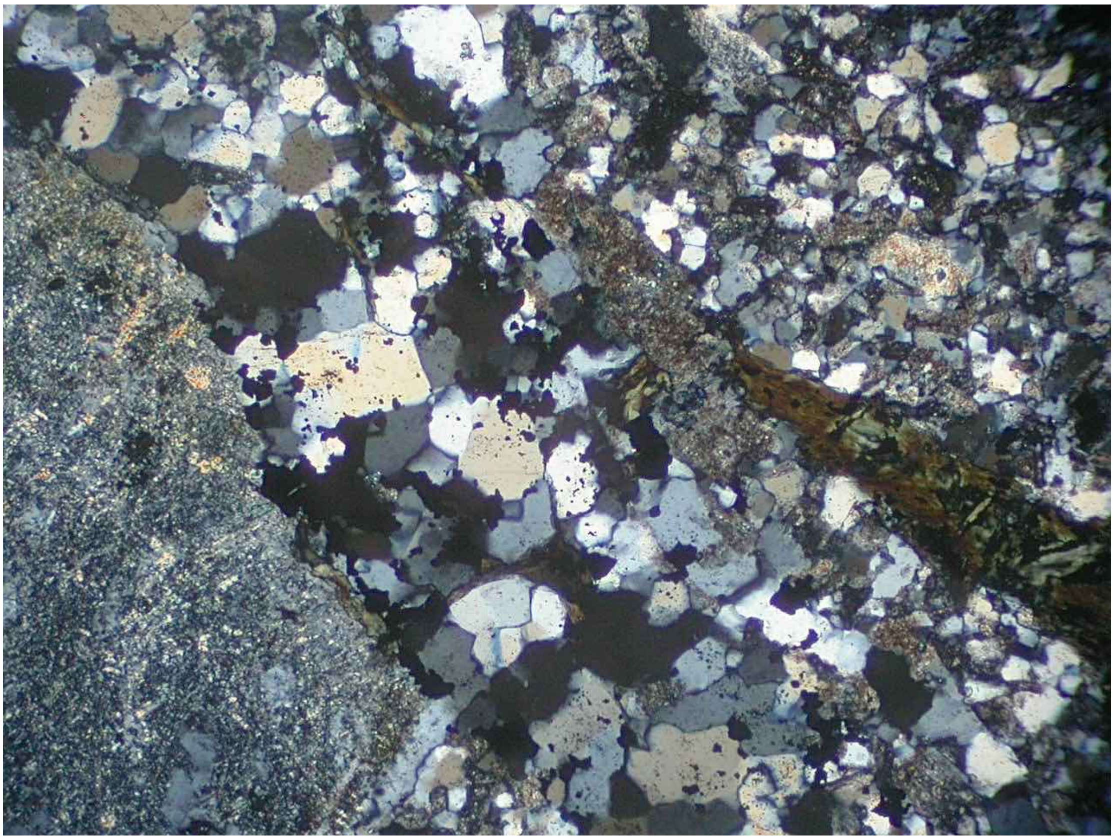

Fig. 22: Diffuse vein containing inequigranular quartz and fine grained magnetite (black) cutting diagonally across the porphyritic microtonalite host. At left is part of a weakly sericitised plagioclase phenocryst and at right is part of a chlorite-altered hornblende phenocryst (dark khaki). Transmitted light, crossed polarisers, field of view 2 mm across.

SMD015 168.25 m PTS

Summary: Strongly hydrothermally altered porphyritic dacite, with a few veins that locally contain chalcopyrite and pyrite. The rock retains partly altered plagioclase phenocrysts and a few relict quartz phenocrysts. Former small grains of ferromagnesian material (e.g. hornblende) and FeTi oxide are completely altered and the original fine grained groundmass (probably containing plagioclase, alkali feldspar and quartz) was strongly altered. The alteration assemblage is dominated by fine grained sericite, with minor clay, albite and quartz (e.g. in groundmass), with traces of rutile, pyrite and chalcopyrite. In part of the sample, there is veining by quartz, sericite, pyrite and chalcopyrite, as well as scattered aggregates of pyrite and/or chalcopyrite. One chalcopyrite aggregate shows trace development of digenite and bornite (maybe a deep supergene alteration process).

Handspecimen: The drill core sample is composed of a strongly hydrothermally altered and locally veined, creamy-coloured porphyritic felsic igneous rock (Fig. 23). It contains scattered, partly altered feldspar (e.g. plagioclase) phenocrysts up to 5 mm across and a few grey quartz phenocrysts up to 2 mm across in a fine grained altered quartzofeldspathic groundmass (Fig. 23). The rock probably has sericite/clay alteration, and there are a few irregular to veinlike aggregates up to 1-2 mm wide containing pyrite, chalcopyrite and quartz (Fig. 23). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

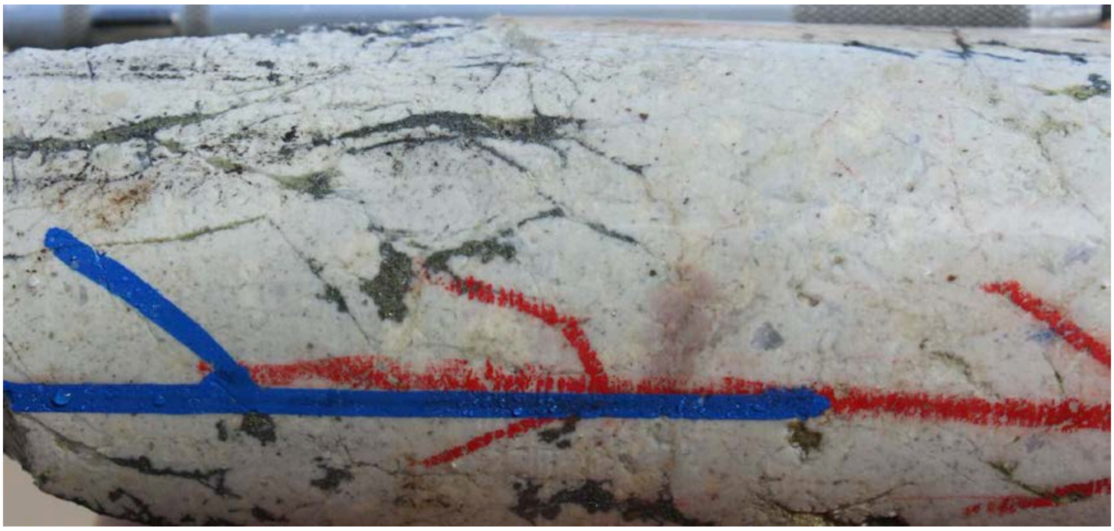

Fig. 23: Drill core sample showing pale coloured, sericite-altered porphyritic dacite, with a few thin veinlets containing pyrite and chalcopyrite (dark).

Petrographic description

a) Primary rock characteristics: In the section, it is evident that the rock is strongly altered, but relict porphyritic texture is moderately well preserved (Fig. 24). There are scattered, partly altered plagioclase phenocrysts up to 5 mm across and a few relict quartz phenocrysts up to 2.5 mm across set in a fine grained altered groundmass (Fig. 24). In places, there are small pseudomorphs (up to 1 mm long) interpreted to be after a former prismatic ferromagnesian phase (e.g. hornblende) and uncommon pseudomorphs up to 1 mm across after former FeTi oxide grains. Traces of accessory apatite are noted at altered ferromagnesian sites and enclosed in plagioclase, and rare zircon is also noted at FeTi oxide sites. The groundmass is altered, but is speculated to have originally contains abundant plagioclase and alkali feldspar, with minor quartz. From the interpreted primary characteristics, the rock is considered to represent an altered porphyritic dacite.

b) Alteration and structure: Strong pervasive alteration effects were imposed, but there is some preservation of plagioclase phenocrysts, with these typically showing variable replacement by sericite (and perhaps locally to albite) (Fig. 24). All interpreted former ferromagnesian material was replaced by sericite, commonly with fringing low-birefringent clay (e.g. kaolinite) with traces of rutile and chalcopyrite, and similarly, all FeTi oxide was replaced by aggregates of rutile, with one or more of quartz, sericite and chalcopyrite. Alteration of the groundmass produced a fine grained turbid aggregate, probably dominated by sericite, but also including clay, quartz and possible albite. Sparsely scattered throughout in the groundmass are traces of pyrite and chalcopyrite. In part of the section, there are a few irregular to sub-planar veins up to 0.6 mm wide and in association with these, the host rock contains a few aggregates of pyrite and chalcopyrite (Fig. 25). Veins contain quartz and/or sericite (in places showing extensional growth texture), pyrite and chalcopyrite (Fig. 25). The alteration assemblage in the sample is considered to be of transitional phyllic-argillic type.

c) Mineralisation: The sample contains a little pyrite and chalcopyrite, with these mostly concentrated towards one end of the section that hosts a few veins. In the latter, there are a few grains of medium grained pyrite and a little chalcopyrite (aggregates up to 2 mm long), and in places adjacent, the rock has pyrite aggregates up to 2 mm across and irregularly distributed chalcopyrite up to 0.8 mm across (Fig. 25). One chalcopyrite aggregate shows slight replacement by digenite and bornite, perhaps reflecting an incipient deep supergene overprint.

Mineral Mode (by volume): plagioclase (including albite) 40%, sericite 30%, quartz 12%, clay 10%, alkali feldspar 5%, pyrite and chalcopyrite each 1% and traces of apatite, zircon, rutile, digenite and bornite.

Interpretation and comment: It is interpreted that the sample represents a porphyritic dacite, overprinted by alteration of phyllic-argillic type and with a few veins that locally contain chalcopyrite and pyrite. Plagioclase phenocrysts and a few relict quartz phenocrysts are largely retained but former small grains of ferromagnesian material (e.g. hornblende) and FeTi oxide are completely altered. The original groundmass (probably containing plagioclase, alkali feldspar and quartz) was strongly altered. The alteration assemblage is dominated by fine grained sericite, with minor clay, albite and quartz (e.g. in groundmass), with traces of rutile, pyrite and chalcopyrite. In part of the sample, there is veining by quartz, sericite, pyrite and chalcopyrite, as well as scattered aggregates of pyrite and/or chalcopyrite. One chalcopyrite aggregate shows trace development of digenite and bornite (maybe a deep supergene alteration process).

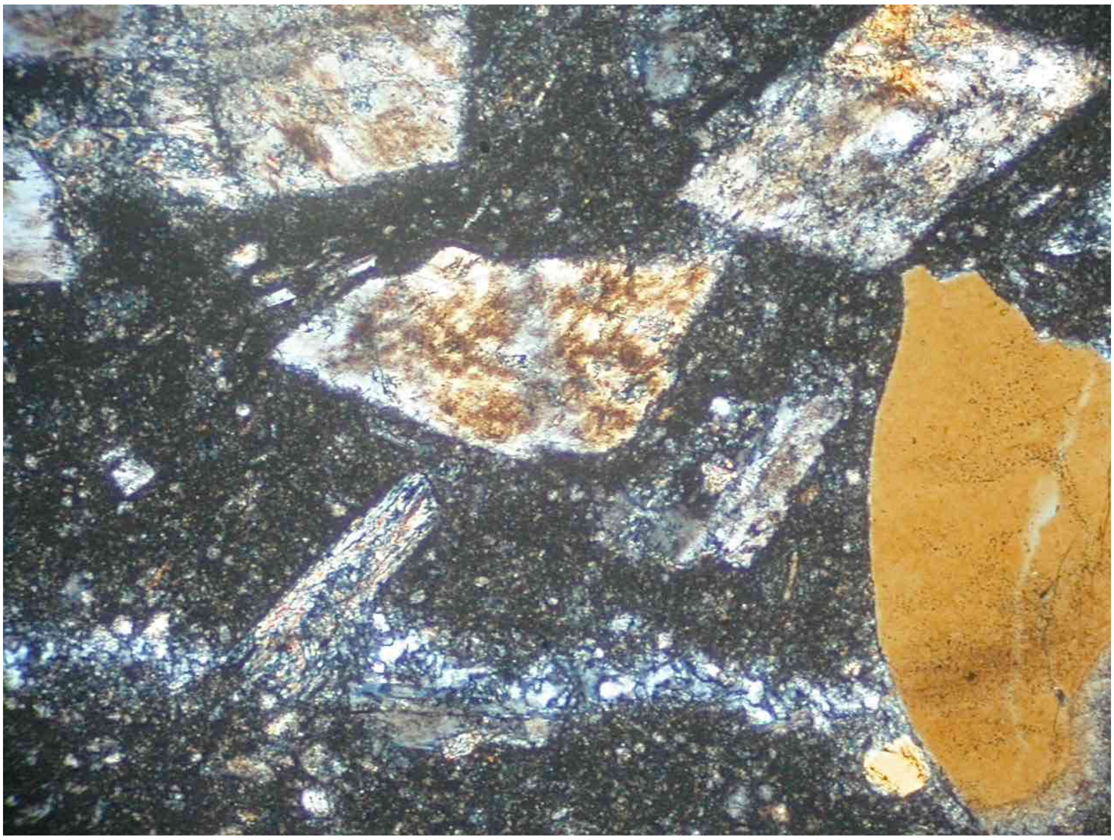

Fig. 24: Slightly sericitised plagioclase phenocrysts, a relict quartz phenocryst (right) and a sericitised ferromagnesian grain (lower centre left) in a fine grained turbid groundmass, hosting a small, fine grained quartz vein. Transmitted light, crossed polarisers, field of view 2 mm across.

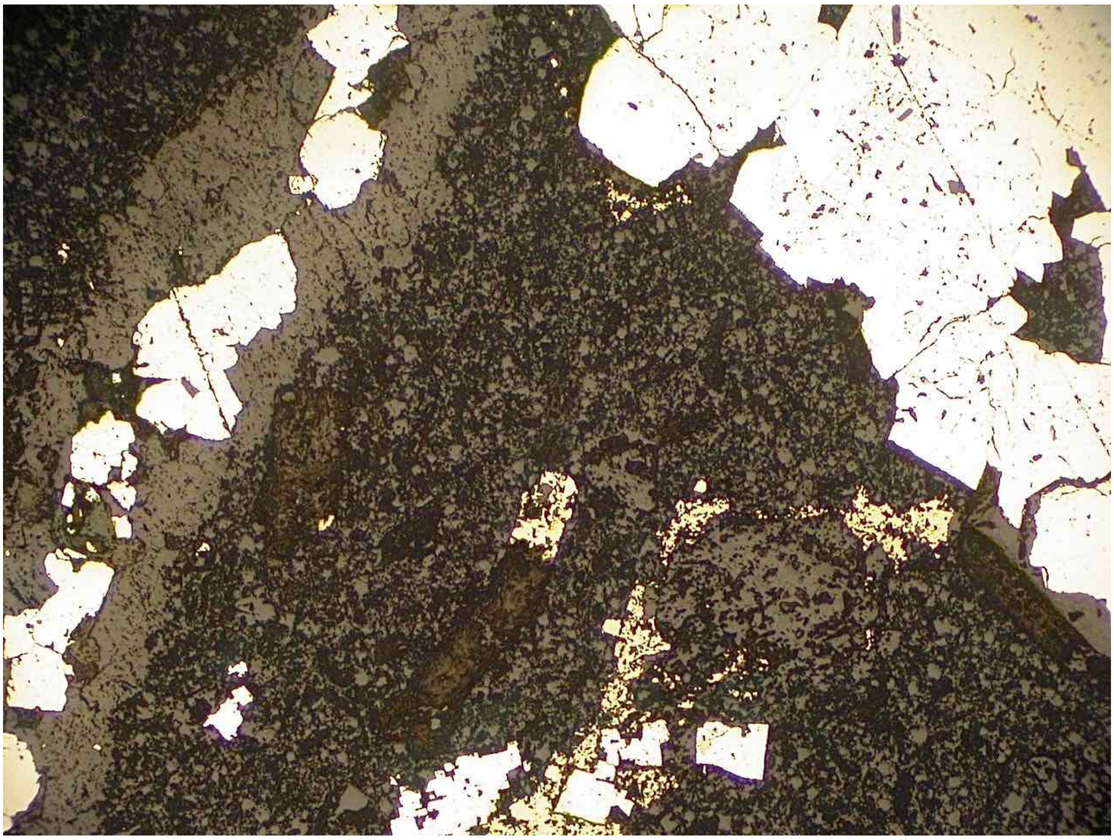

Fig. 25: Altered host rock containing aggregates of pyrite (pale creamy) and chalcopyrite (yellow) and cut by a quartz-pyrite vein at left. Plane polarised reflected light, field of view 2 mm across.

