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

For

Stavely Minerals

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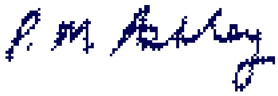

Introduction

A suite of fourteen drill core samples from the Thursday's Gossan project in the Cambrian age Stavely Belt in western Victoria was submitted for petrographic preparation, description and interpretation. Samples were from drill holes MSD001 (1 sample), SMD013 (1 sample), SMD014 (1 sample), SMD039 (1 sample), SMD040 (1 sample), SMD041 (1 sample), SMD042 (1 sample), SMD044 (4 samples) and SMD044W1 (3 samples) and were from downhole depths ranging from 367.1 m to 996.2 m. Samples were fresh, with no indications of supergene alteration. Brief drill core descriptions and handspecimen photos for the samples were provided.

Petrographic sections were prepared at Thin Section Australia Pty Ltd in Brisbane, with eight polished thin sections (PTS) and six 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. Ten sample offcuts were treated with hydrofluoric acid and sodium cobaltinitrite to check for the presence of K-feldspar, and a few offcuts were also tested with dilute HCl to check carbonate speciation.

The purpose of the petrographic work was to identify the primary rock types, the nature of alteration, veining and mineralisation. Several questions were posed with the notes accompanying sample submission and these are addressed in the individual descriptions and in the interpretations below.

Summary descriptions of the samples are listed following:

MSD001 405.9 m PTS

Summary: Strongly porphyritic dacite with moderately well preserved primary texture, but showing strong pervasive hydrothermal alteration and local veining. The rock retains a few relict quartz phenocrysts, but originally rather abundant plagioclase and ferromagnesian (e.g. hornblende, pyroxene) phenocrysts are totally altered. The rock also contained small amounts of FeTi oxide and apatite microphenocrysts, as well as a finely granular quartzofeldspathic groundmass. Pervasive alteration is interpreted to be of transitional potassic-propylitic type. It has involved the replacement of plagioclase phenocrysts by albite and turbid K-feldspar (patchily abundant), with minor sericite, prehnite and epidote. All former ferromagnesian material was altered, with replacement by chlorite, as well as prehnite, epidote and quartz. Igneous FeTi oxide was replaced by hematite and titanite. A few veins occur, including irregular to sub-planar and discontinuous examples containing prehnite, as well as others with epidote, chalcopyrite, bornite and chlorite.

SMD013 396.05 m PTS

Summary: The drill core sample has a contact between a strongly porphyritic dacite and a fine to medium grained, more even-grained quartz microdiorite. The former rock type retains scattered large plagioclase phenocrysts and also has less common, altered ferromagnesian phenocrysts (probably originally hornblende) in a finely granular quartzofeldspathic groundmass. The latter rock type originally contained small plagioclase phenocrysts in a fine to medium grained, inequigranular groundmass of plagioclase, quartz and ferromagnesian material. The quartz microdiorite was evidently microbrecciated, and both rock types show pervasive hydrothermal alteration of propylitic type. Much original feldspar (except for some of the plagioclase phenocrysts in the dacite) was replaced by albite and ferromagnesian material by chlorite, with these phases being accompanied by smaller amounts of sericite, carbonate, epidote, pyrite and trace rutile and titanite. A single vein of sericite, pyrite, prehnite, chlorite and carbonate occurs, along with a few later, thin, sub-planar carbonate veins.

<u>SMD014 477.5 m TS</u>

<u>Summary</u>: The drill core sample has a contact between a strongly altered, mildly porphyritic andesite, and a coarse fragmental rock, considered to represent a type of epiclastic sandstone. Relict textures are rather well preserved in both rock types. The andesite originally contained hornblende and a minor proportion of plagioclase phenocrysts in a fine grained feldspathic groundmass. The fragmental rock has a largely matrix-supported texture and contains scattered lithic grains (altered volcanic material, sandstone, siltstone) and apparently detrital quartz grains, in a finer grained silty to sandy matrix. Both rock types are strongly propylitically altered, with replacement by dominant carbonate (calcite) and chlorite. Minor quartz, sericite, albite, pyrite and a little leucoxene, occur in the andesite. Minor veining occurs, mainly in the andesite, with paragenetically early veining by quartz, pyrite, chlorite and trace epidote, being cut by later carbonate-quartz-pyrite-chlorite veining.

<u>SMD039 446.5 m TS</u>

<u>Summary</u>: The drill core sample shows an intrusive contact between a strongly porphyritic dacite and a more altered, porphyritic hornblende microdiorite. The contact is sharp and rather intricate, and there are a couple of xenoliths of microdiorite hosted in dacite. The latter rock contains phenocrysts of plagioclase and hornblende, with a few small microphenocrysts of quartz, in a fine grained feldspathic groundmass. Microdiorite originally contained phenocrysts of hornblende and plagioclase in a fine to medium grained feldspathic groundmass. Both rock types have imposed propylitic alteration, more strongly evident in the microdiorite, where there is little preservation of primary minerals, in contrast to the dacite. The alteration assemblage includes considerable albite (from plagioclase phenocrysts and groundmass feldspar) and chlorite, with minor carbonate and sericite, and trace quartz, hematite, leucoxene and epidote. A couple of carbonate-rich veins occur in the sample.

<u>SMD040 482.5 m TS</u>

<u>Summary</u>: Porphyritic hornblende (-quartz) microdiorite, with moderate to strong propylitic alteration. There is considerable retention of primary texture and some preservation of igneous hornblende, titanomagnetite and apatite. The rock hosted scattered plagioclase and hornblende phenocrysts in a fine to medium grained feldspar-rich groundmass, but with subordinate ferromagnesian material (now altered), quartz and a little titanomagnetite and apatite. Pervasive alteration led to development of an assemblage dominated by albite and chlorite, with patchy epidote, mainly at plagioclase phenocryst sites, as well as scattered aggregates of carbonate (-quartz-actinolite-epidote) and quartz. A single thin vein occurs, containing carbonate and quartz, with minor actinolite, chlorite, epidote and trace bornite.

<u>SMD041 367.1 m TS</u>

<u>Summary</u>: Strongly altered and veined porphyritic dacite. There is moderate preservation of primary texture, indicating that the rock contained scattered plagioclase phenocrysts, and a

few small microphenocrysts of quartz, ferromagnesian material and FeTi oxide in a fine grained, probably quartzofeldspathic composition groundmass. Pervasive alteration led to replacement of plagioclase phenocrysts by albite and minor sericite and carbonate, with development of finely granular quartz and albite in the groundmass, plus minor carbonate, sericite, leucoxene and trace chalcopyrite and pyrite. There are abundant veins and irregular hydrothermal patches of carbonate (calcite), with varying amounts of quartz and albite, minor sericite and chalcopyrite.

SMD042 921.05 m TS

Summary: Strongly altered, probably fragmental volcanic rock, considered to be of high-Mg basaltic composition and locally displaying relict porphyritic and amygdular textures. Pseudomorphs after former ferromagnesian phenocrysts (e.g. pyroxene) occur locally and the rock retains traces of disseminated fine grained Cr spinel (chromite) that might have formerly occurs as inclusions in igneous phases such as olivine and pyroxene. The rock was replaced (except for Cr spinel) by a heterogeneous assemblage with abundant chlorite, plus less common sericite, carbonate (calcite) and quartz, plus traces of leucoxene and rare pyrite. Amygdules tend to be mainly filled by calcite.

SMD044 645.7 m PTS

Summary: Intensely hydrothermally altered rock, perhaps originally of mafic to ultramafic composition and retaining sparsely scattered small relict grains of Cr spinel (chromite). No relict texture is preserved and much of the rock was replaced by an assemblage of quartz and chlorite, with patchy anhydrite and specular hematite. Cr spinel grains are rimmed by magnetite and in turn by hematite. There is a common association between hematite and small aggregates of chalcopyrite and/or bornite, and elsewhere in the rock, there is a little disseminated pyrite. A diffuse veinlike masses occurs containing anhydrite, gypsum, a clay phase (e.g. dickite), quartz, chlorite and trace pyrite and chalcopyrite. Textures suggest that gypsum could have replaced anhydrite. The alteration and vein assemblage is interpreted to be transitional between advanced argillic and propylitic types.

SMD044 924.3 m PTS

Summary: Intensely hydrothermally altered rock, perhaps originally of felsic igneous type. It retains a few relict quartz phenocrysts in what would have been a fine grained groundmass. The rock sustained alteration that is transitional between silicification and advanced argillic type, with replacement of the groundmass by fine grained quartz, plus irregularly distributed pyrite, minor fine grained pyrophyllite and traces of anhydrite, rutile, bornite and chalcocite. There are abundant irregular to veinlike masses of pyrite ± quartz ± pyrophyllite and these grade into paragenetically later aggregates of medium to coarse bornite and chalcocite that are also associated with quartz. The veinlike masses locally contain a little anhydrite, a low-birefringent clay phase (e.g. dickite) and enargite. The last phase tends to occurs as small included masses in pyrite and bornite. The sulphide mineralisation assemblage is consistent with high sulphidation type.

SMD044 946.3 m PTS

Summary: Possible sparsely porphyritic dacite, showing intense hydrothermal alteration, patchy deformation effects and emplacement of major veining, with subsequent minor veining. In places, the rock has moderate retention of relict, sparsely porphyritic texture. It formerly contained a few feldspar and ferromagnesian (hornblende) phenocrysts in a fine grained quartzofeldspathic groundmass. The rock was overprinted by alteration that ranges from phyllic type (fine grained quartz, sericite, minor pyrite, anhydrite and trace chalcopyrite and rutile) to silicic type (quartz-rich, with minor pyrite, chalcopyrite). The rock locally shows foliation development and this is co-planar with emplacement of early diffuse veining that is

quartz-rich (in places with fibre texture), with large irregular patches and disseminations of pyrite and chalcopyrite, minor carbonate and anhydrite. Much anhydrite in the sample was replaced by gypsum and there are a few later veins of gypsum and/or carbonate, with local patches of low-birefringent clay (e.g. dickite).

SMD044 996.2 m PTS

Summary: Porphyritic dacite, with abundant plagioclase phenocrysts and less common phenocrysts of quartz and altered ferromagnesian material (perhaps hornblende) in a fine grained granular quartzofeldspathic groundmass. The rock was subject to moderate to strong pervasive alteration, although there is some preservation of igneous minerals. The alteration is dominated by albite and chlorite, with lesser sericite, minor anhydrite and a little carbonate, chalcopyrite and rutile. A few thin veins occur, with contents including carbonate, anhydrite, quartz and sericite.

SMD044W1 859.0 m PTS

Summary: Massive sulphides, representing the product of complete hydrothermal replacement and/or infill. No host rock is recognised. The sample is dominated by abundant fine through to coarse grained pyrite, with abundant interstitial bornite and chalcocite, subordinate fine to medium grained quartz, minor anhydrite and a little sericite and gypsum. Pyrite ranges from disseminated to semi-massive and is surrounded and probably invaded by bornite + chalcocite. Pyrite also contains sparse small inclusions of bornite and chalcocite, with rare chalcopyrite, enargite and a phase tentatively identified as colusite. Bornite and chalcopyrite also contain uncommon small inclusions of colusite and enargite. The textures and mineralogy of the rock conforms to high sulphidation type, formed under hypogene conditions.

SMD044W1 866.3 m PTS

Summary: Strongly hydrothermally altered porphyritic felsic igneous rock, perhaps originally of microgranodiorite or microtonalite type. The rock has abundant, largely altered plagioclase phenocrysts, a few relict quartz phenocrysts and pseudomorphs after former ferromagnesian phenocrysts (could have included biotite, hornblende) in a fine to medium grained, inequigranular quartzofeldspathic groundmass. Strong phyllic alteration was imposed, with replacement by quartz and sericite, plus minor disseminated pyrite, anhydrite and traces of bornite and rutile. Alteration is strongest about a sub-planar vein dominated by quartz and pyrite. Where more strongly altered, plagioclase was replaced by sericite, with minor anhydrite, quartz and pyrite.

SMD044W1 950.0 m TS

Summary: Porphyritic dacite (transitional to microtonalite/microgranodiorite) with a small volume of intrusive leucocratic microtonalite. The former rock type has scattered partly altered phenocrysts of plagioclase and a small amount of quartz and altered ferromagnesian phenocrysts in a rather fine grained quartzofeldspathic groundmass. A couple of zones of leucocratic microtonalite occur, probably as intrusive dikelets, cutting the porphyritic dacite. The leucocratic microtonalite is medium grained, inequigranular to locally porphyritic and contains partly altered plagioclase, interlocking with quartz and minor altered ferromagnesian material (former biotite). Both rock types show moderate to strong alteration. It is possible that early mild potassic alteration occurred in the porphyritic dacite, with minor development of hydrothermal biotite. However, both rock types are overprinted by propylitic alteration, with development of albite, sericite, chlorite and anhydrite from plagioclase, and chlorite from ferromagnesian components (including any former hydrothermal biotite). A few thin, sub-planar veins occur, containing carbonate, anhydrite, albite, sericite and quartz.

Interpretation and comment

Samples in the suite represent a variety of protolith types. These are dominated by igneous rocks, but there is a contact against a probable coarse fragmental sedimentary rock in one sample (SMD014/477.5 m). Igneous rocks were probably mostly intrusives, but a few of the fine grained types could represent volcanics, including a fragmental type in one sample. A massive sulphide sample (SMD044W1/859.0 m) has no recognised protolith and could be the product of intense hydrothermal replacement and/or hydrothermal infill. Effects of hydrothermal alteration are quite diverse, with many samples also having related veining, and several (three in particular) having minor to abundant sulphide mineralisation.

Primary rock types

Several different primary rock types occur. In many, there is moderately to well preserved primary characteristics, including the local preservation of primary (igneous) minerals. A few samples are intensely altered and consequently, recognition of the protolith is more speculative, although even in some of these, there is some preservation of diagnostic primary minerals.

The most common igneous rock type is porphyritic dacite and its probably slightly coarser grained equivalent, a porphyritic microtonalite or microgranodiorite. Porphyritic dacite is recognised in MSD001/405.9 m, SMD013/396.05 m (and contact against microdiorite), SMD039/446.5 m (and contact against microdiorite), SMD041/367.1 m and SMD044/996.2 m. Although intensely altered, the protolith for SMD044/924.3 m might have also been porphyritic dacite. Slightly coarser groundmasses in samples SMD044W1/866.3 m and SMD044W1/950.0 m indicate a transition from dacite to porphyritic microtonalite or microgranodiorite. These rocks typically contain rather abundant phenocrysts of plagioclase and less common quartz and ferromagnesian material. In some, quartz is only a microphenocryst phase, along with FeTi oxide (e.g. titanomagnetite). Relict shapes of altered ferromagnesian phases suggest that most were originally hornblende, although it is possible that pyroxene and maybe biotite could have occurred. A groundmass component typically constitutes at least half the porphyritic dacites and is generally dominated by fine grained, inequigranular plagioclase and quartz, with minor altered ferromagnesian material and traces of FeTi oxide, apatite and zircon. If K-feldspar was originally present as a groundmass phase, it was probably altered, except in MRD001/405.9 m, where K-feldspar occurs with plagioclase. Many of the dacites have textures that are typical of those observed in “classic” porphyry systems.

In sample SMD044W1/950.0 m, porphyritic dacite appears to have been intruded by small dykelets of a more evolved, felsic igneous rock, interpreted as medium grained, leucotonalite. This rock has abundant sodic plagioclase and quartz, and originally contained a small amount of biotite. Porphyritic microdiorite constitutes sample SMD040/482.5 m and is also present, contacting against porphyritic dacite in SMD013/396.05 m and SMD039/446.5 m. In the latter two samples, it is suspected that dacite is later than (and intrusive into) microdiorite. The microdiorites originally contained phenocrysts of plagioclase and hornblende, and had plagioclase-rich groundmasses, with minor quartz and ferromagnesian material, and a little apatite. Sample SMD014/477.5 m has a contact between porphyritic hornblende andesite and a coarsely fragmental rock considered to represent a coarse epiclastic sandstone. It is likely that the andesite is intrusive into the latter. In the andesite, there are phenocrysts of hornblende (some is unaltered) and plagioclase in a fine grained feldspathic groundmass. The interpreted epiclastic sandstone has a matrix-supported texture and contains large lithic grains (fine grained volcanic, sandstone, siltstone) as well as apparent detrital quartz and rare garnet.

Although intensely hydrothermally altered, it is considered that samples SMD042/921.05 m and SMD044/645.7 m had protoliths of likely high-Mg mafic to ultramafic igneous composition. In the former sample, there is some preservation of coarse, fragmental texture, a few pseudomorphs after former pyroxene grains and local amygdules, with this rock possibly representing an original basaltic fragmental (e.g. hyaloclastite). In SMD044/645.7 m, no diagnostic relict texture is preserved, but both of these samples retain sparse small grains of refractory Cr spinel (chromite). Such a phase could have occurred as inclusions in original igneous olivine or pyroxene grains and its presence attests to a Mg-rich composition igneous protolith (e.g. high-Mg basalt, picrite). Due to the intense alteration, it could be speculated that these high-Mg protoliths were part of a pre-intrusive mafic volcanic suite.

Apart from the high-Mg mafic protolith material, the other igneous rocks in the suite range from intermediate to felsic in composition and could represents an evolutionary range, with the more evolved types (porphyritic dacite, leucotonalite) being later and intrusive into the intermediate composition types. The overall compositions are of calc-alkaline I-type, and probably mostly of low-K affinity. Comments from Hamish Forgan about some igneous rocks having significantly higher Ti and P contents could point to a different magmatic lineage also occurring, perhaps one with more alkalic affinities.

Alteration

All samples in the suite display effects of alteration imposed upon primary constituents, and in many, there is related veining. Most effects are probably due to hydrothermal fluid flux, although the imprint of subsequently imposed low grade regional metamorphism (e.g. at sub-greenschist to lower greenschist facies) could have also augmented mineralogical changes.

Definite potassic alteration has only been observed in MSD001/405.9 m, where there was probably minor development of hydrothermal K-feldspar, replacing plagioclase. In this sample, some of the feldspar has a prominent pink (-orange) colour in handspecimen, but this includes both K-feldspar and albite. Similarly, a few other samples (e.g. SMD044W1/950.0 m) contain pink feldspar, but sodium cobaltinitrite staining did not indicate the presence of K-feldspar, and albite is clearly occurring. In this latter sample, there are indications that fine grained hydrothermal biotite could have formed early, from former ferromagnesian material, but it was subsequently retrogressed.

Propylitic alteration occurs in many samples and it could have overprinted earlier potassic alteration (e.g. in SMD044W1/950.0 m), or be transitional into potassic alteration (in MSD001/405.9 m), or advanced argillic alteration (in SMD044/645.7 m). Typical products of propylitic alteration include albite, and in some samples, sericite, chlorite, epidote, carbonate and prehnite, developed from plagioclase (and possibly, K-feldspar), and chlorite (± carbonate, epidote, sericite, leucoxene-rutile, pyrite) from ferromagnesian phases. Igneous FeTi oxide was commonly replaced by leucoxene-rutile. Other minor phases that are observed in some propylitic assemblages include hematite, titanite, actinolite, anhydrite and trace chalcopyrite and bornite.

Phyllic alteration occurs strongly in SMD044W1/866.3 m, where the host porphyritic felsic igneous rock was largely replaced by an assemblage of quartz, sericite and pyrite, plus minor anhydrite and traces of rutile and Cu sulphides. Similar alteration occurs in SMD044/946.3 m, although it is transitional to silicic type, as parts of the alteration assemblage are quartz-rich. A type of intense alteration that is considered to be transitional between silicic (quartz-rich) and advanced argillic occurs in SMD044/924.3 m, accompanying strong sulphide mineralisation. In this rock, abundant quartz and sulphides are accompanied by probable pyrophyllite and minor anhydrite, along with traces of rutile and diaspore. In the high-Mg basaltic protolith sample SMD044/645.7 m, intense alteration could be of transitional propylitic to advanced argillic type, where abundant chlorite and quartz occur with anhydrite, hematite and small amounts of magnetite and CuFe sulphides. The minor amounts of gangue components in massive sulphide sample SMD044W1/859.0 m include quartz, anhydrite and a little sericite, inferring affinities to silicic-phyllic alteration.

Veining

Veins occur in most samples, although vein density is probably low overall, and vein widths are relatively narrow in many. In the sulphide-rich samples, however, vein fillings could dominate (in SMD044/924.3 m, SMD044/946.3 m, SMD044W1/859.0 m). Vein assemblages are mostly related (mineralogically) to the host rock alteration assemblages, but there are a few samples with evidently later veining by phases that could have formed at lower temperatures, e.g. carbonate, gypsum, clay. In the "higher rank" alteration (e.g. phyllic to silicic and advanced argillic), hydrothermal infillings of veins include variably abundant quartz, pyrite, Cu sulphides and anhydrite, with probable pyrophyllite recognised in SMD044/924.3 m. As temperatures decreased after these assemblages were deposited, there appears to have been local replacement of anhydrite by gypsum and development of aggregates of a medium grained, crystalline clay phase with low birefringence, e.g. dickite (e.g. in SMD044/645.7 m, SMD044/946.3 m, SMD044W1/866.3 m). In propylitic-altered rocks, vein assemblages are varied and include carbonate (mostly calcite), quartz, sericite, chlorite, anhydrite, epidote, albite, pyrite and traces of Cu sulphides. Prehnite veining is conspicuous in MSD001/405.9 m.

Mineralisation

Most samples in the suite contain trace through to abundant sulphides as part of the pervasive alteration assemblages and hydrothermal infillings of veins. Three sulphide-rich samples (SMD044/924.3 m, SMD044/946.3 m, SMD044W1/859.0 m) might also represent zones of substantial sulphide development by replacement of the host rocks, as well as having a large vein component. It is apparent that larger amounts of sulphides in the samples are also related to the "higher rank" alteration of silicic, advanced argillic and phyllic types.

Sample SMD044W1/859.0 m is composed of massive sulphides, with an estimated >80% sulphide minerals, and in SMD044/924.3 m, the sulphide amount approaches 40%. In these two samples, pyrite is the dominant sulphide, with subordinate amounts of bornite, typically intergrown with chalcocite. Bornite-chalcocite textures are typical of those formed under hypogene (hydrothermal) conditions, with the minerals in apparent equilibrium and showing delicate intergrowths (locally micrographic). There is no evidence for the two Cu sulphides to have formed by deep supergene alteration, or to have been deposited from a sulphide melt (i.e. inconsistent with associated gangue minerals and textures). In SMD044/946.3 m, abundant pyrite (estimated 12%) and chalcopyrite (estimated 10%) occur as disseminations and in veins, but there is no overprinting by bornite or chalcocite. Traces of chalcopyrite, bornite and chalcocite are observed as small inclusions in pyrite. Small amounts of chalcopyrite (up to 1%) occur in MSD001/405.9 m, SMD041/367.1 and SMD044/645.7 m and traces of chalcopyrite and/or bornite are found in several other samples, with the two sulphides being in apparent equilibrium where found together (e.g. MSD001/405.9 m). There are small amounts of enargite, hosted mainly in bornite and chalcocite in SMD044/924.3 m, and similarly in SMD044W1/859.0 m, a little enargite also occurs, along with a phase tentatively identified as colusite ($Cu_{13}VAs_3S_{16}$). In all of the sulphide assemblages with pyrite and Cu-bearing sulphides, pyrite is paragenetically early, and locally it can be implied that there has been replacement of pyrite on grain boundaries and along fractures.

No other base metal sulphides were observed in the samples, and molybdenite was not recognised (although it was implied to occur in SMD044/946.3 m). Similarly, no discrete precious metal phase was observed. Possible hydrothermal magnetite was only present in SMD044/645.7 m, as replacements of relict igneous chromite, and as rare tiny inclusions in pyrite in SMD044/946.3 m. A significant amount (~5%) of specular hematite occurs as part of the alteration assemblage in SMD044/645.7 m, and there are traces of alteration-derived hematite in a few other samples.

The alteration-mineralisation characteristics of the samples examined indicate that the hydrothermal system must have been relatively oxidised (e.g. mineral assemblages containing phases such as hematite, anhydrite, bornite-chalcocite and epidote), at low to moderate temperature and in places, relatively acidic, so as to generate characteristics conforming to silicic, advanced argillic and phyllic alteration. As mentioned above, it appears that stronger sulphide mineralisation is associated with the "higher rank" alteration. The mineralogy of the sulphide-rich rocks and associated alteration conform to the high sulphidation style of system. A direct association of the alteration-mineralisation with a particular intrusive rock type is, at present, not demonstrated, but it is speculated that there could be a link to the magmatic evolution to more felsic compositions, e.g. the medium grained leucotonalite.

Individual sample descriptions

MSD001 405.9 m PTS

Summary: Strongly porphyritic dacite with moderately well preserved primary texture, but showing strong pervasive hydrothermal alteration and local veining. The rock retains a few relict quartz phenocrysts, but originally rather abundant plagioclase and ferromagnesian (e.g. hornblende, pyroxene) phenocrysts are totally altered. The rock also contained small amounts of FeTi oxide and apatite microphenocrysts, as well as a finely granular quartzofeldspathic groundmass. Pervasive alteration is interpreted to be of transitional potassic-propylitic type. It has involved the replacement of plagioclase phenocrysts by albite and turbid K-feldspar (patchily abundant), with minor sericite, prehnite and epidote. All former ferromagnesian material was altered, with replacement by chlorite, as well as prehnite, epidote and quartz. Igneous FeTi oxide was replaced by hematite and titanite. A few veins occur, including irregular to sub-planar and discontinuous examples containing prehnite, as well as others with epidote, chalcopyrite, bornite and chlorite.

