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

For

Stavely Minerals

Reference: phone and email communications with Hamish Forgan, July 2017.
Sample receipt 9-8-17.

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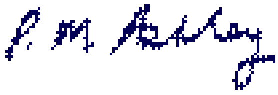
ABN 59 334 039 958

November, 2017

Report #1017



Introduction

A suite of forty drill core samples from the Thursday's Gossan prospect in the Cambrian age Stavely Belt in western Victoria was submitted for petrographic preparation, description and interpretation. Samples were from drill holes SMD006 (17 samples), SMD007 (11), SMD008 (6) and SMD009 (6) and were from downhole depths ranging from 43 m to 351.5 m. Most samples were fresh, but very slight supergene alteration effects occur in a couple of the shallower samples. Petrographic sections were prepared at Australian Petrographics in Queanbeyan, with 16 polished thin sections (PTS) and 24 standard thin sections (TS) being produced. Subsequently, PTS were examined microscopically in transmitted and reflected light, and TS in transmitted and oblique reflected light. Several 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 of each sample.

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

Summary descriptions of the samples are listed following:

Drill hole SMD006

SMD006 60.2 m PTS

Summary: Quartz-pyrite-sericite rock, perhaps representing a type of hydrothermal breccia. Possible host rock fragments are diffuse and extremely altered, with no relict characteristics preserved. They were replaced by varying proportions of fine to medium grained quartz, fine to coarse grained pyrite and subordinate infill fine grained sericite. A trace of rutile occurs at these sites. The possible breccia fragments are enclosed by, and merge into, infill zones of medium grained quartz, with minor patchy pyrite and sericite aggregates. Pyrite-rich domains in the rock commonly show fracturing and invasion by fine grained quartz and sericite, and a trace of chalcopyrite, with pyrite locally hosting tiny inclusions of chalcopyrite and rare bornite. A trace of covellite is present with chalcopyrite, maybe reflecting incipient supergene oxidation effects.

SMD006 60.6 m PTS

Summary: Quartz-pyrite-sericite rock, representing a type of matrix-supported hydrothermal breccia. Possible diffuse breccia fragments have little preserved relict texture and were intensely replaced by fine to medium grained quartz, subordinate sericite and pyrite, and a trace of rutile. Altered fragments merge into hydrothermal infill that contains irregularly distributed semi-massive aggregates of fine to medium grained pyrite, large irregular sericite aggregates and abundant medium grained quartz. A little chalcopyrite is observed interstitial to quartz and pyrite, and it also occurs as trace inclusions in pyrite. Quartz textures in the sample have significant resemblance to those observed in epithermal systems. Very slight supergene oxidation effects are apparent, with incipient replacement of chalcopyrite by digenite and covellite. The sample is similar to that at 60.2 m.

SMD006 114.0 m PTS

Summary: Pyrite-rich vein abutting a strongly deformed and hydrothermally altered zone of host rock in which relict texture is either poorly preserved or completely obliterated. Vague vestiges of the host rock suggest that it was of felsic igneous type, with scattered small phenocrysts of feldspar and quartz in a fine grained groundmass. The rock was affected by shearing and micro-cataclasis, causing severe disaggregation, accompanied by phyllic alteration, resulting in replacement by fine grained sericite, quartz, disseminated pyrite, a little chalcopyrite and trace rutile. This altered and deformed zone merges via a more quartz-rich deformed zone into semi-massive pyrite, with a little interstitial quartz and sericite. Both the host rock, but more particularly the vein material, is overprinted by possible retrograde chalcedonic quartz and subordinate clay (e.g. kaolinite).

SMD006 121.0 m TS

Summary: Porphyritic hornblende-quartz microdiorite, with strong propylitic alteration. Relict texture is well preserved, but most primary minerals are altered. The rock contains sparsely scattered plagioclase phenocrysts, along with less common, and smaller, hornblende phenocrysts in a medium grained, inequigranular groundmass with abundant plagioclase, less common ferromagnesian material, minor quartz and a little FeTi oxide. Imposition of pervasive alteration led to strong replacement by albite, with chlorite and patchy epidote also being common. A little sericite also formed at altered plagioclase sites and leucoxene developed at ferromagnesian sites and from FeTi oxide. Sparsely distributed throughout the rock are irregular to veinlike epidote aggregates, locally associated with traces of carbonate, bornite and rare chalcopyrite. The altered rock is cut by a few thin, sub-planar veins of chlorite and rare quartz.

SMD006 134.5 m PTS

Summary: Strongly altered and locally veined porphyritic dacite. The rock has moderately well preserved relict texture, indicating that it contained plagioclase and hornblende phenocrysts, as well as a few microphenocrysts of FeTi oxide and quartz, set in a finely granular quartzofeldspathic groundmass. Imposed alteration was of propylitic type and it caused albitisation of plagioclase and as well as significant replacement by sericite, plus minor chlorite and carbonate. Ferromagnesian material was replaced by chlorite, with a little quartz, sericite, epidote, rutile and trace chalcopyrite. FeTi oxide was replaced by rutile ± carbonate ± chalcopyrite. Irregularly scattered are apparent replacive alteration patches containing sericite, chlorite, quartz and local chalcopyrite, pyrite, sphalerite, epidote and rutile. There was minor early thin quartz-rich veining and this was followed by more extensive veining by sericite and with possible overprinting carbonate (maybe siderite) and epidote, with traces of chalcopyrite and sphalerite.

SMD006 147.7 m PTS

Summary: Porphyritic dacite, showing moderate to strong propylitic alteration and hosting a few mineralised veins. The rock has well preserved relict texture and retains partly altered plagioclase phenocrysts, along with a few quartz and apatite microphenocrysts. All former ferromagnesian (e.g. hornblende) phenocrysts are altered. The phenocrystal phases occur in a very fine grained, low weakly flow foliated groundmass containing plagioclase, alkali feldspar and subordinate quartz. The imposition of alteration led to part replacement of plagioclase by albite, sericite and epidote. All former ferromagnesian material was replaced, mostly by chlorite and epidote, but with a little quartz, carbonate, chalcopyrite and rutile. A prominent quartz-rich vein occurs, containing minor chalcopyrite and bornite, and there are a few other narrow veins with quartz and/or carbonate and a little chalcopyrite and bornite.

<u>SMD006 202.2 m TS</u>

Summary: Porphyritic dacite, with rather strong propylitic alteration and having well preserved relict texture. The rock contained scattered plagioclase and hornblende phenocrysts (now altered) and retains a few smaller quartz phenocrysts. These are enclosed in a fine grained quartzofeldspathic groundmass containing characteristic small subhedral quartz grains. Pervasive alteration led to plagioclase being replaced by albite and significant sericite, with all ferromagnesian material being altered, mainly to chlorite. In the groundmass, there is some preservation of primary alkali feldspar, but significant replacement by albite, chlorite and carbonate has occurred. A few thin sericite and/or carbonate veins pervade the rock. A trace of chalcopyrite is observed, at altered ferromagnesian and FeTi oxide sites.

<u>SMD006 216.9 m TS</u>

Summary: Porphyritic dacite, with rather strong propylitic alteration and having well preserved relict texture. Scattered plagioclase and hornblende phenocrysts originally occurred, but are now altered. A few relict quartz phenocrysts are preserved, along with rare microphenocrysts of apatite, but all former FeTi oxide microphenocrysts are altered. A fine grained quartzofeldspathic groundmass hosted the phenocrystal phases, with it displaying characteristic small subhedral quartz grains. Pervasive alteration led to replacement of plagioclase by albite and sericite, and minor carbonate, with former hornblende replaced by chlorite, plus a little carbonate, and FeTi oxide is replaced by leucoxene. Alteration-derived sericite and chlorite is common in the groundmass. Rare small grains of pyrite are associated with altered hornblende and plagioclase sites.

<u>SMD006 263.0 m TS</u>

Summary: Strongly altered porphyritic hornblende-quartz microdiorite. The rock has moderately well preserved relict texture and evidently contained scattered plagioclase and probable hornblende phenocrysts originally, with these set in a fine to medium grained groundmass composed of abundant plagioclase, subordinate ferromagnesian material and minor quartz and FeTi oxide. The rock was subject to pervasive propylitic alteration, with this causing albitisation of plagioclase and commonly strong overprinting by sericite, carbonate (calcite) and chlorite. Ferromagnesian material was replaced mostly by chlorite and carbonate, and FeTi oxide by leucoxene-rutile. A little pyrite occurs sparsely as part of the alteration, in the groundmass and at former ferromagnesian sites. A couple of carbonate veins cut the altered rock.

<u>SMD006 272.5 m PTS</u>

Summary: Porphyritic hornblende dacite, displaying rather strong hydrothermal alteration of transitional propylitic to argillic type. Relict texture is well preserved, however, and it is apparent that the rock contained scattered phenocrysts of plagioclase and a ferromagnesian phase (e.g. hornblende) as well as a few quartz phenocrsts and microphenocrysts of FeTi oxide and apatite. Phenocrystal grains occur in a fine grained, granular groundmass containing characteristic small subhedra of quartz, as well as plagioclase and alkali feldspar. Apart from quartz and apatite, all phenocrystal phases are altered, and there has also been some replacement of the groundmass. Plagioclase was initially replaced by albite, with further replacement by sericite, clay (e.g. kaolinite) and carbonate. Ferromagnesian material is mostly replaced by chlorite and FeTi oxide by rutile. A little pyrite has formed in the groundmass and at ferromagnesian sites, and at the latter, there are also small amounts of chalcopyrite and rare sphalerite. A couple of thin, discontinuous carbonate-clay veins occur.

<u>SMD006 278.2 m PTS</u>

Summary: Intensely hydrothermally altered rock hosting an array of veins. No definite relict textures are preserved in the host rock, which also has indications of micro-cataclasis and foliation, although it is speculated that it was originally of felsic igneous type. The deformation in the host rock could be an indication of control of vein emplacement, i.e. in a sheared and cataclastic zone. The host rock was replaced by a phyllic assemblage of dominant sericite and quartz, with irregularly distributed pyrite, minor chlorite and carbonate, and trace chalcopyrite and rutile. Possible early veining of the host rock occurred, with these veins being quartz-rich and having considerable pyrite and minor chalcopyrite. These veins show imposed deformation features. The major veining in the sample is dominated by medium to coarse carbonate (calcite), with subordinate quartz, a few aggregates of chalcopyrite and a little pyrite, sericite, chlorite and trace galena and sphalerite.

SMD006 297.5 m PTS

Summary: Strongly hydrothermally altered and veined rock, originally or porphyritic intermediate to felsic type, possibly quartz microdiorite or microtonalite. The host rock contained a few plagioclase phenocrysts in a medium grained groundmass of feldspar, ferromagnesian material (e.g. hornblende), minor quartz and FeTi oxide. It was strongly veined, with elongate screens of altered host rock being incorporated into the vein array. Relict texture is poorly to moderately preserved in the host rock, which has been replaced by sericite, chlorite, quartz and minor pyrite plus traces of rutile, but in some of the vein-hosted screens, alteration is more intense, to chlorite and pyrite, with a little associated Fe-poor sphalerite, sericite, quartz and carbonate. Veins are dominated by carbonate (calcite) with local quartz, and a little pyrite, sericite, chlorite, Fe-poor sphalerite and trace chalcopyrite.

SMD006 303.8 m TS

Summary: Medium to coarse grained felsic igneous rock, possibly of original tonalite type, showing strong hydrothermal alteration and local zones of microbrecciation. Due to the imposed effects, relict texture is poorly to moderately preserved, but it is likely that the rock originally contained abundant plagioclase, ferromagnesian material (perhaps hornblende and maybe biotite) and interstitial quartz, with plagioclase locally occurring as phenocrysts. The rock contains irregular zones of microbrecciation, apparently developed prior to, or during hydrothermal alteration. The latter process caused initial albitisation of plagioclase, but widespread replacement by chlorite, subordinate fine grained quartz, minor sericite and leucoxene. A couple of quartz veins occur, but were evidently disrupted, and there is also a single thin carbonate vein.

SMD006 314.5 m PTS

Summary: Strongly hydrothermally altered and locally veined, porphyritic hornblende dacite, transitional to quartz andesite. The rock has moderately well preserved relict texture, indicating that it formerly contained phenocrysts of plagioclase and hornblende and a few microphenocrysts of FeTi oxide, and rare quartz and apatite. The phenocrystal phases occurred in a fine grained granular groundmass of quartzofeldspathic type. Pervasive alteration is of propylitic type and although plagioclase was initially albitised, much was subsequently replaced by sericite and local carbonate. Ferromagnesian material was mostly replaced by chlorite and FeTi oxide by rutile. In the groundmass, fine grained sericite, chlorite and quartz are abundantly developed in places, and there is a little disseminated pyrite and trace sphalerite. A few veins occur, commonly with significant carbonate (calcite) as well as scattered pyrite, sericite, local quartz and chlorite, and several small aggregates of Fe-poor sphalerite.

SMD006 324.6 m PTS

Summary: Porphyritic intermediate to felsic igneous rock showing very strong hydrothermal alteration. Portion has minor retention of relict texture, suggesting that it formerly contained possible feldspar (e.g. plagioclase) and ferromagnesian phenocrysts, as well as a few microphenocrysts of FeTi oxide, in a finer grained groundmass. This part of the sample was replaced by a fine to medium grained assemblage of quartz, with subordinate sericite and carbonate, minor chlorite and a little rutile and pyrite. The remainder of the sample shows irregular to veinlike masses of medium to coarse grained pyrite, with interstitial aggregates of sericite, carbonate (calcite) and chlorite. A little rutile occurs in these domains, attesting to them being a product of intense replacement, rather than hydrothermal infill. A little Fe-poor sphalerite is associated with pyrite, generally filling fractures.

SMD006 336.1 m TS

Summary: Porphyritic hornblende dacite with moderately preserved relict texture, and having strongly overprinting alteration of propylitic type, as well as emplacement of several veins. The rock originally contained scattered phenocrysts of feldspar (probably plagioclase) and ferromagnesian material (e.g. hornblende) as well as rare quartz, in a fine to medium grained, largely quartzofeldspathic groundmass. Initially, plagioclase was replaced by albite, with subsequent strong development of sericite ± carbonate. Ferromagnesian material was largely replaced by chlorite ± carbonate, and FeTi oxide by leucoxene-rutile. Apparently earlier vein sets contain chlorite and/or quartz, in places with small amounts of sulphides, including chalcopyrite, galena, Fe-poor sphalerite and pyrite. These veins might evolve into, and/or are overprinted by, carbonate-rich veins ± quartz and sericite.

SMD006 351.5 m PTS

Summary: Porphyritic hornblende dacite showing strong propylitic alteration and patchy irregular to veinlike masses containing minor sulphides. The rock has moderately preserved relict texture, indicating that it contained plagioclase and ferromagnesian (e.g. hornblende) phenocrysts, along with rare, small quartz phenocrysts, set in a fine grained quartzofeldspathic groundmass. The imposed alteration led to significant albite development, overprinted by abundant sericite, and lesser chlorite and carbonate, with quartz and sericite being rather abundant in the groundmass. A little pyrite and rutile were also components of the alteration. The irregular and veinlike replacive aggregates contain varying proportions of sericite, chlorite and carbonate, with locally associated aggregates of Fe-poor sphalerite, pyrite and a little chalcopyrite, commonly forming composites.

Drill hole SMD007

SMD007 194.0 m TS

Summary: Strongly altered weakly porphyritic hornblende-quartz microdiorite. The rock has moderately preserved relict texture, indicating that it was originally feldspar (probably plagioclase)-rich, with subordinate ferromagnesian material (e.g. hornblende), minor interstitial quartz and a little disseminated FeTi oxide. Original feldspar was totally replaced, by varying proportions of fine grained sericite and clay (perhaps illite-smectite and/or kaolinite), with minor quartz and chlorite. Ferromagnesian material was replaced by chlorite and trace leucoxene, and FeTi oxide was replaced by leucoxene. Sparsely scattered in the rock are alteration aggregates of quartz and chlorite, locally with a little pyrite and chalcopyrite.

SMD007 218.0 m PTS

Summary: Former porphyritic quartz microdiorite or microtonalite with very strong hydrothermal alteration and emplacement of veins. Due to alteration, relict texture is rather poorly preserved, but the protolith did contain a few large feldspar (e.g. plagioclase) phenocrysts, enclosed in a medium grained mass of feldspar, subordinate ferromagnesian material (maybe hornblende) and minor quartz. The rock was affected by alteration that is considered to be transitional between phyllic and propylitic type, with replacement by abundant sericite, lesser quartz, minor chlorite, pyrite and chalcopyrite and a trace of rutile. A few veins were emplaced with these initially containing medium grained quartz and patchy sericite (mainly adjacent to margins) and locally substantial medium to coarse grained pyrite and chalcopyrite. Subsequently, it appears that the major vein was deformed, being subject to microbrecciation and overprinting by late stage chalcedonic silica, in part containing pigmentation by/small inclusions of a brown clay phase (maybe smectite).

SMD007 221.7 m TS

Summary: Porphyritic microtonalite with strong hydrothermal alteration of transitional propyltic-argillic type. The rock originally contained scattered feldspar (e.g. plagioclase) phenocrysts, enclosed in a medium grained, inequigranular aggregate of feldspar, ferromagnesian material and subordinate quartz, with a little FeTi oxide. Imposed alteration led to feldspar being replaced by fine grained aggregates of sericite, with subordinate clay and minor quartz and chlorite. Ferromagnesian material was replaced by chlorite with a little sericite and leucoxene, and FeTi oxide was replaced by leucoxene. The rock contains a few texturally-destructive replacement aggregates of quartz, chlorite and local sericite, with a little associated carbonate, pyrite and chalcopyrite. A couple of thin veins occur in the rock, containing quartz or carbonate.

SMD007 228.7 m TS

Summary: Medium grained mafic to possibly intermediate igneous rock, interpreted as a hornblende microgabbro, but with strong pervasive alteration. The latter could be due to imposed hydrothermal process or low grade metamorphism. The rock originally contained abundant plagioclase, intergrown with scattered prismatic-acicular amphibole (e.g. hornblende), another ferromagnesian phase (maybe clinopyroxene or olivine) and a little disseminated FeTi oxide. Pervasive alteration led to albitisation of plagioclase, initial replacement of hornblende by tremolite-actinolite, and subsequent rather strong replacement of the rock by chlorite, patchy epidote, minor quartz and a little leucoxene. Subsequently, further retrograde alteration appears to have occurred, with development of a fine grained clay phase (maybe smectite) at ferromagnesian sites.

SMD007 234.9 m TS

Summary: Porphyritic hornblende-quartz microdiorite with strong propylitic alteration and an array of veins, locally forming small zones of hydrothermal breccia. The rock originally contained phenocrysts of plagioclase and a ferromagnesian phase (e.g. hornblende) in a fine to medium grained groundmass rich in feldspar, plus subordinate ferromagnesian material, minor quartz and FeTi oxide. Alteration led to initial albitisation of feldspar, with subsequent strong replacement of the rock by chlorite and sericite, and a little quartz, carbonate and leucoxene. Vein and local breccia fill have abundant sericite in places, with an apparent evolution into fillings with considerable medium grained carbonate (ankerite or siderite), quartz and chlorite, and with trace chalcopyrite and pyrite.

SMD007 238.1 m PTS

Summary: Porphyritic microdiorite having strong propylitic alteration and a stronger zone of phyllic alteration about a major quartz-sulphide-carbonate vein. Although relict texture is poorly to moderately preserved, it is likely that the rock formerly contained scattered feldspar (e.g. plagioclase) and less common ferromagnesian phenocrysts in a finer grained groundmass. A major vein and several subsidiary veins occur, with these containing abundant quartz, strongly disseminated pyrite and chalcopyrite, patchy carbonate, and a little Fe-poor sphalerite. Away from the main vein, the propylitic alteration caused replacement of the rock by sericite, subordinate chlorite and minor quartz and pyrite, whereas in vein-proximal phyllic alteration, sericite is the dominant alteration phase, with subordinate quartz and pyrite, and trace chalcopyrite.

SMD007 240.05 m PTS

Summary: Quartz-sulphide dominated rock, with local disseminations and diffuse bands containing significant chromite, as well as chlorite. The presence of chromite indicates that the rock had an ultramafic composition protolith. It is speculated that there was initial replacement of the ultramafic rock by chlorite, with subsequent flooding with quartz and emplacement of probable quartz-sulphide veining. This process might have been syn-tectonic, as relict chromite is fractured and variably disaggregated, fine through to coarse grained quartz shows strain phenomena, local elongate fibre growth and recrystallization, and pyrite is commonly fractured and invaded by chalcopyrite and quartz. There are many examples of paragenetically early chromite being invaded by quartz, chlorite and sulphides. The rock has a crudely layered appearance due to intercalation of quartz-rich, sulphide-rich, and local chromite-rich bands.

SMD007 240.8 m PTS

Summary: Chlorite-sulphide rock, with minor disseminated relict chromite, and a little alteration-derived quartz, carbonate and trace rutile. Sulphides include chalcopyrite and subordinate pyrite and they range from disseminated to veinlike and massive aggregates hosted in abundant chlorite. The presence of relict chromite and the probable Mg-rich nature of chlorite, plus traces of rutile, suggest that the protolith was of ultramafic to mafic igneous type. It was subject to intense hydrothermal alteration and development of a local clast-supported breccia texture, with chlorite-rich aggregates tending to be enclosed by sulphide-rich domains. Chromite is a relict mineral, paragenetically early and enclosed by sulphides. Pyrite grains are locally zoned, fractured and apparently locally replaced by chalcopyrite.

SMD007 242.2 m TS

Summary: Porphyritic microdiorite with strong argillic alteration. The rock has moderately preserved relict texture, indicating that it contained scattered phenocrysts of plagioclase and two different types of ferromagnesian phase, and a few microphenocrysts of FeTi oxide in a fine to medium grained, plagioclase-rich groundmass, with minor ferromagnesian material and a little quartz. Relict shapes suggest that some of the ferromagnesian phenocrysts were originally hornblende, but others, containing relict tiny inclusions of a possible FeCr spinel phase, could have been clinopyroxene. Strong alteration led to albitisation of plagioclase and its further replacement by sericite and minor clay (e.g. kaolinite). Ferromagnesian material was replaced by quartz, albite, clay and a little carbonate and leucoxene, and FeTi oxide was replaced by leucoxene. A few apparent metasomatic aggregates of quartz and minor carbonate occur in the groundmass and the rock hosts a single thin quartz (-carbonate) vein.

SMD007 242.5 m TS

Summary: Matrix-supported sandstone, tending to conglomerate, containing abundant detrital quartz grains and larger, diverse lithic fragments. The latter include siltstone, grading to cherty argillite, possible chert, ultramafic and mafic igneous rocks. There are also a few detrital grains of chromite, probably liberated from former ultramafic hosts, and rare K-feldspar. The matrix to the sandstone is fine grained and recrystallised. It is likely that rock types expressed in the lithic fragments were altered and/or veined prior to being incorporated into the clastic sedimentary rock. Interpreted ultramafic composition material was replaced by chlorite, and mafic material by quartz and chlorite. Possible chert was finely recrystallised and veined by quartz, but some of this material could also represent intensely silicified rock ultimately of ultramafic or mafic composition. The sandstone matrix was recrystallised to fine grained chlorite and quartz, with all components of the rock being overprinted by disseminations and thin veinlets of sericite and trace carbonate, with this material being impregnated by goethite (possibly a deep supergene alteration effect).

SMD007 246.8 m TS

Summary: Schistose serpentinite, probably derived from a harzburgite protolith, and cut by an array of carbonate-rich veins (e.g. magnesite). The rock retains a few relict chromite grains, with the serpentinite having developed a weak to moderate foliation and a couple of early serpentine (maybe chrysotile) veins. The emplacement of the carbonate-rich veins might have been syn-tectonic as some are emplaced largely co-planar with foliation, whereas others are oblique. These veins commonly show foliation and recrystallization textures and in places contain considerable fine grained talc, along with minor disseminations and elongate concentrations of magnetite. A major carbonate-rich vein contains several elongate magnetite concentrations, some of which are partly replaced by hematite. This vein is also cross-cut by a few narrow quartz-rich veins at a high angle.

Drill hole SMD008

SMD008 142.8 m TS

Summary: Intensely hydrothermally altered and brecciated rock, originally of porphyritic felsic igneous type, perhaps dacite. Relict texture is poorly to moderately preserved and indicates that the protolith contained scattered feldspar and less common quartz and smaller ferromagnesian phenocrysts, and a few microphenocrysts of FeTi oxide in a fine grained quartzofeldspathic groundmass. The rock was affected by hydrothermal alteration of transitional phyllic-argillic type, with abundant veining and breccia infill by medium grained quartz. Feldspar and ferromagnesian phenocrysts were largely replaced by sericite, with minor clay at the former and a little rutile at the latter. FeTi oxide was replaced by rutile and the groundmass was replaced by dominant quartz, with subordinate clay (e.g. kaolinite). There is evidence for imposed strain and part recrystallization on hydrothermal infill quartz and in relict quartz phenocrysts.

SMD008 178.5 m TS

Summary: Fine to medium grained sandstone, tending to siltstone, with strong pervasive alteration transitional between argillic and phyllic types. Relict texture is moderately preserved and it is apparent that the protolith had a largely grain-supported texture, with abundant detrital quartz and subordinate amounts of feldspar, probable fine grained lithics and traces of muscovite, chlorite, FeTi oxide (now altered) and zircon. An original matrix component was probably minor. The rock could have experienced low grade metamorphism, resulting in partial recrystallization as well as local silicification and emplacement of a single, thin sub-planar quartz vein. Subsequently, strong alteration was imposed, causing replacement of detrital feldspar, lithic material and any matrix by fine grained, low-birefringent clay (e.g. kaolinite) and sericite, with trace leucoxene developed from FeTi oxide. In parts of the sample, clay alteration is strongly prevalent, with possible dissolution of detrital quartz.

SMD008 207.0 m TS

Summary: Fine to medium grained sandstone, tending to siltstone, displaying strong hydrothermal alteration and minor veining. The rock has moderate preservation of relict detrital grain texture. It contained abundant detrital quartz and less common detrital feldspar and/or fine grained lithic material, hosted in a relatively large matrix component, such that the rock has a matrix-supported texture. It is likely that the rock initially underwent partial recrystallization due to metamorphism and development of considerable interstitial metamorphic biotite, as well as quartz and muscovite-sericite. Emplacement of a couple of quartz-rich veins could have coincided with extensive retrograde alteration, interpreted to be of transitional propylitic-argillic type, with this resulting in replacement of metamorphic biotite and any prior feldspar, and formation of patchily abundant low-birefringent clay (e.g. kaolinite), chlorite, sericite and traces of leucoxene and pyrite.

SMD008 225.0 m TS

Summary: Fine grained, matrix-supported siltstone, showing local veining and a strong retrograde alteration overprint. Relict detrital grain texture is moderately preserved and it is indicated that the rock had small detrital quartz grains and probably, a subordinate amount of detrital fine grained lithics and feldspar (plagioclase) in a fine grained matrix, now considerably recrystallised. It is proposed that the rock experienced initial metamorphism resulting in development of fine grained metamorphic biotite in the matrix, together with recrystallization of quartz. Veins emplaced are quartz-dominated, but also locally contained plagioclase and possible biotite. The imposition of retrograde alteration of transitional propylitic-argillic type led to destruction of all interpreted biotite and some of the feldspar, and formation of abundant fine grained clay (e.g. kaolinite), chlorite and sericite, and a trace of leucoxene. A single thin vein was emplaced during the retrograde stage and contains chlorite, sericite and pyrite.

SMD008 233.8 m TS

Summary: Very strongly hydrothermally altered and locally veined porphyritic felsic igneous rock, perhaps originally of dacite type. Relict texture is poorly to moderately preserved, but there are scattered relict quartz phenocrysts and pseudomorphs after former feldspar and ferromagnesian phenocrysts in a fine grained altered groundmass. Alteration is largely of phyllic type, but in part transitional to propylitic, with the dominant alteration minerals being quartz and sericite. In part of the sample, chlorite is more prevalent at altered ferromagnesian and feldspar sites, and there are small amounts of clay (e.g. kaolinite), leucoxene-rutile and pyrite. A few quartz-rich veins cut the altered rock and they appear to be post-dated by a couple of thin veins of quartz, pyrite and sericite.

SMD008 238.0 m PTS

Summary: Former fine grained siltstone, with strong hydrothermal alteration and replacement by varying proportions of quartz and sericite, with trace rutile and pyrite. The altered siltstone is fractured and has small irregular veins of sericite, pyrite and quartz. A major quartz-pyrite vein abuts the altered siltstone, originally containing medium to coarse grained quartz and disseminated to semi-massive pyrite. Coarser pyrite grains host sparse small inclusions of chalcopyrite and bornite. Subsequently, the vein was strongly brecciated, developing fragments of quartz, pyrite and a small proportion of strongly altered siltstone. Breccia fragments are thinly encrusted by banded chalcedonic silica.

Drill hole SMD009

SMD009 43.0 m TS

Summary: Rather coarse sedimentary breccia, with a generally matrix-supported texture and containing angular to sub-rounded fragments of fine grained porphyritic mafic to intermediate volcanic rock and fine grained siltstone, hosted in a fine grained siltstone matrix that is pigmented by carbonaceous material and contains minor disseminated pyrite. Relict texture is well preserved and demonstrates that the volcanic fragments contained scattered plagioclase phenocrysts in a fine grained groundmass. Siltstone fragments had a minor proportion of detrital muscovite and quartz grains, but are dominated by fine grained matrix. Similarly, the breccia matrix is fine grained siltstone, containing sparse grains of plagioclase (disaggregated from volcanic fragments) as well as minor quartz. It is likely that the rock has experienced low grade alteration (e.g. burial metamorphism), with development of abundant fine grained clay phases (maybe illite-smectite and kaolinite) and less common chlorite and sericite, along with minor disseminated pyrite.

SMD009 59.4 m PTS

Summary: Relatively massive serpentinite showing effects of overprinting hydrothermal alteration and associated veining. Relict textures in the serpentinite suggest that it was derived from an olivine-rich peridotite protolith (e.g. harzburgite) also containing a few former pyroxene grains and retaining a few chromite grains. Imposed alteration led to development of irregular and veinlike masses of fine grained carbonate (e.g. ferroan magnesite) along with minor associated sulphides and talc. A few aggregates of chlorite developed elsewhere in the rock. Sulphides include fine grained pyrite and a trace of pyrrhotite, and they are most common in veins and small aggregates hosted in carbonate.

SMD009 78.7 m TS

Summary: Massive serpentinite, derived from a peridotite (harzburgite) protolith. Relict mesh texture after olivine, and bastite texture after orthopyroxene grains occur, and there are a few preserved primary chromite grains. The protolith was replaced by lizardite and a little magnetite (outlining mesh texture) and then cut by an array of thin serpentine (maybe chrysotile) veins and subsequently by serpentine + magnetite veining. A little disseminated and veinlet carbonate formed later.

SMD009 84.1 m TS

Summary: Porphyritic microdiorite with crowded phenocryst texture, probably intrusive into a former mafic to ultramafic composition igneous rock, and with both subsequently being overprinted by deformation and metamorphic recrystallization. The interpreted microdiorite had abundant plagioclase phenocrysts and subordinate ferromagnesian material. The mafic to ultramafic rock appears to have contained a few large plagioclase grains and it retains sparsely scattered small grains of FeCr spinel. The remainder of this rock type was presumably rich in ferromagnesian minerals. The imposition of metamorphism and deformation led to extensive recrystallization of the mafic-ultramafic rock, with replacement by weakly to moderately foliated fine through to coarse amphibole (tremolite-actinolite or magnesio-hornblende) and locally common interstitial fine grained talc. In the microdiorite, plagioclase was locally overgrown by amphibole, and there was also development of a little sericite and chlorite. Metamorphic conditions imposed on the protolith materials could have ranged from greenschist to (lower) amphibolite.

SMD009 142.0 m TS

Summary: Metamorphosed and deformed coarse grained mafic to ultramafic igneous rock, perhaps ultimately of norite-gabbro to pyroxenitic composition. Although largely replaced, it is considered that the protolith was dominated by pyroxenes (e.g. orthopyroxene and clinopyroxene), plagioclase and possible amphibole, and there is retention of sparse grains of FeCr spinel. There was imposition of metamorphism at greenschist to lower amphibole facies conditions, as well as penetrative deformation. This led to replacement of primary ferromagnesian phases, as well as some primary plagioclase, with development of abundant fine through to coarse grained amphibole (tremolite-actinolite or magnesio-hornblende), with subordinate amounts of interstitial talc and minor phlogopite-biotite. The rock was later cut by irregular zones of micro-cataclasis, with development of microbreccia containing disaggregated host rock in a fine grained amphibole-rich matrix.

SMD009 157.5 m TS

Summary: Prehnite-tremolite rock, representing the product of intense calc-silicate alteration of a possible mafic to intermediate igneous composition protolith (e.g. gabbro, diorite). No relict texture is preserved from a protolith, which was replaced by intercalated domains rich in one or the other of amphibole and prehnite. Amphibole is typically near-colourless, but locally pale green, commonly of prismatic form and occurring in sub-radiating aggregates. Prehnite is commonly a little coarser grained and inequigranular to sub-radiating in form. A little titanite occurs irregularly throughout, and there are a couple of weakly foliated chlorite-rich aggregates. The alteration assemblage could have formed under greenschist facies metamorphic conditions and is typical of that found in metasomatic reaction zones associated with serpentinites.

Interpretation and comment

The sample suite comprises a diverse group of original igneous and sedimentary rocks showing an equally wide range of products of imposed processes. Igneous rocks range from felsic to ultramafic compositions, with sedimentary rocks ranging from fine to coarse clastic types. Imposed processes include hydrothermal alteration and associated veining and sulphide mineralisation, and in some samples, effects of deformation and metamorphism.

Primary rock types

Identification of primary rock types is based on interpretation of relict textures and relict minerals, where preserved. There is a range in the samples from well preserved primary characteristics through to those in which these characteristics are poorly preserved, or in a few rocks, totally obliterated. In the situations of poor or no preservation, the nature of the primary rock type has been inferred from the bulk mineralogical constitution of alteration assemblages.

Felsic to intermediate composition, and commonly porphyritic rocks constitute the majority of samples in the suite (25 out of 40). Where discernable, the major rock types in this large group include porphyritic dacite (maybe locally grading to quartz andesite), porphyritic microdiorite and quartz microdiorite, and porphyritic microtonalite and tonalite. Due to intense alteration, it can only be inferred in a few samples (SMD006/60.2 m, SMD006/60.6 m, SMD006/114.0 m, SMD006/278.2 m) that the protoliths were also originally of felsic igneous type. The dacites typically contained plagioclase and hornblende phenocrysts, with many also having quartz, and microphenocrysts of FeTi oxide and apatite. Apart from quartz and uncommon apatite, the phenocrystal phases are now altered. The groundmass of the dacites, although now commonly altered, would have contained abundant feldspars and quartz, with minor ferromagnesian material. Porphyritic microdioritic and microtonalitic rocks are similar, only varying in the amount of primary quartz. Again, they typically contained plagioclase phenocrysts and in many, hornblende phenocrysts, but with the groundmass components being coarser grained than in the dacites. The single sample identified as a tonalite (SMD006/303.8 m) appears to be medium to coarse grained and contained plagioclase, quartz and probable hornblende and biotite. It is now strongly altered and microbrecciated, blurring primary characteristics.

The porphyritic felsic to intermediate composition igneous rocks were probably emplaced as relatively shallow (e.g. sub-volcanic) intrusives. Only one sample (SMD009/84.1 m) has an actual intrusive relationship, with a strongly porphyritic microdiorite evidently having invaded a more mafic composition igneous rock (and having xenoliths of the latter). The former presence of hornblende in most rocks indicates that the igneous suite was of I-type character and that the magmas were hydrous.

Mafic and ultramafic igneous protoliths are recognised in several samples in SMD007 and SMD009. Hornblende microgabbro is interpreted to constitute sample SMD007/228.7 m, with it having undergone later low grade alteration (probable metamorphism). In samples SMD009/84.1 m and SMD009/142.0 m, there is a metamorphosed and deformed rock of amphibolitic character that is interpreted to have originally been of mafic to possibly ultramafic type (e.g. norite-gabbro to pyroxenite) and formerly containing abundant pyroxene, with lesser plagioclase and also retaining small grains of a FeCr spinel phase (chromite). Sample SMD009/157.5 m is interpreted as having had a plagioclase-rich igneous protolith, probably of gabbroic type, but it is intensely altered. The nature of the imposed processes on these protoliths is expanded upon subsequently. Other samples from SMD007 and SMD009 had ultramafic protoliths and some are identified as serpentinites (SMD007/246.8 m, SMD009/59.4 m, SMD009/78.7 m), derived from a likely harzburgite precursor, with each retaining a little relict chromite. The presence of relict chromite (of the same form as in the serpentinites) has been crucial in assigning an ultramafic protolith for samples SMD007/240.05 m and SMD007/240.8 m, even though these samples are now intensely altered and mineralised.

The relationship of the mafic and ultramafic rocks to the porphyritic felsic to intermediate igneous rocks in the suite remains speculative. As mentioned above, in SMD007/84.1 m, a porphyritic microdiorite appears to be intrusive into an amphibolitic mafic to ultramafic composition rock, and the mafic to ultramafic rocks are more deformed and metamorphosed than the felsic to intermediate rocks. Do the mafic and ultramafic rocks constitute some form of basement?

Six clastic sedimentary rocks are identified in the sample suite. Five of these samples have experienced effects of hydrothermal alteration and local veining (SMD007/242.5 m, SMD008/178.5 m, SMD008/207.0 m, SMD008/225.0 m, SMD008/238.0 m) and the sixth (SMD009/43.0 m) appears to have only enjoyed low grade alteration (e.g. burial metamorphism). The last sample is a rather coarse sedimentary breccia with a matrix-supported texture and containing fragments of intermediate to mafic volcanic rock and siltstone, in a fine grained carbonaceous and pyritic siltstone matrix. The other samples are significantly quartz-rich and range from fine grained siltstone to sandstone and local conglomerate. They have considerable relict detrital quartz, and evidently, some contained former detrital feldspar and lithic components. SMD007/242.5 m is of interest as amongst its contained lithic grains, there is ultramafic and mafic material and rare detrital chromite.

Deformation

The majority of samples in the suite, including most of the felsic to intermediate igneous rocks and sedimentary rocks, do not show significant effects of penetrative or brittle deformation. A few samples, do have development of foliation and these are mainly those of mafic to ultramafic composition. One of the serpentinites (SMD007/246.8 m) is schistose, and the metamorphosed mafic to ultramafic samples SMD009/84.1 m and SMD009/142.0 m have a weak to moderate foliation defined by preferred orientation of metamorphic prismatic/acicular amphibole. Possibly localised tectonic breccias appear to have formed, manifest in micro-cataclastic zones (microbreccia) cutting the amphibolitic rock in SMD009/142.0 m, and in tonalite sample SMD006/303.8 m. A few of the strongly hydrothermally altered rocks of former felsic igneous type (e.g. SMD006/114.0 m, SMD006/278.2 m) have evidence of shearing and micro-cataclasis that was developed during or after hydrothermal alteration and associated veining.