SMD015 168.8 m TS

Summary: Massive porphyritic dacite with moderate to strong alteration of transitional propylitic to argillic type. The rock has well preserved relict texture and there is some preservation of plagioclase and quartz phenocrysts. Smaller phenocrystal grains of ferromagnesian material (e.g. prismatic hornblende) and FeTi oxide are completely altered. The fine grained groundmass was originally plagioclase-rich, with minor quartz, alkali feldspar and ferromagnesian material. Imposed alteration led to some albitisation of plagioclase, but also replacement by sericite and clay (e.g. kaolinite), with ferromagnesian material being replaced largely by chlorite and minor clay, and FeTi oxide by leucoxene-rutile. A few thin discontinuous veins of sericite and/or clay occur in the altered rock.

Handspecimen: The drill core sample is composed of a massive, porphyritic felsic igneous rock, with moderate pervasive alteration. There are scattered large whitish feldspar (e.g. plagioclase) phenocrysts up to 8 mm across and a few grey quartz phenocrysts up to 4 mm across, as well as smaller, altered, dark grey-green ferromagnesian prisms (maybe former hornblende), occurring in a fine grained pale grey quartzofeldspathic groundmass (Fig. 26). The rock probably has pervasive sericite/clay and chlorite alteration. It is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

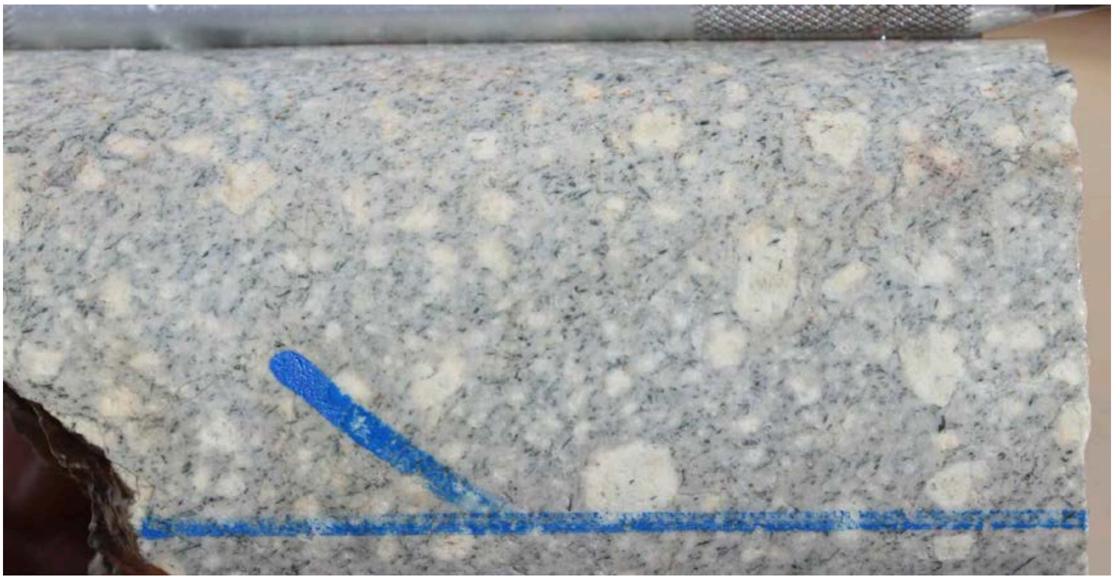

Fig. 26: Drill core sample of porphyritic dacite showing blocky whitish plagioclase phenocrysts and small, dark grey-green altered hornblende phenocrysts in a fine grained, pale grey, partly altered quartzofeldspathic groundmass.

Petrographic description

a) Primary rock characteristics: In the section, original porphyritic texture is well preserved and there is some retention of igneous plagioclase and quartz. The rock has scattered, partly altered blocky plagioclase phenocrysts and a few quartz phenocrysts up to 4 mm across (Fig. 27). In addition, there are pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 2.5 mm long (Fig. 27) and a few pseudomorphs after former FeTi oxide grains up to 1.2 mm across. Traces of apatite and zircon occur at former FeTi oxide sites and rare apatite and zircon are also present in the groundmass. The latter was fine grained and holocrystalline, being probably rich in plagioclase and having minor quartz, alkali feldspar and ferromagnesian material (Fig. 27). The interpreted primary textural and mineralogical characteristics of the rock indicate that it was a porphyritic hornblende dacite.

b) Alteration and structure: The igneous rock experienced moderate to strong hydrothermal alteration. Phenocrystal and groundmass plagioclase might be partly albitised, as well as being variably replaced by fine grained sericite and a low-birefringent clay phase (e.g. kaolinite, mainly in the central parts of large grains). All former ferromagnesian grains were replaced by pale green chlorite, local patches of clay and traces of leucoxene-rutile (Fig. 27). FeTi oxide grains were completely pseudomorphed by leucoxene-rutile and in the groundmass, there is minor sericite and chlorite development throughout. A few thin (<0.2 mm) anastomosing veins of sericite, as well as paragenetically later clay, cut the altered rock. The observed alteration assemblage is interpreted to be transitional between propylitic and argillic types.

c) Mineralisation: No sulphide minerals are observed. Original igneous FeTi oxide grains are replaced by leucoxene-rutile.

<u>Mineral Mode (by volume)</u>: plagioclase (including albite) 65%, quartz 15%, chlorite 7%, alkali feldspar 5%, sericite 4%, clay (e.g. kaolinite) 3%, leucoxene-rutile 1% and traces of apatite and zircon.

<u>Interpretation and comment</u>: It is interpreted that the sample is an altered porphyritic dacite. It has well preserved relict texture and plagioclase and quartz phenocrysts are commonly preserved. Smaller phenocrystal grains of ferromagnesian material (e.g. prismatic hornblende) and FeTi oxide are completely altered. The fine grained groundmass was originally plagioclase-rich, with minor quartz, alkali feldspar and ferromagnesian material. Pervasive propylitic-argillic alteration was imposed, causing variable albitisation of plagioclase, as well as replacement by sericite and clay (e.g. kaolinite), with ferromagnesian material being replaced largely by chlorite and minor clay, and FeTi oxide by leucoxene-rutile. A few thin discontinuous veins of sericite and/or clay occur in the altered rock.

Fig. 27: Porphyritic dacite, with largely preserved plagioclase (upper right) and quartz (lower left) phenocrysts, and with an altered prismatic hornblende phenocryst near centre. The latter has replacement by chlorite and clay. The fine grained groundmass has abundant plagioclase, with minor quartz. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD015 194.9 m PTS

Summary: Strongly altered porphyritic andesite, with several veins. Due to imposed alteration, relict texture is poorly preserved, but it is likely that the rock originally contained scattered feldspar (e.g. plagioclase) phenocrysts as well as a ferromagnesian phase, enclosed in a fine grained groundmass. The rock experienced pervasive argillic-propylitic alteration, with replacement by fine grained chlorite, a clay phase (e.g. kaolinite), minor quartz, rutile and pyrite, and trace chalcopyrite. A paragenetically early array of intersecting quartz-rich veins was emplaced, with these also containing a little chlorite and trace pyrite and chalcopyrite, and the rock was later cut by pyrite-rich veining, with associated clay, chlorite, sericite and quartz, and having sericitic alteration selvedges.

Handspecimen: The drill core sample is composed of a strongly altered and veined, porphyritic igneous rock, with a fine grained groundmass and probably originally being of intermediate composition. There are scattered whitish, altered feldspar phenocrysts up to 3 mm across and a few dark grey-green pseudomorphic aggregates after former ferromagnesian grains up to 2.5 mm long, set in a pale grey-green fine grained groundmass (Fig. 28). The rock is cut by an array of early pale grey quartz-rich veins up to 4 mm wide, with these subsequently being cut by a couple of sub-planar pyrite veins with pale creamy sericitic alteration selvedges (Fig. 28). It is likely that the rock has strong pervasive alteration to sericite/clay and chlorite, with a little disseminated pyrite. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 28: Drill core sample of altered porphyritic andesite, showing earlier network quartz-rich veins cut by pyrite veins bordered by pale sericitic alteration selvedges.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is poorly preserved, due to strong alteration effects and veining. It is apparent that the rock originally contained a few blocky feldspar (e.g. plagioclase) phenocrysts up to 3 mm across and there are possible pseudomorphic aggregates up to 2 mm across after a former ferromagnesian phase (e.g. hornblende and/or pyroxene). There are also altered microphenocrysts of FeTi oxide up to 0.7 mm long, with all of these phases occurring in what would have been a fine grained groundmass, likely to have contained abundant feldspar and ferromagnesian material, minor

FeTi oxide and trace apatite. From the preserved primary characteristics, the original rock is tentatively identified as a porphyritic andesite.

b) Alteration and structure: The igneous rock underwent strong pervasive hydrothermal alteration and emplacement of several veins. Much of the rock was replaced by a fine grained assemblage of chlorite and a low-birefringent clay phase (e.g. kaolinite, mainly at former feldspar and groundmass sites), with minor quartz, a little rutile, and in places, a little pyrite and trace chalcopyrite. Two phases of veining occurred, with the earlier vein set being sub-planar, up to 4 mm wide and locally intersecting, being dominated by fine to medium grained quartz, with a little chlorite and traces of pyrite and chalcopyrite (Fig. 29). The quartz-rich veining was cut by a couple of later, sub-planar veins up to 1.5 mm wide containing abundant medium grained pyrite, with associated clay, chlorite, sericite and minor quartz, and in the adjacent host rock, bordered by a prominent alteration selvedge up to 2 mm wide of fine grained sericite and quartz, with minor pyrite. The alteration assemblage in the sample is interpreted as being of argillic-propylitic type.

c) Mineralisation: In the altered host rock, there is a little disseminated pyrite and trace chalcopyrite, mostly adjacent to the veins (Fig. 29). Early quartz-rich veining has traces of pyrite and chalcopyrite, and the latter veining contains abundant medium grained pyrite (individual grains up to 1.5 mm), with the sericitic alteration selvedges also containing minor pyrite.

Mineral Mode (by volume): quartz 35%, chlorite 30%, clay (e.g. kaolinite) 25%, sericite 5%, pyrite 4%, rutile 1% and traces of chalcopyrite and apatite.

Interpretation and comment: It is interpreted that the sample represents a strongly altered and veined porphyritic andesite. Relict texture is poorly preserved, but it is likely that the rock formerly contained scattered feldspar (e.g. plagioclase) and ferromagnesian phenocrysts, enclosed in a fine grained groundmass. Pervasive alteration of argillic-propylitic type was imposed, with replacement by chlorite, a clay phase (e.g. kaolinite), minor quartz, rutile and pyrite, and trace chalcopyrite. A paragenetically early array of intersecting quartz-rich veins was emplaced, with these also containing a little chlorite and trace pyrite and chalcopyrite, and the rock was later cut by pyrite-rich veining, with associated clay, chlorite, sericite and quartz, and having sericitic alteration selvedges.

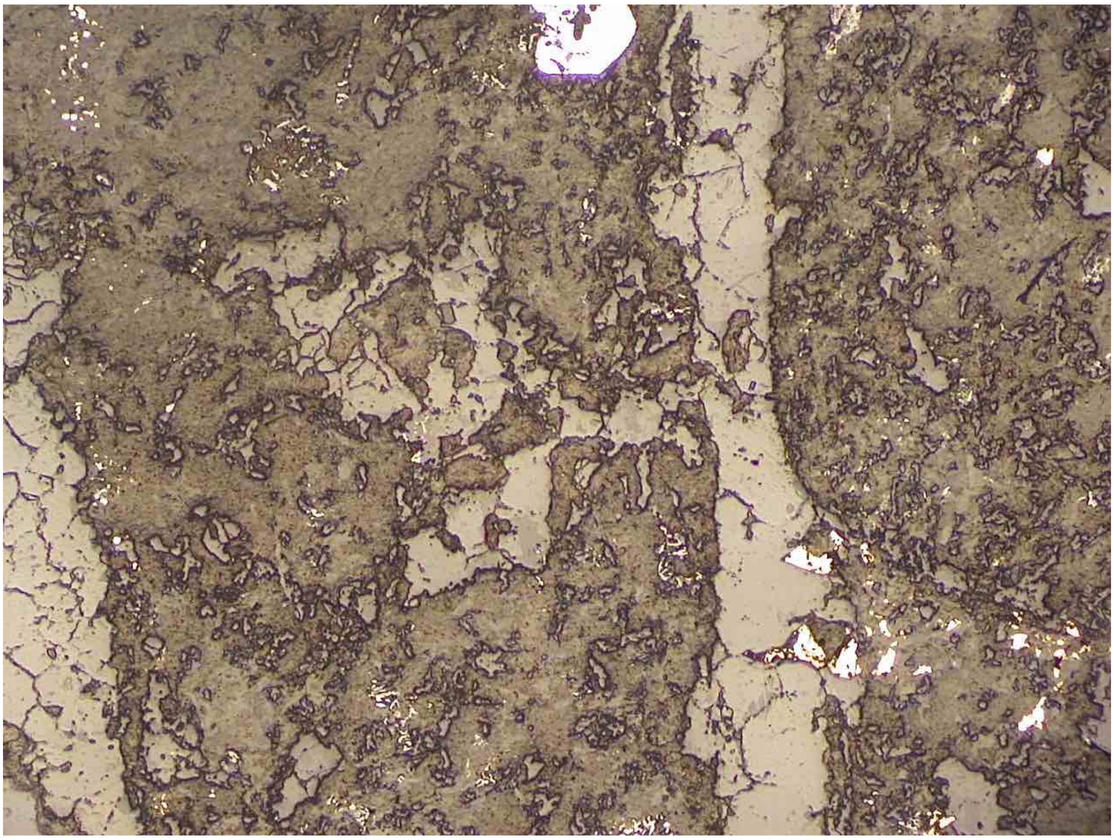

Fig. 29: Quartz-rich veins cutting strongly altered andesitic host rock that is replaced by chlorite, clay, minor quartz, pyrite (top centre), rutile and chalcopyrite (lower right). Plane polarised reflected light, field of view 2 mm across.

SMD015 196.6 m PTS

Summary: Massive sulphide material, showing crude banding and composed largely of pyrite and chalcopyrite, with subordinate amounts of bornite, quartz and sericite. No relict texture after a protolith is recognised and the rock could be the product of complete hydrothermal replacement, or represent hydrothermal infill. Sulphides are intergrown with, and enclose irregular to elongate masses of fine to medium grained quartz, fine grained sericite and a trace of anhydrite. Abundant pyrite is paragenetically early and invaded by abundant chalcopyrite and associated bornite. Within chalcopyrite-bornite domains, there are uncommon small grains of galena, chalcocite and ?wittichenite.

Handspecimen: The drill core sample is composed of a weakly banded aggregate of fine to medium grained massive sulphides, dominated by pyrite and chalcopyrite that locally contain considerable bornite, apparently concentrated into bands in places (Fig. 30). Some bands contain significant pale grey quartz. The rock could be partly leached, manifest as a few scattered cavities up to several millimetres across. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

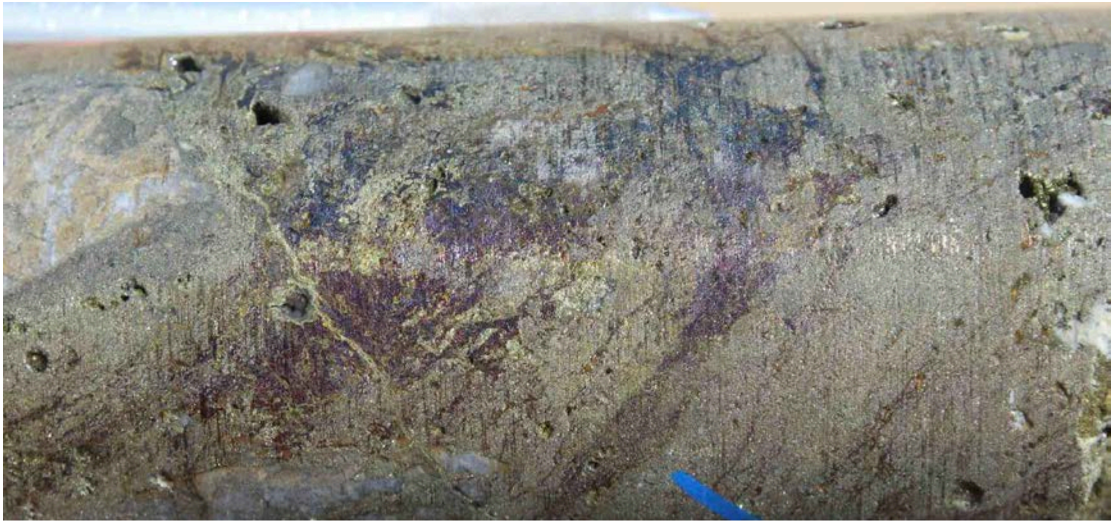

Fig. 30: Drill core sample of massive sulphides, showing crude banding and a few voids (dark). Much of the rock is composed of fine to medium grained pyrite and chalcopyrite, with subordinate bornite, locally concentrated into bands.