Handspecimen: The drill core sample is composed of a strongly porphyritic felsic igneous rock. It contains abundant blocky pale creamy to pink feldspar phenocrysts up to 8 mm across and less common pale grey quartz phenocrysts up to 3 mm across and altered, commonly elongate, dark grey-green ferromagnesian phenocrysts up to a few millimetres long, enclosed in a finely granular, pale grey quartzofeldspathic groundmass (Fig. 1). Moderate to strong pervasive alteration is apparent, with development of chlorite (e.g. at former ferromagnesian sites), as well as probable sericite and epidote, and there are a few thin, discontinuous veining that includes chlorite, epidote, prehnite and chalcopyrite, and trace bornite. Staining of the section offcut with sodium cobaltinitrite indicated that there is patchy development of K-feldspar, mainly from igneous feldspar phenocrysts (Fig. 1). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

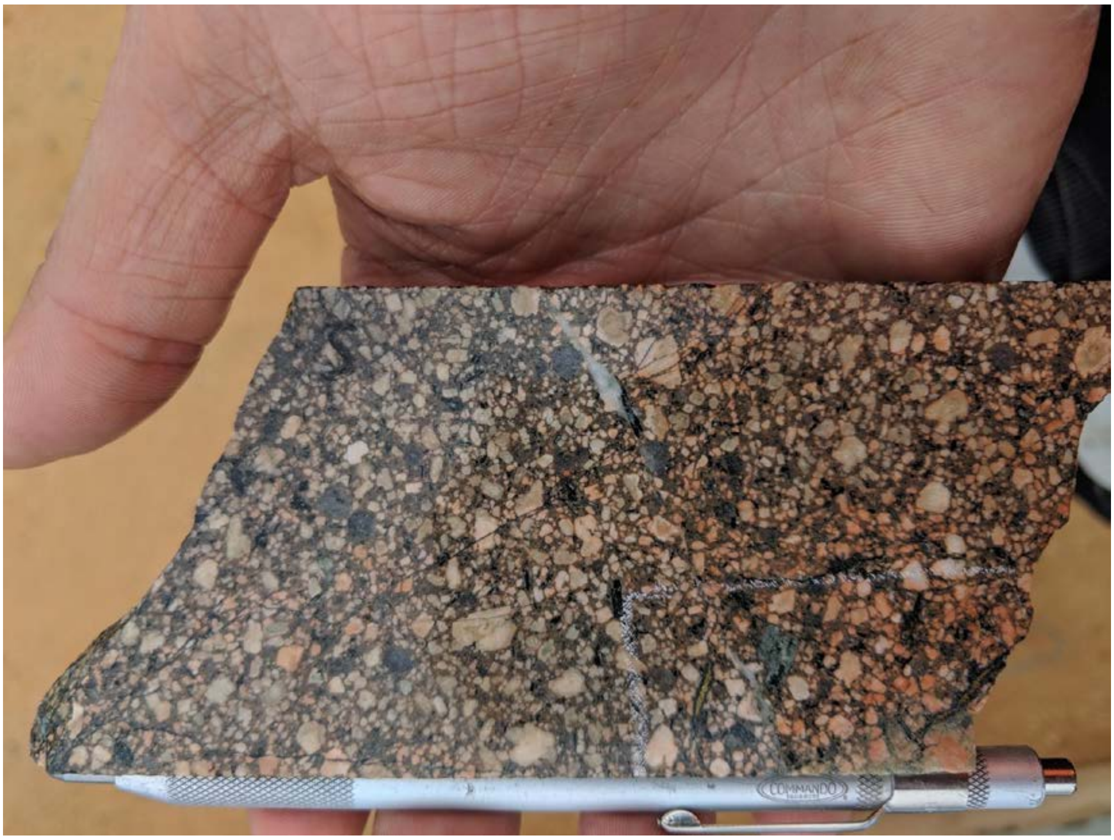

Fig. 1: Drill core sample of altered, strongly porphyritic dacite. Pinker zone at right has stronger K-feldspar alteration.

Petrographic description

a) Primary rock characteristics: In the section, relict strongly porphyritic texture is moderately well preserved. The rock contains a considerable proportion of altered, blocky plagioclase phenocrysts up to 7 mm across, as well as less abundant relict quartz phenocrysts (up to 3 mm across) and altered ferromagnesian phenocrysts (up to several millimetres long and of elongate to blocky form, including a few grain clusters) (Figs 2, 3) Relict shapes after ferromagnesian grains suggest that hornblende and pyroxene were originally present. The rock also contained a few microphenocrysts of FeTi oxide up to 0.6 mm across (now altered) and uncommon apatite grains up to 0.5 mm across. Phenocrystal phases were enclosed in a finely granular groundmass, constituting 40-50% of the rock and originally containing abundant feldspars (plagioclase and K-feldspar) and quartz, plus minor ferromagnesian material (Figs 2, 3). The interpreted primary textural and mineralogical features of the rock indicate that it is a porphyritic dacite.

b) Alteration and structure: The igneous rock experienced strong pervasive hydrothermal alteration and emplacement of a few small veins. Original plagioclase phenocrysts were albitised, as well as being patchily replaced by turbid K-feldspar, plus small amounts of prehnite, epidote, sericite and trace chlorite and carbonate (Figs 2, 3). All former ferromagnesian material was altered, mostly to chlorite (Fig. 2), but in places with prehnite, epidote, quartz (at pyroxene sites) and trace titanite. All igneous FeTi oxide was replaced by hematite ± titanite. In the groundmass, there was minor patchy replacement by K-feldspar, as well as chlorite, prehnite and epidote. Several irregular patches of prehnite, grading to veins up to 1 mm across, occur (Fig. 3), and there are also a few discontinuous, irregular veinlets up to 1.5 mm wide of epidote, chalcopyrite, bornite, in places with chlorite and trace apatite (Fig. 4). The alteration assemblage is regarded as being of transitional potassic-propylitic type. There is no evidence for propylitic alteration to have overprinted earlier potassic alteration.

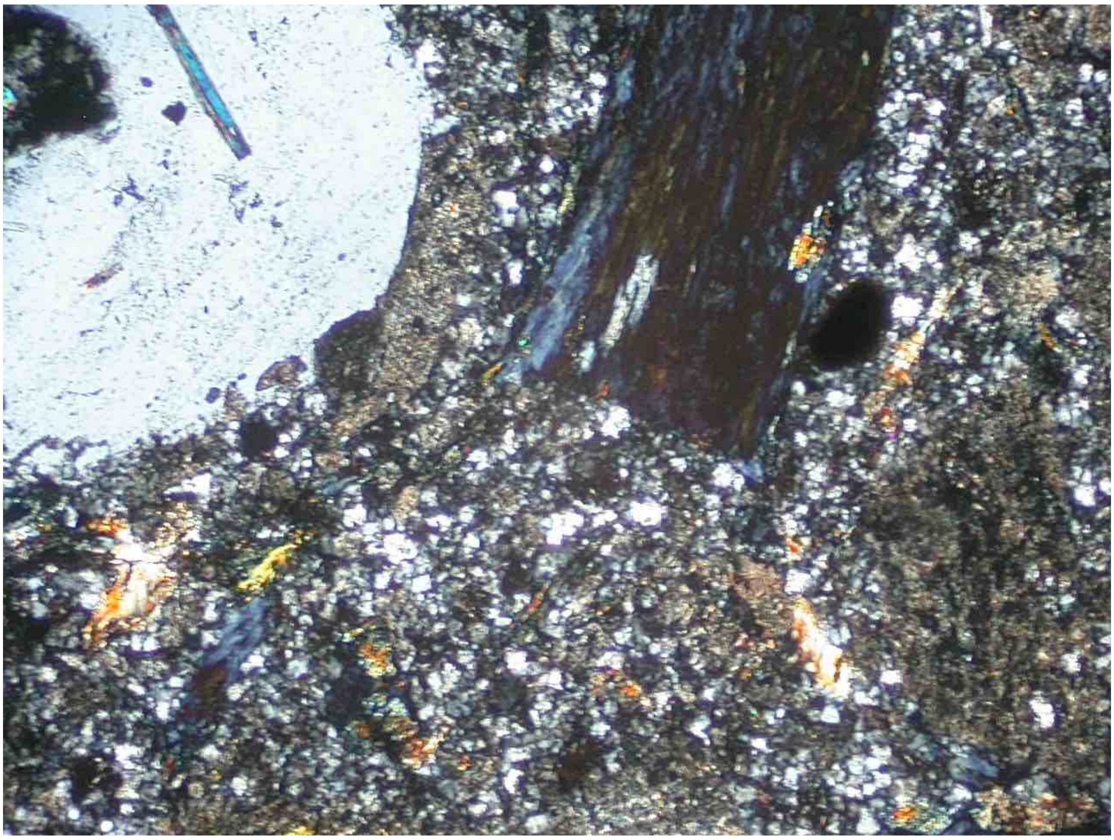

Fig. 2: Relict texture in altered porphyritic dacite, with relict quartz phenocryst at upper left, an altered (chloritised) ferromagnesian grain at upper centre and turbid pseudomorphs (now albite, K-feldspar) after plagioclase, in a finely granular quartz-feldspar groundmass. Small brightly coloured grains are prehnite. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The sample contains minor sulphides, restricted to veins. Here, there are a few aggregates containing chalcopyrite and minor bornite, associated mostly with epidote and up to 1.5 mm wide (Fig. 4).

<u>Mineral Mode (by volume)</u>: plagioclase (albite) 40%, quartz 23%, K-feldspar 15%, chlorite 12%, prehnite 5%, epidote 2%, sericite and chalcopyrite each 1% and traces of apatite, hematite, titanite, bornite and carbonate.

<u>Interpretation and comment</u>: It is interpreted that the sample represents a pervasively hydrothermally altered and locally veined, porphyritic dacite. The rock retains a few relict quartz phenocrysts, but former plagioclase and ferromagnesian (e.g. hornblende, pyroxene) phenocrysts are totally altered. The rock also contained small amounts of FeTi oxide and apatite microphenocrysts, as well as a finely granular quartzofeldspathic groundmass. Alteration is interpreted to be of transitional potassic-propylitic type and has involved the replacement of plagioclase phenocrysts by albite and turbid K-feldspar (patchily abundant), with minor sericite, prehnite and epidote. All former ferromagnesian material was altered, with replacement by chlorite, as well as prehnite, epidote and quartz. Igneous FeTi oxide was replaced by hematite and titanite. A few veins occur, including irregular to sub-planar and discontinuous examples containing prehnite, as well as others with epidote, chalcopyrite, bornite and chlorite.

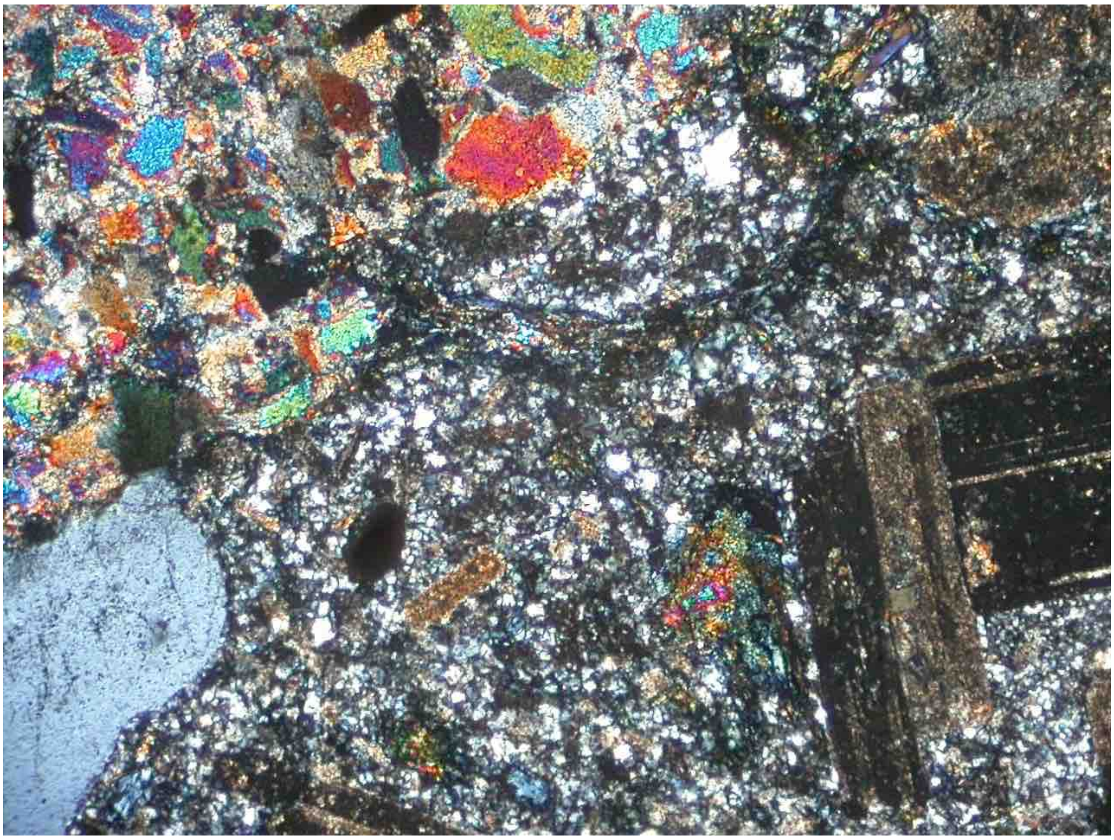

Fig. 3: Vein of prehnite (upper left) cutting altered porphyritic dacite that retains a quartz phenocryst (lower left) and turbid, albitised plagioclase phenocrysts in a finely granular quartz-feldspar groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.

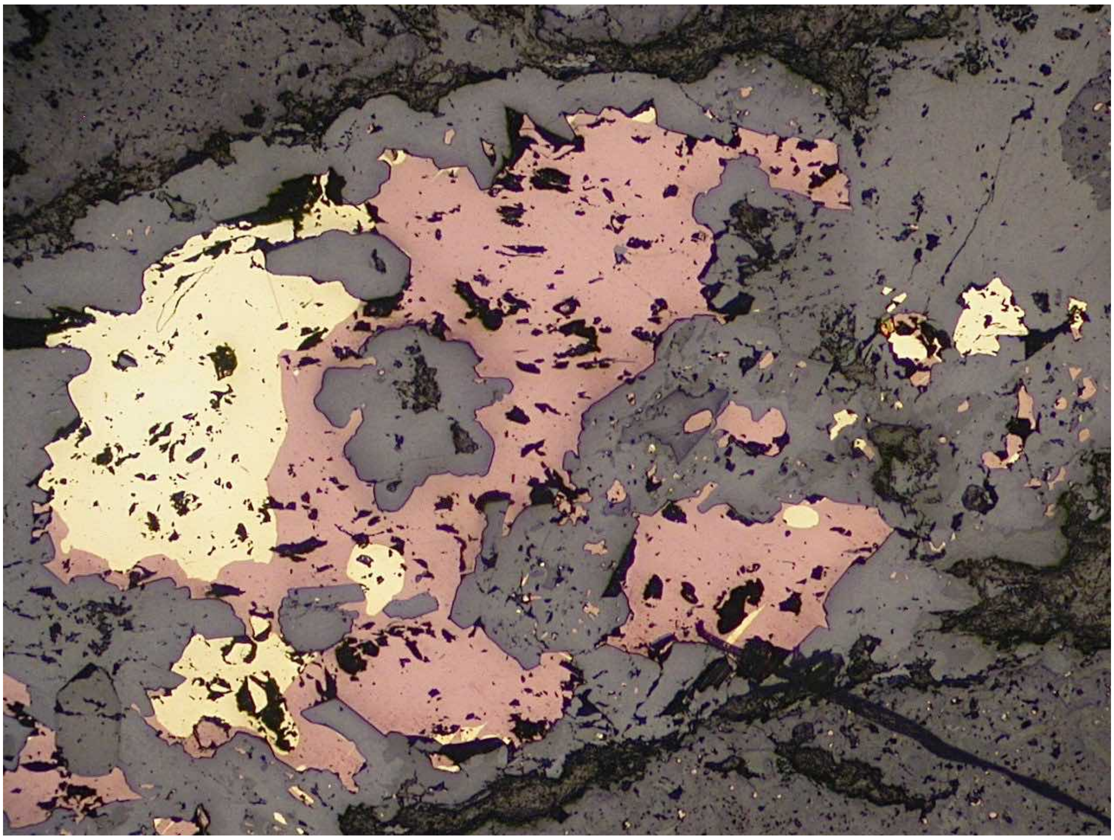

Fig. 4: Part of a vein assemblage of epidote (mid-grey) with enclosed chalcopyrite (yellow) and bornite (dark pink). Plane polarised reflected light, field of view 2 mm across.

SMD013 396.05 m PTS

Summary: The drill core sample has a contact between a strongly porphyritic dacite and a fine to medium grained, more even-grained quartz microdiorite. The former rock type retains scattered large plagioclase phenocrysts and also has less common, altered ferromagnesian phenocrysts (probably originally hornblende) in a finely granular quartzofeldspathic groundmass. The latter rock type originally contained small plagioclase phenocrysts in a fine to medium grained, inequigranular groundmass of plagioclase, quartz and ferromagnesian material. The quartz microdiorite was evidently microbrecciated, and both rock types show pervasive hydrothermal alteration of propylitic type. Much original feldspar (except for some of the plagioclase phenocrysts in the dacite) was replaced by albite and ferromagnesian material by chlorite, with these phases being accompanied by smaller amounts of sericite, carbonate, epidote, pyrite and trace rutile and titanite. A single vein of sericite, pyrite, prehnite, chlorite and carbonate occurs, along with a few later, thin, sub-planar carbonate veins.

Handspecimen: The drill core sample displays a contact between a dark grey, strongly porphyritic felsic to intermediate igneous rock and a paler grey, weakly porphyritic strongly feldspathic igneous rock, perhaps also of felsic to intermediate composition (Fig. 5). The porphyritic rock has pale creamy to pale grey plagioclase phenocrysts up to 8 mm across and less common, smaller, altered ferromagnesian phenocrysts set in a fine grained quartzofeldspathic groundmass (Fig. 5). The other rock type is probably rather plagioclase-rich, with minor altered ferromagnesian material. It shows indications of micro-brecciation (Fig. 5). Imposed alteration appears to have formed a moderate amount of chlorite from ferromagnesian material and there are scattered pyrite aggregates up to 3 mm across. A few thin veins occur, with some containing pyrite, and others being evidently carbonate-rich. Testing of the section offcut with sodium cobaltinitrite did not reveal the presence of K-feldspar. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Fig. 5: Drill core sample showing contact between strongly porphyritic dacite (darker grey at left) and fine to medium grained, slightly porphyritic quartz microdiorite at right. The latter has indications of imposed micro-brecciation.

Petrographic description

a) Primary rock characteristics: In the section, relict texture is moderately well preserved and it is evident that there are two distinct igneous rock types, with a relatively sharp contact in-between. On the scale of the section, timing relations are not diagnostic, but the fact that the less porphyritic rock is micro-brecciated could imply that it is earlier. This rock type contains rather sparse blocky plagioclase phenocrysts up to 2 mm across, enclosed in a fine to medium grained, inequigranular aggregate of plagioclase, quartz, altered ferromagnesian material, and originally, a little disseminated FeTi oxide (now altered) (Fig, 6). It is interpreted from the relict characteristics that this rock type is a porphyritic quartz microdiorite. The other rock type is strongly porphyritic, with scattered, partly altered blocky plagioclase phenocrysts up to 8 mm across, and less common pseudomorphs after a former ferromagnesian phase up to 2 mm long (Fig. 7). Relict shapes of the latter suggest that it was probably hornblende. There are also a few microphenocrysts of FeTi oxide (altered) and apatite, all enclosed in a finely granular quartzofeldspathic groundmass (Fig. 7). The strongly porphyritic rock is interpreted as a porphyritic dacite.

Fig. 6: Weakly porphyritic quartz microdiorite showing small plagioclase phenocrysts (left) and with the rock having an alteration assemblage of albite + chlorite, with minor sericite and epidote. Transmitted light, crossed polarisers, field of view 2 mm across.

b) Alteration and structure: Both rock types were affected by pervasive hydrothermal alteration and emplacement of a few narrow veins. The quartz microdiorite was evidently affected by microbrecciation (probably prior to alteration). Much original plagioclase in the rocks was altered, although large phenocrysts in the porphyritic dacite commonly retain igneous zoning. The replacement of igneous plagioclase, as well as groundmass feldspar (e.g. could have included K-feldspar) was by albite, commonly accompanied by sericite and carbonate, and by trace epidote and chlorite. Original ferromagnesian material was replaced mostly by chlorite, although epidote is locally present (Figs 6, 7) and trace titanite, and all igneous FeTi oxide was replaced by rutile ± titanite. Albite development in groundmass domains was also accompanied by chlorite, minor sericite, epidote, carbonate, patchy and veinlike pyrite, and trace rutile and titanite. A single irregular vein up to 0.6 mm wide contains varying amounts of sericite, carbonate, pyrite, prehnite and chlorite, and there are also a few paragenetically later, thin sub-planar carbonate veins up to 0.2 mm wide. The alteration and vein assemblage in the sample is consistent with propylitic type.

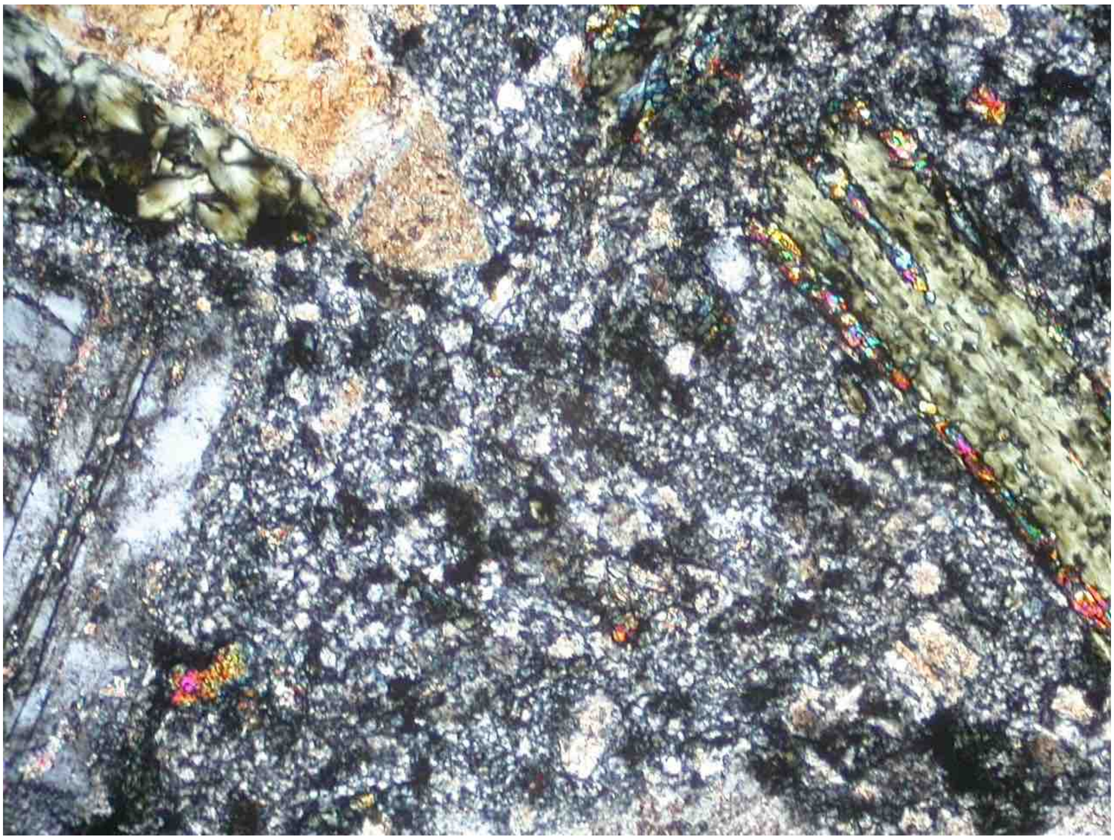

Fig. 7: Porphyritic dacite with remnant plagioclase phenocrysts at left and a couple of elongate pseudomorphs after former hornblende, now replaced by chlorite and a little epidote. Note finely granular quartzofeldspathic groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The sample contains sparsely scattered aggregates of fine to medium grained pyrite up to 3 mm across, some tending veinlike. Individual subhedral to anhedral pyrite grains are up to 1 mm across.

Mineral Mode (by volume): plagioclase (including albite) 60%, quartz 15%, chlorite 10%, sericite 5%, carbonate 4%, pyrite 3%, epidote 2% and traces of apatite, rutile, titanite and prehnite.

Interpretation and comment: It is interpreted that the sample has a contact between strongly porphyritic dacite and fine to medium grained, more even-grained quartz microdiorite. The former rock type retains scattered large plagioclase phenocrysts and also has altered ferromagnesian phenocrysts (probably originally hornblende) in a finely granular quartzofeldspathic groundmass. The latter rock type originally contained small plagioclase phenocrysts in a fine to medium grained, inequigranular groundmass of plagioclase, quartz and ferromagnesian material. The quartz microdiorite was evidently microbrecciated, and both rock types have moderate to strong propylitic alteration. Much original feldspar (except for some of the plagioclase phenocrysts in the dacite) was replaced by albite and ferromagnesian material by chlorite, with these phases being accompanied by smaller amounts of sericite, carbonate, epidote, pyrite and trace rutile and titanite. A single vein of sericite, pyrite, prehnite, chlorite and carbonate occurs, along with a few later, thin, sub-planar carbonate veins.

SMD014 477.5 m TS

Summary: The drill core sample has a contact between a strongly altered, mildly porphyritic andesite, and a coarse fragmental rock, considered to represent a type of epiclastic sandstone. Relict textures are rather well preserved in both rock types. The andesite originally contained hornblende and a minor proportion of plagioclase phenocrysts in a fine grained feldspathic groundmass. The fragmental rock has a largely matrix-supported texture and contains scattered lithic grains (altered volcanic material, sandstone, siltstone) and apparently detrital quartz grains, in a finer grained silty to sandy matrix. Both rock types are strongly propylitically altered, with replacement by dominant carbonate (calcite) and chlorite. Minor quartz, sericite, albite, pyrite and a little leucoxene, occur in the andesite. Minor veining occurs, mainly in the andesite, with paragenetically early veining by quartz, pyrite, chlorite and trace epidote, being cut by later carbonate-quartz-pyrite-chlorite veining.

