PETROGRAPHIC REPORT ON FIFTEEN DRILL CORE (INCLUDING AIR-CORE) SAMPLES FROM WESTERN VICTORIA (TOORA WEST, REGIONAL AND THURSDAYS GOSSAN PROJECTS)

For

Stavely Minerals

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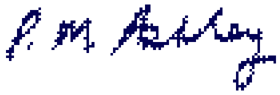


Introduction

A suite of twelve drill core and three air core samples from the Cambrian age Stavely Belt in western Victoria was submitted for petrographic preparation, description and interpretation. Nine drill core samples from the Toora West project (from drill holes STWD004, -005 and -006), three drill core samples from Thursday Gossan (from drill holes SMD130, -158 and -159) and three air core samples from regional investigation (from drill holes STAC0013, -0018 and -0019) were examined. All samples were relatively fresh, and most contained trace through to abundant sulphide minerals. Handspecimen photos and accompanying field notes for the samples were provided.

Petrographic sections were prepared at Thin Section Australia Pty Ltd in Brisbane, with polished thin sections (PTS) being prepared from eleven samples and standard thin section (TS) from the remaining four samples. Subsequently, PTS were examined microscopically in transmitted and reflected light, and TS in transmitted and oblique reflected light. Nine section offcuts were treated with hydrofluoric acid and sodium cobaltinitrite to check for the presence of K-feldspar and a couple of samples were tested with dilute HCl to check carbonate speciation. All samples were measured for magnetic susceptibility and representative photomicrographs of textural and mineralogical characteristics were taken.

The purpose of the petrographic work was mainly to identify the primary rock types, imposed hydrothermal alteration and the nature of the mineralisation, especially in conspicuously sulphide-mineralised samples.

Summary descriptions of samples are listed following (Toora West {STWD} initially, then regional {STAC} and Thursday Gossan {SMD}) in that order:

STWD004 223.5 m TS

Summary: Porphyritic hornblende-quartz microdiorite, with moderate to strong propylitic alteration. Relict texture is well preserved and there is some retention of primary igneous minerals. The rock formerly contained scattered phenocrysts of plagioclase (some megacrystic), hornblende and few possible biotite, in a fine to medium grained groundmass rich in plagioclase, with lesser interstitial quartz, minor ferromagnesian material, K-feldspar and trace apatite, FeTi oxide and zircon. Pervasive alteration led to replacement of plagioclase by slightly turbid, hematite-pigmented albite, along with minor epidote, sericite, carbonate and chlorite. Primary ferromagnesian phases are replaced by chlorite, epidote, carbonate and a little titanite (although some hornblende is preserved) and in the groundmass, there is an assemblage of albite, with minor chlorite., epidote, carbonate and trace hematite. No sulphides are recognised and there is no veining on the scale of the section. The rock has some primary similarity that in sample STWD005/407.8 m (with the latter having secondary biotite development).

STWD005 287.1 m PTS

Summary: Sample is largely composed of vein infill, with small, adhering zones of intensely hydrothermally altered host rock. The latter has no recognised relict characteristics and its original nature remains obscure. It was replaced by quartz and minor to locally abundant sericite, chalcopyrite and traces of tetrahedrite, pyrite and molybdenite. Vein infill is dominated by coarse quartz (commonly zoned), with patches of interstitial chalcopyrite, locally intergrown tetrahedrite and traces of pyrite and molybdenite. There was subsequent fracturing of the quartz-sulphide infill and emplacement of a few irregular veins of "epithermal texture" fine grained quartz, grading to chalcedonic and opaline types, and with a little associated sericite and Fe-poor sphalerite in places.

STWD005 407.8 m PTS

Summary: Pervasively and strongly altered porphyritic hornblende-biotite-quartz microdiorite. The rock retains large plagioclase phenocrysts, but most original phenocrysts of hornblende and (igneous) biotite are altered, replaced by secondary biotite and small amounts of quartz, chalcopyrite and pyrite. The rock had an original rather fine grained groundmass of plagioclase and ferromagnesian material, minor interstitial quartz, a little K-feldspar and apatite. Imposed alteration was initially of potassic type (secondary biotite), accompanied by thin veining by chalcopyrite ± quartz. Subsequently, moderate retrograde alteration was imposed, with chlorite ± clay being developed from primary and secondary biotite, and sericite ± clay from plagioclase phenocrysts. The rock has some primary similarities to that in STWD004/223.5 m, but differs in that secondary biotite development is strong.

STWD006 108.3 m PTS

Summary: Intercalation of zones of medium grained albite and quartz, with coarse grained quartz-rich material, maybe representing the transition between fluid-rich late magmatic, crystallisation of a leucocratic granitic rock, and hydrothermal infill. The texture is analogous to "brain rock". Albite and quartz are commonly intergrown in graphic texture, with albite being variably replaced by fine to medium grained sericite-muscovite. There are also traces of chalcopyrite, pyrite, rutile and molybdenite, mostly associated with sericite aggregates. There is a gradation from albite-quartz zones into the quartz-rich zones, with the latter locally having aggregates of sericite and a few individual grains of pyrite and associated trace chalcopyrite.

STWD006 128.2 m TS

Summary: Strongly porphyritic hornblende (-quartz-biotite) microdiorite. The rock has scattered large plagioclase phenocrysts, with prismatic to blocky green hornblende, and a few smaller phenocrysts of biotite, quartz and apatite. Hornblende also forms small clusters (possible micro-enclaves). The phenocrystal phases occur in a fine grained groundmass dominated by plagioclase and with minor hornblende, biotite, quartz and K-feldspar. The rock is little-altered, with small amounts of sericite (from plagioclase) and chlorite (from ferromagnesian phases) occurring. Only a single grain of pyrite was observed. The rock has primary textural and mineralogical affinities with samples STWD004/223.5 m and STWD005/407.8 m.

STWD006 167.2 m PTS

Summary: Medium to coarse grained, rather leucocratic biotite tonalite, with moderate propylitic alteration. The rock contains abundant plagioclase, interlocking with subordinate quartz and flaky biotite, in places occurring in clusters. Imposed alteration led to considerable replacement of biotite by chlorite, pyrite and carbonate, with trace rutile and titanite. Plagioclase generally shows minor patchy replacement by sericite, carbonate, albite and trace prehnite. Apart from occurring at altered biotite sites, pyrite is also found interstitially to primary igneous minerals, forming irregular aggregates.

STWD006 172.8 m PTS

Summary: Intensely hydrothermally altered rock, perhaps originally of granitoid (e.g. tonalite) type and possibly having been rich in plagioclase. It was replaced by initial albite, with subsequent overprinting by sericite-muscovite, carbonate (calcite), chlorite, pyrite, a little molybdenite and trace rutile. There was invasion of the altered rock by medium to coarse grained quartz-rich, grading to pyrite-rich masses, with minor associated albite, overprinting sericite-muscovite, carbonate, a little chlorite and trace molybdenite. Traces of chalcopyrite also occur, mostly associated with pyrite. There is no evidence, on the scale of the section, for molybdenite to be paragenetically later than quartz and pyrite.

STWD006 308.7 m PTS

Summary: Metamorphosed and altered rock, probably of ultramafic to mafic igneous type. No definite relict texture is recognised due to replacement and recrystallisation, but there are sparse small grains of relict chromite. These are small and equant and their presence could imply that the protolith was of picritic type. The rock experienced replacement by a heterogeneous assemblage under conditions of at least biotite grade metamorphism, forming abundant greenish biotite, chlorite, amphibole (tremolite-actinolite, but could include anthophyllite), lesser amounts of plagioclase, quartz and magnetite, and traces of talc, pyrite, epidote and chalcopyrite. Amphibole tends to be more closely associated with plagioclase, and chlorite and/or biotite commonly form aggregates.

STWD006 322.6 m PTS

Summary: Porphyritic biotite microtonalite, with moderate to strong alteration and local veining. The original rock contained scattered phenocrysts of plagioclase and biotite, and there could have been a few hornblende phenocrysts (subsequently altered). The phenocrystal phases occurred in a fine to medium grained, inequigranular groundmass of plagioclase and quartz, with minor biotite and K-feldspar. A single small enclave occurs, perhaps formerly more mafic than the host and interpreted as biotite-quartz microdiorite. It is possible that the rock experienced initial mild potassic alteration, with replacement of interpreted hornblende by biotite, and development of the latter in the enclave. A few quartz (-carbonate-pyrite) veins were emplaced, associated with narrow K-feldspar alteration selvedges. Subsequently, alteration evolved into an argillic type, with patchy replacement of plagioclase by fine grained clay (e.g. kaolinite), sericite, and biotite by chlorite ± carbonate ± rutile.

STAC0013 68 m PTS

Summary: Sample is composed of largely massive, fine grained Fe sulphides, dominated by marcasite and with minor pyrite. A few relict grains of quartz are enclosed by the sulphides, with shapes of larger grains suggesting that they represent former phenocrysts in a felsic igneous rock. Some quartz grains show invasion by marcasite. There are also a few pseudomorphs after possible former phenocrystal grains of feldspar, replaced by marcasite and fine grained clay (e.g. illite), as well as a few discrete irregular aggregates of illite and a few voids. About voids and illite aggregates, marcasite is typically overgrown by pyrite. No other sulphide minerals are recognised and the sample is interpreted as a product of low temperature sulphidic replacement of a former porphyritic felsic igneous rock.

STAC0018 82 m PTS

Summary: Porphyritic dacite, with initial local development of secondary biotite and subsequent mild argillic alteration. Relict texture is well preserved, with the rock retaining phenocrysts of plagioclase and a few of quartz, but interpreted former small hornblende phenocrysts were replaced by aggregates of fine grained biotite. Phenocrysts occurred in a fine grained groundmass, rich in plagioclase, but with minor quartz, K-feldspar and biotite. Initial mild potassic alteration was followed by slight retrograde effects, with formation of a little sericite, chlorite, pyrite and rutile, along with pervasive clouding of groundmass feldspar by clay (e.g. kaolinite).

STAC0019 25 m TS

Summary: Coarse grained, rather leucocratic tonalite, with moderate propylitic alteration. The rock originally contained abundant anhedral to blocky plagioclase, intergrown with quartz and minor amounts of interstitial biotite (locally in clusters) and K-feldspar. Trace titanite appears to have occurred with biotite. Imposed alteration led to replacement of all prior biotite, mostly by chlorite and/or epidote, and with trace titanite and hematite. Plagioclase shows albitisation in places, with associated development of a little sericite, turbid ultrafine clay and trace epidote and prehnite.

SMD130 181.6 m PTS

Summary: Intensely hydrothermally altered and mineralised ultramafic rock. No definite relict texture is recognised, but there are a few isolated relict grains of chromite (locally fractured) indicating that the protolith was of ultramafic type (speculated to have been harzburgite). There was replacement of the protolith by a Mg-rich assemblage of fine grained talc, subordinate chlorite and Fe-poor sphalerite, minor patchy carbonate (dolomite or magnesite) and pyrite. In places, there are small aggregates of chalcedonic quartz. Sphalerite commonly exhibits abundant small chalcopyrite inclusions ("chalcopyrite disease" texture) as well as inclusions of pyrite and uncommon galena and hematite.

SMD158 520.6 m TS

Summary: Contact between a rather coarse grained hornblende (-quartz) diorite and a porphyritic hornblende microdiorite. On the scale of the sample, there is no indication of timing relations. The diorite was composed of interlocking plagioclase and brown hornblende, with a little quartz and FeTi oxide (maybe ilmenite). The porphyritic microdiorite contained phenocrysts of plagioclase and brown hornblende, in a fine grained plagioclase-rich groundmass, originally with subordinate hornblende and a little quartz and FeTi oxide. Both rock types were subsequently affected by strong alteration, probably as a result of imposed low grade metamorphism. In the diorite, there was extensive replacement by prehnite and chlorite, with trace epidote and leucoxene. All former plagioclase was replaced although hornblende is partly preserved. In the porphyritic microdiorite, there is replacement of plagioclase by albite and minor prehnite, and much hornblende was replaced by chlorite. Minor veining occurs in both rock types, mostly by prehnite or by carbonate.

SMD159 547.7 m PTS

Summary: Intensely hydrothermally altered and mineralised ultramafic rock. There are scattered relict chromite grains indicative of the ultramafic nature of the protolith, but chromite is significantly more abundant than expected for a typical ultramafic, such as harzburgite or derived serpentinite, and hence it is proposed that chromite was concentrated by residual enrichment due to dissolution and replacement of the host rock. The replacement assemblage is dominated by chlorite, pyrite and chalcopyrite. Initially deposited pyrite is coarse grained, with these masses being apparently disaggregated and enclosed in a matrix with varying proportions of chlorite, fine to medium grained pyrite and chalcopyrite, and a little Fe-poor sphalerite. A trace of millerite is observed in chalcopyrite.

Interpretation and comment

Samples in the suite include a variety of igneous protoliths, ranging from felsic to ultramafic in composition. One sample appears to be largely composed of vein filling. The igneous protoliths have a range from moderately to intensely hydrothermally altered (and accompanying primary textural destruction) and several have abundant sulphide mineralisation.

Toora West

There is considerable variety in primary rock types in the nine samples from Toora West. One sample (STWD005/287.1 m), however, is mostly vein material with only a small amount of adhering host rock that has been intensely altered such that the nature of the protolith is obscure. The other samples have preservation of primary textural and mineralogical characteristics ranging from poor (e.g. in STWD006/172.8 m) to rather well retained. Samples STWD004/223.5 m, STWD005/407.8 m and

STWD006/128.2 m are similar and interpreted as porphyritic hornblende microdiorite, with phenocrysts of plagioclase and hornblende, and in some, biotite and quartz, enclosed in rather fine grained groundmasses containing abundant plagioclase. Sample STWD006/322.6 m is interpreted as a porphyritic biotite microtonalite, STWD006/167.2 m is a leucocratic tonalite and it is possible that the protolith in intensely altered STWD006/172.8 m could have been similar. The tonalitic rocks are plagioclase-rich, with quartz and minor biotite. Sample STWD006/108.3 m is interpreted as a leucocratic granitic rock, but with textures suggestive of crystallisation under conditions transitional to the hydrothermal stage, forming a crudely layered "brain rock texture". It is speculated that K-feldspar might have formerly occurred, but replaced by albite. The other sample from Toora West is distinctly different, being of mafic to ultramafic composition. Although no relict texture is preserved, it does retain sparsely scattered small equant grains of chromite and the bulk mineralogical constitution of the alteration/metamorphic assemblage is Mg-rich. Consequently, it is interpreted that the protolith was of picritic type.

As mentioned above, the vein-dominated sample STWD005/287.1 m has a small amount of adhering intensely altered host rock. This was replaced by an assemblage of quartz and sericite, with minor chalcopyrite and trace pyrite, molybdenite and rutile, i.e. a phyllic assemblage. All the other Toora West igneous samples also show imposed hydrothermal (± metamorphic) effects, overprinting the primary mineralogy, and which in sample STWD006/172.8 m has led to considerable primary textural destruction. There is evidence for initial potassic alteration to have occurred in STWD005/407.8 m, with development of secondary (hydrothermal) biotite and a little quartz, chalcopyrite and pyrite, plus emplacement of a couple of chalcopyrite-quartz veins. In this rock, original hornblende phenocrysts were replaced by biotite and the groundmass also has significant biotite development. Minor biotite alteration has also occurred in microtonalite STWD006/322.6 m, and biotite is abundant in the assemblage that has replaced the interpreted picrite STWD006/308.7 m, inferring hydrothermal K addition. In STWD006/322.6 m, thin K-feldspar alteration selvedges have formed along quartz-rich veining. In the leucocratic granitic composition "brain rock" STWD006/108.3 m there is patchy greisen alteration (sericite-muscovite and a small amount of pyrite, trace chalcopyrite, molybdenite) imposed on albite. In STWD006/172.8 m, the possible tonalite protolith appears to have had initial sodic (albite) alteration, overprinted by strong propylitic alteration (sericite-carbonate-chlorite) with abundant pyrite and a small amount of molybdenite and chalcopyrite. Other samples from Toora West have development of a propylitic through to argillic alteration assemblage, in places superimposed on earlier potassic alteration. This has involved formation of weak through to strong development of phases including albite, chlorite, sericite, clay (e.g. kaolinite), epidote and trace prehnite, rutile and pyrite. It is mentioned above that considerable biotite has formed in picrite STWD006/308.7 m, indicating hydrothermal addition of K. The replacement assemblage in this sample is also consistent with having formed under metamorphic conditions (at least biotite grade), containing biotite, chlorite, amphibole, plagioclase, quartz and magnetite, with trace epidote, talc, pyrite and chalcopyrite.

Apart from vein-dominated sample STWD005/287.1 m, there is only minor veining in other Toora West samples. STWD005/287.1 m is dominated by quartz, with scattered chalcopyrite aggregates, minor tetrahedrite and trace pyrite and molybdenite, with later imposed thin veinlets of chalcedonic to opaline material containing traces of Fe-poor sphalerite and sericite. Sample STWD006/322.6 m has a few veins of quartz (-carbonate-pyrite) and STWD005/407.6 m has thin chalcopyrite-pyrite veining, related to potassic alteration. In intensely altered tonalite STWD006/172.8 m, there are irregular masses ranging from quartz- to pyrite-rich, with these also having small amounts of albite, sericite-muscovite, carbonate, chlorite, chalcopyrite and molybdenite.

Many of the Toora West samples contain trace through to relatively abundant sulphides, and minor magnetite (interpreted to represent a metamorphic product) has formed in STWD006/308.7 m. The vein-dominated sample STWD005/287.1 m contains an estimated 7% chalcopyrite, with ~1% intergrown (and also discrete) tetrahedrite, and traces of pyrite and molybdenite. Intensely altered tonalite STWD006/172.8 m has patchy, mostly coarse pyrite, as well as a little disseminated molybdenite (estimated at ~1% and more abundant in the altered host rock, rather than in quartz-rich masses) and a trace of chalcopyrite. Minor chalcopyrite occurs as part of the potassic alteration in STWD005/407.8 m, and small amounts of pyrite and trace chalcopyrite occur as part of the replacement assemblages in STWD006/108.3 m (with trace molybdenite), STWD006/167.2 m, STWD006/308.7 m and STWD006/322.6 m.

Alteration and mineralisation in some of the Toora West samples appear to have affinities with that found at porphyry Cu (-Mo) systems.

Regional

The three regional air core samples represent variably altered felsic igneous rocks. Primary characteristics are rather well preserved in STAC0018/82 m and STAC0019/25 m. The former is interpreted as a porphyritic dacite (containing plagioclase, quartz and possibly hornblende phenocrysts) and the latter is a leucocratic tonalite, dominated by plagioclase and quartz, and with minor biotite and K-feldspar. Sample STAC0013/68 m is intensely altered and replaced, but retains a few relict quartz phenocrysts and possible pseudomorphs after former feldspar phenocrysts. The protolith for this sample was a porphyritic, perhaps fine grained, felsic igneous rock.