Petrographic description

a) Primary rock characteristics: In the section, no protolith material is recognised (e.g. no textural or mineralogical relicts) and the sample probably represents the product of complete hydrothermal replacement and/or that it represents hydrothermal infill (e.g. of a vein). Apart from abundant sulphides, the rock contains a subordinate gangue component of quartz and sericite, with a trace of anhydrite.

b) Alteration and structure: The sample is composed of largely massive, fine to medium grained sulphides, with approximately a quarter of the rock being interstitial and intergrown gangue phases, and there are a few irregular voids up to several millimetres across. Gangue phases occur as small irregular masses enclosed by sulphides, grading into larger, irregular to elongate masses up to several millimetres across, typically intergrown with sulphides (Fig. 31). Fine to medium grained quartz is the most common gangue phase, forming inequigranular grains up to 0.5 mm across, with textures suggesting recrystallization and local development of a preferred orientation. Quartz is commonly associated with aggregates of fine grained sericite, and there is a gradation into sericite-rich masses. Traces of anhydrite occur with quartz, but appear to be more prevalent as inclusions in sulphides, where largest aggregates are up to 0.5 mm across. Pyrite, chalcopyrite and bornite are the dominant sulphides (Fig. 31), with masses of fractured and otherwise disrupted pyrite that are apparently invaded by composite masses of chalcopyrite ± bornite. The latter mineral is locally more concentrated into crude bands a few millimetres wide. Within chalcopyrite-bornite domains, there are uncommon small grains of galena, chalcocite and rare ?wittichenite (Fig. 32).

c) Mineralisation: The sample is composed of abundant sulphides, with paragenetically early pyrite forming strong disseminations through to largely massive aggregates up to a few millimetres across. Pyrite shows fracturing and disruption, with individual grains now up to 0.4 mm across and apparently invaded by abundant chalcopyrite and subordinate bornite (Fig. 31). The latter mineral is locally more concentrated into crude bands. In chalcopyrite-bornite domains, there are a few irregular grains of galena and chalcocite up to 0.2 mm across, as well as a rare phase forming grains up to 0.1 mm across (Fig. 32). The last phase is pale grey-brown and nearly isotropic and tentatively identified as wittichenite (Cu_3BiS_3).

Mineral Mode (by volume): chalcopyrite and pyrite each 35%, quartz 12%, bornite 10%, sericite 7% and traces of anhydrite, galena, chalcocite and ?wittichenite.

Interpretation and comment: It is interpreted that the sample is composed of weakly banded massive sulphides. It is dominated by fine to medium grained pyrite and chalcopyrite, with subordinate amounts of bornite, quartz and sericite. No relict texture after a protolith is recognised and the rock could be the product of complete hydrothermal replacement, or represent hydrothermal infill. Sulphides are intergrown with, and enclose irregular to elongate masses of quartz, sericite and a trace of anhydrite. Abundant pyrite is paragenetically early and invaded by abundant chalcopyrite and associated bornite. Within chalcopyrite-bornite domains, there are uncommon small grains of galena, chalcocite and ?wittichenite.

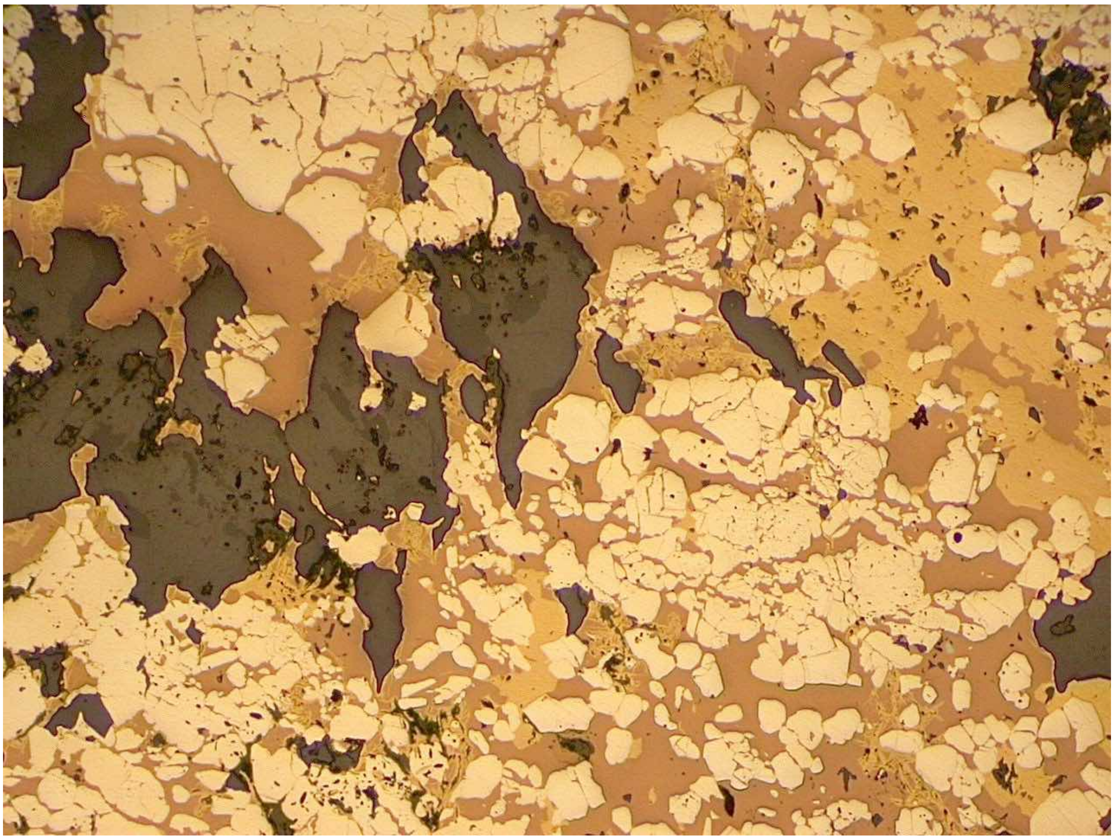

Fig. 31: Largely massive sulphide aggregate, with the dark grey inclusions being mostly quartz. Paragenetically early pyrite (pale creamy) is invaded by chalcopyrite (yellow) and bornite (pink-brown). Plane polarised reflected light, field of view 2 mm across.

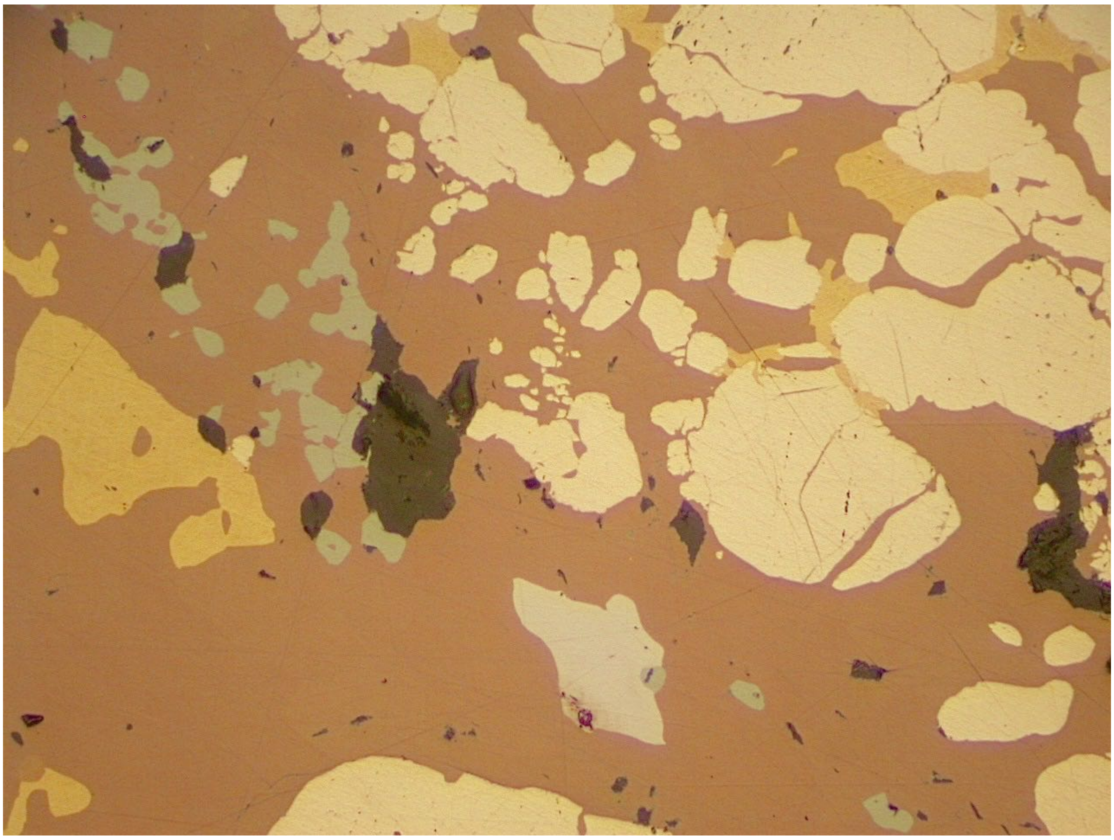

Fig. 32: Pyrite (pale creamy) enclosed by bornite (pink-brown) and minor chalcopyrite (yellow) with small grains of galena (pale silvery grey) and chalcocite (pale blue-grey) enclosed in bornite. Plane polarised reflected light, field of view 0.5 mm across.

SMD015 198.0 m PTS

Summary: Very strongly hydrothermally altered porphyritic dacite, containing probably two vein sets, one of which hosts abundant bornite. The rock has moderate preservation of primary texture, indicating that it contained scattered phenocrysts of feldspar (e.g. plagioclase), quartz and a prismatic ferromagnesian phase (e.g. hornblende) in a fine grained quartzofeldspathic groundmass. Phyllic alteration was imposed, with an assemblage of fine grained sericite and quartz, with minor pyrite, a little bornite and traces of rutile, chalcopyrite, chalcocite and digenite being formed. A couple of early sub-planar veins were emplaced, with these being quartz-rich and containing minor pyrite and trace bornite. These veins were cut by later veining with local extensional growth textures, containing quartz, bornite and pyrite, with local sericite, chalcocite and trace digenite and chalcopyrite. Textures in the Cu sulphides indicate that they are paragenetically later than pyrite and that they could be largely due to hypogene processes.

Handspecimen: The drill core sample is composed of a strongly hydrothermally altered and veined, porphyritic felsic igneous rock. It contains grey quartz and altered feldspar phenocrysts up to a few millimetres across in a pale grey to creamy-coloured, fine grained altered groundmass (Fig. 33). The rock probably has strong phyllic (sericite-quartz) alteration, with a little disseminated pyrite, and is cut by a couple of pale grey, sub-planar quartz-rich veins and subsequently by veins up to a few millimetres wide of bornite, pyrite and quartz at moderate to high angles to the core axis (Fig. 33). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 33: Drill core sample of strongly phyllic altered porphyritic dacite, showing early quartz veining cut by later veins rich in bornite (dark).

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved, but the rock is evidently very strongly hydrothermally altered and veined. There are scattered pseudomorphs after former blocky feldspar phenocrysts (e.g. plagioclase) up to 7 mm across, a few relict quartz up to 3 mm and pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 3 mm long (Fig. 34). The rock evidently also contained a few microphenocrysts of FeTi oxide and a fine grained groundmass component (occupying ~60% of the rock) that was probably of quartzofeldspathic composition. In the groundmass, there are sparsely scattered, but characteristic, small quartz grains up to 0.2 mm across with squarish outlines. From the preserved primary characteristics, the original rock is tentatively interpreted as a porphyritic dacite.

b) Alteration and structure: Very strong hydrothermal alteration was imposed along with emplacement of several veins. Feldspar phenocrysts were replaced by fine grained sericite aggregates, in places with pyrite and a little bornite and trace chalcopyrite and digenite, with ferromagnesian phenocrysts being replaced by sericite, quartz, pyrite, bornite and trace rutile, chalcocite and digenite, and FeTi oxide by rutile, pyrite, bornite and chalcopyrite (Figs 34, 35). The altered rock appears to host two different vein sets. Earlier veins are sub-planar and discontinuous, up to 4 mm wide, dominated by fine to medium grained quartz and also containing minor pyrite and trace bornite. These veins are cut by a few veins up to 3 mm wide containing quartz, bornite and pyrite, local sericite and chalcocite, and traces of digenite and chalcopyrite (Fig. 35). In some of the latter veins, there is locally evident extensional growth texture developed, with fibre quartz and oriented sericite aggregates normal to the vein walls. Pervasive alteration in the sample is consistent with phyllic type.

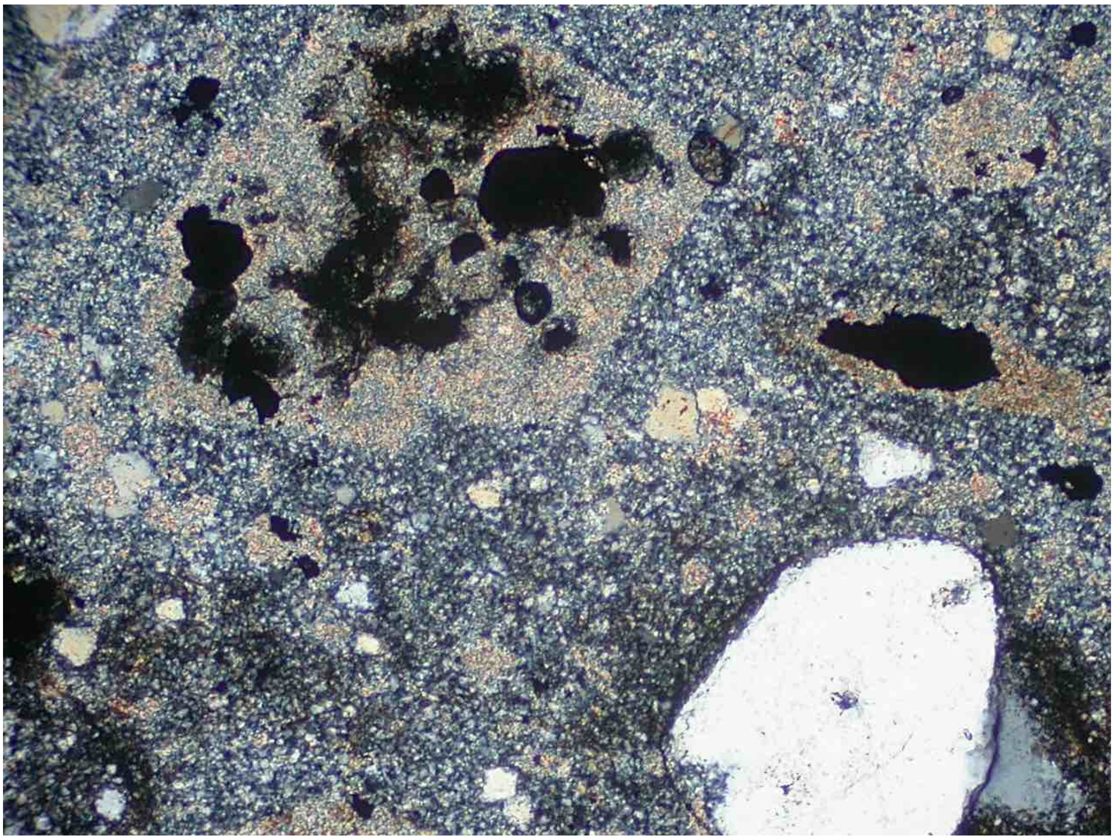

Fig. 34: Altered porphyritic dacite containing a relict quartz phenocryst (lower right), and altered feldspar and ferromagnesian grains (replaced by sericite and sulphides) in a fine grained quartz-sericite-altered groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: In the altered host rock, there is minor disseminated host rock and a little accompanying bornite (and trace chalcocite, digenite and chalcopyrite) as part of the alteration assemblage (e.g. at former feldspar and ferromagnesian sites, and in the groundmass) (Figs 34, 35). In the earlier veins, there is minor pyrite and trace bornite, and in the later veins, bornite is commonly abundant in aggregates up to a few millimetres across, in places associated with considerable pyrite (up to 0.8 mm), local chalcocite (up to 1.5 mm) and traces of digenite, chalcopyrite and rare covellite. Textures indicate that the Cu sulphides are paragenetically later than pyrite and that chalcocite and digenite are in equilibrium with bornite (and may not be supergene alteration products).

Mineral Mode (by volume): quartz 50%, sericite 35%, pyrite and bornite each 7% and traces of rutile, chalcocite, digenite, chalcopyrite and covellite.