Handspecimen: The drill core sample has a sharp, but rather irregular contact at a moderate angle to the core axis between a fine grained, pale grey, sparsely porphyritic intermediate igneous rock, and a darker grey, evidently fragmental rock with an apparent matrix-supported texture (Fig. 8). The latter has scattered fine grained lithic grains up to several millimetres across. The sparsely porphyritic rock has altered phenocrysts, maybe originally feldspar and ferromagnesian material up to 3 mm across in a fine grained, perhaps feldspathic groundmass (Fig. 8). Both rock types have strong pervasive alteration, most likely with development of chlorite and carbonate, but also perhaps including sericite and disseminated pyrite (Fig. 8). A few veins of white carbonate up to 1 mm wide have also been emplaced at low angles to the core axis. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. Testing with sodium cobaltinitrite did not reveal the presence of K-feldspar. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Fig. 8: Drill core sample showing contact between strongly altered, sparsely porphyritic andesite (paler grey) and darker grey, altered coarse fragmental rock (e.g. coarse epiclastic sandstone). Both rock types are dominated by carbonate-chlorite alteration.

Petrographic description

a) Primary rock characteristics: In the section, primary textural characteristics are rather well preserved, despite strong alteration. It is apparent that there are two distinct rock types separated by a sharp and irregular contact. One rock type is clearly igneous, being fine grained and porphyritic, and it appears to have intruded the other rock type, which is a coarsely fragmental type (Figs 9, 10). The porphyritic rock contains pseudomorphs after scattered former elongate ferromagnesian phenocrysts up to 2.5 mm long (probably originally hornblende) and less common plagioclase phenocrysts up to 1.2 mm across (Fig. 9). There are also a few pseudomorphs after former FeTi oxide grains up to 0.5 mm across and sparse apatite grains are preserved. The phenocrystal grains are enclosed in a fine grained altered groundmass, that was probably of original feldspathic composition (Fig. 9). Based on the preserved primary characteristics, the igneous rock is interpreted as a porphyritic hornblende andesite. The fragmental rock type is strongly heterogeneous, with a generally matrix-supported texture. It contains abundant diffuse to well-defined altered lithic grains up to several millimetres across, as well as scattered apparently detrital quartz grains up to 0.5 mm across and rare carbonate and garnet grains, all occurring in a finer grained, apparently silty to sandy matrix (Fig. 10). Lithic grains could include altered fine grained volcanic material, matrix-supported fine to medium grained sandstone, and siltstone. The preserved primary characteristics of the fragmental rock infer that it could represent a coarse epiclastic sandstone.

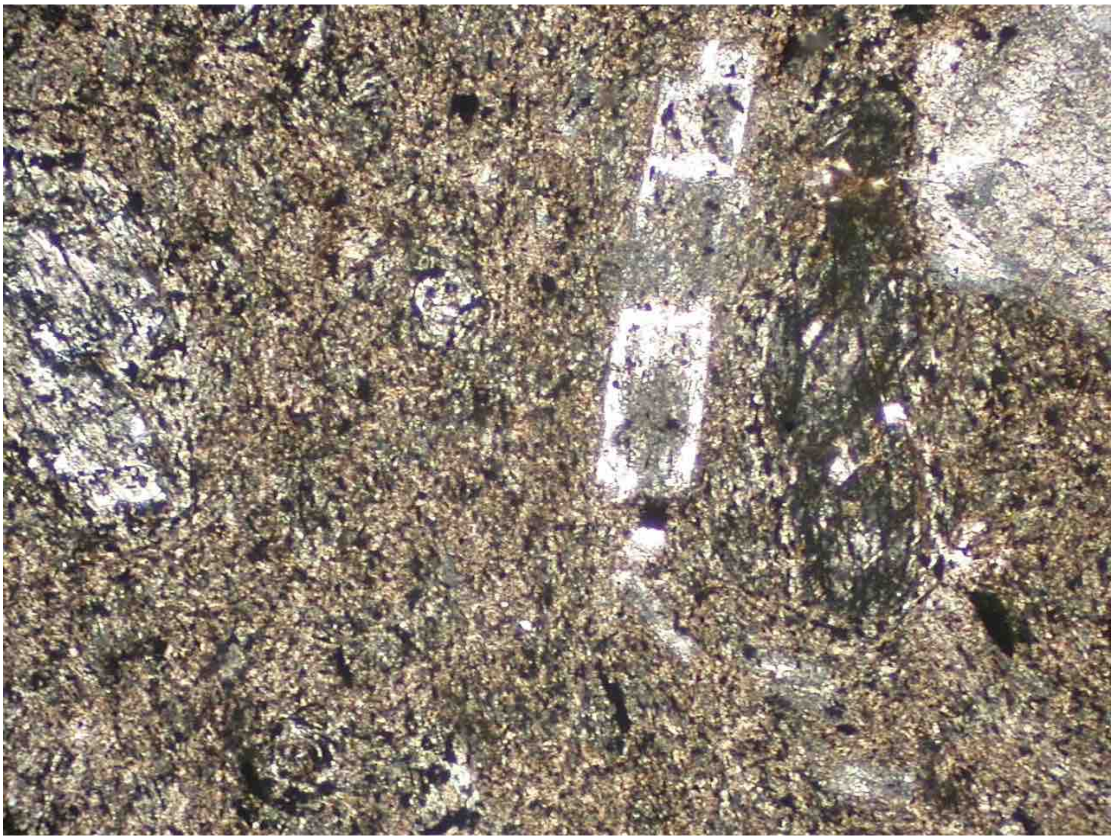

Fig. 9: Relict texture in altered porphyritic andesite, with pseudomorphs after small phenocrysts of plagioclase (clearer) and hornblende in a fine grained, turbid groundmass, now

with considerable carbonate-chlorite alteration. Plane polarised transmitted light, field of view 2 mm across.

b) Alteration and structure: Both rock types are strongly and pervasively altered, and minor veining is also present. The alteration assemblage is dominated by fine grained carbonate (calcite) and chlorite, both with irregularly patchy distribution (Figs 9, 10). In the altered andesite, there is also minor quartz, albite, sericite, pyrite and a little leucoxene and trace epidote, but in the fragmental rock, carbonate and chlorite are only accompanied by traces of pyrite and leucoxene. Diffuse veining occurs, mostly in the altered andesite, with paragenetically early veining up to 1 mm wide of quartz, pyrite, chlorite and trace epidote, cut by later veining up to 2.5 mm wide of carbonate, quartz, pyrite and chlorite. The alteration and vein assemblage is consistent with propylitic type.

c) Mineralisation: Minor pyrite occurs in the sample, mostly in the altered andesite, and largely confined to vein assemblages. There are pyrite aggregates up to 1 mm across, with individual grains up to 0.5 mm across.

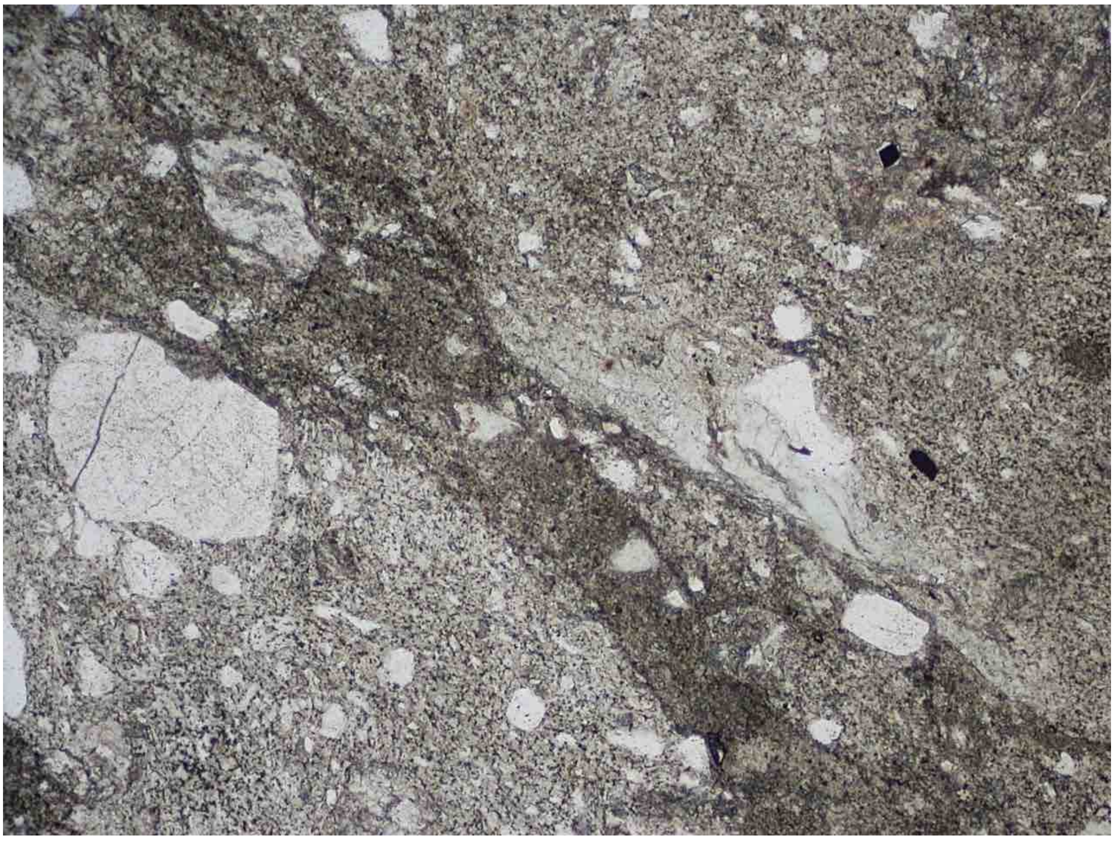

Fig. 10: Relict texture in coarse fragmental rock, perhaps an epiclastic sandstone. Large altered lithic grains (siltstone and possible volcanic) are accompanied by minor quartz grains in a silty matrix. There is strong carbonate-chlorite alteration throughout. Plane polarised transmitted light, field of view 2 mm across.

<u>Mineral Mode (by volume)</u>: carbonate (calcite) 50%, chlorite 35%, quartz 8%, sericite 3%, albite 2%, pyrite 1% and traces of leucoxene, epidote, apatite and garnet.

<u>Interpretation and comment</u>: It is interpreted that the sample displays a contact between strongly altered, porphyritic andesite, and a coarse fragmental rock, maybe a type of epiclastic sandstone. Relict textures are rather well preserved in both rock types. The andesite originally

contained hornblende and plagioclase phenocrysts in a fine grained feldspathic groundmass. The fragmental rock has a largely matrix-supported texture and contains scattered lithic grains (altered volcanic material, sandstone, siltstone) and apparently detrital quartz grains, in a finer grained silty to sandy matrix. Strong propylitic alteration has pervaded both rock types, with replacement by dominant carbonate (calcite) and chlorite. Minor quartz, sericite, albite, pyrite and a little leucoxene, occur in the andesite. Minor veining occurs, mainly in the andesite, with paragenetically early veining by quartz, pyrite, chlorite and trace epidote, being cut by later carbonate-quartz-pyrite-chlorite veining.

SMD039 446.5 m TS

Summary: The drill core sample shows an intrusive contact between a strongly porphyritic dacite and a more altered, porphyritic hornblende microdiorite. The contact is sharp and rather intricate, and there are a couple of xenoliths of microdiorite hosted in dacite. The latter rock contains phenocrysts of plagioclase and hornblende, with a few small microphenocrysts of quartz, in a fine grained feldspathic groundmass. Microdiorite originally contained phenocrysts of hornblende and plagioclase in a fine to medium grained feldspathic groundmass. Both rock types have imposed propylitic alteration, more strongly evident in the microdiorite, where there is little preservation of primary minerals, in contrast to the dacite. The alteration assemblage includes considerable albite (from plagioclase phenocrysts and groundmass feldspar) and chlorite, with minor carbonate and sericite, and trace quartz, hematite, leucoxene and epidote. A couple of carbonate-rich veins occur in the sample.

Handspecimen: The drill core sample displays two different igneous rock types, with the sharp contact, although irregular, being generally at a low angle to the core axis (Fig. 11). One rock type appears to be finer grained and less porphyritic, but containing possible altered feldspar and ferromagnesian phenocrysts, with the other rock being strongly porphyritic and containing pale grey to creamy plagioclase phenocrysts in a fine grained dark grey groundmass (Fig. 11). It is likely that moderate to strong alteration has affected both rock types, with development of fine grained chlorite, as well as sericite at plagioclase sites. A couple of thin, sub-planar carbonate veins up to 1 mm wide occur at varying angles to the core axis. Testing with sodium cobaltinitrite did not reveal the presence of K-feldspar. The strongly porphyritic rock is moderately magnetic, with susceptibility up to 200 x 10^{-5} SI and the less porphyritic rock is moderately to strongly magnetic, with susceptibility up to 1070 x 10^{-5} SI, indicating the presence of a little magnetite.

Fig. 11: Drill core sample showing intrusive contact between strongly porphyritic dacite (with pale plagioclase phenocrysts) and less porphyritic microdiorite. Both rock types are affected by propyltic alteration with development of albite, chlorite and carbonate, plus minor sericite.

<u>Petrographic description</u>

a) Primary rock characteristics: In the section, primary textural characteristics are rather well preserved and it is evident that there are two distinct igneous rock types. One is apparently more altered and has clearly been intruded by the other rock type. The more altered rock is strongly porphyritic and has abundant pseudomorphs after elongate ferromagnesian phenocrysts (e.g. former hornblende) up to 3 mm long and less common blocky plagioclase up to 2 mm across in a fine to medium grained, inequigranular groundmass, probably originally with abundant plagioclase, subordinate ferromagnesian material and minor quartz and FeTi oxide (titanomagnetite) and trace apatite (Fig. 12). From the relict characteristics, this rock is interpreted as an altered porphyritic hornblende (-quartz) microdiorite. The other rock has a sharp, but intricate, intrusive relationship with the microdiorite and also contains a couple of xenoliths of microdiorite up to several millimetres across. The intrusive rock is strongly porphyritic and less altered than the microdiorite, retaining scattered large (up to 7 mm) plagioclase phenocrysts and largely altered hornblende phenocrysts up to 2.5 mm long (Fig. 13). There are also a few microphenocrysts of quartz up to 0.7 mm across, all enclosed in a fine grained, inequigranular groundmass rich in feldspar (probably plagioclase > K-feldspar, but with all groundmass feldspar being subsequently altered), minor ferromagnesian material, quartz and FeTi oxide (Fig. 13). From the preserved primary characteristics, this rock is interpreted as a porphyritic hornblende dacite.

Fig. 12: Altered porphyritic microdiorite showing an albitised plagioclase phenocryst at right and a pseudomorph after a former hornblende phenocryst at left, replaced largely by chlorite (dark). The groundmass contains albite, chlorite and minor quartz and apatite, with the rock

being cut by a narrow carbonate vein. Transmitted light, crossed polarisers, field of view 2 mm across.

b) Alteration and structure: Both rock types are altered, but effects are stronger in the microdiorite, where most primary minerals are replaced, with only small amounts of relict plagioclase, titanomagnetite and trace apatite being preserved. In the dacite, plagioclase phenocrysts are commonly only partly altered (Fig. 13) and there is local preservarion of hornblende and titanomagnetite. Throughout the sample, primary feldspar was variably replaced by albite and minor sericite and carbonate. Hornblende was largely replaced by chlroite, with local carbonate and epidote, and trace quartz and leucoxene (Figs 12, 13), and titanomagnetite shows minor alteration to hematite and leucoxene. A couple of sub-planar veins up to 0.5 mm wide occur in the sample, mostly in microdiorite, with these containing carbonate (Fig. 12) and local chlorite and quartz. The alteration assemblage conforms to propylitic type.

c) Mineralisation: Both rock types retain a little igneous titanomagnetite, showing minor alteration to hematite and leucoxene. No sulphide minerals were observed.

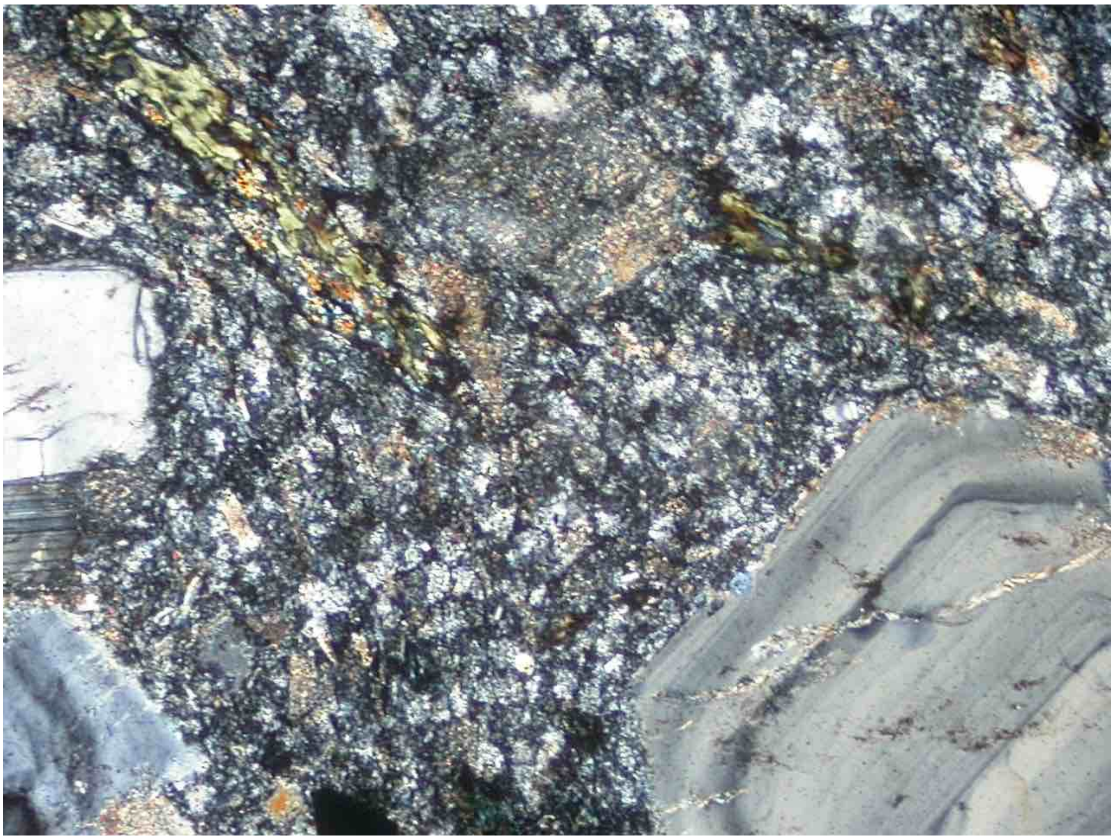

Fig. 13: Porphyritic dacite retaining plagioclase phenocrysts, but with former elongate hornblende phenocrysts being replaced by chlorite and trace epidote. The groundmass is strongly feldspathic. Transmitted light, crossed polarisers, field of view 2 mm across.

<u>Mineral Mode (by volume)</u>: plagioclase (includes albite) 70%, chlorite 13%, carbonate 7%, quartz 5%, sericite 3%, FeTi oxide (titanomagnetite) 1% and traces of apatite, hematite, leucoxene, hornblende and epidote.

<u>Interpretation and comment</u>: It is interpreted that the sample has an intrusive contact between strongly porphyritic hornblende dacite and a more altered, porphyritic hornblende

microdiorite. The contact is sharp and intricate, and there are a couple of microdiorite xenoliths hosted in dacite. The latter rock contains phenocrysts of plagioclase and hornblende, with a few microphenocrysts of quartz, in a fine grained feldspathic groundmass. Microdiorite originally contained phenocrysts of hornblende and plagioclase in a fine to medium grained feldspathic groundmass. Both rock types experienced propylitic alteration, more strongly evident in the microdiorite, where there is little preservation of primary minerals, in contrast to the dacite. The alteration assemblage includes considerable albite (from plagioclase phenocrysts and groundmass feldspar) and chlorite, with minor carbonate and sericite, and trace quartz, hematite, leucoxene and epidote. A couple of carbonate-rich veins occur in the sample.

SMD040 482.5 m TS

Summary: Porphyritic hornblende (-quartz) microdiorite, with moderate to strong propylitic alteration. There is considerable retention of primary texture and some preservation of igneous hornblende, titanomagnetite and apatite. The rock hosted scattered plagioclase and hornblende phenocrysts in a fine to medium grained feldspar-rich groundmass, but with subordinate ferromagnesian material (now altered), quartz and a little titanomagnetite and apatite. Pervasive alteration led to development of an assemblage dominated by albite and chlorite, with patchy epidote, mainly at plagioclase phenocryst sites, as well as scattered aggregates of carbonate (-quartz-actinolite-epidote) and quartz. A single thin vein occurs, containing carbonate and quartz, with minor actinolite, chlorite, epidote and trace bornite.

Handspecimen: The drill core sample is composed of a massive, altered porphyritic intermediate to felsic igneous rock (Fig. 14). It has scattered pale creamy-grey plagioclase phenocrysts and a few dark grey-green ferromagnesian phenocrysts (e.g. hornblende) up to a few millimetres long, set in a grey, fine grained feldspathic groundmass (Fig. 14). It is likely that pervasive alteration has caused development of fine grained chlorite and maybe minor sericite and epidote (e.g. at plagioclase sites). The rock is cut by a couple of thin, sub-planar carbonate veins up to 0.5 mm wide at a high angle to the core axis. Testing with sodium cobaltinitrite did not reveal the presence of K-feldspar. The sample is moderately magnetic, with susceptibility up to 890 x 10^{-5} SI, indicating the presence of a little magnetite.

Fig. 14: Drill core sample of massive porphyritic microdiorite, with altered plagioclase phenocrysts, a few hornblende phenocrysta, and a fine to medium grained groundmass. The rock has pervasive development of albite and chlorite, with minor epidote, carbonate and quartz.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is generally well preserved and there is some preservation of primary igneous minerals (Figs 15, 16). The rock contains scattered altered, blocky plagioclase phenocrysts up to 3 mm across, as well as variably altered, prismatic brown hornblende phenocrysts up to 4 mm long, occurring in a fine to medium grained groundmass that is rather feldspar-rich, but would have also contained a subordinate amount of ferromagnesian material (e.g. hornblende, but now altered), a little interstitial quartz, FeTi oxide (titanomagnetite) and a few prismatic microphenocrysts of apatite (Figs 15, 16). Although the groundmass was evidently plagioclase-dominated, it could have formerly contained some K-feldspar, but if so, the latter is altered. The preserved primary characteristics of the rock are interpreted to indicate that it represents a porphyritic hornblende (-quartz) microdiorite.

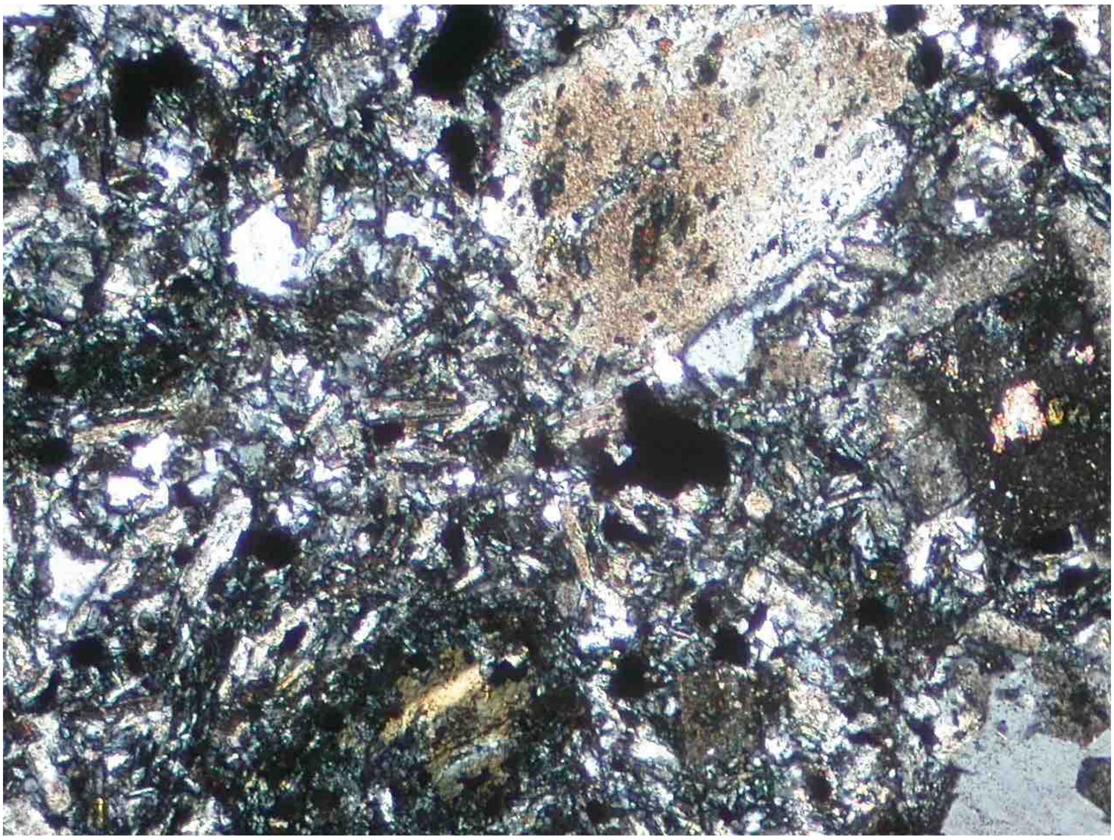

Fig. 15: Altered porphyritic microdiorite with an albitised plagioclase phenocryst at top and a partly chlorite-replaced hornblende phenocryst (lower) in a groundmass rich in feldspar, plus minor altered ferromagnesian material, quartz and FeTi oxide. Transmitted light, crossed polarisers, field of view 2 mm across.

b) Alteration and structure: Moderate to strong pervasive alteration of propylitic type was imposed on the igneous rock. Plagioclase phenocrysts and groundmass feldspar were replaced by turbid albite (Fig. 15), in places accompanied by patchy epidote, local chlorite, carbonate and traces of sericite and magnetite. Igneous hornblende was variably replaced by chlorite, with the groundmass ferromagnesian phase being completely replaced by chlorite. Traces of carbonate and epidote have also developed at some hornblende phenocryst sites. Igneous FeTi oxide was partly replaced by hematite, leucoxene and titanite. Throughout the rock are sparsely scattered irregular masses of medium grained quartz up to 1.5 mm across that are texturally of late magmatic to hydrothermal origin. There are also a few larger (up to 5mm) irregular aggregates of rather coarse carbonate, with accompanying quartz, actinolite, epidote and trace magnetite (Fig. 16), and the rock is cut by a single sub-planar to irregular vin up to 0.7 mm wide containing carbonate and quartz, with minor actinolite, chlorite, epidote and trace bornite.

c) Mineralisation: A couple of aggregates of bornite up to 0.5 mm across occur in the single carbonate-quartz-dominated vein, with bornite associated with epidote. At some altered plagioclase phenocryst sites, epidote replacement aggregates are accompanied by trace magnetite.