In STAC0018/82 m, there are indications for initial mild potassic alteration, with interpreted original hornblende being replaced by secondary biotite. Subsequently, this rock had a retrograde overprint of argillic-propylitic type with development of minor sericite, chlorite and clay. STAC0019/25 m exhibits moderate propylitic alteration, with development of minor chlorite, epidote and albite, and a little sericite, prehnite, clay, pyrite and hematite. Intense sulphidic alteration was imposed on the protolith of STAC0013/68 m. This probably occurred at relatively low temperature and is manifest as abundant fine grained marcasite, in places fringed by pyrite, and with clay (maybe illite) locally developed (e.g. at former feldspar sites). No veining was observed in the regional air core samples, and sulphide mineralisation is dominated by Fe sulphides, e.g. abundant low-temperature marcasite in STAC0013/68 m, and a little disseminated pyrite in STAC0018/82 m.

Thursdays Gossan

Two of the three samples from Thursdays Gossan are interpreted to have had ultramafic composition protoliths (SMD130/181.6 m and SMD159/547.7 m). Despite intense hydrothermal alteration and replacement having occurred, both samples retain a minor amount of relict chromite (whose characteristics imply an ultimately harzburgite type of protolith) and a Mg-rich alteration assemblage. No other primary characteristics are preserved in these samples. The other sample from Thursdays Gossan is SMD158/520.6 m. It displays a contact between two texturally different intermediate igneous rocks (although primary compositions would have been similar). One is a rather coarse hornblende diorite, and the other is a porphyritic hornblende microdiorite, originally with plagioclase and brown hornblende phenocrysts in a fine grained plagioclase-rich groundmass. No criteria are recognised on the scale of the sample as to timing relations.

In ultramafic sample SMD130/181.6 m, there was replacement by an assemblage of talc, chlorite, Fe-poor sphalerite and minor amounts of carbonate (dolomite or magnesite) and pyrite, and a little chalcopyrite. Relict chromite locally shows fractures and slight replacement by magnetite. It is implied that there was strong hydrothermal addition of S, CO_2 and Zn (-Cu) into the protolith. In sample SMD159/547.7 m, there was replacement of the protolith (except for chromite, which might have experienced residual enrichment) by chlorite, pyrite, chalcopyrite and a little sphalerite. Again, there must have been considerable hydrothermal addition of S, Fe and Cu (-Zn) to the protolith. The diorite-microdiorite sample SMD158/520.6 m has strong alteration that could have occurred under low grade metamorphic conditions and involved Ca addition. There was replacement by varying amounts of prehnite, chlorite and albite, and a little epidote, and veining mostly by carbonate and prehnite.

The altered ultramafic rock samples have abundant sulphides as part of the replacement assemblages. In SMD130/181.6 m, patchily abundant Fe-poor sphalerite developed, with minor, paragenetically earlier pyrite. Sphalerite hosts considerable fine grained chalcopyrite (as “chalcopyrite disease” texture) as well as traces of galena and hematite. Marginal zones of sphalerite tend to be inclusion-free. In SMD159/547.7 m, abundant pyrite and chalcopyrite occur, with indications of initial deposition of paragenetically early coarse pyrite that was subsequently disaggregated (?brecciated) and invaded by disseminated through to almost massive finer grained pyrite, chalcopyrite and a little Fe-poor sphalerite. Chalcopyrite hosts a trace of millerite.

It is interpreted that the strong sulphide mineralisation in the two ultramafic host rocks is a variant of the replacement lode style manifest in the Cayley Lode. The Zn-rich type present in SMD130/181.6 m could represent a relatively low-temperature, more distal type of mineralisation.

Individual sample descriptions

STWD004 223.5 m TS

Summary: Porphyritic hornblende-quartz microdiorite, with moderate to strong propylitic alteration. Relict texture is well preserved and there is some retention of primary igneous minerals. The rock formerly contained scattered phenocrysts of plagioclase (some megacrystic), hornblende and few possible biotite, in a fine to medium grained groundmass rich in plagioclase, with lesser interstitial quartz, minor ferromagnesian material, K-feldspar and trace apatite, FeTi oxide and zircon. Pervasive alteration led to replacement of plagioclase by slightly turbid, hematite-pigmented albite, along with minor epidote, sericite, carbonate and chlorite. Primary ferromagnesian phases are replaced by chlorite, epidote, carbonate and a little titanite (although some hornblende is preserved) and in the groundmass, there is an assemblage of albite, with minor chlorite, epidote, carbonate and trace hematite. No sulphides are recognised and there is no veining on the scale of the section. The rock has some primary similarity that in sample STWD005/407.8 m (with the latter having secondary biotite development).

Handspecimen: The drill core sample is composed of a massive, moderately porphyritic, but otherwise fine grained intermediate to felsic composition igneous rock. It contains scattered subhedral megacrystic feldspar (plagioclase) phenocrysts up to 1.5 cm across of pink to creamy colour, as well as scattered dark grey-green ferromagnesian phenocrysts (e.g. hornblende) up to 4 mm long, hosted in a grey to slightly pinkish, feldspathic groundmass (Fig. 1). The rock could have moderate alteration with formation of sericite, chlorite and epidote, and is cut by a couple of fractures, coated thinly with pale yellowish sericite. Staining of the section offcut with sodium cobaltinitrite showed that there is a little K-feldspar in the groundmass. The sample is weakly magnetic, with susceptibility up to 90 x 10^{-5} SI.

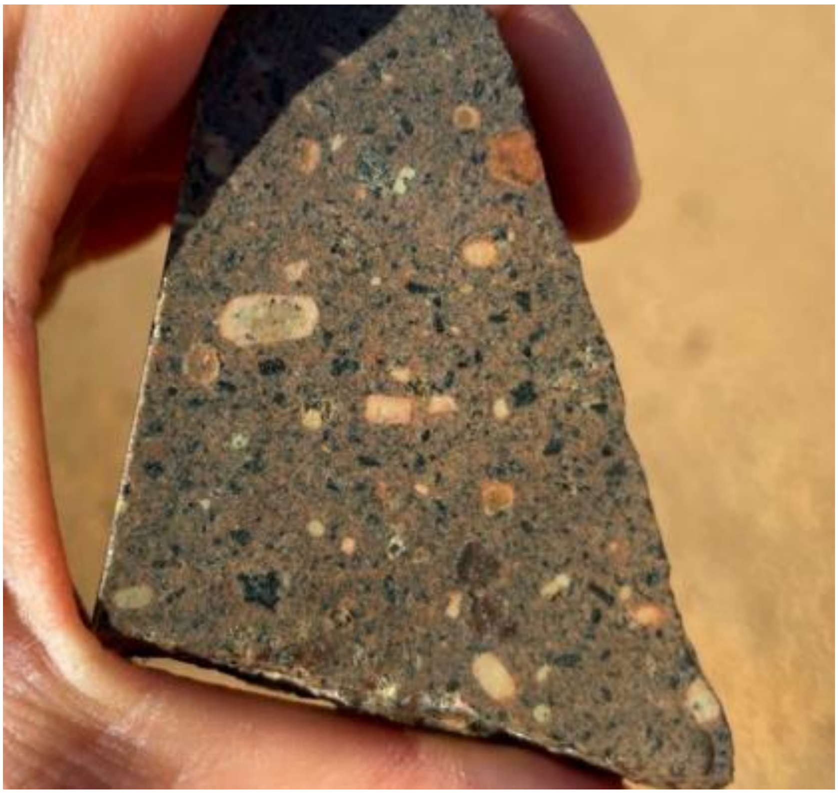


Fig. 1: Drill core sample of porphyritic hornblende-quartz microdiorite, with phenocrysts of plagioclase and hornblende in a feldspathic-dominated groundmass. There is pervasive moderate to strong alteration of propylitic type that has formed albite, chlorite and minor epidote, carbonate,

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock has moderate to strong pervasive alteration, but relict igneous texture is well preserved and there is some retention of primary igneous minerals (Fig. 2). There are scattered, altered blocky plagioclase phenocrysts up to >5 mm across and stubby, prismatic green hornblende phenocrysts up to 3 mm long (Fig. 2). There are a few pseudomorphic aggregates up to 2 mm across that are suggestive, from relict shapes, to have replaced former biotite phenocrysts. The phenocrystal phases occurred in a fine to medium grained groundmass with abundant small grains of slightly turbid plagioclase, lesser amounts of interstitial quartz, minor altered ferromagnesian material, K-feldspar and traces of FeTi oxide (e.g. magnetite), apatite (rare microphenocrysts to 0.8 mm) and zircon (Fig. 2). The preserved primary characteristics of the rock suggest that it was a porphyritic hornblende-quartz microdiorite.

b) Alteration and structure: Moderate to strong pervasive hydrothermal alteration has affected the igneous rock. All plagioclase (phenocrysts and groundmass) was replaced by slightly hematite-pigmented (turbid) albite, with minor epidote, carbonate, sericite and trace chlorite. There is considerable replacement of hornblende (and all prior biotite) by chlorite, with local epidote, carbonate and trace titanite (Fig. 2). In the groundmass, apart from albite development, there is minor chlorite and patchily distributed carbonate and epidote (aggregates up to 2 mm) and small, diffuse patches of hematite. The alteration is considered to be of propylitic type, occurring under rather oxidising conditions and involving hydrothermal CO_2 introduction. No veining was noted on the scale of the section and no sulphide minerals were recognised.

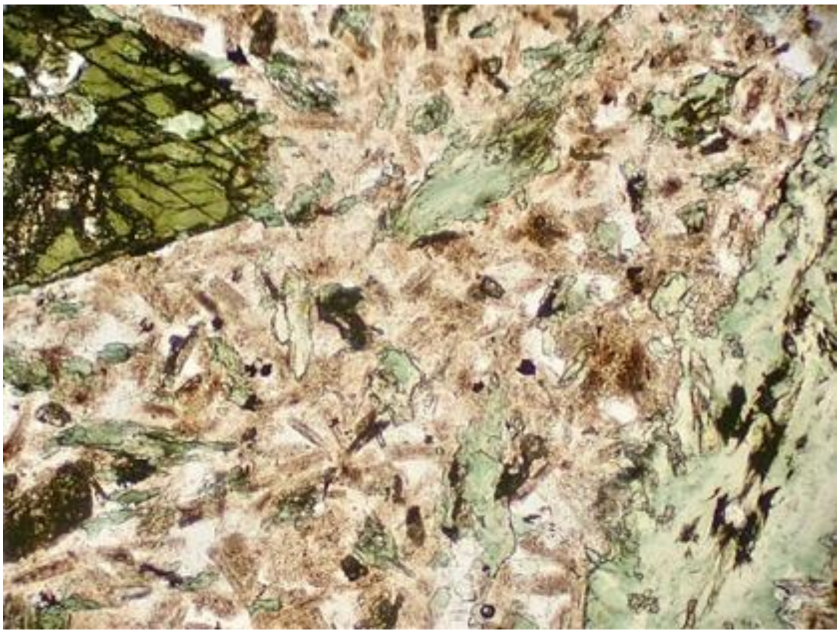


Fig. 2: Porphyritic microdiorite, with largely fresh hornblende phenocryst at upper left and a chloritized equivalent at right. The groundmass is composed of slightly turbid albite, minor interstitial quartz and chlorite-altered ferromagnesian grains. Plane polarised

c) Mineralisation: No sulphide minerals were recognised. There is a tiny trace of fine grained relict magnetite and a little hematite, as small diffuse patches and in albite, as part of the alteration.

Mineral Mode (by volume): plagioclase (albite) 65%, chlorite 15%, quartz 8%, epidote and carbonate each 3%, hornblende 2%, K-feldspar, sericite and hematite each 1% and traces of apatite, magnetite, zircon and titanite.

Interpretation and comment: It is interpreted that the sample represents a moderately to strongly altered porphyritic hornblende-quartz microdiorite, showing considerable preservation of primary characteristics. It contained scattered phenocrysts of plagioclase (some megacrystic), hornblende and possible biotite, in a fine to medium grained groundmass rich in plagioclase, with lesser interstitial quartz, minor ferromagnesian material, K-feldspar and trace apatite, FeTi oxide and zircon. Pervasive propylitic alteration was imposed, causing replacement of plagioclase by slightly turbid, hematite-pigmented albite, along with minor epidote, sericite, carbonate and chlorite. Primary ferromagnesian phases are replaced by chlorite, epidote, carbonate and a little titanite (although some hornblende is preserved) and in the groundmass, there is an assemblage of albite, with minor chlorite, epidote, carbonate and trace hematite. No sulphides are recognised and there is no veining on the scale of the section. The rock is similar to sample STWD005/407.8, but the latter is more altered, with secondary biotite development.

STWD005 287.1 m PTS

Summary: Sample is largely composed of vein infill, with small, adhering zones of intensely hydrothermally altered host rock. The latter has no recognised relict characteristics and its original nature remains obscure. It was replaced by quartz and minor to locally abundant sericite, chalcopyrite and traces of tetrahedrite, pyrite and molybdenite. Vein infill is dominated by coarse quartz (commonly zoned), with patches of interstitial chalcopyrite, locally intergrown tetrahedrite and traces of pyrite and molybdenite. There was subsequent fracturing of the quartz-sulphide infill and emplacement of a few irregular veins of "epithermal texture" fine grained quartz, grading to chalcedonic and opaline types, and with a little associated sericite and Fe-poor sphalerite in places.

Handspecimen: The drill core sample is composed largely of vein material (Fig. 3). A quartz-sulphide vein, perhaps at least 2 cm wide, occupies most of the sample and is oriented at ~75° to the core axis (Fig. 3). It appears to be locally bordered by fine grained grey to pale creamy-grey, intensely altered host rock (e.g. containing sericite, quartz and sulphides) (Fig. 3). The vein is dominated by coarse milky quartz, with aggregates of chalcopyrite up to 2 cm across, small amounts of a silvery-grey sulphide (perhaps tetrahedrite) and pyrite (Fig. 3). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

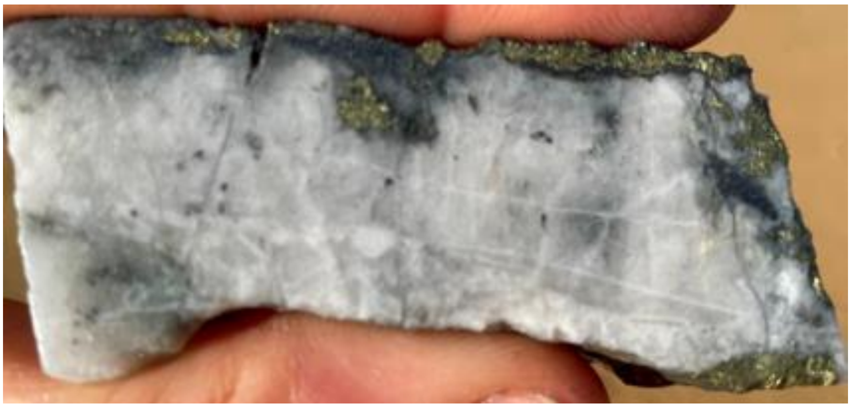


Fig. 3: Drill core sample of dominant milky vein quartz, with patches of chalcopyrite and associated minor tetrahedrite. Band at top represents intensely altered host rock.

Petrographic description

a) Primary rock characteristics: In the section, most of the sample (80-90%) represents vein infill. Along both sides of the vein are discontinuous zones up to a few millimetres wide of intensely altered material interpreted as former host rock. No recognised relict primary characteristics occur, with this material now dominated by fine through to medium grained quartz, patchily abundant sericite and chalcopyrite, and traces of tetrahedrite, molybdenite and pyrite (Fig. 4). The primary nature of the host rock remains obscure.

b) Alteration and structure: The domains of possible former host rock adhering to the vein were intensely replaced by varying proportions of fine through to medium grained quartz, patchily abundant sericite and chalcopyrite, and traces of tetrahedrite, molybdenite, pyrite and rare rutile (Fig. 4) (silicic to phyllic alteration). Vein infill is dominated by medium grained to very coarse quartz (>1 cm in places, commonly with zoning), and with irregularly scattered interstitial patches of chalcopyrite and/or (subordinate) tetrahedrite up to several millimetres across, and traces of molybdenite and pyrite (Figs 4, 5, 6). Subsequently, coarse quartz was fractured and invaded by later infill of "epithermal texture" finely granular quartz, grading to sub-radiating and crustiform chalcedonic quartz and local opaline silica infill (Fig. 4). Locally, these later veins, which are up to 1 mm wide, also contain small patches of sericite and fine grained Fe-poor sphalerite.

c) Mineralisation: In the intensely altered host rock domains, there is locally abundant chalcopyrite (and minor tetrahedrite, molybdenite) concentrated along vein margins in sericite-rich zones. Molybdenite tends to be intergrown finely with sericite, in flakes up to 0.1 mm across, adjacent to chalcopyrite (Fig.

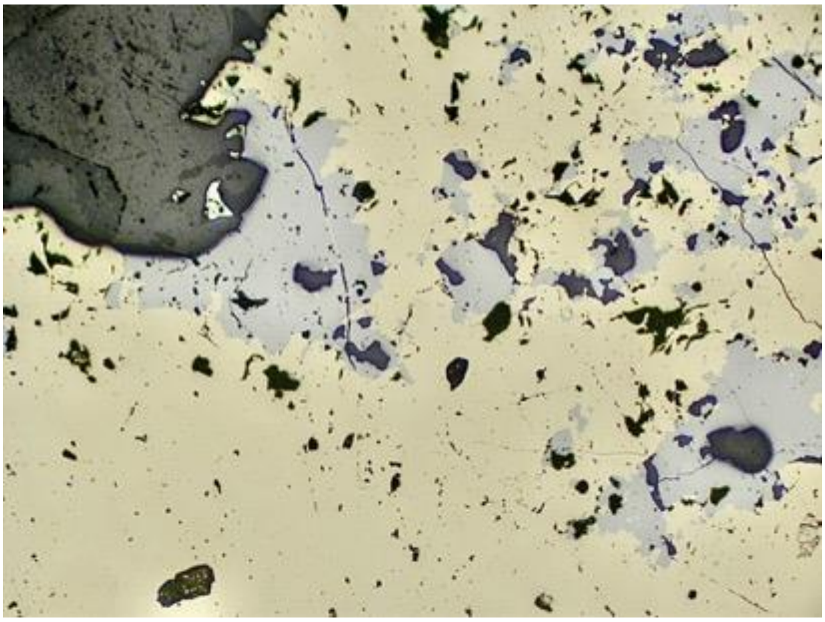
6). In the quartz-rich vein infill, patchy interstitial zones of chalcopyrite are up to several millimetres across, and can be associated with substantial amounts of tetrahedrite. There are also a couple of discrete masses of tetrahedrite. A little pyrite, in aggregates up to 0.5 mm across, occurs as inclusions in chalcopyrite (-tetrahedrite) aggregates. Molybdenite also occurs as rare discrete aggregates in quartz, but adjacent to chalcopyrite. In the later "epithermal texture" veining cutting coarse quartz, there are a couple of small aggregates of fine grained, Fe-poor sphalerite.

Mineral Mode (by volume): quartz (including chalcedonic material and opaline silica) 85%, chalcopyrite 7%, sericite 6%, tetrahedrite 1% and traces of pyrite, sphalerite, molybdenite and rutile.