Interpretation and comment: It is interpreted that the sample represents a former porphyritic, hornblende-bearing dacite that experienced very strong phyllic alteration and emplacement of several veins. Primary texture is moderately retained, indicating that it contained scattered phenocrysts of feldspar (e.g. plagioclase), quartz and hornblende in a fine grained quartzofeldspathic groundmass. Alteration formed abundant sericite and quartz, with minor pyrite, a little bornite and traces of rutile, chalcopyrite, chalcocite and digenite. A couple of early sub-planar quartz-rich veins were emplaced, with these containing minor pyrite and trace bornite. These were later cut by veins with local extensional growth textures, containing quartz, bornite and pyrite, with local sericite, chalcocite and trace digenite and chalcopyrite. Textures in the Cu sulphides indicate that they are paragenetically later than pyrite and that they could be largely due to hypogene processes.

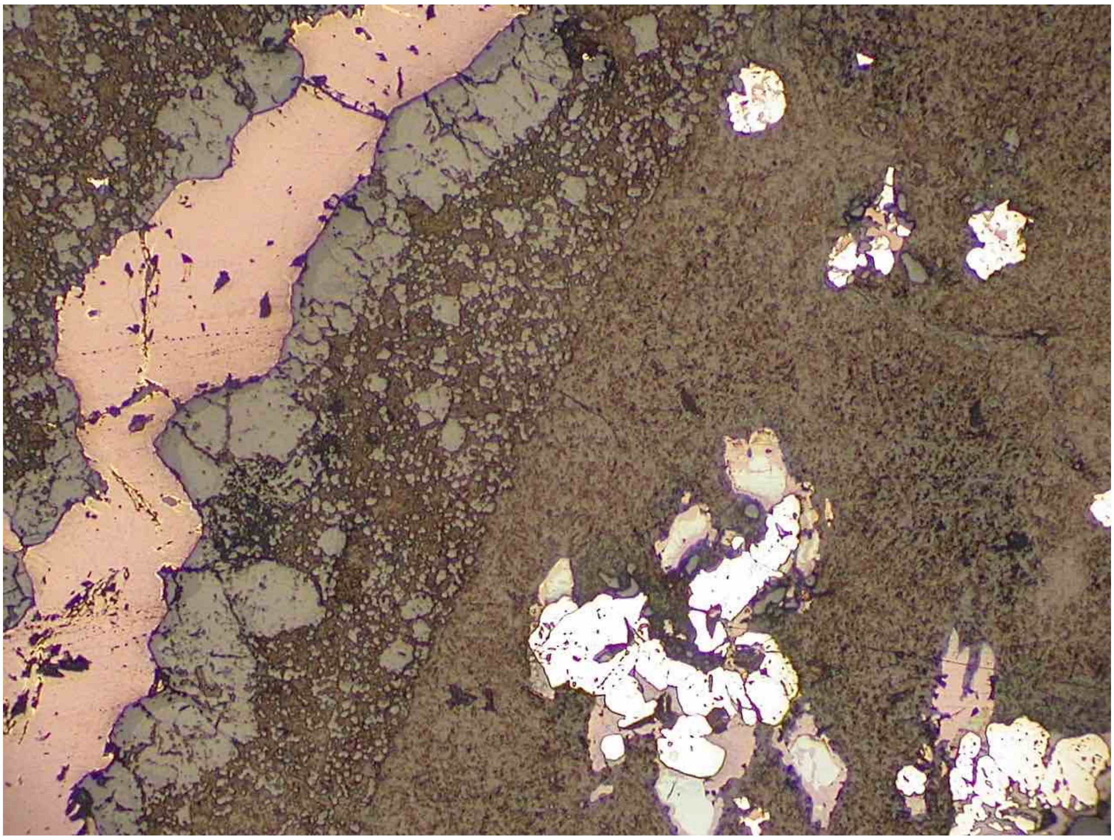

Fig. 35: Quartz-bornite vein (left) adjacent to a large, sericite-altered feldspar phenocryst (right) containing aggregates of pyrite (whitish), bornite and chalcocite (pale grey). Plane polarised reflected light, field of view 2 mm across.

SMD015 204.1 m PTS

Summary: Strongly hydrothermally altered, porphyritic andesite, cut by a few quartz-sulphide veins. There is moderate preservation of primary texture, indicating that the original rock contained rather sparse phenocrysts of feldspar (e.g. plagioclase) and ferromagnesian material (e.g. hornblende, pyroxene) in a fine grained groundmass of feldspar and subordinate ferromagnesian material, a little FeTi oxide and possible quartz. Pervasive alteration is of transitional phyllic-propylitic type, with replacement by abundant sericite, subordinate quartz and chlorite, a little rutile, pyrite and chalcopyrite. Veining is dominated by quartz and pyrite, but there are zones with significant chlorite (in part as immediate alteration selvedges) and chalcopyrite (interstitial to pyrite and quartz).

Handspecimen: The drill core sample is composed of a strongly hydrothermally altered pale grey-brown to pale red-brown, porphyritic fine grained igneous rock, cut by a few sub-planar quartz-sulphide veins (Fig. 36). The rock has sparsely scattered whitish to pale grey-green altered phenocrysts (e.g. former feldspar) in a fine grained altered groundmass. It is likely that the rock has pervasive sericite-quartz alteration, perhaps with minor chlorite and disseminated pyrite. Veins are up to 2 cm wide, locally intersecting and at moderate to high angles to the core axis (Fig. 36). They contain grey quartz and disseminated to locally massive pyrite, as well as minor chlorite. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 36: Drill core sample of altered, fine grained, weakly porphyritic andesite, hosting a few veins of quartz, pyrite and minor chlorite and chalcopyrite. Andesite has pervasive strong alteration to sericite, quartz and subordinate chlorite.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved. There are sparsely scattered pseudomorphs after former feldspar (e.g. plagioclase) phenocrysts up to 2.5 mm across, and after a few blocky to prismatic ferromagnesian grains up to 1.5 mm across (Fig. 37). Based on relict shapes, the latter could have included hornblende and maybe pyroxene. The rock also contained scattered small FeTi oxide grains up to 0.4 mm, now completely altered, and occurring in what would have been a fine grained groundmass (Fig. 37). The latter probably contained abundant feldspar, subordinate ferromagnesian material, minor FeTi oxide, and possibly a little quartz. The preserved primary characteristics of the rock suggest that it was originally a porphyritic andesite.

b) Alteration and structure: The igneous rock experienced strong hydrothermal alteration and emplacement of a few veins. Original feldspar phenocrysts were replaced by fine grained sericite and ferromagnesian grains by chlorite ± sericite, quartz and trace rutile, pyrite and chalcopyrite (Fig. 37). Igneous FeTi oxide was replaced by rutile ± pyrite and chalcopyrite. In the groundmass, there was complete replacement by fine grained sericite, subordinate quartz, a little chlorite and traces of rutile, pyrite and chalcopyrite. A complex, compositionally banded major vein cuts the altered rock, along with a few narrower (up to 0.6 mm wide) subsidiary veins (fig. 37). The major vein is sub-planar, up to 2 cm wide and irregularly bordered by intense alteration selvedges of quartz + chlorite, with minor disseminated pyrite and trace chalcopyrite. In this vein, there are domains that vary from fine to medium grained quartz-rich to quartz-sulphide, to sulphide-rich, with all containing minor chlorite and late infill chalcedonic quartz, plus a little sericite. Sulphides are dominated by medium to coarse grained pyrite, but there is locally common interstitial chalcopyrite (Fig. 38). The major vein shows local imposed deformation effects, manifest in the growth of fibre texture quartz and aligned chlorite, oblique to the vein walls. Subsidiary veins contain varying proportions of quartz, chlorite, pyrite and chalcopyrite (Fig. 37). The alteration mineral assemblage is considered to be transitional between phyllic and propylitic types.

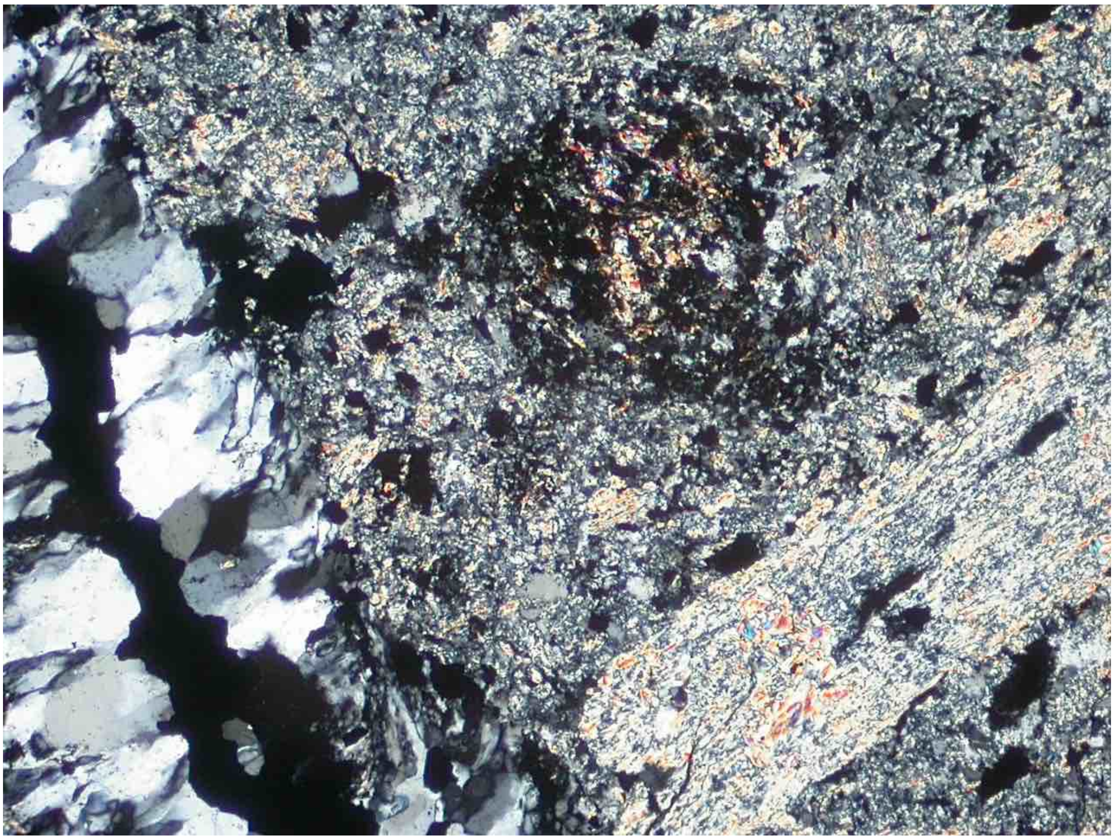

Fig. 37: Altered porphyritic andesite, with a sericite pseudomorph after a former feldspar phenocryst at right and a diffuse aggregate that includes chlorite, sericite, rutile and pyrite after a former ferromagnesian phenocryst (upper centre). At left is part of a subsidiary quartz-chalcopyrite vein. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: In the altered host rock, there is a little irregularly distributed pyrite and chalcopyrite, mostly adjacent to the major vein. In this vein, there is disseminated to locally massive medium to coarse grained pyrite (aggregates up to several millimetres), commonly with minor interstitial and fracture-controlled chalcopyrite (Fig. 38). Minor veins contain variable amounts of pyrite and chalcopyrite.

<u>Mineral Mode (by volume)</u>: sericite 45%, quartz (including chalcedony) 25%, pyrite 15%, chlorite 12%, chalcopyrite 2% and rutile 1%.

Interpretation and comment: It is interpreted that the sample is a former rather sparsely porphyritic andesite that has been affected by strong hydrothermal alteration of transitional phyllic to propylitic type, and with emplacement of a few quartz-sulphide veins. Primary texture is moderately preserved, indicating that the rock formerly contained phenocrysts of feldspar (e.g. plagioclase) and ferromagnesian material (e.g. hornblende, pyroxene) in a groundmass of feldspar and subordinate ferromagnesian material, a little FeTi oxide and possible quartz. Imposed alteration caused replacement by abundant sericite, subordinate quartz and chlorite, a little rutile, pyrite and chalcopyrite. Veining is dominated by quartz and pyrite, but there are zones with significant chlorite (in part as immediate alteration selvedges) and chalcopyrite (interstitial to pyrite and quartz).

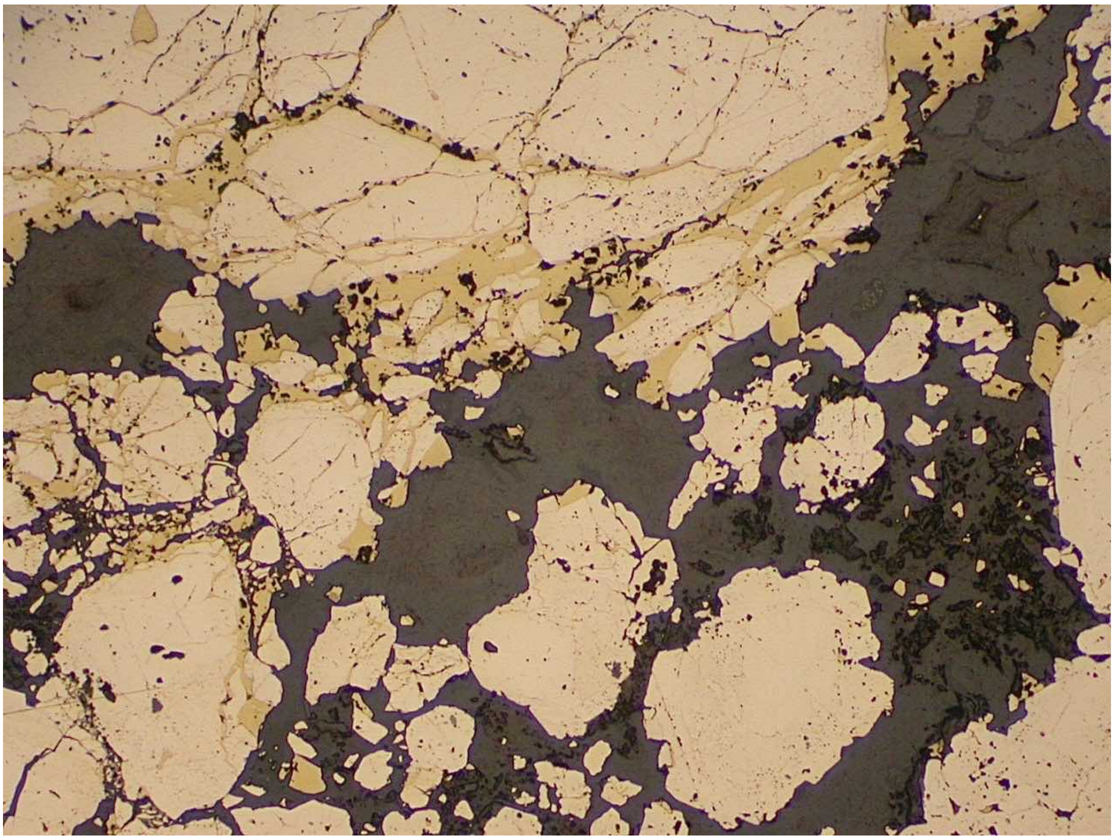

Fig. 38: Portion of the major quartz-sulphide vein showing abundant pyrite (commonly fractured), with interstitial quartz (dark grey) and chalcopyrite (yellow). Note fracture-filling habit of chalcopyrite. Plane polarised reflected light, field of view 2 mm across.

SMD015 240.0 m TS

Summary: Fine to medium grained massive dolerite, with overprinting strong propylitic alteration (or simply the effects of low grade metamorphism). Original texture is moderately preserved suggesting that the rock formerly contained abundant plagioclase, intergrown with a subordinate amount of ferromagnesian material and a little FeTi oxide. There were also a few small amygdules. The alteration assemblage is dominated by albite (replacing original plagioclase) and chlorite. Initially, it appears that a minor amount of acicular amphibole (e.g. tremolite-actinolite) developed, but it was mostly replaced by chlorite and sericite. Minor disseminated epidote, quartz, a little leucoxene-rutile and trace hematite occur throughout. The altered rock is cut by a couple of veins of epidote and/or chalcedonic quartz.