Imposed alteration and veining

All samples in the suite have indications of alteration and commonly associated veining that has been imposed on the various protolith types. A few samples have alteration that can probably be related to imposed metamorphism and to serpentinisation and related metasomatism, but a large majority have alteration that is related to hydrothermal processes probably intrusion-driven.

It is interpreted that some of the mafic and ultramafic composition protoliths and one of the sedimentary protoliths have experienced metamorphism, with little subsequent hydrothermal flux. Microgabbro sample SMD007/228.7 m was replaced by a lower greenschist facies metamorphic assemblage including albite, actinolite, chlorite and epidote. Mafic to ultramafic composition samples SMD009/84.1 m and SMD009/142.0 m have been largely replaced by foliated amphibole (maybe magnesio-hornblende) and talc, with minor phlogopite-biotite in the latter. It could be inferred that these rocks could have experienced metamorphism up to lower amphibolite facies. Serpentinisation of ultramafic protoliths in SMD007/246.6 m, SMD009/59.4 m and SMD009/78.7 m would have occurred under low grade metamorphic conditions to form lizardite ± magnetite. The subsequent development of carbonate (e.g. magnesite) veining and replacement (with local talc, pyrite) in these rocks could also be related to metamorphic fluids, or reflect a later, intrusion-driven hydrothermal overprint. In the interpreted altered gabbroic rock SMD009/157.5 m, the replacement assemblage is dominated by prehnite and tremolite, with a little chlorite and titanite. This calc-silicate rock has formed under low grade metamorphic conditions and it is similar to (or the same as) certain calc-silicate reaction zone rocks found in serpentinite environments (e.g. related to rodingites). The sedimentary breccia sample SMD009/43.0 m is enigmatic as it has relatively well preserved relict texture and indications of having undergone only very low grade alteration, perhaps of burial metamorphic type, forming fine grained phases including clay minerals, chlorite, sericite and minor pyrite. It also contains matured carbonaceous material in the matrix. In sedimentary protolith sample SMD008/207.0 m, there are indications that the sandstone-siltstone was initially metamorphosed, with development of biotite in the matrix, but the rock was later overprinted by hydrothermal alteration.

The majority of samples have effects of hydrothermal alteration and associated veining (and local hydrothermal brecciation). Alteration ranges from moderate to intense, with varying destruction of primary texture and minerals (generally complete except for original quartz and phases such as apatite, zircon and chromite). No hydrothermal alteration of higher temperature or low-pH types are recognised (e.g. potassic, or advanced argillic). Assemblages developed from breakdown of primary mineral phases (e.g. plagioclase and possible alkali feldspar, hornblende, biotite and FeTi oxide) are varied and conform to a range of types including propylitic, argillic and phyllic, with intergradations between, as well as local silicic, chlorite- and sulphide-rich.

Typical propylitic assemblages contain albite, chlorite and sericite, commonly with carbonate, leucoxene-rutile and pyrite, but there are variations to evidently more intense alteration in which albite is absent and there is a high proportion of sericite and/or chlorite, carbonate and quartz. The intensely altered ultramafic rock in SMD007/240.8 m, with abundant chlorite and sulphides (plus minor quartz and carbonate) could be viewed as a variant of propylitic type. Several samples are interpreted as having alteration transitional between propylitic and argillic types, manifest by the occurrence of minor to moderate amounts of clay (generally considered to be of kaolinite type), but otherwise having typical propylitic assemblages. With a decrease in amounts of albite and chlorite, and large increase in amounts of sericite, quartz (± pyrite), there is a transition from propylitic to phyllic alteration types, and there are also a couple of samples interpreted to have transitional phyllic-argillic assemblages (e,g, dacite sample SMD008/142.8 m and sandstone-siltstone SMD008/178.5 m), with phases including sericite, clay and quartz.. Strong phyllic alteration (e.g. in SMD006/60.2 m, SMD006/60.6 m, SMD006/114.0 m, SMD006/278.2 m, SMD008/238.0 m) is characterised by an assemblage of sericite, quartz and pyrite, with small amounts of Cu sulphides and trace leucoxene-rutile. These samples and others with transitions to silicic (quartz-rich) and propylitic alteration generally have the highest amounts of associated sulphides. An unusual alteration variant occurs in SMD007/240.05 m, where an interpreted ultramafic protolith was initially strongly replaced by chlorite and was overprinted by quartz replacement (silicification) and emplacement of quartz-sulphide veins. Despite these overprints, relict chromite is preserved.

Almost all hydrothermally altered rocks have associated veining, ranging from minor to abundant. In a few samples, veining grades into zones of hydrothermal brecciation (e.g. SMD006/60.2 m, SMD006/60.6 m, SMD007/234.9 m, SMD007/240.8 m, SMD008/142.8 m). Hydrothermal infill assemblages are related (and similar) to those in the enclosing host rock. Typical infill minerals are fine to locally coarse grained quartz, carbonate (commonly calcite, but some have ankerite/siderite), sulphides (mostly pyrite and chalcopyrite), and variations to those with sericite, chlorite and clay (kaolinite). Infillings with more abundant quartz and sulphides tend to be associated with phyllic (to silicic) alteration, and those with clay are associated with transitional propylitic-argillic alteration. In some serpentinites, there are early thin veins of magnetite (related to serpentinisation) and later carbonate (± pyrite, talc) and quartz and hematite. In a couple of relatively sulphide-rich and strongly altered rocks (SMD007/218.0 m, SMD008/238.0 m), there are indications of imposed microbrecciation on previously emplaced quartz-sulphide-dominated veins. Subsequently, the interstices of the breccia were filled by fine grained, thinly encrusting chalcedonic silica, most likely emplaced at rather low temperature.

Mineralisation

Minor disseminated and vein (and hydrothermal breccia) hosted sulphides occur in most samples of the suite. Sulphide contents are estimated to range from a trace, up to values of 25-40%, although a large majority have <10%. No hydrothermal magnetite is recognised with sulphides, although minor fine grained magnetite has formed as a serpentinisation product in a couple of the ultramafic rocks. Also a few of the ultramafic (to mafic) composition protoliths retain sparsely disseminated chromite (more abundant in SMD007/240.05 m at an estimated 7%), although this is really of importance only to confirm the original nature of the protolith. Chromite is seen to be paragenetically early and is commonly fractured and locally invaded by sulphides.

Samples with higher sulphide contents, as part of the alteration, and as part of hydrothermal infill, have alteration styles of strong phyllic, phyllic to propylitic and silicic types, with the major concentrations being infill (of veins and breccia zones). Generally, the most abundant sulphide phase is pyrite, with amounts ranging up to 35% (e.g. pyrite-rich samples SMD006/60.2 m, SMD006/114.0 m, SMD006/324.6 m, SMD007/240.05 m, SMD008/238.0 m). Pyrite ranges from fine to coarse grained, can host small inclusions of phases such as chalcopyrite, bornite and rare galena, and is typically paragenetically earlier than the base metal sulphides, particularly chalcopyrite, with which it is commonly associated. Chalcopyrite is generally present in sulphide-bearing assemblages up to ~1% (e.g. several samples in SMD006), but there are a few samples in SMD007 where it is more abundant. In the intensely altered ultramafic samples SMD007/240.05 m and SMD007/240.8 m, estimated chalcopyrite contents are 18% and 25%, respectively, associated with considerable pyrite. It is estimated that there is also 3% chalcopyrite in SMD007/218.0 m and 2% in SMD007/238.1 m, again associated with considerable pyrite. Chalcopyrite aggregates locally host and invade pyrite, and can be associated with generally uncommon sphalerite, bornite and rare galena. A trace through to ~1% of Fe-poor sphalerite occurs in several samples, mainly in the lower sample intervals in SMD006. Sphalerite can occur discretely, but also occurs in small composites with chalcopyrite, pyrite and uncommon galena, and in some samples shows development of “chalcopyrite disease” texture. Trace amounts of bornite are observed in three samples in SMD006 and in SMD008/238.0 m, either as tiny inclusions in pyrite, or in small composites with chalcopyrite. Galena is another rare sulphide mineral observed, associated with sphalerite and chalcopyrite, and as tiny inclusions in pyrite. In the sample suite, the only other hypogene sulphide mineral observed is a trace of pyrrhotite, in places forming composites with pyrite, in thin carbonate veins and aggregates in altered serpentinite sample SMD009/59.4 m. Tiny traces of covellite and digenite have formed by replacement of chalcopyrite in SMD006/60.2 m and 60.6 m. Evidently, these rather shallow samples have been incipiently affected by supergene oxidation.

No molybdenite or precious metal phases (e.g. gold, electrum) have been recognised in the sample suite.

Individual sample descriptions

<u>SMD006 60.2 m PTS</u>

Summary: Quartz-pyrite-sericite rock, perhaps representing a type of hydrothermal breccia. Possible host rock fragments are diffuse and extremely altered, with no relict characteristics preserved. They were replaced by varying proportions of fine to medium grained quartz, fine to coarse grained pyrite and subordinate infill fine grained sericite. A trace of rutile occurs at these sites. The possible breccia fragments are enclosed by, and merge into, infill zones of medium grained quartz, with minor patchy pyrite and sericite aggregates. Pyrite-rich domains in the rock commonly show fracturing and invasion by fine grained quartz and sericite, and a trace of chalcopyrite, with pyrite locally hosting tiny inclusions of chalcopyrite and rare bornite. A trace of covellite is present with chalcopyrite, maybe reflecting incipient supergene oxidation effects.

Handspecimen: The drill core sample is composed of an intensely hydrothermally altered rock, with a possible breccia texture. Diffuse apparent fragments are up to a few centimetres across and contain pale creamy-grey quartz, sericite and pyrite, merging into pyrite-rich masses. They appear to be enclosed by patches of pale grey infill quartz and pyrite-rich aggregates. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock is extremely hydrothermally altered and that there is no recognisable relict texture. There are scattered diffuse aggregates that could represent breccia fragments, perhaps constituting about half of the sample, with the remainder perhaps being hydrothermal infill and zones of complete replacement. The possible breccia fragments have been replaced by an assemblage with varying amounts of quartz, pyrite and sericite, and they also contain traces of fine grained rutile, indicative of the replacement of protolith material, but of unknown character. The small amount of rutile present could imply that protolith material had a low Ti content and hence could have been of relatively felsic bulk composition.

b) Alteration and structure: It is speculated that protolith material was intensely hydrothermally altered and brecciated. Resulting fragments are diffuse and replaced by fine to medium grained, inequigranular to prismatic quartz, disseminated to locally massive pyrite, small patches, grading to semi-massive aggregates of fine grained sericite, and a trace of rutile (Figs 1, 2). The altered fragments merge into, and are enclosed by hydrothermal infill that is dominated by medium grained inequigranular to prismatic quartz (grains up to 2 mm), with patchy pyrite and sericite (Fig. 1). Quartz textures in fragments and infill have similarities to those occurring in epithermal systems. The overall alteration and infill mineral assemblage ranges from phyllic to silicic type.

c) Mineralisation: The sample contains abundant pyrite, ranging from fine to coarse grained (up to 3 mm) and being more concentrated in interpreted altered fragments, where it is locally massive. Coarser pyrite is commonly fractured and invaded by fine grained quartz, sericite and trace chalcopyrite. Some pyrite aggregates have possible growth zoning textures and there are sparse small (<0.1 mm) inclusions of chalcopyrite and very rare bornite and rutile (Fig. 2). Chalcopyrite grains locally show slight replacement by covellite, implying that incipient supergene oxidation was imposed.

Mineral Mode (by volume): quartz 60%, pyrite 25%, sericite 15% and traces of rutile, chalcopyrite, bornite and covellite.

Interpretation and comment: It is interpreted that the sample is a quartz-pyrite-sericite rock, representing a product of intense hydrothermal alteration and possible hydrothermal brecciation. Diffuse possible host rock fragments have no relict characteristics preserved and were replaced by quartz, pyrite, subordinate infill sericite and a trace of rutile. The possible breccia fragments are enclosed by, and merge into, infill zones of medium grained quartz, with minor patchy pyrite and sericite aggregates. Pyrite-rich domains in the rock commonly show fracturing and invasion by fine grained quartz and sericite, and a trace of chalcopyrite, with pyrite locally hosting tiny inclusions of chalcopyrite and rare bornite. A trace of covellite is present with chalcopyrite, maybe reflecting incipient supergene oxidation effects.

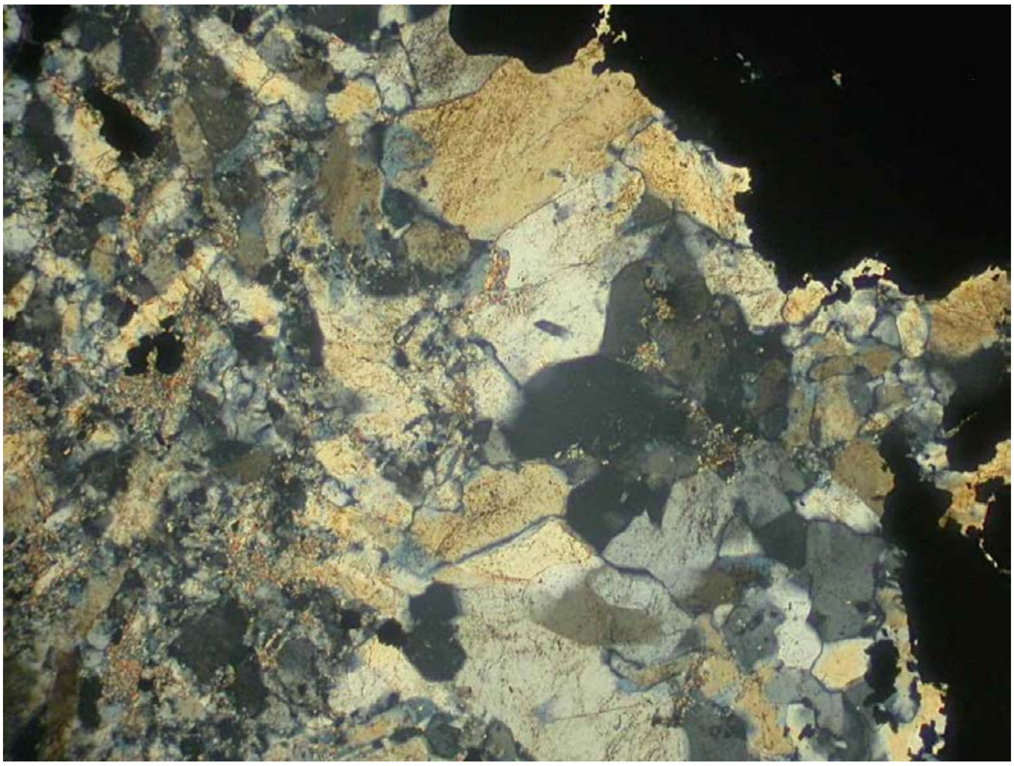


Fig. 1: Zone of medium grained hydrothermal infill quartz (centre), bordered by semi-massive pyrite (black at right) and a possible breccia fragment at left, replaced by prismatic quartz and minor sericite and pyrite. Transmitted light, crossed polarisers, field of view 2 mm across.

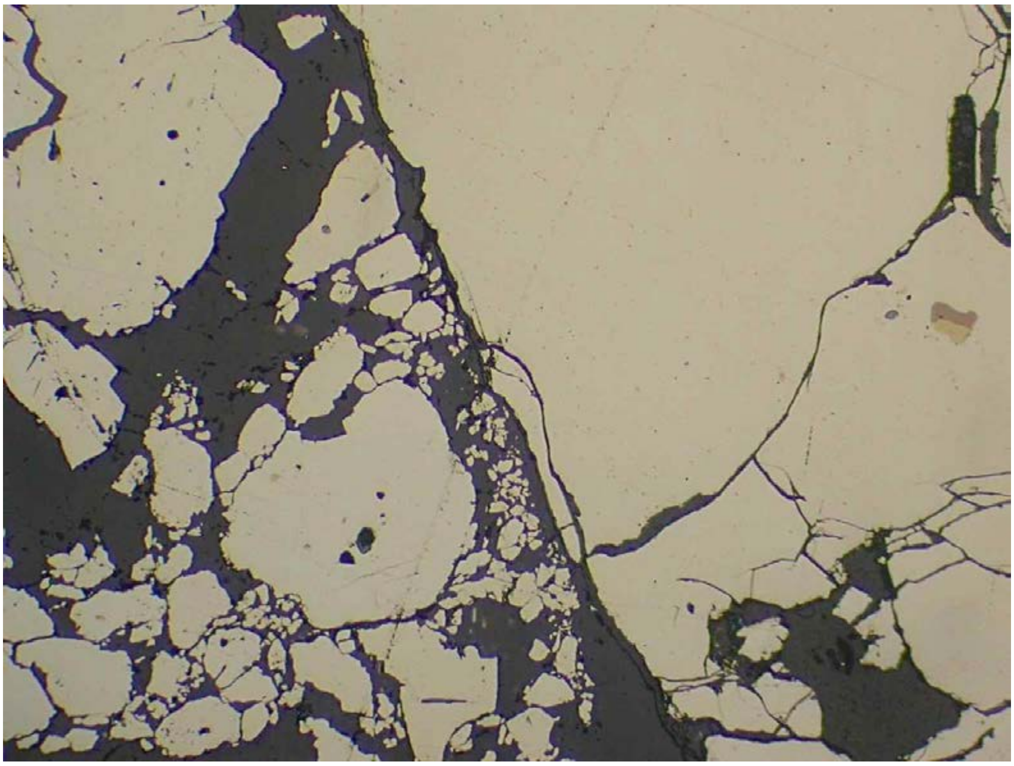


Fig. 2: Fine to coarse grained pyrite, showing local fracturing, and at right, a small composite inclusion of chalcopyrite and bornite. Plane polarised refllected light, field of view 1 mm across.

SMD006 60.6 m PTS

Summary: Quartz-pyrite-sericite rock, representing a type of matrix-supported hydrothermal breccia. Possible diffuse breccia fragments have little preserved relict texture and were intensely replaced by fine to medium grained quartz, subordinate sericite and pyrite, and a trace of rutile. Altered fragments merge into hydrothermal infill that contains irregularly distributed semi-massive aggregates of fine to medium grained pyrite, large irregular sericite aggregates and abundant medium grained quartz. A little chalcopyrite is observed interstitial to quartz and pyrite, and it also occurs as trace inclusions in pyrite. Quartz textures in the sample have significant resemblance to those observed in epithermal systems. Very slight supergene oxidation effects are apparent, with incipient replacement of chalcopyrite by digenite and covellite. The sample is similar to that at 60.2 m.

Handspecimen: The drill core sample is composed of an intensely hydrothermally altered rock, with a possible breccia texture. Apparent fragments are diffuse and up to 1-2 cm across, containing pale creamy-grey quartz, sericite and pyrite. They are enclosed by, and merge into, domains of pale grey quartz infill, associated with scattered pyrite aggregates up to 1 cm across and pale yellowish sericite aggregates up to several millimetres across. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock is extremely hydrothermally altered. There are scattered textural domains up to 1-2 cm across that are finer grained and speculated to represent possible intensely hydrothermally altered breccia fragments. Generally, these have no recognised relict texture, but locally, there are possible pseudomorphic aggregates of sericite that could be after former feldspar grains up to 1 mm across (Fig. 3). This could imply that the protolith was an igneous rock and the alteration assemblage of quartz, sericite and pyrite, with a trace of rutile, might infer a relatively felsic composition.

b) Alteration and structure: Potential protolith material was intensely hydrothermally altered and brecciated. Fragments are diffuse, up to 1-2 cm across and replaced by fine to medium grained, inequigranular to prismatic quartz, commonly disseminated pyrite, fine grained sericite forming disseminations in quartz and also small massive aggregates that could be pseudomorphic (e.g. after former feldspar), and a trace of rutile (Fig. 3). The altered fragments merge into, and are enclosed by hydrothermal infill that is dominated by medium grained inequigranular to prismatic quartz (grains up to 2 mm), with disseminated to semi-massive pyrite and scattered irregular massive aggregates of sericite up to 1 cm across. Quartz textures in fragments and infill have similarities to those occurring in epithermal systems. Breccia fragment alteration and infill mineral assemblage range from phyllic to silicic type.

c) Mineralisation: The sample contains abundant pyrite, with it generally being disseminated in the altered breccia fragments, through to disseminated and semi-massive as part of the breccia infill. Coarser pyrite (up to 2 mm) tends to be part of the infill. Within many larger pyrite grains, growth zoning is apparent and a few of the finer grained aggregates display possible bladed pseudomorphic texture (maybe after former carbonate, or marcasite). Traces of chalcopyrite occur within pyrite, locally as tiny fracture fillings. Sparse chalcopyrite also occurs elsewhere, interstitial to quartz and pyrite, forming discrete masses up to 0.5 mm across and a few composites with pyrite (Fig. 4). There are indications for incipient supergene oxidation effects, with traces of digenite and covellite having formed from chalcopyrite.

Mineral Mode (by volume): quartz 70%, pyrite and sericite each 15% and traces of rutile, chalcopyrite, digenite and covellite.

Interpretation and comment: It is interpreted that the sample represents a quartz-pyrite-sericite rock, perhaps being a matrix-supported hydrothermal breccia, with diffuse breccia fragments having little preserved relict texture and being intensely replaced by quartz, subordinate sericite and pyrite, and a trace of rutile. Altered fragments merge into hydrothermal infill containing irregularly distributed semi-massive aggregates of pyrite, with a little chalcopyrite occurring interstitial to quartz and pyrite. Quartz textures in the sample have significant resemblance to those observed in epithermal systems. Very slight supergene oxidation effects are apparent, with incipient replacement of chalcopyrite by digenite and covellite. The sample is similar to that at 60.2 m.

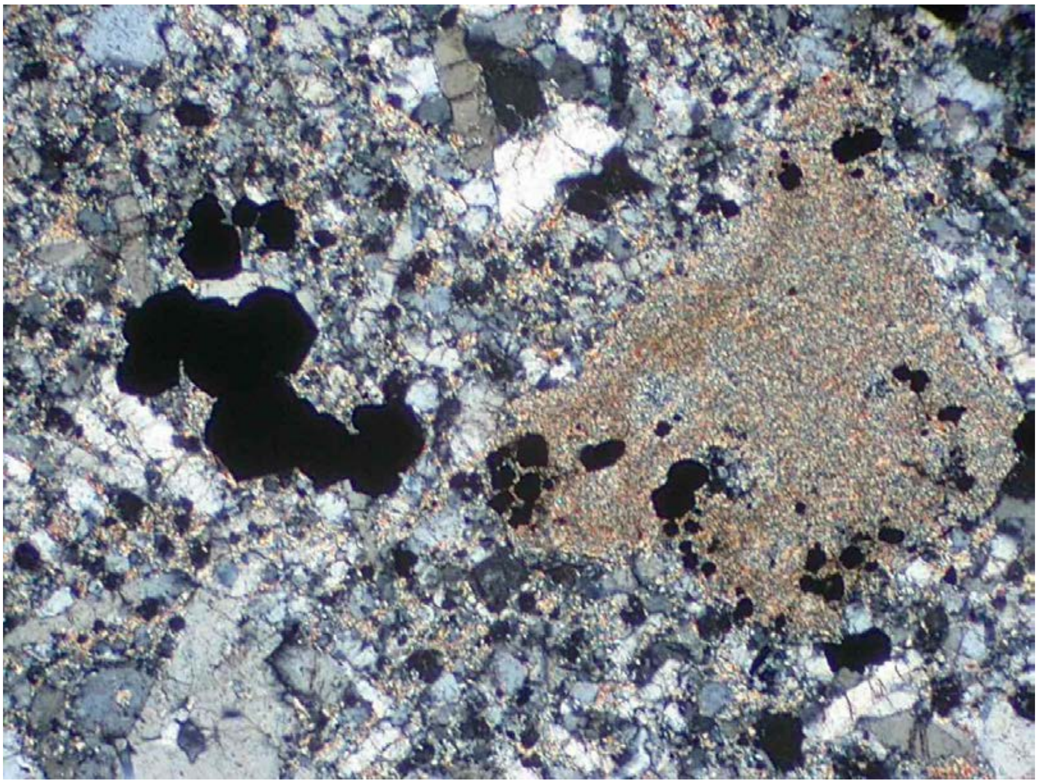


Fig. 3: Finer grained textural domain possibly representing portion of a breccia fragment of intensely altered host rock. It is composed of inequigranular to prismatic quartz, scattered sericite (including a possible pseudomorphic aggregate after a former feldspar grain) and disseminated pyrite (black). Transmitted light, crossed polarisers, field of view 2 mm across.

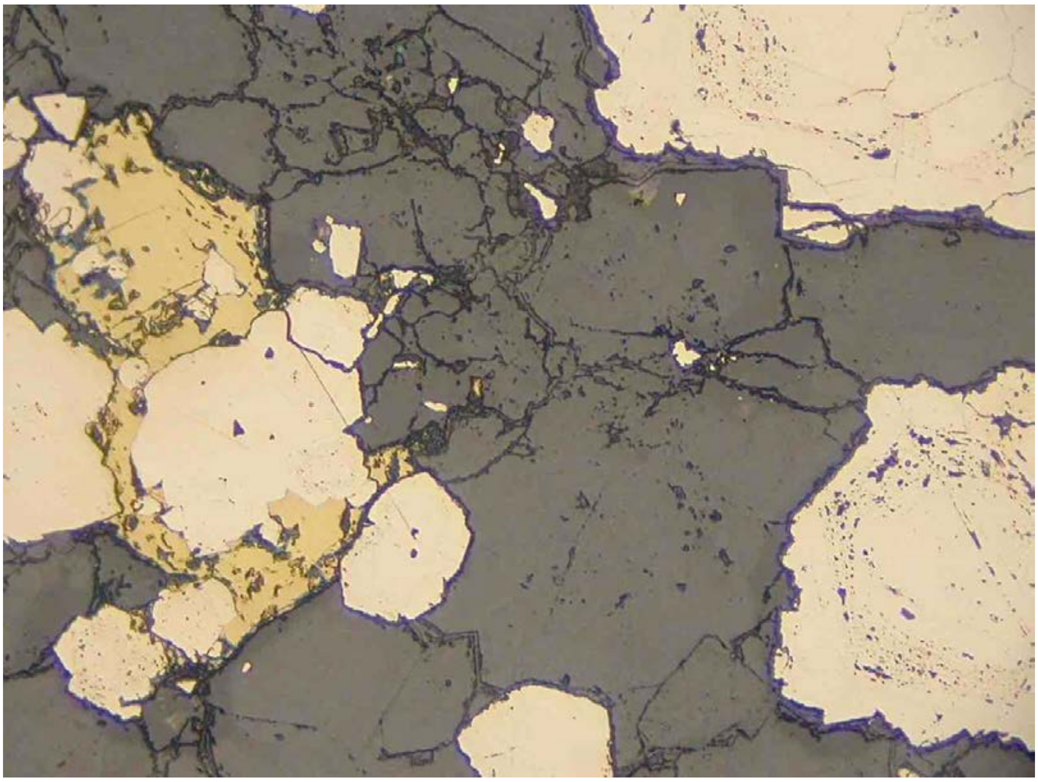


Fig. 4: Composite aggregate of pyrite and chalcopyrite (left) and weakly zoned pyrite grains (right) hosted in quartz (dark grey). Plane polarised reflected light, field of view 1 mm across.

SMD006 114.0 m PTS

Summary: Pyrite-rich vein abutting a strongly deformed and hydrothermally altered zone of host rock in which relict texture is either poorly preserved or completely obliterated. Vague vestiges of the host rock suggest that it was of felsic igneous type, with scattered small phenocrysts of feldspar and quartz in a fine grained groundmass. The rock was affected by shearing and micro-cataclasis, causing severe disaggregation, accompanied by phyllic alteration, resulting in replacement by fine grained sericite, quartz, disseminated pyrite, a little chalcopyrite and trace rutile. This altered and deformed zone merges via a more quartz-rich deformed zone into semi-massive pyrite, with a little interstitial quartz and sericite. Both the host rock, but more particularly the vein material, is overprinted by possible retrograde chalcedonic quartz and subordinate clay (e.g. kaolinite).

Handspecimen: The drill core sample exhibits a 4 cm wide veinlike mass of medium to coarse grained, largely massive pyrite, at ~45° to the core axis, patchily bordered by white quartz, and hosted within strongly hydrothermally altered and deformed host rock. The latter is pale creamy-grey in colour, in places having a sheared and brecciated texture, and replaced by fine grained sericite, quartz, local pyrite and a trace of chalcopyrite. Little relict texture is recognised in the host rock although it could be speculated to have been fine grained and possibly porphyritic. It is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, about 60% of the sample represents a zone of deformed and strongly hydrothermally altered host rock and the remainder is probably vein infill material. The interpreted host rock displays effects of shearing and micro-brecciation, as well as overprinting alteration, such that relict texture is largely destroyed (Fig. 5). In a few places, however, there are indications that the host rock could have been a porphyritic, fine grained felsic igneous type, containing microphenocrysts (<1 mm across) of feldspar (now completely altered), quartz, and a possible ferromagnesian phase, in a fine grained, quartzofeldspathic groundmass.

b) Alteration and structure: An interpreted fine grained porphyritic felsic igneous rock was strongly affected by deformation, causing development of a clast-supported microbreccia, with angular to sub-rounded fragments up to a few millimetres across, that shows weak shearing (foliation) in places (Fig. 5). Fragments are commonly disaggregated, with liberation of original phenocrystal quartz (Fig. 5) and development of elongate zones of micro-cataclasis. This deformed zone could have controlled emplacement of the adjacent vein. The deformed host rock was replaced by strong phyllic alteration, with varying proportions of fine grained sericite and quartz (local foliated quartz-rich aggregates), disseminated pyrite, a little chalcopyrite and trace rutile. Adjacent to some pyrite grains, there has been fibre quartz development as "pressure shadows". The phyllic alteration appears to be patchily overprinted by development of interstitial fine grained chalcedonic quartz and a little clay (e.g. kaolinite). There is a gradation over several millimetres from the strongly altered and deformed host rock into probable vein filling, with deformed and fragmented medium grained quartz being common in the intervening zone. The vein filling is dominated by medium to coarse grained, semi-massive pyrite, with interstitial fine grained chalcedonic quartz (as fine encrustation) and infill low-birefringent clay (e.g. kaolinite) as well as minor patchy quartz and sericite. Pyrite grains host rare small inclusions of ?anhydrite and chalcopyrite. The chalcedonic quartz-clay infill could be retrograde and may replace earlier quartz and sericite.

c) Mineralisation: In the probable vein filling, pyrite is abundant, being medium to coarse grained (individual grains up to 2 mm and aggregates up to 3.5 mm). Tiny inclusions of chalcopyrite occur sparse in coarser pyrite. In the deformed and altered host rock, disseminated pyrite is common (grains up to 1 mm) and there are local occurrences of chalcopyrite (up to 0.5 mm) in places forming composites with pyrite (Fig. 6). No molybdenite was observed in the sample.

Mineral Mode (by volume): quartz and pyrite each 30%, sericite 25%, chalcedonic quartz 10%, clay 5% and traces of chalcopyrite, rutile and ?anhydrite.

Interpretation and comment: It is interpreted that the sample is a strongly deformed and hydrothermally altered rock, in which relict texture is either poorly preserved or completely obliterated, and with this material abutting against a pyrite-rich vein. Vestiges of relict texture in the host rock suggest that it was of fine grained, porphyritic felsic igneous type. The rock was affected by shearing and micro-cataclasis, causing considerable disaggregation, and it was overprinted by strong phyllic alteration, causing replacement by sericite, quartz, disseminated pyrite, a little chalcopyrite and trace rutile. This altered and deformed zone could have controlled adjacent vein emplacement and it merges through a more quartz-rich deformed zone into semi-massive pyrite, with a little interstitial quartz and sericite. Both the host rock, but more particularly the vein material, is overprinted by possible retrograde chalcedonic quartz and subordinate clay (e.g. kaolinite).

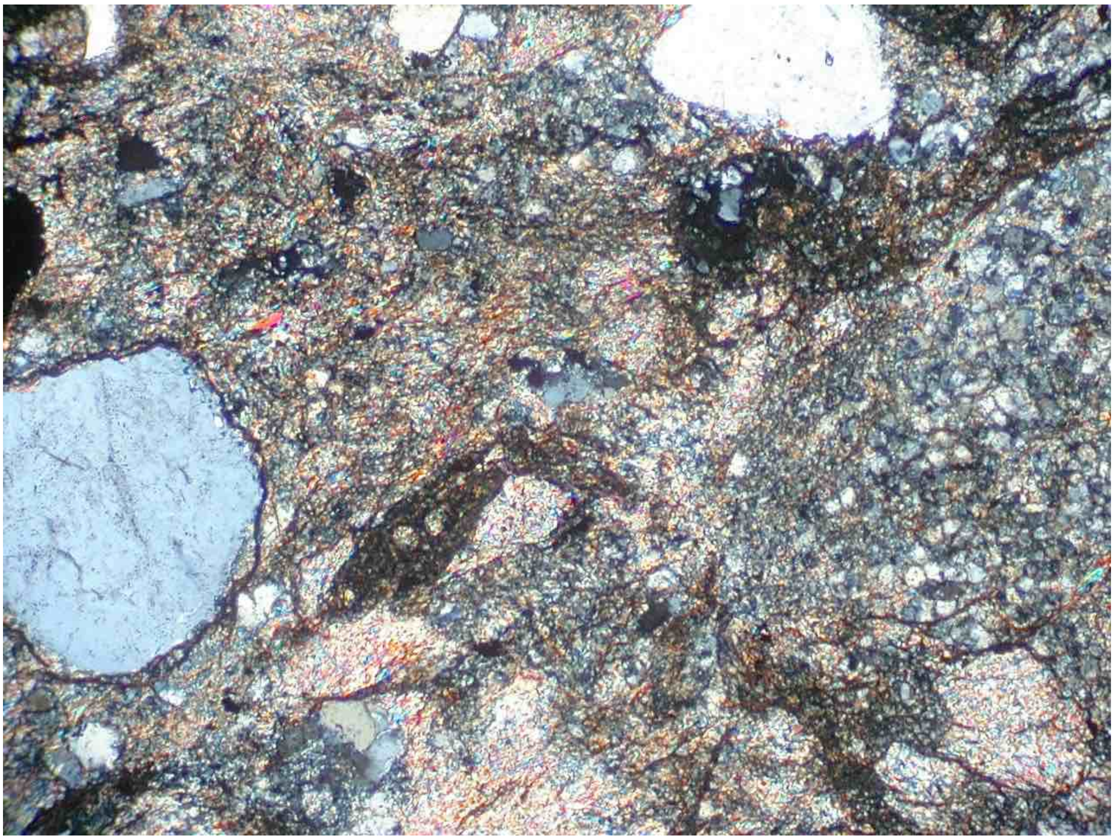


Fig. 5: Disaggregated porphyritic felsic igneous rock, with a couple of relict phenocrystal grains of quartz and at bottom, a few sericitised possible former feldspar grains. This rock type has been brecciated, weakly sheared and strongly altered to fine grained sericite and quartz. Transmitted light, crossed polarisers, field of view 2 mm across.

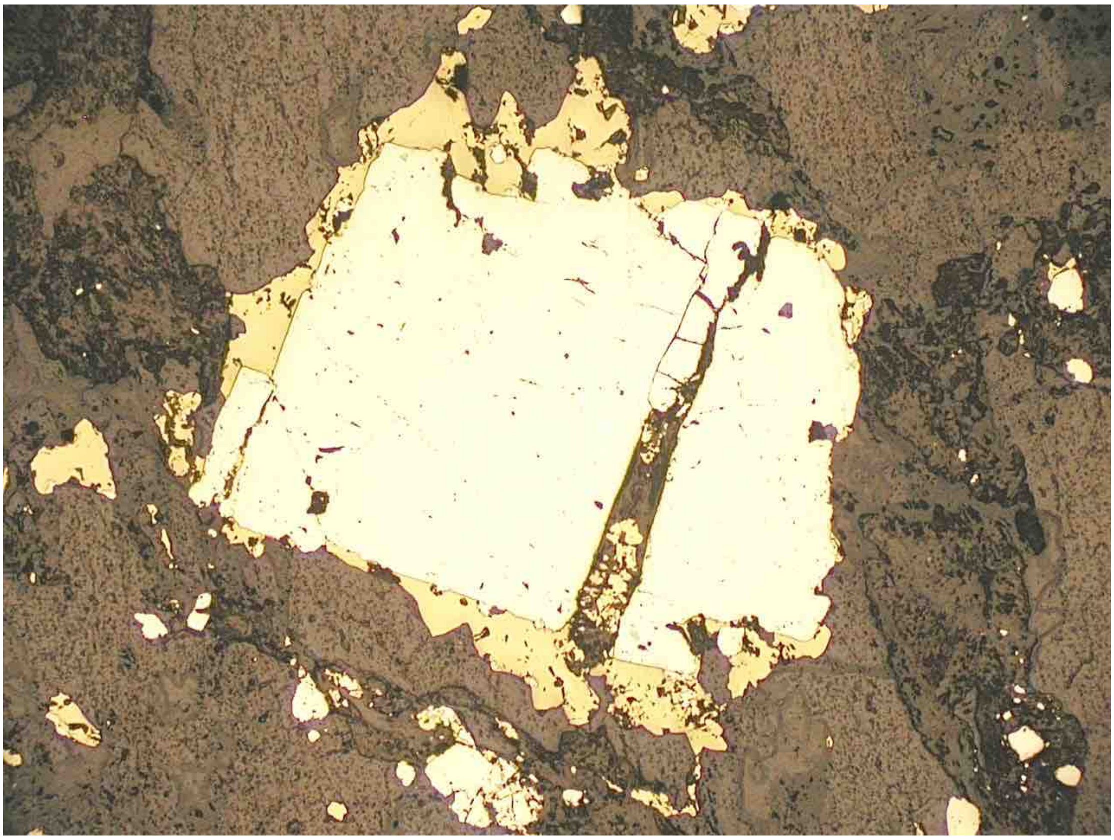


Fig. 6: Composite sulphide aggregates in the altered and deformed host rock zone, with pyrite grains being bordered by chalcopyrite (yellow). Plane polarised reflected light, field of view 2 mm across.