<u>Mineral Mode (by volume)</u>: plagioclase (albite) 60%, chlorite 22%, quartz 5%, hornblende and carbonate each 4%, epidote 3%, titanomagnetite/magnetite 1% and traces of apatite, actinolite, hematite, leucoxene, titanite, sericite and bornite.

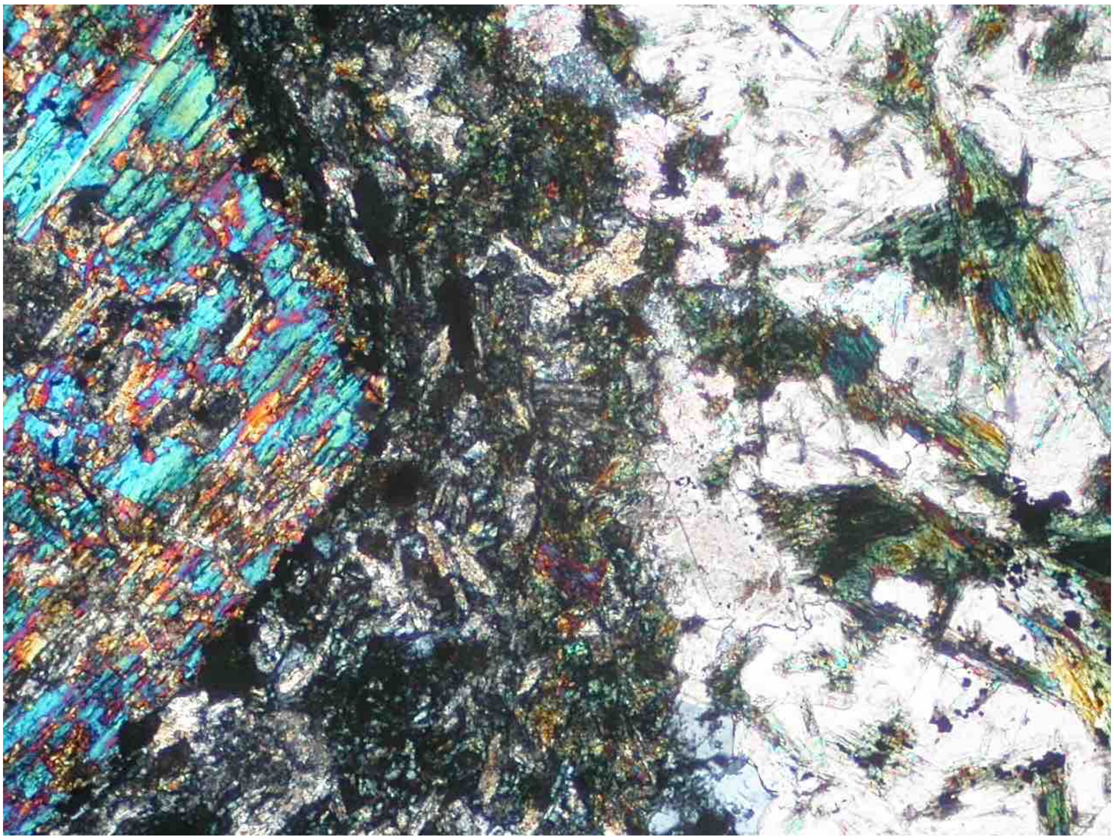

Fig. 16: Part of a large relict hornblende phenocryst (left) in fine grained altered groundmass, adjacent to a replacive aggregate of carbonate (whitish), actinolite and fringing epidote. Transmitted light, crossed polarisers, field of view 2 mm across.

<u>Interpretation and comment</u>: It is interpreted that the sample represents an altered porphyritic hornblende (-quartz) microdiorite. Primary texture is rather well preserved and there is some preservation of igneous hornblende, titanomagnetite and apatite. The rock hosted scattered plagioclase and hornblende phenocrysts in a fine to medium grained feldspar-rich groundmass, but with subordinate ferromagnesian material (now altered), quartz and a little titanomagnetite and apatite. Pervasive moderate to strong propylitic alteration was imposed, cauing development of an assemblage of albite and chlorite, with patchy epidote, mainly at plagioclase phenocryst sites, as well as scattered aggregates of carbonate (-quartz-actinolite-epidote) and quartz. A single thin vein occurs, containing carbonate and quartz, with minor actinolite, chlorite, epidote and trace bornite.

SMD041 367.1 m TS

Summary: Strongly altered and veined porphyritic dacite. There is moderate preservation of primary texture, indicating that the rock contained scattered plagioclase phenocrysts, and a few small microphenocrysts of quartz, ferromagnesian material and FeTi oxide in a fine grained, probably quartzofeldspathic composition groundmass. Pervasive alteration led to replacement of plagioclase phenocrysts by albite and minor sericite and carbonate, with development of finely granular quartz and albite in the groundmass, plus minor carbonate, sericite, leucoxene and trace chalcopyrite and pyrite. There are abundant veins and irregular hydrothermal patches of carbonate (calcite), with varying amounts of quartz and albite, minor sericite and chalcopyrite.

Handspecimen: The drill core sample is composed of a creamy to pale orange coloured, altered porphyritic felsic igneous rock (Fig. 17). Relict texture is only moderately preserved, with the rock containing scattered blocky plagioclase phenocrysts up to 3 mm across in a fine grained groundmass, probably originally of quartzofeldspathic composition. The rock is strongly altered, with development of carbonate and quartz, minor sericite and sparse fine grained, dark grey sulphide disseminations and veinlets, probably mostly chalcopyrite (Fig. 17). An irregular array of pale grey to white veins occurs, up to a few millimetres wide, and containing carbonate and quartz. A single large, fracture-controlled grey vein at least 6 mm wide cuts the rock at a high angle to the core axis (Fig. 17) and contains carbonate and minor disseminated pyrite. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. Testing with sodium cobaltinitrite did not reveal the presence of K-feldspar. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 17: Drill core sample of strongly altered porphyritic dacite, with an alteration assemblage of albite, calcite, quartz and sericite. The small grey disseminated aggregates are fine grained chalcopyrite. At right is a grey calcite vein containing a little disseminated pyrite.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved, but the rock is evidently strongly altered and veined. There are pseudomorphs after former blocky plagioclase phenocrysts up to 3 mm across and after sparse microphenocrysts of a former ferromagnesian phase and FeTi oxide (Fig. 18, 19). There are also a few small microphenocrysts of quartz, with all these phases set in a finely granular groundmass (Figs 18, 19), originally of quartzofeldspathic composition. The preserved primary characteristics suggest that the rock represents an altered porphyritic dacite.

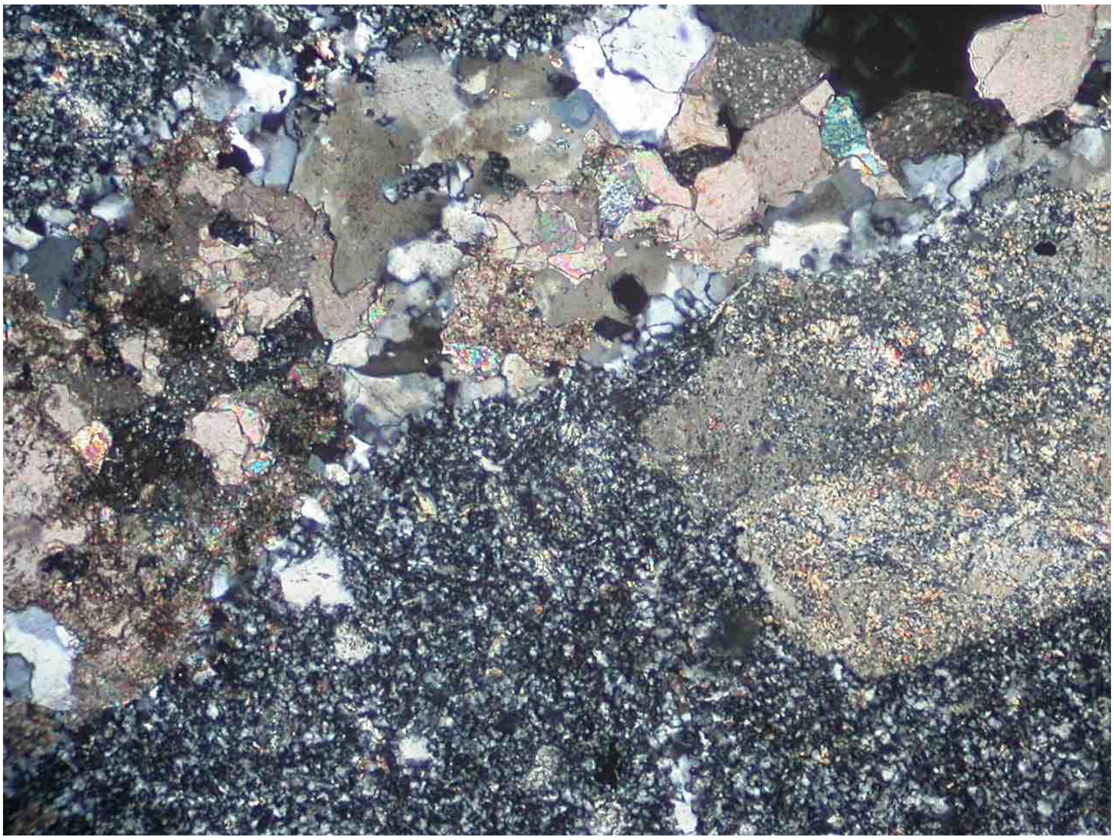

Fig. 18: Altered porphyritic dacite with a plagioclase phenocryst at right, replaced by albite and minor sericite. The finely granular groundmass is dominated by albite and quartz. A carbonate-quartz vein cuts the altered rock. Transmitted light, crossed polarisers, field of view 2 mm across.

b) Alteration and structure: The original rock was strongly hydrothermally altered and veined. Former plagioclase phenocrysts were replaced by albite and minor sericite and carbonate, with ferromagnesian grains being replaced by sericite, and FeTi oxide by leucoxene (aggregates up to 0.5 mm across) (Figs 18, 19). In the groundmass, there was replacement by finely granular albite and quartz, with minor carbonate and sericite, and traces of leucoxene, pyrite and chalcopyrite. Irregular patches and veins are abundant, being up to several millimetres across and commonly dominated by fine to medium grained carbonate (calcite), in places also containing considerable quartz and albite, with minor sericite and chalcopyrite (Figs 18, 19). The alteration and vein assemblage is regarded as being a variant of propylitic type and it has involved mobility (and possible introduction) of silica and Na, introduction of CO_2, Ca, Cu and S, and loss of Mg and Fe, creating the strongly "bleached" appearance of the handspecimen.

c) Mineralisation: The sample contains a little chalcopyrite and a trace of pyrite, mostly in the veins, but locally disseminated as part of the alteration. Chalcopyrite is intergrown with carbonate, quartz and albite, and forms irregular aggregates up to 1.5 mm across (Fig. 19). Rare pyrite is up to 0.4 mm across.

Mineral Mode (by volume): plagioclase (albite) 35%, carbonate (calcite) 30%, quartz 27%, sericite 7%, chalcopyrite 1% and a trace of leucoxene and pyrite.

Interpretation and comment: It is interpreted that the sample is a porphyritic dacite that experienced strong hydrothermal alteration and veining. Primary texture is moderately preserved, indicating that the rock contained scattered plagioclase phenocrysts, and a few small microphenocrysts of quartz, ferromagnesian material and FeTi oxide in a fine grained, probably quartzofeldspathic composition groundmass. Imposed alteration caused replacement of plagioclase phenocrysts by albite and minor sericite and carbonate, with development of finely granular quartz and albite in the groundmass, plus minor carbonate, sericite, leucoxene and trace chalcopyrite and pyrite. Abundant veins and irregular hydrothermal patches of carbonate (calcite) occur, with these also hosting varying amounts of quartz and albite, minor sericite and chalcopyrite.

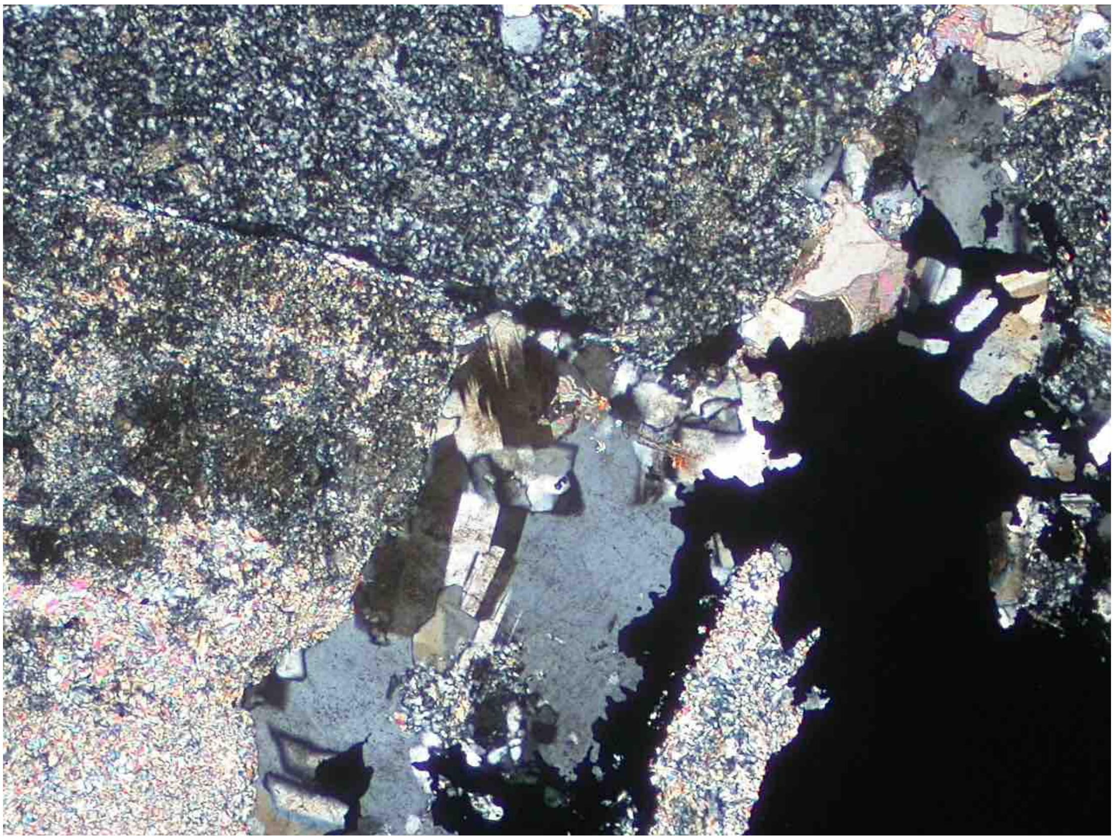

Fig. 19: Plagioclase phenocryst at left, showing replacement by albite and sericite, with adjacent fine grained groundmass (upper), and with the rock cut by a wide vein of chalcopyrite (black), quartz, carbonate, albite and sericite (right). Transmitted light, crossed polarisers, field of view 2 mm across.

SMD042 921.05 m TS

Summary: Strongly altered, probably fragmental volcanic rock, considered to be of high-Mg basaltic composition and locally displaying relict porphyritic and amygdular textures. Pseudomorphs after former ferromagnesian phenocrysts (e.g. pyroxene) occur locally and the rock retains traces of disseminated fine grained Cr spinel (chromite) that might have formerly occurs as inclusions in igneous phases such as olivine and pyroxene. The rock was replaced (except for Cr spinel) by a heterogeneous assemblage with abundant chlorite, plus less common sericite, carbonate (calcite) and quartz, plus traces of leucoxene and rare pyrite. Amygdules tend to be mainly filled by calcite.

Handspecimen: The drill core sample is composed of a strongly altered, possibly coarsely fragmental, mafic volcanic rock, with much being dark grey-green, and with gradations to mid grey and hosting scattered white to pale grey aggregates (Fig. 20). The latter are up to several millimetres across and appear to be dominated by carbonate. Possible fragments are up to1 cm across, with some areas possibly having relict amygdular texture. The protolith was evidently replaced by abundant fine grained chlorite, with patchy carbonate (Fig. 20). Sericite is locally apparent on sheared surfaces. 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.

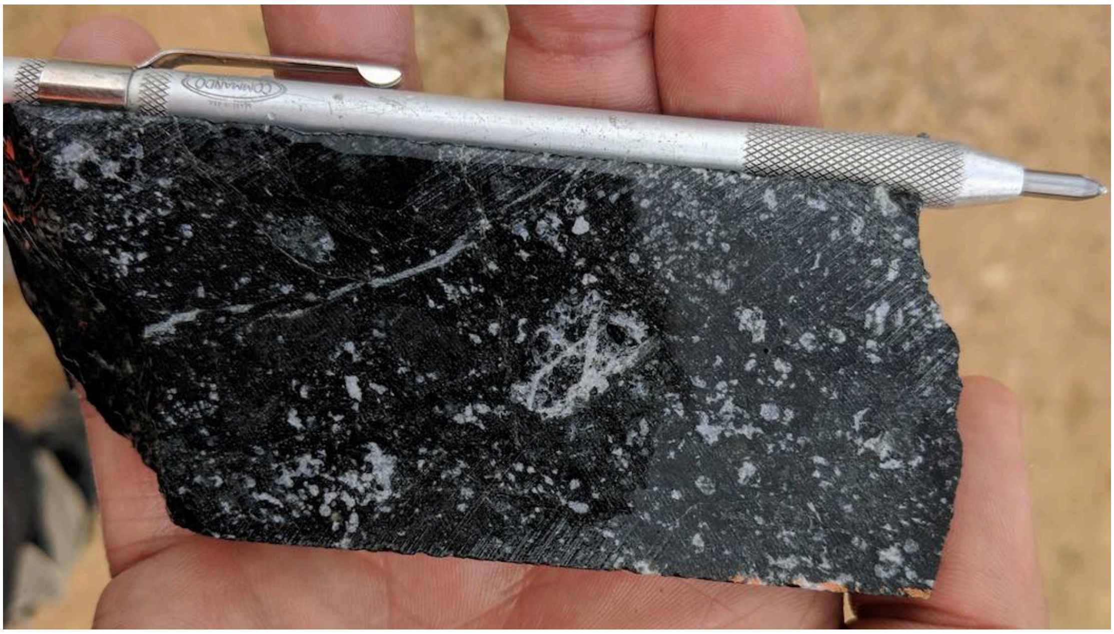

Fig. 20: Drill core sample of strongly altered, possibly fragmental basaltic rock, evidently with high Mg content and containing abundant chlorite, with lesser sericite, calcite and quartz. Traces of fine grained Cr spinel (chromite) occur throughout.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic and amygdular textures are locally preserved (Fig. 21) and there are some indications that the rock could have been coarsely fragmental, with irregular, strongly altered volcanic fragments up to several millimetres across (Fig. 22). Some fragments were evidently fine grained (perhaps including former glass), but others retain relict porphyritic and amygdular texture. In places, the sample has relict pseudomorphic shapes after former ferromagnesian phenocrysts up to 2.5 mm long (e.g. pyroxene) and there are also scattered sub-spheroidal amygdular aggregates up to 3 mm across (Fig. 21). Throughout the sample, there are sparsely distributed small relict subhedral grains of Cr spinel (chromite) up to 0.3 mm across (Fig. 23) which possibly originally occurred as inclusions in igneous ferromagnesian phases such as olivine and pyroxene. The presence of relict Cr spinel and the pervasive alteration assemblage in the rock, being rich in chlorite and also containing carbonate (calcite), sericite and quartz, are considered to indicate that the protolith was a former olivine-bearing basaltic rock, maybe a high-Mg type and probably coarsely fragmental (e.g. hyaloclastite).

b) Alteration and structure: Strong pervasive alteration was imposed on the protolith and all original phases were replaced, except for the small grains of Cr spinel. The alteration minerals are heterogeneously distributed, and include abundant fine grained, pale green chlorite, fine grained sericite (in places in small, sub-radiating aggregates), fine through to coarse grained carbonate (calcite) that is locally veinlike, and fine to medium grained quartz (locally textures suggest replacement of original chalcedony) (Figs 21, 22, 23). The rock also has a trace of finely disseminated leucoxene and rare pyrite. Amygdular structures tend to be filled by carbonate, with a little quartz. Assuming a mafic igneous composition protolith, the alteration assemblage implies that there was considerable addition of CO_2, as well as minor K, and probable loss of Na. Mg could be residually enriched.

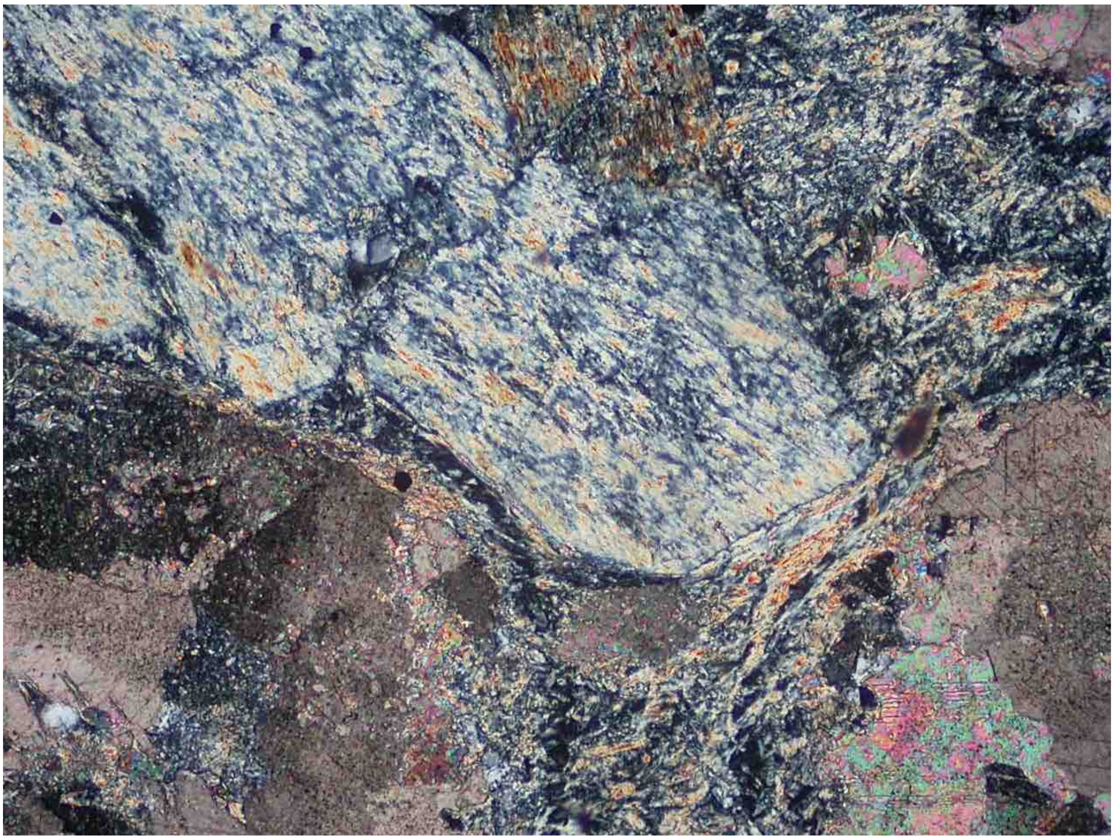

Fig. 21: Pseudomorph after a former ferromagnesian phenocryst, replaced by chlorite and sericite, adjacent to a couple of carbonate-filled amygdules (lower left and lower right). Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: There are sparsely distributed small relict grains up to 0.3 mm across of Cr spinel (chromite) that were inherited from the protolith, perhaps formerly occurring as inclusions in igneous ferromagnesian minerals. Rare grains of pyrite, <0.1 mm across, are observed as part of the alteration.

Mineral Mode (by volume): chlorite 40%, sericite 25%, carbonate (calcite) 20%, quartz 14% and traces of chromite, leucoxene and pyrite.

Interpretation and comment: It is interpreted that the sample represents a strongly altered, probably fragmental mafic volcanic rock, e.g. of high-Mg basaltic composition. Relict porphyritic and amygdular textures are locally preserved. Pseudomorphs after former ferromagnesian phenocrysts (e.g. pyroxene) are observed and the rock retains traces of disseminated fine grained Cr spinel (chromite) that might have formerly occurs as inclusions in igneous phases such as olivine and pyroxene. The rock was replaced (except for Cr spinel) by a heterogeneous assemblage with abundant chlorite, plus less common sericite, carbonate (calcite) and quartz, plus traces of leucoxene and rare pyrite. Amygdules tend to be mainly filled by calcite.