Handspecimen: The drill core sample is composed of a massive, pale khaki, fine grained altered igneous rock, with scattered grey-green aggregates that could represent former ferromagnesian sites (Fig. 39). It is speculated that the rock was originally of mafic to intermediate type. Imposed alteration may have developed considerable chlorite, sericite and epidote (Fig. 39). A single vein of pale yellowish epidote occurs at a low angle to the core axis. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

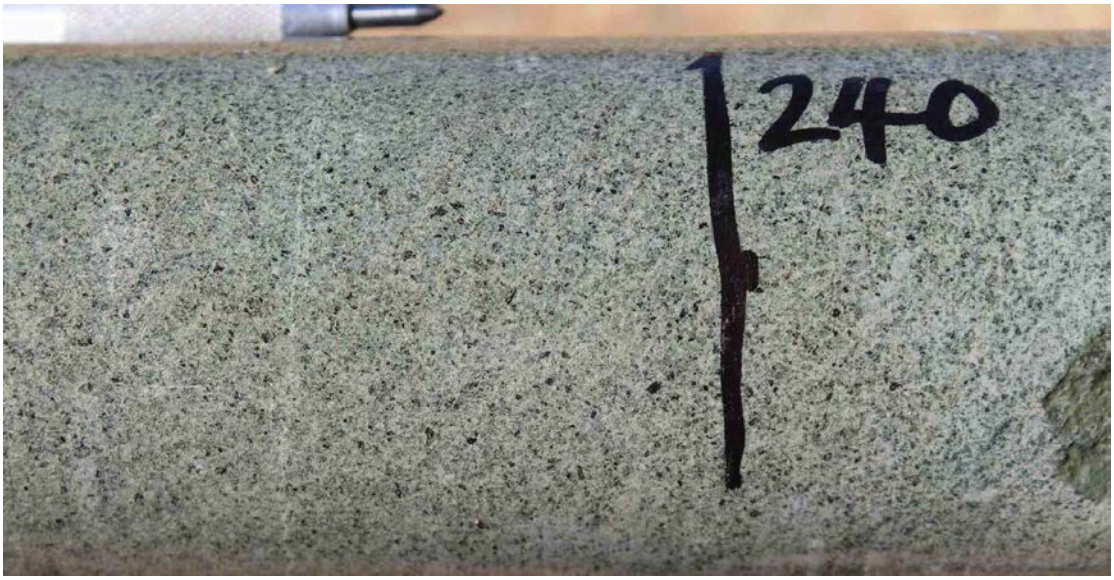

Fig. 39: Drill core sample of altered, fine to medium grained massive dolerite, now containing an assemblage of albite and chlorite, with minor sericite, epidote, quartz and leucoxene-rutile.

Petrographic description

a) Primary rock characteristics: In the section, primary igneous texture is at best moderately preserved, and it is evident that the rock is strongly altered. It appears to have originally contained abundant lathlike to tabular plagioclase grains up to 1.5 mm long, intergrown with a subordinate amount of ferromagnesian material, and a little FeTi oxide (Fig. 40). Some former ferromagnesian material formed blocky grains up to 1 mm across and could have been pyroxene (or possibly olivine) whereas other grains were more elongate (and might have included amphibole). A few possible small ovoid amygdules up to 0.6 mm across were hosted in the rock, which from it preserved primary characteristics is interpreted as having been a dolerite.

b) Alteration and structure: The igneous rock was strongly altered with replacement of all primary minerals. Plagioclase was albitised and also locally replaced by chlorite, epidote and quartz (Fig. 40). It appears that there was initial development of minor amounts of acicular amphibole (e.g. tremolite-actinolite), but this was later largely retrogressed to chlorite and sericite. Other original ferromagnesian grains were largely replaced by chlorite, with a little associated epidote and leucoxene-rutile and trace hematite (Fig. 40). FeTi oxide was replaced by leucoxene-rutile. The few possible amygdules are filled by quartz. A couple of sub-planar to anastomosing veins up to 0.3 mm wide cut the rock, with one containing abundant epidote and minor chalcedonic quartz, and the other being mostly chalcedonic quartz. Although the alteration assemblage in the rock is consistent with propylitic type, it could have simply formed as a result of imposition of low grade metamorphism, e.g. at chlorite grade of the greenschist facies.

c) Mineralisation: No sulphide minerals are observed.

Mineral Mode (by volume): plagioclase (albite) 65%, chlorite 20%, quartz (including chalcedonic material) and sericite each 5%, epidote 4%, leucoxene-rutile 1% and traces of hematite and amphibole.

Interpretation and comment: It is interpreted that the sample represents an altered dolerite. Original texture is at best moderately preserved indicating that there was formerly abundant plagioclase, intergrown with a subordinate amount of ferromagnesian material and a little FeTi oxide. There were also a few small amygdules. The alteration assemblage is dominated by albite and chlorite. Initially, a minor amount of acicular amphibole (e.g. tremolite-actinolite) appears to have formed, but it was mostly replaced by chlorite and sericite. Minor disseminated epidote, quartz, a little leucoxene-rutile and trace hematite are found throughout. The altered rock is cut by a couple of veins of epidote and/or chalcedonic quartz.

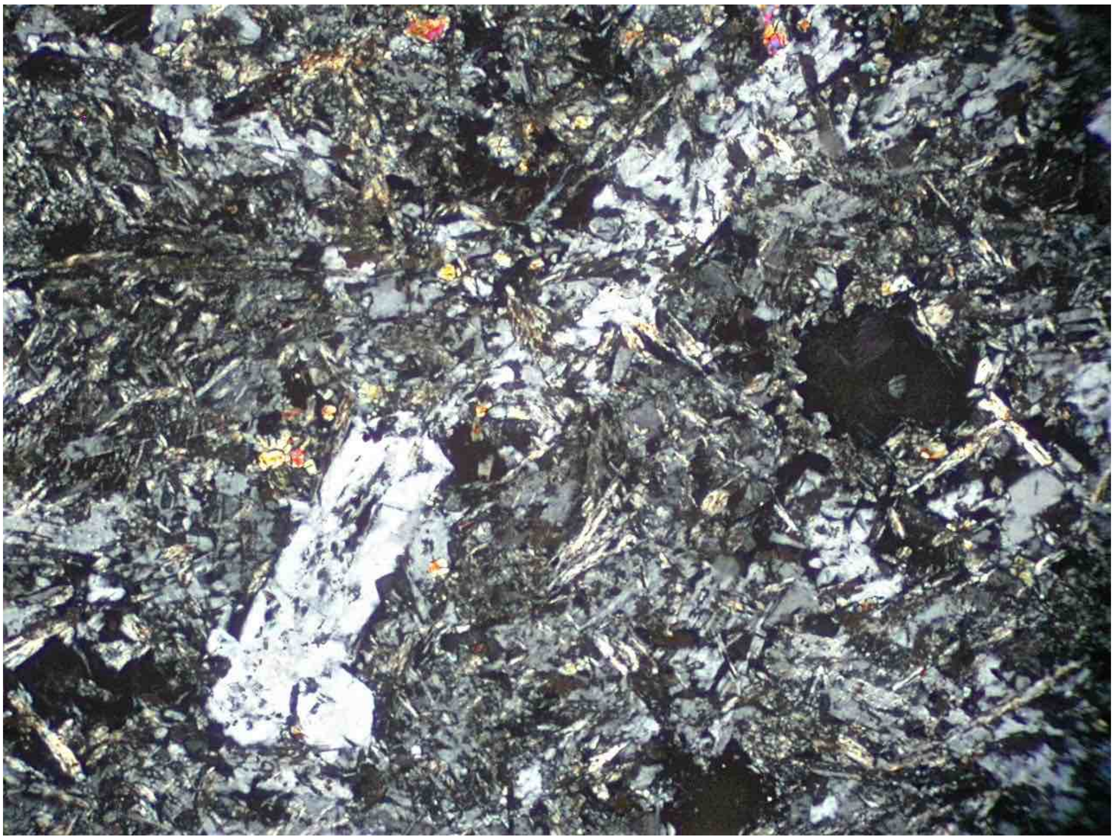

Fig. 40: Vaguely preserved relict texture in interpreted dolerite that has undergone strong alteration to albite and chlorite, with minor sericite, epidote and leucoxene-rutile. Note pseudomorphs after original plagioclase laths. The dark aggregates are chlorite, which have

replaced former ferromagnesian grains. Transmitted light, crossed polarisers, field of view 2 mm across.

<u>SMD015 249.0 m PTS</u>

Summary: Strongly hydrothermally altered porphyritic microdiorite. Due to alteration, relict texture is poorly to moderately preserved, but it is likely that the rock originally contained phenocrysts of feldspar (e.g. plagioclase) and a prismatic ferromagnesian phase (e.g. hornblende) and a few microphenocrysts of FeTi oxide, enclosed in a fine to medium grained groundmass of feldspar, ferromagnesian material and a little FeTi oxide and apatite. Pervasive alteration is of phyllic type, with replacement of the rock by abundant fine grained sericite, subordinate quartz, minor pyrite, a little rutile and trace chalcopyrite. A single thin quartz vein occurs, but in the handspecimen, minor quartz-pyrite veining is more prevalent.

Handspecimen: The drill core sample is composed of a strongly altered, porphyritic fine grained igneous rock. It is pale brown-grey to khaki colour, with scattered whitish altered feldspar phenocrysts up to 3 mm across in a fine grained groundmass (Fig. 41). The rock probably has strong replacement by sericite, quartz and minor disseminated pyrite, and is cut by a few quartz-pyrite veins, generally <1 mm wide and at low to moderate angles to the core axis (Fig. 41). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 41: Drill core sample of strongly altered porphyritic microdiorite. There are evident pale pseudomorphs after former feldspar phenocrysts, with the rock being replaced by sericite, quartz, minor disseminated pyrite and a little rutile. Small veins contain quartz and pyrite.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is poorly to moderately preserved, commonly obscured due to strong alteration. It is apparent that the rock originally contained rather sparsely scattered blocky feldspar phenocrysts (e.g. plagioclase) up to 4.5 mm across (mostly <2 mm) and there are a few pseudomorphs after elongate, prismatic ferromagnesian grains (e.g. former hornblende) up to 3.5 mm long, and also after a few microphenocrysts of FeTi oxide up to 0.8 mm long (Fig. 42). The original groundmass could have been fine to medium grained and is speculated to have contained abundant feldspar and subordinate ferromagnesian material, plus a little FeTi oxide and apatite. From the preserved primary characteristics, the original rock is interpreted as a porphyritic microdiorite.

b) Alteration and structure: Strong pervasive hydrothermal alteration of phyllic type was imposed, causing replacement of all original igneous minerals, probably excepting accessory apatite. The rock was replaced by an assemblage of abundant fine grained sericite, with subordinate fine to medium grained quartz, minor disseminated pyrite, a little rutile (e.g. at ferromagnesian and FeTi oxide sites) and a trace of chalcopyrite (Fig. 42). Original feldspar phenocrysts were replaced by sericite, ferromagnesian grains by sericite, quartz, pyrite and rutile, and FeTi oxide by rutile ± pyrite. Small quartz aggregates up to 0.5 mm across are characteristic in the groundmass, and the altered rock is cut by a single narrow, discontinuous quartz vein.

c) Mineralisation: The alteration assemblage contains minor, irregularly distributed fine to medium grained pyrite (aggregates up to 2 mm across) and a trace of chalcopyrite.

Mineral Mode (by volume): sericite 65%, quartz 30%, pyrite 3%, rutile and apatite each 1% and a trace of chalcopyrite.

Interpretation and comment: It is interpreted that the sample is a strongly phyllic altered porphyritic microdiorite. Relict texture is poorly to moderately preserved due to alteration, but it can be ascertained that the rock formerly contained phenocrysts of feldspar (e.g. plagioclase) and a prismatic ferromagnesian phase (e.g. hornblende) and a few microphenocrysts of FeTi oxide, enclosed in a groundmass of feldspar, ferromagnesian material and a little FeTi oxide and apatite. Pervasive alteration caused replacement of the rock by abundant fine grained sericite, subordinate quartz, minor pyrite, a little rutile and trace chalcopyrite. A single thin quartz vein occurs, but in the handspecimen, minor quartz-pyrite veining is more prevalent.

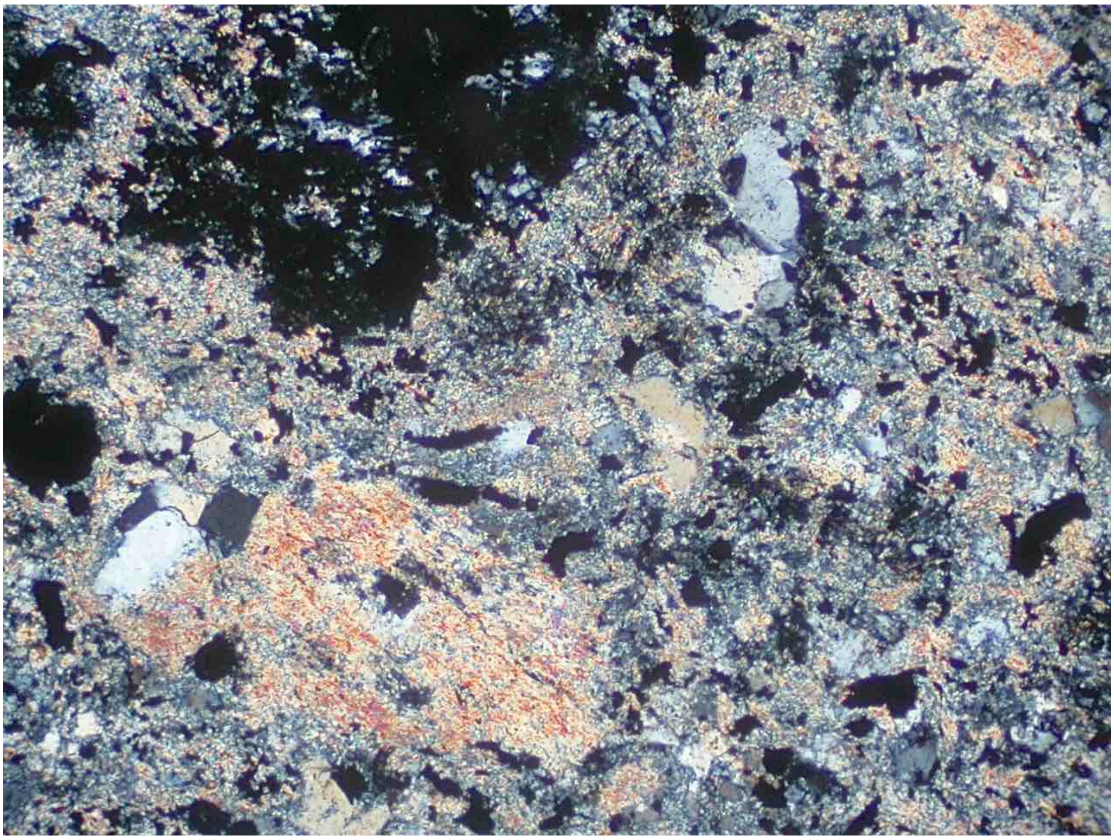

Fig. 42: Pseudomorph of sericite after a former feldspar grain (lower left) in an altered groundmass of sericite, quartz and a little rutile and pyrite (both black). In the upper part of the image, the dark aggregate represents a site of a former ferromagnesian grain, now composed of quartz, pyrite and rutile. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD015 254.9 m PTS

Summary: Strongly mineralised hydrothermal breccia containing scattered intensely altered fragments and a matrix that is rich in sulphides and quartz. The rock has a matrix-supported texture, with fragments locally retaining possible relict porphyritic texture. The protolith is speculated to have been of andesite, but was replaced by abundant quartz, subordinate sericite and pyrite, a little bornite and chalcocite, and traces of rutile and apatite. In the breccia matrix, fine to medium grained quartz is intergrown with abundant sulphides and traces of sericite and anhydrite. In the sulphide aggregates, pyrite is paragenetically early and enclosed and replaced by bornite and chalcocite.

Handspecimen: The drill core sample is composed of a strongly sulphide-mineralised hydrothermal breccia (Fig. 43). It generally has a matrix-supported texture, with scattered hydrothermally altered angular to sub-rounded fragments up to 2 cm across. Fragments are pale grey, have no recognised relict texture and are quartz-rich, but with minor probable sericite and minor pyrite and Cu sulphides. The matrix evidently contains abundant sulphides (pyrite and paragenetically later aggregates of bornite and chalcocite up to several millimetres across, and minor quartz (Fig. 43). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

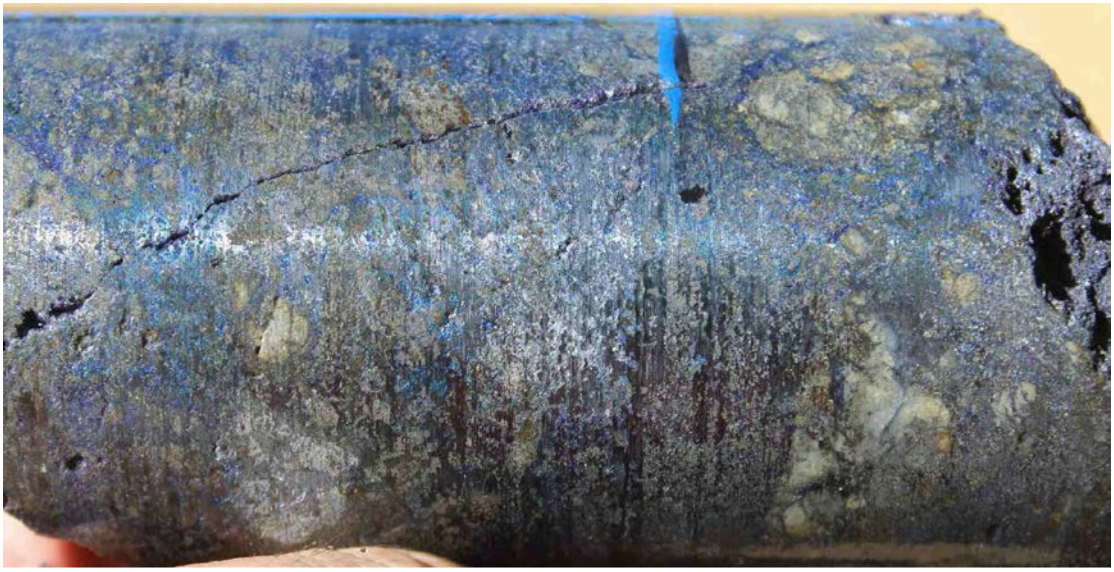

Fig. 43: Drill core sample of hydrothermal breccia containing abundant matrix sulphides (pyrite, bornite, chalcocite) and associated quartz, enclosing fragments of intensely hydrothermally altered protolith (possibly andesite) that has been replaced by quartz and minor sericite and sulphides.