SMD006 121.0 m TS

Summary: Porphyritic hornblende-quartz microdiorite, with strong propylitic alteration. Relict texture is well preserved, but most primary minerals are altered. The rock contains sparsely scattered plagioclase phenocrysts, along with less common, and smaller, hornblende phenocrysts in a medium grained, inequigranular groundmass with abundant plagioclase, less common ferromagnesian material, minor quartz and a little FeTi oxide. Imposition of pervasive alteration led to strong replacement by albite, with chlorite and patchy epidote also being common. A little sericite also formed at altered plagioclase sites and leucoxene developed at ferromagnesian sites and from FeTi oxide. Sparsely distributed throughout the rock are irregular to veinlike epidote aggregates, locally associated with traces of carbonate, bornite and rare chalcopyrite. The altered rock is cut by a few thin, sub-planar veins of chlorite and rare quartz.

Handspecimen: The drill core sample is composed of a massive, altered, weakly porphyritic, medium grained intermediate to felsic igneous rock. It contains sparsely scattered whitish feldspar (e.g. plagioclase) phenocrysts up to a few millimetres across in a rather granular, grey-green groundmass, evidently with considerable feldspar and altered ferromagnesian material. It is likely that low grade alteration (e.g. propylitic) was imposed on the rock, with development of chlorite and minor epidote. The sample is moderately magnetic, with susceptibility up to 390 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is well preserved (Fig. 7) although the rock is strongly altered. There are sparse, large blocky altered plagioclase phenocrysts up to 5 mm across and these are accompanied by a few pseudomorphs after a former blocky to prismatic ferromagnesian phase (e.g. hornblende) up to 2 mm long (Fig. 7). The remainder of the rock, constituting 85-90% and forming a medium grained groundmass, is composed of abundant smaller plagioclase grains, with subordinate altered ferromagnesian material, interstitial quartz (grains up to 0.5 mm) and a little disseminated FeTi oxide (e.g. titanomagnetite, now mostly altered). The preserved primary characteristics of the rock indicate that it represents a porphyritic hornblende-quartz microdiorite.

b) Alteration and structure: The igneous rock was subject to strong pervasive alteration of propylitic type. This led to replacement of all plagioclase (and any prior minor K-feldspar) by albite, with minor flecking by sericite and chlorite, and development of a few epidote aggregates (Fig. 7). All ferromagnesian material was replaced by chlorite (Fig. 7), with a little leucoxene, in places epidote, and rare small grains of bornite and chalcopyrite. Most igneous FeTi oxide was replaced by leucoxene. Throughout the rock, there are irregular to veinlike aggregates of fine to medium grained epidote up to a few millimetres across, with these being accompanied rarely by carbonate and a trace of bornite and chalcopyrite. A few thin (<0.1 mm) sub-planar veins of chlorite, and rare quartz, cut the altered rock.

c) Mineralisation: A trace of relict igneous FeTi oxide (e.g. titanomagnetite) remains, but most is altered to leucoxene. A trace of bornite, forming rare aggregates up to 0.2 mm across, and accompanied by tiny grains of chalcopyrite, occurs in a few of the epidote aggregates and in chlorite at altered ferromagnesian sites.

Mineral Mode (by volume): plagioclase (albite) 75%, chlorite 11%, quartz 7%, epidote 4%, sericite and leucoxene each 1% and traces of carbonate, FeTi oxide, bornite and chalcopyrite.

Interpretation and comment: It is interpreted that the sample represents a propylitically altered, porphyritic hornblende-quartz microdiorite. Relict texture is well preserved, with the rock containing sparsely scattered altered plagioclase phenocrysts, along with less common, and smaller, altered hornblende phenocrysts in a medium grained, inequigranular groundmass with abundant plagioclase, less common ferromagnesian material, minor quartz and a little FeTi oxide. The alteration caused strong replacement of plagioclase by albite, with a little sericite, chlorite and epidote, and ferromagnesian material was replaced by chlorite, with a little leucoxene and epidote. Leucoxene also developed from FeTi oxide. Sparsely distributed throughout the rock are irregular to veinlike epidote aggregates, locally associated with traces of carbonate, bornite and rare chalcopyrite. The altered rock is cut by a few thin, sub-planar veins of chlorite and rare quartz.

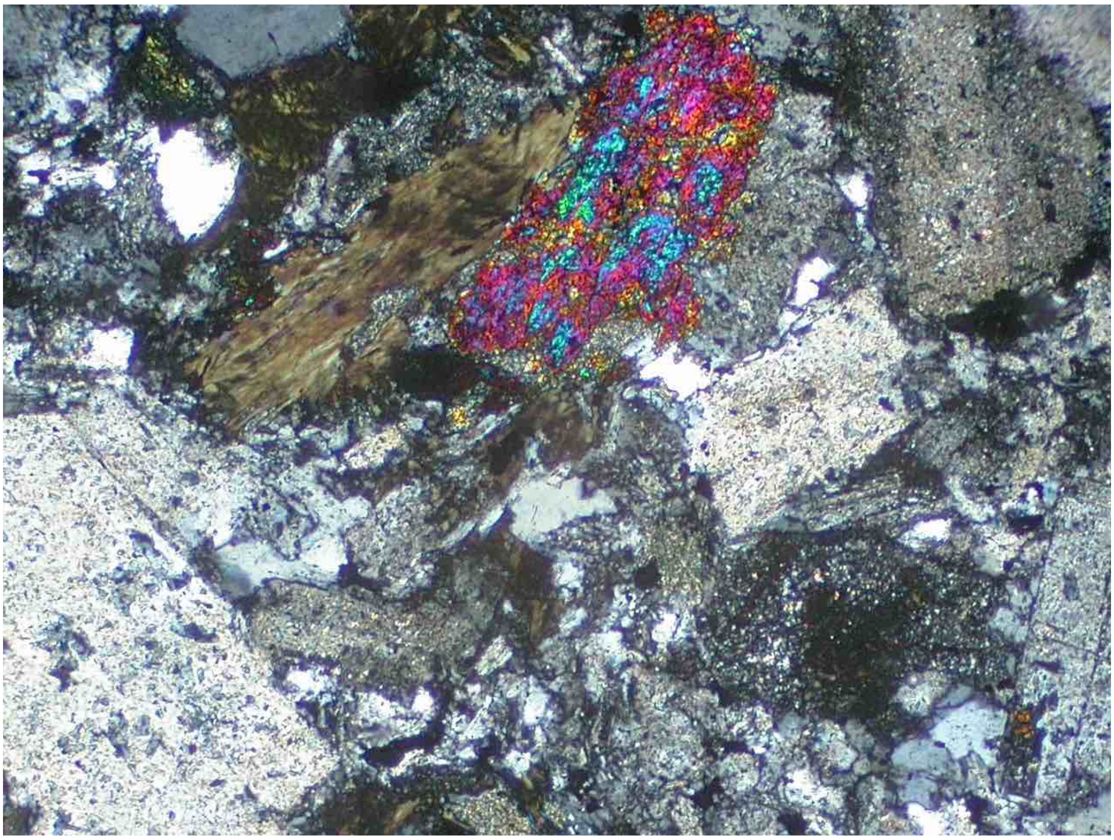


Fig. 7: Relict texture in altered microdiorite, showing blocky plagioclase, replaced by albite, a former hornblende grain replaced by chlorite (khaki) and development of a replacive aggregate of epidote (bright colours). Transmitted light, crossed polarisers, field of view 2 mm across.

SMD006 134.5 m PTS

Summary: Strongly altered and locally veined porphyritic dacite. The rock has moderately well preserved relict texture, indicating that it contained plagioclase and hornblende phenocrysts, as well as a few microphenocrysts of FeTi oxide and quartz, set in a finely granular quartzofeldspathic groundmass. Imposed alteration was of propylitic type and it caused albitisation of plagioclase and as well as significant replacement by sericite, plus minor chlorite and carbonate. Ferromagnesian material was replaced by chlorite, with a little quartz, sericite, epidote, rutile and trace chalcopyrite. FeTi oxide was replaced by rutile ± carbonate ± chalcopyrite. Irregularly scattered are apparent replacive alteration patches containing sericite, chlorite, quartz and local chalcopyrite, pyrite, sphalerite, epidote and rutile. There was minor early thin quartz-rich veining and this was followed by more extensive veining by sericite and with possible overprinting carbonate (maybe siderite) and epidote, with traces of chalcopyrite and sphalerite.

Handspecimen: The drill core sample is composed of a locally veined, but otherwise relatively massive, altered porphyritic felsic igneous rock. It contains scattered pale creamy feldspar (e.g. plagioclase) phenocrysts up to a few millimetres across and dark grey-green altered ferromagnesian phenocrysts (e.g. originally hornblende) up to 4 mm long, set in a fine grained, pale creamy quartzofeldspathic groundmass. Ferromagnesian phenocrysts are probably altered to chlorite, and plagioclase phenocrysts could be partly sericitised. A trace of chalcopyrite is observed, probably associated with altered ferromagnesian sites. The rock is cut by an array of sub-planar, sub-parallel veins up to 3 mm wide, at a moderate angle to the core axis, containing pale brown carbonate and fine grained, pale creamy sericite/clay. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately well preserved (Fig. 8). There are scattered altered blocky plagioclase phenocrysts up to 4 mm across, with a few clusters up to 7 mm across, along with pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 3 mm long (Fig. 8). The rock retains a few microphenocrysts of quartz (up to 0.9 mm) and pseudomorphs after former FeTi oxide grains (now altered; Fig. 9). Rare small grains of apatite and zircon occur at altered ferromagnesian sites. The phenocrystal phases are found in a finely granular groundmass, probably originally rich in plagioclase and alkali feldspar, plus subordinate quartz and a little ferromagnesian material. The preserved primary characteristics of the rock indicate that it represents a porphyritic hornblende dacite.

b) Alteration and structure: The igneous rock experienced strong hydrothermal alteration and emplacement of several veins. Plagioclase phenocrysts and groundmass feldspar were albitised, although some alkali feldspar could remain in the groundmass. Plagioclase sites are also strongly replaced by sericite, with a little carbonate, chlorite and quartz, and all ferromagnesian material was replaced by chlorite, with local quartz, sericite, epidote and traces of chalcopyrite, pyrite and rutile (Figs 8, 9). Igneous FeTi oxide was replaced by rutile ± carbonate ± chalcopyrite (Fig. 9). A number of irregular to veinlike replacement aggregates have formed in the groundmass and also replace adjacent phenocrysts; these are up to a few millimetres across and contain sericite and/or chlorite, with local quartz, chalcopyrite, epidote, and trace sphalerite, pyrite and rutile. An irregular network of sub-planar to anastomosing veins cut the altered rock. There are a few thin (<0.2 mm) quartz-rich veins that appear to be earliest. A more abundant set, up to 1.5 mm wide, tend to be rich in sericite and also have local chlorite and quartz. These tend to be overprinted by carbonate (maybe siderite) ± epidote ± sericite, with carbonate also forming irregular masses up to 3 mm wide and containing traces of chalcopyrite and sphalerite. The observed alteration and vein assemblage conforms to propylitic type.

c) Mineralisation: The sample contains sparsely distributed chalcopyrite, as part of the alteration assemblage and mainly occurring in the sericite-chlorite-quartz replacement aggregates and in carbonate-rich veining, and altered ferromagnesian sites (Fig. 9). Chalcopyrite aggregates are up to 2 mm across and can be associated with traces of pyrite and sphalerite (up to 0.2 mm).

Mineral Mode (by volume): plagioclase (albite) 50%, quartz and sericite each 15%, chlorite 8%, alkali feldspar 5%, carbonate 4%, epidote and chalcopyrite each 1% and traces of rutile, apatite, zircon, pyrite and sphalerite.

Interpretation and comment: It is interpreted that the sample is a porphyritic dacite that has strong propylitic alteration and is cut by several veins. Relict texture is moderately well preserved and the rock originally contained plagioclase and hornblende phenocrysts, and a few microphenocrysts of FeTi oxide and quartz, set in a finely granular quartzofeldspathic groundmass. Alteration caused albitisation of plagioclase and as well as replacement by sericite, minor chlorite and carbonate. Ferromagnesian material was replaced by chlorite, a little quartz, sericite, epidote, rutile and trace chalcopyrite, and FeTi oxide was replaced by rutile ± carbonate ± chalcopyrite. Irregularly scattered are apparent replacive alteration patches containing sericite, chlorite, quartz and local chalcopyrite, pyrite, sphalerite, epidote and rutile. There was minor early thin quartz-rich veining and this was followed by more extensive veining by sericite and with possible overprinting carbonate (maybe siderite) and epidote, with traces of chalcopyrite and sphalerite.

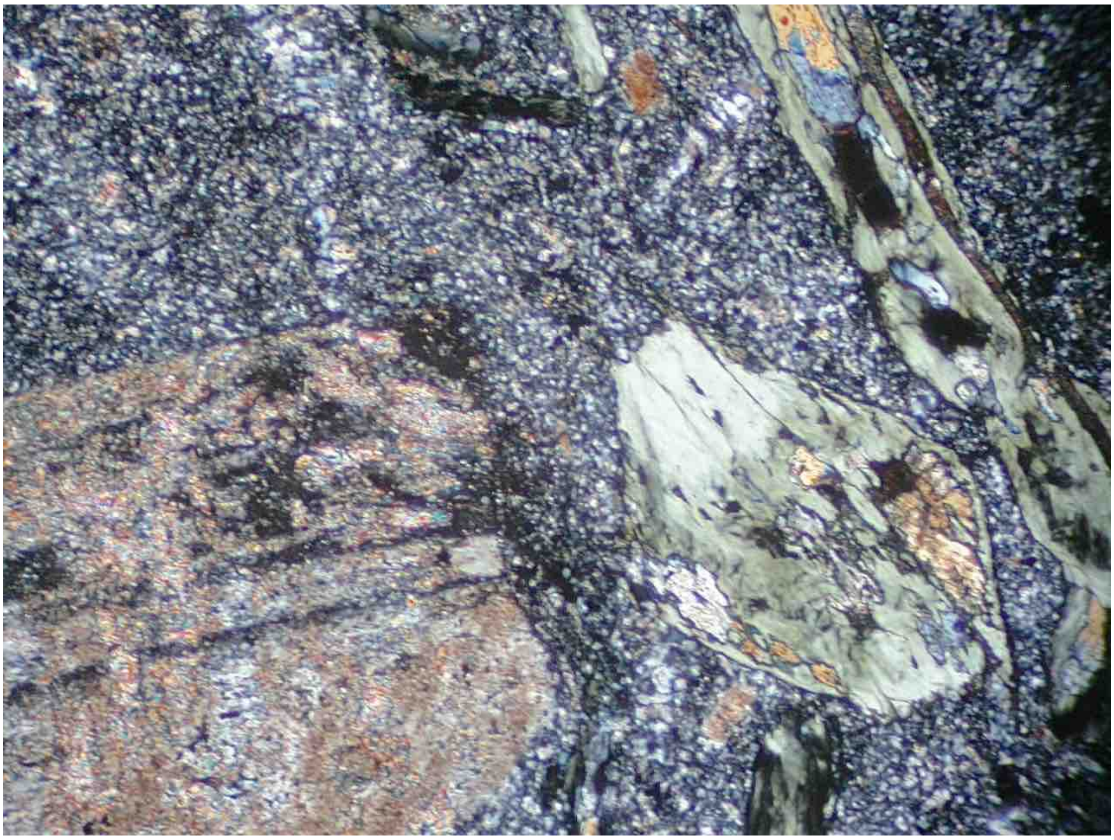


Fig. 8: Relict texture in porphyritic dacite, with a partly sericitised plagioclase grain at left, and chlorite-replaced hornblende prisms at right, set in a finely granular quartzofeldspathic groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.

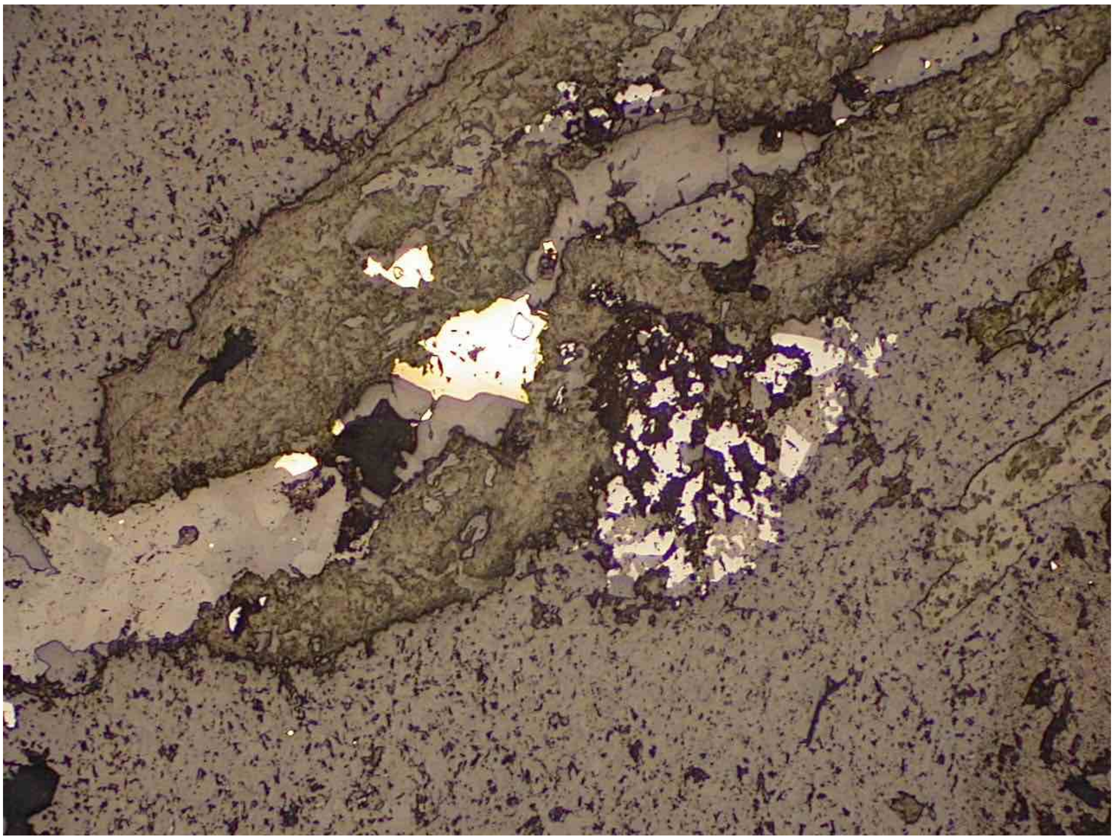


Fig. 9: Former hornblende phenocryst site, now composed of chlorite, with minor quartz and chalcopyrite (pale yellow), and partly cut by a thin carbonate vein (left). At centre right is an altered FeTi oxide grain, replaced by granular rutile (pale grey). Plane polarised reflected light, field of view 2 mm across.

SMD006 147.7 m PTS

Summary: Porphyritic dacite, showing moderate to strong propylitic alteration and hosting a few mineralised veins. The rock has well preserved relict texture and retains partly altered plagioclase phenocrysts, along with a few quartz and apatite microphenocrysts. All former ferromagnesian (e.g. hornblende) phenocrysts are altered. The phenocrystal phases occur in a very fine grained, low weakly flow foliated groundmass containing plagioclase, alkali feldspar and subordinate quartz. The imposition of alteration led to part replacement of plagioclase by albite, sericite and epidote. All former ferromagnesian material was replaced, mostly by chlorite and epidote, but with a little quartz, carbonate, chalcopyrite and rutile. A prominent quartz-rich vein occurs, containing minor chalcopyrite and bornite, and there are a few other narrow veins with quartz and/or carbonate and a little chalcopyrite and bornite.

Handspecimen: The drill core sample is composed of a relatively massive, porphyritic felsic igneous rock with a fine grained grey quartzofeldspathic groundmass and scattered pale creamy feldspar (e.g. plagioclase) phenocrysts up to 8 mm across and smaller, dark grey-green ferromagnesian phenocrysts (e.g. hornblende). The rock could be moderately altered, with development of sericite from plagioclase, and chlorite at ferromagnesian sites. The rock is cut by a couple of sub-planar veins up to 1 mm wide at a moderate angle to the core axis. Larger veins contain quartz and a little chalcopyrite and bornite, and a few smaller, discontinuous veins contain pale brown carbonate. The sample is weakly magnetic, with susceptibility up to 60 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is well preserved (Fig. 10). The rock contains scattered, partly altered blocky plagioclase phenocrysts up to 5 mm across, smaller altered prismatic ferromagnesian phenocrysts up to 2 mm long (relict shapes suggest the original phase was hornblende), a few microphenocrysts of quartz (up to 0.6 mm) and uncommon microphenocrysts of FeTi oxide (e.g. titanomagnetite, mostly altered) and apatite (Fig. 10). The phenocrystal phases occur in a very fine grained, rather granular groundmass that in places preserves weak flow foliation. The groundmass probably contained abundant plagioclase and alkali feldspar, with subordinate quartz and a little ferromagnesian material. A single enclave ~4 mm across is hosted in the rock and although altered, relict characteristics suggest it was dominated by medium grained hornblende. The preserved primary characteristics of the rock indicate that it represents a porphyritic hornblende dacite. It is similar to the sample from SMD006 at 134.5 m.

b) Alteration and structure: The igneous rock was subject to moderate to strong hydrothermal alteration and emplacement of a few veins. Plagioclase was partly replaced by albite, sericite, local epidote and traces of quartz and chlorite (Fig. 10). All former ferromagnesian material was replaced by chlorite ± epidote, with a little quartz, carbonate, chalcopyrite and traces of rutile and bornite (Figs 10, 11). Igneous FeTi oxide was largely replaced by rutile. Groundmass feldspar was probably partly albitised, but some alkali feldspar is likely to remain. The pervasive alteration assemblage is consistent with propylitic type. A prominent sub-planar quartz-rich vein about 1 mm wide cuts the rock. Quartz is fine to medium grained and there are scattered aggregates of chalcopyrite and/or bornite (Fig. 11) as well as a trace of carbonate, sericite and chlorite. This vein is accompanied by a couple of narrower veins (<0.4 mm) with quartz and/or carbonate and a little chalcopyrite and trace bornite, and by a few discontinuous carbonate veins up to 0.8 mm wide. Carbonate in the veins could be siderite.

c) Mineralisation: As part of the pervasive alteration, a little chalcopyrite (and rare bornite) developed, mostly at altered ferromagnesian sites. The prominent quartz-rich vein contains aggregates of chalcopyrite and/or bornite up to 2 mm long (Fig. 11) and there are small amounts of chalcopyrite and trace bornite in other veins.

Mineral Mode (by volume): plagioclase (including albite) 60%, quartz 15%, alkali feldspar 10%, chlorite 6%, sericite 3%, carbonate and epidote each 2%, chalcopyrite 1% and traces of rutile, apatite, FeTi oxide and bornite.

Interpretation and comment: It is interpreted that the sample represents a propylitically altered porphyritic dacite, hosting a few veins. Relict texture is well preserved and the rock has partly altered plagioclase phenocrysts, and a few quartz microphenocrysts. All former ferromagnesian (e.g. hornblende) phenocrysts are altered. The phenocrystal phases occur in a very fine grained, low weakly flow foliated groundmass containing plagioclase, alkali feldspar and subordinate quartz. Alteration caused part replacement of plagioclase by albite, sericite and epidote. All former ferromagnesian material was replaced, mostly by chlorite and epidote, but with a little quartz, carbonate, chalcopyrite and rutile. A prominent quartz-rich vein containing minor chalcopyrite and bornite is present, and there are a few other narrow veins with quartz and/or carbonate and a little chalcopyrite and bornite.

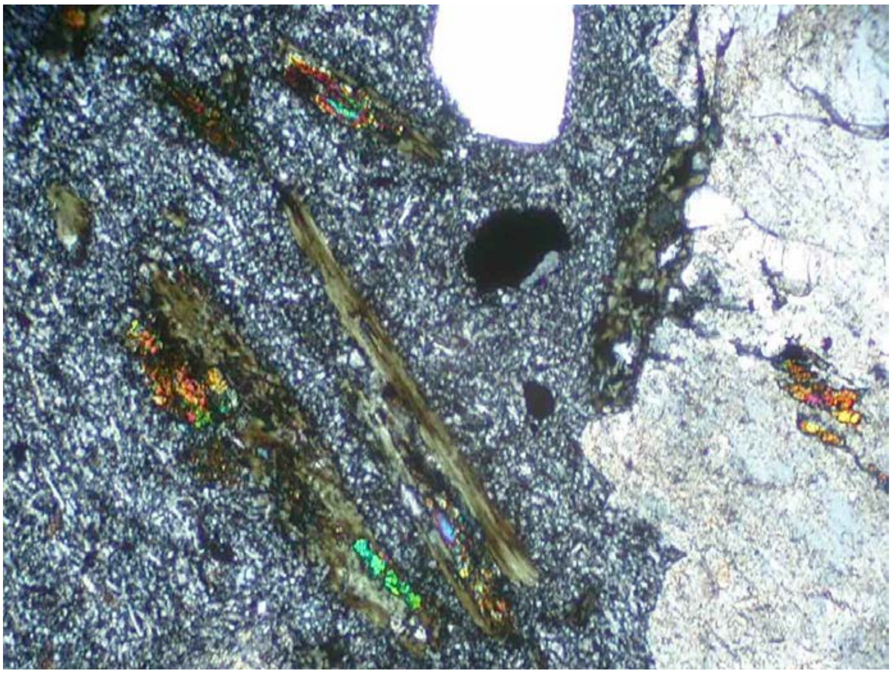


Fig. 10: Plagioclase phenocryst at right, replaced by albite and a little epidote, with former elongate hornblende phenocrysts replaced by chlorite (dark khaki) and epidote. Note the very fine grained quartzofeldspathic groundmass, the quartz microphenocryst (upper) and the black grain of altered FeTi oxide. Transmitted light, crossed polarisers, field of view 2 mm across.

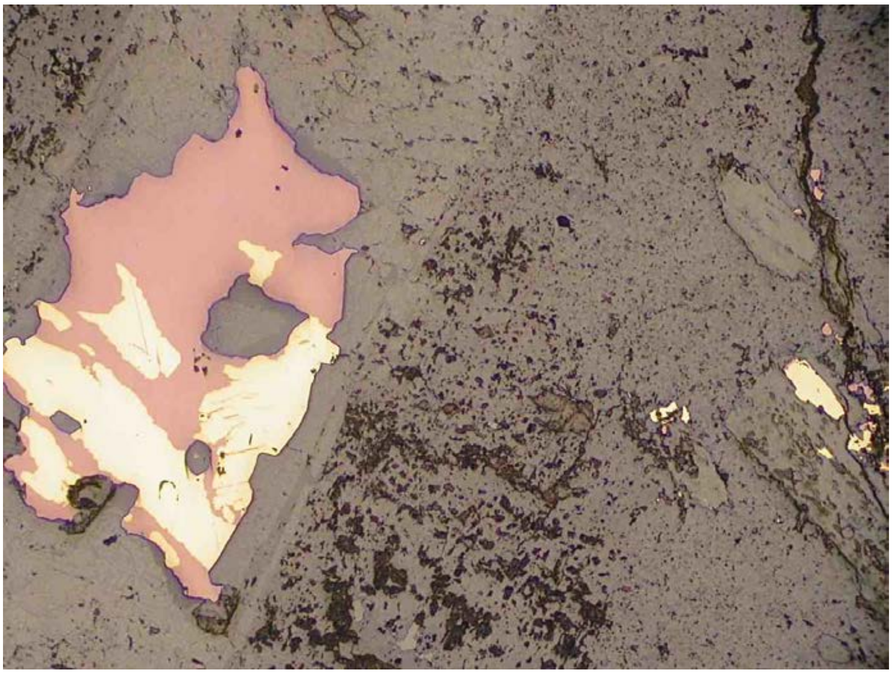


Fig. 11: Quartz vein at left containing a composite aggregate of bornite and chalcopyrite. At right are small, chlorite-replaced hornblende grains with trace chalcopyrite and bornite. Plane polarised reflected light, field of view 2 mm across.

SMD006 202.2 m TS

Summary: Porphyritic dacite, with rather strong propylitic alteration and having well preserved relict texture. The rock contained scattered plagioclase and hornblende phenocrysts (now altered) and retains a few smaller quartz phenocrysts. These are enclosed in a fine grained quartzofeldspathic groundmass containing characteristic small subhedral quartz grains. Pervasive alteration led to plagioclase being replaced by albite and significant sericite, with all ferromagnesian material being altered, mainly to chlorite. In the groundmass, there is some preservation of primary alkali feldspar, but significant replacement by albite, chlorite and carbonate has occurred. A few thin sericite and/or carbonate veins pervade the rock. A trace of chalcopyrite is observed, at altered ferromagnesian and FeTi oxide sites.

Handspecimen: The drill core sample is composed of a massive, strongly porphyritic felsic igneous rock, probably with moderate to strong alteration. It contains scattered whitish feldspar (e.g. plagioclase) phenocrysts up to 1 cm across and less common dark grey-green ferromagnesian phenocrysts up to 3 mm long, set in a fine grained, grey-green quartzofeldspathic groundmass. Relict shapes of the ferromagnesian phase suggest that it was originally hornblende. Alteration could have led to development of fine grained sericite from plagioclase, and chlorite from hornblende. A couple of thin carbonate veins occur, at low to moderate angles to the core axis. The sample is weakly magnetic, with susceptibility up to 70×10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is well preserved despite strong alteration (Fig. 12). The rock contains scattered blocky plagioclase phenocrysts up to 6 mm across and pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 3 mm long (Fig. 12). There are also a few relict quartz phenocrysts up to 1.5 mm across (Fig. 12) and rare grains of apatite and FeTi oxide (e.g. titanomagnetite, most of which are associated with ferromagnesian sites and which are now largely altered). The phenocrystal phases occur in a fine grained, granular groundmass, typically with small (up to 0.2 mm) subhedral quartz grains, plus plagioclase, interstitial alkali feldspar, minor altered ferromagnesian material and trace altered FeTi oxide (Fig. 12). The preserved primary characteristics of the rock indicate that it represents a porphyritic hornblende dacite.

b) Alteration and structure: Rather strong pervasive propylitic alteration was imposed on the igneous rock. Plagioclase was replaced by albite, with considerable fine grained sericite and a little carbonate, chlorite and quartz (Fig. 12). All former ferromagnesian material was replaced by chlorite (Fig. 12), with local sericite, carbonate, quartz and trace leucoxene and chalcopyrite, and FeTi oxide was replaced by aggregates of leucoxene up to 0.6 mm across. In the groundmass, it is likely that there is considerable preservation of alkali feldspar, but otherwise, there is replacement by albite, chlorite and carbonate, with trace sericite, epidote and leucoxene, with a few ragged replacement aggregates of chlorite and carbonate up to 2 mm across. The rock hosts a few thin (<0.1 mm) anastomosing veins of sericite and carbonate.

c) Mineralisation: Almost all original igneous FeTi oxide was replaced by leucoxene (and a tiny trace of chalcopyrite). Elsewhere, a trace of chalcopyrite (grains up to 0.2 mm) is observed at altered ferromagnesian sites.

Mineral Mode (by volume): plagioclase (mostly albite) 45%, quartz 20%, alkali feldspar 15%, chlorite 10%, carbonate 5%, sericite 4% and traces of epidote, chalcopyrite, apatite, FeTi oxide and leucoxene.

Interpretation and comment: It is interpreted that the sample is a porphyritic dacite, with well preserved relict texture, despite the imposition of rather strong propylitic alteration. Originally, the rock hosted plagioclase and hornblende phenocrysts, and a few smaller quartz phenocrysts, enclosed in a fine grained quartzofeldspathic groundmass containing characteristic small subhedral quartz grains. Alteration caused plagioclase to be replaced by albite and sericite, with all ferromagnesian material being altered, mainly to chlorite. In the groundmass, there is some preservation of primary alkali feldspar, but significant replacement by albite, chlorite and carbonate has occurred. A few thin sericite and/or carbonate veins pervade the rock. A trace of chalcopyrite is observed, at altered ferromagnesian and FeTi oxide sites.

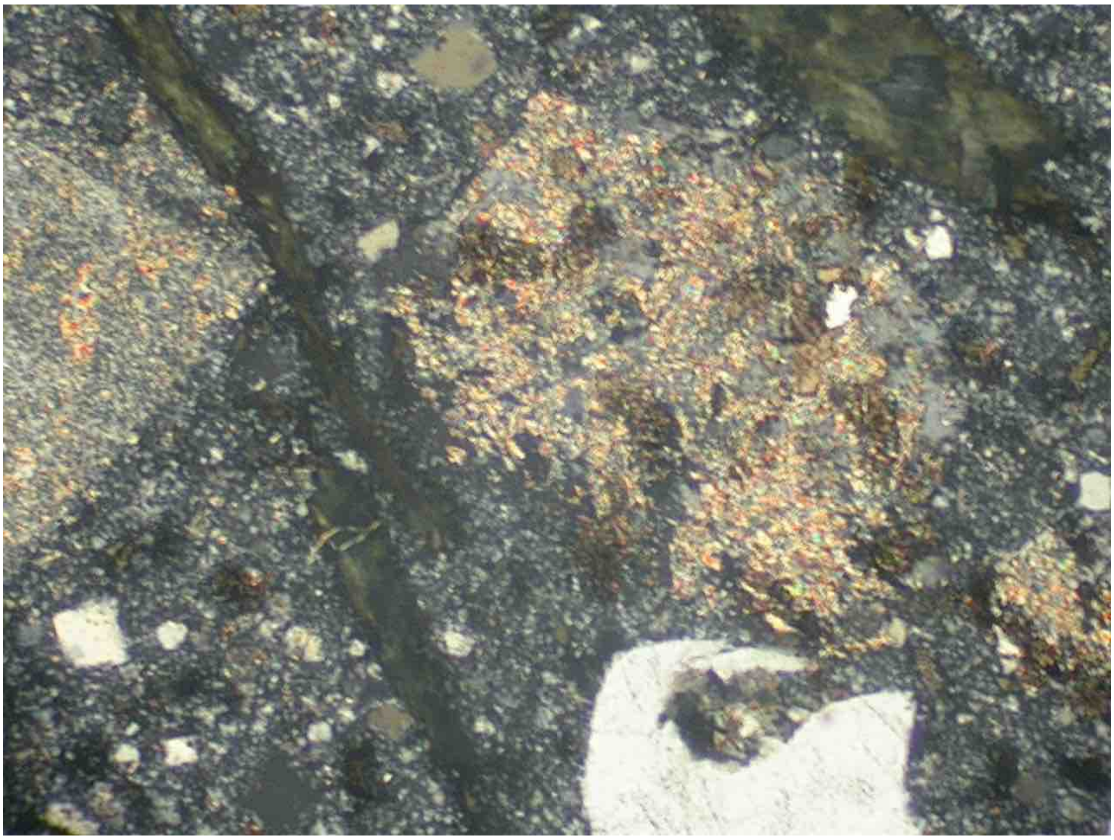


Fig. 12: Partly sericitised plagioclase phenocrysts, accompanied by a couple of elongate, dark khaki chlorite pseudomorphs after former hornblende phenocrysts. Portion of a quartz phenocryst is visible at lower right. In the fine grained groundmass, small subhedra of quartz are characteristic. Transmitted light, crossed polarisers, field of view 2 mm across.

<u>SMD006 216.9 m TS</u>

<u>Summary</u>: Porphyritic dacite, with rather strong propylitic alteration and having well preserved relict texture. Scattered plagioclase and hornblende phenocrysts originally occurred, but are now altered. A few relict quartz phenocrysts are preserved, along with rare microphenocrysts of apatite, but all former FeTi oxide microphenocrysts are altered. A fine grained quartzofeldspathic groundmass hosted the phenocrystal phases, with it displaying characteristic small subhedral quartz grains. Pervasive alteration led to replacement of plagioclase by albite and sericite, and minor carbonate, with former hornblende replaced by chlorite, plus a little carbonate, and FeTi oxide is replaced by leucoxene. Alteration-derived sericite and chlorite is common in the groundmass. Rare small grains of pyrite are associated with altered hornblende and plagioclase sites.

<u>Handspecimen</u>: The drill core sample is composed of a massive, strongly porphyritic felsic igneous rock, probably with moderate to strong alteration. It contains scattered pale creamy feldspar (e.g. plagioclase) phenocrysts up to 7 mm across that appear to be partly sericitised and less common dark grey-green ferromagnesian phenocrysts up to 4 mm long. The latter could have been hornblende, but are now replaced by chlorite. These altered phenocrysts, together with a few relict quartz phenocrysts, occur in a pale grey-green quartzofeldspathic groundmass that contains a few small pale brown aggregates of leucoxene (e.g. from alteration of igneous FeTi oxide). A couple of pale brown, sub-planar carbonate veins up to 1 mm wide cut the rock at a moderate angle to the core axis. The sample is very weakly magnetic, with susceptibility up to 30 x 10^{-5} SI.

<u>Petrographic description</u>

a) Primary rock characteristics: In the section, relict porphyritic texture is well preserved despite strong alteration (Fig. 13). The rock originally contained scattered blocky plagioclase phenocrysts up to 6 mm across and a prismatic ferromagnesian phase (e.g. hornblende) up to 3.5 mm long, with both of these phases now being altered. Traces of apatite, zircon and FeTi oxide occur at the altered ferromagnesian sites. A few quartz phenocrysts up to 2.5 mm across are retained, and there are uncommon microphenocrysts of apatite and FeTi oxide (the latter now altered), all enclosed in a fine grained, granular quartzofeldspathic groundmass (Fig. 13). Characteristically, there are small subhedra of quartz up to 0.2 mm across, with the remainder of the groundmass having abundant plagioclase and alkali feldspar, minor ferromagnesian material and traces of FeTi oxide and apatite. The relict characteristics of the rock indicate that it represents a porphyritic hornblende dacite.

b) Alteration and structure: Rather strong pervasive hydrothermal alteration of propylitic type was imposed on the igneous rock. Plagioclase is replaced by albite and commonly abundant sericite (Fig. 13), plus minor carbonate and trace pyrite. All ferromagnesian material was replaced by chlorite (Fig. 13), with local sericite, carbonate and trace leucoxene and pyrite. FeTi oxide was replaced by leucoxene aggregates up to 0.6 mm across. In the groundmass, although there is some preservation of alkali feldspar, substantial replacement has occurred, with development of sericite and chlorite, minor carbonate and trace leucoxene. No significant veining occurs in the rock; only a couple of thin, discontinuous sericite veinlets have been observed.

c) Mineralisation: Rare grains of pyrite up to 0.3 mm across have formed at altered ferromagnesian and plagioclase sites.

<u>Mineral Mode (by volume)</u>: plagioclase (albite) 50%, quartz 20%, alkali feldspar 10%, chlorite and sericite each 8%, carbonate 3% and traces of leucoxene, apatite, zircon and pyrite.