Fig. 4: Quartz-sericite-altered host rock (left) abutting coarse vein infill (right and lower) consisting of quartz and interstitial tetrahedrite (black), and cut by a later crustiform texture vein of chalcedonic quartz and banded opaline silica infill (black). Transmitted light, crossed polarisers, field of

Interpretation and comment: It is interpreted that the sample is mostly vein infill, with small, adhering zones of intensely hydrothermally altered host rock that has no recognised relict characteristics and its original nature remains obscure. It was replaced by quartz and minor to locally abundant sericite, chalcopyrite and traces of tetrahedrite, pyrite and molybdenite. Vein infill is mostly coarse quartz (commonly zoned), with patches of interstitial chalcopyrite, associated subordinate tetrahedrite and traces of pyrite and molybdenite. There was subsequent fracturing of the quartz-sulphide infill and emplacement of a few irregular veins of "epithermal texture" fine grained quartz, grading to chalcedonic and opaline types, and with a little associated sericite and Fe-poor sphalerite in places.

Fig. 5: Vein infill mass of chalcopyrite (yellow), with intergrown tetrahedrite (pale olive grey), and at upper left, dark quartz. Plane polarised reflected light, field of view 2 mm across.



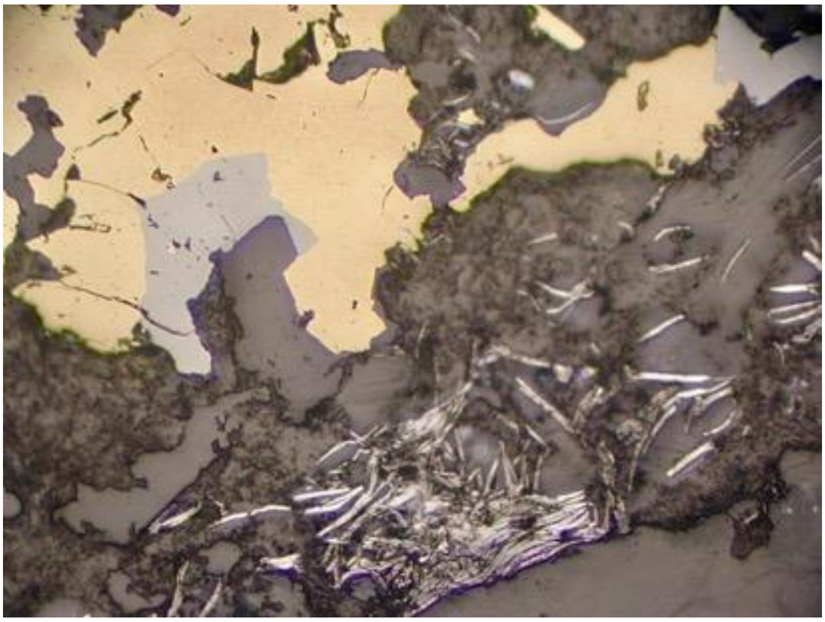


Fig. 6: Aggregate of flaky molybdenite (silvery grey, lower) intergrown with sericite, and adjacent to a composite aggregate of chalcopyrite (yellow) and tetrahedrite (pale grey). Plane polarised reflected light, field of view 0.5 mm across.

<u>STWD005 407.8 m PTS</u>

Summary: Pervasively and strongly altered porphyritic hornblende-biotite-quartz microdiorite. The rock retains large plagioclase phenocrysts, but most original phenocrysts of hornblende and (igneous) biotite are altered, replaced by secondary biotite and small amounts of quartz, chalcopyrite and pyrite. The rock had an original rather fine grained groundmass of plagioclase and ferromagnesian material, minor interstitial quartz, a little K-feldspar and apatite. Imposed alteration was initially of potassic type (secondary biotite), accompanied by thin veining by chalcopyrite ± quartz. Subsequently, moderate retrograde alteration was imposed, with chlorite ± clay being developed from primary and secondary biotite, and sericite ± clay from plagioclase phenocrysts. The rock has some primary similarities to that in STWD004/223.5 m, but differs in that secondary biotite development is strong.

Handspecimen: The drill core sample is composed of a massive, porphyritic, intermediate to felsic composition igneous rock (Fig. 7). It contains scattered white feldspar (plagioclase) phenocrysts up to 1 cm across and a few smaller dark phenocrysts of ferromagnesian material up to several millimetres across in a rather fine grained groundmass. Although likely of feldspathic composition, the groundmass has strong pervasive development of biotite and the ferromagnesian phenocrysts could also be replaced by biotite and traces of chalcopyrite and pyrite (Fig. 7). A single thin chalcopyrite vein <0.5 mm wide is observed. Staining of the section offcut with sodium cobaltinitrite showed that there is a little K-feldspar in the groundmass. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 7: Drill core sample of altered porphyritic hornblende-biotite-quartz microdiorite, with prominent white phenocrysts of plagioclase. There are also a few dark altered ferromagnesian phenocrysts, with the dark colour of the rather feldspathic groundmass due to development of fine grained secondary biotite. Thin vein at right contains chalcopyrite.

Petrographic description

a) Primary rock characteristics: In the section, it is evident that the rock is strongly hydrothermally altered, but there is considerable retention of primary porphyritic texture and some preservation of primary minerals. There are scattered, mostly fresh, blocky plagioclase phenocrysts up to 1 cm across (commonly zoned) along with mostly altered phenocrysts of biotite and altered hornblende (each up to 2.5 mm across) and a few of quartz (up to 2 mm) and uncommon microphenocrysts of apatite up to 0.8 mm long (Figs 8, 9). A trace of fresh hornblende and trace magnetite is preserved in quartz phenocrysts, but all other hornblende is altered, resulting in formation of pseudomorphs (Fig. 9). The phenocrystal phases occur in a rather fine grained groundmass with abundant plagioclase, subordinate ferromagnesian material (now altered), interstitial quartz, minor K-feldspar and trace apatite (Figs 8, 9).

The primary characteristics of the rock indicate that it represents a porphyritic hornblende-biotite-quartz microdiorite. It has textural and compositional similarities to STWD004/223.5 m.

b) Alteration and structure: There was pervasive strong development of hydrothermal (secondary) biotite in the groundmass, and replacing primary hornblende and biotite phenocrysts (Figs 8, 9). Biotite development is accompanied by formation of a little disseminated chalcopyrite and less common pyrite. There was also emplacement of a couple of chalcopyrite ± quartz veins up to 0.4 mm wide (Fig. 10). The rock appears to have subsequently experienced moderate retrograde alteration. This is manifest in local patchy replacement of plagioclase phenocrysts by fine grained sericite and low-birefringent clay (e.g. kaolinite) and replacement of primary and secondary biotite by chlorite ± clay. Overall alteration in the rock is of potassic (biotite) type, with a mild argillic overprint.

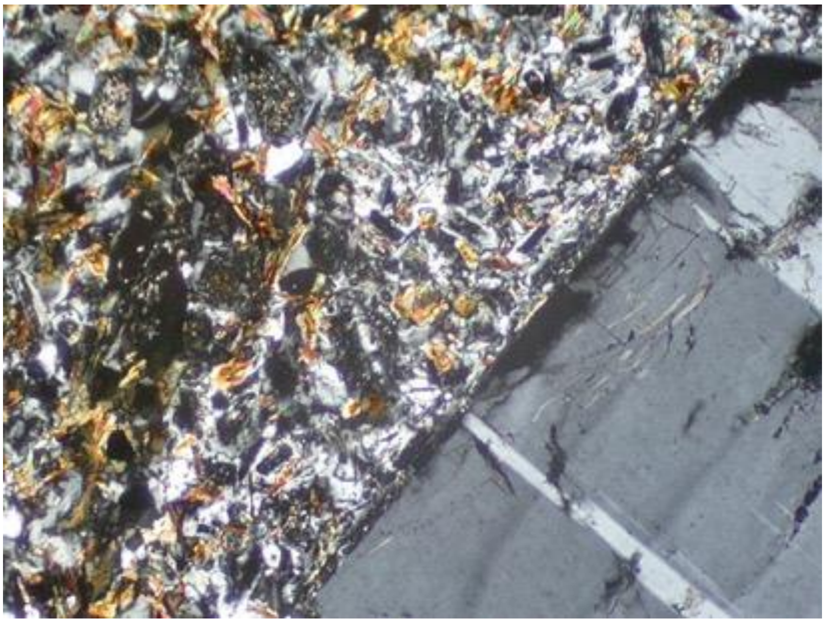
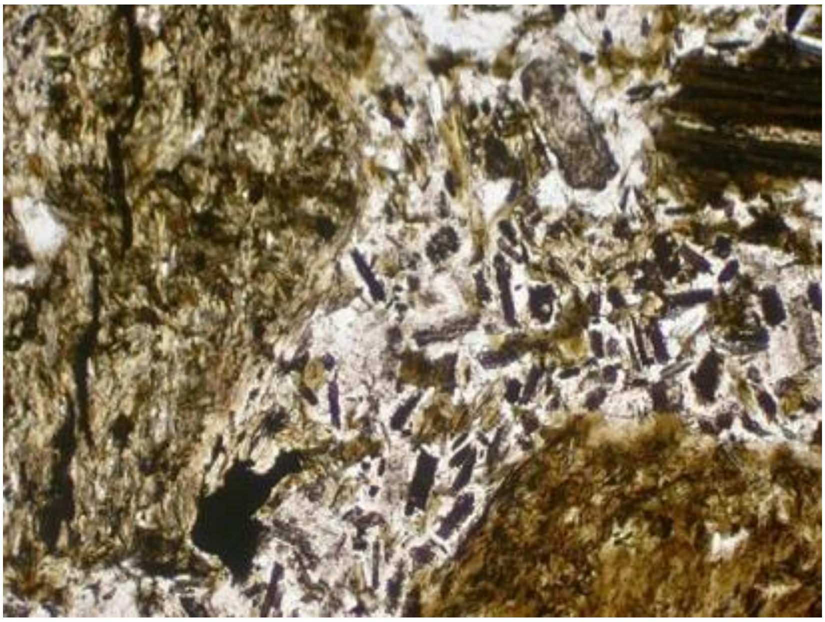


Fig. 8: Part of a fresh plagioclase phenocryst (right) abutting against groundmass material with abundant small plagioclase grains, interstitial secondary biotite (brownish) and a little quartz. Transmitted light, crossed polarisers, field of

c) Mineralisation: As part of the initial potassic alteration, a little chalcopyrite and less common pyrite, each forming aggregates up to 0.5 mm across, were deposited, commonly at altered ferromagnesian sites and in the groundmass. A chalcopyrite (-quartz) vein up to 0.4 mm wide was emplaced (Fig. 10), locally intersecting with another thin chalcopyrite vein.

<u>Mineral Mode (by volume)</u>: plagioclase 60%, biotite 25%, quartz 7%, chalcopyrite, chlorite and sericite each 2%, clay and K-feldspar each 1% and traces of hornblende, magnetite, apatite and pyrite.

Fig. 9: Pseudomorphic aggregates of secondary biotite after former hornblende phenocrysts (left and lower right) and a dark, relict biotite phenocryst (upper right) in a finer grained groundmass of plagioclase, quartz and secondary biotite. The black grain at lower left is chalcopyrite. Plane



Interpretation and comment: It is interpreted that the sample is a porphyritic hornblende-biotite-quartz microdiorite with strong potassic (biotite) alteration. Large plagioclase phenocrysts are retained, but most original phenocrysts of hornblende and (igneous) biotite are altered to secondary biotite and small amounts of quartz, chalcopyrite and pyrite. The rock had an original rather fine grained groundmass of plagioclase and ferromagnesian material, minor interstitial quartz, a little K-feldspar and apatite. Potassic alteration was accompanied by thin veining by chalcopyrite ± quartz. Subsequently, moderate retrograde (argillic) alteration was imposed, with chlorite ± clay being developed from primary and secondary biotite, and sericite ± clay from plagioclase phenocrysts. The rock has some primary similarities to that in STWD004/223.5 m, but differs in that secondary biotite development is strong.

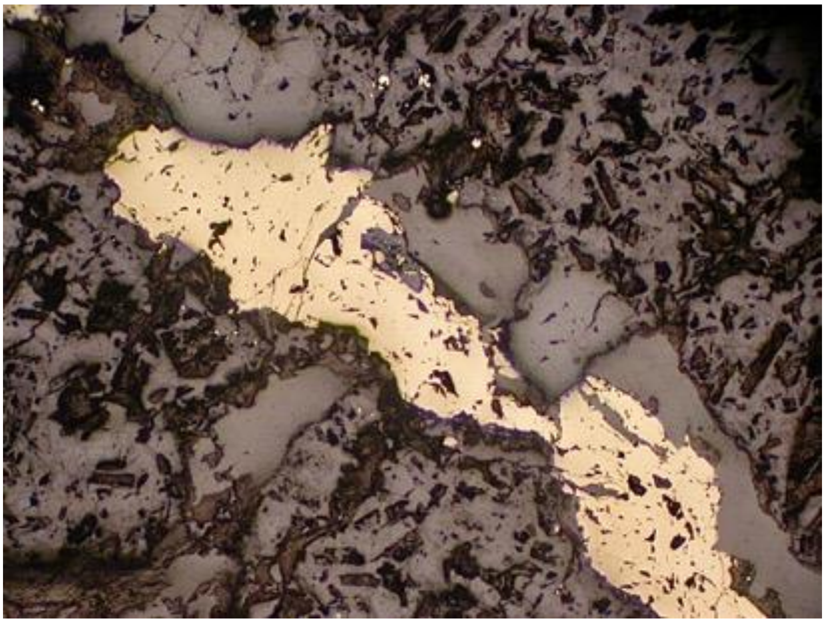


Fig. 10: Vein of chalcopyrite (yellow) and quartz, cutting altered microdiorite. Plane polarised reflected light, field of view 2 mm across.

STWD006 108.3 m PTS

Summary: Intercalation of zones of medium grained albite and quartz, with coarse grained quartz-rich material, maybe representing the transition between fluid-rich late magmatic, crystallisation of a leucocratic granitic rock, and hydrothermal infill. The texture is analogous to "brain rock". Albite and quartz are commonly intergrown in graphic texture, with albite being variably replaced by fine to medium grained sericite-muscovite. There are also traces of chalcopyrite, pyrite, rutile and molybdenite, mostly associated with sericite aggregates. There is a gradation from albite-quartz zones into the quartz-rich zones, with the latter locally having aggregates of sericite and a few individual grains of pyrite and associated trace chalcopyrite.

Handspecimen: The drill core sample is composed of a mass of intercalated pale creamy coloured feldspar + quartz zones and pale grey, semi-translucent coarse grained quartz aggregates (Fig. 11). The latter are up to 2 cm across and locally contain individual grains and clusters of pyrite and chalcopyrite up to a few millimetres across, along with one or two voids and aggregates of sericite. In the feldspar + quartz zones, there is apparent local replacement of feldspar by sericite and traces of pyrite and chalcopyrite. A single fracture cuts the rock at a moderate angle to the core axis, and is thinly coated by fine grained yellowish sericite. The texture of the rock could be indicative of crystallisation conditions transitional between late magmatic and hydrothermal. 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 x 10^{-5} SI.

Fig. 11: Drill core sample of intercalated texture with pale creamy, medium grained albite + quartz, with pale grey hydrothermal quartz-rich infill. Albite has variable replacement by sericite-muscovite. There is a little pyrite in quartz, and traces of chalcopyrite, pyrite and molybdenite associated with altered albite.

Petrographic description

a) Primary rock characteristics: In the section, there is an intercalation of zones up to 2.5 cm across, dominated by coarse grained quartz (up to 1 cm grainsize) with zones of largely medium grained (locally coarser) albite + quartz, with these zones grading into one another. The albite-quartz zones have rather coarse graphic texture, with individual irregular albite grains up to 2 mm across (Fig. 12). It could be speculated that some albite might have replaced prior K-feldspar, but there is no confirmation (optically or by staining) that any K-feldspar is present. It is interpreted that the texture and composition of the rock could represent the transition between fluid-saturated, late magmatic crystallisation of a leucocratic granitic rock, and hydrothermal quartz-rich infill.

b) Alteration and structure: The graphic texture albite-quartz rock might have formerly contained K-feldspar, since replaced by albite, although no K-feldspar is recognised. Subsequently, albite was variably replaced by fine to medium grained sericite-muscovite (i.e. a type of greisen alteration) with traces of associated chalcopyrite, pyrite, rutile and molybdenite (Fig. 13). Interpreted quartz-rich infill is coarse grained and contains abundant primary and pseudosecondary fluid inclusions up to 20 µm across, with these typically being 2-phase, liquid > vapour types. In the quartz-rich zones, there are a couple of included aggregates of sericite, as well as individual grains of pyrite, with trace associated chalcopyrite (Fig. 14), and rare rutile. Where sericite was removed during section preparation, there are one or two voids.

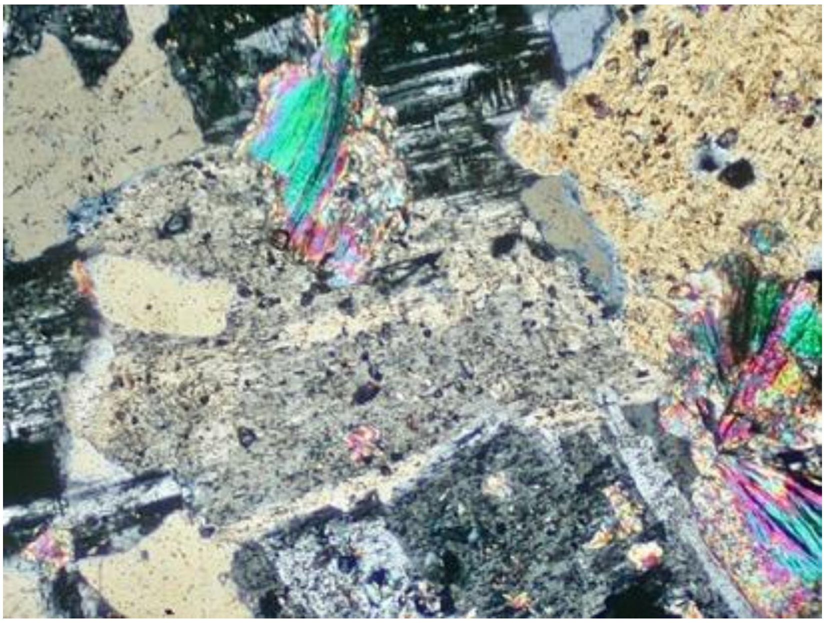


Fig. 12: Intergrown albite and quartz, with local replacement of albite by rosettes of sericite-muscovite. There is a tendency for graphic texture development between albite and quartz. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: In the quartz-rich infill, there are a couple of pyrite grains up to 2 mm across, one of which has a few small attached grains of chalcopyrite (Fig. 14). A little chalcopyrite and pyrite (locally in small composites) occur in sericite-altered albite, and one sericite aggregate has a few small clusters of fine grained molybdenite flakes (Fig. 13).

Mineral Mode (by volume): quartz 65%, albite 30%, sericite-muscovite 4%, pyrite 1% and traces of chalcopyrite, rutile and molybdenite.