Petrographic description

a) Primary rock characteristics: In the section, the sample is estimated to contain ~30 volume % of strongly altered angular to sub-rounded breccia fragments up to2 cm across. Generally, there is no recognisable relict texture, but locally, possible relict porphyritic texture is retained, with a few pseudomorphs up to 2 cm long after a former prismatic ferromagnesian phase, as well as a few pseudomorphs after former FeTi oxide microphenocrysts. From these vestiges and the immobile trace element assay data, the protolith is speculated to have been a porphyritic intermediate composition type, e.g. andesite.

b) Alteration and structure: The original rock underwent hydrothermal brecciation, with development of a matrix-supported breccia, with fragments up to 2 cm across in a hydrothermal matrix dominated by sulphides and quartz. Fragments were intensely altered to assemblages that vary from being dominated by finely inequigranular quartz to those with quartz and sericite, with disseminated pyrite, minor bornite and chalcocite, and traces of rutile and apatite (Fig. 44). These assemblages indicate that alteration ranged from silicic to phyllic in character. Matrix material is composed of abundant fine to medium grained quartz, grading into zones with semi-massive to massive sulphides, with a trace of sericite associated with quartz, and trace anhydrite (grains up to 0.2 mm) hosted in sulphides. The sulphides include abundant, paragenetically early pyrite, enclosed and replaced by bornite, which in turn tends to be enclosed and replaced by chalcocite (Fig. 45).

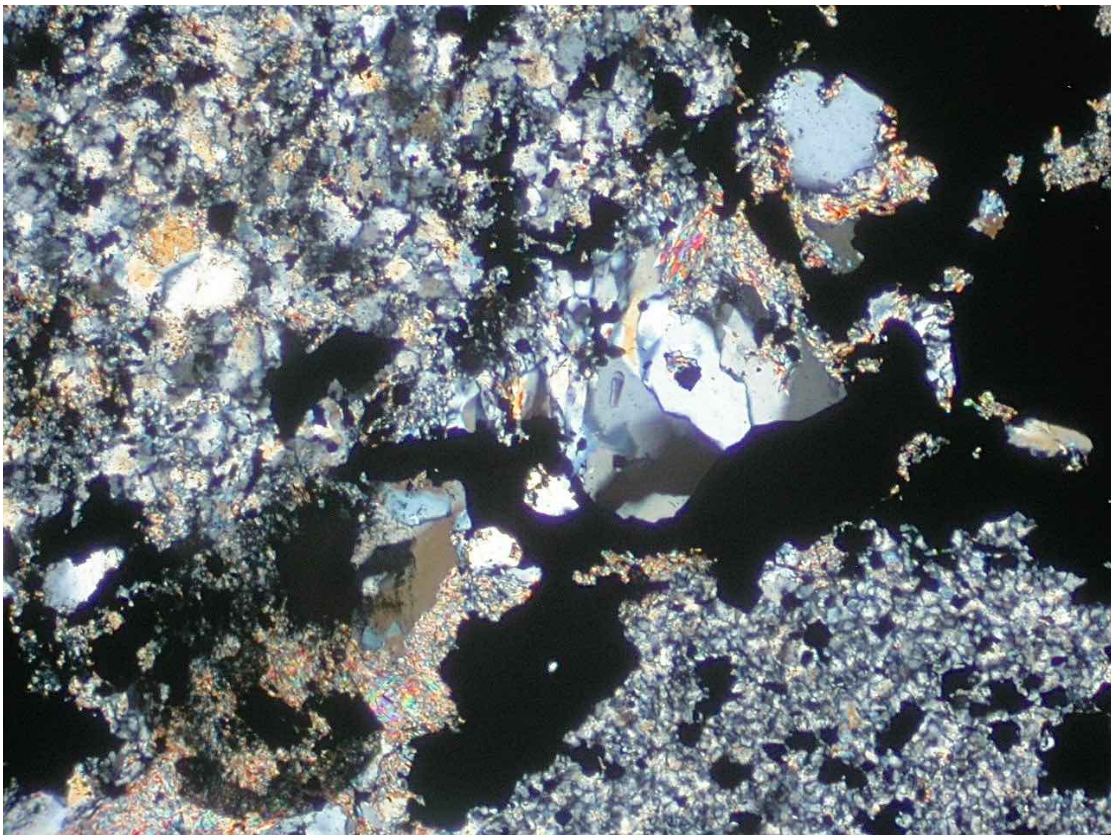

Fig. 44: Intensely altered breccia fragments (upper and lower) with quartz-sericite replacement, and veined and enclosed by aggregates of sulphides (pyrite, bornite, chalcocite, all black) and minor quartz and sericite. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: In the intensely altered breccia fragments, there is minor to abundantly disseminated pyrite (mostly <0.5 mm) with minor to common small aggregates of bornite ± chalcocite, mainly around the fragment boundaries. The breccia matrix contains abundant sulphides, with paragenetically early pyrite (masses up to a few millimetres across), enclosed and replaced by bornite, and subsequently by paragenetically later chalcocite (Fig. 45). Aggregates rich in bornite and/or chalcocite are up to several millimetres across, with chalcocite typically being medium to coarse grained.

<u>Mineral Mode (by volume)</u>: quartz 45%, chalcocite 18%, pyrite 15%, bornite 12%, sericite 9% and traces of rutile, apatite and anhydrite.

<u>Interpretation and comment</u>: It is interpreted that the sample represents a strongly mineralised hydrothermal breccia, with a generally matrix-supported texture. It has scattered,

intensely altered fragments, possibly derived from an andesitic protolith, and a matrix rich in sulphides and quartz. Breccia fragments were replaced by abundant quartz, subordinate sericite and pyrite, a little bornite and chalcocite, and traces of rutile and apatite. In the breccia matrix, patchily abundant quartz is intergrown with sulphides and traces of sericite and anhydrite. In the sulphide aggregates, pyrite is paragenetically early and enclosed and replaced by bornite and chalcocite.

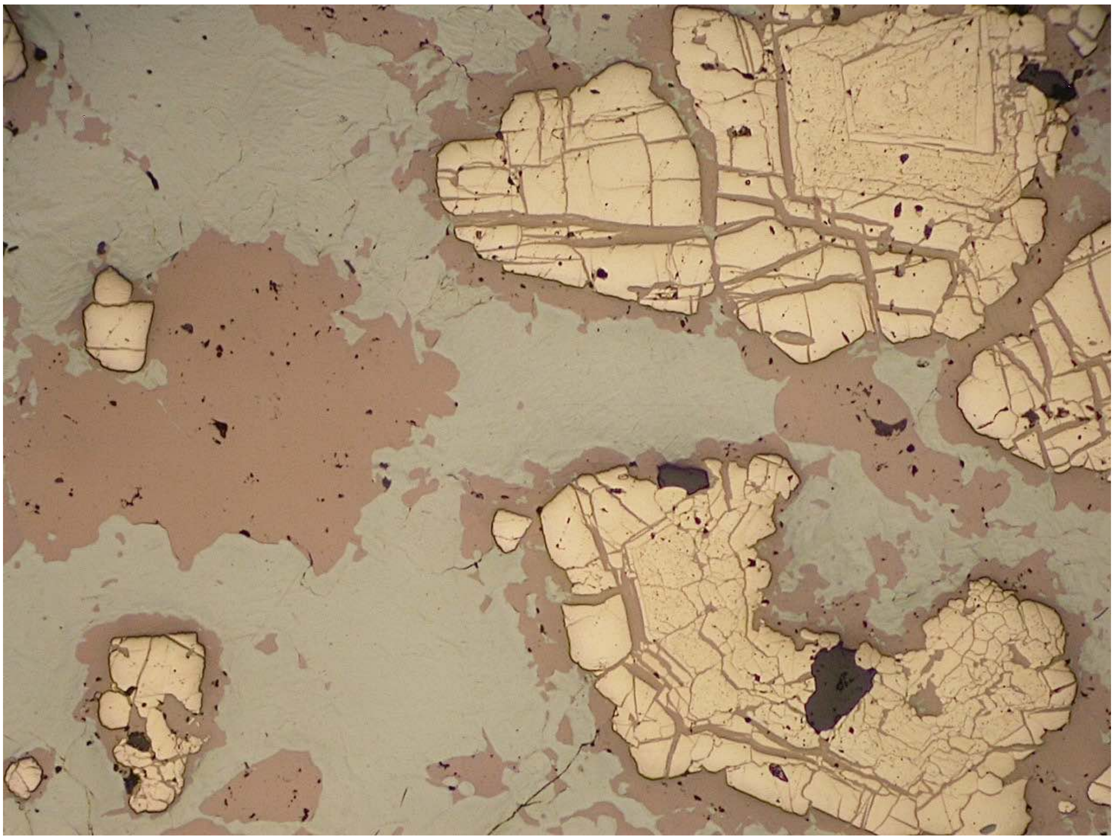

Fig. 45: Zone of massive sulphides in the breccia matrix, showing fractured, paragenetically early pyrite (pale creamy) invaded by bornite (pink-brown) and paragenetically later chalcocite (pale bluish grey). Plane polarised reflected light, field of view 2 mm across.

SMD015 335.8 m PTS

Summary: Strongly hydrothermally altered porphyritic microgranodiorite or dacite, with moderate preservation of original texture. Plagioclase phenocrysts were initially albitised, but later largely replaced by sericite, minor quartz and chlorite, and small amounts of sulphides. There are a few relict quartz phenocrysts, and a few pseudomorphs after former small ferromagnesian phenocrysts, that were originally set in a finely inequigranular quartzofeldspathic groundmass. Chlorite, quartz and sericite also formed at ferromagnesian sites and in the groundmass and sparsely disseminated sulphides (mostly occurring at former feldspar sites) are mostly pyrite and chalcopyrite, with a little Fe-poor sphalerite and a tiny trace of galena.

Handspecimen: The drill core sample is composed of a massive, strongly hydrothermally altered felsic igneous rock. It has a mottled appearance, with intercalated pale creamy and grey domains up to a few millimetres across (Fig. 46). Vaguely preserved relict porphyritic texture is apparent, with a few relict quartz phenocrysts and altered feldspar phenocrysts, each up to 4 mm across. The rock has probably been altered to a quartz-sericite assemblage, but some original feldspar could remain (Fig. 46). Minor disseminated pyrite is also observed. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 46: Drill core sample of strongly hydrothermally altered porphyritic micogranodiorite or dacite, It is now replaced largely by an assemblage of sericite and quartz, with minor chlorite and a little pyrite, chalcopyrite and traces of rutile and sphalerite.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved (Fig. 47). There are a few relict quartz phenocrysts up to 4 mm across and largely altered blocky plagioclase phenocrysts, also up to 4 mm across, as well as a few pseudomorphs after a former prismatic ferromagnesian phase (e.g. former hornblende) up to 1.5 mm long (Fig. 47). The rock retains a few microphenocrysts of apatite, as well as small pseudomorphic aggregates after former FeTi oxide grains, with which are associated rare tiny relict grains of zircon. The original groundmass was finely inequigranular in texture and contained abundant plagioclase and quartz, with minor alkali feldspar and ferromagnesian material, with trace FeTi oxide and apatite. The preserved primary characteristics of the rock suggest that it represents an altered porphyritic microgranodiorite or dacite.

b) Alteration and structure: The igneous rock experienced strong pervasive hydrothermal alteration, with replacement of igneous phases, except for quartz and apatite. Original plagioclase phenocrysts were initially albitised, but there was further strong replacement by fine grained sericite, and local quartz and pale green chlorite (Mg-rich) (Fig. 47) and small amounts of disseminated sulphides (Fig. 48). Ferromagnesian grains were replaced by sericite and/or chlorite, with a little quartz, sulphides and trace rutile, and FeTi oxide was replaced by rutile. In the groundmass, there was patchy strong replacement by quartz and sericite, and trace sulphides, but elsewhere there is some preservation of groundmass feldspar. In one large quartz phenocryst, there are included masses of sericite, with one of these having associated anhydrite. Sparsely disseminated sulphides are part of the alteration assemblage and include pyrite and chalcopyrite, with trace Fe-poor sphalerite (in places in composite aggregates with pyrite and/or chalcopyrite) and a couple of rare tiny grains of galena. The alteration assemblage is of propylitic type, but evidently transitional to propylitic where quartz-sericite development is strong.

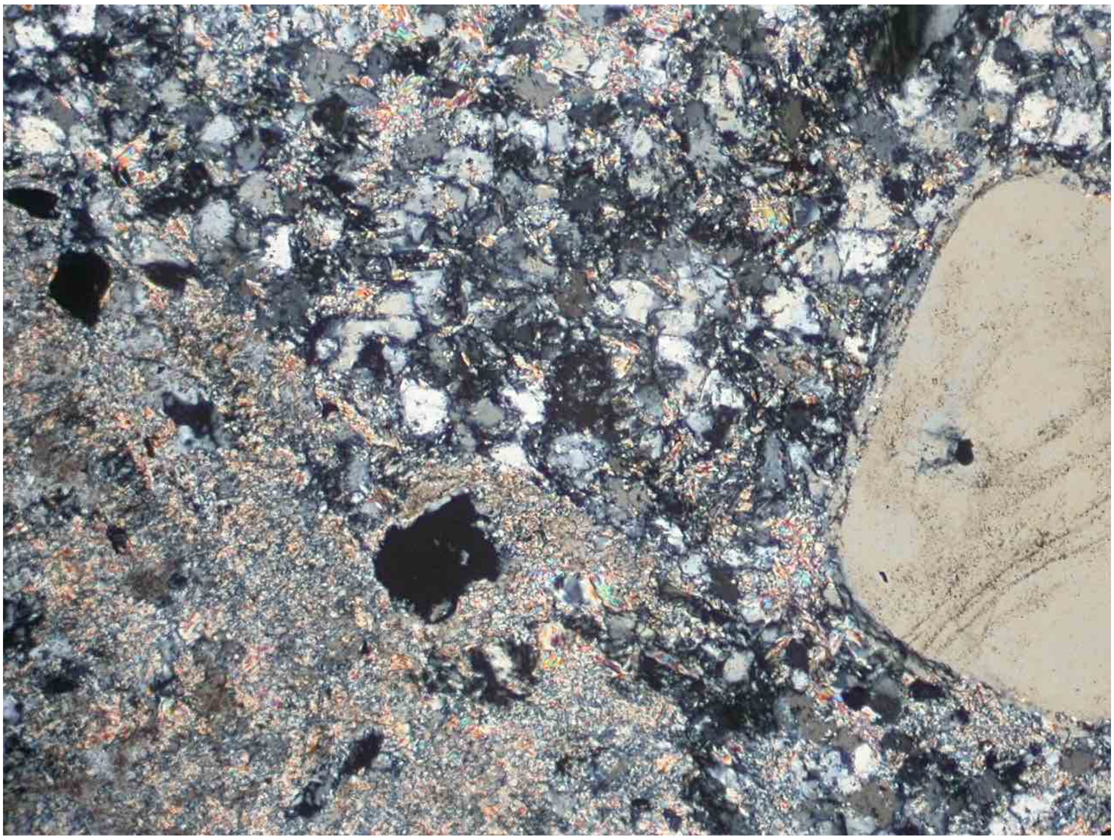

Fig. 47: Relict quartz phenocryst at right and an albite-sericite-altered plagioclase phenocryst at left, with the groundmass being dominated by quartz and sericite. The small black entities are pyrite. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The rock contains a small amount of disseminated sulphides as part of the pervasive alteration. These tend to occur mostly at altered feldspar phenocryst sites, but they are also found in the groundmass and at former ferromagnesian sites. The most common sulphides are pyrite (up to 0.8 mm) and chalcopyrite (up to 0.7 mm), locally forming composites, and there is also a little Fe-poor sphalerite (up to 0.4 mm) again forming composites with pyrite and chalcopyrite (Fig. 48). A tiny amount of galena is noted in some of these composites.