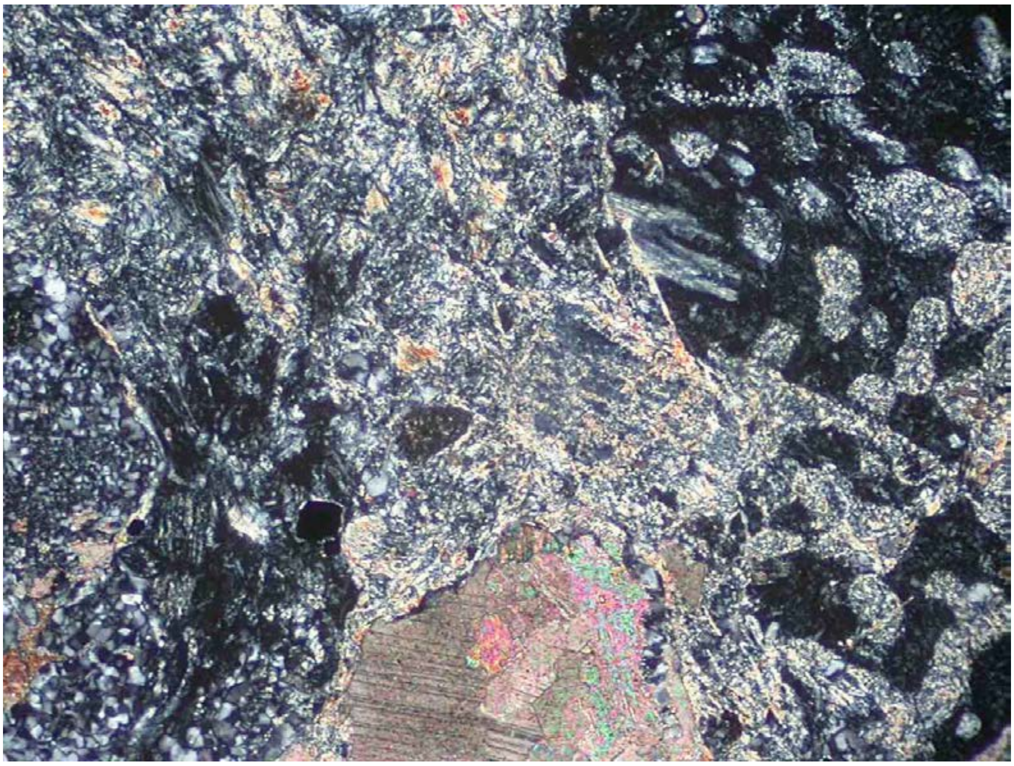

Fig. 22: Possible fragmental texture with a couple of dark, chlorite-rich altered mafic fragments enclosed by an alteration matrix of sericite, chlorite, carbonate and quartz. Note relict texture in fragment at right. Transmitted light, crossed polarisers, field of view 2 mm across.

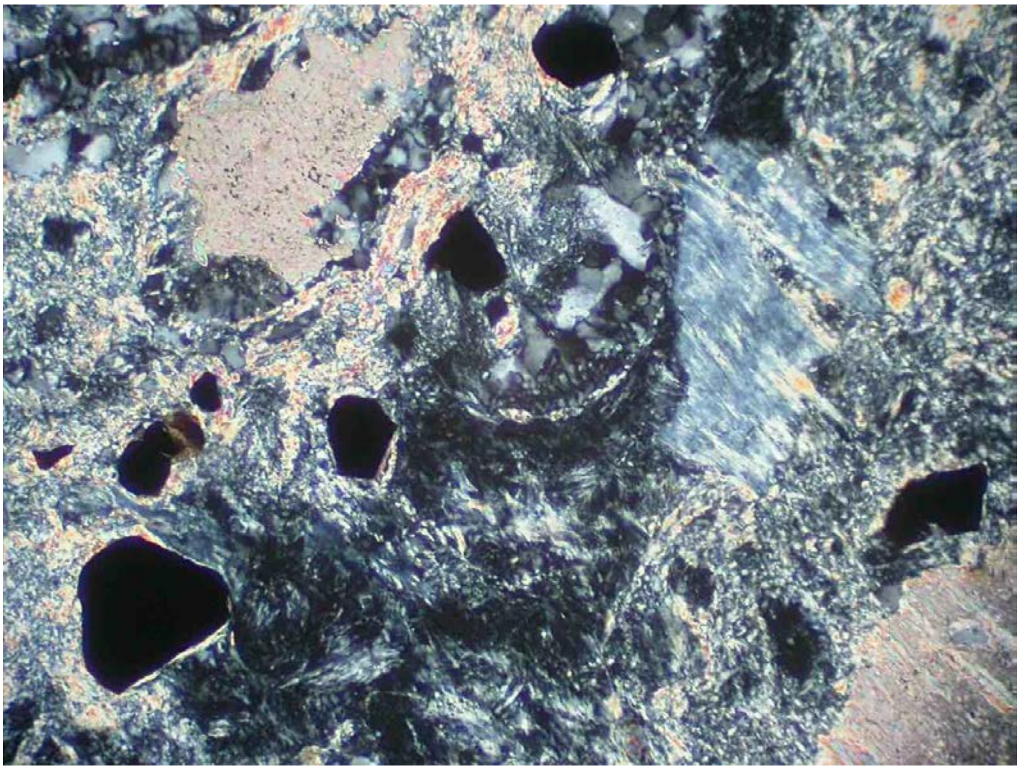

Fig. 23: Small relict grains of Cr spinel (black) hosted in altered rock with an assemblage of chlorite (dark grey to pale bluish grey), sericite and minor carbonate. Transmitted light, crossed polarisers, field of view 1 mm across.

SMD044 645.7 m PTS

Summary: Intensely hydrothermally altered rock, perhaps originally of mafic to ultramafic composition and retaining sparsely scattered small relict grains of Cr spinel (chromite). No relict texture is preserved and much of the rock was replaced by an assemblage of quartz and chlorite, with patchy anhydrite and specular hematite. Cr spinel grains are rimmed by magnetite and in turn by hematite. There is a common association between hematite and small aggregates of chalcopyrite and/or bornite, and elsewhere in the rock, there is a little disseminated pyrite. A diffuse veinlike mass occurs containing anhydrite, gypsum, a clay phase (e.g. dickite), quartz, chlorite and trace pyrite and chalcopyrite. Textures suggest that gypsum could have replaced anhydrite. The alteration and vein assemblage is interpreted to be transitional between advanced argillic and propylitic types.

Handspecimen: The drill core sample is composed of a strongly altered rock ranging from dark green-grey to paler grey in colour and with a few whitish and dark reddish aggregates (Fig. 24). The paler grey zones appear to be in part, diffuse veinlike masses, at a low angle to the core axis (Fig. 24). The rock has no recognised relict texture and appears to be totally replaced by fine grained chlorite and quartz, and with the paler grey zones also containing a soft crystalline phase (e.g. gypsum). Dark reddish aggregates are composed of hematite and there is a little irregularly distributed chalcopyrite and trace pyrite and bornite. The rock is strongly magnetic, with susceptibility up to 3850 x 10^{-5} SI, indicating the presence of minor disseminated magnetite.

Fig. 24: Drill core sample of intensely altered mafic to ultramafic rock, with dominant replacement assemblage of chlorite and quartz, plus minor anhydrite and hematite. Paler grey zone tends to contain more abundant anhydrite, along with gypsum, clay (dickite), chlorite and quartz.

Petrographic description

a) Primary rock characteristics: In the section, no definite relict texture is recognised, but there are sparsely dispersed relict grains of Cr spinel (chromite) up to 0.2 mm across (Fig. 25). The major alteration assemblage in the rock, consisting of chlorite and quartz, with minor anhydrite, hematite and small amounts of magnetite and sulphides is not diagnostic of protolith type. However, the presence of relict Cr spinel indicates that the rock must have been of ultramafic, or high-Mg mafic type, perhaps similar to that interpreted in sample SMD042/921.05 m.

b) Alteration and structure: The interpreted mafic to ultramafic composition protolith experienced intense hydrothermal reconstitution, and emplacement of a broad, diffuse veinlike zone up to 2 cm wide. Much of the rock was replaced by abundant fine grained pale green chlorite, interspersed with aggregates of fine to medium grained quartz, patchy fine to medium grained anhydrite (aggregates up to 1.5 mm across), patchy aggregates of semi-massive, fine to medium grained specular hematite (up to several millimetres across) and small amounts of magnetite (enclosing Cr spinel) and sulphides (Figs 25, 26). The latter are up to 0.6 mm across and include chalcopyrite and bornite, commonly associated with hematite (Fig. 27). Elsewhere in the rock, in the absence of hematite, there is a little disseminated pyrite and trace chalcopyrite. The diffuse veinlike zone has interspersed aggregates of chlorite and quartz, but there are generally surrounded by masses of medium to coarse grained gypsum (with anhydrite inclusions), fine through to coarse grained anhydrite forming masses up to several millimetres across, a near-colourless to pale brown, medium grained low-birefringent clay phase (e.g. dickite) forming masses up to 2.5 mm across and having inclusions of anhydrite, and traces of pyrite and chalcopyrite (Fig. 28). In this paragenesis, it is likely that gypsum has partly replaced anhydrite. The alteration assemblage in the sample is interpreted as being transitional between advanced argillic and propylitic types. Alteration evidently occurred under oxidising conditions.

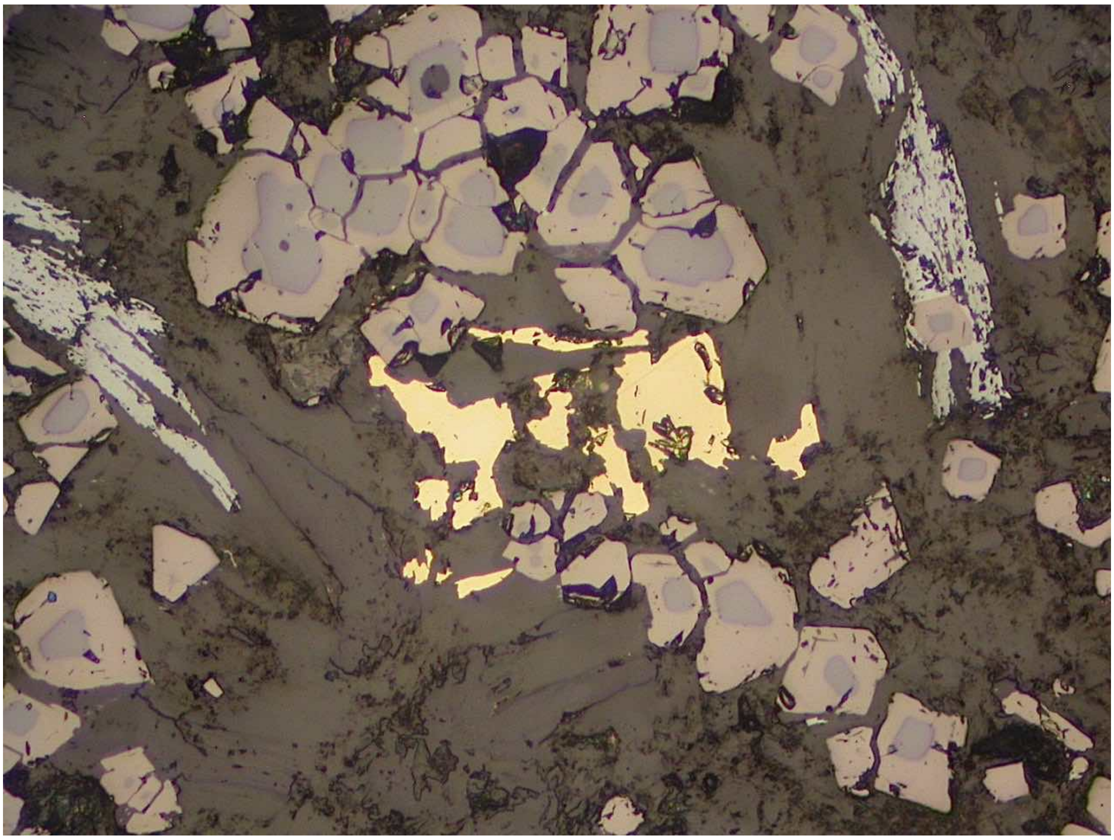

Fig. 25: Cluster of small chromite grains (mid grey) enclosed by magnetite (paler brownish grey), with minor associated bladed specular hematite (pale grey) and chalcopyrite (yellow) enclosed in quartz and chlorite (dark grey). Plane polarised reflected light, field of view 0.5 mm across.

c) Mineralisation: There are sparsely and irregularly distributed small relict grains up to 0.2 mm across of Cr spinel (chromite) that were inherited from the protolith, with these typically being surrounded and replaced by magnetite, and in turn by hematite (Fig. 25). Commonly, magnetite shows replacement by hematite, and there are also discrete masses of specular hematite up to several millimetres across in places with hematite forming composites with chalcopyrite and/or bornite (Figs 26, 27). Elsewhere in the sample (in hematite-free zones), there is a little disseminated pyrite (grains up to 0.3 mm) and trace chalcopyrite.

Mineral Mode (by volume): quartz 40%, chlorite 30%, anhydrite 10%, gypsum 8%, hematite 5%, clay (dickite) 4%, magnetite and chalcopyrite each 1% and traces of Cr spinel, bornite and pyrite.

Interpretation and comment: It is interpreted that the sample is an intensely hydrothermally altered rock, which although having no recognised relict texture, does retain sparsely scattered small relict grains of Cr spinel (chromite) and thus indicating that the protolith must have been of ultramafic to high-Mg mafic igneous composition. Much of the rock was replaced by quartz and chlorite, with patchy anhydrite and specular hematite. Cr spinel grains are rimmed by magnetite and in turn by hematite. There is a common association between hematite and small aggregates of chalcopyrite and/or bornite, and elsewhere in the rock, there is a little disseminated pyrite. A diffuse veinlike masses occurs containing anhydrite, gypsum, a clay phase (e.g. dickite), quartz, chlorite and trace pyrite and chalcopyrite. Textures suggest that gypsum has probably replaced anhydrite. The alteration and vein assemblage is interpreted to be transitional between advanced argillic and propylitic types.

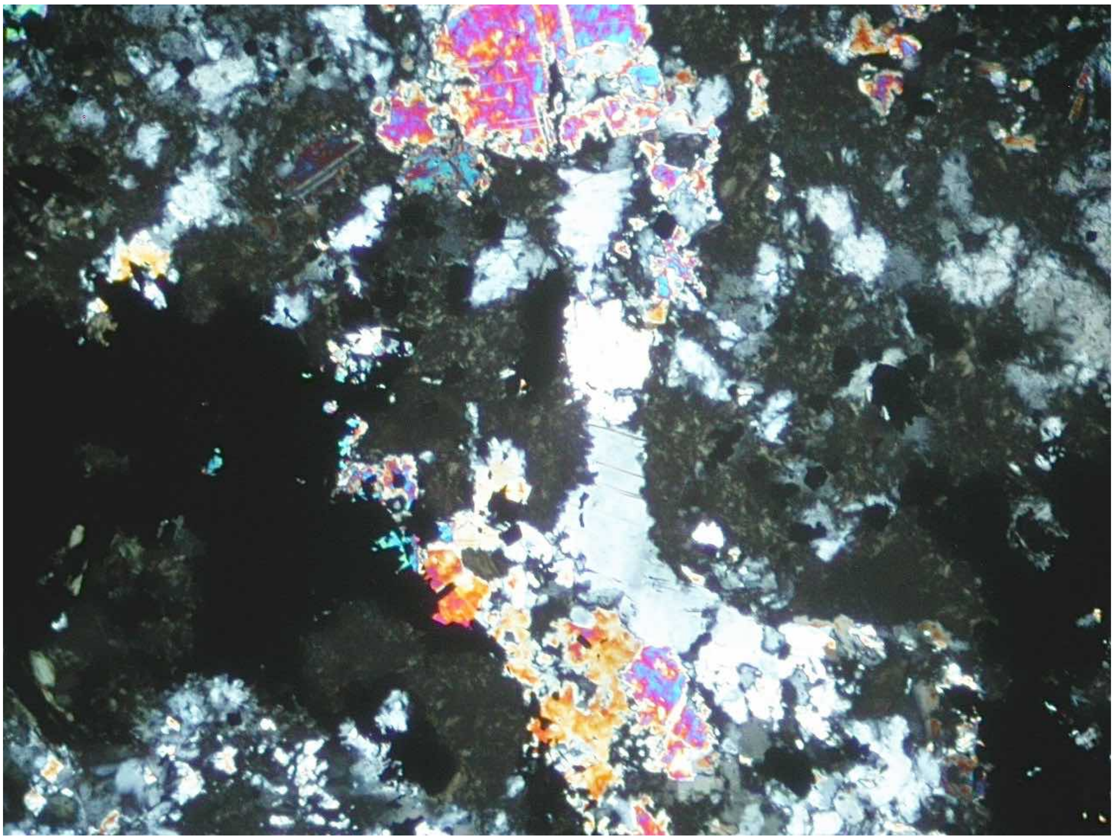

Fig. 26: Typical alteration assemblage in much of the sample, displaying chlorite (dark grey-khaki), quartz (white to grey), anhydrite (bright colours) and hematite (black). Transmitted light, crossed polarisers, field of view 2 mm across.

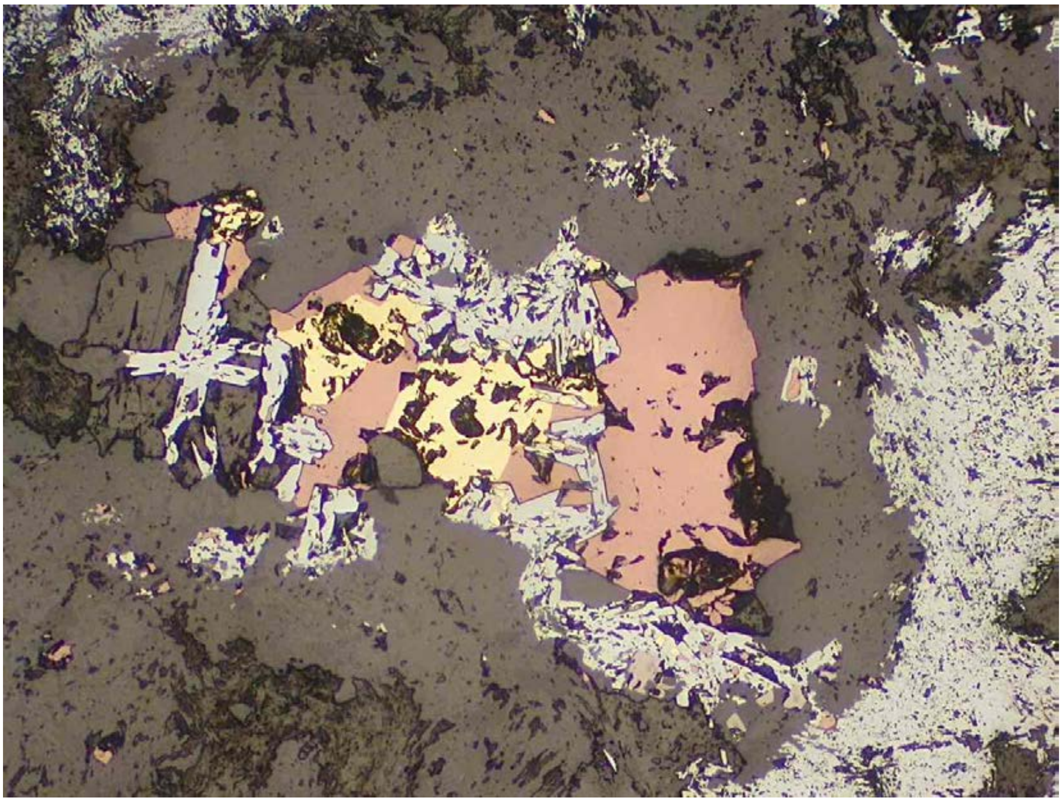

Fig. 27: Small composite aggregate of bornite (pinkish), chalcopyrite (yellow), finely bladed hematite (pale grey) in a gangue aggregate of quartz and chlorite (dark grey). Plane polarised reflected light, field of view 1 mm across.

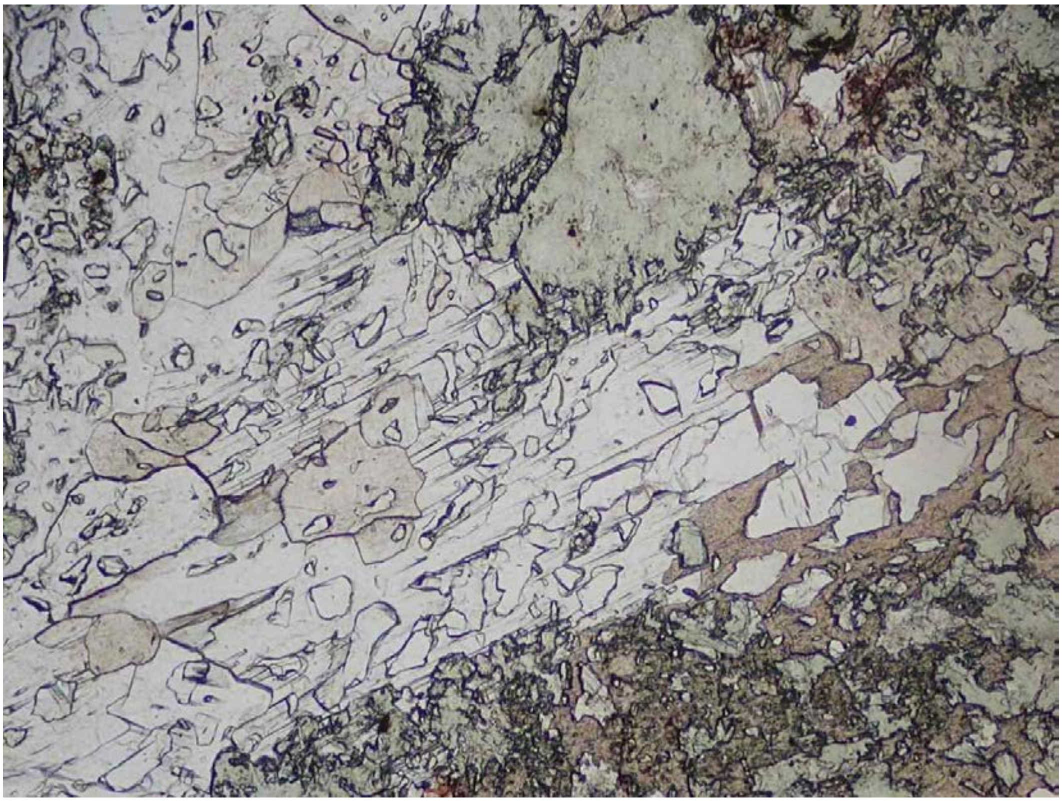

Fig. 28: Part of the diffuse veinlike mass containing coarse gypsum (clear, cleaved), clay (dickite; pale brown shades), anhydrite (clear, as inclusions in gypsum and clay, with associated pale green chlorite. Plane polarised transmitted light, field of view 1 mm across.

SMD044 924.3 m PTS

Summary: Intensely hydrothermally altered rock, perhaps originally of felsic igneous type. It retains a few relict quartz phenocrysts in what would have been a fine grained groundmass. The rock sustained alteration that is transitional between silicification and advanced argillic type, with replacement of the groundmass by fine grained quartz, plus irregularly distributed pyrite, minor fine grained pyrophyllite and traces of anhydrite, rutile, bornite and chalcocite. There are abundant irregular to veinlike masses of pyrite ± quartz ± pyrophyllite and these grade into paragenetically later aggregates of medium to coarse bornite and chalcocite that are also associated with quartz. The veinlike masses locally contain a little anhydrite, a low-birefringent clay phase (e.g. dickite) and enargite. The last phase tends to occurs as small included masses in pyrite and bornite. The sulphide mineralisation assemblage is consistent with high sulphidation type.