Interpretation and comment: It is interpreted that the sample represents a porphyritic dacite, displaying well preserved relict texture, but having rather strong propylitic alteration. It originally contained plagioclase and hornblende phenocrysts, a few quartz phenocrysts and uncommon small microphenocrysts of apatite and FeTi oxide. A fine grained quartzofeldspathic groundmass hosted the phenocrystal phases, with it displaying characteristic small subhedral quartz grains. Pervasive alteration led to replacement of plagioclase by albite and sericite, and minor carbonate, with former hornblende replaced by chlorite, plus a little carbonate, and FeTi oxide is replaced by leucoxene. Alteration-derived sericite and chlorite is common in the groundmass. Rare small grains of pyrite are associated with altered hornblende and plagioclase sites.

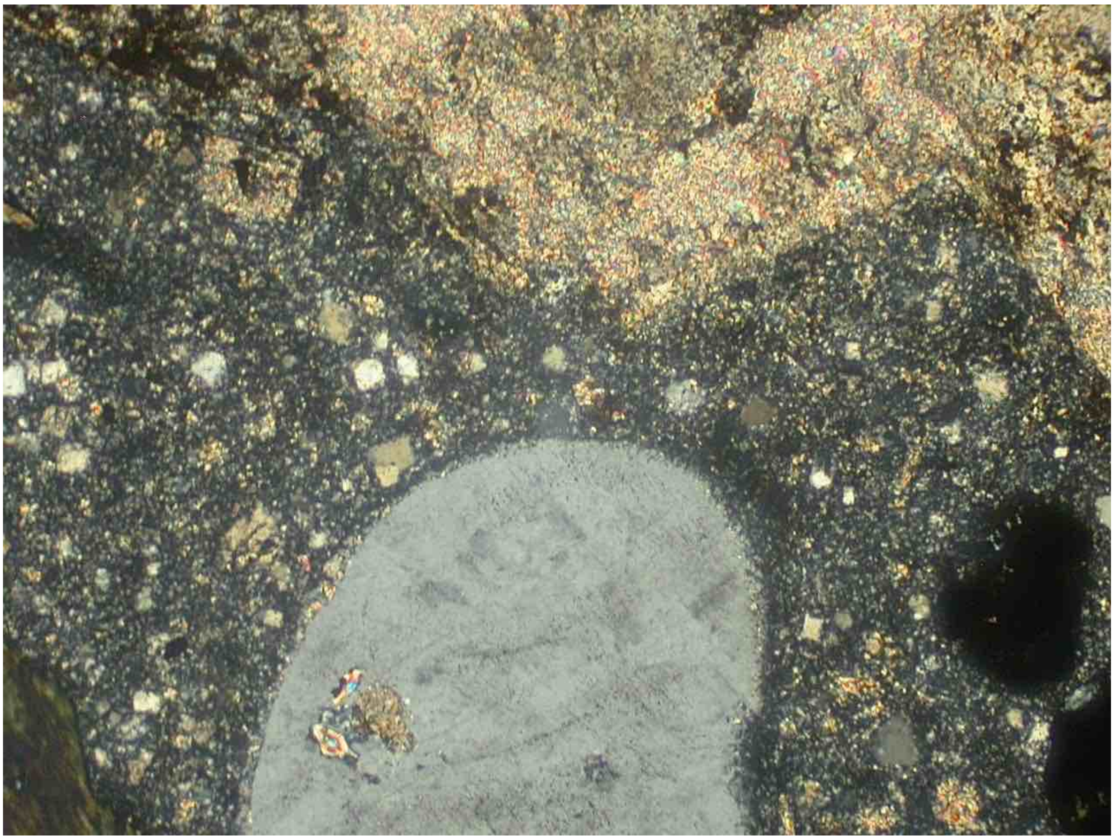


Fig. 13: Sericitised plagioclase phenocryst at top, with a relict quartz phenocryst at bottom. Dark shapes at left are portions of chlorite-altered hornblende grains and the black shapes at lower right are altered FeTi oxide grains. In the fine grained groundmass, small subhedra of quartz are characteristic. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD006 263.0 m TS

Summary: Strongly altered porphyritic hornblende-quartz microdiorite. The rock has moderately well preserved relict texture and evidently contained scattered plagioclase and probable hornblende phenocrysts originally, with these set in a fine to medium grained groundmass composed of abundant plagioclase, subordinate ferromagnesian material and minor quartz and FeTi oxide. The rock was subject to pervasive propylitic alteration, with this causing albitisation of plagioclase and commonly strong overprinting by sericite, carbonate (calcite) and chlorite. Ferromagnesian material was replaced mostly by chlorite and carbonate, and FeTi oxide by leucoxene-rutile. A little pyrite occurs sparsely as part of the alteration, in the groundmass and at former ferromagnesian sites. A couple of carbonate veins cut the altered rock.

Handspecimen: The drill core sample is composed of a massive, strongly altered and mildly porphyritic intermediate igneous rock. It is grey-green in colour, with apparent pseudomorphs after a few feldspar and ferromagnesian phenocrysts, each up to a few millimetres across, set in a fine to medium grained groundmass that could be of feldspathic composition, but with significant ferromagnesian material. Pervasive alteration has probably occurred to develop fine grained chlorite, sericite and carbonate, with traces of disseminated pyrite and small pale brown grains of leucoxene. Chlorite appears to be concentrated at former ferromagnesian sites. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. A couple of narrow sub-planar veins occur, containing carbonate, pyrite and chlorite. The sample is very weakly magnetic, with susceptibility up to 35 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately well preserved despite strong alteration (Fig. 14). The rock contained scattered blocky plagioclase phenocrysts up to 4 mm across, now completely altered, with these being accompanied by pseudomorphs after a former ferromagnesian phase, typically of prismatic form and up to 5 mm long. The relict shapes suggest that this phase was hornblende. The phenocrysts occurred in a fine to medium grained, inequigranular groundmass that contained abundant plagioclase, subordinate ferromagnesian material, minor interstitial quartz and a little FeTi oxide (all altered). The interpreted primary characteristics of the rock suggest that it was a porphyritic hornblende-quartz microdiorite.

b) Alteration and structure: Strong pervasive hydrothermal alteration of propylitic type was imposed on the igneous rock (Fig. 14). Original plagioclase was albitised and further replaced by locally abundant sericite and carbonate, lesser chlorite and trace quartz. All ferromagnesian material was replaced by chlorite, locally with sericite and carbonate, a little quartz, leucoxene-rutile and pyrite. Igneous FeTi oxide was totally replaced by leucoxene-rutile. Scattered sparsely in the groundmass and adjacent phenocrysts are medium grained replacive carbonate masses up to several millimetres across, and the rock is also cut by a couple of sub-planar carbonate veins up to 0.5 mm wide.

c) Mineralisation: Sparse single grains and aggregates of pyrite up to 0.8 mm across occur irregularly throughout, in the altered groundmass and at former ferromagnesian sites.

Mineral Mode (by volume): plagioclase (albite) 45%, carbonate (calcite) 20%, chlorite 15%, sericite 13%, quartz 5% and leucoxene-rutile and pyrite each 1%.

Interpretation and comment: It is interpreted that the sample is a porphyritic hornblende-quartz microdiorite with strong pervasive propylitic alteration. Relict texture is moderately well preserved and the rock originally contained plagioclase and hornblende phenocrysts, set in a fine to medium grained groundmass with abundant plagioclase, subordinate ferromagnesian material and minor quartz and FeTi oxide. Imposed alteration led to albitisation of plagioclase and commonly strong overprinting by sericite, carbonate (calcite) and chlorite. Ferromagnesian material was replaced mostly by chlorite and carbonate, and FeTi oxide by leucoxene-rutile. A little pyrite occurs sparsely as part of the alteration, in the groundmass and at former ferromagnesian sites. A couple of carbonate veins cut the altered rock.

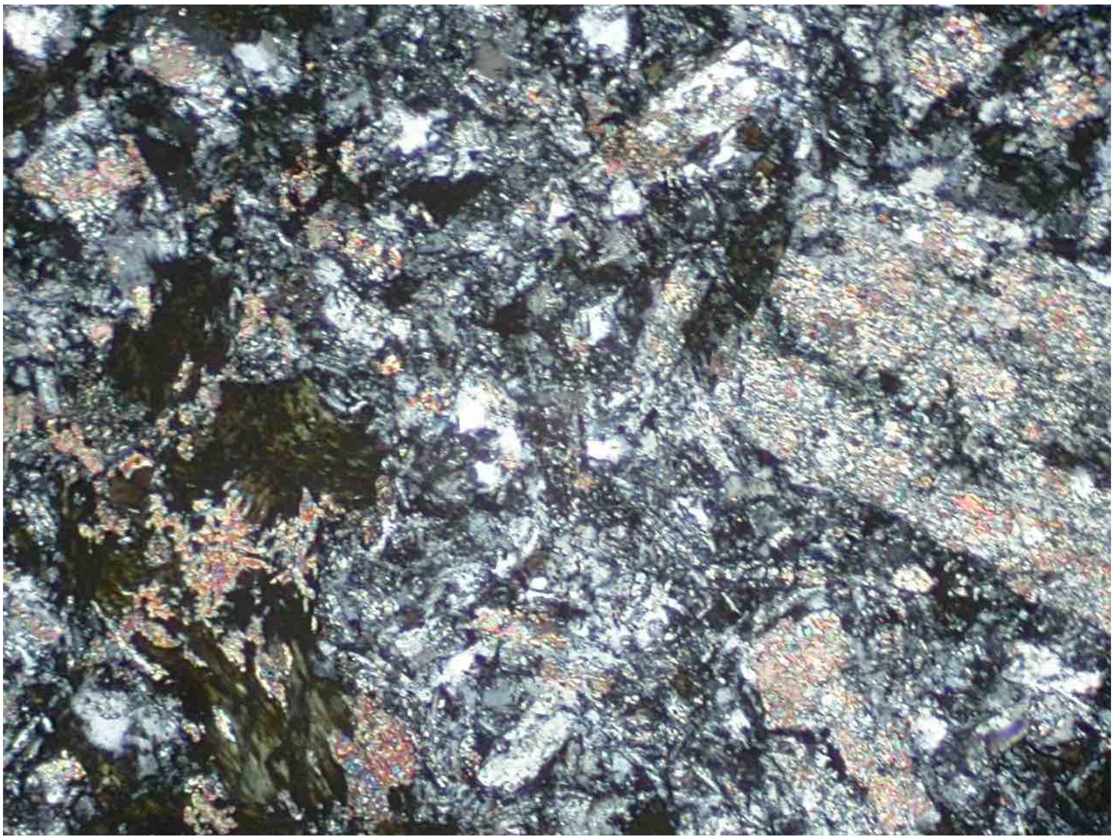


Fig. 14: Small plagioclase phenocrysts showing replacement by sericite and carbonate, and at left a ragged aggregate of chlorite (dark) and carbonate has replaced a former hornblende grain. The groundmass contains abundant albitised plagioclase, with minor quartz and chlorite. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD006 272.5 m PTS

Summary: Porphyritic hornblende dacite, displaying rather strong hydrothermal alteration of transitional propylitic to argillic type. Relict texture is well preserved, however, and it is apparent that the rock contained scattered phenocrysts of plagioclase and a ferromagnesian phase (e.g. hornblende) as well as a few quartz phenocrsts and microphenocrysts of FeTi oxide and apatite. Phenocrystal grains occur in a fine grained, granular groundmass containing characteristic small subhedra of quartz, as well as plagioclase and alkali feldspar. Apart from quartz and apatite, all phenocrystal phases are altered, and there has also been some replacement of the groundmass. Plagioclase was initially replaced by albite, with further replacement by sericite, clay (e.g. kaolinite) and carbonate. Ferromagnesian material is mostly replaced by chlorite and FeTi oxide by rutile. A little pyrite has formed in the groundmass and at ferromagnesian sites, and at the latter, there are also small amounts of chalcopyrite and rare sphalerite. A couple of thin, discontinuous carbonate-clay veins occur.

Handspecimen: The drill core sample is composed of a massive, altered porphyritic felsic igneous rock. It contains rather abundant, pale creamy-grey, altered feldspar (e.g. plagioclase) phenocrysts up to 6 mm across, less common dark grey-green pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 4 mm long, and uncommon quartz phenocrysts, occurring in a grey, fine grained quartzofeldspathic groundmass. It is likely that the rock has pervasive propylitic alteration, with development of sericite, chlorite and maybe minor carbonate, along with a little disseminated pyrite and a few small pale brown aggregates of leucoxene. The rock is cut by a couple of thin white carbonate veins at a low to moderate angle to the core axis. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is well preserved despite rather strong alteration (Fig. 15). It is evident that the rock originally contained scattered blocky plagioclase phenocrysts up to 5 mm across (and a few clusters up to 8 mm), along with pseudomorphs after a former prismatic ferromagnesian phase (e.g. hornblende) up to 2 mm long (Fig. 15). The rock retains a few quartz phenocrysts up to 3.5 mm across (plus many smaller microphenocrysts) (Fig. 15) as well as microphenocrysts of FeTi oxide (now altered) and uncommon apatite. Phenocrystal phases occurred in a finely granular groundmass, with characteristic small subhedral quartz grains up to 0.2 mm, plus small plagioclase grains, interstitial alkali feldspar, minor ferromagnesian material and trace FeTi oxide and apatite. The preserved primary characteristics of the rock indicate that it represents a porphyritic hornblende dacite.

b) Alteration and structure: Rather strong pervasive hydrothermal alteration was imposed. Plagioclase was initially albitised, with further patchy, but strong replacement by sericite, carbonate and a low-birefringent clay phase (e.g. kaolinite) (Fig. 15). All ferromagnesian material was replaced by chlorite, with local carbonate, quartz, sericite, rutile, pyrite and chalcopyrite. Igneous FeTi oxide was replaced by rutile, with a little chlorite, pyrite and chalcopyrite (Fig. 16). Although considerable alkali feldspar is probably retained in the groundmass, there has also been replacement by albite, minor sericite, chlorite, carbonate and pyrite. The alteration assemblage is interpreted to be transitional between propylitic and argillic types. A couple of discontinuous carbonate-clay veins up to 0.4 mm wide cut the altered rock.

c) Mineralisation: Minor disseminated pyrite has formed as an alteration product, occurring as aggregates and individual grains up to 1 mm across, and found in the groundmass and at altered ferromagnesian sites (Figs 15, 16). It is accompanied by a trace of chalcopyrite (Fig.

16). In several altered ferromagnesian and FeTi oxide sites, there are sparse grained of chalcopyrite up to 0.4 mm across, and in a couple of these there are composite aggregates of sphalerite and pyrite.

Mineral Mode (by volume): plagioclase (albite) 40%, quartz 20%, alkali feldspar 15%, sericite 8%, carbonate 7%, chlorite 6%, clay (kaolinite) 2%, pyrite 1% and traces of rutile, apatite, chalcopyrite and sphalerite.

Interpretation and comment: It is interpreted that the sample represents a rather strongly altered porphyritic hornblende dacite. The rock formerly contained scattered phenocrysts of plagioclase and a ferromagnesian phase (e.g. hornblende) as well as a few quartz phenocrysts and microphenocrysts of FeTi oxide and apatite. Phenocrystal grains occur in a fine grained, granular groundmass containing characteristic small subhedra of quartz, as well as plagioclase and alkali feldspar. The rock was subject to rather strong alteration of transitional propylitic-argillic type. Plagioclase was initially replaced by albite, with further replacement by sericite, clay (e.g. kaolinite) and carbonate. Ferromagnesian material is altered to chlorite, and FeTi oxide by rutile. A little pyrite formed in the groundmass and at ferromagnesian sites, and at the latter, there are also small amounts of chalcopyrite and rare sphalerite. A couple of thin, discontinuous carbonate-clay veins cut the altered rock.

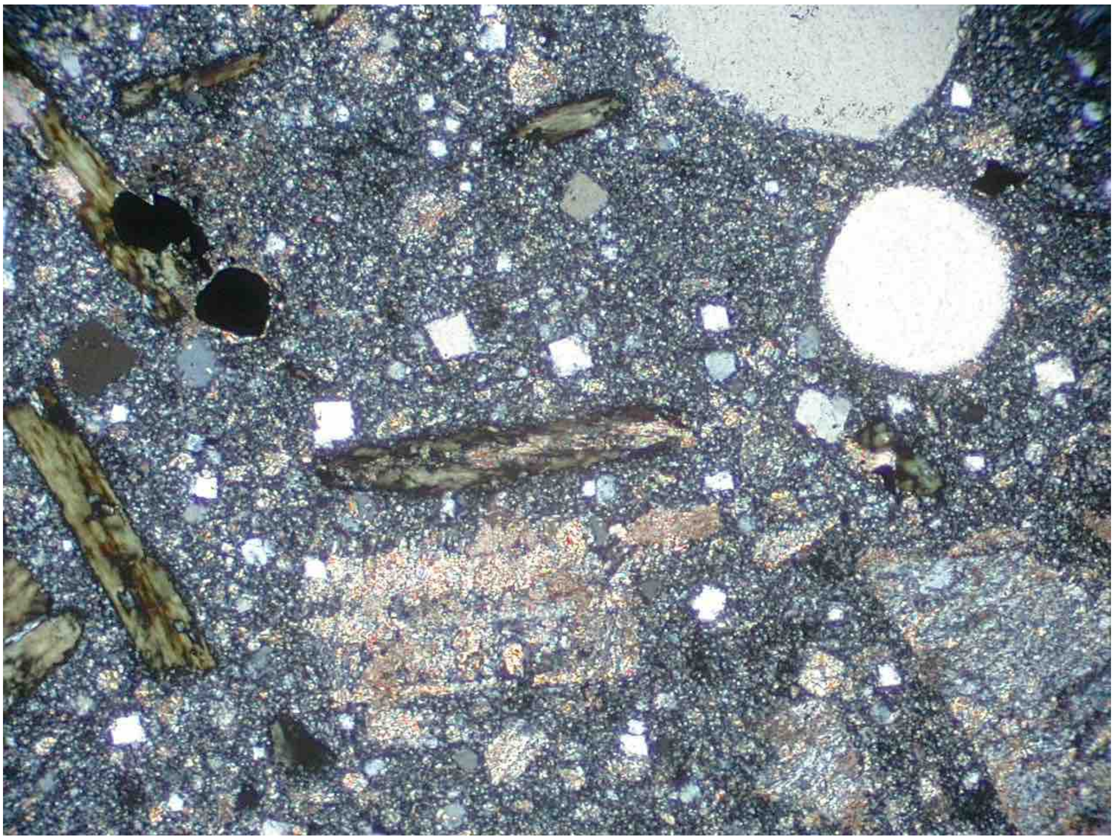


Fig. 15: Plagioclase phenocrysts, replaced by albite, sericite and carbonate (lower), plus a couple of small relict quartz phenocrysts and chlorite-replaced hornblende phenocrysts (left) in a fine grained quartzofeldspathic groundmass that has characteristic small subhedra of quartz. The small black grains at left are pyrite. Transmitted light, crossed polarisers, field of view 2 mm across.

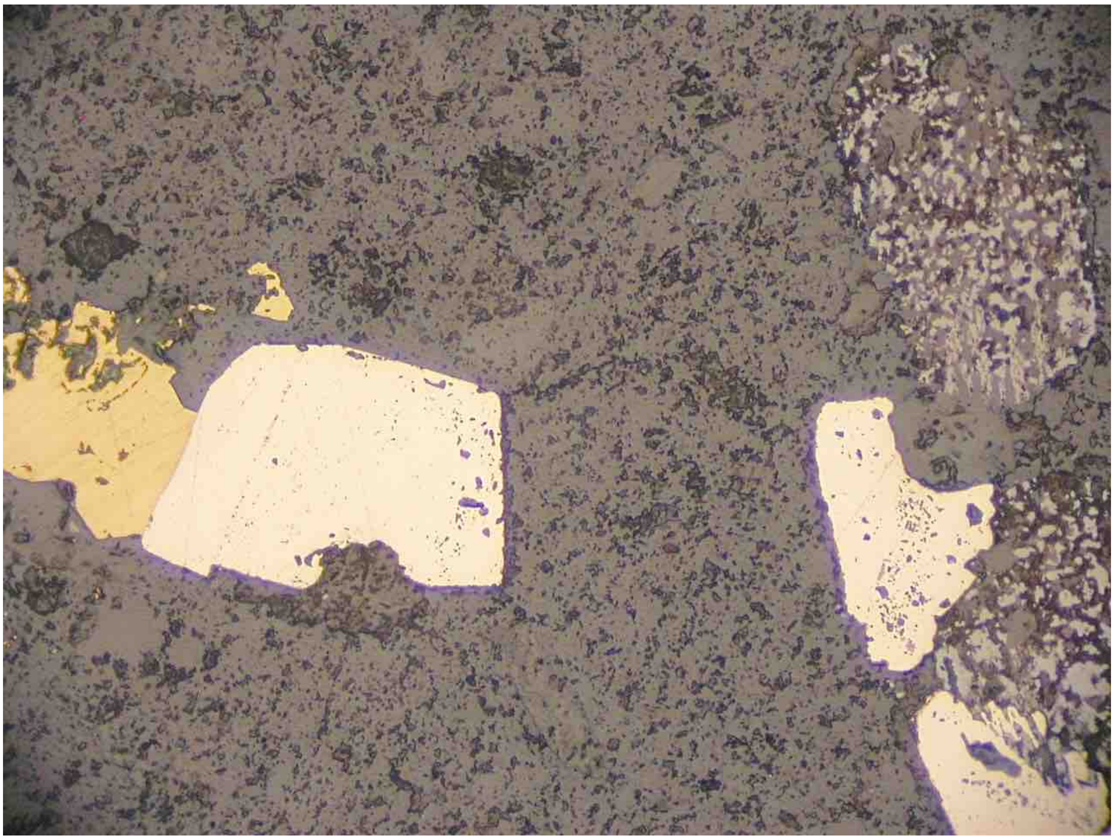


Fig. 16: Rutile aggregates (right) pseudomorphous after former FeTi oxide grains and associated with pyrite (pale creamy) and chalcopyrite (yellow) in a fine grained altered quartzofeldspathic groundmass. Plane polarised reflected light, field of view 1 mm across.

SMD006 278.2 m PTS

Summary: Intensely hydrothermally altered rock hosting an array of veins. No definite relict textures are preserved in the host rock, which also has indications of micro-cataclasis and foliation, although it is speculated that it was originally of felsic igneous type. The deformation in the host rock could be an indication of control of vein emplacement, i.e. in a sheared and cataclastic zone. The host rock was replaced by a phyllic assemblage of dominant sericite and quartz, with irregularly distributed pyrite, minor chlorite and carbonate, and trace chalcopyrite and rutile. Possible early veining of the host rock occurred, with these veins being quartz-rich and having considerable pyrite and minor chalcopyrite. These veins show imposed deformation features. The major veining in the sample is dominated by medium to coarse carbonate (calcite), with subordinate quartz, a few aggregates of chalcopyrite and a little pyrite, sericite, chlorite and trace galena and sphalerite.

Handspecimen: The drill core sample is composed of a coarse grained white to faintly pinkish carbonate vein about 2 cm thick, bordered by intensely hydrothermally altered and probably deformed host rock. The latter is pale creamy-grey to dark grey in colour, weakly foliated and with thin bands varying from sericite-rich to quartz-rich and with varying amounts of pyrite and carbonate. No relict texture is apparent in the host rock, which is cut by a number of thin veins, as well as the major carbonate-dominated vein. Contents of the veins include carbonate and quartz, with minor chalcopyrite and pyrite. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. The slight pinkish colour of carbonate could imply that it also contains minor Mn. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, about one third of the sample is interpreted as host rock and the remainder represents hydrothermal infill (i.e. vein material). Due to imposed alteration and deformation effects, no definite relict texture is recognised. It could be speculated that there are a few small pseudomorphic aggregates after former feldspar grains and partly recrystallised quartz, maybe hosted in a finer grained groundmass. The bulk mineralogical constitution of the alteration assemblage is dominated by sericite and quartz, with irregularly distributed pyrite, minor chlorite and carbonate, and trace chalcopyrite and rutile (Fig. 17). This assemblage could imply derivation from a former felsic igneous protolith.

b) Alteration and structure: A speculative felsic igneous protolith was strongly deformed and intensely hydrothermally altered, with the deformed zone showing local micro-cataclasis and foliation, perhaps controlling the emplacement of veins. The protolith was replaced by a phyllic assemblage of fine grained sericite and quartz, with minor chlorite, irregular distributed pyrite, a little carbonate and traces of chalcopyrite and rutile (Figs 17, 18). It also hosts a major vein ~2 cm wide and several approximately co-planar subsidiary veins up to 2 mm wide. Elongate fragments of the altered host rock occur in the major vein (Fig. 18). It is possible that some of the smaller veins in the host rock were emplaced before the major veining; these veins are dominated by fine to medium grained quartz and pyrite, with minor chalcopyrite, and show imposed deformation features including fracturing of pyrite, and strain and fibre development in quartz. Major veining is dominated by medium to coarse grained carbonate (calcite), forming individual grains up to 8 mm across. Near vein margins, carbonate locally has prismatic growth texture normal to vein walls (i.e. extensional growth texture). The carbonate-rich veins also contain locally abundant unstrained quartz (up to 4 mm grainsize) and a few aggregates of chalcopyrite (up to 3 mm), a little sericite, chlorite, pyrite and traces of galena and Fe-poor sphalerite.

c) Mineralisation: In the altered host rock, there is patchily abundant fine to medium grained pyrite as part of the alteration. In places, there is also a little chalcopyrite that is paragenetically later than pyrite (Fig. 18). Apparently earlier quartz-rich veins contain considerable pyrite and minor chalcopyrite, and later, carbonate-rich veins contain scattered irregular to elongate aggregates of chalcopyrite, a little pyrite and traces of galena and Fe-poor sphalerite. The latter two minerals are mostly associated with chalcopyrite and also enclosed by carbonate and quartz, in grains up to 0.5 mm across.

Mineral Mode (by volume): carbonate (calcite) 40%, quartz 25%, sericite 23%, pyrite 8%, chlorite 3%, chalcopyrite 1% and traces of rutile, galena and sphalerite.

Interpretation and comment: It is interpreted that the sample is an intensely hydrothermally altered rock of possible former felsic igneous type, hosting an array of veins. No definite relict textures are preserved, due to alteration and development of micro-cataclasis and foliation. The deformation zone probably controls vein emplacement. The host rock was replaced by a phyllic assemblage of sericite and quartz, subordinate pyrite, minor chlorite and carbonate, and trace chalcopyrite and rutile. Possible early veining of the host rock occurred, with these veins being quartz-rich and having considerable pyrite and minor chalcopyrite. These veins show imposed deformation features. The major veining in the sample is dominated by medium to coarse carbonate (calcite), with subordinate quartz, a few aggregates of chalcopyrite and a little pyrite, sericite, chlorite and trace galena and sphalerite.

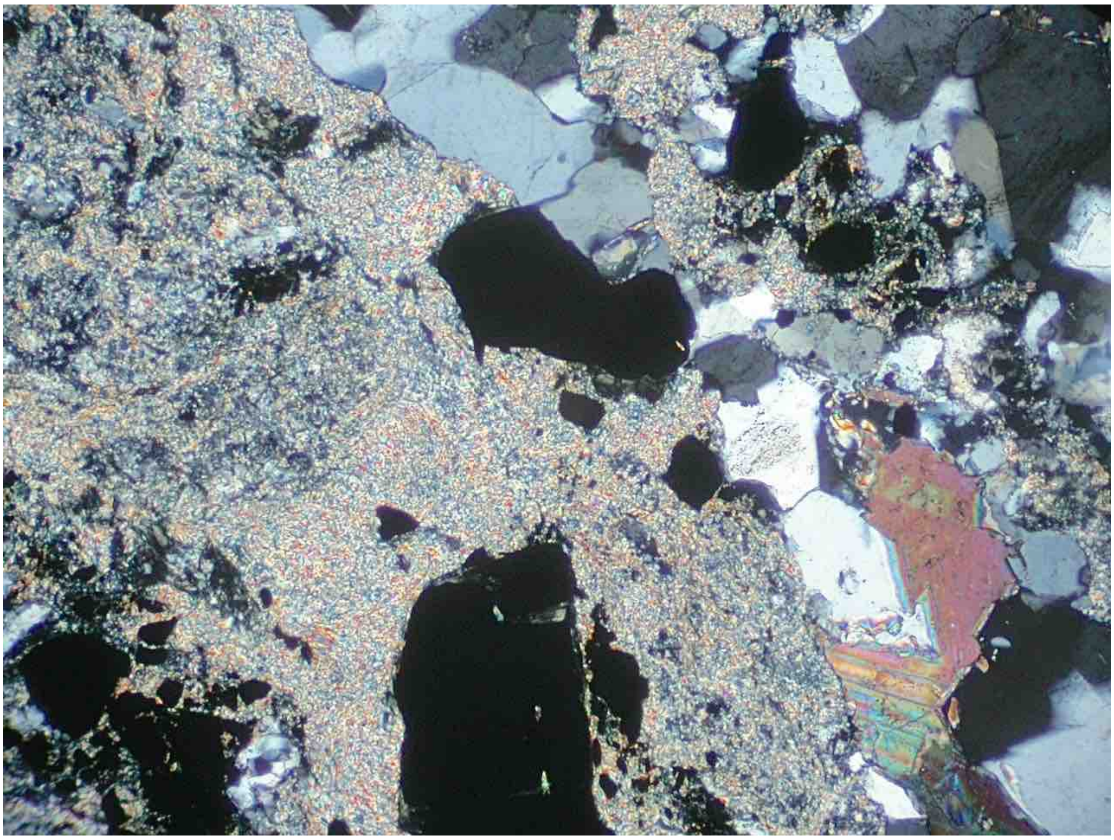


Fig. 17: Intensely hydrothermally altered host rock at left, replaced by sericite, a few grains of pyrite (black) and a little quartz. The host rock borders on to vein infill at right, composed of quartz and calcite. Transmitted light, crossed polarisers, field of view 2 mm across.

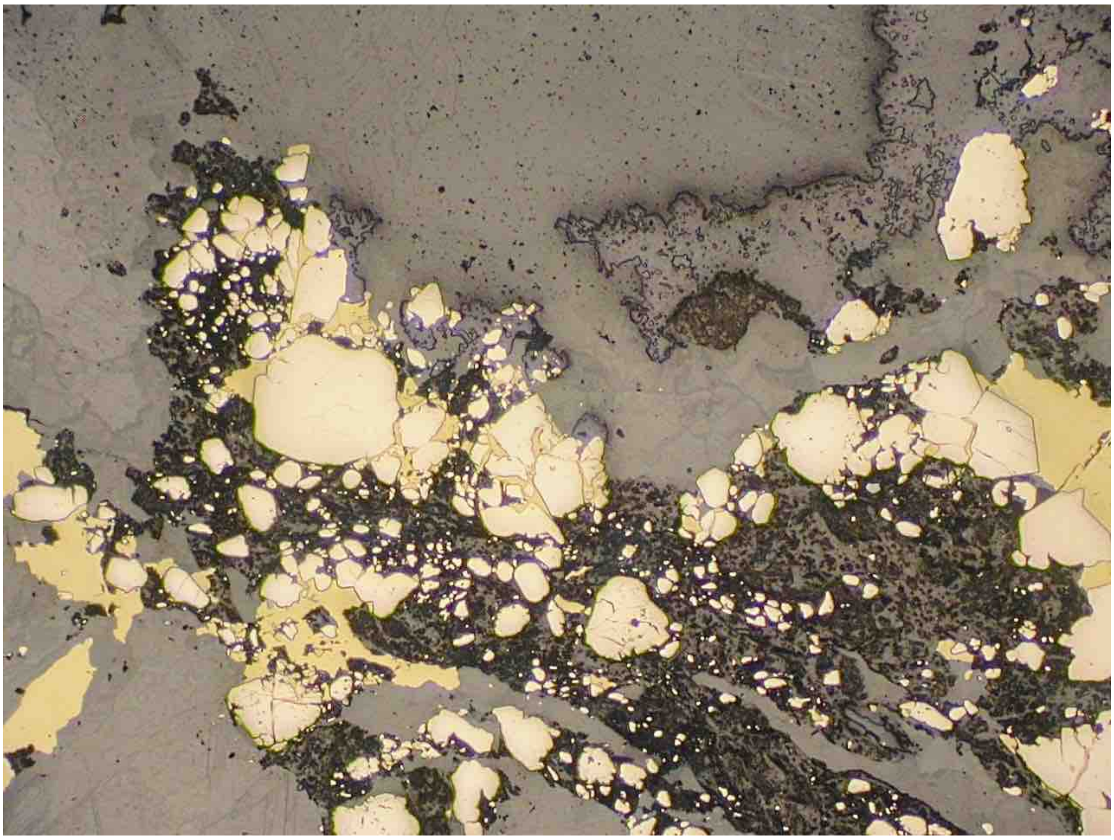


Fig. 18: Portion of a strongly altered and mineralised host rock fragment enclosed in vein-filling calcite and quartz. The fragment was replaced by sericite (dark), pyrite (pale creamy) and paragenetically later chalcopyrite (yellow). Plane polarised reflected light, field of view 2 mm across.

<u>SMD006 297.5 m PTS</u>

<u>Summary</u>: Strongly hydrothermally altered and veined rock, originally or porphyritic intermediate to felsic type, possibly quartz microdiorite or microtonalite. The host rock contained a few plagioclase phenocrysts in a medium grained groundmass of feldspar, ferromagnesian material (e.g. hornblende), minor quartz and FeTi oxide. It was strongly veined, with elongate screens of altered host rock being incorporated into the vein array. Relict texture is poorly to moderately preserved in the host rock, which has been replaced by sericite, chlorite, quartz and minor pyrite plus traces of rutile, but in some of the vein-hosted screens, alteration is more intense, to chlorite and pyrite, with a little associated Fe-poor sphalerite, sericite, quartz and carbonate. Veins are dominated by carbonate (calcite) with local quartz, and a little pyrite, sericite, chlorite, Fe-poor sphalerite and trace chalcopyrite.

<u>Handspecimen</u>: The drill core sample is composed of a dark grey-green, strongly altered rock, with vaguely preserved relict porphyritic texture, hosting a zone of strong veining up to 1.5 cm wide, as well as a few narrower subsidiary veins, arranged at a low to moderate angle to the core axis. The host rock may have had feldspar and ferromagnesian phenocrysts up to a few millimetres across, with the remainder being medium grained. The rock is strongly altered to chlorite and sericite, probable quartz, as well as disseminated pyrite. Individual veins are up to 5 mm wide and contain white to faintly pink carbonate, minor quartz and pyrite, and are bordered by abundant pyrite. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. The slight pinkish colour of carbonate could imply that it also contains minor Mn. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

<u>Petrographic description</u>

a) Primary rock characteristics: In the section, about a quarter of the sample represents vein infill, with the remainder being strongly altered host rock, in part preserved as elongate screens separated by veins. In the host rock, relict texture is poorly to moderately preserved, but it indicates that the rock was originally porphyritic, with sparsely scattered blocky feldspar (e.g. plagioclase) phenocrysts up to 3 mm across, occurring in a medium grained (up to 1.5 mm) groundmass consisting of feldspar (probably plagioclase), ferromagnesian material (probably hornblende, judging by relict shapes) and subordinate quartz, plus a few grains of FeTi oxide up to 0.6 mm across and a trace of apatite (Fig. 19). It is not possible to accurately determine the primary rock type due to strong alteration effects, but it is suggested that it was formerly a porphyritic quartz microdiorite or microtonalite.

b) Alteration and structure: The igneous protolith was affected by strong pervasive hydrothermal alteration and considerable veining. In elongate altered host rock screens within veined zones, primary texture is destroyed and there is replacement by chlorite and pyrite, with minor sericite, quartz, carbonate and traces of rutile and Fe-poor sphalerite (Fig. 20). In the more coherent part of the host rock, there is some textural preservation and the rock is replaced by sericite, chlorite and quartz, with minor disseminated pyrite and trace rutile (e.g. at former FeTi oxide sites). Chlorite is commonly concentrated at former ferromagnesian sites, whereas sericite ± quartz has replaced former feldspar (Fig. 19). The alteration assemblage is consistent with strong propylitic type. Individual veins in the vein array are sub-planar, up to 5 mm wide and dominated by medium to coarse grained carbonate (calcite), although there are finer grained zones of carbonate. Veins also contain minor fine to medium grained quartz (locally bladed), minor pyrite, a little chlorite and sericite, and a few aggregates of Fe-poor sphalerite and trace associated chalcopyrite.

c) Mineralisation: The altered host rock contains minor through to abundant anhedral to subhedral pyrite (up to 1.5 mm across). In the vein-hosted altered host rock screens, pyrite is abundant (up to 2 mm across), commonly fractured and accompanied by a little paragenetically later Fe-poor sphalerite (Fig. 20). In the carbonate-rich veining, there is also minor disseminated pyrite (up to 0.8 mm) and rare individual grains of Fe-poor sphalerite (up to 1 mm) and traces of associated chalcopyrite.

Mineral Mode (by volume): carbonate (calcite) and quartz each 30%, sericite and chlorite each 15%, pyrite 9% and traces of rutile, apatite, chalcopyrite and sphalerite.

Interpretation and comment: It is interpreted that the sample represents a strongly hydrothermally altered and veined porphyritic quartz microdiorite or microtonalite, although relict texture is only poorly to moderately preserved. It originally contained plagioclase phenocrysts in a medium grained groundmass of feldspar, ferromagnesian material (e.g. hornblende), minor quartz and FeTi oxide. The rock was strongly veined, with elongate screens of altered host rock incorporated into the vein array. Strong propylitic altered caused replacement by sericite, chlorite, quartz and minor pyrite plus traces of rutile, but in some of the vein-hosted screens, alteration is more intense, to chlorite and pyrite, with a little associated Fe-poor sphalerite, sericite, quartz and carbonate. Veins are dominated by carbonate (calcite) with local quartz, and a little pyrite, sericite, chlorite, Fe-poor sphalerite and trace chalcopyrite.