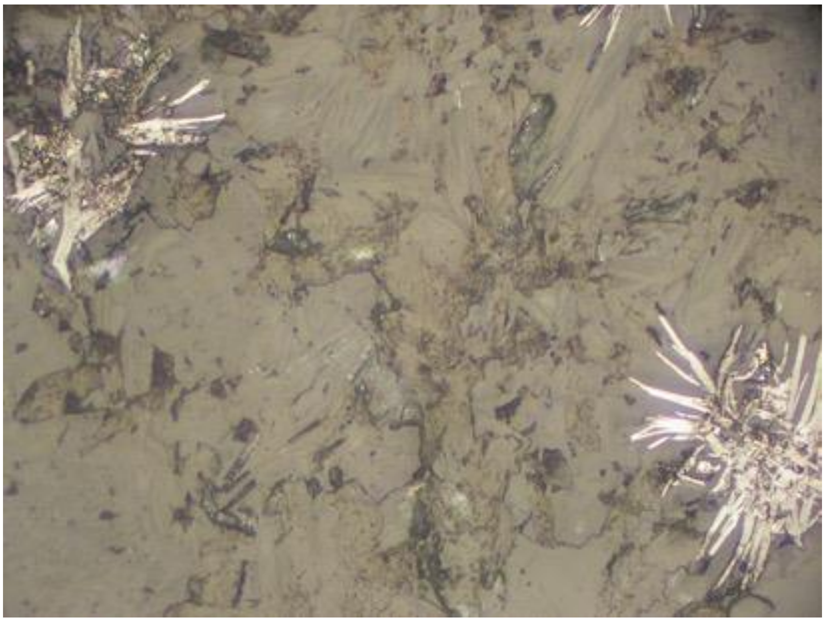


Fig. 13: Small sub-radiating clusters of flaky molybdenite (silvery grey) in a sericite-rich alteration patch. Plane polarised reflected light, field of view 0.5 mm across.

<u>Interpretation and comment</u>: It is interpreted that the sample represents an intercalation between zones of medium grained albite and quartz, and coarse grained quartz-rich material, maybe representing the transition between fluid-rich, late magmatic crystallisation of a leucocratic granitic rock, and hydrothermal infill. The texture is analogous to "brain rock". Albite and quartz are commonly intergrown in graphic texture, with albite being variably replaced by sericite-muscovite (greisen alteration). There are also traces of chalcopyrite, pyrite, rutile and molybdenite, mostly associated with sericite aggregates. There is a gradation from albite-quartz zones into the quartz-rich zones, with the latter locally having aggregates of sericite and a few individual grains of pyrite and associated trace chalcopyrite.

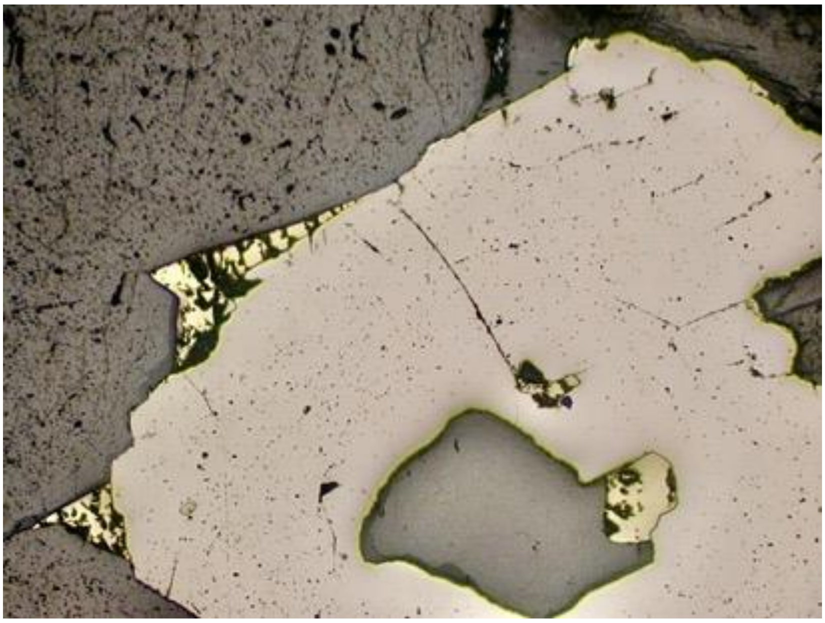


Fig. 14: Large pyrite (pale creamy) with small, attached chalcopyrite (pale yellow) grains, hosted in quartz-rich hydrothermal infill. Plane polarised reflected light, field of view

STWD006   128.2 m   TS

Summary: Strongly porphyritic hornblende (-quartz-biotite) microdiorite. The rock has scattered large plagioclase phenocrysts, with prismatic to blocky green hornblende, and a few smaller phenocrysts of biotite, quartz and apatite. Hornblende also forms small clusters (possible micro-enclaves). The phenocrystal phases occur in a fine grained groundmass dominated by plagioclase and with minor hornblende, biotite, quartz and K-feldspar. The rock is little-altered, with small amounts of sericite (from plagioclase) and chlorite (from ferromagnesian phases) occurring. Only a single grain of pyrite was observed. The rock has primary textural and mineralogical affinities with samples STWD004/223.5 m and STWD005/407.8 m.

Handspecimen: The drill core sample is composed of a strongly porphyritic intermediate to felsic igneous rock. It contains prominent white feldspar (plagioclase) phenocrysts up to 1 cm across and dark grains of likely hornblende up to several millimetres long in a fine grained grey groundmass (Fig. 15). Although probably considerably feldspathic in composition, the groundmass evidently contains minor ferromagnesian material. Staining of the section offcut with sodium cobaltinitrite showed that there is a little K-feldspar in the groundmass. The rock appears to be relatively fresh, with little indication of replacement of igneous minerals. The sample is moderately magnetic, with susceptibility up to 170 x 10^{-5} SI.

Fig. 15: Drill core sample of porphyritic hornblende (-quartz-biotite) microdiorite. Large plagioclase phenocrysts are accompanied by dark, elongate hornblende phenocrysts in a fine grained, grey, feldspathic-dominated groundmass.

Petrographic description

a) Primary rock characteristics: In the section, the rock is relatively fresh and has a crowded porphyritic texture (Fig. 16). There are scattered blocky to tabular plagioclase phenocrysts up to 1 cm across (in places zones), along with prismatic to blocky green hornblende phenocrysts up to 6 mm long (Fig. 16). Hornblende also occurs in a few aggregates of smaller grains, with trace of associated magnetite, with these aggregates possibly representing micro-enclaves. The rock also hosts a few quartz phenocrysts up to 1,5 mm across, biotite up to 2.5 mm and a few smaller apatite grains up to 1 mm long. The phenocrystal phases are hosted in a fine (to locally medium) grained groundmass that is rich in plagioclase, with minor amounts of hornblende, biotite, quartz and K-feldspar, and traces of apatite, magnetite, titanite, zircon and possible ilmenite (Fig. 16). The mineralogy and texture of the rock indicate that it is a porphyritic hornblende (-quartz-biotite) microdiorite. It clearly has textural and mineralogical affinities with samples STWD004/223.5 m and STWD005/407.8 m.

b) Alteration and structure: Only minor, mild alteration was imposed on the igneous rock. Alteration is of propylitic type and manifest in local replacement of biotite by chlorite and trace epidote, and plagioclase phenocrysts by patch fine grained sericite. A few of the hornblende clusters have replacement by chlorite, and possible former rare grains of ilmenite are largely altered to leucoxene. A single grain of pyrite is observed and could be a result of imposed alteration.

c) Mineralisation: A few grains of magnetite up to 0.5 mm across occur, associated with hornblende, and texturally of magmatic crystallisation. A single grain of pyrite ~0.6 mm across is observed and could be part of the imposed alteration.

<u>Mineral Mode (by volume)</u>: plagioclase 65%, hornblende 20%, quartz 6%, biotite 3%, K-feldspar 2%, apatite, sericite and chlorite each 1% and traces of magnetite, ilmenite, leucoxene, titanite, zircon, epidote and pyrite.

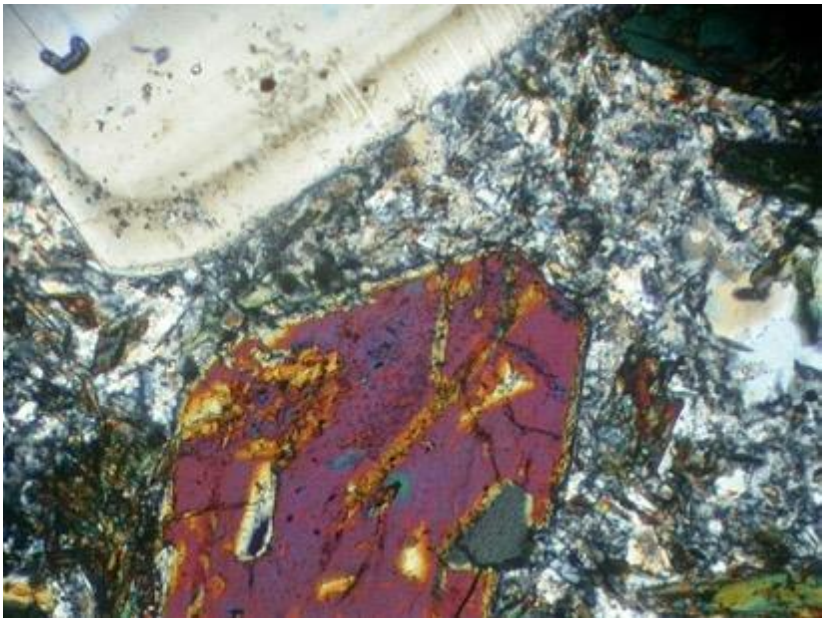


Fig. 16: Typical texture of microdiorite, with part of a large zoned plagioclase phenocryst at top and a subhedral phenocryst of hornblende. The finer grained groundmass contains abundant plagioclase, with minor quartz, hornblende, biotite and K-feldspar. Transmitted light, crossed polarisers, field

<u>Interpretation and comment</u>: It is interpreted that the sample is a slightly altered, strongly porphyritic hornblende (-quartz-biotite) microdiorite. It contains large plagioclase phenocrysts, with prismatic to blocky green hornblende, and a few smaller phenocrysts of biotite, quartz and apatite. Hornblende also forms small clusters (possible micro-enclaves). The phenocrystal phases occur in a fine grained groundmass with abundant plagioclase, minor hornblende, biotite, quartz and K-feldspar. Only localised mild propylitic alteration effects are apparent, with small amounts of sericite (from plagioclase) and chlorite (from ferromagnesian phases) occurring. Only a single grain of pyrite was observed. The rock has primary textural and mineralogical affinities with samples STWD004/223.5 m and STWD005/407.8 m.

STWD006 167.2 m PTS

Summary: Medium to coarse grained, rather leucocratic biotite tonalite, with moderate propylitic alteration. The rock contains abundant plagioclase, interlocking with subordinate quartz and flaky biotite, in places occurring in clusters. Imposed alteration led to considerable replacement of biotite by chlorite, pyrite and carbonate, with trace rutile and titanite. Plagioclase generally shows minor patchy replacement by sericite, carbonate, albite and trace prehnite. Apart from occurring at altered biotite sites, pyrite is also found interstitially to primary igneous minerals, forming irregular aggregates.

Handspecimen: The drill core sample is composed of a massive, pale grey, medium to coarse grained granitic rock (Fig. 17). It has a phaneritic texture, with abundant white to pale grey feldspar (plagioclase), intergrown with subordinate semi-translucent pale grey quartz and minor dark grey-green altered ferromagnesian material (perhaps formerly biotite). There is likely alteration of the ferromagnesian phase to chlorite, and locally, there are associated aggregates of pyrite up to several millimetres across (Fig. 17). Staining of the section offcut with sodium cobaltinitrite showed that there is a trace of K-feldspar. The rock is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 17: Drill core sample of massive tonalite. Dark patches are largely altered biotite (mostly replaced by chlorite) and associated with a few pyrite aggregates.

Petrographic description

a) Primary rock characteristics: In the section, there is considerable preservation of primary igneous texture and minerals. The rock is a type of rather leucocratic granitoid, containing abundant anhedral to blocky plagioclase (individual grains up to 4 mm across and locally zoned), interlocking with subordinate quartz (up to 2 mm) and biotite (individual flakes up to 2 mm long and locally forming clusters) (Fig. 18). There is also a trace of interstitial K-feldspar and rare apatite (up to 0.5 mm) and zircon. The primary texture and mineralogy indicate that the rock is a relatively leucocratic biotite tonalite.

b) Alteration and structure: Moderate pervasive alteration was imposed on the igneous rock. Considerable alteration of biotite has occurred, with replacement by chlorite, with local grains and aggregates of pyrite (Fig. 19), a little carbonate and trace rutile and titanite. Although much plagioclase remains fresh, there are patches with significant replacement by albite, fine grained sericite, carbonate and trace prehnite (Fig. 18). Scattered aggregates of pyrite up to several millimetres across occur, commonly associated with altered biotite (Fig. 19), but also occurring interstitially to plagioclase, quartz and biotite. The alteration is interpreted as being of propylitic type, with evident hydrothermal introduction of CO_2 and S.

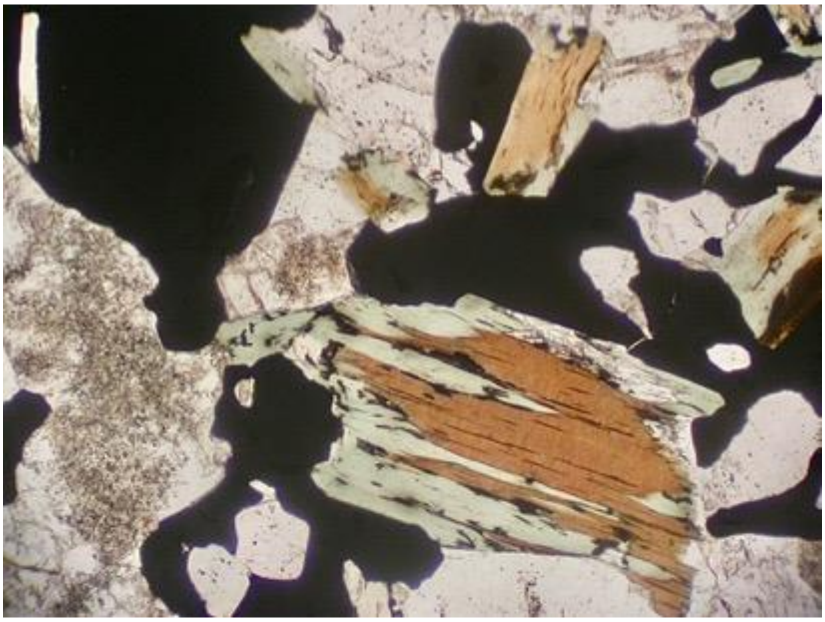
c) Mineralisation: Minor pyrite has formed as part of the alteration, commonly associated with altered biotite sites (Fig. 19), but also found elsewhere interstitial to primary minerals. Individual pyrite grains are up to 1.5 mm across (with very rare tiny inclusions of pyrrhotite and chalcopyrite) and with clusters up to several millimetres across.

Mineral Mode (by volume): plagioclase (includes albite) 65%, quartz 20%, chlorite 6%, pyrite 3%, biotite and sericite each 2%, carbonate 1% and traces of apatite, zircon, rutile, titanite, prehnite, chalcopyrite and pyrrhotite.

Fig. 18: Typical texture of tonalite, with slightly sericitised plagioclase (left and lower right) intergrown with quartz and biotite (right). There is slight alteration of biotite to carbonate and chlorite. Transmitted light, crossed polarisers, field of view 2

Interpretation and comment: It is interpreted that the sample represents a moderately altered biotite tonalite. It is medium to coarse grained and rather leucocratic, containing abundant plagioclase, interlocking with subordinate quartz and biotite, in places occurring in clusters. Imposed alteration of propylitic type caused considerable replacement of biotite by chlorite, pyrite and carbonate, with trace rutile and titanite. Plagioclase has minor patchy replacement by sericite, carbonate, albite and trace prehnite. Apart from occurring at altered biotite sites, pyrite is also found interstitially to primary igneous minerals, forming irregular aggregates.

Fig. 19: Cluster of biotite grains, partly replaced by pale green chlorite and having an associated large aggregate of pyrite (black). Plagioclase at left is turbid due to mild sericite replacement. Plane polarised transmitted light, field of view 2 mm across.



STWD006 172.8 m PTS

Summary: Intensely hydrothermally altered rock, perhaps originally of granitoid (e.g. tonalite) type and possibly having been rich in plagioclase. It was replaced by initial albite, with subsequent overprinting by sericite-muscovite, carbonate (calcite), chlorite, pyrite, a little molybdenite and trace rutile. There was invasion of the altered rock by medium to coarse grained quartz-rich, grading to pyrite-rich masses, with minor associated albite, overprinting sericite-muscovite, carbonate, a little chlorite and trace molybdenite. Traces of chalcopyrite also occur, mostly associated with pyrite. There is no evidence, on the scale of the section, for molybdenite to be paragenetically later than quartz and pyrite.

Handspecimen: The drill core sample is composed of an intensely hydrothermally altered rock, invaded by irregular to veinlike masses of pale grey to milky quartz up to several centimetres wide that locally contain medium to coarse grained aggregates of pyrite up to 2.5 cm across and a little molybdenite (Fig. 20). Zones of probable original host rock are grey to pale orange in colour, with no definite relict texture observed (Fig. 20). They could contain considerable feldspar, patchy fine grained sericite, pyrite, carbonate and a little disseminated molybdenite (Fig. 20). Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. The rock is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 20: Drill core sample of intensely altered and veined rock. There are diffuse veinlike patches of milky quartz and coarse pyrite that have invaded the host rock, now replaced by albite (pale orange), sericite-muscovite, carbonate (calcite), chlorite, pyrite and a little molybdenite.

Petrographic description

a) Primary rock characteristics: In the section, it is evident that the host rock is intensely altered and invaded by irregular masses containing quartz and/or pyrite, along with local carbonate, albite, sericite-muscovite, chlorite, molybdenite and trace chalcopyrite. Interpreted former host rock domains are up to a few centimetres across and generally have no diagnostic relict texture. In a few places, however, it is possible that original medium to coarse grained, inequigranular texture is retained, with the rock having been plagioclase-rich, perhaps with minor ferromagnesian material (e.g. biotite), a little quartz, and traces of FeTi oxide (now altered), zircon and apatite. It is speculated that the protolith was of granitoid type, e.g. tonalite.

b) Alteration and structure: An interpreted granitoid protolith was intensely hydrothermally altered and replaced by fine through to locally rather coarse albite, which in turn was replaced by variably abundant sericite-muscovite, carbonate (calcite), local chlorite, quartz, patchy minor to locally abundant pyrite, a little molybdenite and traces of rutile and chalcopyrite (Figs 21, 22, 23). Probably coeval with alteration, there was invasion by irregular masses of fine grained through to coarse grained quartz, pyrite, with minor intergrown albite, carbonate, chlorite, sericite-muscovite and traces of molybdenite and chalcopyrite. It is interpreted that initial alteration of the host rock was of sodic type, but with evolution to an intense type transitional between propylitic and phyllic, with evident hydrothermal introduction of S, CO_2, Fe and Mo, and mobility of Ca, Na and K.

c) Mineralisation: Coarse grained pyrite aggregates are up to a few centimetres across and hosted in quartz as well as the altered host rock. Pyrite hosts a few small inclusions of chalcopyrite and rare pyrrhotite, and there also one or two discrete grains of chalcopyrite up to 0.4 mm across associated with pyrite (Fig. 23). Molybdenite forms small, fine grained aggregates up to 1 mm across, mostly in the altered host rock and at the margins of pyrite masses (Fig. 22). There is only a little disseminated magnetite hosted in quartz-rich masses. There is no evidence, on the scale of the section, for quartz-molybdenite veining of an earlier quartz-pyrite-feldspar assemblage.