Handspecimen: The drill core sample is composed of a strongly sulphide-mineralised altered rock, containing abundant pale grey to darker grey, fine to medium grained quartz, with disseminations and diffuse bands of semi-massive pyrite up to several millimetres across and a few whitish clay aggregates, all cut by irregular to veinlike masses of bornite and chalcocite up to 1 cm wide (Fig. 29). No definite relict texture is recognised in the rock, which represents the product of intense hydrothermal overprinting and sulphide deposition. The rock is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

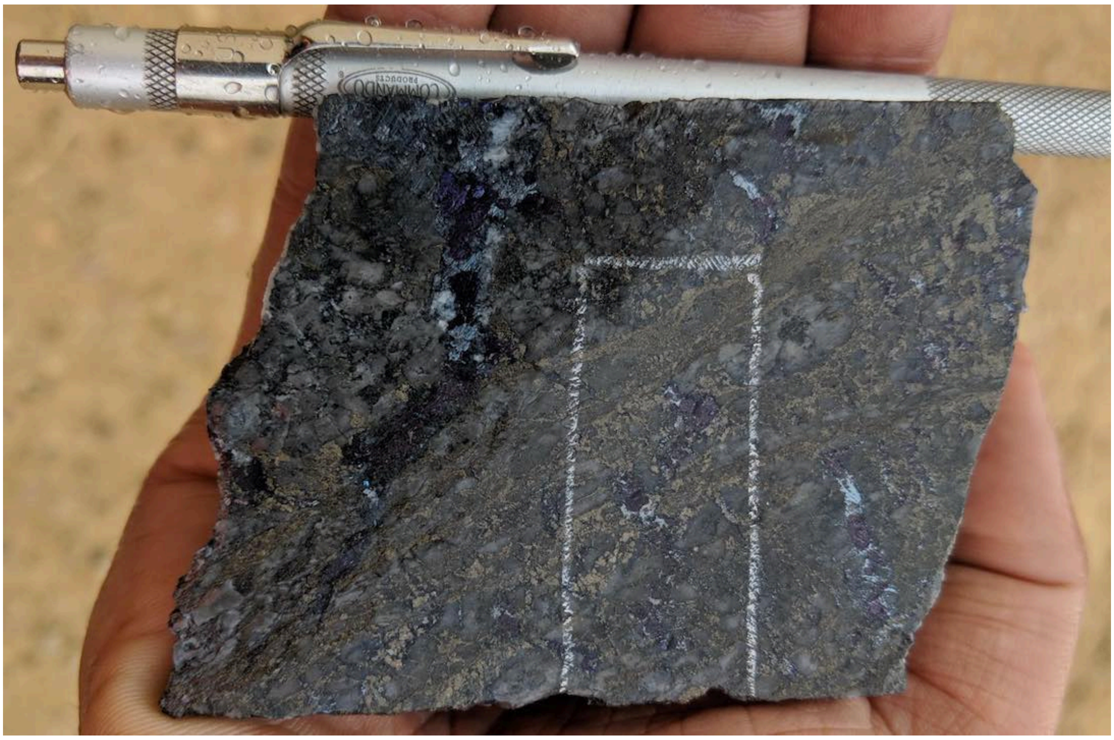

Fig. 29: Drill core sample of intensely altered rock, possibly of felsic porphyritic type, showing replacement by abundant quartz and pyrite, and at left, by dark veinlike masses of bornite and chalcocite.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the original rock was intensely hydrothermally altered and veined (Fig. 30). It appears to have been fine grained, and apart from a few relict phenocrystal grains of quartz up to 1.5 mm across (Fig. 30), no other primary characteristics are recognised from a protolith. Given the relict quartz phenocrysts and fine grainsize, the protolith could have been a felsic volcanic or shallow intrusive, e.g. "quartz porphyry".

b) Alteration and structure: Intense hydrothermal alteration and considerable veining were imposed on the protolith (Figs 30, 31). Apart from the few relict quartz phenocrysts, the groundmass was totally replaced by abundant fine grained quartz, with irregularly distributed grains and semi-massive aggregates of pyrite, plus minor disseminations and aggregates of fine grained pyrophyllite, and traces of bornite, chalcocite, anhydrite and rutile (Figs 30, 31). A network of irregular veins cuts the altered rock, with these being up to 1 cm wide and containing variable amounts of sulphides, quartz, locally common fine grained pyrophyllite, a little anhydrite (grains up to 0.5 mm), a low-birefringent fine to medium grained crystalline clay (e.g. dickite) forming aggregates up to 3 mm across, and a trace of possible diaspore (occurring with pyrophyllite aggregates). In the veins, there is commonly abundant, paragenetically early pyrite forming masses up to several millimetres across, in places enclosed by irregular to veinlike aggregates of bornite and chalcocite up to 1 cm across, and with uncommon small aggregates of enargite (Fig. 32). The alteration assemblage in the sample is considered to be transitional between silicification and advanced argillic type.

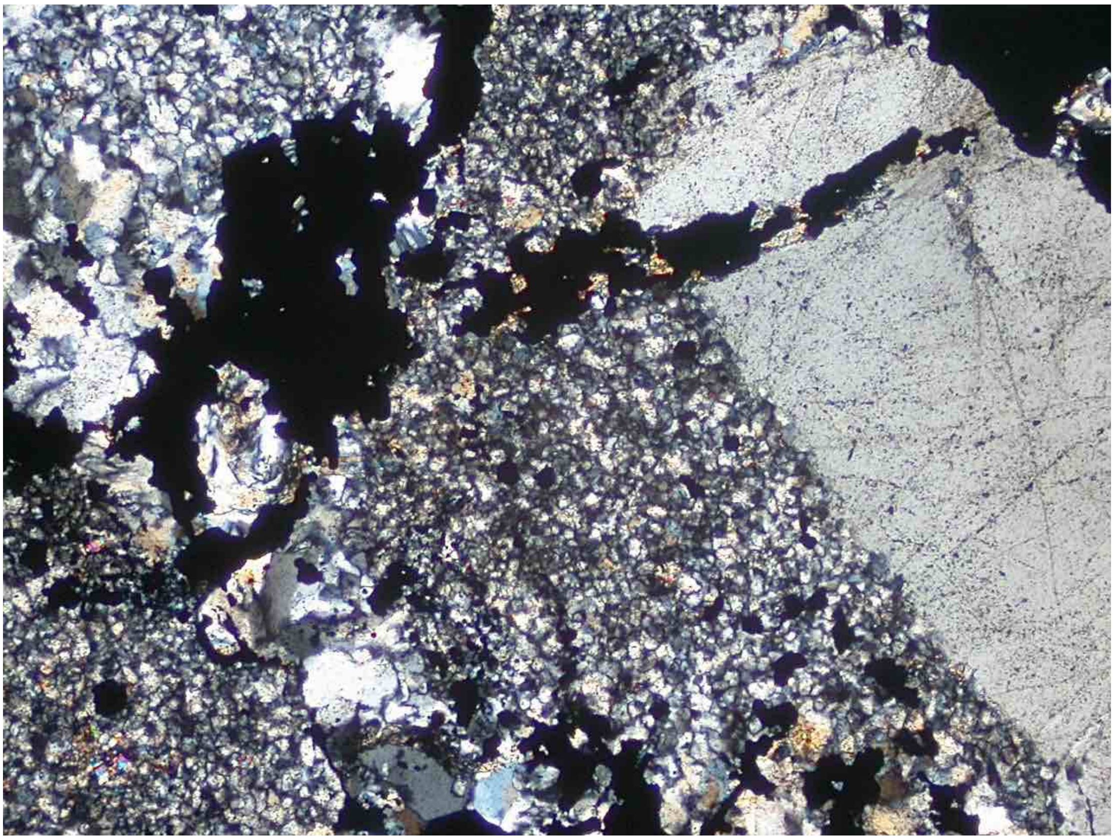

Fig. 30: Relict quartz phenocryst at right in a fine grained altered groundmass, rich in quartz and with a little pyrophyllite. The altered rock is cut by a few irregular veins of quartz and sulphides (black). Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The sample contains abundant sulphides, as part of the pervasive alteration and in irregular to veinlike aggregates up to 1 cm wide (Figs 30, 31) There is abundant, paragenetically early, fine to medium grained pyrite, commonly in semi-massive aggregates up to several millimetres across (Fig. 32). In places, pyrite aggregates host a little bornite, chalcocite and enargite (Fig. 32), but the rock also contains abundant medium to coarse aggregates of bornite and chalcopyrite that are paragenetically later than pyrite. These aggregates commonly enclose pyrite masses and a little enargite (aggregates up to 0.8 mm across) and chalcocite can also show eutectoid intergrowths with bornite (Fig. 33). The sulphide mineralisation conforms to high sulphidation type.

Mineral Mode (by volume): quartz 50%, pyrite 20%, bornite 11%, pyrophyllite 10%, chalcocite 7%, clay (dickite) 1% and traces of anhydrite, rutile, enargite and diaspore.

Interpretation and comment: It is interpreted that the sample represents a possible quartz-phyric fine grained felsic igneous rock ("quartz porphyry") that has undergone intense hydrothermal alteration of transitional silicic to advanced argillic type, and emplacement of irregular masses and veins. Apart from a few relict quartz phenocrysts, there is no other recognised relict texture. The fine grained groundmass was replaced by quartz, irregularly distributed pyrite, minor fine grained pyrophyllite and traces of anhydrite, rutile, bornite and chalcocite. There are abundant irregular to veinlike masses of pyrite ± quartz ± pyrophyllite and these grade into paragenetically later aggregates of medium to coarse bornite and chalcocite that are also associated with quartz. The veinlike masses locally contain a little anhydrite, a low-birefringent clay phase (e.g. dickite) and enargite. The last phase tends to occur as small, included masses in pyrite and bornite. The sulphide mineralisation assemblage is consistent with high sulphidation type. Note: The identification of pyrophyllite in this sample is only tentative and it could in fact be sericite. Accurate determination might need to be made by a spectral technique.

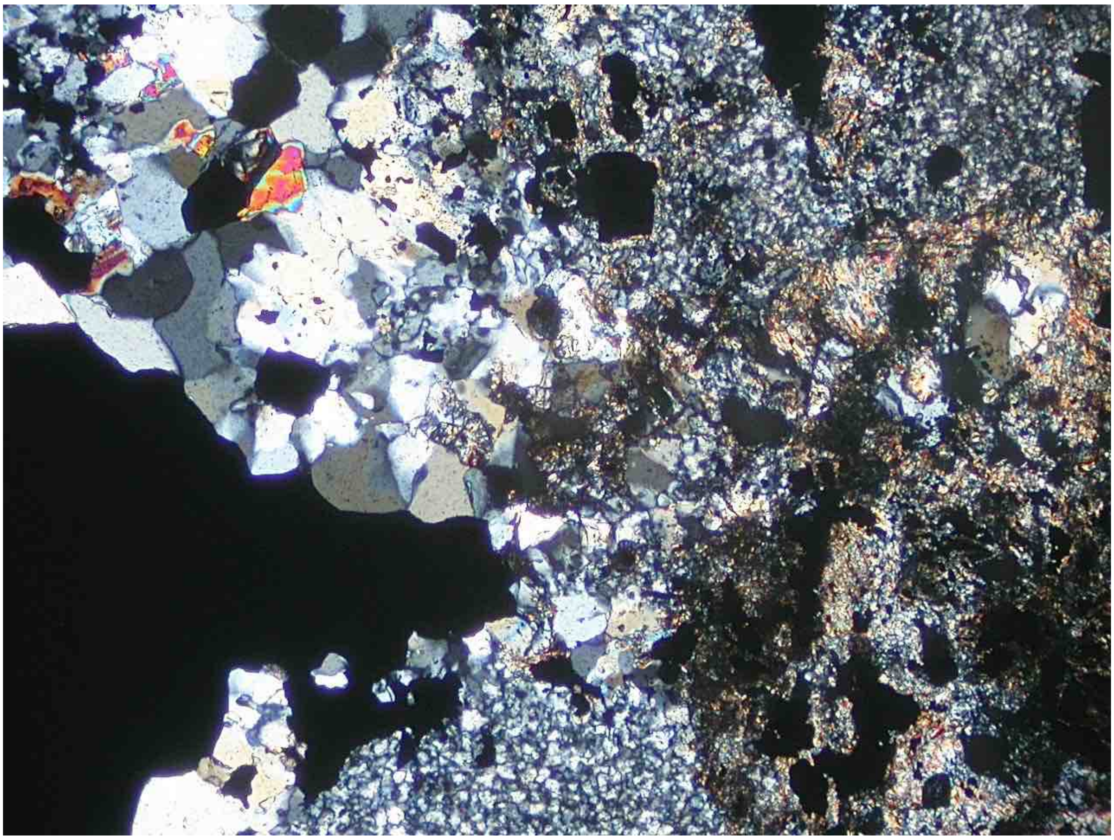

Fig. 31: Veinlike mass at left containing sulphides (black), quartz and a little anhydrite (bright colours) abutting against intensely altered host rock at right containing fine grained quartz and aggregates of pyrophyllite and disseminated pyrite. Transmitted light, crossed polarisers, field of view 2 mm across.

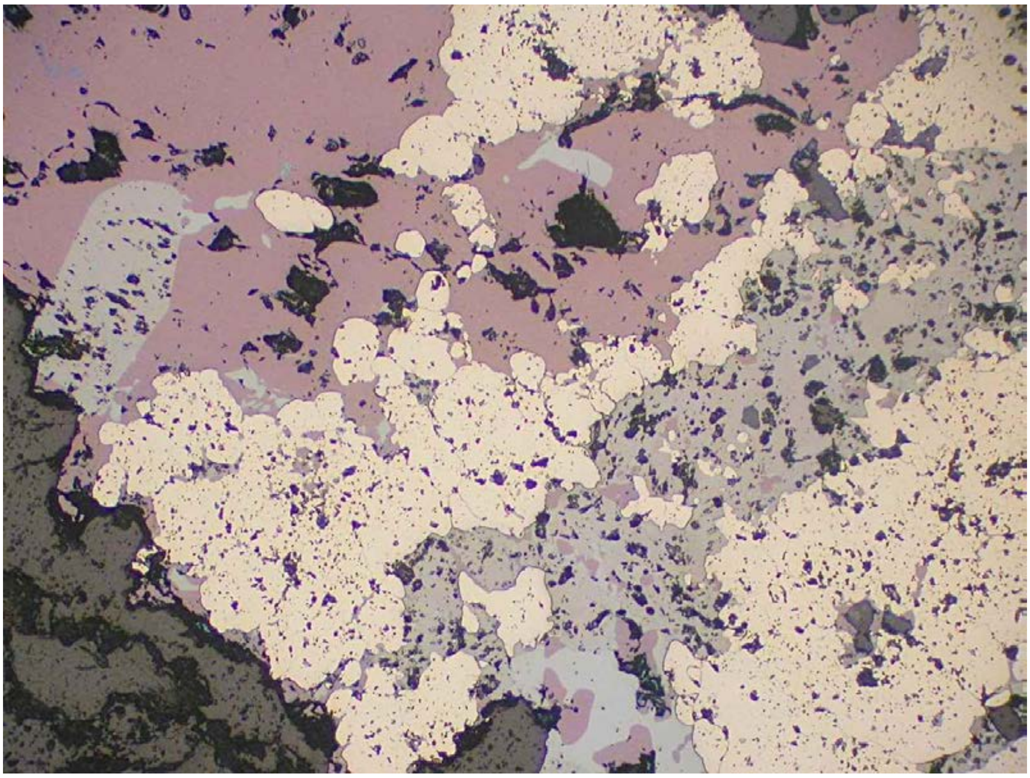

Fig. 32: Aggregates of pyrite (pale creamy), partly enclosing an aggregate of enargite (pale grey) and a little chalcocite (pale bluish-grey) and bornite, adjacent to a large mass of bornite at left, containing enargite, pyrite and small chalcocite inclusions. Plane polarised reflected light, field of view 1 mm across.

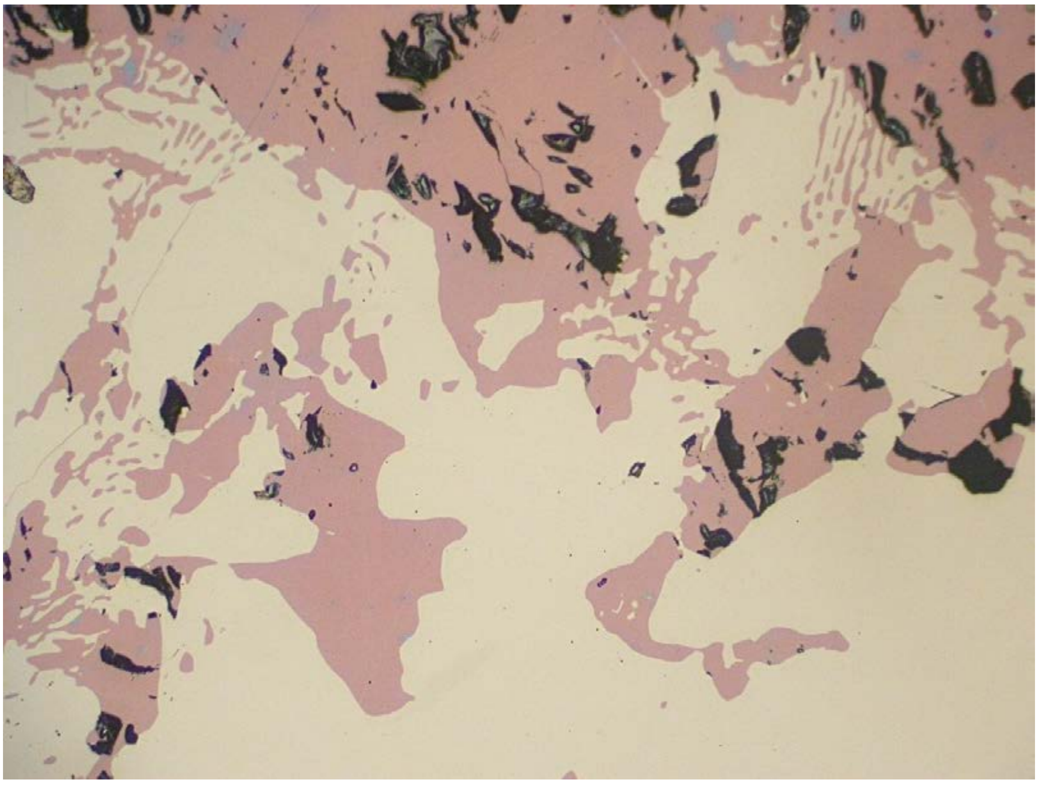

Fig. 33: Possible equilibrium intergrowth (locally eutectoid texture) between bornite and chalcocite. Plane polarised reflected light, field of view 1 mm across.

SMD044 946.3 m PTS

Summary: Possible sparsely porphyritic dacite, showing intense hydrothermal alteration, patchy deformation effects and emplacement of major veining, with subsequent minor veining. In places, the rock has moderate retention of relict, sparsely porphyritic texture. It formerly contained a few feldspar and ferromagnesian (hornblende) phenocrysts in a fine grained quartzofeldspathic groundmass. The rock was overprinted by alteration that ranges from phyllic type (fine grained quartz, sericite, minor pyrite, anhydrite and trace chalcopyrite and rutile) to silicic type (quartz-rich, with minor pyrite, chalcopyrite). The rock locally shows foliation development and this is co-planar with emplacement of early diffuse veining that is quartz-rich (in places with fibre texture), with large irregular patches and disseminations of pyrite and chalcopyrite, minor carbonate and anhydrite. Much anhydrite in the sample was replaced by gypsum and there are a few later veins of gypsum and/or carbonate, with local patches of low-birefringent clay (e.g. dickite).

Handspecimen: The drill core sample is composed of an intensely hydrothermally altered rock hosting a vein array up to several centimetres wide at ~30° to the core axis (Fig. 34). Vein material is dominated by grey to white quartz, with patchily abundant pyrite and chalcopyrite. The latter occur in irregular to elongate aggregates up to 6 cm long (Fig. 34). Minor carbonate and possible gypsum also occur in the quartz-sulphide veining, but are also apparently present as thin, later white veins. The altered host rock ranges from pale grey to pale creamy-orange and is evidently replaced by abundant quartz, probably with significant sericite, and minor pyrite and chalcopyrite (Fig. 34). Testing of the section offcut with dilute HCl did not give a reaction on carbonate, suggesting that it is dolomite or ankerite. The host rock is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI, but the vein material can be moderately magnetic, with susceptibility up to 530 x 10^{-5} SI.

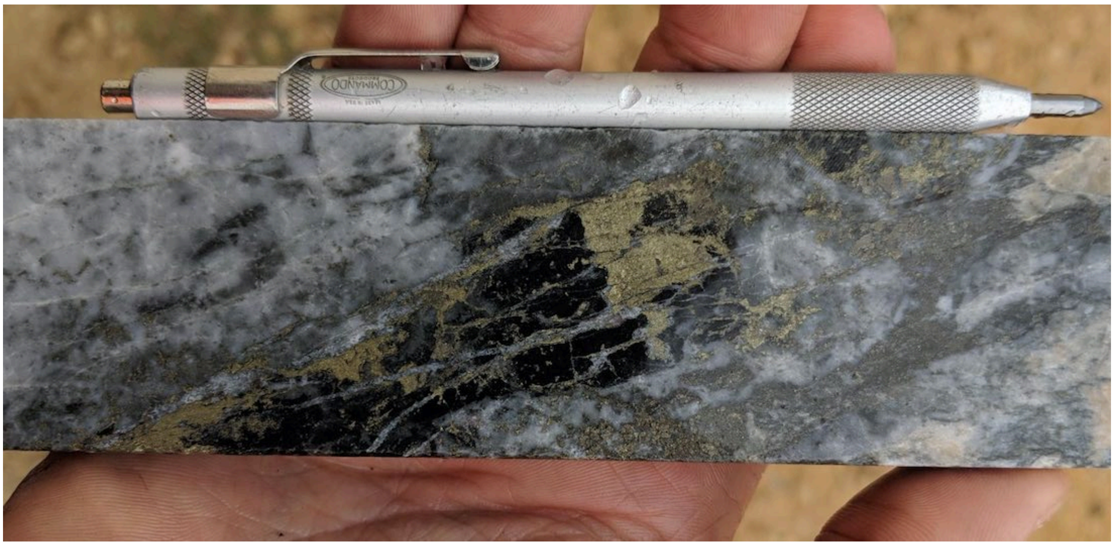

Fig. 34: Drill core sample showing pale grey strongly altered and weakly deformed host rock (probably a sparsely porphyritic dacite with phyllic to silicic alteration) and cut by an array of veins at a moderate angle to the core axis. The veins are dominated by quartz, pyrite and chalcopyrite.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock is intensely hydrothermally altered and significantly veined. Locally, relict texture is moderately preserved, indicating that the rock was originally fine grained and sparsely porphyritic. It has a few pseudomorphs after former prismatic ferromagnesian grains up to 1 mm long (perhaps hornblende, judging by relict shapes) and also after a few blocky feldspar phenocrysts up to 2 mm across (Fig. 35). There is a single relict quartz microphenocryst, with the phenocrystal phases occurring in a fine grained groundmass, assumed to have been of quartzofeldspathic composition. From the preserved primary characteristics, the rock is interpreted as a sparsely porphyritic dacite.

b) Alteration and structure: The protolith was intensely hydrothermally altered and significantly veined. In part of the sample, there is a pervasive phyllic alteration assemblage of fine grained quartz and sericite, with sericite aggregates having replaced former feldspar and ferromagnesian phenocrysts (Fig. 35). Also present are small amounts of disseminated pyrite and traces of anhydrite (largely replaced by gypsum), rutile and chalcopyrite. Part of the rock has complete destruction of primary texture and replacement by fine to medium grained, inequigranular quartz, with minor disseminated grains and aggregates of chalcopyrite, pyrite and gypsum (having largely replaced former anhydrite) and trace sericite. This alteration is of silicic type. The altered rock was cut by a few diffuse, early veins, perhaps related to the strong alteration and maybe emplaced syn-tectonically, as commonly the veins and immediate host rock have deformation effects. These veins are up to several millimetres wide and contain fine to medium grained quartz, commonly with fibre growth texture co-planar with local foliation in the host rock, with scattered irregular aggregates (up to several mililmetres) and isolated grains of pyrite and chalcopyrite, minor carbonate (also locally deformed), sericite and trace anhydrite (Figs 36, 37). The quartz-sulphide-dominated veins and host rock appear to have also been subsequently cut by a few sub-planar to irregular veins up to 1.5 mm wide containing gypsum (in part replacing anhydrite), carbonate, and medium grained, low-birefringent clay masses (e.g. dickite) up to a few millimetres long.

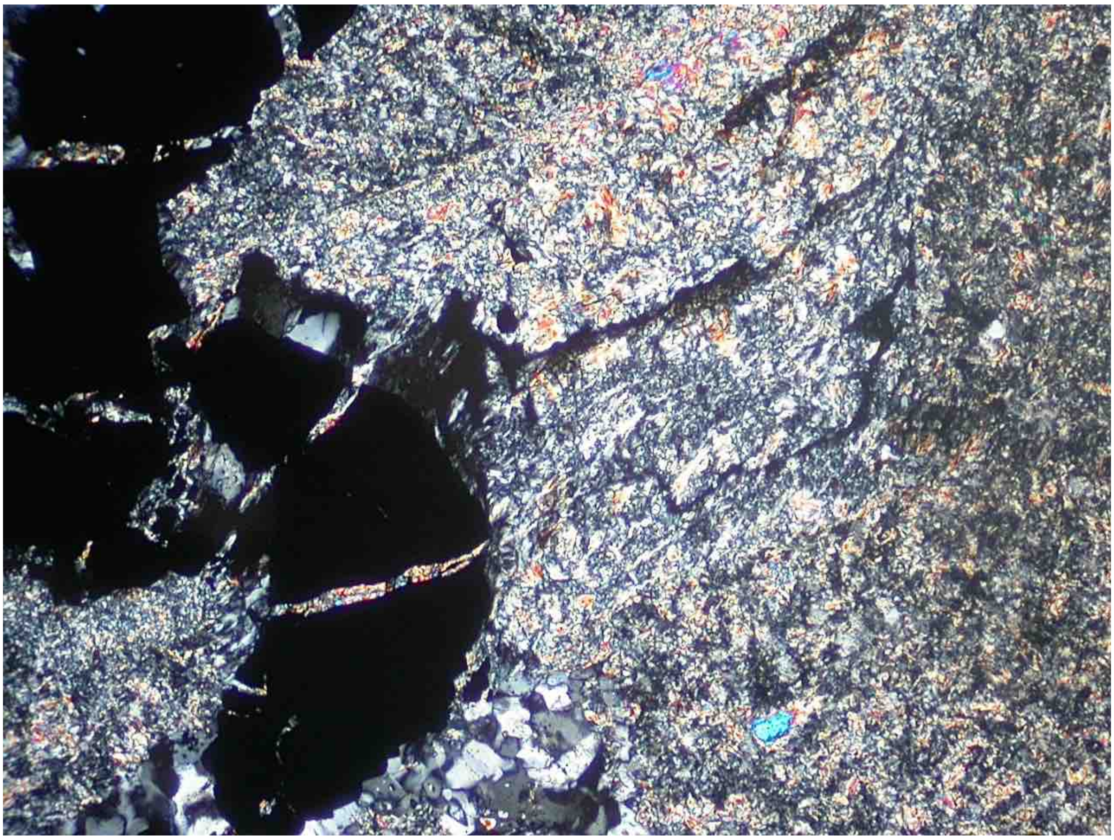

Fig. 35: Strong phyllic alteration of the host rock, showing a diffuse sericite pseudomorph after a former feldspar phenocryst (upper centre), and cut at left by irregular veins containing

pyrite (black), quartz and sericite. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The sample contains abundant sulphides, mostly in the diffuse veins with quartz, where there are disseminated grains, grading to irregular to elongate aggregates up to several millimetre across of pyrite, and paragenetically later chalcopyrite (Figs 35, 36, 37). Locally, where veins show deformation features, chalcopyrite occurs in "pressure shadows" about pyrite. The altered host rock also contains minor disseminated pyrite and trace chalcopyrite. In the veins, pyrite is observed to contain rare tiny inclusions of magnetite. No molybdenite was observed in the sample.