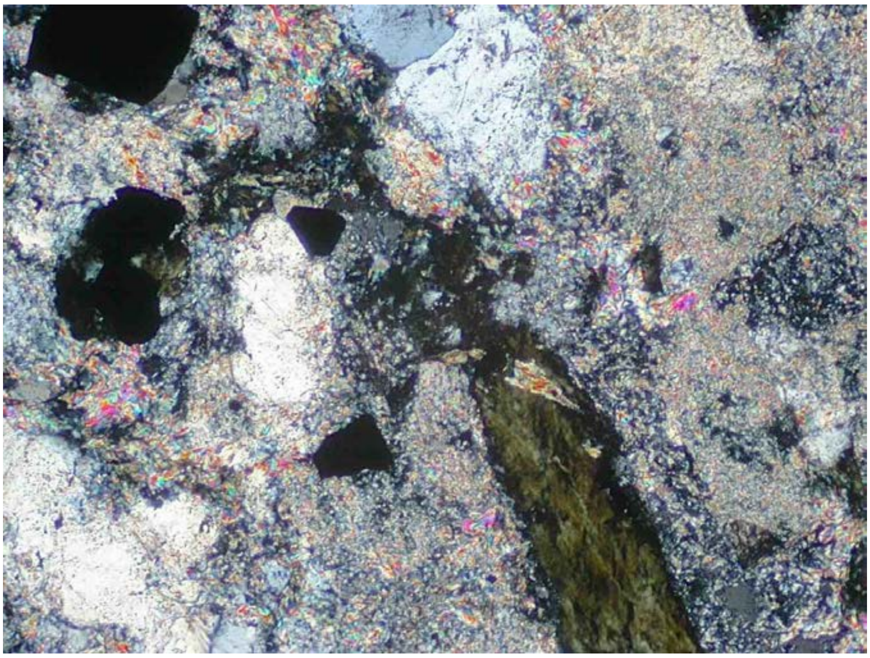


Fig. 19: Strongly hydrothermally altered host rock replaced by sericite, quartz, chlorite and pyrite (black). Note chlorite pseudomorph (dark khaki) after probable former hornblende grain. Transmitted light, crossed polarisers, field of view 2 mm across.

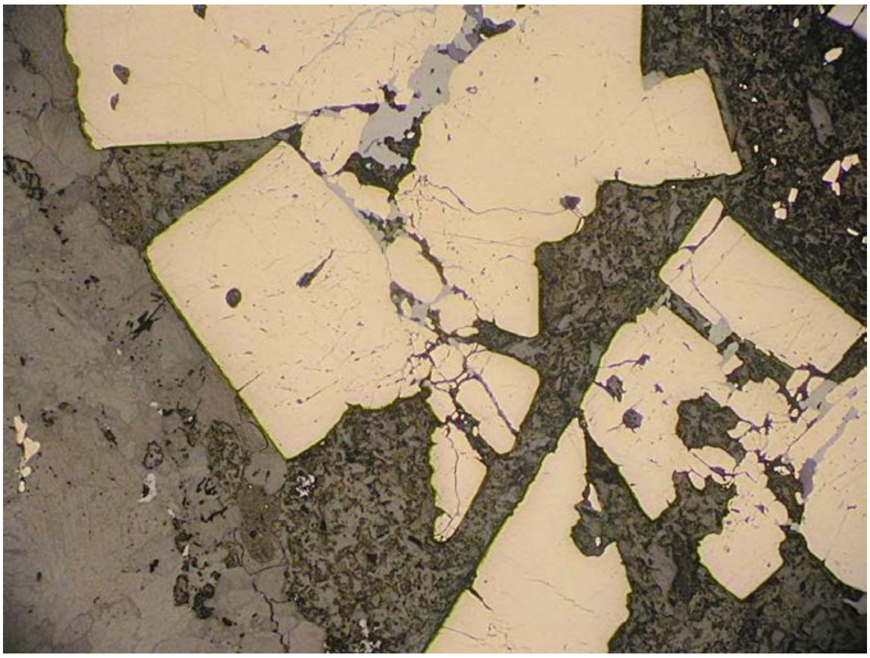


Fig. 20: Concentration of pyrite (pale creamy) within intensely altered host rock, adjacent to carbonate vein (left). Fractured pyrite hosts a small amount of sphalerite (mid grey). Plane polarised reflected light, field of view 2 mm across.

SMD006 303.8 m TS

Summary: Medium to coarse grained felsic igneous rock, possibly of original tonalite type, showing strong hydrothermal alteration and local zones of microbrecciation. Due to the imposed effects, relict texture is poorly to moderately preserved, but it is likely that the rock originally contained abundant plagioclase, ferromagnesian material (perhaps hornblende and maybe biotite) and interstitial quartz, with plagioclase locally occurring as phenocrysts. The rock contains irregular zones of microbrecciation, apparently developed prior to, or during hydrothermal alteration. The latter process caused initial albitisation of plagioclase, but widespread replacement by chlorite, subordinate fine grained quartz, minor sericite and leucoxene. A couple of quartz veins occur, but were evidently disrupted, and there is also a single thin carbonate vein.

Handspecimen: The drill core sample is composed of a relatively massive, dark grey-green, strongly altered rock. It has vaguely preserved relict medium to coarse grained texture and indications that it was formerly porphyritic, originally with abundant feldspar and ferromagnesian material. Alteration has produced abundant chlorite, with scattered paler grey domains probably containing quartz (locally veinlike) and maybe residual feldspar. In places, the rock appears to have a finely brecciated texture. The sample is moderately magnetic, with susceptibility up to 370 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock is strongly hydrothermally altered and locally, there are indications that it has been microbrecciated (Fig. 21). Generally, relict texture is poorly to moderately preserved, but observations suggest that the original rock was medium to coarse grained, locally porphyritic (e.g. feldspar, probably plagioclase, phenocrysts up to 4 mm across) and contained abundant plagioclase (probably mostly plagioclase), ferromagnesian material (perhaps hornblende and maybe biotite) and interstitial quartz, with a little disseminated fine grained FeTi oxide (e.g. titanomagnetite). It is not possible to accurately determine the protolith type due to imposed effects, but the relict characteristics infer that is was a tonalite.

b) Alteration and structure: The igneous protolith experienced strong hydrothermal alteration, local development of microbreccia and emplacement of a couple of quartz veins that show indications of subsequent disaggregation. The development of irregular cataclastic zones up to several millimetres across (Fig. 21) may have pre-dated, or overlapped with, the imposition of alteration. Original plagioclase was albitised, and commonly further replaced by fine grained chlorite ± quartz ± a little sericite, carbonate and trace epidote, with original ferromagnesian material being replaced by chlorite, with minor associated quartz, sericite and trace leucoxene (Fig. 22). Igneous FeTi oxide grains were variably replaced by leucoxene. Discontinuous, disrupted veins of medium grained quartz are up to 1.5 mm wide. In microbrecciated zones, the breccia matrix tends to be dominated by fine grained chlorite and quartz (Fig. 21), although minor sericite is locally observed. The altered rock is cut by a single anastomosing carbonate vein up to 0.2 mm wide. The strong chlorite-quartz alteration in the sample is viewed as a variant of propylitic type.

c) Mineralisation: The rock retains sparse small (<0.2 mm) relict grains of igneous FeTi oxide (titanomagnetite). A tiny trace of pyrite is observed as part of the alteration.

<u>Mineral Mode (by volume)</u>: quartz and chlorite each 40%, plagioclase (albite) 16%, sericite 2%, carbonate and leucoxene each 1% and traces of FeTi oxide (titanomagnetite), pyrite and epidote.

<u>Interpretation and comment</u>: It is interpreted that the sample is a strongly altered and locally microbrecciated tonalite. Relict texture is poorly to moderately preserved, but suggests that the protolith was medium to coarse grained and formerly contained abundant plagioclase, ferromagnesian material (perhaps hornblende and maybe biotite) and interstitial quartz, with plagioclase locally occurring as phenocrysts. Irregular zones of microbrecciation occur, apparently developed prior to, or during hydrothermal alteration. The latter process caused initial albitisation of plagioclase, with subsequent replacement by abundant chlorite, subordinate fine grained quartz, minor sericite and leucoxene. A couple of quartz veins occur, but were evidently disrupted, and there is also a single thin carbonate vein.

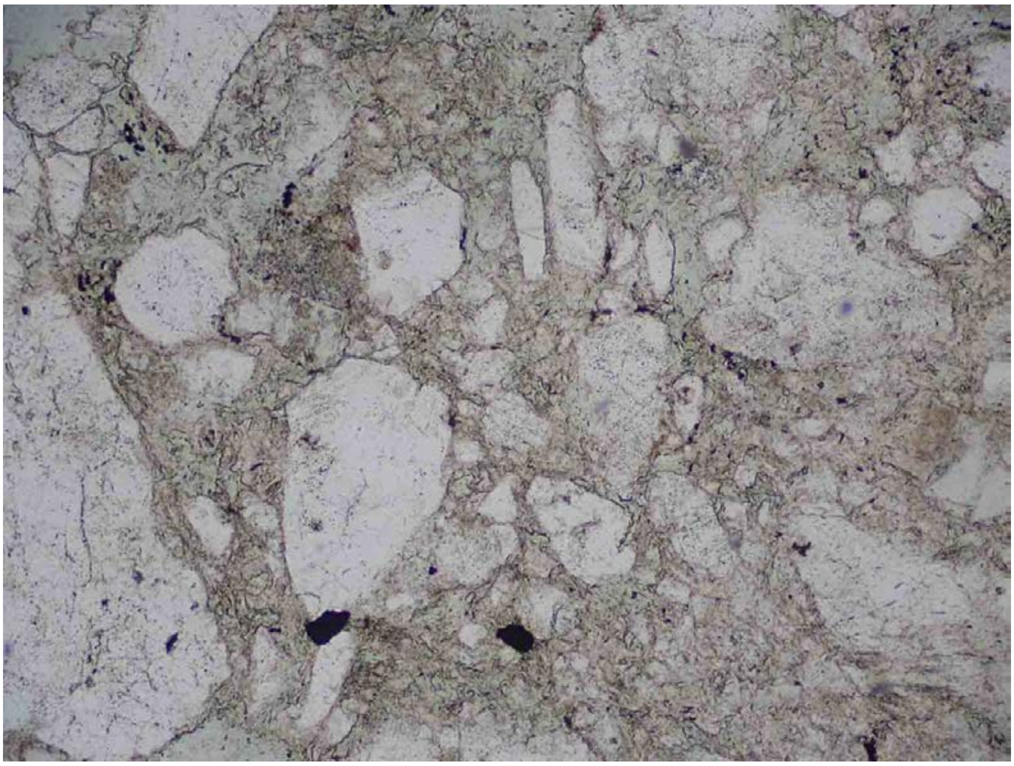


Fig. 21: Portion of a zone of microbreccia. Small fragments are either single grains of quartz, or represent quartz-replaced host rock, with the breccia matrix containing fine grained chlorite and quartz. Small black aggregates are leucoxene. Plane polarised transmitted light, field of view 2 mm across.

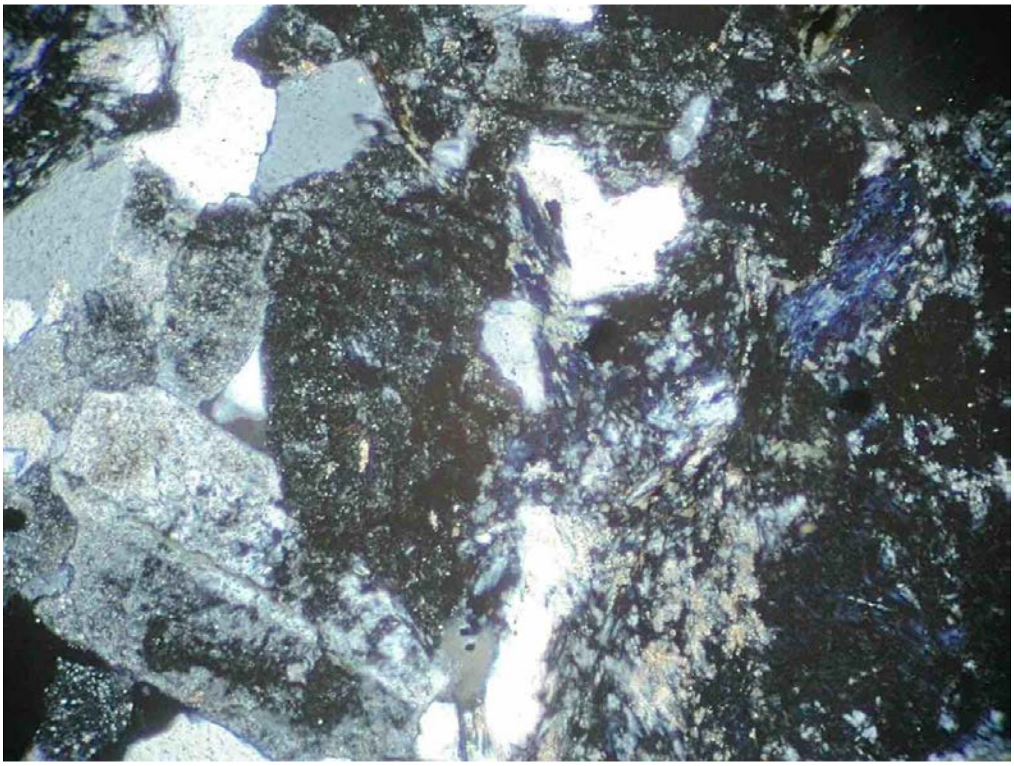


Fig. 22: Strongly altered tonalite, showing albitised plagioclase (left) and more strongly replaced plagioclase and ferromagnesian material at centre-right, with development of

abundant chlorite (dark grey to blue). Transmitted light, crossed polarisers, field of view 2 mm across.

<u>SMD006 314.5 m PTS</u>

Summary: Strongly hydrothermally altered and locally veined, porphyritic hornblende dacite, transitional to quartz andesite. The rock has moderately well preserved relict texture, indicating that it formerly contained phenocrysts of plagioclase and hornblende and a few microphenocrysts of FeTi oxide, and rare quartz and apatite. The phenocrystal phases occurred in a fine grained granular groundmass of quartzofeldspathic type. Pervasive alteration is of propylitic type and although plagioclase was initially albitised, much was subsequently replaced by sericite and local carbonate. Ferromagnesian material was mostly replaced by chlorite and FeTi oxide by rutile. In the groundmass, fine grained sericite, chlorite and quartz are abundantly developed in places, and there is a little disseminated pyrite and trace sphalerite. A few veins occur, commonly with significant carbonate (calcite) as well as scattered pyrite, sericite, local quartz and chlorite, and several small aggregates of Fe-poor sphalerite.

Handspecimen: The drill core sample is composed of a generally massive, strongly altered porphyritic igneous rock, maybe of intermediate composition and containing altered phenocrysts that included feldspar (e.g. plagioclase) and ferromagnesian material (e.g. hornblende) up to 7 mm across, set in a fine grained groundmass. Pervasive alteration is likely to have developed rather abundant fine grained sericite, chlorite, perhaps quartz and carbonate, a little disseminated pyrite and a few small pale brown aggregates of leucoxene-rutile. The rock is cut by several sub-planar and locally intersecting veins up to a few millimetres wide containing creamy white carbonate, locally abundant pyrite and a trace of grey sphalerite. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately well preserved (Fig. 23), despite the pervasive alteration. The rock originally contained scattered blocky plagioclase phenocrysts up to 4 mm across, as well as a prismatic ferromagnesian phase up to 5 mm long (e.g. hornblende) (Fig. 23). There are also a few microphenocrysts of FeTi oxide (now altered) and rare apatite and quartz, all enclosed in a finely granular groundmass that originally contained abundant plagioclase and probably minor quartz, alkali feldspar and ferromagnesian material. Some quartz in the groundmass has characteristic squarish outlines, similar to several other samples in the suite. From the preserved primary characteristics, the sample is interpreted as a porphyritic hornblende dacite, perhaps transitional to quartz andesite.

b) Alteration and structure: Strong pervasive hydrothermal alteration of propylitic type was imposed on the igneous protolith and a few veins emplaced. Initially, plagioclase was albitised, but subsequently, it and any alkali feldspar were extensively replaced by fine grained sericite, local carbonate and trace chlorite (Fig. 23). All former ferromagnesian material was replaced by chlorite, with locally common sericite, carbonate and a little quartz, pyrite and rutile. Igneous FeTi oxide was replaced by rutile aggregates up to 0.6 mm across. In the groundmass, there was patchy replacement of feldspars by sericite, chlorite, quartz, with a little pyrite and trace sphalerite. A prominent vein occurs, widening from 0.5 mm to 8 mm, and there are a few other sub-planar veins up to 0.8 mm wide. Veins contain fine to medium grained carbonate (calcite), patchily abundant pyrite and sericite, minor quartz and chlorite, and a few aggregates of Fe-poor sphalerite, with trace associated chalcopyrite (Fig. 24). Several pyrite grains have inclusions of anhydrite up to 0.2 mm across and rare chalcopyrite.

c) Mineralisation: In the altered host rock, there are sparse grains of pyrite up to 1 mm across and a trace of sphalerite, formed as part of the alteration. Sulphides are more common in the veins, where subhedra of pyrite up to 1 mm across are locally abundant (Fig. 24). There are also a few aggregates of Fe-poor sphalerite up to 1.5 mm log in the veins, paragenetically later than pyrite and hosting tiny chalcopyrite inclusions ("chalcopyrite disease texture").

Mineral Mode (by volume): quartz and sericite each 25%, plagioclase (albite) 20%, chlorite 13%, carbonate 10%, pyrite 5%, sphalerite 1% and traces of apatite, rutile, anhydrite and chalcopyrite.

Interpretation and comment: It is interpreted that the sample represents a porphyritic hornblende dacite, transitional to quartz andesite, which has undergone strong propylitic hydrothermal alteration and veining. It has moderately well preserved relict texture, formerly containing plagioclase and hornblende phenocrysts and a few microphenocrysts of FeTi oxide, and rare quartz and apatite, all enclosed in a fine grained granular quartzofeldspathic groundmass. Alteration led to initial albitisation of plagioclase, with was subsequent strong replacement by sericite and local carbonate. Ferromagnesian material was mostly replaced by chlorite and FeTi oxide by rutile. In the groundmass, fine grained sericite, chlorite and quartz are abundantly developed in places, and there is a little disseminated pyrite and trace sphalerite. A few veins occur, commonly with significant carbonate (calcite) as well as scattered pyrite, sericite, local quartz and chlorite, and several small aggregates of Fe-poor sphalerite.

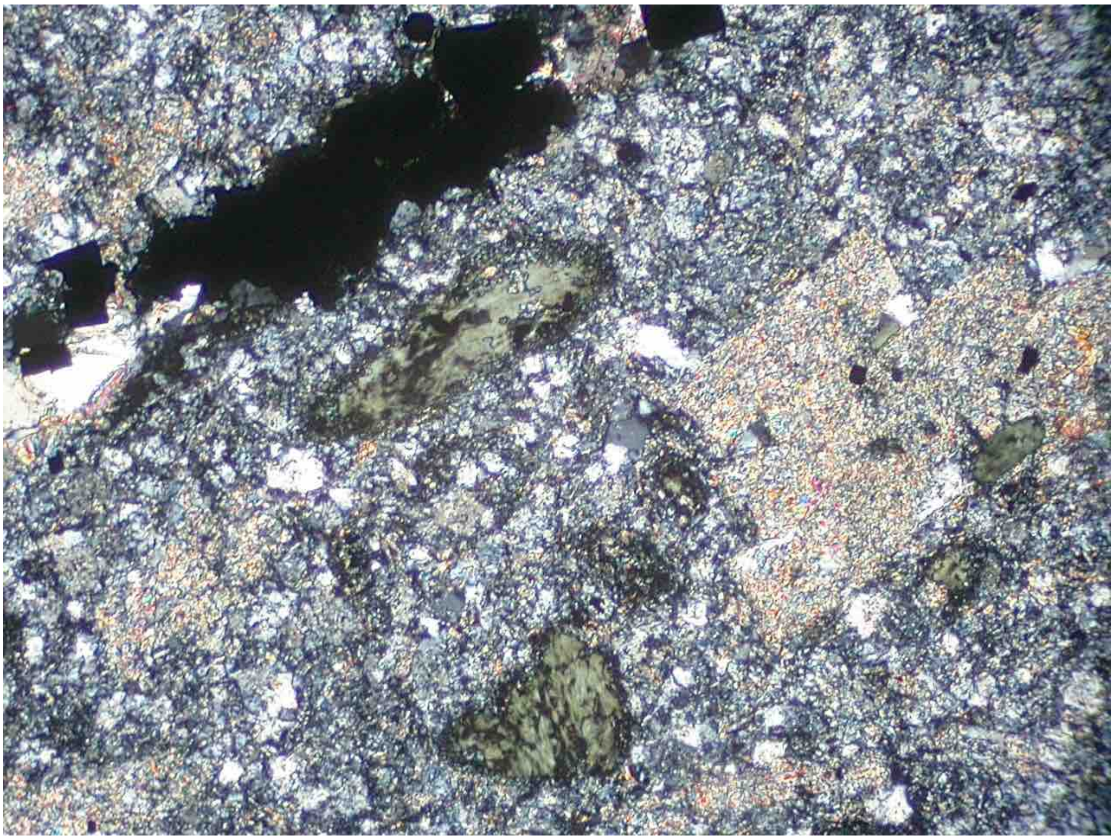


Fig. 23: Relict porphyritic texture, showing small, sericitised plagioclase and chloritised hornblende phenocrysts in a fine grained altered groundmass with considerable quartz. At upper left is part of a vein containing pyrite and sphalerite (both black), quartz and carbonate. Transmitted light, crossed polarisers, field of view 2 mm across.

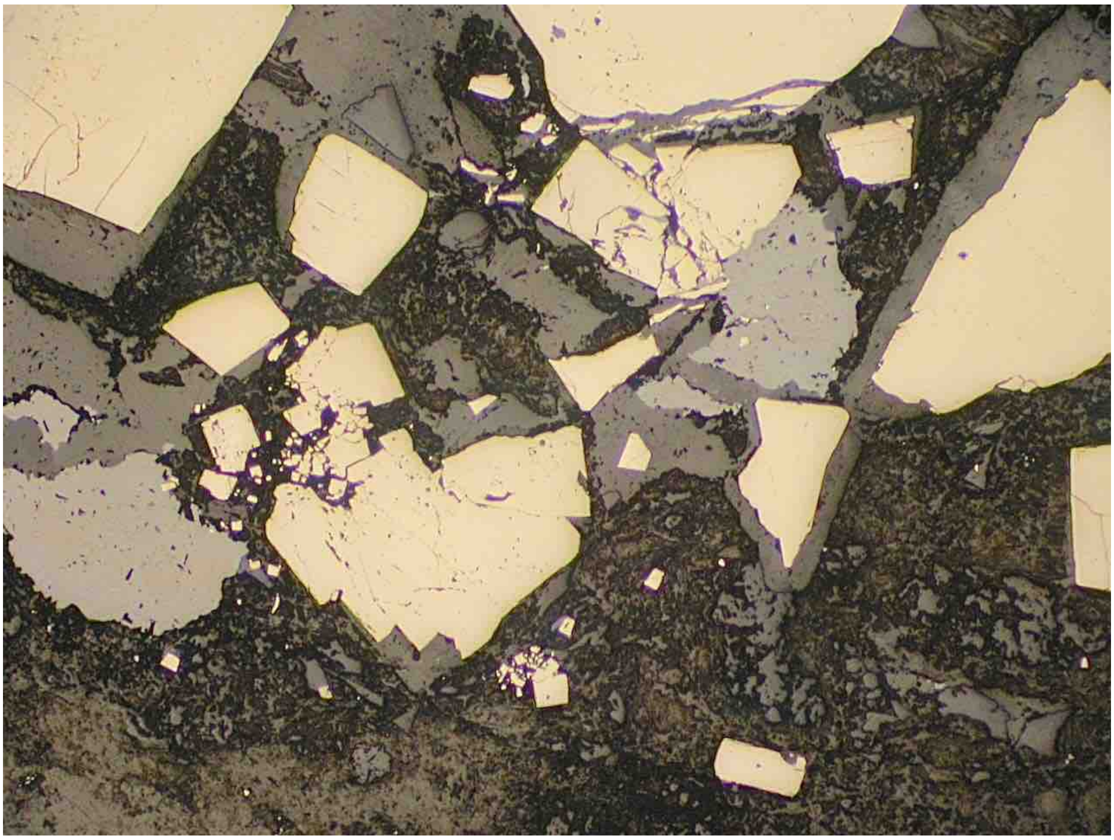


Fig. 24: Margin of sulphide-rich portion of vein adjacent to strongly altered host rock (dark). In the vein, subhedral and locally fractured pyrite (pale creamy) is associated with minor sphalerite (paler grey) and carbonate (darker grey). Plane polarised reflected light, field of view 2 mm across.

SMD006 324.6 m PTS

Summary: Porphyritic intermediate to felsic igneous rock showing very strong hydrothermal alteration. Portion has minor retention of relict texture, suggesting that it formerly contained possible feldspar (e.g. plagioclase) and ferromagnesian phenocrysts, as well as a few microphenocrysts of FeTi oxide, in a finer grained groundmass. This part of the sample was replaced by a fine to medium grained assemblage of quartz, with subordinate sericite and carbonate, minor chlorite and a little rutile and pyrite. The remainder of the sample shows irregular to veinlike masses of medium to coarse grained pyrite, with interstitial aggregates of sericite, carbonate (calcite) and chlorite. A little rutile occurs in these domains, attesting to them being a product of intense replacement, rather than hydrothermal infill. A little Fe-poor sphalerite is associated with pyrite, generally filling fractures.

Handspecimen: The drill core sample is mostly composed of a massive, strongly altered igneous rock, with possible relict porphyritic texture, and with irregular to veinlike zones of intense hydrothermal replacement and/or infill by aggregates of semi-massive pyrite, accompanied by dark green-grey chlorite and pale creamy carbonate. These zones are up to 2-3 cm across, with some at a moderate angle to the core axis. The host rock is mottled pale grey-green to darker grey-green, and evidently replaced by fine grained sericite, chlorite and quartz. In places, there are probable sericite pseudomorphs after original feldspar phenocrysts up to a few millimetres across, set in a finer grained groundmass. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, about half of the sample represents strongly altered host rock in which there is poorly preserved relict texture (Fig. 25). The remainder represents irregular and veinlike domains that are the product of complete alteration and primary textural destruction (with no preserved texture) as well as possible hydrothermal infill. In the former zone, there are a few pseudomorphic aggregates after former feldspar (e.g. plagioclase) and ferromagnesian phenocrysts up to 4 mm across, and less common pseudomorphs after smaller FeTi oxide grains. The original phenocrysts occurred in an apparently finer grained groundmass. Due to the intensity of alteration and generally poor preservation of relict texture, the nature of the protolith remains rather speculative, but it was perhaps porphyritic and of intermediate to felsic type (e.g. andesite-dacite).

b) Alteration and structure: Approximately half of the sample has some indications of relict texture, but it is strongly replaced by an assemblage of fine to medium grained quartz, with subordinate sericite, carbonate, minor chlorite, a few aggregates of rutile (at former FeTi oxide sites) and trace pyrite. In this domain, former phenocrysts were replaced mostly by sericite ± carbonate, but there are a few small former plagioclase grains that retain albite, and several of the sericite ± carbonate-rich aggregates also have central zones with chlorite (Fig. 25). A couple of sub-planar carbonate veins up to 1 mm wide cut this altered zone, which has sharp, relatively planar contacts against domains with no preservation of relict texture. The latter have abundant semi-massive, medium to coarse grained pyrite, with interstitial masses of fine grained sericite, patchy chlorite (enclosed by sericite) and medium grained carbonate (calcite), some of which is veinlike. A trace of rutile is enclosed in the silicates and its presence suggests that at least some of these pyrite-rich zones formed by total replacement of a protolith, rather than necessarily being hydrothermal infill. A trace of sphalerite occurs with the pyrite-rich aggregates (Fig. 26) and no anhydrite is recognised.

c) Mineralisation: The domain of host rock with some preservation of relict texture contains sparse grains of pyrite as part of the alteration. Elsewhere in the sample, there is abundant, medium to coarse grained pyrite, commonly as semi-massive aggregates. Grainsize is up to several millimetres, with pyrite being locally fractured. Locally, pyrite is associated with a little Fe-poor sphalerite, in part filling fractures (Fig. 26). Tiny chalcopyrite inclusions ("chalcopyrite disease") occur in sphalerite.

Mineral Mode (by volume): pyrite 35%, quartz 25%, sericite 18%, carbonate (calcite) 12%, chlorite 9%, albite 1% and traces of rutile, sphalerite and chalcopyrite.

Interpretation and comment: It is interpreted that the sample is a former porphyritic intermediate to felsic igneous rock that was affected by very strong hydrothermal alteration, leading to complete replacement. In places, there is minor retention of relict texture, suggesting that it formerly contained possible feldspar (e.g. plagioclase) and ferromagnesian phenocrysts, as well as a few microphenocrysts of FeTi oxide, in a finer grained groundmass. This part of the sample was replaced by a fine to medium grained assemblage of quartz, with subordinate sericite and carbonate, minor chlorite and a little rutile and pyrite. The remainder of the sample was replaced by medium to coarse grained pyrite, interstitial aggregates of sericite, carbonate (calcite) and chlorite. A little rutile occurs in these domains, attesting to them being a product of intense replacement, rather than necessarily by hydrothermal infill. A little Fe-poor sphalerite is associated with pyrite, generally filling fractures.

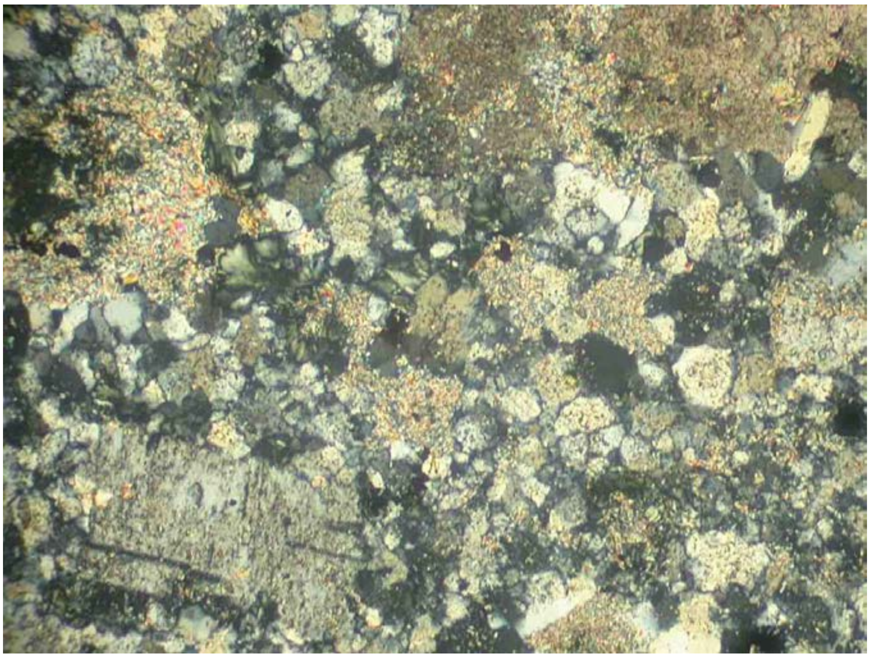


Fig. 25: Altered rock with pseudomorphs after former phenocrysts (albite at lower left, carbonate at upper right, and sericite + chlorite at upper left) in a totally replaced groundmass rich in quartz and sericite. Transmitted light, crossed polarisers, field of view 2 mm across.

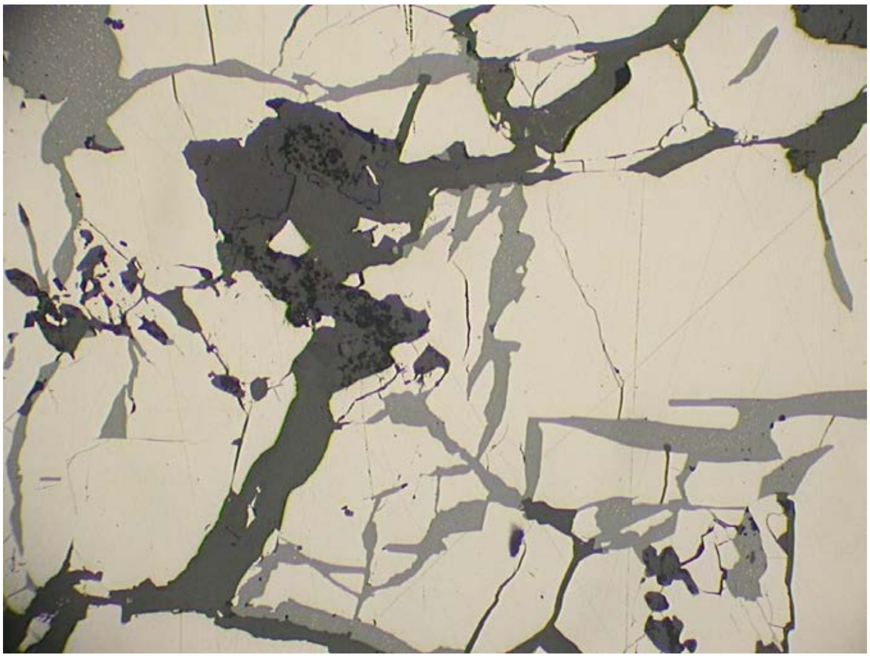


Fig. 26: Fractured pyrite showing invasion by sphalerite (mid grey) and carbonate (dark grey). Plane polarised reflected light, field of view 1 mm across.

<u>SMD006 336.1 m TS</u>

Summary: Porphyritic hornblende dacite with moderately preserved relict texture, and having strongly overprinting alteration of propylitic type, as well as emplacement of several veins. The rock originally contained scattered phenocrysts of feldspar (probably plagioclase) and ferromagnesian material (e.g. hornblende) as well as rare quartz, in a fine to medium grained, largely quartzofeldspathic groundmass. Initially, plagioclase was replaced by albite, with subsequent strong development of sericite ± carbonate. Ferromagnesian material was largely replaced by chlorite ± carbonate, and FeTi oxide by leucoxene-rutile. Apparently earlier vein sets contain chlorite and/or quartz, in places with small amounts of sulphides, including chalcopyrite, galena, Fe-poor sphalerite and pyrite. These veins might evolve into, and/or are overprinted by, carbonate-rich veins ± quartz and sericite.

Handspecimen: The drill core sample is mostly composed of a relatively massive, strongly altered porphyritic felsic to intermediate igneous rock. It contains pseudomorphs after probable feldspar and ferromagnesian phenocrysts up to a few millimetres across in a fine grained, pale grey-green altered groundmass, maybe originally of quartzofeldspathic composition. Pervasive alteration led to replacement by fine grained sericite (e.g. at feldspar sites), chlorite (e.g. at ferromagnesian sites) as well as quartz, a little pyrite and a few small grains of pale brown leucoxene. A few sub-planar veins occur, with a few narrow, chlorite-bearing types, and wider (up to 2 mm) and more common, white carbonate veins at a moderate angle to the core axis. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved (Fig. 27). The rock is strongly altered, but there are scattered pseudomorphic shapes after former feldspar (e.g. plagioclase) phenocrysts up to 5 mm across and prismatic ferromagnesian phenocrysts (e.g. former hornblende) up to 4 mm long (Fig. 27). A single relict quartz phenocryst ~1.5 mm across is observed and there are small grains of FeTi oxide (all altered) and rare apatite, with all enclosed in a groundmass containing scattered small grains of plagioclase and ferromagnesian material (both altered) and interstitial fine grained quartzofeldspathic material. From the preserved characteristics, it is interpreted that the original rock was a porphyritic hornblende dacite.

b) Alteration and structure: The igneous rock was subject to strong pervasive hydrothermal alteration of propylitic type and the emplacement of several veins. Plagioclase was initially albitised, but was subsequently further replaced by abundant sericite, local carbonate and a little chlorite (Fig. 27). Ferromagnesian material was replaced by chlorite, in places with carbonate, sericite and traces of leucoxene-rutile and pyrite, and all FeTi oxide was replaced by leucoxene-rutile. In the groundmass, it is likely that there was considerable replacement by quartz and sericite, but some albite remains. Several anastomosing to sub-planar veins occur. There could have been two generations of veining, but perhaps overlapping. Apparently earlier-emplaced were irregular veins of chlorite and/or quartz up to 1 mm wide, locally hosting small amounts of chalcopyrite, galena, Fe-poor sphalerite and pyrite. These veins might contain later central infillings, or be overprinted by, veining up to 2 mm wide of medium grained carbonate (calcite) with local quartz and minor bordering sericite.

c) Mineralisation: In the host rock, there is a trace of pyrite forming grains up to 0.2 mm that forms part of the alteration. In the apparently earlier chlorite-quartz veining, there are minor amounts of irregularly distributed chalcopyrite (up to 0.8 mm), galena (up to 0.4 mm), pyrite (up to 0.2 mm) and Fe-poor sphalerite (up to 0.3 mm).

Mineral Mode (by volume): quartz 40%, sericite 28%, carbonate (calcite), chlorite and albite each 10%, leucoxene-rutile 1% and traces of apatite, pyrite, galena, sphalerite and chalcopyrite.

Interpretation and comment: It is interpreted that the sample represents a strongly altered and locally veined porphyritic hornblende dacite. It has moderately preserved relict texture, indicating that it hosted scattered phenocrysts of feldspar (probably plagioclase) and ferromagnesian material (e.g. hornblende) as well as rare quartz, in a fine to medium grained, largely quartzofeldspathic groundmass. Alteration of propylitic type led to initial albitisation of plagioclase, with subsequent strong development of sericite ± carbonate. Ferromagnesian material was largely replaced by chlorite ± carbonate, and FeTi oxide by leucoxene-rutile. Apparently earlier vein sets contain chlorite and/or quartz, in places with small amounts of sulphides, including chalcopyrite, galena, Fe-poor sphalerite and pyrite. These veins might evolve into, and/or are overprinted by, carbonate-rich veins ± quartz and sericite.