Mineral Mode (by volume): quartz 35%, pyrite 20%, plagioclase (albite) 15%, sericite-muscovite 13%, carbonate (calcite) 10%, chlorite 5%, molybdenite 1% and traces of rutile, zircon, apatite, chalcopyrite and pyrrhotite.

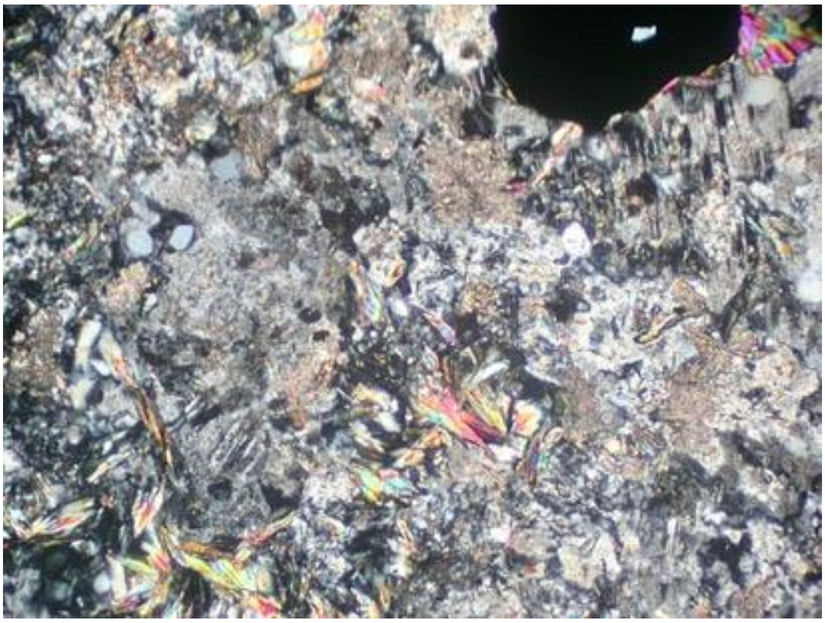
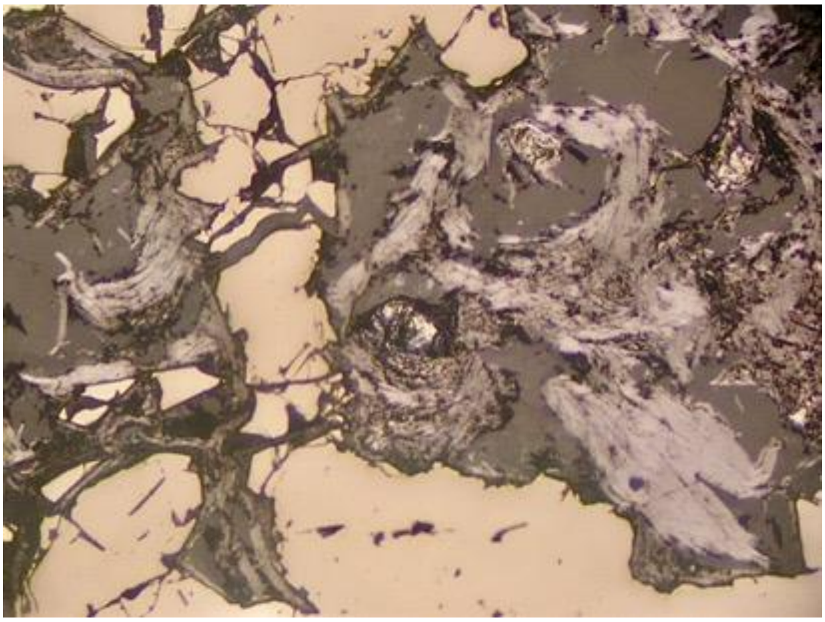


Fig. 21: Intensely altered host rock, with abundant albite overprinted by sericite-muscovite, carbonate, pyrite (black) and a little chlorite. Transmitted light, crossed polarisers, field of view 2 mm across.

Interpretation and comment: It is interpreted that the sample is an intensely hydrothermally altered granitoid (perhaps formerly of tonalite type and having been rich in plagioclase), replaced by initial albite, with subsequent overprinting by sericite-muscovite, carbonate (calcite), chlorite, pyrite, a little molybdenite and trace rutile. There was invasion of the altered rock by medium to coarse grained quartz-rich, grading to pyrite-rich masses, with minor associated albite, overprinting sericite-muscovite, carbonate, a little chlorite and trace molybdenite. Pyrite masses are locally associated with molybdenite aggregates and traces of chalcopyrite. There is no evidence, on the scale of the section, for molybdenite to be paragenetically later than quartz and pyrite.

Fig. 22: Irregular aggregates of flaky molybdenite (pale silvery grey with mauve tint) interstitial to fractured pyrite (pale creamy). Plane polarised reflected light, field of view 1 mm across.



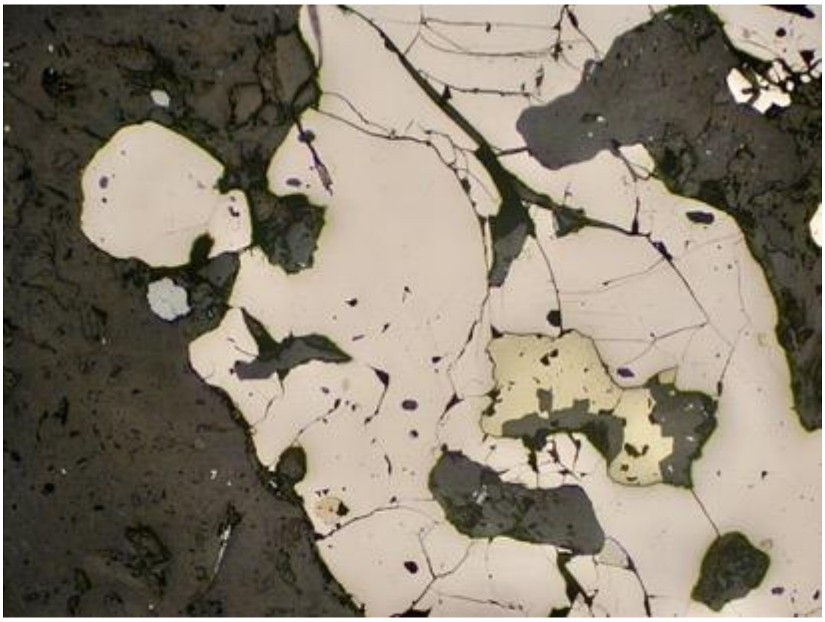


Fig. 23: Large pyrite mass hosted in quartz (dark), with small, associated chalcopyrite masses (pale yellow). Small pale grey grains at left are rutile. Plane polarised reflected light, field of view 2 mm

STWD006 308.7 m PTS

Summary: Metamorphosed and altered rock, probably of ultramafic to mafic igneous type. No definite relict texture is recognised due to replacement and recrystallisation, but there are sparse small grains of relict chromite. These are small and equant and their presence could imply that the protolith was of picritic type. The rock experienced replacement by a heterogeneous assemblage under conditions of at least biotite grade metamorphism, forming abundant greenish biotite, chlorite, amphibole (tremolite-actinolite, but could include anthophyllite), lesser amounts of plagioclase, quartz and magnetite, and traces of talc, pyrite, epidote and chalcopyrite. Amphibole tends to be more closely associated with plagioclase, and chlorite and/or biotite commonly form aggregates.

Handspecimen: The drill core sample is composed of a compositionally heterogeneous metamorphic rock ranging from grey to dark grey-green and black in colour (Fig. 24). It is fine to medium grained and has a recrystallised texture, with domains evidently rich in biotite and perhaps with other phases including chlorite, amphibole, feldspar and quartz (Fig. 24). There are rare grains of pyrite up to 1 mm across and as the rock is strongly magnetic, with susceptibility up to 3910 x 10^{-5} SI, there must be minor disseminated magnetite throughout. No definite relict texture is recognised.

Fig. 24: Drill core sample of metamorphosed and altered rock, probably of former ultramafic to mafic igneous type (e.g. picrite). It retains traces of relict chromite and has been heterogeneously replaced by an assemblage of biotite, chlorite, amphibole (tremolite-actinolite and possible anthophyllite), quartz, plagioclase and magnetite.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the sample is strongly recrystallised to a fine to medium grained metamorphic aggregate and that it is compositionally heterogeneous (Fig. 25). No definite relict texture is recognised, but there are uncommon small relict equant grains of chromite up to 0.2 mm across, typically encapsulated in magnetite (Fig. 26) and their presence could imply that the protolith was of ultramafic to mafic igneous type. The metamorphic mineral assemblage that formed contains varying (but abundant) proportions of biotite and chlorite, lesser amphibole (tremolite-actinolite, but could include anthophyllite), plagioclase, quartz and magnetite (Fig. 25). It is speculated from the bulk mineral assemblage, which is clearly Mg-rich, and the presence of relict chromite that the protolith could have been of picritic type.

b) Alteration and structure: It is considered that an ultramafic to mafic igneous protolith experienced hydrothermal alteration and metamorphism, at least to biotite grade, with complete replacement of the original rock, except for sparse small grains of relict chromite (Fig. 26). The replacement assemblage is fine to medium grained, randomly oriented and displays heterogeneous distribution of the major mineral constituents. These include khaki-coloured biotite, pale green chlorite, pale yellow-brown to pale green acicular amphibole (up to 0.5 mm long and probably mostly tremolite-actinolite, but there might be some anthophyllite as well), patchy finely granular plagioclase, quartz (locally up to 1 mm), finely granular magnetite (commonly enclosing chromite), a few grains of epidote (up to 0.8 mm), pyrite (up to 0.7 mm) and chalcopyrite (Fig. 25). In a small part of the section, there is minor talc associated with chlorite, biotite and amphibole. Chlorite and biotite tend to occur together, either admixed, and/or as discrete aggregates, and amphibole tends to occurs with plagioclase ± biotite (Fig. 25). Assuming an ultramafic to mafic composition igneous protolith, there must have been pre- to syn-metamorphic hydrothermal introduction of K (S, silica).

c) Mineralisation: The rock contains sparsely scattered relict equant grains of chromite up to 0.2 mm across, typically enclosed by magnetite (Fig. 26). Elsewhere, finely granular magnetite (grains up to 0.2 mm) forms irregularly distributed disseminations and aggregates. There are a few porphyroblastic grains of pyrite up to 0.8 mm across (with small magnetite inclusions) and a couple of grains of chalcopyrite up to 0.2 mm, in places associated with magnetite.

Mineral Mode (by volume): biotite and chlorite each 30%, amphibole (tremolite-actinolite and perhaps anthophyllite) 15%, plagioclase and quartz each 10%, magnetite 4% and traces of epidote, talc, chromite, pyrite and chalcopyrite.

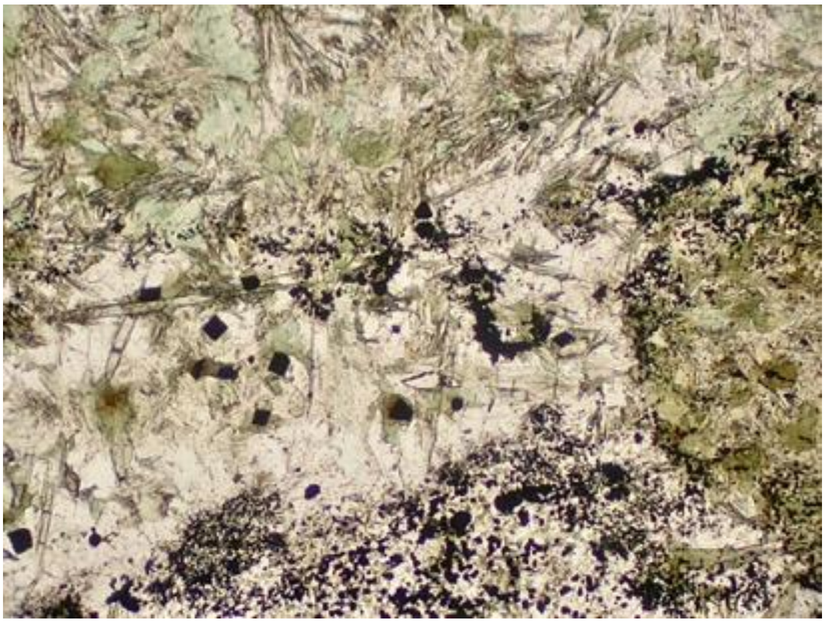


Fig. 25: Heterogeneous metamorphic assemblage of biotite (khaki), pale green chlorite, quartz and plagioclase (clear) and irregularly distributed fine grained magnetite (black). Plane polarised transmitted light, field of view 2 mm

Interpretation and comment: It is interpreted that the sample could represent a former ultramafic to mafic composition igneous rock (e.g. picrite) that experienced hydrothermal alteration and metamorphism (to at least biotite grade). No definite relict texture is recognised due to replacement and recrystallisation, but there are sparse small equant grains of relict chromite. The protolith experienced replacement by a heterogeneous assemblage containing abundant greenish biotite, chlorite, amphibole (tremolite-actinolite, but could include anthophyllite), lesser amounts of plagioclase, quartz and magnetite, and traces of talc, pyrite, epidote and chalcopyrite. Amphibole tends to be more closely associated with plagioclase, and chlorite and/or biotite commonly form aggregates.

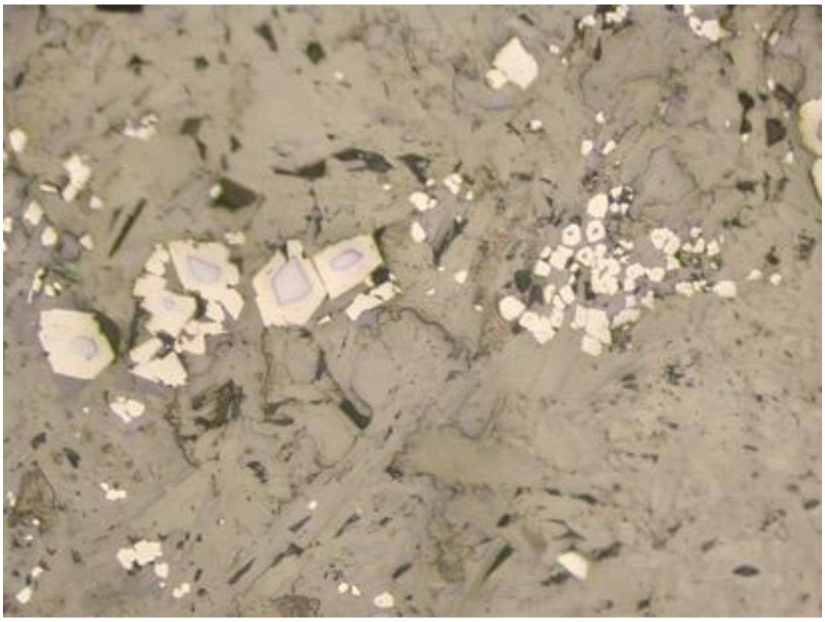


Fig. 26: Small relict equant grains of chromite (slightly darker grey) enclosed by magnetite (paler grey) and hosted in a recrystallised assemblage of biotite, chlorite and amphibole. Plane polarised reflected

STWD006 322.6 m PTS

Summary: Porphyritic biotite microtonalite, with moderate to strong alteration and local veining. The original rock contained scattered phenocrysts of plagioclase and biotite, and there could have been a few hornblende phenocrysts (subsequently altered). The phenocrystal phases occurred in a fine to medium grained, inequigranular groundmass of plagioclase and quartz, with minor biotite and K-feldspar. A single small enclave occurs, perhaps formerly more mafic than the host and interpreted as biotite-quartz microdiorite. It is possible that the rock experienced initial mild potassic alteration, with replacement of interpreted hornblende by biotite, and development of the latter in the enclave. A few quartz (-carbonate-pyrite) veins were emplaced, associated with narrow K-feldspar alteration selvedges. Subsequently, alteration evolved into an argillic type, with patchy replacement of plagioclase by fine grained clay (e.g. kaolinite), sericite, and biotite by chlorite ± carbonate ± rutile.

Handspecimen: The drill core sample is composed of a massive to possibly weakly flow-aligned, porphyritic intermediate to felsic igneous rock. It contains pale grey-green, variably altered feldspar (plagioclase) phenocrysts up to 3 mm across and dark biotite phenocrysts (locally aligned) up to several millimetres long, in a fine grained pale orange-pink-grey groundmass, probably of quartzofeldspathic composition (Fig. 27). Plagioclase phenocrysts are clouded and could have sericite/clay alteration, and biotite phenocrysts could be variably chloritized. The rock is cut by a few sub-planar quartz-rich veins (with a little carbonate and pyrite) up to 2 mm wide at moderate angles to the core axis (Fig. 27). Staining of the section offcut with sodium cobaltinitrite showed that there is a little K-feldspar in the groundmass and that K-feldspar is also developed as thin selvedges about the quartz-rich veins. The rock is weakly magnetic, with susceptibility up to 80 x 10^{-5} SI.

Fig. 27: Drill core sample of porphyritic biotite microtonalite. It has scattered phenocrysts of plagioclase and biotite in a finer grained quartzofeldspathic groundmass. A few thin quartz (-carbonate) veins occur with thin K-feldspar alteration selvedges.

Petrographic description

a) Primary rock characteristics: In the section, relict moderately porphyritic texture is rather well preserved (Fig. 28). The rock contained scattered blocky plagioclase phenocrysts up to 3 mm across and flaky biotite grains up to 2.5 mm across (Fig. 28). It is possible that a few elongate, prismatic phenocrysts of another ferromagnesian phase (e.g. hornblende) up to 2 mm long occurred, but if so, they were completely altered (Fig. 28). The phenocrystal phases occur in a fine to medium grained, inequigranular groundmass composed of abundant plagioclase and interstitial quartz, with minor biotite, a little K-feldspar and trace apatite. The preserved primary characteristics of the rock indicates that it represents a porphyritic biotite microtonalite. A single enclave ~6 mm across occurs, with it being more strongly altered and recrystallised than the host rock. It appears to have been initially slightly more mafic in composition, but containing the same igneous minerals (e.g. it was a biotite-quartz microdiorite).

b) Alteration and structure: The original rock experienced moderate to strong hydrothermal alteration and emplacement of a few veins. There is local indication for development of patchy secondary (hydrothermal) biotite, e.g. in the enclave and at possible former hornblende sites (Fig. 28). A few sub-planar veins up to 2 mm wide were emplaced, being these being quartz-rich, with minor interstitial carbonate and pyrite, and in places bordered by thin selvedges of turbid K-feldspar (replacing host rock plagioclase) (Fig. 29). The formation of minor biotite and K-feldspar indicates that mild potassic alteration occurred, with the rock subsequently being overprinted by moderate to strong retrograde alteration of argillic type. This caused variable replacement of plagioclase by fine grained, low-birefringent clay (e.g. kaolinite), albite, sericite and carbonate, and replacement of biotite by chlorite ± carbonate ± rutile ± pyrite (Fig. 29). In the groundmass, traces of rutile, chalcopyrite and pyrite have formed as part of the alteration.

c) Mineralisation: In the quartz-rich veins, there are a few individual grains and irregular to elongate aggregates up to 2 mm long of pyrite. Traces of disseminated pyrite (up to 0.4 mm across) and rare chalcopyrite have formed as part of the pervasive alteration, e.g. at former biotite sites.