Mineral Mode (by volume): quartz 55%, pyrite 12%, sericite and chalcopyrite each 10%, carbonate 8%, gypsum 3%, clay (dickite) 2% and traces of anhydrite, rutile and magnetite.

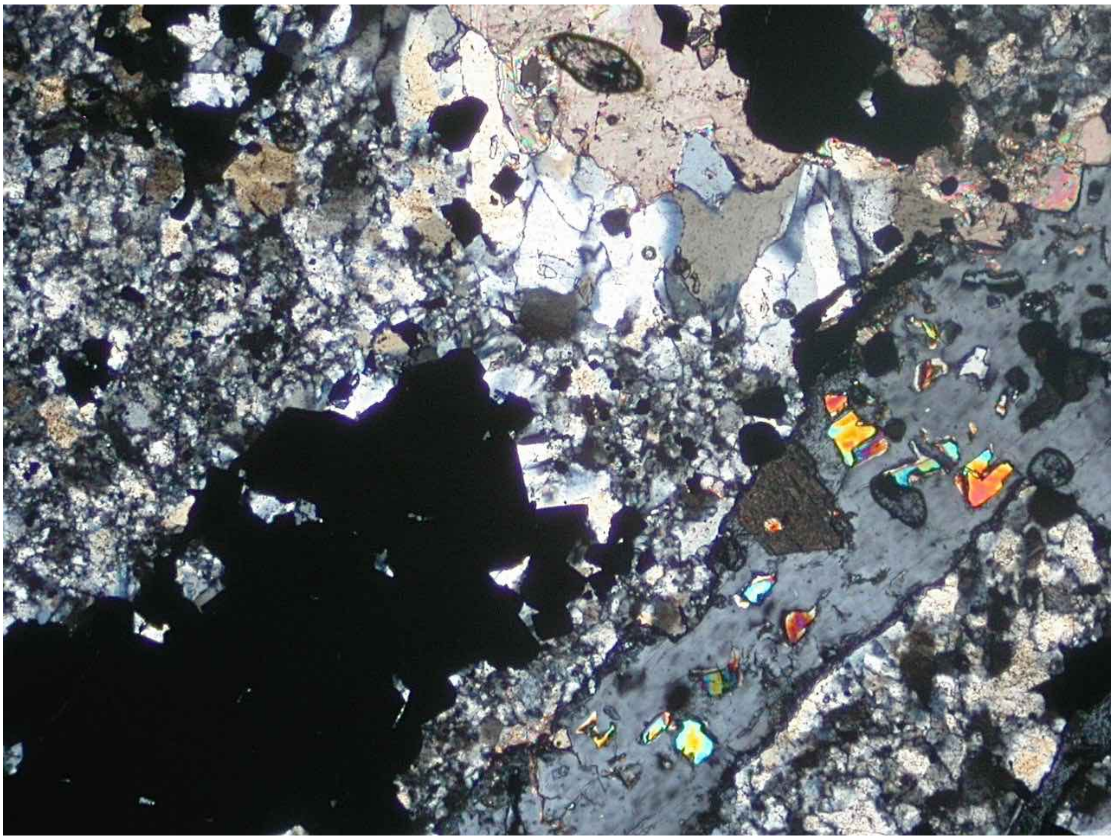

Fig. 36: Late gypsum vein (with small, coloured anhydrite inclusions) cutting a zone of intensely altered host rock (left, replaced by quartz and pyrite (black)) and an early vein of quartz, carbonate and pyrite (upper). Transmitted light, crossed polarisers, field of view 2 mm across.

Interpretation and comment: It is interpreted that the sample is an intensely altered and veined felsic igneous rock, which, based on locally moderately preserved relict texture, could have been a sparsely porphyritic dacite. It formerly contained a few feldspar and ferromagnesian (hornblende) phenocrysts in a fine grained quartzofeldspathic groundmass. The rock was overprinted by alteration that ranges from phyllic (fine grained quartz, sericite, minor pyrite, anhydrite and trace chalcopyrite and rutile) to silicic type (quartz-rich, with minor pyrite, chalcopyrite). It locally shows foliation development and this is co-planar with emplacement of early diffuse quartz-rich veining (in places with fibre texture), with large irregular patches and disseminations of pyrite and chalcopyrite, minor carbonate and anhydrite. Much anhydrite in the sample was replaced by gypsum and there are a few later veins of gypsum and/or carbonate, with local patches of low-birefringent clay (e.g. dickite).

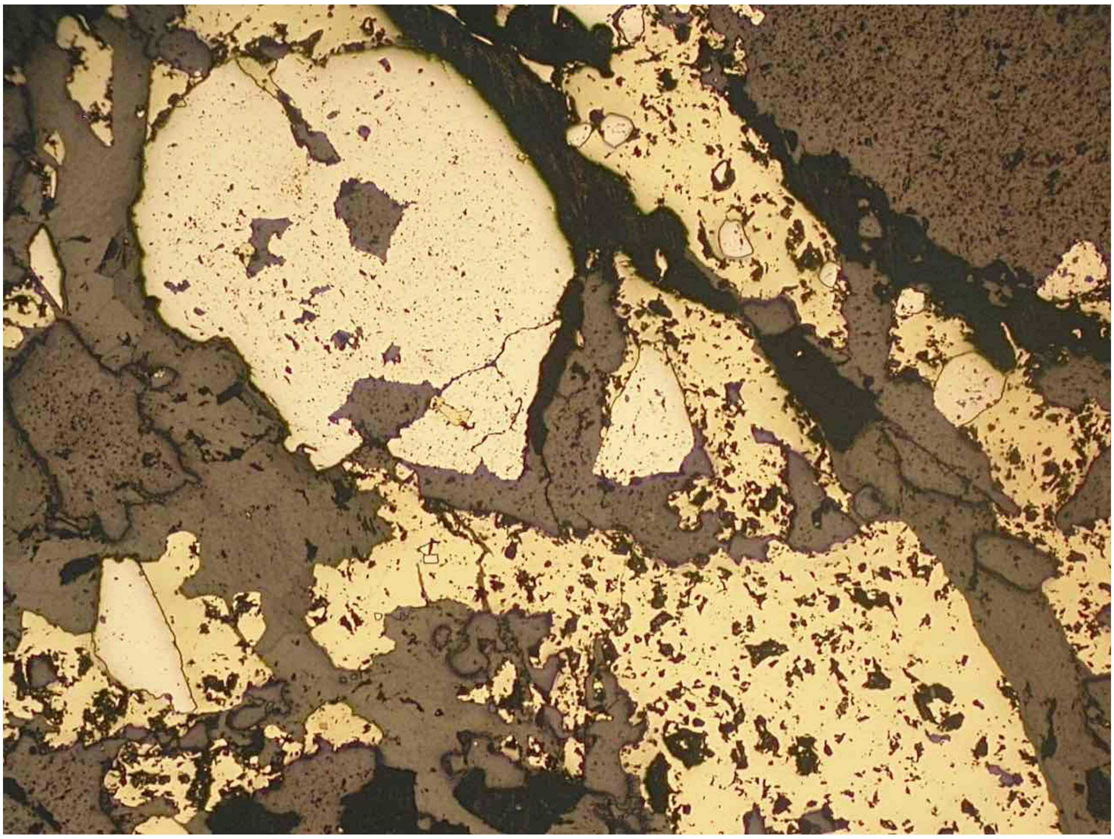

Fig. 37: Part of a large vein containing quartz (dark grey), pyrite (pale creamy) and paragenetically later chalcopyrite (yellow). Plane polarised reflected light, field of view 2 mm across.

<u>SMD044 996.2 m PTS</u>

<u>Summary</u>: Porphyritic dacite, with abundant plagioclase phenocrysts and less common phenocrysts of quartz and altered ferromagnesian material (perhaps hornblende) in a fine grained granular quartzofeldspathic groundmass. The rock was subject to moderate to strong pervasive alteration, although there is some preservation of igneous minerals. The alteration is dominated by albite and chlorite, with lesser sericite, minor anhydrite and a little carbonate, chalcopyrite and rutile. A few thin veins occur, with contents including carbonate, anhydrite, quartz and sericite.

<u>Handspecimen</u>: The drill core sample is composed of a massive, strongly porphyritic felsic igneous rock, probably with moderate alteration and containing abundant pale grey blocky phenocrysts of plagioclase up to 6 mm across (Fig. 38). There are also less common phenocrysts of grey, translucent quartz and dark grey-green aggregates than represent altered ferromagnesian sites, all enclosed by a grey, fine grained quartzofeldspathic groundmass (Fig. 38). Alteration could have developed minor chlorite (from ferromagnesian sites) and sericite (from plagioclase), as well as a trace of chalcopyrite. Testing of the section offcut with sodium cobaltinitrite did not reveal the presence of K-feldspar. The sample is weakly to moderately magnetic, with susceptibility up to 110 x 10^{-5} SI.

Fig. 38: Drill core sample of strongly porphyritic dacite, characterised by abundant plagioclase phenocrysts in a fine grained grey quartzofeldspathic groundmass. The rock has moderate alteration to chlorite, albite, sericite and a little anhydrite, carbonate and trace chalcopyrite.

<u>Petrographic description</u>

a) Primary rock characteristics: In the section, porphyritic texture is well preserved and there is some preservation of primary igneous minerals (Fig. 39). The rock contains scattered blocky plagioclase phenocrysts up to 6 mm across (also forming clusters up to 1 cm across), as well as a few quartz phenocrysts up to 3.5 mm across and pseudomorphs after former ferromagnesian phenocrysts up to 2 mm long (Fig. 39). Relict shapes of the latter suggest that hornblende would have been present. The phenocryst phases occurred in a finely granular groundmass with abundant feldspar and quartz, plus minor altered ferromagnesian material and traces of FeTi oxide (e.g. titanomagnetite), apatite and zircon. If K-feldspar was originally present in the groundmass, then it was probably subsequently altered. The preserved primary characteristics of the rock indicate that it is a porphyritic dacite.

b) Alteration and structure: Moderate to strong pervasive hydrothermal alteration has affected the igneous rock. Plagioclase phenocrysts and groundmass feldspar were variably replaced by albite, as well as minor to abundant fine grained sericite, plus traces of anhydrite, carbonate and chlorite (Figs 39, 40). All former ferromagnesian material was replaced by chlorite (Fig.

39), with local anhydrite and traces of quartz, carbonate, chalcopyrite and rutile, and igneous FeTi oxide was largely replaced by rutile ± anhydrite and chlorite. Throughout the rock, there are sparse replacement aggregates up to 3 mm across containing one or more of anhydrite, chlorite, quartz and chalcopyrite (Fig. 40). A single sub-planar vein up to 0.5 mm wide containing quartz and anhydrite cuts the rock, and there are also a few later, thin veins of carbonate + sericite and trace anhydrite. The alteration assemblage in the sample is regarded as being largely of propylitic type.

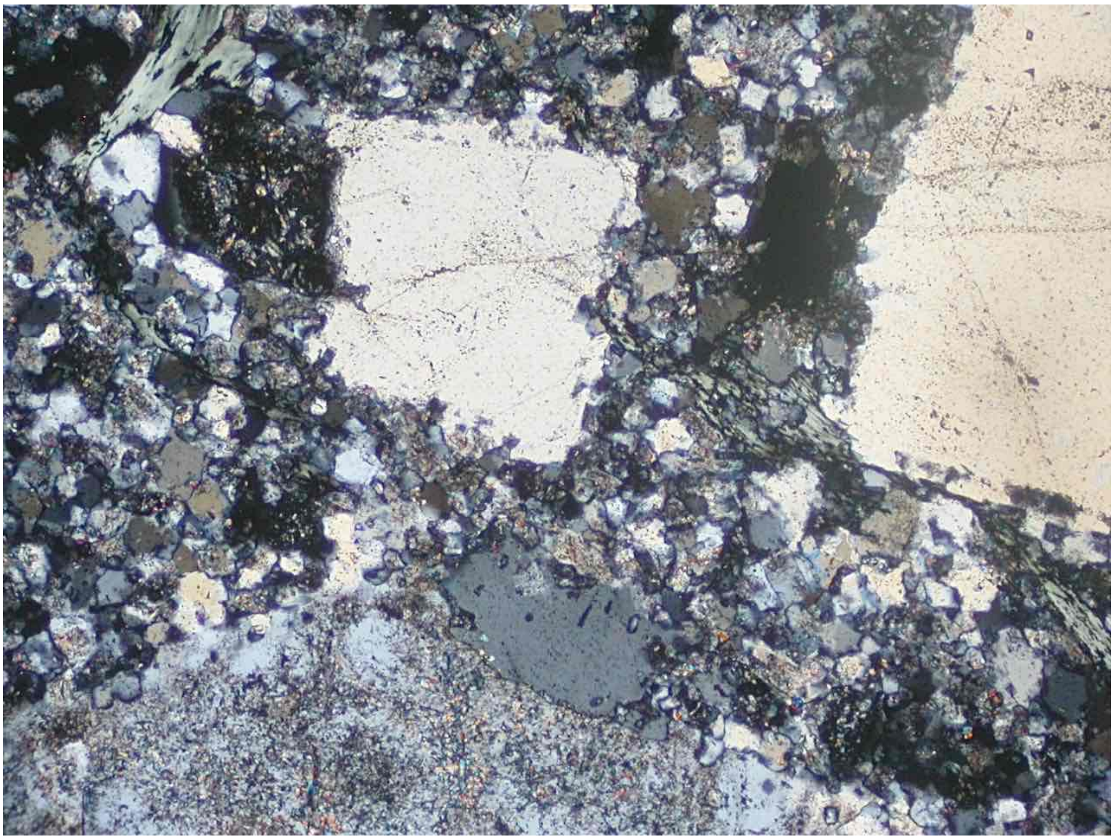

Fig. 39: Relict quartz phenocrysts and part of a plagioclase phenocryst (lower, partly replaced by albite and sericite) in a finely granular groundmass of quartz and albite, with a couple of elongate chlorite aggregates after former ferromagnesian grains. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: The rock contains a few small aggregates of chalcopyrite up to 1.5 mm across as part of the alteration, associated with anhydrite, chlorite and quartz (Fig. 40). A trace of relict igneous titanomagnetite is also present.

<u>Mineral Mode (by volume)</u>: plagioclase (includes albite) 55%, quartz 28%, chlorite 8%, sericite 5%, anhydrite 2%, carbonate 1% and traces of chalcopyrite, rutile, apatite, zircon and FeTi oxide (titanomagnetite).

<u>Interpretation and comment</u>: It is interpreted that the sample represents a moderately altered porphyritic dacite, containing abundant, variably altered plagioclase phenocrysts and less common phenocrysts of quartz and altered ferromagnesian material (perhaps hornblende) in a fine grained granular quartzofeldspathic groundmass. Alteration is considered to be of propylitic type and is dominated by albite and chlorite, with lesser sericite, minor anhydrite and a little carbonate, chalcopyrite and rutile. A few thin veins occur, with contents including carbonate, anhydrite, quartz and sericite.

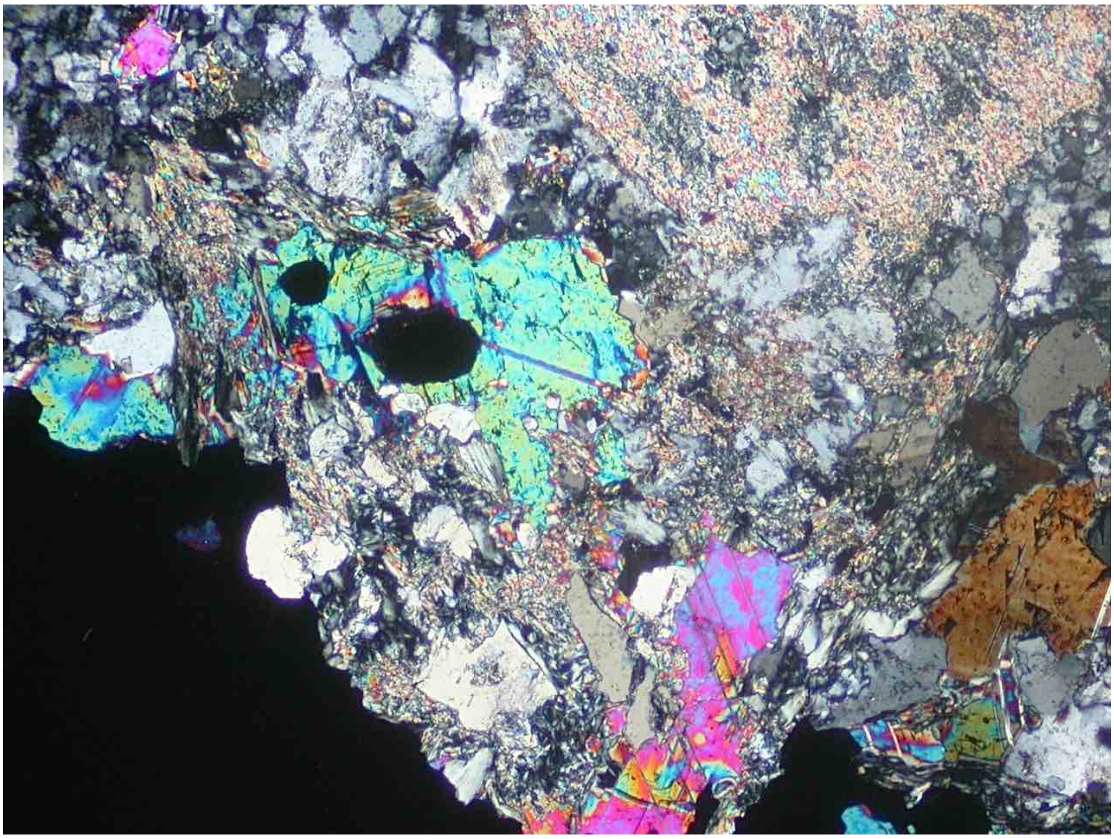

Fig. 40: Part of a replacement aggregate of chalcopyrite (black), anhydrite (bright colours) and quartz in porphyritic dacite, containing a strongly sericitised plagioclase phenocryst at upper right. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD044W1 859.0 m PTS

Summary: Massive sulphides, representing the product of complete hydrothermal replacement and/or infill. No host rock is recognised. The sample is dominated by abundant fine through to coarse grained pyrite, with abundant interstitial bornite and chalcocite, subordinate fine to medium grained quartz, minor anhydrite and a little sericite and gypsum. Pyrite ranges from disseminated to semi-massive and is surrounded and probably invaded by bornite + chalcocite. Pyrite also contains sparse small inclusions of bornite and chalcocite, with rare chalcopyrite, enargite and a phase tentatively identified as colusite. Bornite and chalcopyrite also contain uncommon small inclusions of colusite and enargite. The textures and mineralogy of the rock conforms to high sulphidation type, formed under hypogene conditions.

Handspecimen: The drill core sample is composed of massive sulphides, displaying interspersed aggregates of medium grained pyrite and bornite + chalcocite aggregates, and with local, pale grey to white aggregates of quartz up to 1.5 cm across (Fig. 41). Bornite-chalcocite aggregates are up to 5 cm across and appear to have invaded pyrite, especially along grain boundaries (Fig. 41). No host rock is recognised and the sample is probably the product of total hydrothermal replacement and/or infill. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 41: Drill core sample of massive sulphide aggregate showing abundant pyrite and scattered irregular, apparently invasive masses of bornite (dark purple-brownish) and chalcocite (blue-grey).

Petrographic description

a) Primary rock characteristics: In the section, no host rock is recognised and the sample is dominated by sulphides (pyrite > bornite > chalcocite), with subordinate interstitial quartz, minor anhydrite and a little sericite and gypsum. The observed assemblage could be the product of total hydrothermal replacement and/or infill.

b) Alteration and structure: As mentioned above, no host rock remnants are recognised and the sample is considered to be the product of complete hydrothermal replacement and/or infill. It is dominated by fine through to coarse grained sulphides, with pyrite > bornite >

chalcocite, and with scattered interstitial aggregates of fine to medium grained, inequigranular quartz up to 6 mm across, in places with a little associated fine grained sericite, and a few aggregates of medium grained anhydrite up to 4.5 mm across. There is also a little interstitial gypsum that could have formed by replacement of anhydrite.

c) Mineralisation: The sample is largely composed of massive sulphides. Pyrite is abundant, being disseminated to semi-massive and fine through to coarse grained (individual anhedral to subhedral grains up to 3 mm across) (Figs 42, 43). Pyrite hosts a few small inclusions of bornite and chalcocite (commonly composite) and rare small grains of chalcopyrite, enargite and a phase that is tentatively identified as colusite. Interstitial to pyrite is abundant bornite, typically intergrown with chalcocite (Figs 42, 43). Bornite is somewhat more abundant than chalcocite, with these two phases forming masses up to at least 1.5 cm across. Textures imply that bornite and chalcocite could be largely in equilibrium (and locally have micrographic/eutectoid texture) and could have replaced pyrite along fractures and grain boundaries (Figs 42, 43). Bornite-chalcocite aggregates host a few small inclusions of enargite (up to 0.8 mm across) and colusite (up to 0.4 mm across) (Figs 42, 43). The sulphide assemblage in the sample is characteristic of high sulphidation type and it is likely to have formed by a hypogene hydrothermal process. There is no evidence for the assemblage to have formed by deep supergene processes.

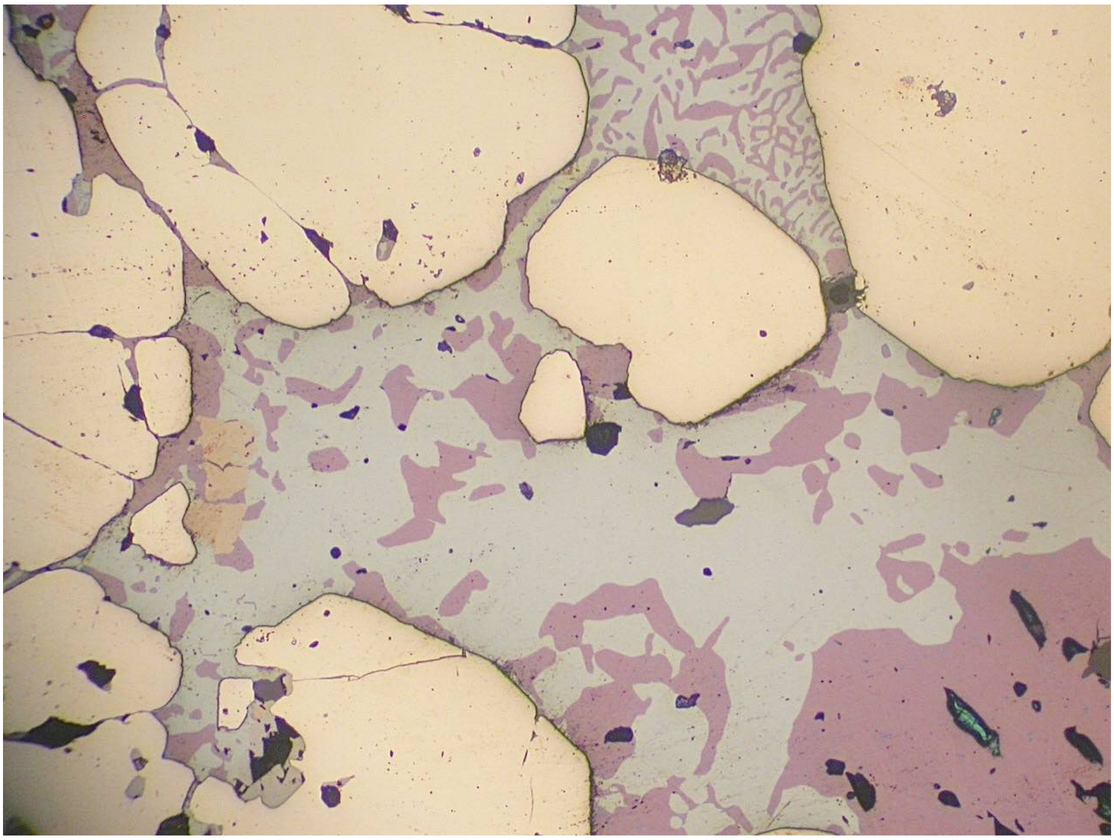

Fig. 42: Sub-rounded pyrite grains (pale creamy) enclosed by intergrown chalcocite (pale blue-grey) and bornite (mauve-pink), showing local eutectoid texture. At left is a pale orange-brown-grey grain of possible colusite. Plane polarised reflected light, field of view 1 mm across.

<u>Mineral Mode (by volume)</u>: pyrite 55%, bornite 15%, chalcocite and quartz each 12%, anhydrite 4% sericite 1% and traces of enargite, colusite, chalcopyrite and gypsum.

Interpretation and comment: It is interpreted that the sample is composed of massive sulphides, dominated by abundant pyrite, with interstitial bornite and chalcocite, subordinate fine to medium grained quartz, minor anhydrite and a little sericite and gypsum. No host rock is recognised and the sample could be the product of complete hydrothermal replacement and/or infill. Pyrite ranges from disseminated to semi-massive and is surrounded and probably invaded by bornite + chalcocite. Pyrite also contains sparse small inclusions of bornite and chalcocite, with rare chalcopyrite, enargite and a phase tentatively identified as colusite. Bornite and chalcopyrite also contain uncommon small inclusions of colusite and enargite. The textures and mineralogy of the rock conforms to high sulphidation type, formed under hypogene conditions.