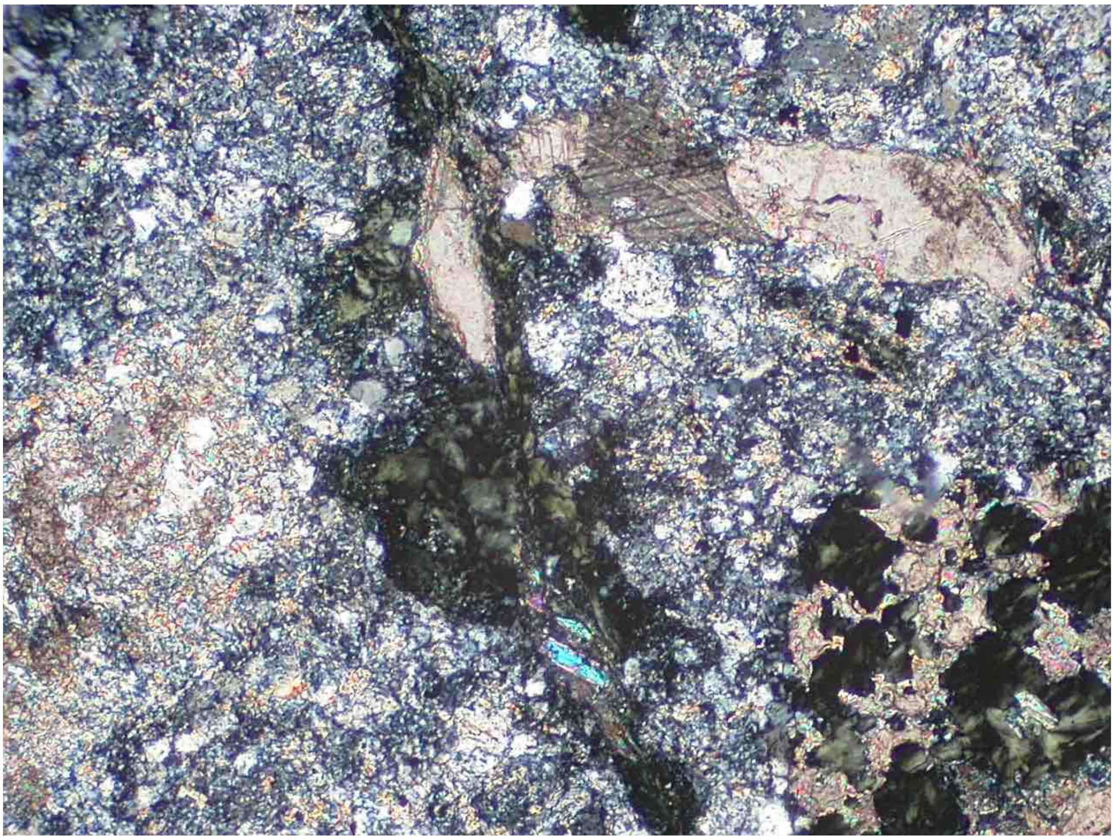


Fig. 27: Relict porphyritic texture in altered dacite, showing a plagioclase phenocryst at left, replaced by albite, sericite and carbonate, and a ferromagnesian phenocryst at lower right, replaced by chlorite and carbonate. The fine grained groundmass is cut by a chlorite-rich vein (dark) and a discontinuous carbonate vein. Transmitted light, crossed polarisers, field of view 2 mm across.

<u>SMD006 351.5 m PTS</u>

<u>Summary</u>: Porphyritic hornblende dacite showing strong propylitic alteration and patchy irregular to veinlike masses containing minor sulphides. The rock has moderately preserved relict texture, indicating that it contained plagioclase and ferromagnesian (e.g. hornblende) phenocrysts, along with rare, small quartz phenocrysts, set in a fine grained quartzofeldspathic groundmass. The imposed alteration led to significant albite development, overprinted by abundant sericite, and lesser chlorite and carbonate, with quartz and sericite being rather abundant in the groundmass. A little pyrite and rutile were also components of the alteration. The irregular and veinlike replacive aggregates contain varying proportions of sericite, chlorite and carbonate, with locally associated aggregates of Fe-poor sphalerite, pyrite and a little chalcopyrite, commonly forming composites.

<u>Handspecimen</u>: The drill core sample is composed of a strongly altered, porphyritic felsic to intermediate igneous rock. It has a mottled appearance, with scattered dark grey-green alteration aggregates up to several millimetres across, and smaller whitish alteration aggregates, in a pale grey-green fine grained altered groundmass. Some of the dark and whitish alteration aggregates could represent sites of former ferromagnesian and feldspar phenocrysts, respectively, but others might be replacement aggregates in the groundmass. The pervasive alteration assemblage probably includes sericite and chlorite, and perhaps carbonate and quartz, and a little disseminated pyrite. A few thin irregular veins occur, containing chlorite, sericite and carbonate, with a few aggregates of sulphides up to 2 mm across, including grey sphalerite, plus pyrite and chalcopyrite. The rock also hosts a couple of white carbonate veins up to a few millimetres wide, occurring at a moderate angle to the core axis. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

<u>Petrographic description</u>

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved, but it is evident that the rock is strongly altered. There are scattered pseudomorphs after plagioclase phenocrysts up to 4 mm across (with rare clusters up to 8 mm) and after a former prismatic ferromagnesian phase (e.g. hornblende) up to 3.5 mm long (Fig. 28). The rock also contains uncommon quartz phenocrysts up to 1.5 mm across and uncommon microphenocrysts of apatite and FeTi oxide (now altered). The phenocrystal phases occurred in a fine grained quartzofeldspathic groundmass, now altered and largely recrystallised. From the relict characteristics, the rock is interpreted as a porphyritic hornblende dacite.

b) Alteration and structure: Strong pervasive hydrothermal alteration of propylitic type was imposed on the igneous rock and several irregular to veinlike alteration aggregates developed. Original plagioclase was albitised and further replaced by commonly abundant sericite and carbonate, and a little chlorite (Fig. 28). All ferromagnesian material was replaced by chlorite, accompanied by carbonate, sericite and traces of pyrite, rutile and sphalerite (Fig. 28). Igneous FeTi oxide was replaced by rutile and chlorite. In the groundmass, significant albite development from feldspar occurred, probably overprinted by sericite and quartz, and a little chlorite, carbonate and trace pyrite and rutile. Throughout the rock, there are irregular replacive masses up to several millimetres across, grading into anastomosing veins (Fig. 28) that contain varying amounts of sericite, chlorite and carbonate, and a few ragged aggregates of Fe-poor sphalerite and/or pyrite, commonly with a little associated chalcopyrite (Fig. 29).

c) Mineralisation: The altered host rock contains sparse pyrite grains up to 1 mm across, but most sulphides occur in the irregular to veinlike masses rich in sericite, chlorite and carbonate. In these sites, there are a few ragged aggregates rich in Fe-poor sphalerite up to 2.5 mm across, with associated chalcopyrite (in part as "chalcopyrite disease" texture) and pyrite (Fig.

29). There are also a few pyrite-rich aggregates up to 2 mm across, with associated sphalerite and chalcopyrite.

Mineral Mode (by volume): sericite 30%, quartz 25%, albite 20%, chlorite 12%, carbonate 9%, pyrite 2%, sphalerite 1% and traces of apatite, rutile and chalcopyrite.

Interpretation and comment: It is interpreted that the sample is a strongly propylitically altered porphyritic hornblende dacite. It has moderately preserved relict texture, with altered plagioclase and ferromagnesian (e.g. hornblende) phenocrysts, along with a few relict quartz phenocrysts, set in a fine grained quartzofeldspathic groundmass. Imposed alteration caused significant albite development, overprinted by abundant sericite, and lesser chlorite and carbonate, with quartz and sericite being rather abundant in the groundmass. A little pyrite and rutile were also components of the alteration. Irregular and veinlike replacive aggregates invading the rock contain varying proportions of sericite, chlorite and carbonate, with sparse associated aggregates of Fe-poor sphalerite, pyrite and a little chalcopyrite, commonly forming composites.

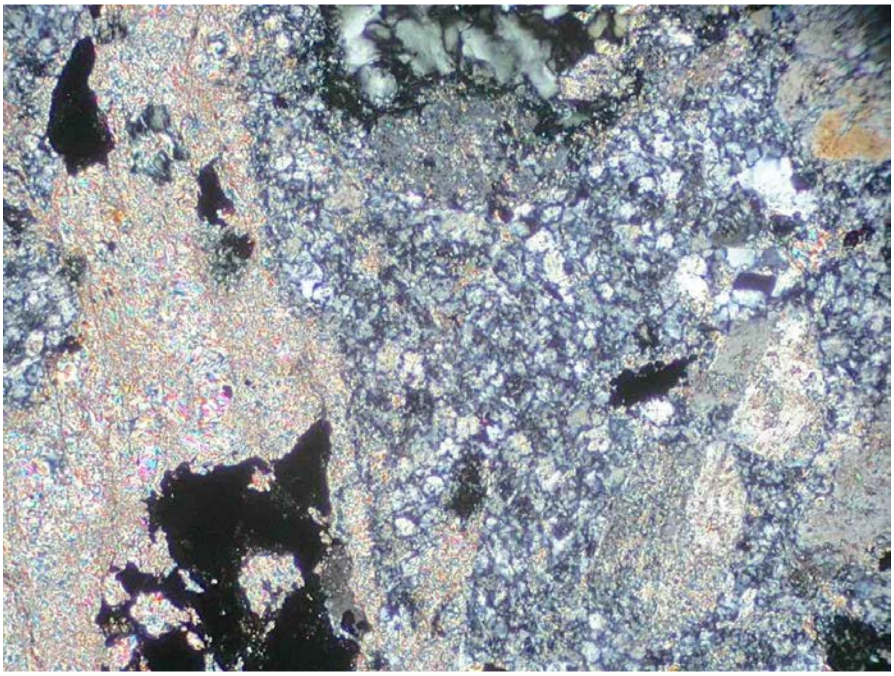


Fig. 28: Portion of a veinlike aggregate of sericite and sulphides (mostly sphalerite) at left, cutting altered dacite that has an altered ferromagnesian phenocryst at top, and a couple of small, albitised plagioclase phenocrysts in a fine grained groundmass. Transmitted light, crossed polarisers, field of view 2 mm across.

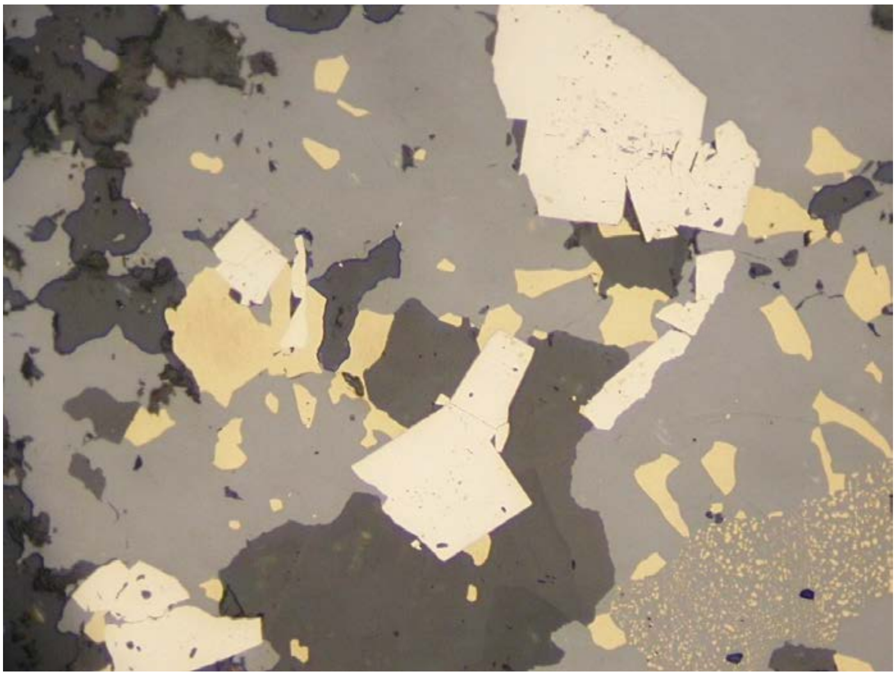


Fig. 29: Portion of a sulphide-rich aggregate within a veinlike alteration aggregate. Sulphides include Fe-poor sphalerite (mid grey), pyrite (pale creamy) and chalcopyrite (yellow). Note patch of "chalcopyrite disease" texture at lower right. Plane polarised reflected light, field of view 1 mm across.

SMD007 194.0 m TS

Summary: Strongly altered weakly porphyritic hornblende-quartz microdiorite. The rock has moderately preserved relict texture, indicating that it was originally feldspar (probably plagioclase)-rich, with subordinate ferromagnesian material (e.g. hornblende), minor interstitial quartz and a little disseminated FeTi oxide. Original feldspar was totally replaced, by varying proportions of fine grained sericite and clay (perhaps illite-smectite and/or kaolinite), with minor quartz and chlorite. Ferromagnesian material was replaced by chlorite and trace leucoxene, and FeTi oxide was replaced by leucoxene. Sparsely scattered in the rock are alteration aggregates of quartz and chlorite, locally with a little pyrite and chalcopyrite.

Handspecimen: The drill core sample is composed of a massive, strongly altered, intermediate igneous rock, retaining relict weakly porphyritic and medium grained, inequigranular texture. There are a few pseudomorphs after former feldspar phenocrysts up to 5 mm across, with the remainder of the rock originally consisting of abundant feldspar, subordinate ferromagnesian material (maybe hornblende in grains up to 2 mm across) and minor quartz. Pervasive alteration led to replacement of feldspar by fine grained, creamy-white sericite/clay, and ferromagnesian material by dark green-grey chlorite. A few small chlorite-quartz aggregates have developed, with traces of associated pyrite and chalcopyrite. The sample is very weakly magnetic, with susceptibility up to 25 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict texture is moderately preserved, but it is evident that the rock is strongly altered (Fig. 30). There are a few pseudomorphs after blocky feldspar (e.g. plagioclase) phenocrysts up to 4 mm across, with these enclosed in a medium grained (up to 2 mm) inequigranular mass of intergrown blocky feldspar (probably plagioclase), blocky to prismatic ferromagnesian material (e.g. hornblende), minor interstitial quartz and a little disseminated FeTi oxide. From the relict characteristics, it is interpreted that the original rock was a slightly porphyritic hornblende-quartz microdiorite.

b) Alteration and structure: Strong pervasive hydrothermal alteration was imposed and only relict igneous quartz is preserved. All former feldspar was replaced by fine grained aggregates of sericite and a clay phase – could include illite-smectite and/or kaolinite, with local quartz and chlorite (Fig. 30). Former ferromagnesian material was replaced by chlorite (Fig. 30), with traces of leucoxene and pyrite, and igneous FeTi oxide was replaced by leucoxene. The rock contains a few irregular replacive aggregates up to 3 mm across of medium grained quartz, plus chlorite and local pyrite and/or chalcopyrite. The alteration assemblage is considered to be of transitional propylitic-argillic type. No veins were observed in the section.

c) Mineralisation: The alteration assemblage contains uncommon grains of pyrite and chalcopyrite, mostly associated with the quartz-chlorite alteration aggregates and at altered ferromagnesian sites. One chalcopyrite grain is ~1 mm across and the largest pyrite grain is ~0.5 mm across.

Mineral Mode (by volume): clay (illite-smectite and/or kaolinite) 40%, sericite 25%, chlorite 19%, quartz 15%, leucoxene 1% and traces of pyrite and chalcopyrite.

Interpretation and comment: It is interpreted that the sample represents a sparsely porphyritic hornblende-quartz microdiorite that has been affected by strong hydrothermal alteration of transitional propylitic-argillic type. The rock has moderately preserved relict texture, indicating that it was originally feldspar (probably plagioclase)-rich, with subordinate ferromagnesian material (e.g. hornblende), minor interstitial quartz and a little disseminated FeTi oxide. During alteration, feldspar was replaced by sericite and clay (perhaps illite-smectite and/or kaolinite), with minor quartz and chlorite. Ferromagnesian material was replaced by chlorite and trace leucoxene, and FeTi oxide was replaced by leucoxene. Sparsely scattered in the rock are alteration aggregates of quartz and chlorite, locally with a little pyrite and chalcopyrite.

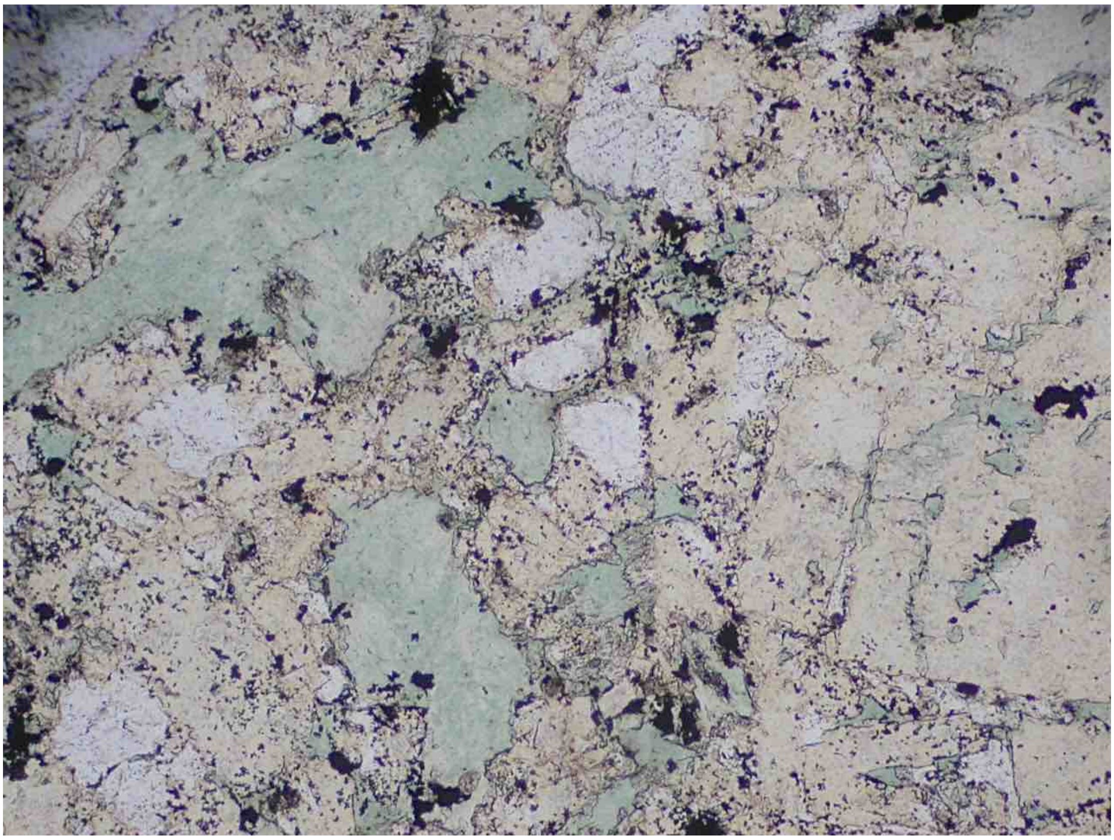


Fig. 30: Strongly altered microdiorite showing former feldspar replaced by pale creamy clay and/or sericite, and former ferromagnesian material by pale green chlorite. Note small grains of interstitial quartz (clear) and black aggregates of leucoxene. Plane polarised transmitted light, field of view 2 mm across.

SMD007 218.0 m PTS

Summary: Former porphyritic quartz microdiorite or microtonalite with very strong hydrothermal alteration and emplacement of veins. Due to alteration, relict texture is rather poorly preserved, but the protolith did contain a few large feldspar (e.g. plagioclase) phenocrysts, enclosed in a medium grained mass of feldspar, subordinate ferromagnesian material (maybe hornblende) and minor quartz. The rock was affected by alteration that is considered to be transitional between phyllic and propylitic type, with replacement by abundant sericite, lesser quartz, minor chlorite, pyrite and chalcopyrite and a trace of rutile. A few veins were emplaced with these initially containing medium grained quartz and patchy sericite (mainly adjacent to margins) and locally substantial medium to coarse grained pyrite and chalcopyrite. Subsequently, it appears that the major vein was deformed, being subject to microbrecciation and overprinting by late stage chalcedonic silica, in part containing pigmentation by/small inclusions of a brown clay phase (maybe smectite).

Handspecimen: The drill core sample is composed largely of a strongly altered, green-grey, massive medium grained igneous rock. Relict texture is poorly preserved, but it is speculated that the rock was of rather felsic type, probably with minor ferromagnesian material. Hydrothermal alteration caused replacement by fine grained sericite, quartz and chlorite, with disseminated pyrite, but with part of the rock also being paler in colour (creamy-white) and evidently lacking chlorite. A prominent sub-planar vein several millimetres wide occurs at a moderate angle to the core axis, and there are a couple of other thin veins. These structures contain quartz, with scattered aggregates of pyrite and chalcopyrite (up to 3 mm across), patches of pale creamy fine grained sericite and quartz, and rare pale green sericite (?fuchsite), and an apparent central zone up to a few millimetres wide ranging from vuggy texture to massive and containing pale grey, fine colloform encrustations of chalcedonic silica, grading to massive, fine grained hard chalcedonic silica with a brown-grey colour. The chalcedonic silica zone could be an overprint on an earlier quartz-sericite-sulphide vein assemblage. The sample is very weakly magnetic, with susceptibility up to 40 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, a prominent vein zone ~1 cm wide cuts the altered host rock, and there are a couple of other narrower veins. The host rock has poor preservation of relict texture, due to the intensity of alteration, but it is likely that the protolith had a few blocky feldspar (e.g. plagioclase) phenocrysts up to 4 mm across, enclosed in a medium grained aggregate that included abundant feldspar, subordinate ferromagnesian material (probably hornblende, with grains up to 2 mm long), minor quartz and a little FeTi oxide. From the relict characteristics, it is speculated that the rock was a porphyritic quartz microdiorite or microtonalite.

b) Alteration and structure: The original igneous rock was very strongly hydrothermally altered and had a few veins emplaced. There was complete replacement of the primary igneous minerals (except quartz) by fine grained sericite, quartz, minor chlorite, pyrite, chalcopyrite and trace rutile. In part of the rock, there is little or now chlorite and a greater proportion of quartz. The observed alteration assemblage varies from locally of phyllic type, to transitional propylitic to phyllic. Initial veining was related to the strong alteration and was composed of medium grained quartz, with aggregates of pyrite and chalcopyrite, minor sericite and traces of rutile and sphalerite. Perhaps bordering the main vein (which is up to several millimetres wide) is a zone rich in sericite. In the main vein, there appears to have been imposed deformation and a later hydrothermal overprint. This caused variable brecciation of the initial vein contents and subsequent deposition of abundant fine grained, locally crustiform texture, through to massive chalcedonic silica, in places impregnated by small orange-brown aggregates of a possible smectite clay phase (Figs 31, 32). Within the nearly isotropic chalcedonic silica zones, there are scattered fragments of quartz, sericite-rich material, chlorite-rich material, pyrite and chalcopyrite (Figs 31, 32). In adjacent altered host rock, there are also local pervading masses of chalcedonic silica.

c) Mineralisation: The host rock contains considerable disseminated pyrite (grains to 0.8 mm) and lesser chalcopyrite (grains to 0.5 mm) as part of the alteration assemblage, with relatively common composites of the two. Early quartz (-sericite) veining contains scattered aggregates of pyrite and chalcopyrite (up to 4 mm across), and in these, sulphides appear to be interstitial to quartz and locally form composites (Fig. 32), with a tiny trace of adjacent sphalerite. Sulphides appear to be interstitial to quartz. In these veins, sulphides are commonly fragmented and locally encrusted by chalcedonic silica (Fig. 32).

Mineral Mode (by volume): sericite 45%, quartz 30%, chalcedonic silica 10%, pyrite 6%, chlorite 5%, chalcopyrite 3%, clay (?smectite) 1% and traces of rutile and sphalerite.

Interpretation and comment: It is interpreted that the sample is a very strongly altered porphyritic quartz microdiorite or microtonalite, hosting a few veins. The protolith appears to have contained a few large feldspar (e.g. plagioclase) phenocrysts, enclosed in a medium grained mass of feldspar, subordinate ferromagnesian material (maybe hornblende) and minor quartz. Strong alteration is transitional between phyllic and propylitic types, with replacement by abundant sericite, lesser quartz, minor chlorite, pyrite and chalcopyrite and a trace of rutile. Veins contain an initial assemblage of medium grained quartz and patchy sericite (mainly adjacent to margins) and locally substantial medium to coarse grained pyrite and chalcopyrite. Subsequently, the major vein was apparently deformed, being subject to microbrecciation and overprinting by late stage chalcedonic silica, in part containing pigmentation by/small inclusions of a brown clay phase (maybe smectite).

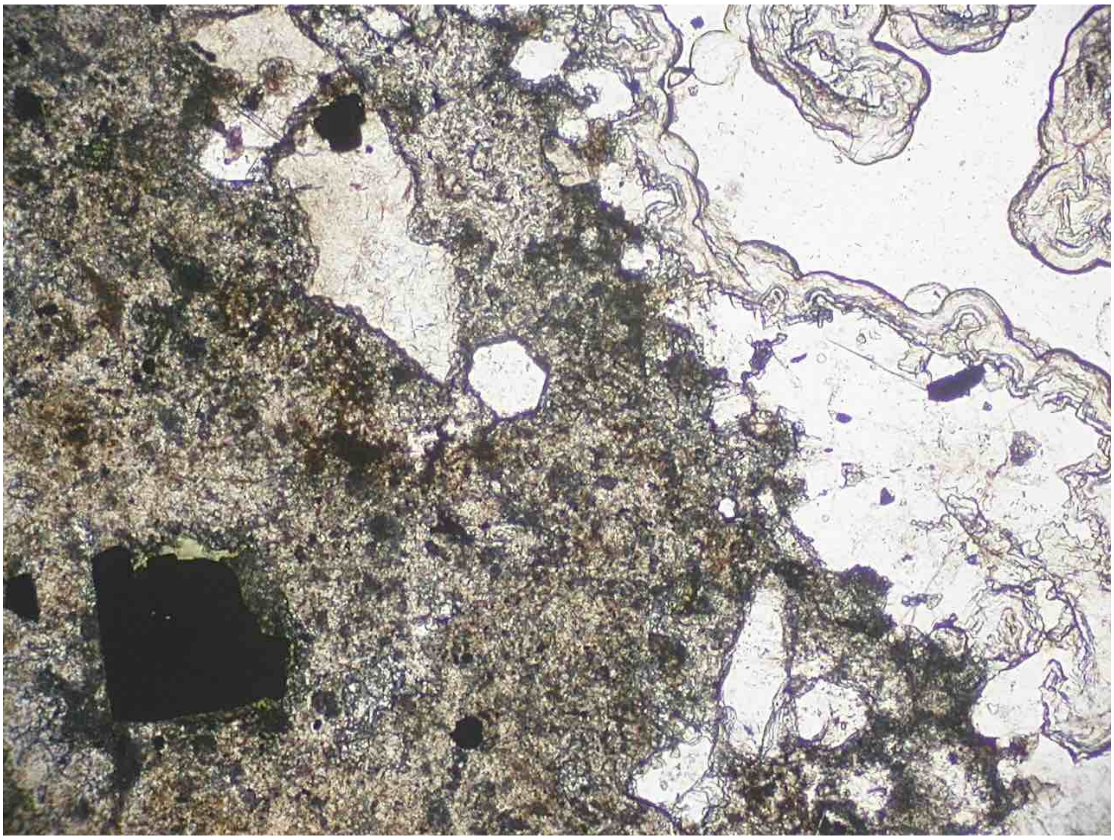


Fig. 31: Central part of the major vein with fragments of quartz (clear), sericite-rich material (upper left) and pyrite (black) overprinted by colloform texture chalcedonic silica (right) and turbid, clay-impregnated chalcedonic silica (brownish-grey). Plane polarised transmitted light, field of view 2 mm across.

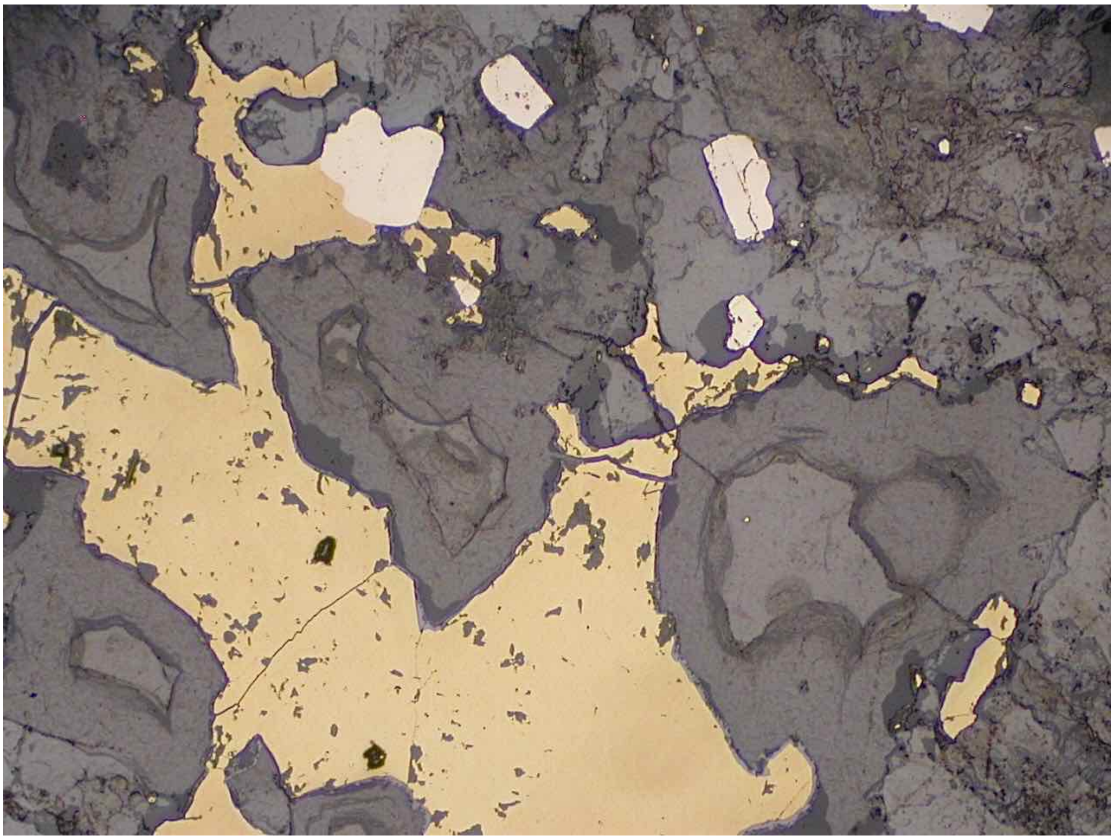


Fig. 32: Fragments of chalcopyrite and nearby pyrite overgrown by colloform texture chalcedonic silica. Plane polarised reflected light, field of view 2 mm across.

SMD007 221.7 m TS

Summary: Porphyritic microtonalite with strong hydrothermal alteration of transitional propyltic-argillic type. The rock originally contained scattered feldspar (e.g. plagioclase) phenocrysts, enclosed in a medium grained, inequigranular aggregate of feldspar, ferromagnesian material and subordinate quartz, with a little FeTi oxide. Imposed alteration led to feldspar being replaced by fine grained aggregates of sericite, with subordinate clay and minor quartz and chlorite. Ferromagnesian material was replaced by chlorite with a little sericite and leucoxene, and FeTi oxide was replaced by leucoxene. The rock contains a few texturally-destructive replacement aggregates of quartz, chlorite and local sericite, with a little associated carbonate, pyrite and chalcopyrite. A couple of thin veins occur in the rock, containing quartz or carbonate.

Handspecimen: The drill core sample is composed of a massive, strongly altered, porphyritic medium grained intermediate to felsic igneous rock. There are rather sparsely scattered whitish altered feldspar phenocrysts up to 4 mm across, hosted in a medium grained aggregate of white to pale grey altered feldspar and dark grey-green altered ferromagnesian material, with minor quartz. Alteration is pervasive, with replacement of feldspar by a clay/sericite phase, and ferromagnesian material by chlorite. A trace of disseminated pyrite is also apparent. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is poorly to moderately preserved. The rock originally contained rather sparsely scattered blocky feldspar (e.g. plagioclase) phenocrysts up to 3.5 mm across, enclosed in a medium grained, inequigranular aggregate with abundant feldspar (probably plagioclase), subordinate ferromagnesian material (could have included hornblende) and interstitial quartz and a little disseminated FeTi oxide. Grainsize of this aggregate is typically <2 mm. From the relict characteristics, it is interpreted that the original rock could have been a porphyritic microtonalite. It appears to have been similar to the sample SMD007/194.0 m.

b) Alteration and structure: The original igneous rock was strongly hydrothermally altered. All former feldspar was replaced by a fine grained aggregate of sericite (Fig. 33), in places accompanied by a clay phase (a rather low birefringent type and could have included illite-sericite, or kaolinite) and minor quartz and chlorite. Former ferromagnesian material was replaced by chlorite, with local sericite and trace leucoxene (Fig. 33) and with igneous FeTi oxide being replaced by leucoxene. Irregularly scattered in the sample are diffuse aggregates up to several millimetres across containing medium grained quartz, with associated chlorite, local sericite, and in a few examples, aggregates of carbonate, pyrite and trace chalcopyrite. These aggregates are destructive of original igneous texture. A single thin (~0.2 mm), discontinuous quartz vein cuts the altered rock, and there are also a couple of sub-parallel, discontinuous carbonate veins <0.2 mm wide. The alteration assemblage is considered to be of transitional propylitic-argillic type and is similar to that found in SMD007/194.0 m.

c) Mineralisation: The rock contains a few aggregates of pyrite with associated trace chalcopyrite, associated with replacement masses of quartz-chlorite-sericite. One aggregate has a strongly disseminated sulphide mass ~3 mm across.

Mineral Mode (by volume): sericite 50%, quartz 20%, chlorite 18%, clay 10%, leucoxene and carbonate each 1% and traces of pyrite and chalcopyrite.

Interpretation and comment: It is interpreted that the sample represents a strongly altered porphyritic microtonalite. It originally contained scattered feldspar (e.g. plagioclase) phenocrysts, enclosed in a medium grained, inequigranular aggregate of feldspar, ferromagnesian material and subordinate quartz, with a little FeTi oxide. Alteration is of transitional propyltic-argillic type and caused replacement of feldspar by sericite, subordinate clay and minor quartz and chlorite. Ferromagnesian material was replaced by chlorite with a little sericite and leucoxene, and FeTi oxide was replaced by leucoxene. The rock contains a few texturally-destructive replacement aggregates of quartz, chlorite and local sericite, with a little associated carbonate, pyrite and chalcopyrite. A couple of thin veins occur in the rock, containing quartz or carbonate.

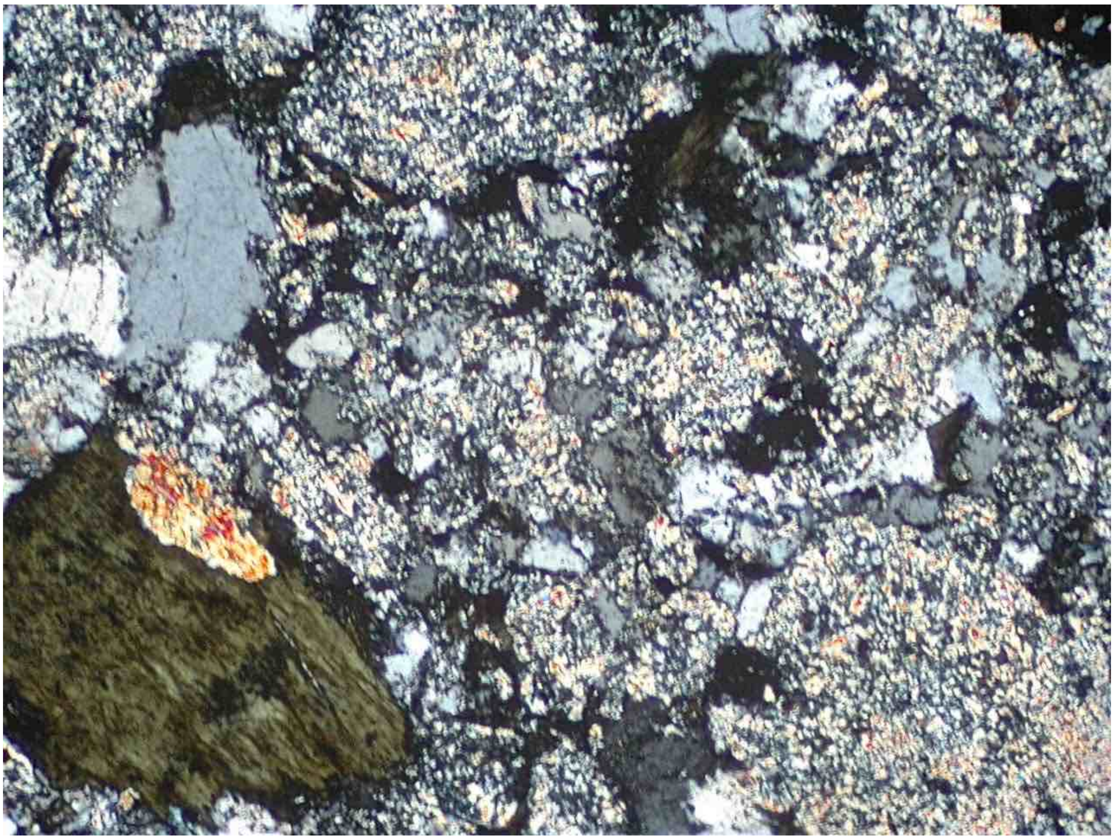


Fig. 33: Typical alteration assemblage with fine grained aggregates of sericite that have replaced feldspar grains, and dark khaki aggregates of chlorite (± minor sericite) that have replaced ferromagnesian material. Minor quartz, accompanied by fine grained sericite and chlorite occur interstitially. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD007 228.7 m TS

Summary: Medium grained mafic to possibly intermediate igneous rock, interpreted as a hornblende microgabbro, but with strong pervasive alteration. The latter could be due to imposed hydrothermal process or low grade metamorphism. The rock originally contained abundant plagioclase, intergrown with scattered prismatic-acicular amphibole (e.g. hornblende), another ferromagnesian phase (maybe clinopyroxene or olivine) and a little disseminated FeTi oxide. Pervasive alteration led to albitisation of plagioclase, initial replacement of hornblende by tremolite-actinolite, and subsequent rather strong replacement of the rock by chlorite, patchy epidote, minor quartz and a little leucoxene. Subsequently, further retrograde alteration appears to have occurred, with development of a fine grained clay phase (maybe smectite) at ferromagnesian sites.

Handspecimen: The drill core sample is composed of a massive, medium grained, intermediate to mafic igneous rock with evident strong alteration. It is grey-green in colour, but with patchy paler yellow-green and slightly pinkish zones. Relict texture is moderately preserved and it is likely that the rock contained abundant feldspar and intergrown ferromagnesian material. Imposed alteration has led to development of considerable chlorite, with minor epidote and a little hematite dusting. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, relict texture is moderately well preserved, although the rock is strongly altered. It formerly contained abundant small blocky grains of plagioclase up to 1 mm across, intergrown with a prismatic-acicular amphibole (e.g. hornblende) up to 3 mm long and another ferromagnesian phase, plus a little disseminated FeTi oxide (Fig. 34). The other ferromagnesian phase is completely altered and does not have particularly distinctive pseudomorphic shapes, although some grains were up to 1.5 mm across and hosted rare tiny inclusions of possible FeCr spinel. From this information it is considered that this ferromagnesian phase could have been clinopyroxene and/or olivine. Due to the imposed alteration, the nature of the protolith is not well established, but it was possibly a hornblende microgabbro.

b) Alteration and structure: The igneous rock underwent strong low grade alteration, resulting in replacement of almost all of the igneous minerals. The alteration process might have been due to low grade metamorphism or imposed hydrothermal effects. Original plagioclase was replaced by albite, minor epidote, a little chlorite and trace hematite dusting. Interpreted hornblende prisms were initially replaced by very pale green tremolite-actinolite, but this was further overprinted by chlorite, epidote and minor quartz (Fig. 34). The other ferromagnesian phase was replaced mostly by chlorite, with a little epidote, and igneous FeTi oxide was replaced by leucoxene. In places, there are irregular alteration aggregates of epidote (in places with associated quartz), and elsewhere, a few interstitial masses of quartz (up to 1 mm across), with associated chlorite and epidote. The rock appears to have been subsequently further overprinted by a retrograde event, leading to development of aggregates of a fine grained, pale brown clay phase (maybe smectite) up to 2 mm across, overprinting ferromagnesian sites.

c) Mineralisation: A tiny trace of pyrite (<0.1 mm grains) has formed as part of the alteration.