Mineral Mode (by volume): quartz 40%, sericite 35%, albite 15%, chlorite 5%, alkali feldspar 2%, pyrite and chalcopyrite each 1% and traces of apatite, rutile, zircon, sphalerite, galena and anhydrite.

Interpretation and comment: It is interpreted that the sample is a porphyritic microgranodiorite or dacite, displaying strong hydrothermal alteration that ranges from propylitic to phyllic type. The rock has moderate preservation of primary texture, indicating that there were phenocrysts of plagioclase, quartz and possible hornblende in a fine grained quartzofeldspathic groundmass. Plagioclase phenocrysts were initially albitised, but later largely replaced by sericite, minor quartz and chlorite, and small amounts of sulphides. Chlorite, quartz and sericite also formed at ferromagnesian sites and in the groundmass and sparsely disseminated sulphides (mostly occurring at former feldspar sites) are mostly pyrite and chalcopyrite, with a little Fe-poor sphalerite and a tiny trace of galena.

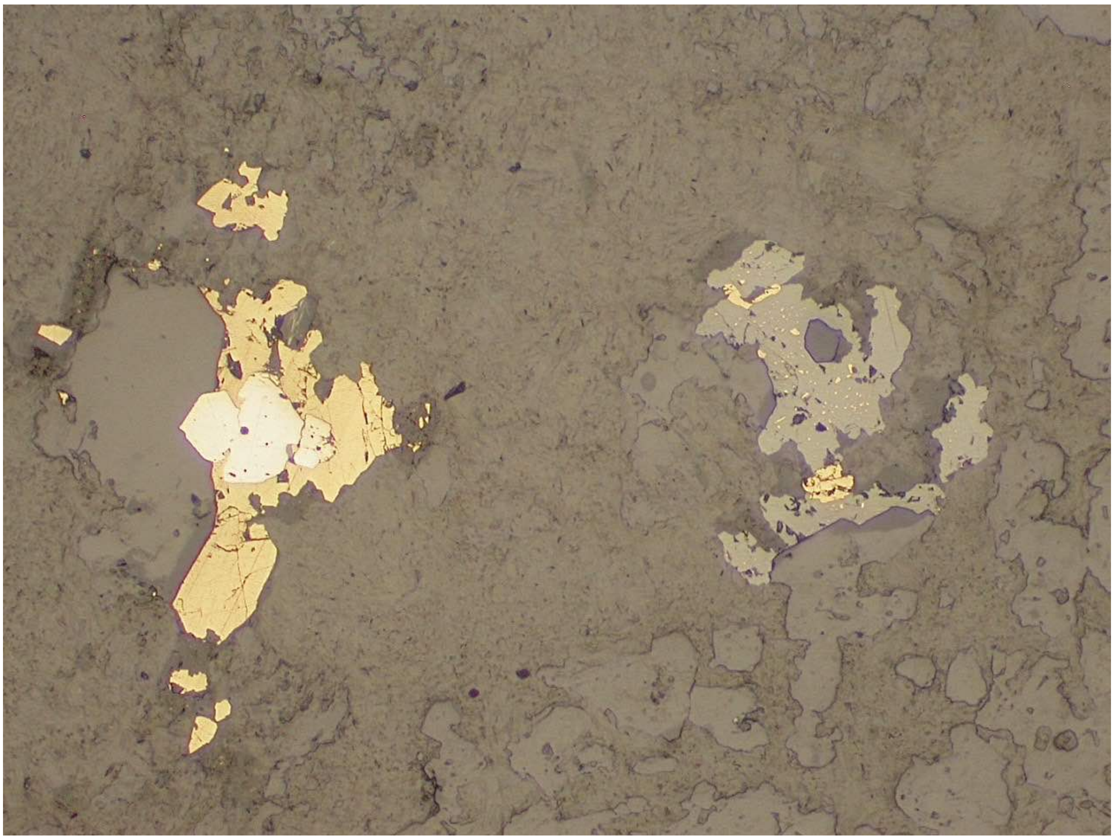

Fig. 48: Small aggregates of chalcopyrite (yellow), pyrite (pale creamy) and sphalerite (pale grey), largely hosted within a sericitised plagioclase phenocryst site. Plane polarised reflected light, field of view 0.8 mm across.

STRC019D 151.5 m PTS

Summary: Hydrothermal quartz-sulphide rock, representing the product of complete hydrothermal replacement of a protolith whose original nature is obscure, and/or representing hydrothermal infill. There is an intercalation of fine to medium grained quartz-rich domains, with sulphide-rich domains. A few aggregates of fine grained sericite occur in the quartz zones and these also have scattered irregular voids, in part lined by crystalline quartz. Pyrite is the dominant sulphide, locally semi-massive to massive and containing small inclusions of chalcopyrite and rare bornite and anhydrite. A little chalcopyrite also occurred interstitial to pyrite and hosted in quartz. The rock contains extensive chalcocite, apparently replacive towards chalcopyrite and pyrite. It is possible that chalcocite represents a deep supergene alteration product.

Handspecimen: The drill core sample is composed of a quartz-sulphide rock hosting irregular voids up to 1 cm across (Fig. 49). It contains pale grey quartz-rich domains up to 2.5 cm across that also contain minor to locally abundant pyrite and chalcocite. The quartz-rich domains merge into and are enclosed by semi-massive to massive sulphides, with abundant pyrite and paragenetically later chalcocite (Fig. 49). In the quartz-rich domains, no diagnostic relict texture from a protolith is recognised. It is possible that the rock has been affected by deep supergene alteration. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 49: Drill core sample of semi-massive sulphides showing local pale grey quartz-rich domains and abundant pyrite with coatings/replacements of dark bluish-grey chalcocite. Note substantial amount of void space.

Petrographic description

a) Primary rock characteristics: In the section, the sample is a quartz-sulphide rock, with an intercalation of quartz-rich and sulphide-rich domains on a scale of up to a few centimetres, and with a few irregular voids. No diagnostic relict texture is recognised and the rock is likely to be the product of total hydrothermal replacement of a protolith whose original nature is obscure, and/or that there is abundant hydrothermal infill.

b) Alteration and structure: The sample displays an intercalation of diffuse quartz-rich domains up to at least 2.5 cm across, with irregular sulphide-rich masses. There are also a few irregular voids up to several millimetres across. Quartz-rich domains contain fine to medium grained, inequigranular to locally prismatic quartz (up to 2 mm), with a few fine grained sericite aggregates up to 2 mm across and minor to locally abundant disseminated sulphides. The latter include pyrite, minor chalcopyrite, and replacive masses of chalcocite. The quartz-rich zones merge into sulphide-rich masses (Figs 50, 51). The latter are typically pyrite-rich, with pyrite hosting a little fine grained chalcopyrite and rare small inclusions of bornite and anhydrite. Some medium to coarse pyrite shows zonal growth texture. Chalcopyrite occurs interstitial to pyrite and also hosted in quartz, with common replacement by chalcocite (Fig. 51). Pyrite masses are also invaded and enclosed by chalcocite (Fig. 50). Overall, the sample is probably the product of complete hydrothermal replacement and/or infill and if remnant host rock occurred, it was subject to silicic-phyllic alteration. It is possible that deep supergene alteration was imposed, leading to abundant chalcocite development and its replacement of chalcopyrite and pyrite (Figs 50, 51).

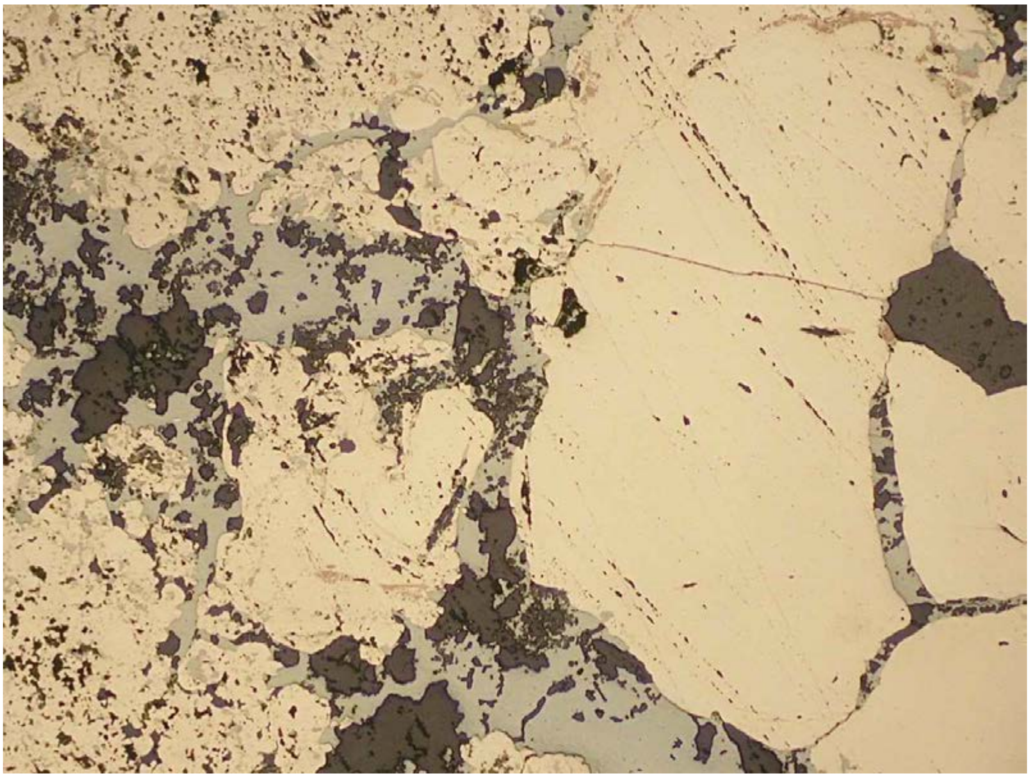

Fig. 50: Largely massive pyrite, with traces of chalcopyrite along fractures, and with invading chalcocite (pale grey). Weak growth zoning is apparent in coarser pyrite grains. Plane polarised reflected light, field of view 2 mm across.

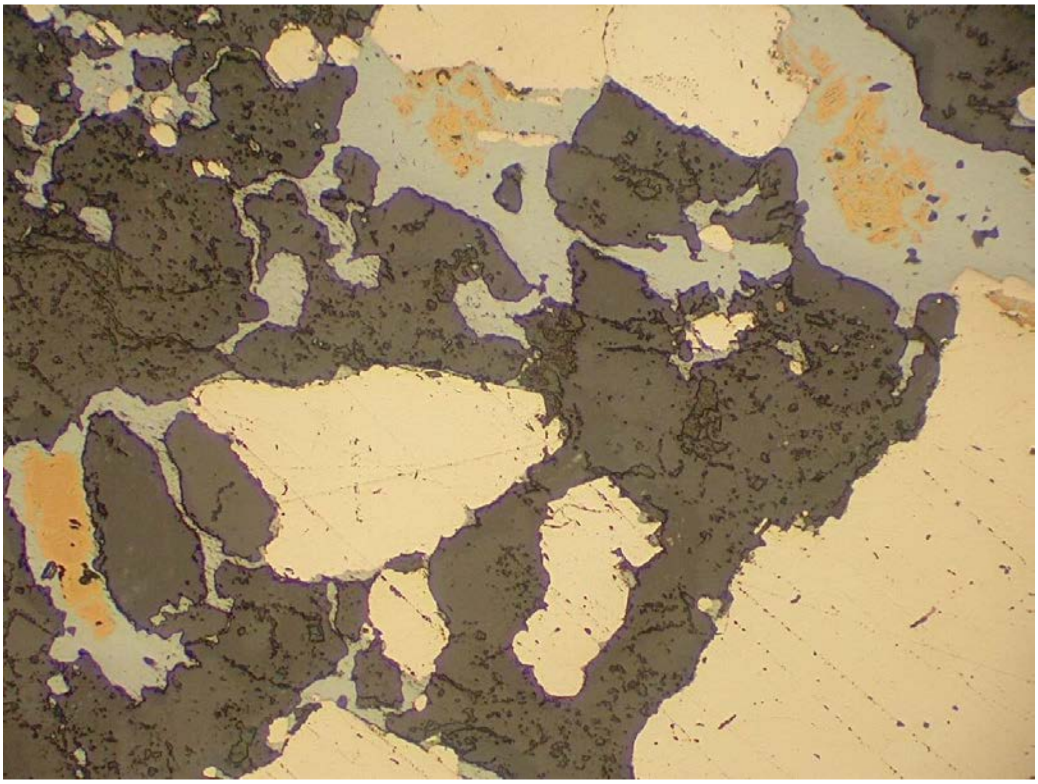

Fig. 51: Intercalation of quartz (dark grey) and pyrite (pale creamy), with minor chalcopyrite (yellow) largely replaced by chalcocite (pale blue-grey). Plane polarised reflected light, field of view 1 mm across.

c) Mineralisation: The rock contains abundant sulphides, with pyrite being dominant. It ranges from fine grained through to medium to coarse grained (up to a few millimetres) with the coarser type locally showing growth zoning. Chalcopyrite is in minor amounts, interstitial to pyrite and in quartz, and locally hosted in pyrite, along with rare tiny grains of bornite. In places, textures suggest that chalcopyrite is paragenetically later than pyrite. Locally abundant chalcocite occurs in the sample, evidently replacing chalcopyrite and pyrite (Figs 50, 51). It is possible that chalcocite is the product of deep supergene alteration.

Mineral Mode (by volume): quartz 45%, pyrite 40%, chalcocite 12%, sericite 2%, chalcopyrite 1% and trace of bornite and anhydrite.

Interpretation and comment: It is interpreted that the sample represents a quartz-sulphide rock, being the product of complete hydrothermal replacement of a protolith whose original nature is obscure, and/or representing hydrothermal infill. Quartz-rich domains are intercalated with sulphide-rich domains, with the former containing a few aggregates of fine grained sericite. The rock also has a few irregular voids, in part lined by crystalline quartz. Pyrite is the dominant sulphide, locally semi-massive to massive and containing small inclusions of chalcopyrite and rare bornite and anhydrite. A little chalcopyrite also occurred interstitial to pyrite and hosted in quartz. The rock contains extensive chalcocite, apparently replacive towards chalcopyrite and pyrite. It is possible that chalcocite represents a deep supergene alteration product.

STRC019D 152.9 m PTS

Summary: Hydrothermal quartz-hematite rock, with minor disseminated sulphides and a little carbonate, representing the product of intense alteration of a former ultramafic protolith. Evidence for the latter is manifest in the presence of sparsely scattered relict chromite grains. The protolith was replaced by abundant fine to medium grained quartz, characteristically with textures typical of formation in the epithermal environment, and patchily abundant disseminations and aggregates of fine grained acicular to prismatic hematite. Disseminated pyrite is relatively common hosted in quartz and hematite, and there is a little chalcopyrite, although it is commonly replaced by chalcocite. Local paragenetically later carbonate infill and narrow veins occur, with carbonate intergrown with chalcocite in places. It is possible that chalcocite represents a deep supergene alteration phase.

Handspecimen: The drill core sample is composed of a quartz-hematite rock, with minor disseminated sulphides (Fig. 52). There is no diagnostic relict texture from a protolith and it is likely that complete hydrothermal alteration and primary textural destruction has occurred. Domains of pale grey, fine to medium grained quartz commonly contain minor hematite and are intercalated with hematite-rich domains that include silvery-grey specular material and finer grained brick red material (Fig. 52). Disseminated sulphides include pyrite, chalcopyrite and chalcocite, forming irregular aggregates up to 3 mm across in both quartz- and hematite-rich domains. The rock is cut by a few sub-planar white quartz veins up to 2 mm wide at moderate to high angles to the core axis. The sample is weakly to moderately magnetic, with susceptibility up to 130 x 10^{-5} SI.