Mineral Mode (by volume): plagioclase (includes albite) 55%, quartz 20%, chlorite 6%, clay (kaolinite) 5%, sericite 4%, K-feldspar, biotite and carbonate each 3% and traces of apatite, rutile, pyrite and chalcopyrite.

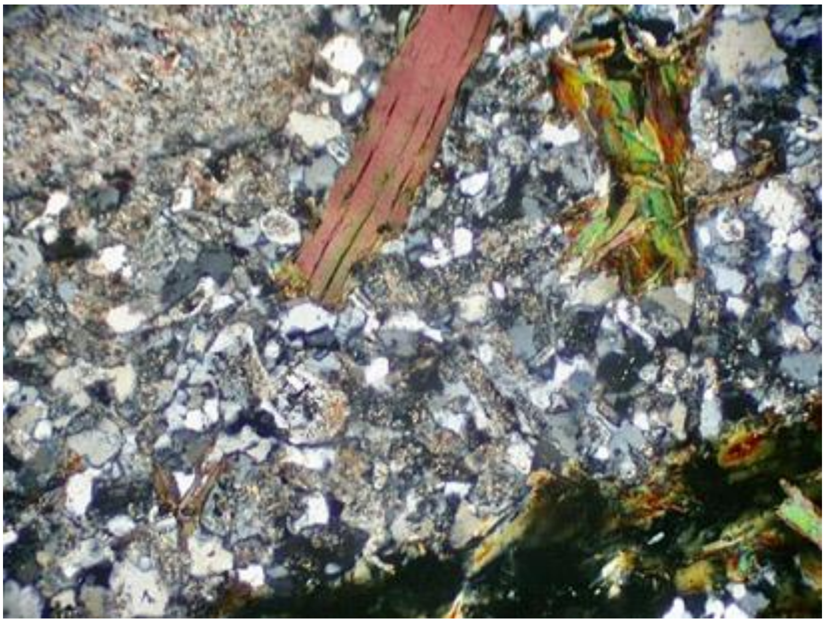


Fig. 28: Altered porphyritic microtonalite containing a partly sericitised plagioclase phenocryst at upper left, a fresh biotite phenocryst (upper centre) and two possible altered hornblende grains (replaced by biotite and dark chlorite in lower aggregate). The groundmass is dominated by finely inequigranular plagioclase (partly altered) and quartz. Transmitted light, crossed

Interpretation and comment: It is interpreted that the sample is a partly altered and veined porphyritic biotite microtonalite. It contained scattered phenocrysts of plagioclase and biotite, and there could have been a few hornblende phenocrysts (subsequently altered), all enclosed in a fine to medium grained, inequigranular groundmass of plagioclase and quartz, with minor biotite and K-feldspar. A single small enclave occurs, perhaps formerly more mafic than the host and interpreted as biotite-quartz microdiorite. It is possible that the rock experienced initial mild potassic alteration, with replacement of interpreted hornblende by biotite, and development of the latter in the enclave. A few veins containing quartz (-carbonate-pyrite) occur, associated with narrow K-feldspar alteration selvedges. Subsequently, alteration evolved into an argillic type, with patchy replacement of plagioclase by fine grained clay (e.g. kaolinite), sericite, and biotite by chlorite ± carbonate ± rutile.

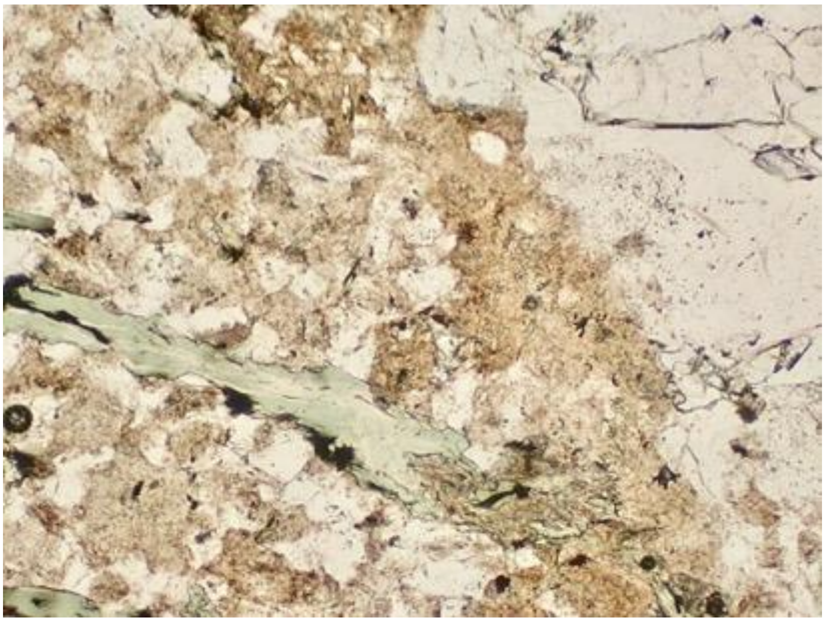


Fig. 29: Part of a quartz-carbonate vein (right) bordered by a narrow selvedge of turbid K-feldspar. An adjacent former biotite phenocryst is replaced by pale green chlorite and a little rutile (dark). Plane polarised

STAC0013 68 m PTS

Summary: Sample is composed of largely massive, fine grained Fe sulphides, dominated by marcasite and with minor pyrite. A few relict grains of quartz are enclosed by the sulphides, with shapes of larger grains suggesting that they represent former phenocrysts in a felsic igneous rock. Some quartz grains show invasion by marcasite. There are also a few pseudomorphs after possible former phenocrystal grains of feldspar, replaced by marcasite and fine grained clay (e.g. illite), as well as a few discrete irregular aggregates of illite and a few voids. About voids and illite aggregates, marcasite is typically overgrown by pyrite. No other sulphide minerals are recognised and the sample is interpreted as a product of low temperature sulphidic replacement of a former porphyritic felsic igneous rock.

Handspecimen: The air core chip is composed of a dense, fine grained aggregate of grey to bronzy coloured Fe sulphides, hosting a few pale grey to white relict quartz grains up to 2 mm across (Fig. 30). The latter are speculated to represent relict igneous phenocrysts, but no other primary characteristics are recognised. Fine grained sulphides host small amounts of patchy fine grained whitish clay. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 30: Air core chip of largely fine grained massive Fe sulphides (dominant marcasite, minor pyrite), with a few white to grey relict grains of quartz.

Petrographic description

a) Primary rock characteristics: In the section, the rock is dominated by fine grained marcasite which encloses sparsely distributed relict quartz grains up to 2 mm across as well as a few pseudomorphs, also up to 2 mm across, after a former blocky phase, speculated to have been feldspar (Figs 31, 32). Shapes of relict quartz grains (Fig. 32) are typical of phenocrysts from a porphyritic felsic igneous rock, and the pseudomorphs after the former blocky phase also resemble shapes of former phenocrysts. It is considered that a protolith could have been similar to then porphyritic dacite in STAC0018/82 m, with subsequent intense hydrothermal replacement having occurred.

b) Alteration and structure: An interpreted former porphyritic felsic igneous rock was initially replaced by abundant fine grained marcasite and associated minor pyrite. This process particularly affected the former groundmass and of interpreted former feldspar phenocrysts (Fig. 31). A couple of the larger relict quartz phenocrysts show invasion by marcasite along fractures Interpreted former feldspar mphenocryst sites were replaced by a fine grained clay phase (e.g. illite) and marcasite, and elsewhere in the rock, there are irregular distributed small (up to 0.1 mm) relict quartz grains, scattered irregular aggregates of illite up to 1 mm across, apparently as void filling, and a few actual voids also up to 1 mm across. About the voids and illite aggregates, marcasite is locally overgrowth by fine grained pyrite. No other mineral phases are recognised in the sample.

c) Mineralisation: The sample is dominated by abundant fine grained (generally <0.1 mm) inequigranular marcasite (Figs 31, 32). About the illite aggregates and voids, marcasite is commonly thinly overgrown by fine grained pyrite.

Mineral Mode (by volume): marcasite 85%%, quartz, clay (illite) and pyrite each 5%.

Interpretation and comment: It is interpreted that the sample represents the product of relatively low temperature sulphidic replacement of a former porphyritic felsic igneous rock. It is now composed of largely massive marcasite and minor pyrite. A few relict grains of quartz are enclosed by the sulphides, with shapes of larger grains suggesting that they represent former phenocrysts in a felsic igneous rock. Some quartz grains show invasion by marcasite. There are also a few pseudomorphs after possible former phenocrystal grains of feldspar, replaced by marcasite and fine grained clay (e.g. illite), as well as a few discrete irregular aggregates of illite and a few voids. About voids and illite aggregates, marcasite is typically overgrown by pyrite. No other sulphide minerals are recognised

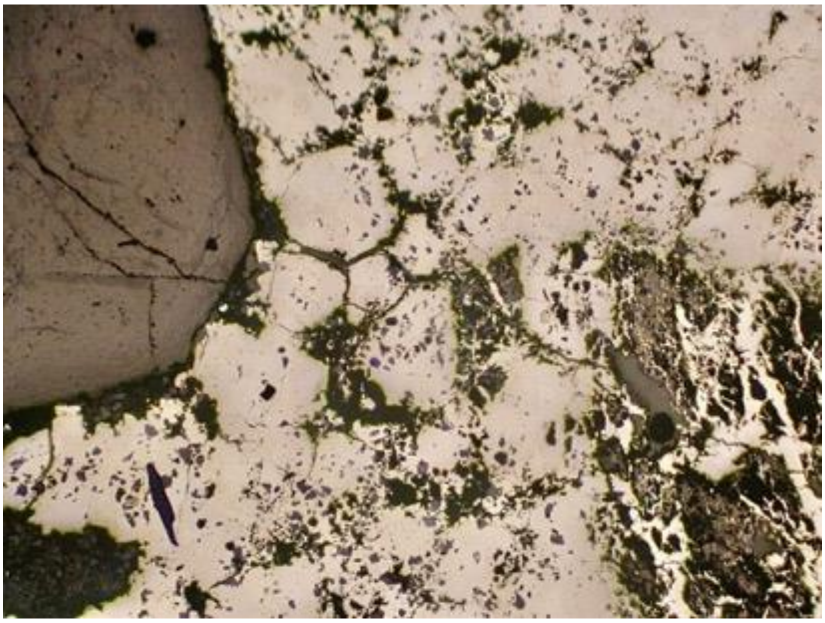


Fig. 31: Portions of a relict phenocrystal quartz grain (left) and a pseudomorphic mass at lower right considered to represent a former phenocrystal grain of feldspar, replaced by marcasite and clay. The remainder of the protolith was replaced by fine grained marcasite (pale creamy). Plane polarised

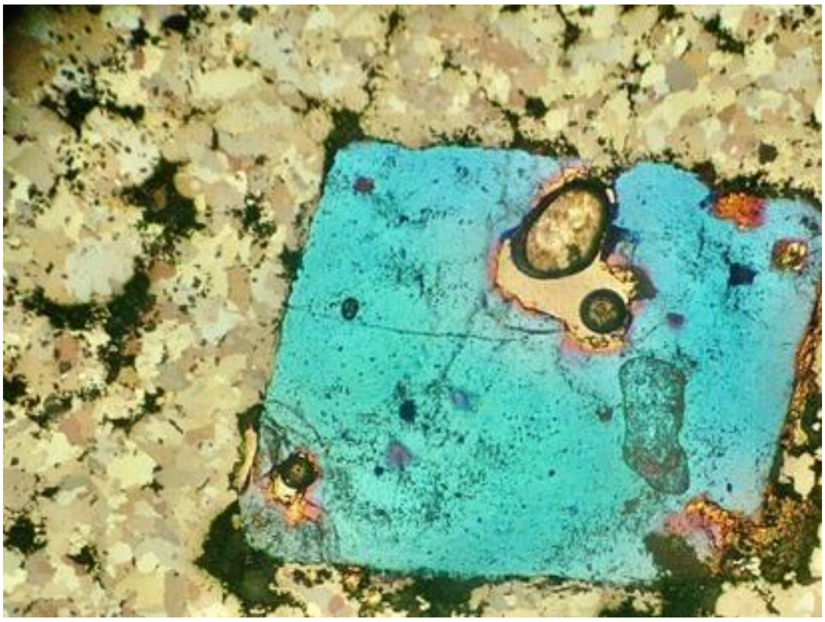


Fig. 32: Relict subhedral phenocrystal quartz grain (aqua) enclosed by finely inequigranular marcasite (speckled). Reflected light, partly crossed polarisers, field of view 2 mm across.

STAC0018 82 m PTS

Summary: Porphyritic dacite, with initial local development of secondary biotite and subsequent mild argillic alteration. Relict texture is well preserved, with the rock retaining phenocrysts of plagioclase and a few of quartz, but interpreted former small hornblende phenocrysts were replaced by aggregates of fine grained biotite. Phenocrysts occurred in a fine grained groundmass, rich in plagioclase, but with minor quartz, K-feldspar and biotite. Initial mild potassic alteration was followed by slight retrograde effects, with formation of a little sericite, chlorite, pyrite and rutile, along with pervasive clouding of groundmass feldspar by clay (e.g. kaolinite).

Handspecimen: The air core chip is composed of a massive, pale grey, altered porphyritic felsic igneous rock (Fig. 33). It contains scattered whitish feldspar phenocrysts and a few dark, altered ferromagnesian phenocrysts (e.g. former hornblende) each up to a few millimetres across, in a fine grained quartzofeldspathic groundmass that could have mild pervasive clay alteration and development of a few small pyrite grains (Fig. 33). Staining of the section offcut with sodium cobaltinitrite showed that there is minor K-feldspar in the groundmass. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 33: Air core chip of porphyritic dacite showing scattered whitish plagioclase phenocrysts and dark, altered hornblende phenocrysts (now biotite) in a pale grey, slightly clay-altered quartzofeldspathic groundmass.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is well preserved. There are scattered blocky phenocrysts of plagioclase up to 3.5 mm across, with these being largely fresh and locally displaying zoning (Fig. 34). There are also a few phenocrysts of quartz up to 1.5 mm across and pseudomorphs after interpreted former elongate ferromagnesian (e.g. hornblende) phenocrysts up to 1.5 mm long (Fig. 34). The phenocryst phases are enclosed in a fine grained (holocrystalline) and slightly flow foliated groundmass, evidently rich in plagioclase, but with minor quartz, K-feldspar, ferromagnesian material (biotite) and traces of apatite, zircon and FeTi oxide (now altered). The primary characteristics of the rock indicate that it represents a porphyritic dacite.

b) Alteration and structure: The igneous rock has moderate pervasive alteration. It is interpreted that there was initial local effects of potassic alteration imposed, manifest in the replacement of former hornblende phenocrysts by aggregates of secondary biotite (Fig. 34). It is possible that a little biotite also formed in the groundmass. Subsequently, retrograde alteration occurred, with small amounts of fine grained sericite being formed in the groundmass and at plagioclase phenocryst sites, traces of chlorite (from biotite), rutile (from igneous FeTi oxide) and pyrite (mostly associated with altered hornblende sites, but also in the groundmass). Turbid fine grained clay (e.g. kaolinite) has formed throughout the groundmass, replacing feldspar (Fig. 34) and being indicative of argillic alteration.

c) Mineralisation: The sample contains a little pyrite, in aggregates up to 0.6 mm across, mostly associated with the altered hornblende sites, but also occurring in the groundmass. Pyrite could have formed as part of the retrograde alteration.

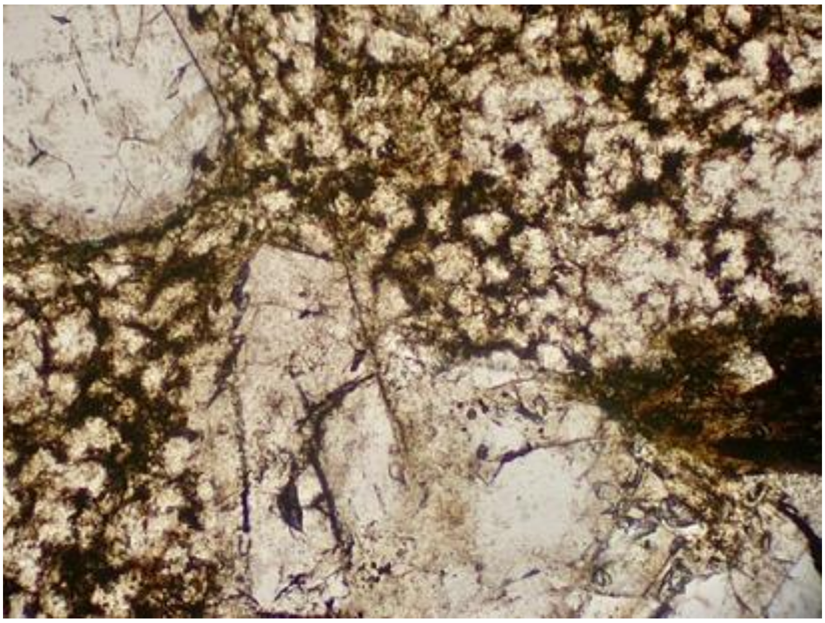


Fig. 34: Porphyritic dacite with a phenocryst of plagioclase (lower), quartz (upper left) and biotite-replaced hornblende (dark brown at right) in a fine grained quartzofeldspathic groundmass that is clouded by clay alteration. Plane polarised transmitted light, field of view 2 mm across.

<u>Mineral Mode (by volume)</u>: plagioclase 70%, quartz 15%, K-feldspar and clay each 5%, biotite 3%, sericite and pyrite each 1% and traces of apatite, zircon, rutile and chlorite.

<u>Interpretation and comment</u>: It is interpreted that the sample is an altered porphyritic dacite. Relict texture is well preserved, with the rock retaining phenocrysts of plagioclase and a few of quartz, but former small hornblende phenocrysts were replaced by aggregates of fine grained biotite. Phenocrysts occurred in a fine grained groundmass, rich in plagioclase, but with minor quartz, K-feldspar and biotite. It is considered that there was mild potassic alteration, manifest in replacement of hornblende by biotite, followed by slight retrograde alteration, with formation of a little sericite, chlorite, pyrite and rutile, along with pervasive clouding of groundmass feldspar by clay (e.g. kaolinite).

STAC0019 25 m TS

Summary: Coarse grained, rather leucocratic tonalite, with moderate propylitic alteration. The rock originally contained abundant anhedral to blocky plagioclase, intergrown with quartz and minor amounts of interstitial biotite (locally in clusters) and K-feldspar. Trace titanite appears to have occurred with biotite. Imposed alteration led to replacement of all prior biotite, mostly by chlorite and/or epidote, and with trace titanite and hematite. Plagioclase shows albitisation in places, with associated development of a little sericite, turbid ultrafine clay and trace epidote and prehnite.