Mineral Mode (by volume): plagioclase (albite) 40%, chlorite 30%, tremolite-actinolite and epidote each 10%, clay phase 7%, quartz 2%, leucoxene 1% and traces of FeCr spinel and pyrite.

Interpretation and comment: It is interpreted that the sample is a strongly altered, medium grained hornblende microgabbro. It formerly contained abundant plagioclase, intergrown with scattered prismatic-acicular amphibole (e.g. hornblende), another ferromagnesian phase (maybe clinopyroxene or olivine) and a little disseminated FeTi oxide. Pervasive low grade alteration resulted in albitisation of plagioclase, initial replacement of hornblende by tremolite-actinolite, and subsequent rather strong replacement of the rock by chlorite, patchy epidote, minor quartz, a little leucoxene and trace hematite. Subsequently, further retrograde alteration occurred, with development of a fine grained clay phase (maybe smectite) at ferromagnesian sites.

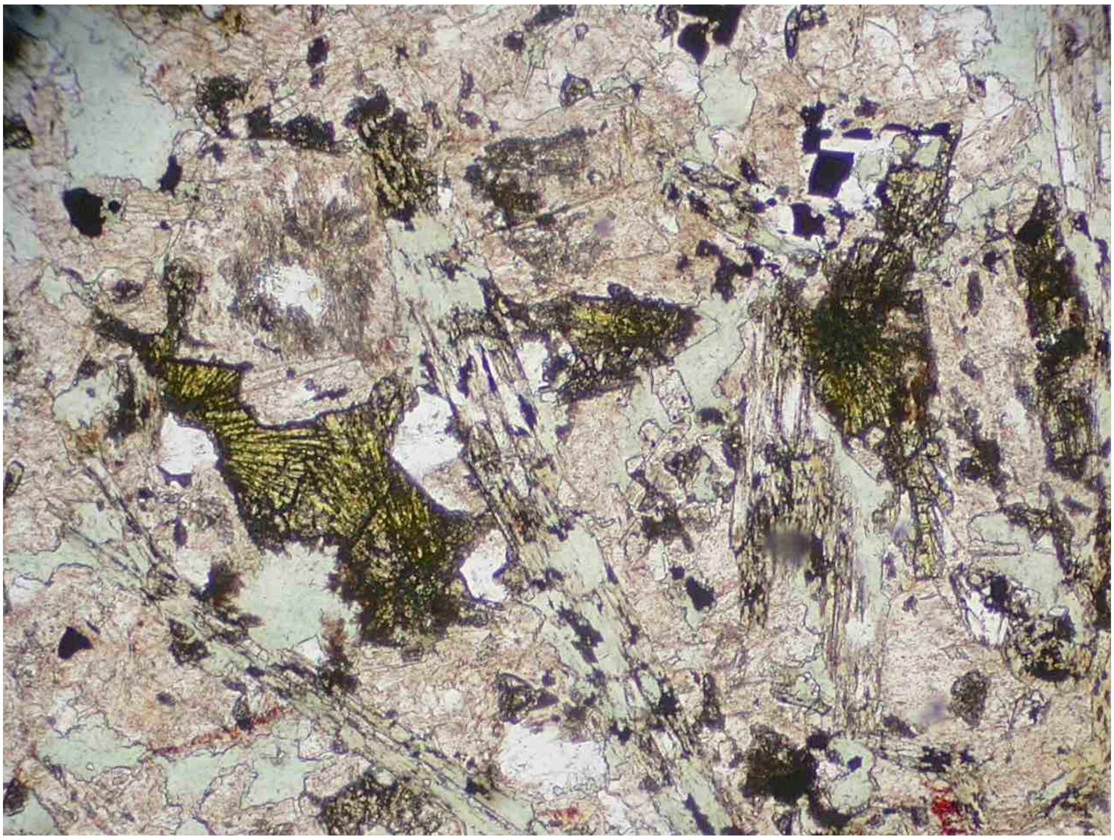


Fig. 34: Relict texture in microgabbro, showing slightly turbid (pale brownish) albitised plagioclase, pseudomorphs after former hornblende prisms (now replaced by tremolite-actinolite and chlorite) and interstitial aggregates of chlorite and epidote (high relief, yellowish). Small black grains are leucoxene. Plane polarised transmitted light, field of view 2 mm across.

<u>SMD007 234.9 m TS</u>

Summary: Porphyritic hornblende-quartz microdiorite with strong propylitic alteration and an array of veins, locally forming small zones of hydrothermal breccia. The rock originally contained phenocrysts of plagioclase and a ferromagnesian phase (e.g. hornblende) in a fine to medium grained groundmass rich in feldspar, plus subordinate ferromagnesian material, minor quartz and FeTi oxide. Alteration led to initial albitisation of feldspar, with subsequent strong replacement of the rock by chlorite and sericite, and a little quartz, carbonate and leucoxene. Vein and local breccia fill have abundant sericite in places, with an apparent evolution into fillings with considerable medium grained carbonate (ankerite or siderite), quartz and chlorite, and with trace chalcopyrite and pyrite.

Handspecimen: The drill core sample is composed of a strongly altered, medium grained and porphyritic intermediate igneous rock of mottled pale grey-green and dark grey-green colour, cut by an array of veins up to several millimetres wide. The rock originally contained abundant feldspar and subordinate ferromagnesian material, with phenocrysts of both up to several millimetres across. Strong alteration was imposed, with replacement by sericite and chlorite. Veins contain pale brown, medium grained carbonate, minor quartz and trace chalcopyrite, with this type possibly overprinting earlier veins with chlorite and sericite. Testing of the section offcut with dilute HCl gave no reaction on vein carbonate, suggesting that it is ankerite or siderite. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved, but the rock is clearly affected by strong alteration and veining. Formerly present were scattered blocky phenocrysts of plagioclase up to 3 mm across and elongate phenocrysts of a ferromagnesian phase (e.g. hornblende) up to 3.5 mm long (Fig. 35). The phenocrysts occurred in a fine to medium grained groundmass with abundant small feldspar grains (probably plagioclase), subordinate ferromagnesian material, minor quartz and finely disseminated FeTi oxide. The preserved primary characteristics of the rock suggest it represents a porphyritic hornblende-quartz microdiorite.

b) Alteration and structure: The igneous rock experienced strong hydrothermal alteration and emplacement of several irregular veins, locally tending into small zones of hydrothermal breccia (Fig. 36). Plagioclase and groundmass feldspar was initially albitised, then further replaced by sericite and local chlorite (Fig. 35). Ferromagnesian grains were replaced by dominant chlorite (Fig. 35), with local carbonate and trace leucoxene, and igneous FeTi oxide was replaced by leucoxene. In the groundmass, there was minor development of chlorite, sericite, quartz and carbonate. Adjacent to some of the wider veins, and in fragments in hydrothermal breccia zones, alteration appears to be stronger, with greater development of sericite and quartz (Fig. 36). A irregular network of veins and local breccia zones up to several millimetres wide has developed (Fig. 36). Initial hydrothermal infill tends to be dominated by fine grained sericite, in places accompanied by chlorite, and with an apparent evolution of infill into zones of medium grained carbonate (ankerite or siderite), quartz, chlorite and a few aggregates of chalcopyrite and pyrite (Fig. 36). Overall, the observed alteration and vein assemblage in the sample conforms to strong propylitic type.

c) Mineralisation: In the vein infill, there are a few aggregates of chalcopyrite up to 0.7 mm across, and a little pyrite, in association with quartz and carbonate.

Mineral Mode (by volume): plagioclase (albite) 45%, chlorite and sericite each 20%, quartz 8%, carbonate 6%, leucoxene 1% and traces of chalcopyrite and pyrite.

Interpretation and comment: It is interpreted that the sample represents a strongly altered and veined porphyritic hornblende-quartz microdiorite. The rock originally contained phenocrysts of plagioclase and a ferromagnesian phase (e.g. hornblende) in a fine to medium grained groundmass rich in feldspar, plus subordinate ferromagnesian material, minor quartz and FeTi oxide. Alteration of propylitic type caused albitisation of feldspar, with subsequent strong replacement of the rock by chlorite and sericite, and a little quartz, carbonate and leucoxene. Veins locally grade into small zones of hydrothermal breccia containing infill of sericite, with an apparent evolution into fillings of considerable medium grained carbonate (ankerite or siderite), quartz and chlorite, and with trace chalcopyrite and pyrite.

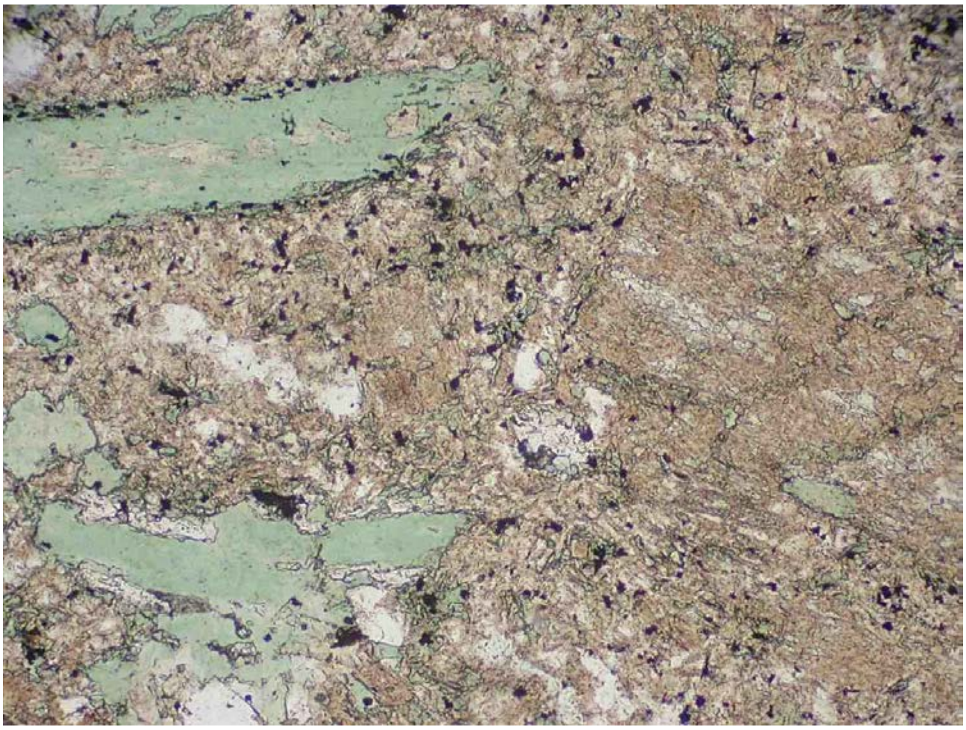


Fig. 35: Blocky plagioclase phenocryst at right, replaced by turbid albite, plus sericite and chlorite. Elongate hornblende phenocrysts are replaced by pale green chlorite. Small clear zones are quartz and small black grains are leucoxene. Plane polarised transmitted light, field of view 2 mm across.

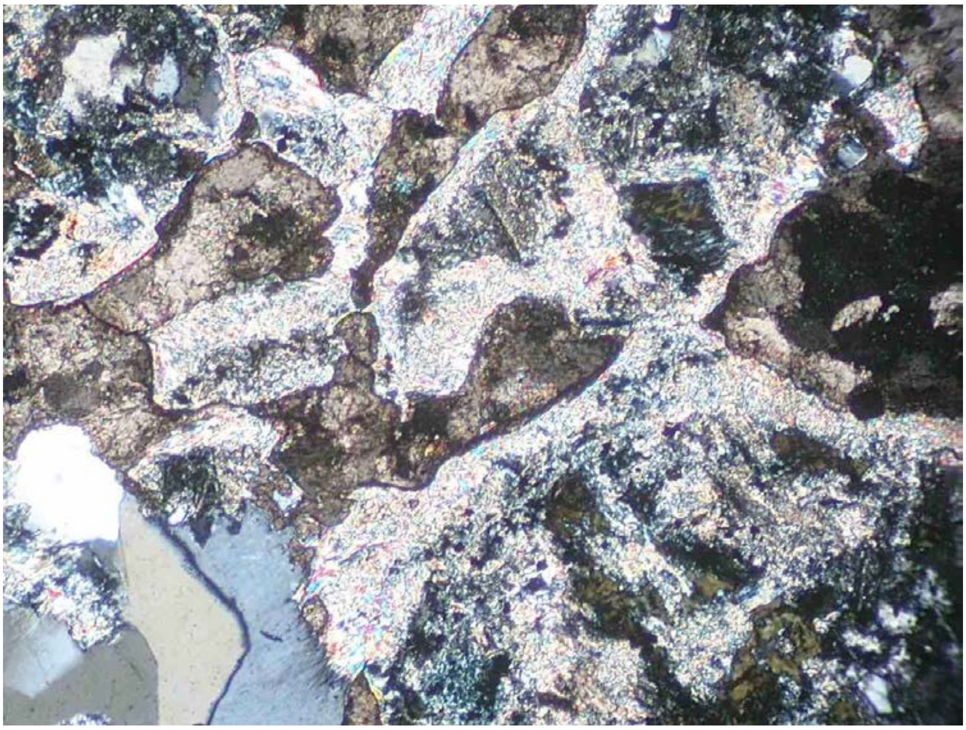


Fig. 36: Hydrothermal breccia zone with small fragments (lower, upper right and upper left) of host rock, replaced by sericite, chlorite and quartz, with infill of sericite, turbid pale grey-brown carbonate and minor quartz (lower left). Transmitted light, crossed polarisers, field of view 2 mm across.

<u>SMD007 238.1 m PTS</u>

Summary: Porphyritic microdiorite having strong propylitic alteration and a stronger zone of phyllic alteration about a major quartz-sulphide-carbonate vein. Although relict texture is poorly to moderately preserved, it is likely that the rock formerly contained scattered feldspar (e.g. plagioclase) and less common ferromagnesian phenocrysts in a finer grained groundmass. A major vein and several subsidiary veins occur, with these containing abundant quartz, strongly disseminated pyrite and chalcopyrite, patchy carbonate, and a little Fe-poor sphalerite. Away from the main vein, the propylitic alteration caused replacement of the rock by sericite, subordinate chlorite and minor quartz and pyrite, whereas in vein-proximal phyllic alteration, sericite is the dominant alteration phase, with subordinate quartz and pyrite, and trace chalcopyrite.

Handspecimen: The drill core sample is composed of a generally massive, strongly altered porphyritic intermediate igneous rock. Relict texture is at best moderately preserved and it is evident that there were scattered phenocrysts up to 4 mm across in a finer grained groundmass. Phenocrysts could have included feldspar and ferromagnesian material. Much of the rock is grey-green in colour, but about a prominent sub-planar vein, there is a pale creamy-grey alteration selvedge up to 2 mm wide. Away from the vein, the alteration assemblage probably includes sericite and chlorite, with disseminated pyrite, but adjacent to the vein, chlorite appears to be absent and sericite-quartz-pyrite dominates. The major vein is ~1.5 cm wide and at ~20° to the core axis, and accompanied by a few subsidiary veins up to 2 mm wide. Veins contain medium grained white quartz, commonly abundant pyrite, scattered chalcopyrite and pale orange carbonate, and a trace of sphalerite. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, it is evident that the protolith is very strongly hydrothermally altered and contains several veins. Relict porphyritic texture is poorly to moderately preserved (Fig. 37), but it is likely that the rock formerly contained scattered feldspar (e.g. plagioclase) phenocrysts up to 2.5 mm across and less common and smaller ferromagnesian phenocrysts, enclosed in a finer grained groundmass that could have contained abundant feldspar, minor ferromagnesian material and quartz and a trace of FeTi oxide. Although primary characteristics are significantly obscured, it is tentatively indicated that the protolith was a porphyritic quartz microdiorite.

b) Alteration and structure: Strong pervasive hydrothermal alteration was imposed and several veins emplaced. The major vein is sub-planar, up to 1.5 cm wide and is bordered by a zone of stronger (and different) alteration, compared to the remainder of the rock. Away from the vein, the alteration assemblage is dominated by fine grained sericite (replacing feldspar), with subordinate chlorite (replacing ferromagnesian material), minor quartz and pyrite, and a trace of rutile. About the main vein, and to a smaller extent about the few subsidiary veins (that are up to 2.5 mm wide), chlorite is absent from the alteration assemblage, which is dominated by sericite, accompanied by subordinate quartz, disseminated pyrite and traces of rutile and chalcopyrite (Fig. 37). The major vein contains abundant medium grained quartz, with strongly disseminated grains and aggregates of pyrite and chalcopyrite (up to 3 mm), patchy infill carbonate and sparse Fe-poor sphalerite (Fig. 38). Narrower veins contain fine to medium grained quartz, scattered pyrite, minor chalcopyrite and a little carbonate, chlorite and sericite. It is interpreted that away from the veining, alteration is of strong propylitic type, whereas adjacent to veining it is of phyllic type.

c) Mineralisation: In the altered host rock there is disseminated pyrite throughout, in masses up to 1.5 mm across and accompanied by a trace of chalcopyrite. Sulphides are abundant in the quartz-rich veins, where there are aggregates and individual grains of pyrite and chalcopyrite up to 3 mm across and a few grains of Fe-poor sphalerite up to 1 mm across (Fig. 38). Rare small grains of galena and chalcopyrite occur as inclusions in vein-hosted pyrite.

Mineral Mode (by volume): sericite 50%, quartz 27%, pyrite 10%, chlorite 6%, carbonate 5%, chalcopyrite 2% and traces of sphalerite, rutile and galena.

Interpretation and comment: It is interpreted that the sample is a strongly altered and veined porphyritic microdiorite. Relict texture is poorly to moderately preserved, but it is likely that there were scattered feldspar (e.g. plagioclase) and less common ferromagnesian phenocrysts in a finer grained groundmass. A major vein and several subsidiary veins occur, with these containing abundant quartz, strongly disseminated pyrite and chalcopyrite, patchy carbonate, and a little Fe-poor sphalerite. Away from the main vein, strong propylitic alteration caused replacement by sericite, subordinate chlorite and minor quartz and pyrite. Proximal to the veining there is strong phyllic alteration in which sericite is the dominant phase, with subordinate quartz and pyrite, and trace chalcopyrite.

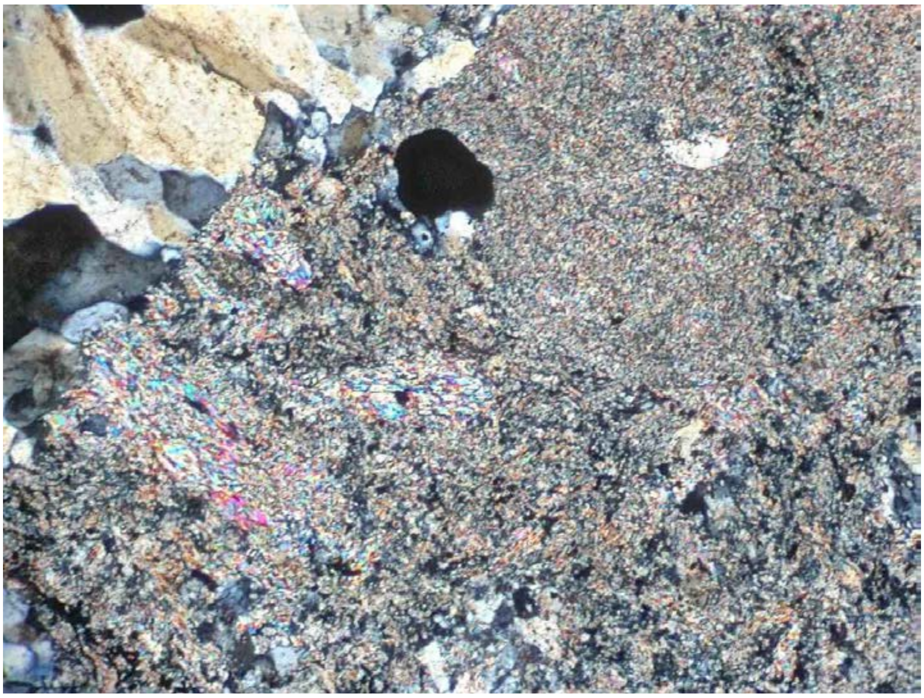


Fig. 37: Strong phyllic alteration adjacent to a quartz-rich vein, with replacement by abundant sericite and minor quartz and pyrite (black). Transmitted light, crossed polarisers, field of view 2 mm across.

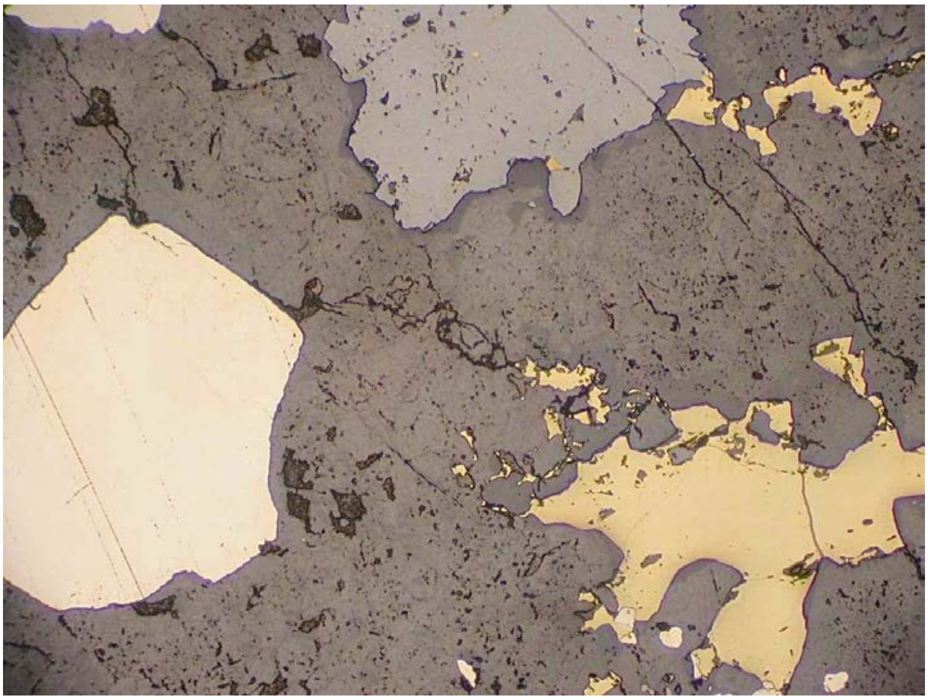


Fig. 38: Portion of the main quartz-rich vein with scattered sulphide grains including pyrite (pale creamy), chalcopyrite (yellow) and sphalerite (mid grey). Plane polarised reflected light, field of view 2 mm across.

SMD007 240.05 m PTS

Summary: Quartz-sulphide dominated rock, with local disseminations and diffuse bands containing significant chromite, as well as chlorite. The presence of chromite indicates that the rock had an ultramafic composition protolith. It is speculated that there was initial replacement of the ultramafic rock by chlorite, with subsequent flooding with quartz and emplacement of probable quartz-sulphide veining. This process might have been syn-tectonic, as relict chromite is fractured and variably disaggregated, fine through to coarse grained quartz shows strain phenomena, local elongate fibre growth and recrystallization, and pyrite is commonly fractured and invaded by chalcopyrite and quartz. There are many examples of paragenetically early chromite being invaded by quartz, chlorite and sulphides. The rock has a crudely layered appearance due to intercalation of quartz-rich, sulphide-rich, and local chromite-rich bands.

Handspecimen: The drill core sample is composed of an intensely hydrothermally altered rock that is probably pervaded by a large proportion of quartz-sulphide veining. There is crude banding apparent at a moderate angle to the core axis and with banding defined by differing proportions of white quartz, pyrite, chalcopyrite, a black rather coarse grained oxide phase (e.g. chromite) and minor amounts of pale grey-green chlorite. Sulphide-rich aggregates are up to a few centimetres across and range from pyrite-rich to chalcopyrite-rich. The oxide mineral phase forms a diffuse band a few millimetres wide and is also disseminated in some of the sulphide-rich domains. The sample is mostly non-magnetic, with susceptibility of <20 x 10^{-5} SI, but there are local zones where the oxide phase is common in which magnetic susceptibility is moderate at 610 x 10^{-5} SI, suggesting that a little magnetite might be present.

Petrographic description

a) Primary rock characteristics: In the section, no relict texture from a protolith is recognised, but there are disseminated grains and a diffuse band up to a few millimetres wide, of medium to coarse grained chromite. Original individual grains of chromite were up to 2-3 mm across, with it subsequently being fractured and variably disaggregated. The presence of significant chromite, as well as disseminations and concentrations of chlorite (probably Mg-rich) in the sample indicates that the protolith was of ultramafic type. The amount of chromite and its typical grainsize is unlike that in a typical ultramafic protolith (e.g. harzburgite and serpentinised equivalent) and the fact that some occurs in a band could imply that the protolith was a layered ultramafic rock with a chromite concentration.

b) Alteration and structure: The interpreted ultramafic protolith was subject to intense hydrothermal alteration and probable veining, along with imposed deformation. Initially, the ultramafic rock was possibly serpentinised, but overprinted by strong chlorite development (maybe with a trace of magnetite) and subsequently by strong silicification, causing disaggregation of the chlorite-rich masses into small fragments and elongate aggregates, in places hosting variably disaggregated chromite grains. Silicification of the host rock (i.e. replacement by quartz) appears to have been accompanied by emplacement of abundant quartz-sulphide veining, with medium to coarse quartz, pyrite and chalcopyrite. This process could have occurred during imposed deformation, as in addition to the disaggregation of chromite, quartz shows strain phenomena, local elongate and fibre growth, and finer grained recrystallisation, with weak foliation in chlorite masses (Fig. 39). Rather coarse pyrite is commonly fractured and it, along with chromite, is commonly invaded by chalcopyrite and quartz. Locally, there could have been further invasion of the altered and veined rock by thin quartz veins.

c) Mineralisation: The sample contains minor disseminated chromite, ranging to local semi-massive concentrations in a diffuse band a few millimetres wide. Individual chromite grains were originally up to 2-3 mm across, but it has typically been strongly fractured (Fig. 40). Chromite ranges from translucent deep orange-brown to opaque and there might be some alteration to a magnetite-like phase. Chromite clearly pre-dated the deposition of sulphides as pyrite and chalcopyrite have both invaded along fractures (Fig. 40). Deposition of commonly abundant sulphides accompanied quartz, with sulphides ranging from pyrite-rich aggregates to chalcopyrite-rich aggregates, each up to 2-3 cm across. Pyrite is commonly fractured and invaded by chalcopyrite and quartz. Chalcopyrite-rich aggregates commonly host small pyrite grains and aggregates, and one chalcopyrite occurrence invading chromite hosts a tiny grain of galena.

Mineral Mode (by volume): quartz 50%, pyrite 20%, chalcopyrite 18%, chromite (maybe including a magnetite-like phase) 7%, chlorite 5% and a trace of galena.

Interpretation and comment: It is interpreted that the sample represents a quartz-sulphide rock, with local disseminations and diffuse bands containing significant chromite, as well as chlorite. The presence of chromite indicates an ultramafic composition protolith. There could have been initial replacement of the ultramafic rock by chlorite, with subsequent hydrothermal silicification and emplacement of probable quartz-sulphide veining. This process might have been syn-tectonic, as relict chromite is fractured and variably disaggregated, fine through to coarse grained quartz shows strain phenomena, local elongate fibre growth and recrystallization, and pyrite is commonly fractured and invaded by chalcopyrite and quartz. Paragenetically early chromite commonly shows invasion by quartz, chlorite and sulphides. The rock has a crudely layered appearance due to intercalation of quartz-rich, sulphide-rich, and local chromite-rich bands.

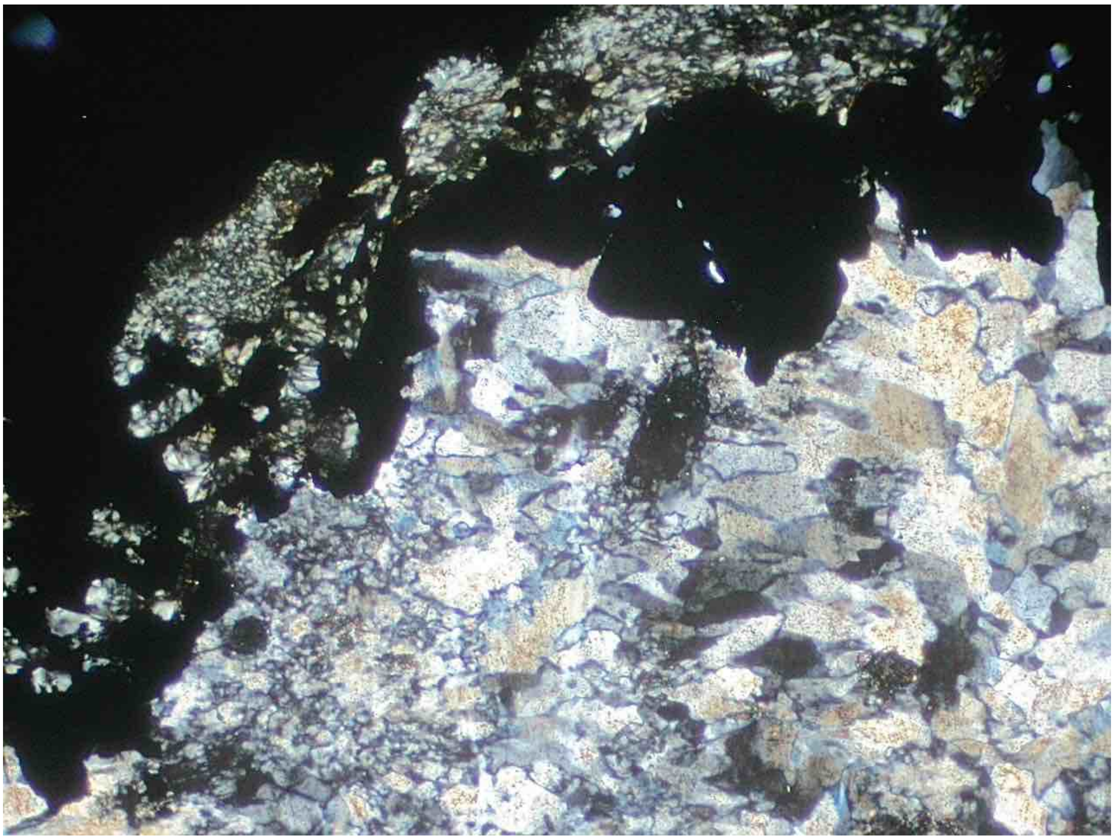


Fig. 39: Deformed and partly recrystallised hydrothermal quartz abutting against a zone of fine grained chlorite (khaki-grey) and sulphides (chalcopyrite and pyrite). Transmitted light, crossed polarisers, field of view 2 mm across.

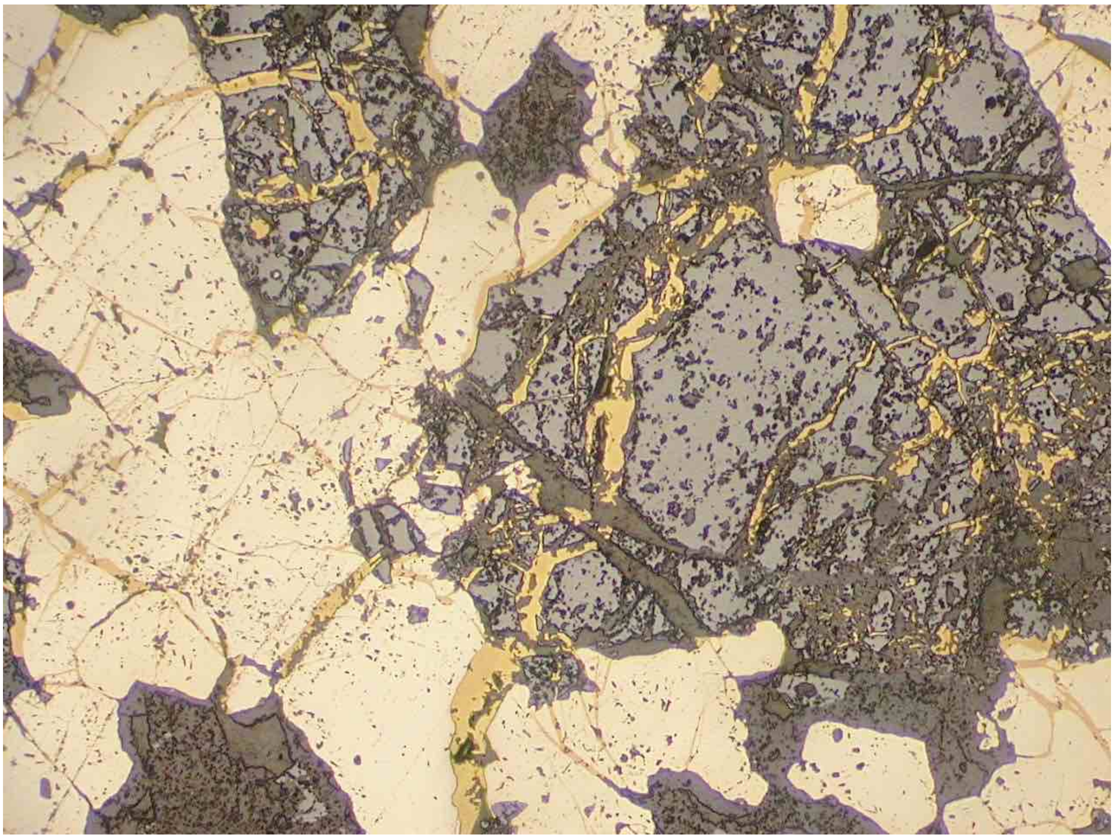


Fig. 40: Fractured chromite (mid grey) invaded by pyrite (pale creamy) and in turn by chalcopyrite (yellow). Plane polarised reflected light, field of view 2 mm across.

SMD007 240.8 m PTS

Summary: Chlorite-sulphide rock, with minor disseminated relict chromite, and a little alteration-derived quartz, carbonate and trace rutile. Sulphides include chalcopyrite and subordinate pyrite and they range from disseminated to veinlike and massive aggregates hosted in abundant chlorite. The presence of relict chromite and the probable Mg-rich nature of chlorite, plus traces of rutile, suggest that the protolith was of ultramafic to mafic igneous type. It was subject to intense hydrothermal alteration and development of a local clast-supported breccia texture, with chlorite-rich aggregates tending to be enclosed by sulphide-rich domains. Chromite is a relict mineral, paragenetically early and enclosed by sulphides. Pyrite grains are locally zoned, fractured and apparently locally replaced by chalcopyrite.

Handspecimen: The drill core sample is composed of a strongly mineralised hydrothermal breccia, with a generally clast-supported texture. Fragments are up to 6 cm across and are angular to sub-rounded and dominated by fine grained grey-green chlorite. Interstitial to and veining the fragments are sulphide-rich aggregates up to a few centimetres across, interspersed with smaller chlorite aggregates. Sulphide-rich masses range from chalcopyrite-rich to pyrite-rich, with chalcopyrite being apparently paragenetically later than pyrite. In the chlorite-rich masses, there are a few black oxide grains up to 1.5 mm across, perhaps chromite. The sample is very weakly magnetic, with susceptibility up to 70 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, no relict texture from a protolith is recognised. However, there are sparsely and irregularly scattered relict chromite grains up to 0.7 mm across. Also, the sample contains abundant pale green, probably Mg-rich chlorite, and a trace of disseminated rutile, suggesting that the protolith was most likely of ultramafic to mafic igneous type.

b) Alteration and structure: It is interpreted that an ultramafic to mafic igneous protolith was intensely hydrothermally altered and replaced, except for the irregularly scattered relict chromite grains. The rock was replaced by abundant fine to medium grained chlorite, with disseminated to locally abundant and massive sulphide aggregates (chalcopyrite and pyrite), patchy minor quartz, a little fine grained disseminated and veinlet carbonate and a few aggregates of rutile up to 0.4 mm across (Fig. 41). Quartz-rich masses are fine to medium grained, intergrown with and maybe replaced by chlorite. Disseminated to locally massive aggregates of chalcopyrite are up to 3 cm across and enclose pyrite, chromite and trace rutile (Fig. 42). Fine grained carbonate veinlets are sub-planar to anastomosing and up to 0.3 mm wide (Fig. 41). The alteration of an originally ultramafic to mafic composition rock probably occurred with substantial influx of S, Cu, Fe and water, plus minor CO_2.

c) Mineralisation: The sample contains minor, irregularly disseminated chromite, in grains up to 0.7 mm across and hosted in chlorite-rich and sulphide-rich portions of the rock (Fig. 42). Chalcopyrite is abundant in the sample, ranging from disseminations to veinlike aggregates and semi-massive to massive aggregates up to 3 cm across. It commonly hosts single grains and aggregates of pyrite up to 8 mm across, as well as rare tiny grains of galena. Pyrite forms individual grains up to 5 mm across, and locally shows zoning texture (Fig. 42) as well as fracturing. Textures indicate that chalcopyrite is paragenetically later than pyrite and has possibly replaced the latter (Fig. 42).

Mineral Mode (by volume): chlorite 60%, chalcopyrite 25%, pyrite 8%, quartz 4%, carbonate 2%, chromite 1% and traces of rutile and galena.

Interpretation and comment: It is interpreted that the sample is a chlorite-sulphide rock, maybe representing the product of intense hydrothermal replacement of an ultramafic to mafic igneous composition protolith. It retains minor disseminated relict chromite attesting to the nature of the protolith. In addition to abundant chlorite, the rock also contains considerable chalcopyrite, subordinate pyrite, minor quartz and carbonate and trace rutile. Sulphides range from disseminated to veinlike and massive aggregates hosted in chlorite.. The protolith appears to have been subject to intense hydrothermal alteration and development of a local clast-supported breccia texture, with chlorite-rich aggregates tending to be enclosed by sulphide-rich domains. Pyrite grains are locally zoned, fractured and apparently locally replaced by chalcopyrite.