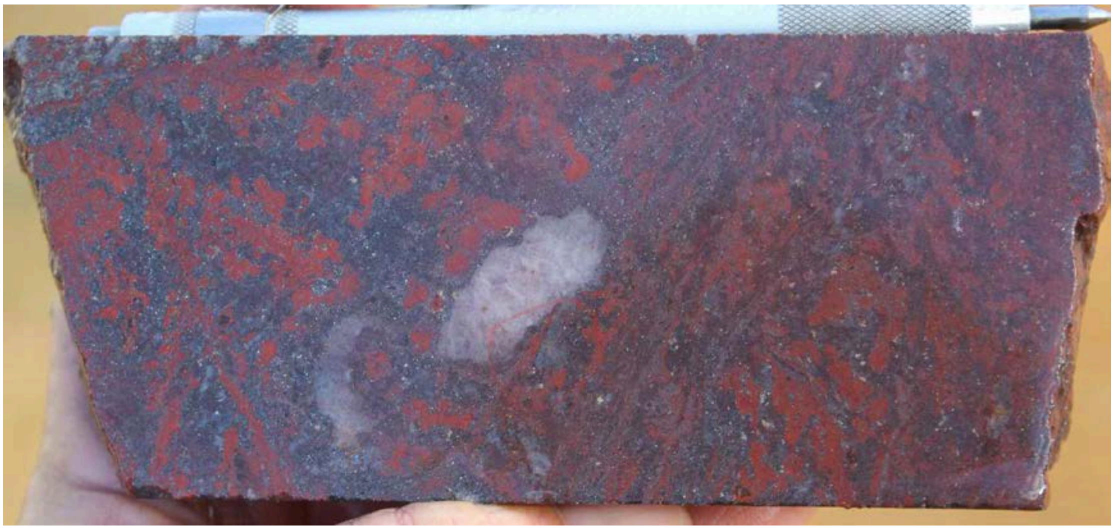

Fig. 52: Drill core sample of quartz-hematite-replaced ultramafic rock, with intercalation of quartz-rich and hematite-rich domains. Small amounts of sulphides occur but are not readily observed in the image.

Petrographic description

a) Primary rock characteristics: In the section, no diagnostic relict texture is recognised, but there are sparse relict grains of chromite up to 1 mm across (Figs 53, 54). This phase, together with the anomalously high geochemical values of Cr, Ni and Co in the sample interval, indicate that the protolith was of ultramafic type. Such a rock has clearly undergone intense hydrothermal alteration to be completely replaced (except for chromite) by an assemblage of quartz and hematite, plus minor sulphides and carbonate.

b) Alteration and structure: An interpreted ultramafic protolith was intensely hydrothermally altered and largely replaced by an assemblage that contains abundant quartz and hematite, minor sulphides and carbonate. Quartz is fine to medium grained (up to 1.5 mm), with textures including inequigranular, locally prismatic, sub-radiating and crustiform banded, typical of that found in the epithermal environment (Fig. 53). There are also a couple of sub-planar veins of medium grained quartz up to 2.5 mm wide that contain a little disseminated chalcopyrite. Hematite occurs as small, disseminated aggregates and individual grains in quartz, but grades to large (several millimetres) semi-massive aggregates dominated by acicular texture material. Some of the larger individual grains are prismatic and up to 0.3 mm long (Figs 53, 54 55, 56). Fine to medium grained pyrite forms aggregates up to 3 mm across in quartz- and hematite-rich aggregates, with pyrite commonly being overgrown by hematite (Fig. 55). A little chalcopyrite occurs in quartz and forms composites with pyrite, but it is less commonly included in hematite aggregates. Chalcopyrite is commonly replaced by chalcocite and the latter phase forms intergrowths with paragenetically late carbonate aggregates up to a few millimetres across (Fig. 56). A few thin, discontinuous carbonate veins up to 0.3 mm wide cut quartz- and hematite-rich zones (Fig. 53). Carbonate locally infills former cavities hosted in quartz. The alteration imposed on the ultramafic protolith is of silicic type, with hematite indicating oxidising conditions. The presence of chalcocite could be speculated to indicate the imposition of deep supergene alteration.

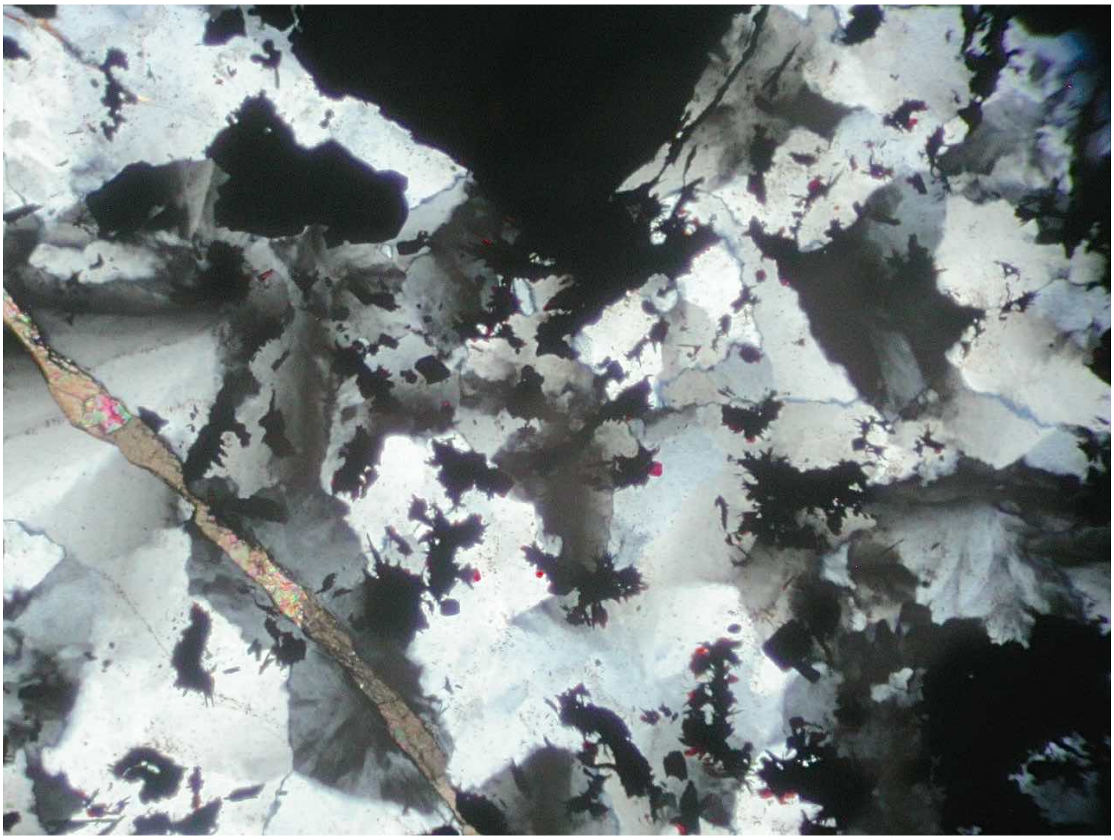

Fig. 53: Typical inequigranular to sub-radiating texture in hydrothermal quartz, with scattered small hematite aggregates. The large dark grain at centre top is relict chromite. Note thin cross-cutting carbonate vein at left. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The rock contains a few relict chromite grains inherited from an ultramafic precursor. These grains are up to 1 mm across and are commonly fractured (Figs 53, 54). There is patchily abundant hematite through, in places forming semi-massive aggregates up to several millimetres across. Textures are dominated by a finely acicular type, but somewhat coarser prismatic grains up to 0.3 mm long occur in places (Figs 53, 54, 55, 56). The rock contains irregularly distributed pyrite, forming aggregates up to 3 mm across, as well as finer grained material hosted in hematite- and quartz-rich domains (Figs 54, 55, 56). Pyrite is locally fringed by acicular hematite (Fig. 56) and associated with chalcopyrite, with the latter also occurring as discrete masses up to 0.8 mm across in quartz. Chalcopyrite is commonly replaced by chalcocite, with the latter also forming intergrowths with carbonate aggregates up to 2 mm across (Fig. 56). It is possible that chalcocite represents a deep supergene alteration product of chalcopyrite.

Mineral Mode (by volume): quartz 55%, hematite 35%, pyrite 5%, chalcocite and carbonate each 2%, chalcopyrite 1% and a trace of chromite.

Interpretation and comment: It is interpreted that the sample is a quartz-hematite rock, with minor disseminated sulphides and a little carbonate, representing the product of intense hydrothermal alteration of an ultramafic protolith. Evidence for the latter is indicated by presence of uncommon relict chromite grains. The replacement assemblage is dominated by quartz (with textures typical of formation in the epithermal environment), and patchily abundant acicular to prismatic hematite. Disseminated pyrite is relatively common in quartz- and hematite-rich zones, and there is a little chalcopyrite, although it is commonly replaced by chalcocite. Local paragenetically later carbonate infill and narrow veins occur, with carbonate intergrown with chalcocite in places. It is possible that chalcocite represents a deep supergene alteration phase.

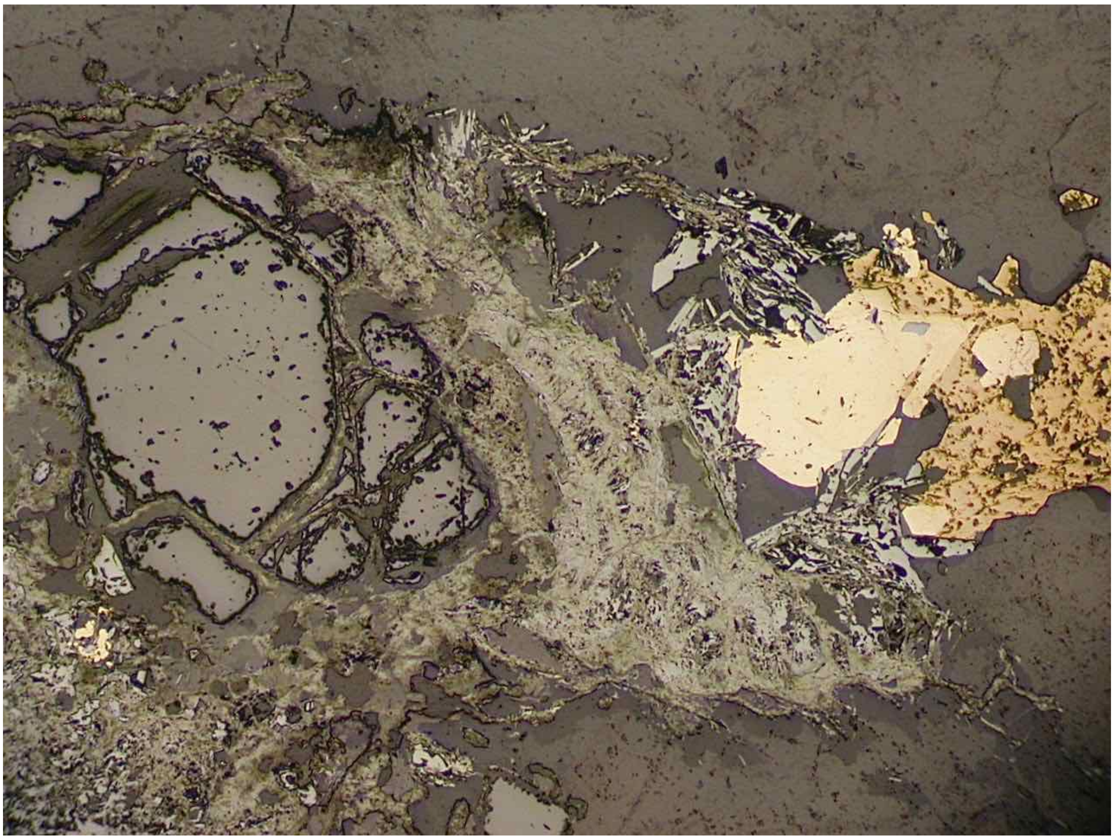

Fig. 54: Relict chromite grain (left) associated with a fine grained hematite aggregate (centre) and a composite aggregate of pyrite and chalcopyrite at right. Enclosing dark grey gangue phase is quartz. Plane polarised reflected light, field of view 2 mm across.

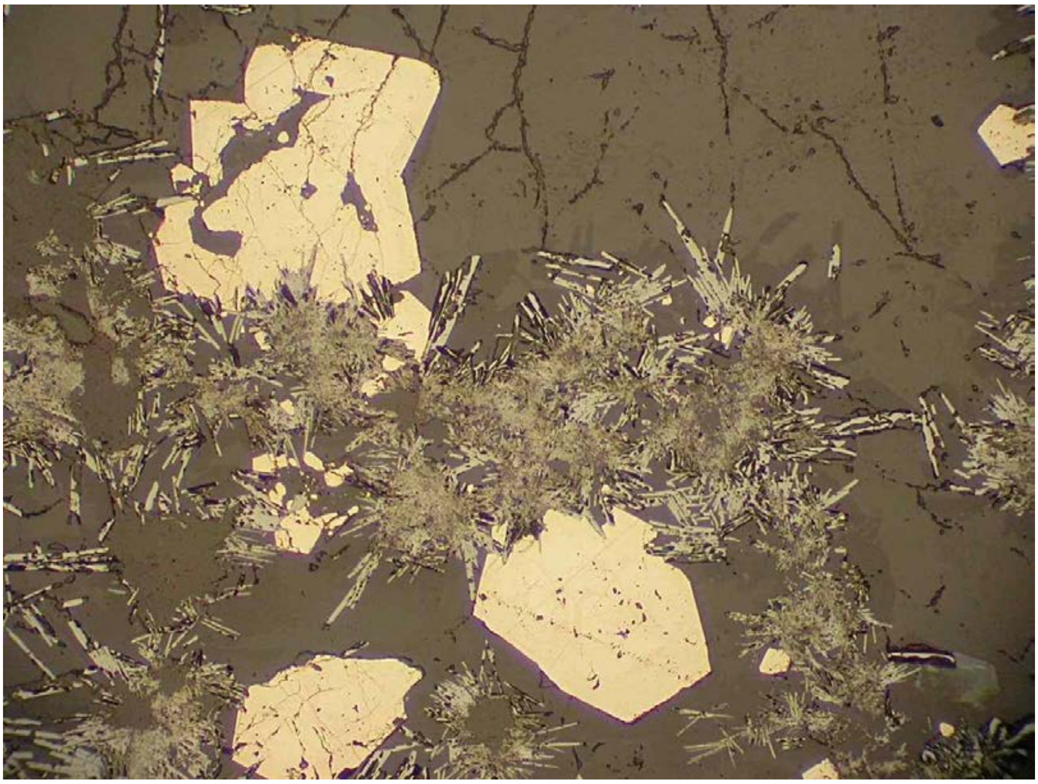

Fig. 55: Scattered pyrite (pale creamy) with associated aggregates of finely acicular hematite in quartz. Note possible replacement of pyrite by hematite. Plane polarised reflected light, field of view 1 mm across.

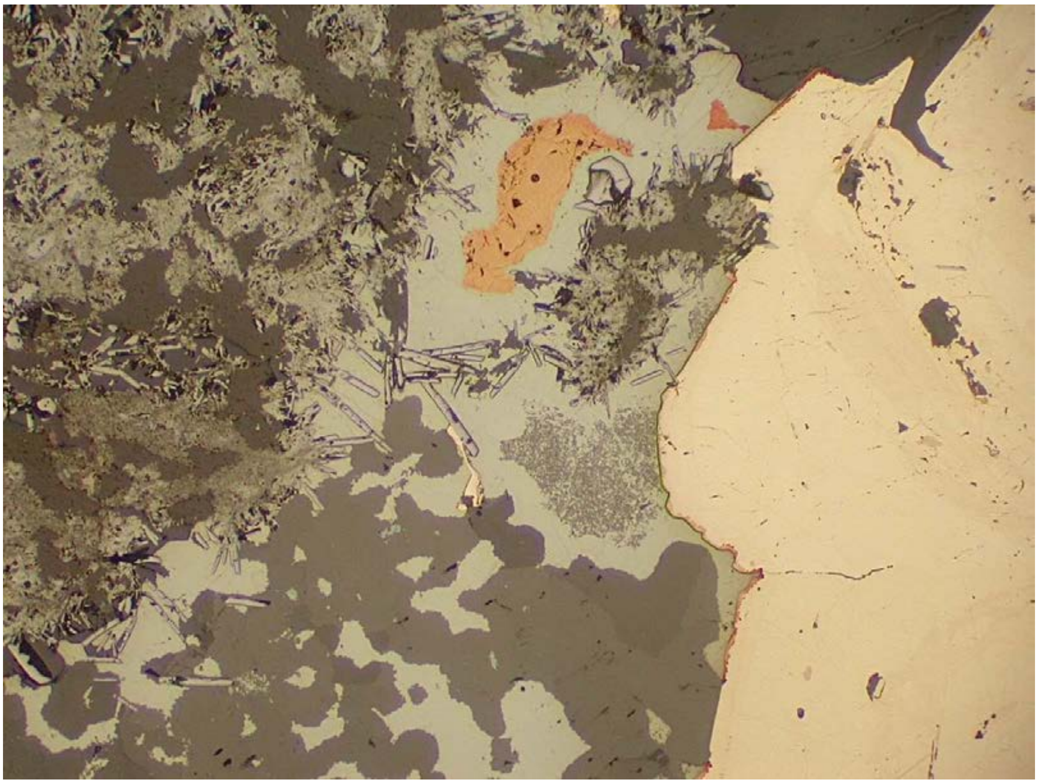

Fig. 56: Chalcocite (pale blue-grey) intergrown with carbonate (lower) and replacing chalcopyrite (upper), adjacent to pyrite (right) and finely acicular hematite at left. Plane polarised reflected light, field of view 1 mm across.