Handspecimen: The air core sample is composed of a massive, medium to coarse grained granitic rock, containing abundant pale pink-orange to creamy coloured feldspar and pale grey quartz, along with a small proportion of dark ferromagnesian material (Fig. 35). The last phase could be altered to chlorite and/or epidote, but relict shapes infer that the primary phase was biotite. Feldspar appears to be slightly clouded by development of clay and/or sericite. Staining of the section offcut with sodium cobaltinitrite showed that there is minor K-feldspar throughout. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 35: Air core sample of moderately altered tonalite, with pink-orange to whitish feldspar, pale grey quartz, and small dark aggregates that were originally biotite, but now mostly replaced by chlorite and epidote.

Petrographic description

a) Primary rock characteristics: In the section, the rock has a phaneritic texture, with coarsely interlocking anhedral to blocky grains of plagioclase up to 5 mm across and quartz up to 4 mm across, with minor interstitial biotite (originally as individual grains and clusters up to 3 mm across, but now entirely altered) and K-feldspar (Fig. 36). A few small aggregates of titanite occur, mostly associated with former biotite sites, and a tiny trace of apatite is observed at some plagioclase grain boundaries. Although variably altered, some plagioclase retains igneous twinning and zoning and could be relatively sodic in composition. The primary texture and mineralogy of the rock infer that it represents a rather leucocratic biotite tonalite. It is similar to sample STWD006/167.2 m.

b) Alteration and structure: Mild alteration was imposed on the igneous rock. All interpreted former biotite was replaced by varying proportions of chlorite and epidote, with trace fine grained titanite and hematite (Fig. 36). Plagioclase is commonly albitised, with destruction of igneous zoning, and there was also development of a little fine grained sericite, ultrafine turbid clay, and trace epidote and prehnite. Alteration is interpreted to be of propylitic type.

c) Mineralisation: No sulphide minerals were observed.

Mineral Mode (by volume): plagioclase (includes albite) 55%, quartz 35%, K-feldspar 4%, chlorite and epidote each 2%, sericite 1% and traces of titanite, hematite, apatite, prehnite and clay.

Interpretation and comment: It is interpreted that the sample represents a moderately altered, coarse grained, rather leucocratic tonalite. It contained abundant anhedral to blocky plagioclase, intergrown with quartz and minor amounts of interstitial biotite (locally in clusters) and K-feldspar. Trace titanite appears to have occurred with biotite. Imposed alteration was of propylitic type, causing replacement of all prior biotite by chlorite and/or epidote, and trace titanite and hematite. Plagioclase shows albitisation in places, with associated development of a little sericite, turbid ultrafine clay and trace epidote and prehnite. No sulphide minerals are recognised in the sample.

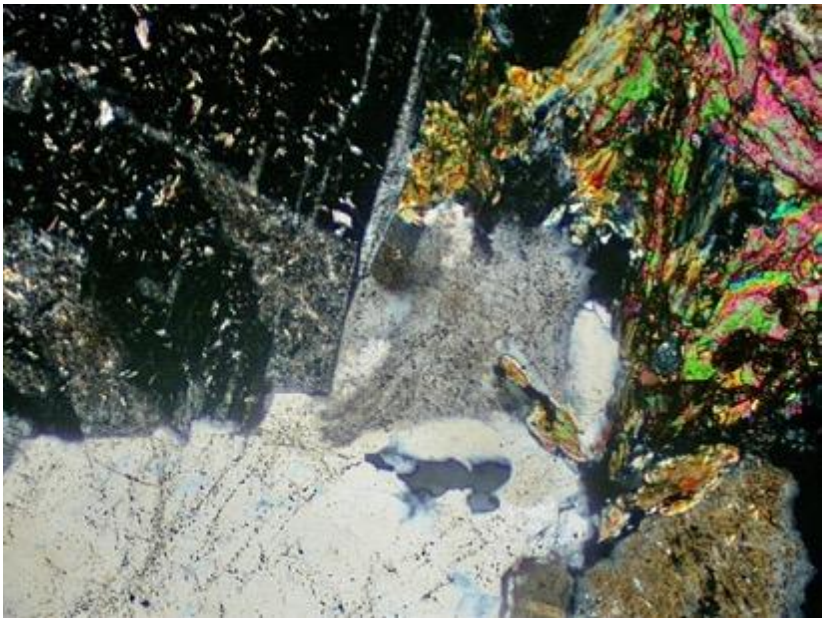


Fig. 36: Interlocking grains of coarse plagioclase (dark at left) and quartz (whitish, lower) and a small mass of K-feldspar (pale grey at centre). At right is part of an epidote (plus minor chlorite) mass that has replaced a former biotite cluster. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD130 181.6 m PTS

Summary: Intensely hydrothermally altered and mineralised ultramafic rock. No definite relict texture is recognised, but there are a few isolated relict grains of chromite (locally fractured) indicating that the protolith was of ultramafic type (speculated to have been harzburgite). There was replacement of the protolith by a Mg-rich assemblage of fine grained talc, subordinate chlorite and Fe-poor sphalerite, minor patchy carbonate (dolomite or magnesite) and pyrite. In places, there are small aggregates of chalcedonic quartz. Sphalerite commonly exhibits abundant small chalcopyrite inclusions ("chalcopyrite disease" texture) as well as inclusions of pyrite and uncommon galena and hematite.

Handspecimen: The drill core sample is composed of a dark grey to grey-green rock with a soft and greasy feel. It is locally sheared and there is a weak foliation in places at a moderate angle to the core axis. The rock is fine grained and probably rich in talc and/or chlorite, but there are also patchy aggregates of dark brown sphalerite and whitish carbonate up to several millimetres across (Fig. 37). No definite relict texture is recognised, but the likely Mg-rich nature of the rock could imply that it had an ultramafic protolith. Testing of the section offcut with dilute HCl gave no reaction on carbonate, suggesting that it could be dolomite or magnesite. The sample is moderately magnetic, with susceptibility up to 470 x 10^{-5} SI.

Fig. 37: Drill core sample of intensely hydrothermally altered and mineralised ultramafic rock. It is composed of dominant fine grained talc (paler grey) and chlorite (darker grey), with patchy dark brown sphalerite and small pale aggregates of carbonate.

Petrographic description

a) Primary rock characteristics: In the section, no definite relict texture is recognised and the rock is the product of almost total replacement. There are a few relict grains of chromite up to 0.8 mm across, with some of these being fractured (Fig. 38). Their presence, as well as their morphology, is indicative of an ultramafic protolith, e.g. harzburgite. The replacement assemblage is dominated by talc, chlorite and carbonate (e.g. dolomite/magnesite), also indicative of a Mg-rich protolith.

b) Alteration and structure: It is interpreted that an ultramafic protolith experienced intense hydrothermal replacement, with preservation of only a few relict chromite grains (Fig. 38). The alteration assemblage is dominated by fine grained talc, with local gradations into zones rich in near-colourless to pale green (Mg-rich) chlorite (with varying dark blue to khaki anomalous interference colours), and patchy aggregates of medium grained carbonate up to several millimetres across (Fig. 39). There is also patchily abundant sphalerite, minor pyrite and a few aggregates of fine grained chalcedonic quartz up to 3 mm across. Sphalerite forms disseminated to semi-massive aggregates, associated with, and enclosing pyrite, as well as commonly having abundant small chalcopyrite inclusions ("chalcopyrite disease" texture) and a few small inclusions of galena and hematite (Figs 40, 41). In a few places, sphalerite is fractured and invaded by carbonate (Fig. 40). Assuming an ultramafic composition protolith, there must have been considerable hydrothermal influx of S, CO_2, Zn (Cu).

c) Mineralisation: There are a few relict grains of chromite up to 0.8 mm across, locally fractured and showing trace reaction rims of magnetite (Fig. 38). Chromite can be hosted in alteration silicates, but is also adjacent to sphalerite and pyrite (Fig. 38). The rock contains abundant sphalerite, ranging up to rather coarse masses up to several millimetres across (Fig. 40). It ranges in colour from orange-brown (mostly in centres of larger grains) to near-colourless, indicating a low Fe content. Sphalerite commonly contains abundant small chalcopyrite inclusions, as well as a few inclusions of pyrite, galena and hematite (Figs 40, 41), although marginal zones of sphalerite can be inclusion-free. Grains of galena and hematite are up to 0.1 mm across, with individual pyrite grains up to 0.6 mm (Fig. 41). A few pyrite aggregates occur (up to 2.5 mm), hosted in gangue phases and sphalerite.

Mineral Mode (by volume): talc 50%, sphalerite 23%, chlorite 15%, carbonate (dolomite/magnesite) and pyrite each 5%, chalcedonic quartz and chalcopyrite each 1% and traces of chromite, magnetite, galena and hematite.

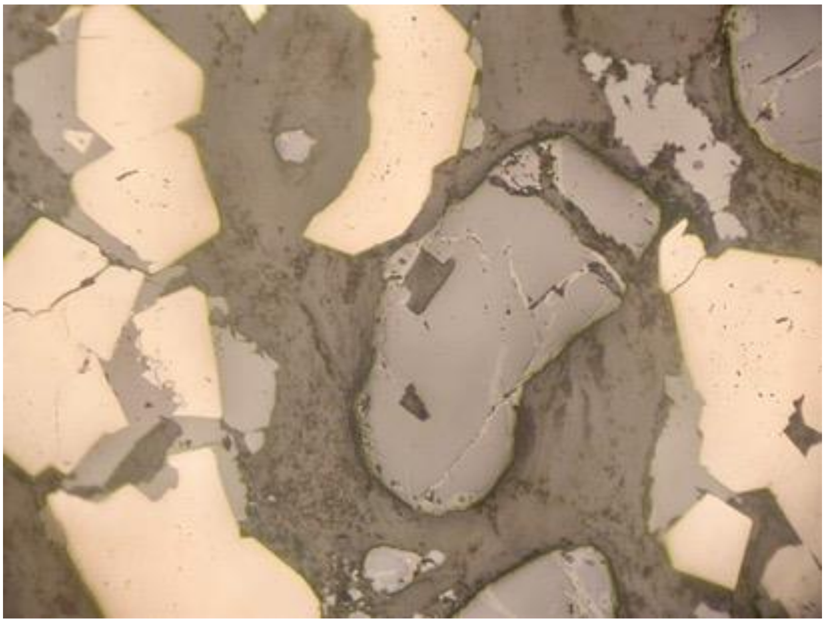
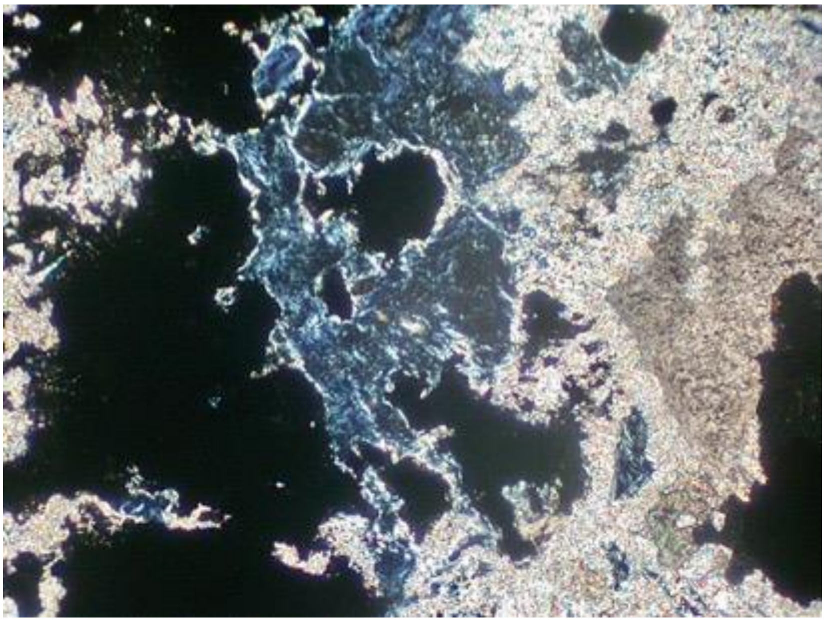


Fig. 38: Relict grains of chromite (mid grey) showing local fracturing and rim replacement by magnetite (paler grey), hosted in talc and with adjacent grains of pyrite (pale creamy) and sphalerite (pale grey). Note at left that pyrite is paragenetically earlier than sphalerite. Plane polarised reflected light,

Interpretation and comment: It is interpreted that the sample represents an intensely hydrothermally altered and mineralised ultramafic rock (e.g. former harzburgite). No definite relict texture is recognised, but there are a few isolated relict grains of chromite (locally fractured). There was replacement of the protolith by a Mg-rich assemblage of fine grained talc, subordinate chlorite and Fe-poor sphalerite, minor patchy carbonate (dolomite or magnesite) and pyrite. In places, there are small aggregates of chalcedonic quartz. Sphalerite commonly exhibits abundant small chalcopyrite inclusions ("chalcopyrite disease" texture) as well as inclusions of pyrite and uncommon galena and hematite.

Fig. 39: Typical replacement assemblage of fine grained talc (pale), chlorite (anomalous dark blue interference colours), sphalerite (black) and at right, carbonate (pale brown). Transmitted light, crossed polarisers, field of



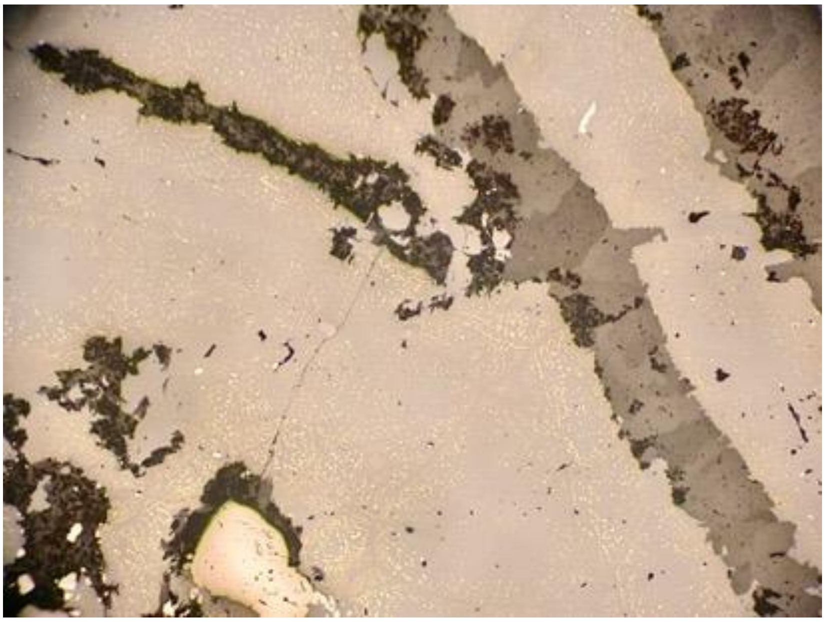
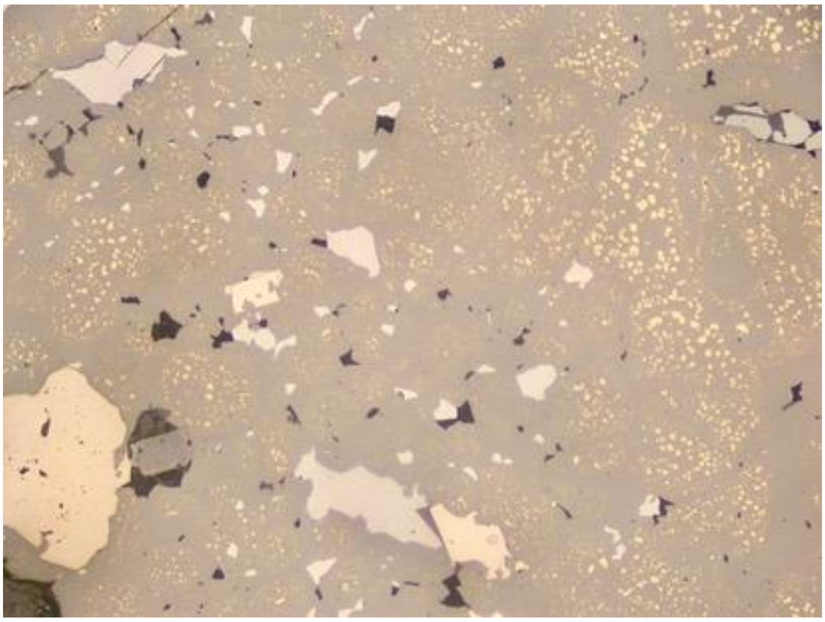


Fig. 40: Coarse sphalerite (pale grey), with fractures filled by carbonate. Sphalerite displays very fine chalcopyrite inclusions (chalcopyrite disease) and at bottom left, a pyrite grain. Whitish inclusion at upper right is galena. Plane polarised reflected light,

Fig. 41: Detail of sphalerite (pale grey) containing chalcopyrite disease texture as well as inclusions of pyrite (lower, pale creamy), galena (silvery white) and a single grain of hematite (pale grey-blue at upper right). Adjacent to the pyrite grain at lower left, there is a small equant relict chromite grain (grey). Plane polarised reflected



SMD158 520.6 m TS

Summary: Contact between a rather coarse grained hornblende (-quartz) diorite and a porphyritic hornblende microdiorite. On the scale of the sample, there is no indication of timing relations. The diorite was composed of interlocking plagioclase and brown hornblende, with a little quartz and FeTi oxide (maybe ilmenite). The porphyritic microdiorite contained phenocrysts of plagioclase and brown hornblende, in a fine grained plagioclase-rich groundmass, originally with subordinate hornblende and a little quartz and FeTi oxide. Both rock types were subsequently affected by strong alteration, probably as a result of imposed low grade metamorphism. In the diorite, there was extensive replacement by prehnite and chlorite, with trace epidote and leucoxene. All former plagioclase was replaced although hornblende is partly preserved. In the porphyritic microdiorite, there is replacement of plagioclase by albite and minor prehnite, and much hornblende was replaced by chlorite. Minor veining occurs in both rock types, mostly by prehnite or by carbonate.

Handspecimen: The drill core sample exhibits a sub-planar contact between a medium to coarse grained mafic to intermediate igneous rock (e.g. diorite or gabbro) and a grey, fine grained porphyritic intermediate igneous rock (Fig. 42). The contact is at ~80° to the core axis. The coarser grained rock was evidently rich in pale feldspar (e.g. plagioclase) and a dark grey-green ferromagnesian phase (e.g. hornblende), whereas the finer grained rock contains rather sparse white feldspar (plagioclase) phenocrysts up to several millimetres long, in a fine grained grey feldspathic groundmass (Fig. 42). Both rock types could have imposed alteration (e.g. chlorite development) and emplacement of a couple of thin, sub-planar veins at varying angles to the core axis. Testing of the section offcut with sodium cobaltinitrite did not indicate the presence of K-feldspar. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

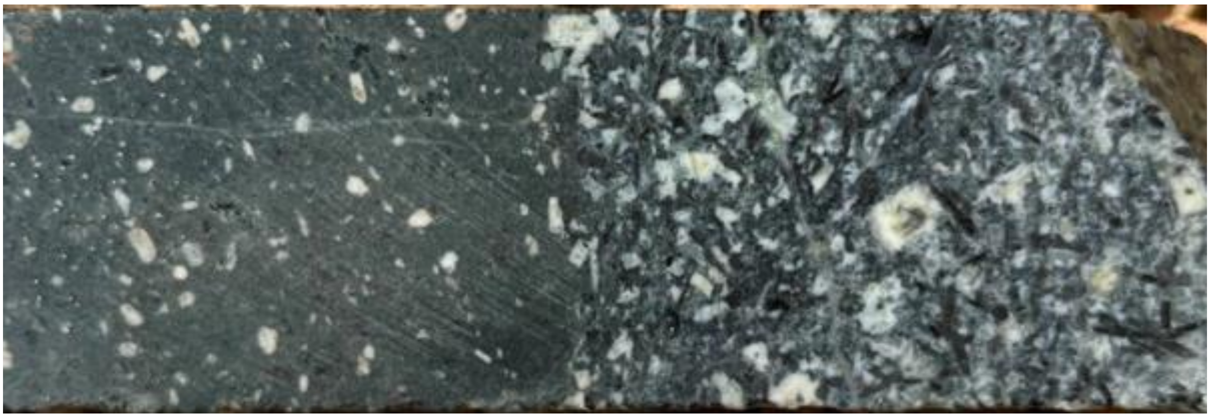


Fig. 42: Drill core sample showing a sub-planar contact between relatively coarse grained hornblende diorite at right, and porphyritic microdiorite at left. Despite the significant preservation of primary texture, there is strong alteration to prehnite, chlorite and albite.