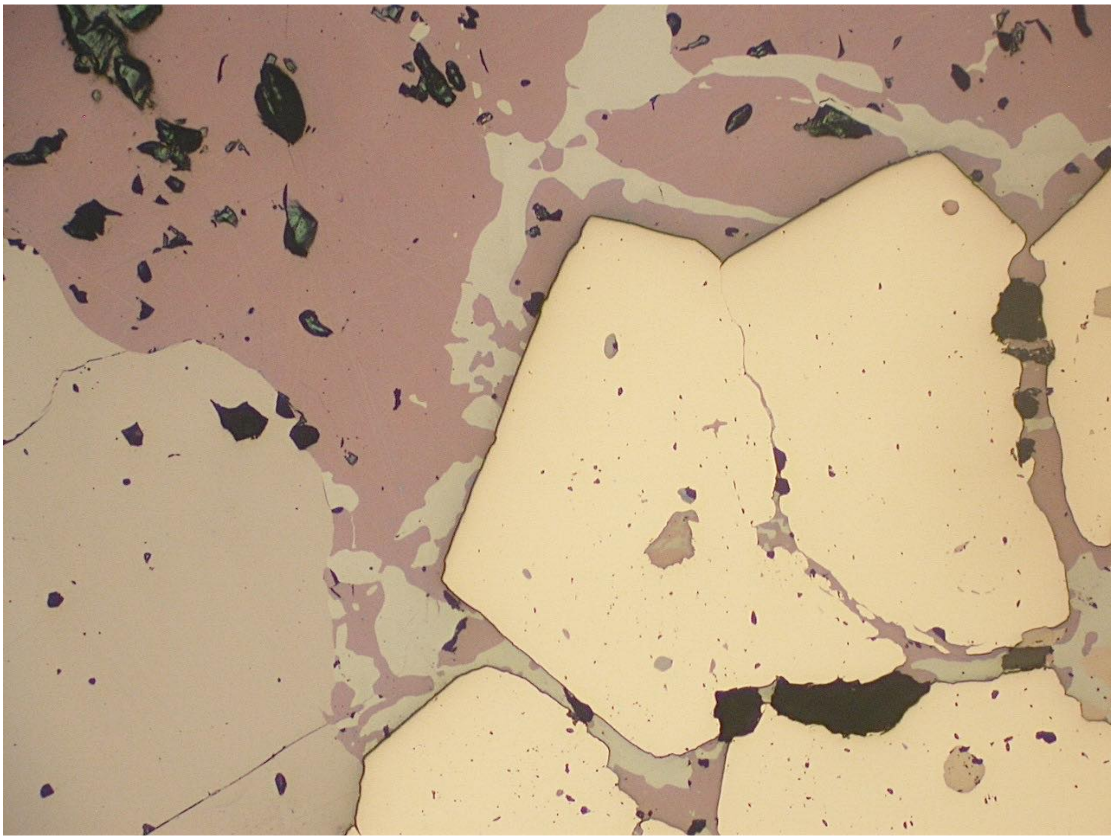

Fig. 43: Subhedral pyrite grains (pale creamy) showing small inclusions of bornite and invasion along grain boundaries by bornite and chalcocite. At left is part of a grain of enargite (pale grey) hosted in bornite and chalcocite. Plane polarised reflected light, field of view 1 mm across.

SMD044W1 866.3 m PTS

Summary: Strongly hydrothermally altered porphyritic felsic igneous rock, perhaps originally of microgranodiorite or microtonalite type. The rock has abundant, largely altered plagioclase phenocrysts, a few relict quartz phenocrysts and pseudomorphs after former ferromagnesian phenocrysts (could have included biotite, hornblende) in a fine to medium grained, inequigranular quartzofeldspathic groundmass. Strong phyllic alteration was imposed, with replacement by quartz and sericite, plus minor disseminated pyrite, anhydrite and traces of bornite and rutile. Alteration is strongest about a sub-planar vein dominated by quartz and pyrite. Where more strongly altered, plagioclase was replaced by sericite, with minor anhydrite, quartz and pyrite.

Handspecimen: The drill core sample is composed of a generally massive, pale grey to locally white and dark grey, strongly altered porphyritic felsic igneous rock (Fig. 44). It contains scattered, partly altered blocky feldspar phenocrysts up to several millimetres across and there are also pseudomorphs after probable former ferromagnesian grains, all enclosed in a fine grained, altered, originally quartzofeldspathic groundmass (Fig. 44). Strong alteration to a fine grained sericite-clay phase and minor disseminated pyrite has occurred, with associated strong development of quartz, apparently associated with a couple of sub-planar veins of quartz and pyrite up to 1 mm wide (Fig. 44). Some of the small dark grey patches appear to contain fine grained pyrite and possible bornite. Testing of the section offcut with sodium cobaltinitrite did not reveal the presence of K-feldspar. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Fig. 44: Drill core sample of strongly phyllic altered porphyritic felsic igneous rock (e.g. microgranodiorite or microtonalite). It formerly contained phenocrysts of plagioclase, ferromagnesian material and uncommon quartz. Alteration of quartz-sericite (-pyrite) type was imposed. Small dark grey zones contain pyrite and trace bornite.

Petrographic description

a) Primary rock characteristics: In the section, the rock has moderately well preserved relict porphyritic texture, although it is evidently strongly altered. The rock contains scattered blocky plagioclase phenocrysts up to 5 mm across, most of which are now altered (Fig. 45). There are a couple of relict quartz phenocrysts up to 1.5 mm across and pseudomorphs after former ferromagnesian grains up to 3 mm long. Relict shapes of the latter indicate that probable biotite and maybe hornblende originally occurred. The phenocrystal phases were set in a fine to medium grained, inequigranular texture groundmass consisting of feldspar, quartz, minor ferromagnesian material, and a few grains of FeTi oxide (now altered) and trace zircon. It is possible that K-feldspar occurred in the groundmass, but if so, it was later altered. The preserved primary characteristics of the rock imply that it was a porphyritic microgranodiorite or microtonalite, maybe related to the porphyritic dacites in the sample suite, but with slightly coarser groundmass.

b) Alteration and structure: Strong pervasive hydrothermal alteration was imposed and a single vein emplaced. Most original feldspar was altered, although in places, relict plagioclase is preserved, perhaps partly albitised. Feldspar was replaced by aggregates of fine grained sericite, locally accompanied by anhydrite (up to 0.5 mm) and a little pyrite and quartz (Fig. 45). All former ferromagnesian grains were replaced by sericite and trace pyrite and rutile, and FeTi oxide by rutile and sericite. It could be speculated that there was early potassic alteration, whereby igneous ferromagnesian grains were replaced by hydrothermal biotite, but if this has occurred, the biotite was subsequently overprinted by strong sericite development. In the groundmass, there was commonly strong replacement by sericite, granular quartz and minor pyrite (Fig. 45). Throughout the rock, there was minor development of disseminated pyrite and trace bornite, with tiny amounts of associated chalcopyrite, chalcocite and digenite (Fig. 46). A single diffuse sub-planar vein up to 1.5 mm wide was emplaced, containing quartz and pyrite, with minor anhydrite and sericite and a little low-birefringent crystalline clay (e.g. dickite) and gypsum. The latter two minerals could be retrograde. About the vein, there is stronger development of quartz and sericite in the host rock. The alteration characteristics in the sample conform to phyllic type.

c) Mineralisation: As part of the pervasive alteration, minor disseminated pyrite was formed throughout, in grains up to 1 mm across. Uncommon small aggregates of bornite up to 0.3 mm across also occur (Fig. 46), with associated tiny amounts of chalcopyrite, chalc.ocite and digenite. Bornite and chalcopyrite also occur as tiny inclusions in pyrite. The vein also hosts considerable pyrite, forming elongate aggregates up to several millimetres long.

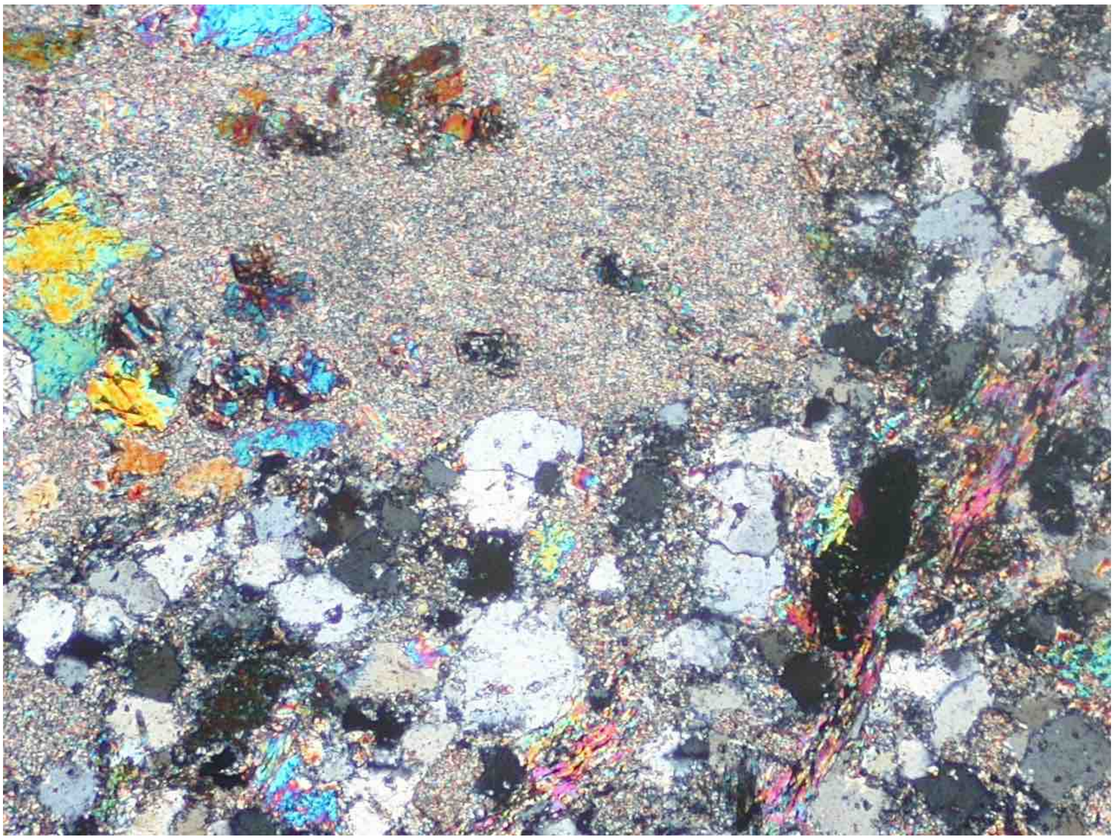

Fig. 45: Strongly phyllic-altered rock, with part of a pseudomorph after a plagioclase phenocryst (upper) replaced by sericite and minor anhydrite (bright colours), in a groundmass that was replaced by inequigranular quartz, flaky sericite and trace rutile (black). Transmitted light, crossed polarisers, field of view 2 mm across.

Mineral Mode (by volume): quartz 50%, sericite 40%, pyrite 5%, plagioclase 2%, anhydrite and clay (dickite) each 1% and traces of zircon, rutile, gypsum, bornite, chalcopyrite, chalcocite and digenite.

Interpretation and comment: It is interpreted that the sample represents a strongly phyllic altered, porphyritic microgranodiorite or microtonalite. It has abundant, largely altered plagioclase phenocrysts, a few relict quartz phenocrysts and pseudomorphs after former ferromagnesian phenocrysts (could have included biotite, hornblende) in a fine to medium grained, inequigranular quartzofeldspathic groundmass. Alteration led to replacement by quartz and sericite, minor disseminated pyrite, anhydrite and traces of bornite and rutile. Alteration is strongest about a sub-planar vein dominated by quartz and pyrite. Where more strongly altered, plagioclase was replaced by sericite, with minor anhydrite, quartz and pyrite.

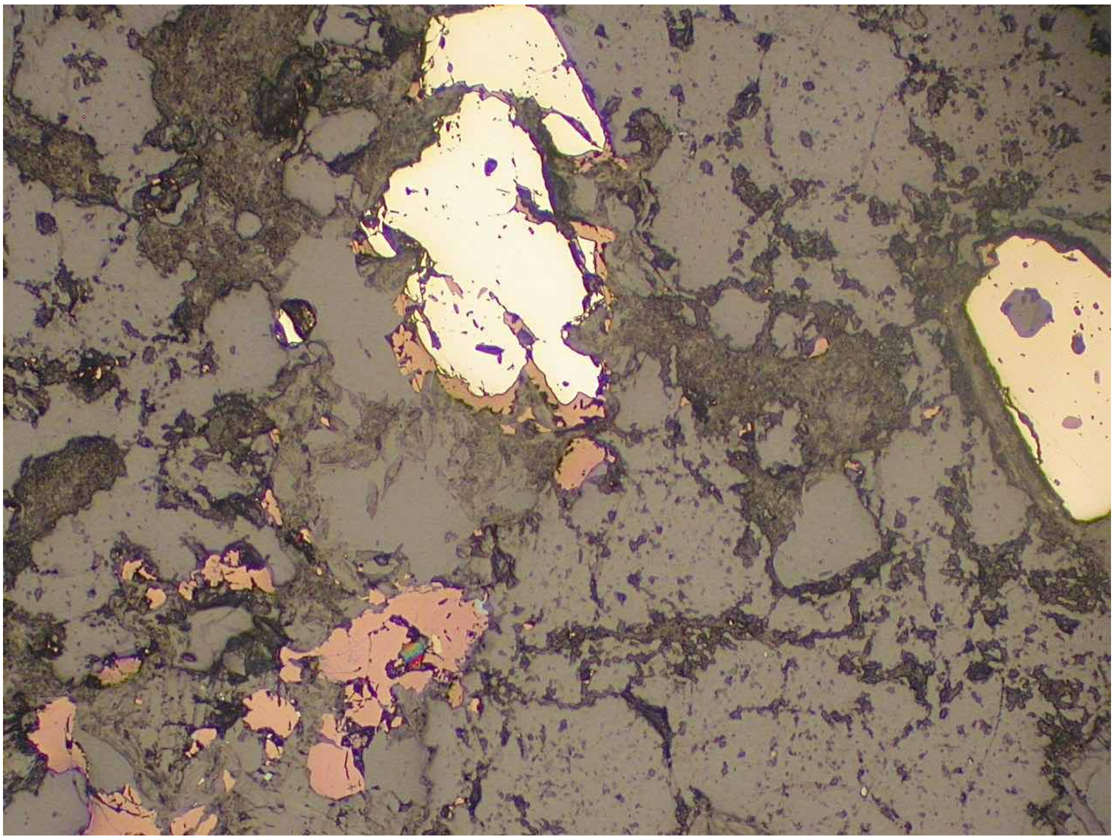

Fig. 46: Small aggregates and individual grains of bornite (pinkish) and pyrite (pale creamy) is a strongly altered aggregate of quartz and sericite (dark grey). Plane polarised reflected light, field of view 1 mm across.

SMD044W1 950.0 m TS

Summary: Porphyritic dacite (transitional to microtonalite/microgranodiorite) with a small volume of intrusive leucocratic microtonalite. The former rock type has scattered partly altered phenocrysts of plagioclase and a small amount of quartz and altered ferromagnesian phenocrysts in a rather fine grained quartzofeldspathic groundmass. A couple of zones of leucocratic microtonalite occur, probably as intrusive dikelets, cutting the porphyritic dacite. The leucocratic microtonalite is medium grained, inequigranular to locally porphyritic and contains partly altered plagioclase, interlocking with quartz and minor altered ferromagnesian material (former biotite). Both rock types show moderate to strong alteration. It is possible that early mild potassic alteration occurred in the porphyritic dacite, with minor development of hydrothermal biotite. However, both rock types are overprinted by propylitic alteration, with development of albite, sericite, chlorite and anhydrite from plagioclase, and chlorite from ferromagnesian components (including any former hydrothermal biotite). A few thin, sub-planar veins occur, containing carbonate, anhydrite, albite, sericite and quartz.

Handspecimen: The drill core sample is composed mostly of an altered, strongly porphyritic felsic igneous rock, but there is a small proportion of a more leucocratic, evenly medium grained felsic igneous rock (Fig. 47). The contact between the two phases is sharp and at a moderate angle to the core axis (Fig. 47). The strongly porphyritic phase has creamy to pink coloured plagioclase phenocrysts up to several millimetres across, dark grey-green alteration aggregates, in part after ferromagnesian and feldspar grains, and a few quartz phenocrysts, in a fine grained, grey altered quartzofeldspathic groundmass. The medium grained rock is specked white and grey and is evidently rich in quartz and feldspar; it could be a type of leucocratic microgranitoid. Pervasive alteration has occurred, with generally minor development of fine grained chlorite and sericite, and there are a couple of sub-planar veins at moderate to low angles to the core axis, up to 1 mm wide and containing carbonate (Fig. 47). Testing of the section offcut with sodium cobaltinitrite did not reveal the presence of K-feldspar. The sample is weakly magnetic, with susceptibility up to 50 x 10^{-5} SI.

Fig. 47: Drill core sample of moderately to strongly altered porphyritic dacite containing scattered pink to creamy, partly replaced plagioclase phenocrysts, and with dark grey-green colour due to chlorite alteration. At upper right is a small zone of intrusive, medium grained leucotonalite.

Petrographic description

a) Primary rock characteristics: In the section, it is evident that there are two distinct felsic igneous rock type, with sharp, sub-planar contacts. It is apparent that the medium grained rock (in handspecimen) occurs in two zones, including one as a thin dykelet only 2-3 mm wide. These occurrences have clearly intruded the strongly porphyritic rock (e.g. cutting off large plagioclase phenocrysts). Both rock types have rather well preserved relict texture and some preservation of primary igneous minerals. The medium grained rock consists of inequigranular, medium grained interlocking sodic plagioclase and quartz (up to ~2 mm), with a few phenocrystal grains of plagioclase up to 3 mm across, and a few pseudomorphs after former ferromagnesian grains up to 2 mm across, with traces of FeTi oxide (now altered) and apatite (Fig. 48). Relict shapes after former ferromagnesian grains suggest that they could have been biotite. The other, strongly porphyritic rock, contains scattered, variably altered, blocky plagioclase phenocrysts up to 4 mm across (locally forming larger clusters), a few quartz phenocrysts up to 2.5 mm and pseudomorphs after former ferromagnesian grains up to 1 mm across (possibly hornblende judging by shapes of pseudomorphs). The phenocrystal phases occurred in a largely fine grained (locally slightly larger), inequigranular texture groundmass of feldspar and quartz (Fig. 49), with minor altered ferromagnesian material and traces of altered FeTi oxide, apatite and rare zircon. If K-feldspar was originall present in the two rock types, it must have been subsequently altered. The medium grained rock is interpreted as a leucotonalite, with the porphyritic type being a dacite, but transitional to microtonalite/microgranodiorite.

b) Alteration and structure: Both rock types experienced moderate to strong hydrothermal alteration. It is possible that early, mild potassic alteration was imposed on the porphyritic dacite, manifest as development of local fine grained aggregates of hydrothermal biotite (e.g. mostly at former ferromagnesian sites), but this type of biotite was subsequently retrogressed. Plagioclase phenocrysts and groundmass in the dacite and plagioclase in the leucotonalite were variably replaced by slightly turbid albite, along with minor sericite, locally significant chlorite (in the dacite), a little anhydrite and trace carbonate (Figs 48, 49). All former ferromagnesian material was replaced by chlorite, with traces of leucoxene, anhydrite, carbonate and pyrite, and igneous FeTi oxide was replaced by leucoxene (aggregates up to 1 mm across). A couple of sub-planar veins occur, cutting both rock types, being up to 0.6 mm wide and containing carbonate, anhydrite, albite, sericite and quartz. The alteration assemblage in the two rock types is regarded as being of broadly propylitic type, but with a possible overprint on earlier mild potassic alteration in the porphyritic dacite.

c) Mineralisation: A few grains of pyrite up to 0.3 mm across have formed as part of the pervasive alteration assemblage.

Mineral Mode (by volume): plagioclase (includes albite) 50%, quartz 35%, chlorite 7%, sericite 5%, carbonate and anhydrite each 1% and traces of leucoxene, zircon, apatite and pyrite.

Interpretation and comment: It is interpreted that the sample has a contact between porphyritic dacite (transitional to microtonalite/microgranodiorite) and small volumes of intrusive leucocratic microtonalite. The former rock type has scattered, partly altered plagioclase phenocrysts, with minor quartz and altered ferromagnesian phenocrysts in a fine grained quartzofeldspathic groundmass. A couple of zones of leucocratic microtonalite occur, probably as intrusive dikelets, cutting the porphyritic dacite. Leucocratic microtonalite is medium grained, inequigranular to locally porphyritic and contains partly altered plagioclase, interlocking with quartz and minor altered ferromagnesian material (former biotite). Both rock types have moderate to strong alteration. Early mild potassic alteration could have been imposed on the porphyritic dacite, with minor development of hydrothermal biotite. However, both rock types are overprinted by propylitic alteration, with development of albite, sericite, chlorite and anhydrite from plagioclase, and chlorite from ferromagnesian components (including any former hydrothermal biotite). A few thin, sub-planar veins occur, containing carbonate, anhydrite, albite, sericite and quartz.

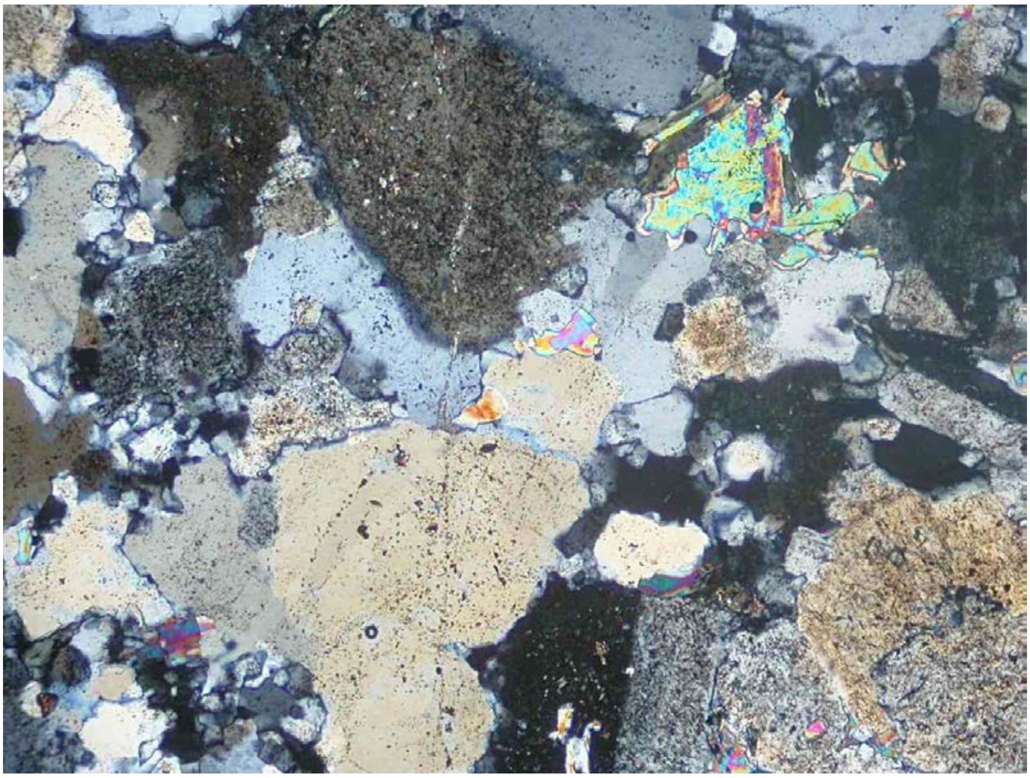

Fig. 48: Medium grained leucotonalite consisting of sodic plagioclase and quartz, with a little alteration-derived anhydrite (bright colours) and trace chlorite and sericite. Transmitted light, crossed polarisers, field of view 2 mm across.

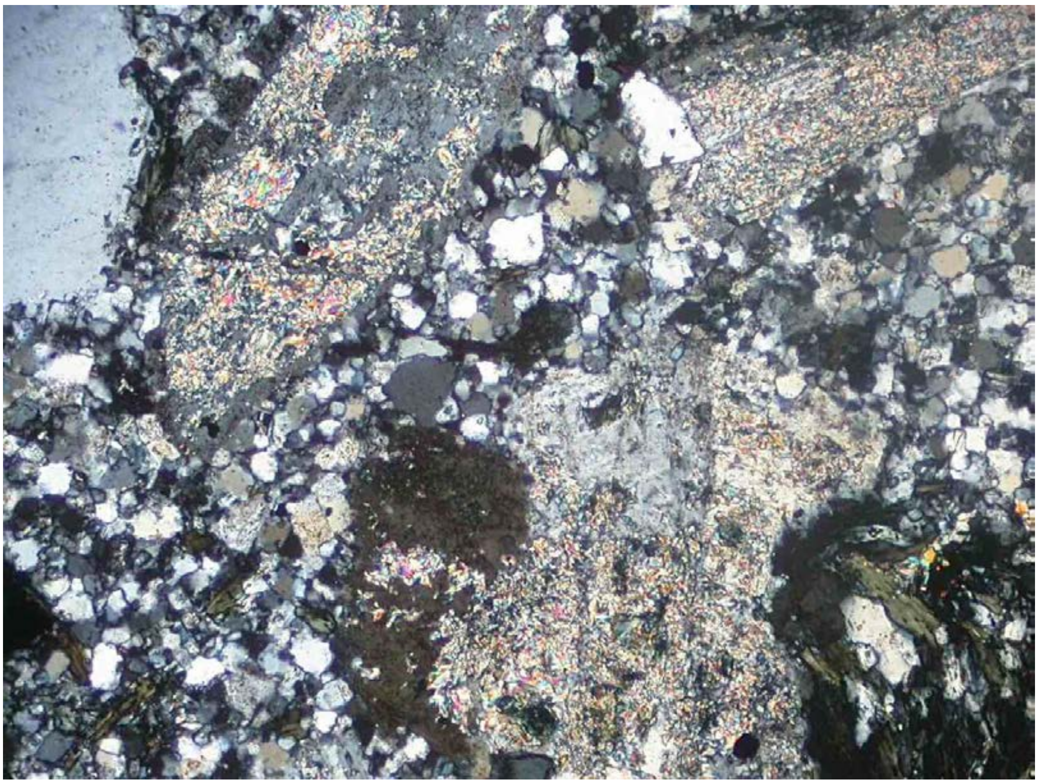

Fig. 49: Porphyritic dacite, with relict quartz phenocryst (upper left), partly sericitised plagioclase phenocrysts, and a chlorite-altered ferromagnesian phenocryst (lower right) in a finely granular quartzofeldspathic groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.