Petrographic description

a) Primary rock characteristics: In the section, there is a sharp, sub-planar contact between two texturally different igneous rock types. No criterion was observed to specify timing relations between the two. A rather coarse grained igneous rock occupies ~60% of the section, with a finer grained, porphyritic type occupying the remainder. Relict texture is moderately well preserved in both rock types, despite strong pervasive alteration (Figs 43, 44). The coarser grained rock type formerly contained abundant plagioclase and elongate brown hornblende grains (both up to 3 mm), with a little quartz (up to 1 mm) and trace of FeTi oxide (possibly ilmenite) (Fig. 43). There is considerable preservation of brown hornblende (Fig. 43). This rock type is interpreted as a hornblende (-quartz) diorite. The other rock type has scattered phenocrystal grains of blocky plagioclase and prismatic brown hornblende (each up to 3 mm) in a fine grained groundmass composed of dominant plagioclase, originally with subordinate hornblende, plus a little quartz and FeTi oxide (e.g. ilmenite) (Fig. 44). The porphyritic rock type is interpreted as a hornblende (-quartz) microdiorite.

b) Alteration and structure: Both igneous rock types experienced strong pervasive alteration, maybe related to low grade metamorphism, with associated emplacement of a few thin veins. In the diorite, there was complete replacement of former plagioclase by prehnite ± chlorite and trace epidote, with hornblende being variably replaced by chlorite ± prehnite and trace leucoxene, and FeTi oxide by leucoxene (Fig. 43). In the porphyritic microdiorite, alteration is less intense, with plagioclase being replaced by albite, with local prehnite and trace epidote, and hornblende being variably replaced by chlorite (more intense in the groundmass) and FeTi oxide by leucoxene (Fig. 44). In the groundmass, there are a few replacive aggregates up to 4 mm across containing chlorite, epidote, actinolite and quartz. Both rock types are cut by a few veins up to 0.5 mm wide that contain prehnite ± quartz ± epidote, or by carbonate ± quartz ± epidote. The alteration and vein assemblage in the two rock types implies considerable Ca mobility.

c) Mineralisation: No sulphide minerals were recognised.

Mineral Mode (by volume): prehnite 35%, plagioclase (albite) 25%, chlorite 20%, hornblende 12%, quartz 4%, carbonate 2%, epidote and actinolite each 1% and traces of FeTi oxide (ilmenite) and leucoxene.

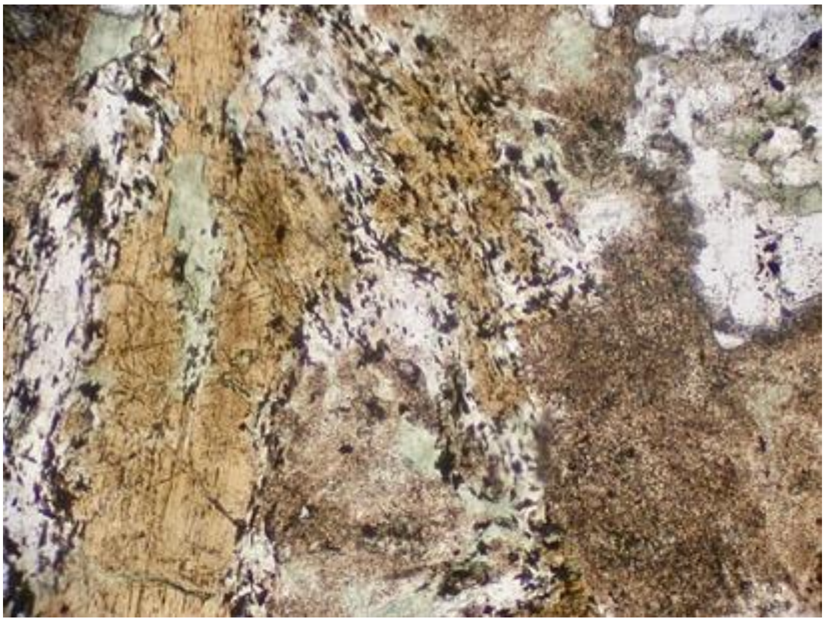


Fig. 43: Coarse grained diorite, originally with brown hornblende (partly altered to pale green chlorite and trace leucoxene) and plagioclase (now replaced by turbid to clear prehnite). At upper right is an aggregate of relict quartz. Plane polarised transmitted light, field of view 2 mm across.

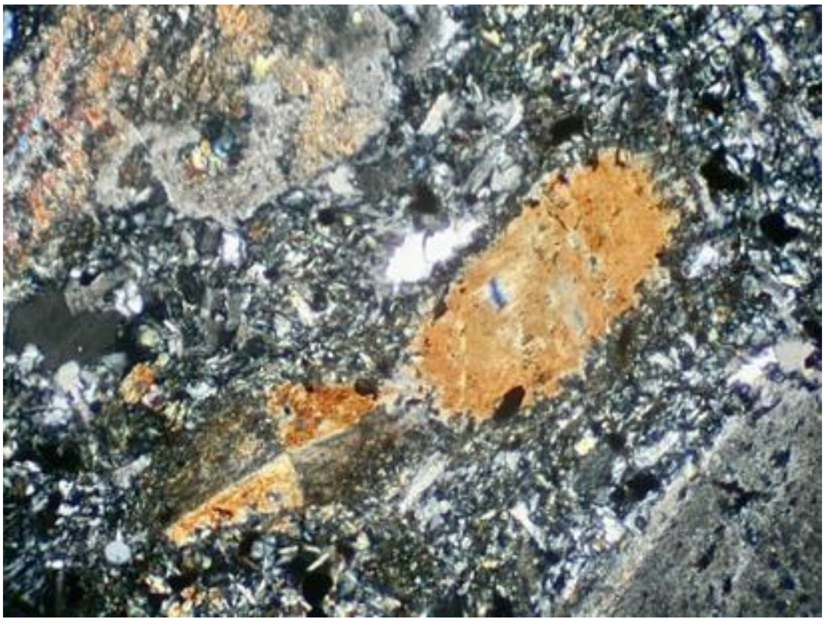


Fig. 44: Porphyritic microdiorite, with plagioclase and hornblende (orange) phenocrysts in a fine grained, plagioclase-rich groundmass. Plagioclase is albitised and the phenocryst at upper left also has prehnite development. Transmitted light, crossed polarisers

Interpretation and comment: It is interpreted that the sample displays a sub-planar contact between coarse grained hornblende (-quartz) diorite and porphyritic hornblende microdiorite. On the scale of the sample, there is no indication of timing relations. Originally, plagioclase and brown hornblende dominated the diorite, with a little quartz and FeTi oxide (maybe ilmenite). Porphyritic microdiorite had phenocrysts of plagioclase and brown hornblende, in a fine grained plagioclase-rich groundmass, originally with subordinate hornblende and a little quartz and FeTi oxide. Both rock types were subsequently affected by low grade metamorphism that led to extensive replacement. In the diorite, all plagioclase and some hornblende were replaced, mostly by prehnite and chlorite, with trace epidote and leucoxene. In the porphyritic microdiorite, plagioclase was replaced by albite and minor prehnite, and much hornblende was replaced by chlorite. Minor veining occurs in both rock types, mostly by prehnite or by carbonate.

SMD159 547.7 m PTS

Summary: Intensely hydrothermally altered and mineralised ultramafic rock. There are scattered relict chromite grains indicative of the ultramafic nature of the protolith, but chromite is significantly more abundant than expected for a typical ultramafic, such as harzburgite or derived serpentinite, and hence it is proposed that chromite was concentrated by residual enrichment due to dissolution and replacement of the host rock. The replacement assemblage is dominated by chlorite, pyrite and chalcopyrite. Initially deposited pyrite is coarse grained, with these masses being apparently disaggregated and enclosed in a matrix with varying proportions of chlorite, fine to medium grained pyrite and chalcopyrite, and a little Fe-poor sphalerite. A trace of millerite is observed in chalcopyrite.

Handspecimen: The drill core sample is composed of a strongly sulphide-mineralised rock, containing apparent fragments up to 1.5 cm across of coarse grained pyrite ± chalcopyrite enclosed in a matrix that ranges from grey, fine grained chlorite-rich material, to strongly disseminated to semi-massive fine grained pyrite and chalcopyrite, hosted in chlorite (Fig. 45). There are also a few dark "coaly-appearing" relict chromite grains up to 3 mm across hosted in the chlorite-sulphide matrix. No definite relict texture is recognised, but the presence of chromite implies an ultramafic composition protolith. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

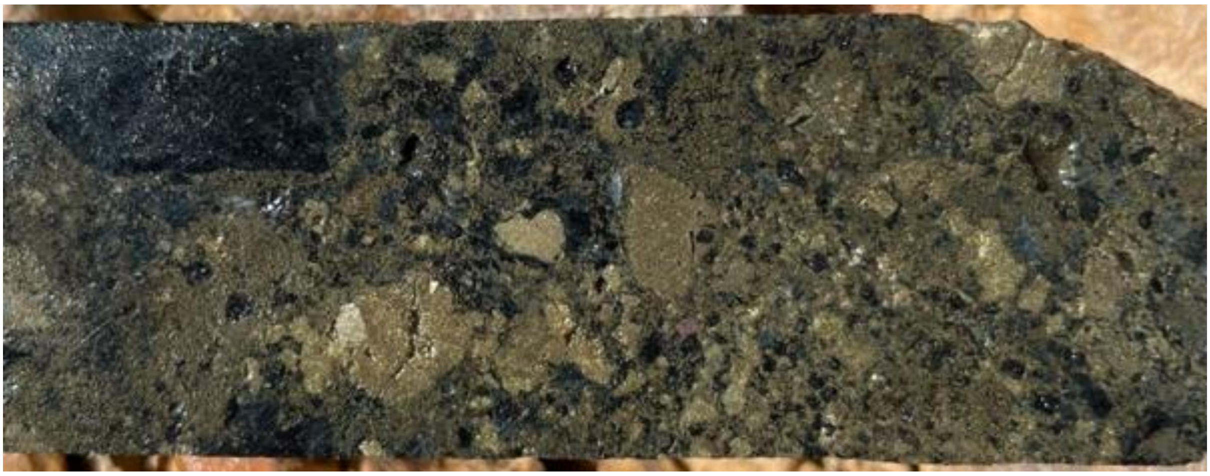


Fig. 45: Drill core sample of intensely altered ultramafic rock, now replaced by chlorite (dark), pyrite and chalcopyrite. Apparent fragments of coarse pyrite are enclosed by a finer grained matrix of chlorite with disseminated to semi-massive pyrite and chalcopyrite. The rock retains a few dark residual grains of chromite.

Petrographic description

a) Primary rock characteristics: In the section, there are irregularly, but generally sparsely scattered grains of relict chromite up to 2.5 mm across, in places fractured, and invaded by sulphides and chlorite (Fig. 46). The presence of chromite indicates an ultramafic composition protolith, with the rather coarse grainsize implying a coarse, harzburgitic protolith. No other relict textural or mineralogical characteristic is recognised, but the presence of abundant chlorite (some is probably Mg-rich) is also consistent with an ultramafic protolith.

b) Alteration and structure: It is interpreted that an ultramafic protolith was intensely hydrothermally altered and replaced, with only relict chromite grains being preserved (Fig. 46). As this phase is considerably more abundant (estimated 3%) than what would be expected in a typical ultramafic rock (e.g. harzburgite or derived serpentinite), it is proposed that chromite was concentrated by residual enrichment due to dissolution and replacement of the host rock. All other primary minerals in the protolith were replaced by abundant chlorite plus sulphides (Fig. 47). Two types of chlorite are apparent: one is khaki-green and has mauve to dark blue anomalous interference colours, and the other is very pale green (perhaps Mg-rich) and has khaki to white interference colours (Fig. 47). Textures suggest that there was initial deposition of coarse grained pyrite (masses up to several millimetres), with this type of material being disaggregated and invaded by abundant sulphides and chlorite, and trace quartz (Fig. 48). The apparently paragenetically later sulphides include fine to medium grained chalcopyrite and pyrite, with a few aggregates of Fe-poor sphalerite up to 2 mm across, and a trace of millerite hosted in chalcopyrite (Figs 48, 49). Assuming an ultramafic composition protolith, there must have been a large hydrothermal influx of S, Fe and Cu.

c) Mineralisation: There are scattered relict grains of chromite up to 2.5 mm across, with these grains being locally fractured and enclosed in coarse pyrite, as well as in the chlorite-pyrite-chalcopyrite matrix (Fig. 46). There was initial deposition of paragenetically early coarse grained pyrite in masses up to several millimetres across, with subsequently imposed variable disaggregation and invasion by chlorite and fine to medium grained pyrite and chalcopyrite (disseminated grading to largely massive) (Fig. 48). A few grains of Fe-poor sphalerite up to 2 mm across and displaying “chalcopyrite disease” texture occur in the chalcopyrite-pyrite masses (Fig. 49), and there is a trace of millerite hosted in chalcopyrite (grains up to 0.3 mm).

<u>Mineral Mode (by volume)</u>: chlorite 55%, pyrite 25%, chalcopyrite 16%, chromite 3%, sphalerite 1% and traces of quartz and millerite.

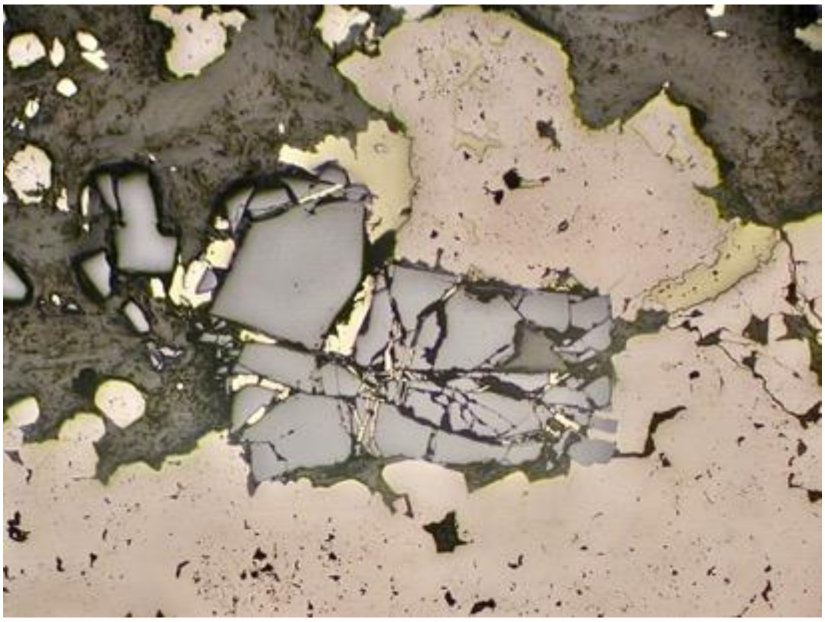
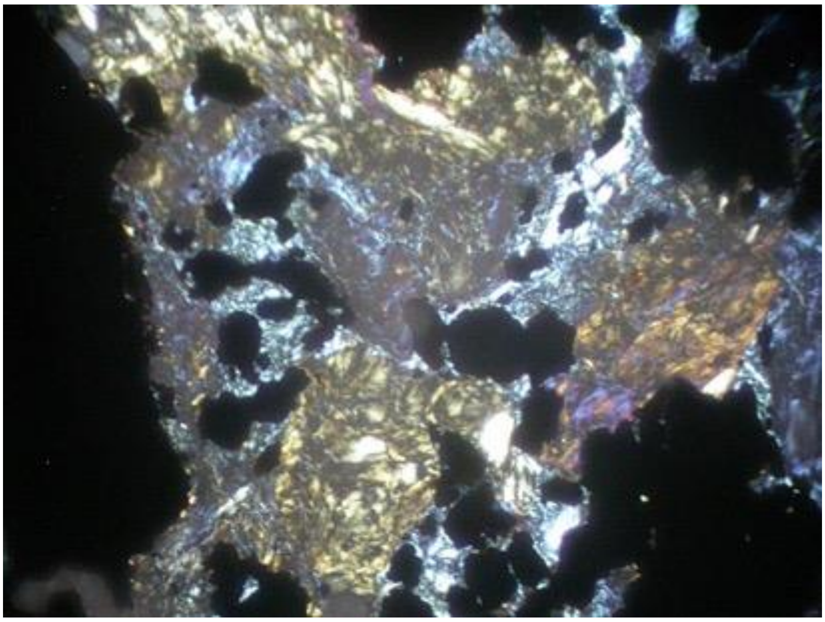


Fig. 46: Fractured relict grain of chromite (mid grey) showing invasion by chalcopyrite (pale yellow) and pyrite (pale creamy), adjacent to semi-massive pyrite and dark chlorite. Plane polarised reflected light, field of view 2 mm across

Fig. 47: Typical replacement assemblage of chlorite (anomalous blue-mauve and khaki interference colours) and pyrite (black). Transmitted light, crossed polarisers, field of view 2 mm across.



Interpretation and comment: It is interpreted that the sample is the product of intense hydrothermal replacement of ultramafic composition protolith. There are scattered relict chromite grains indicative of the ultramafic parentage, but chromite is significantly more abundant than expected for a typical ultramafic, such as harzburgite or derived serpentinite, with chromite possibly being concentrated by residual enrichment due to dissolution and replacement of the host rock. The replacement assemblage is dominated by chlorite, pyrite and chalcopyrite. Initially deposited pyrite is coarse grained, with these masses being apparently disaggregated and enclosed in a matrix with varying proportions of chlorite, fine to medium grained pyrite and chalcopyrite, and a little Fe-poor sphalerite. A trace of millerite is observed in chalcopyrite.

Fig. 48: Coarse fractured pyrite (upper) invaded by chalcopyrite (yellow) that also contains small aggregates of fine to medium grained pyrite. Plane polarised reflected light, field of view 2 mm across

Fig. 49: Coarse pyrite at left adjacent to a composite aggregate of sphalerite (pale grey), fine to medium grained pyrite and minor chalcopyrite (pale yellow). At lower right is portion of a residual chromite grain (high relief, grey). Plane polarised reflected light, field of view 2 mm