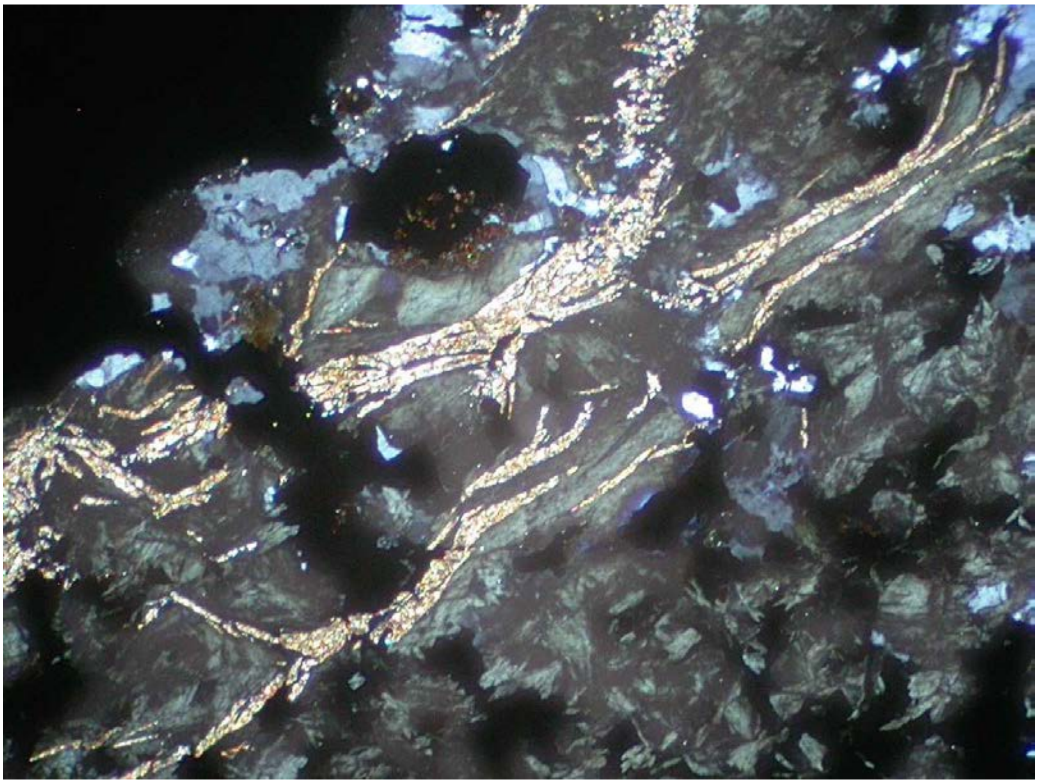


Fig. 41: Chlorite-rich rock (dark khaki-grey), with adjacent sulphides (black), minor associated quartz (pale bluish grey) and an array of thin carbonate veins. Transmitted light, crossed polarisers, field of view 2 mm across.

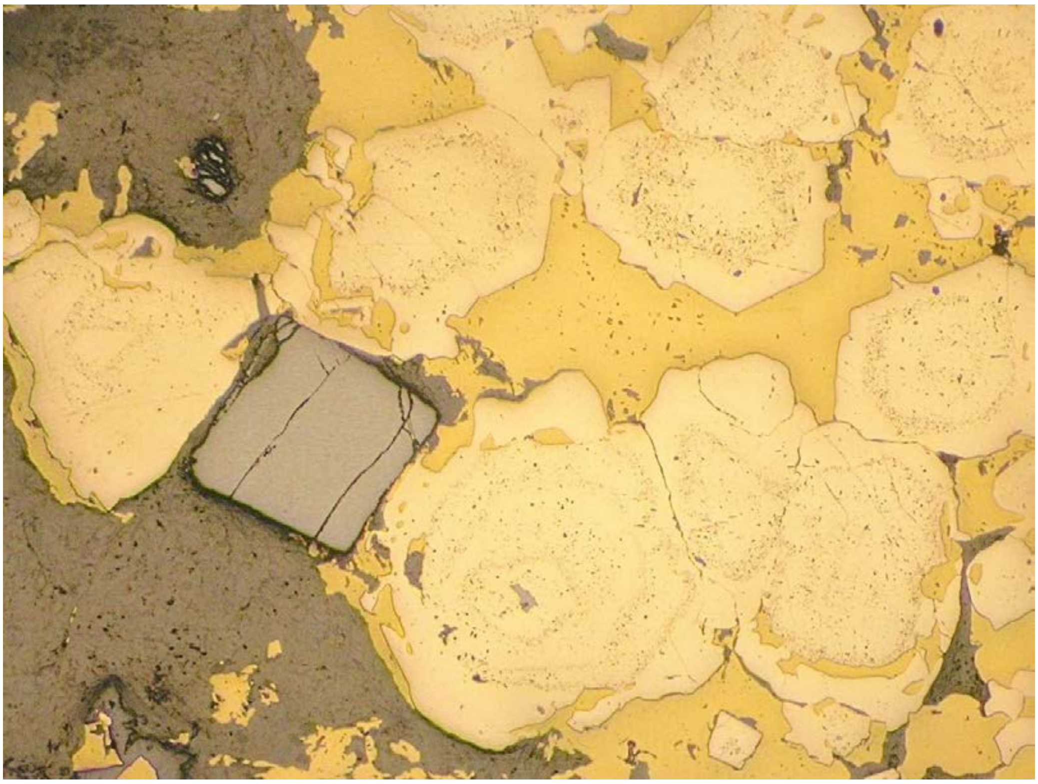


Fig. 42: Relict subhedral chromite grain (pale grey) adjacent to a sulphide aggregate containing paragenetically early pyrite (locally zoned) and later chalcopyrite. Darker grey domains are chlorite. Plane polarised reflected light, field of view 2 mm across.

SMD007 242.2 m TS

Summary: Porphyritic microdiorite with strong argillic alteration. The rock has moderately preserved relict texture, indicating that it contained scattered phenocrysts of plagioclase and two different types of ferromagnesian phase, and a few microphenocrysts of FeTi oxide in a fine to medium grained, plagioclase-rich groundmass, with minor ferromagnesian material and a little quartz. Relict shapes suggest that some of the ferromagnesian phenocrysts were originally hornblende, but others, containing relict tiny inclusions of a possible FeCr spinel phase, could have been clinopyroxene. Strong alteration led to albitisation of plagioclase and its further replacement by sericite and minor clay (e.g. kaolinite). Ferromagnesian material was replaced by quartz, albite, clay and a little carbonate and leucoxene, and FeTi oxide was replaced by leucoxene. A few apparent metasomatic aggregates of quartz and minor carbonate occur in the groundmass and the rock hosts a single thin quartz (-carbonate) vein.

Handspecimen: The drill core sample is composed of a pale creamy-grey, strongly altered porphyritic intermediate igneous rock. There are scattered pseudomorphs after phenocrysts up to 4 mm across, with possibly including former feldspar and ferromagnesian components. Alteration appears to be dominated by fine grained clay/sericite. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is moderately preserved, but it is evident that the rock is strongly altered (Fig. 43). There are scattered pseudomorphs after plagioclase phenocrysts up to 4 mm across and also after ferromagnesian phenocrysts up to 3.5 mm long. Relict shapes of the latter suggest that there were two different ferromagnesian minerals present, one probably hornblende, and the other, possibly clinopyroxene. The former pseudomorphic aggregates host a few small relict apatite inclusions (Fig. 43), whereas the latter contain tiny relict dark brown-black grains of a possible FeCr spinel phase. A few FeTi oxide microphenocrysts up to 0.5 mm across occurred, but are now altered. The phenocrystal phases were enclosed in a fine to medium grained groundmass (grainsize up to 0.3 mm) containing abundant small plagioclase grains, subordinate ferromagnesian material, minor interstitial quartz and a little disseminated FeTi oxide (Fig. 43).

b) Alteration and structure: Strong pervasive alteration was imposed on the igneous rock. Former plagioclase was albitised, then commonly strongly flecked by sericite and minor clay (e.g. kaolinite). All ferromagnesian material was altered, being replaced by varying proportions of quartz, albite, clay (kaolinite) and sericite, plus a little leucoxene. Igneous FeTi oxide was replaced by leucoxene. In the groundmass, albitised plagioclase is accompanied by minor sericite, clay and trace leucoxene, plus a few probable hydrothermal replacement aggregates of quartz up to 0.6 mm across and a few smaller aggregates of carbonate. A single, discontinuous sub-planar vein up to 0.3 mm wide cuts the altered rock, containing quartz and minor carbonate. The observed alteration assemblage in the rock conforms to argillic type.

c) Mineralisation: No sulphide minerals have been recognised in the sample.

Mineral Mode (by volume): plagioclase (albite) 70%, clay (kaolinite) 12%, sericite 10%, quartz 5%, carbonate 2%, leucoxene 1% and traces of apatite and FeCr spinel.

Interpretation and comment: It is interpreted that the sample represents a strongly argillically altered porphyritic microdiorite. Relict texture is moderately preserved, indicating that the rock hosted scattered phenocrysts of plagioclase and two different types of ferromagnesian phase, and a few microphenocrysts of FeTi oxide in a fine to medium grained, plagioclase-rich groundmass, with minor ferromagnesian material and a little quartz. Relict shapes suggest that some of the ferromagnesian phenocrysts were originally hornblende, but others, containing relict tiny inclusions of a possible FeCr spinel phase, could have been clinopyroxene. Plagioclase was initially albitised and further replaced by sericite and minor clay (e.g. kaolinite). Ferromagnesian material was replaced by quartz, albite, clay and a little carbonate and leucoxene, and FeTi oxide was replaced by leucoxene. A few apparent metasomatic aggregates of quartz and minor carbonate occur in the groundmass and the rock hosts a single thin quartz (-carbonate) vein.

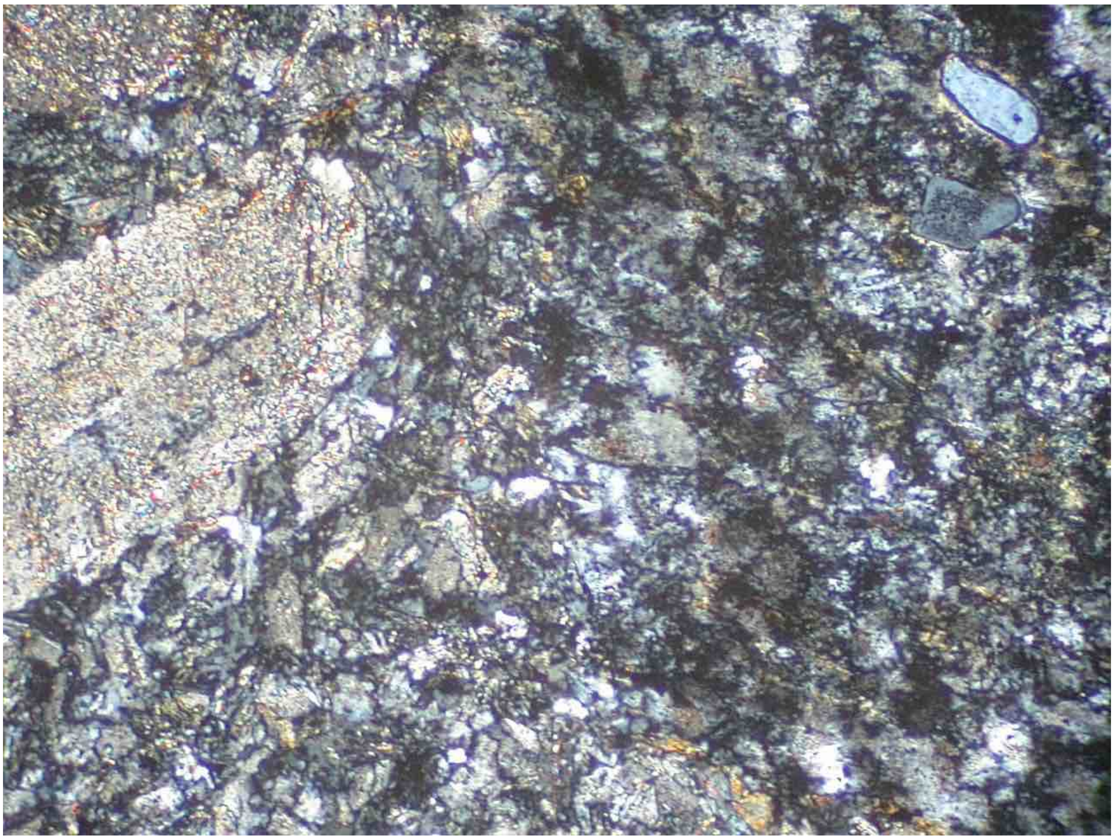


Fig. 43: Plagioclase phenocryst at left, replaced by albite and sericite. At right is a darker grey aggregate consisting of clay and quartz, representing a former ferromagnesian phenocryst. A couple of small relict grains of apatite occur in this aggregate at upper right. The remainder of the rock is finer grained feldspar-rich groundmass, with minor development of sericite and clay. Transmitted light, crossed polarisers, field of view 2 mm across.

<u>SMD007 242.5 m TS</u>

Summary: Matrix-supported sandstone, tending to conglomerate, containing abundant detrital quartz grains and larger, diverse lithic fragments. The latter include siltstone, grading to cherty argillite, possible chert, ultramafic and mafic igneous rocks. There are also a few detrital grains of chromite, probably liberated from former ultramafic hosts, and rare K-feldspar. The matrix to the sandstone is fine grained and recrystallised. It is likely that rock types expressed in the lithic fragments were altered and/or veined prior to being incorporated into the clastic sedimentary rock. Interpreted ultramafic composition material was replaced by chlorite, and mafic material by quartz and chlorite. Possible chert was finely recrystallised and veined by quartz, but some of this material could also represent intensely silicified rock ultimately of ultramafic or mafic composition. The sandstone matrix was recrystallised to fine grained chlorite and quartz, with all components of the rock being overprinted by disseminations and thin veinlets of sericite and trace carbonate, with this material being impregnated by goethite (possibly a deep supergene alteration effect).

Handspecimen: The drill core sample is composed of a grey-khaki, matrix-supported medium grained sandstone, containing a few large, sub-rounded fine grained lithic fragments up to 3.5 cm across, such that the rock is conglomeratic in parts. Lithic fragments range from pale grey quartz-rich (maybe cherty) to dark grey-green chlorite-rich. In the sandstone host, there are abundant detrital quartz grains up to 1 mm across in a fine grained, altered matrix, perhaps containing considerable chlorite, but also with patchy orange-brown pigmentation and thin veining, possibly a type of goethite-impregnated clay. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, relict detrital grain texture is moderately well preserved (Fig. 44). The rock is evidently of clastic sedimentary type, with abundant detrital quartz grains up to 1 mm across (mostly angular), scattered sub-rounded to angular lithic fragments up to 3.5 cm across and a few detrital grains of chromite (up to 1.5 mm) and rare K-feldspar (Fig. 44). Lithic grains are quite diverse and include rather quartz-rich siltstone, grading into cherty argillite and possible chert, along with several chlorite-rich masses and one fragment with a possible relict mafic igneous texture (e.g. dolerite/gabbro). The chlorite-rich masses are commonly elongate, have a weak foliation and some have small relict grains of chromite, suggesting that the protolith for this material was of ultramafic type. Some of the apparent chert could also represent intensely hydrothermally altered (silicified) ultramafic or mafic igneous rock. The lithic fragments and smaller quartz (and other detrital) grains are enclosed in a fine grained, altered and recrystallised matrix, with the rock generally displaying a matrix-supported texture (Fig. 44).

b) Alteration and structure: Original rock types occurring in detrital lithic fragments were evidently altered, deformed and locally veined prior to being incorporated into the clastic sedimentary rock. Interpreted ultramafic rock was replaced by chlorite and a possible mafic fragment was replaced by chlorite, quartz and trace pyrite. Original chert was finely recrystallised, but one large “chert” fragment also has scattered chlorite aggregates and a trace pyrite, and could possibly represent a strongly altered (silicified) ultramafic to mafic igneous rock. The fine grained matrix of the sandstone was recrystallised to chlorite and quartz, and the rock was impregnated by small fine grained aggregates and a few thin veinlets of fine grained sericite and trace carbonate, all impregnated by orange-brown goethite (Fig. 44). A trace of leucoxene and pyrite also occur in the matrix. The origin of the goethite impregnation remains enigmatic, given the depth downhole of the sample. It is speculated that it might represent a deep supergene alteration product.

c) Mineralisation: A trace of pyrite, forming grains and aggregates up to 0.2 mm across occurs in the altered sandstone matrix, in an altered ?mafic fragment and in an apparent "chert" fragment (although it cold be a silicified ultramafic/mafic). The rock contains several grains of chromite up to 1.5 mm across. Some are enclosed in chlorite-rich fragments that are interpreted to represent altered ultramafic material, whereas others have been liberated from such a host rock and now occur as isolated detrital grains (Fig. 44).

Mineral Mode (by volume): quartz 50%, chlorite 40%, sericite + goethite impregnation 9% and traces of chromite, carbonate, leucoxene, K-feldspar and pyrite.

Interpretation and comment: It is interpreted that the sample is an altered matrix-supported sandstone, tending to conglomerate. It contains abundant detrital quartz grains and larger, diverse lithic fragments that include siltstone, grading to cherty argillite, possible chert, ultramafic and mafic igneous rocks. There are also a few detrital grains of chromite, probably liberated from former ultramafic hosts, and rare K-feldspar. The sandstone matrix is fine grained and recrystallised. Rock types present in lithic fragments were altered and/or veined prior to being incorporated into the clastic sedimentary rock. Interpreted ultramafic composition material was replaced by chlorite, and mafic material by quartz and chlorite. Possible chert was finely recrystallised and veined by quartz, but some of this material could also represent intensely silicified rock ultimately of ultramafic or mafic composition. The sandstone matrix was recrystallised to fine grained chlorite and quartz, with all components of the rock being overprinted by disseminations and thin veinlets of sericite and trace carbonate, with this material being impregnated by goethite (possibly a deep supergene alteration effect).

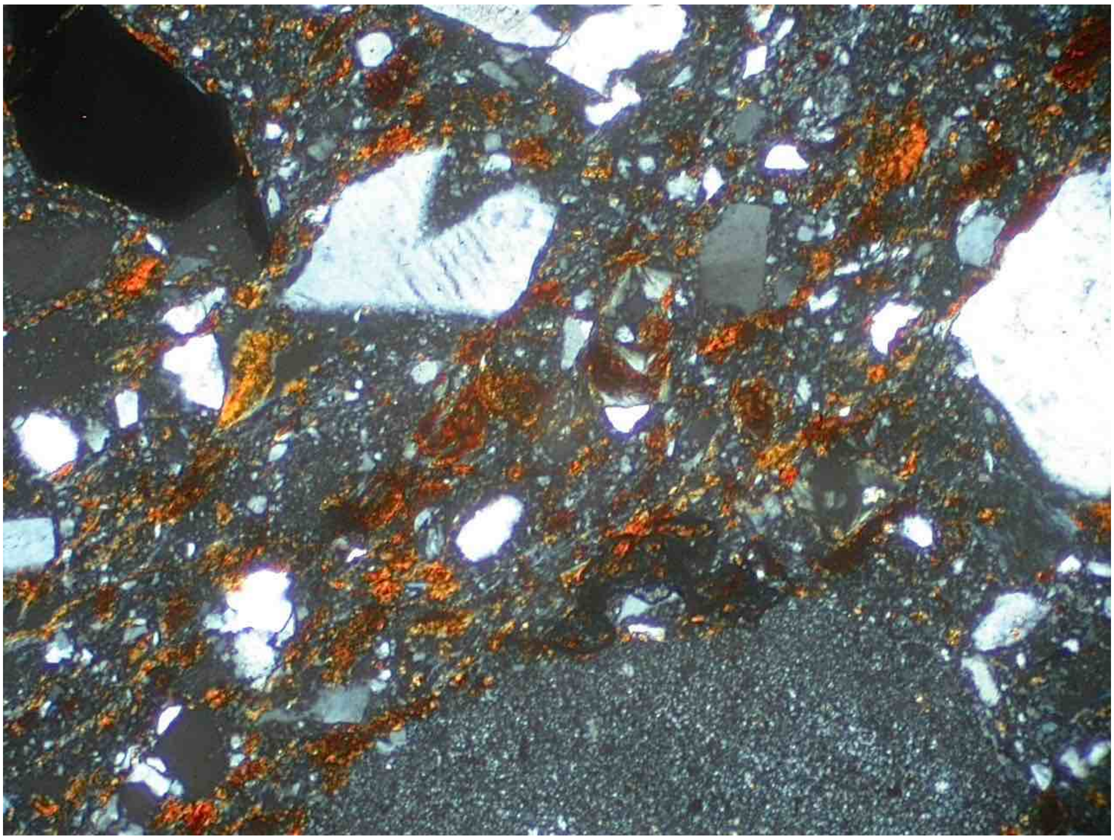


Fig. 44: Matrix-supported sandstone containing scattered detrital quartz grains, a fine grained cherty argillite lithic fragment (lower) and a detrital chromite grain (black at upper left) in a

finely recrystallised matrix, replaced by chlorite and quartz. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD007 246.8 m TS

Summary: Schistose serpentinite, probably derived from a harzburgite protolith, and cut by an array of carbonate-rich veins (e.g. magnesite). The rock retains a few relict chromite grains, with the serpentinite having developed a weak to moderate foliation and a couple of early serpentine (maybe chrysotile) veins. The emplacement of the carbonate-rich veins might have been syn-tectonic as some are emplaced largely co-planar with foliation, whereas others are oblique. These veins commonly show foliation and recrystallization textures and in places contain considerable fine grained talc, along with minor disseminations and elongate concentrations of magnetite. A major carbonate-rich vein contains several elongate magnetite concentrations, some of which are partly replaced by hematite. This vein is also cross-cut by a few narrow quartz-rich veins at a high angle.

Handspecimen: The drill core sample is composed of a moderately foliated, creamy to grey coloured schistose serpentinite. Foliation is at ~70° to the core axis and locally encloses boudinaged, sub-rounded to elongate serpentinite masses. Within serpentinite, there are a couple of small black chromite grains and a little fine grained magnetite, disseminated along the foliation. An array of white to creamy carbonate veins occurs oblique to foliation and these appear to be cut by a major banded carbonate vein up to 2 cm wide that has narrow dark grey bands containing fine grained magnetite concentrations. This vein occurs at ~30° to the core axis. Testing of the section offcut with dilute HCl did not give a reaction, suggesting that the carbonate could be magnesite. Due to the presence of magnetite, the sample is strongly magnetic, with susceptibility up to 7830 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock is a schistose serpentinite, with abundant imposed veining, such that there is a microbreccia texture in places. Relict texture from a parental ultramafic rock is generally not preserved due to deformation and veining, but there are a couple of "bastite" pseudomorphs after original orthopyroxene grains up to 2-3 mm across, and a few relict, but locally fractured and partly altered, grains of chromite up to 2.5 mm across (Figs 45, 46). From these vestiges, it is interpreted that the protolith was of harzburgite type, subsequently serpentinised.

b) Alteration and structure: The ultramafic protolith was serpentinised, with replacement by probable lizardite and minor magnetite. With imposed deformation, a weak to moderate foliation developed, with fine grained magnetite locally concentrated along foliation planes. A couple of irregular serpentine (e.g. chrysotile) veins up to 2 m wide were emplaced at a low angle to the foliation. Subsequently, the rock was cut by an array of carbonate-rich veins (Figs 45, 46). There could be two generations of these, with an earlier set, up to 0.5-1 mm wide, being commonly sub-parallel, but also forming a network, and generally containing significant fine grained talc, as well as minor magnetite, as fine grained disseminations and elongate aggregates (Fig. 46). A possibly later, major carbonate-rich vein is up to 2 cm wide and has fine to medium grained carbonate, a few sub-parallel masses rich in talc, and in fine grained magnetite. The carbonate-rich veins display indications of imposed deformation, with foliation development approximately co-planar with that in the host serpentinite, and showing recrystallization textures. It is possible that the carbonate (-talc-magnetite) veining was syn-tectonic. In the major vein, some of the elongate magnetite bands are partly replaced by hematite and a trace of pyrite. The major carbonate-rich vein and immediate host rock were cut at a high angle by a few quartz veins up to 0.4 mm wide. These later veins could be tension gash types, with quartz having little indication of deformation. Alteration of the ultramafic rock clearly involved substantial hydrothermal CO_2 introduction.

c) Mineralisation: A few grains of relict chromite, up to 2.5 mm across, are preserved in the serpentinite. Minor magnetite was formed during serpentinisation and in carbonate-rich veining, as fine disseminations and in narrow, elongate concentrations. In part of the major vein, magnetite is replaced by hematite and a trace of pyrite.

Mineral Mode (by volume): serpentine minerals 55%, carbonate (magnesite) 35%, talc 5%, magnetite 3%, quartz and hematite each 1% and traces of chromite and pyrite.

Interpretation and comment: It is interpreted that the sample represents a strongly carbonate-veined schistose serpentinite. Ultimately, the rock was derived from a harzburgite protolith and retains a few relict chromite grains, with the serpentinite having developed a weak to moderate foliation and a couple of early serpentine (maybe chrysotile) veins. The emplacement of the carbonate-rich veins might have been syn-tectonic as some are emplaced largely co-planar with foliation, whereas others are oblique. These veins commonly show foliation and recrystallization textures and locally host considerable talc, and minor disseminations and elongate concentrations of magnetite. A major carbonate-rich vein contains several elongate magnetite concentrations, some of which are partly replaced by hematite. This vein is also cross-cut by a few narrow quartz-rich veins at a high angle.

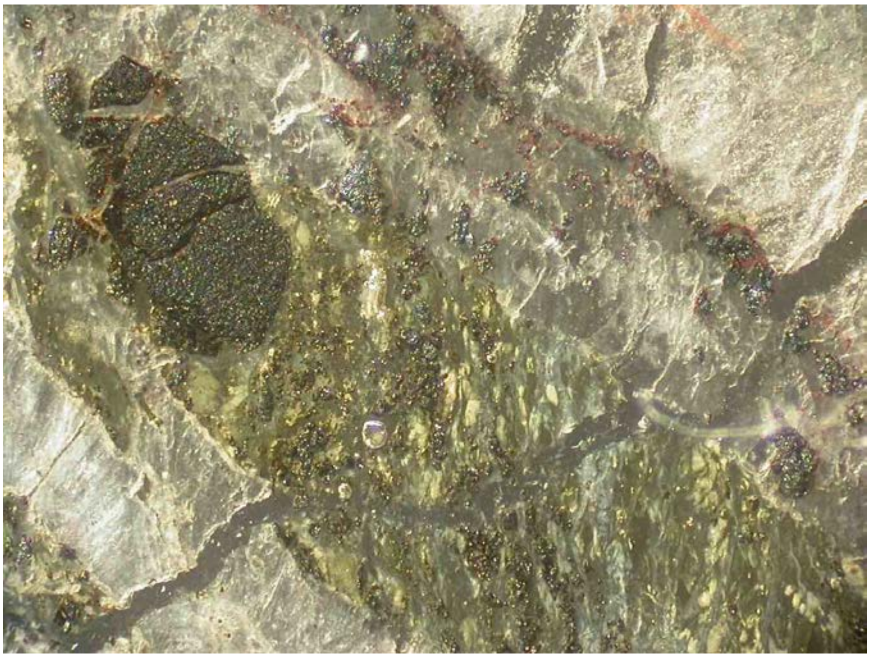


Fig. 45: Relict chromite grain (left) hosted in khaki-coloured serpentinite and cut by wide carbonate veins (whitish), with a little disseminated magnetite, partly replaced by hematite (slight reddish hue), and cut at a high angle by a narrow quartz vein (grey). Plane polarised oblique reflected light, field of view 2 mm across.

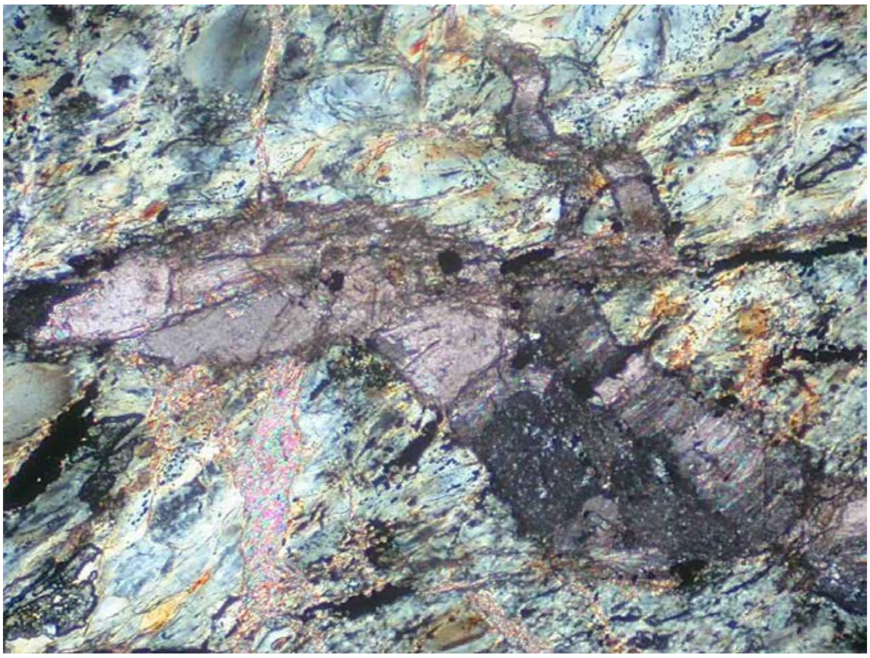


Fig. 46: Schistose serpentinite, with a few thin talc veins (left), cut by medium grained carbonate veins (turbid pale grey-brown). Small black grains are magnetite. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD008 142.8 m TS

Summary: Intensely hydrothermally altered and brecciated rock, originally of porphyritic felsic igneous type, perhaps dacite. Relict texture is poorly to moderately preserved and indicates that the protolith contained scattered feldspar and less common quartz and smaller ferromagnesian phenocrysts, and a few microphenocrysts of FeTi oxide in a fine grained quartzofeldspathic groundmass. The rock was affected by hydrothermal alteration of transitional phyllic-argillic type, with abundant veining and breccia infill by medium grained quartz. Feldspar and ferromagnesian phenocrysts were largely replaced by sericite, with minor clay at the former and a little rutile at the latter. FeTi oxide was replaced by rutile and the groundmass was replaced by dominant quartz, with subordinate clay (e.g. kaolinite). There is evidence for imposed strain and part recrystallization on hydrothermal infill quartz and in relict quartz phenocrysts.

Handspecimen: The drill core sample contains a substantial proportion (probably > half) of pale grey, rather coarse grained quartz, filling veins and zones of hydrothermal breccia. Quartz masses are up to several centimetres across and enclose scattered angular breccia fragments up to 5-6 cm across that have a creamy to locally brownish colour and which have poorly preserved relict porphyritic texture. The fragments retain a few relict quartz phenocrysts up to 3 mm across and pseudomorphic aggregates up to several millimetres across after former possible feldspar and/or ferromagnesian phenocrysts. The alteration assemblage appears to be dominated by clay and/or sericite. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, the sample is evidently a type of hydrothermal breccia, with a generally clast-supported texture. Angular breccia fragments are up to 5 cm across and are enclosed and veined by hydrothermal quartz. In the altered breccia fragments, there are sparsely scattered relict quartz phenocrysts up to 3.5 mm across and scattered alteration aggregates that are pseudomorphous after former blocky feldspar phenocrysts (up to 4.5 mm) and with smaller aggregates after possible ferromagnesian phenocrysts (Fig. 47). The rock also has small alteration aggregates after former FeTi oxide microphenocrysts (Fig. 47). The phenocrystal phases occupied ~40-50% of the rock and were enclosed in a fine grained groundmass, probably of quartzofeldspathic composition, but with a little ferromagnesian material and trace FeTi oxide and zircon. From the preserved primary characteristics, the protolith is interpreted as a porphyritic felsic igneous type, perhaps dacite.

b) Alteration and structure: The original igneous rock was subject to intense hydrothermal alteration and emplacement of abundant veining, so as to produce a largely clast-supported hydrothermal breccia. Interpreted former feldspar phenocrysts were replaced by fine grained aggregates of sericite, locally accompanied by minor low-birefringent clay (e.g. kaolinite) and quartz (Fig. 47). Ferromagnesian material was replaced by sericite and a little rutile, and FeTi oxide by rutile (aggregates up to 0.8 mm across) (Fig. 47). The groundmass was replaced by dominant fine to medium inequigranular quartz, with subordinate interstitial clay, a little sericite and trace rutile. Quartz in veins and breccia infill is commonly medium grained and inequigranular, but it, and relict quartz phenocrysts, also show effects of imposed deformation, leading to strain phenomena and local finer recrystallization. A trace of sericite and hematite occur in the quartz infill. The sample is slightly affected by possible deep supergene alteration, with traces of goethite impregnation at sites of abundant clay/sericite. The pervasive alteration assemblage in the sample is of a type transitional between phyllic and argillic.

c) Mineralisation: No sulphide minerals are observed in the sample.

Mineral Mode (by volume): quartz 55%, sericite 30%, clay (kaolinite) 14% and traces of rutile, zircon, hematite and goethite.

Interpretation and comment: It is interpreted that the sample is a largely clast-supported hydrothermal breccia, containing angular fragments of intensely hydrothermally altered porphyritic felsic igneous rock, perhaps originally dacite. In the breccia fragments, relict texture is poorly to moderately preserved, but it indicates that there were feldspar and less common quartz and smaller ferromagnesian phenocrysts, and a few microphenocrysts of FeTi oxide in a fine grained quartzofeldspathic groundmass. The rock was affected by hydrothermal alteration of transitional phyllic-argillic type, with abundant veining and breccia infill by medium grained quartz. Feldspar and ferromagnesian phenocrysts were largely replaced by sericite, with minor clay at the former and a little rutile at the latter. FeTi oxide was replaced by rutile and the groundmass was replaced by dominant quartz, with subordinate clay (e.g. kaolinite). There is evidence for imposed strain and part recrystallization on hydrothermal infill quartz and in relict quartz phenocrysts.

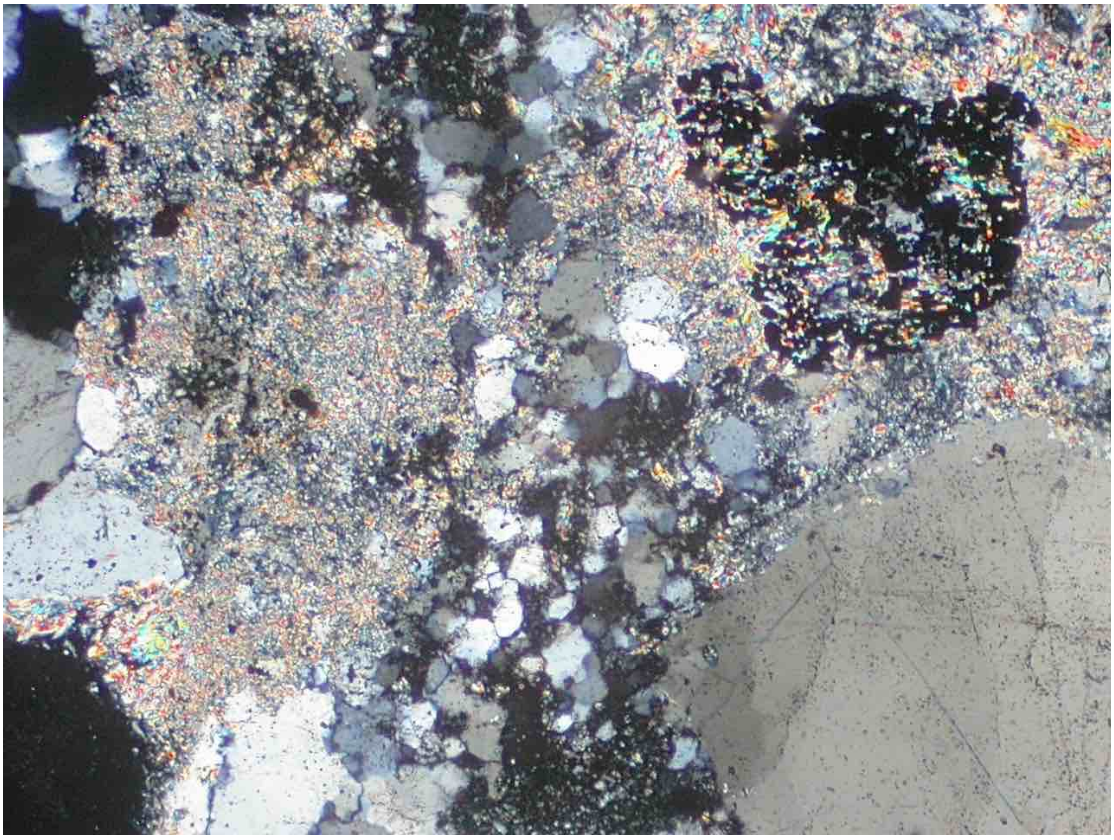


Fig. 47: Portion of a relict quartz phenocryst (lower right), as well as sericite-replaced feldspar grains. At upper right, the dark aggregate is a composed of rutile, having replaced a former FeTi oxide grain. Former phenocrysts occur in a finely granular quartz-rich altered groundmass. At left is part of an adjacent quartz vein. Transmitted light, crossed polarisers, field of view 2 mm across.

<u>SMD008 178.5 m TS</u>

Summary: Fine to medium grained sandstone, tending to siltstone, with strong pervasive alteration transitional between argillic and phyllic types. Relict texture is moderately preserved and it is apparent that the protolith had a largely grain-supported texture, with abundant detrital quartz and subordinate amounts of feldspar, probable fine grained lithics and traces of muscovite, chlorite, FeTi oxide (now altered) and zircon. An original matrix component was probably minor. The rock could have experienced low grade metamorphism, resulting in partial recrystallization as well as local silicification and emplacement of a single, thin sub-planar quartz vein. Subsequently, strong alteration was imposed, causing replacement of detrital feldspar, lithic material and any matrix by fine grained, low-birefringent clay (e.g. kaolinite) and sericite, with trace leucoxene developed from FeTi oxide. In parts of the sample, clay alteration is strongly prevalent, with possible dissolution of detrital quartz.

Handspecimen: The drill core sample is composed of a rather massive, yet soft and friable, strongly altered, creamy-coloured sandstone. It is evidently rich in small detrital quartz grains (mostly <0.5 mm), with abundant interstitial fine grained clay/sericite. A single thin (<0.5 mm) sub-planar quartz vein cuts the rock, which is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict detrital grain texture is moderately preserved, despite partial recrystallization and strong alteration. The rock originally had a grain-supported texture, with abundant detrital quartz and probable feldspar and fine grained lithic material up to 0.6 mm across (Fig. 48). The only other probable detrital grain phases were rare small grains of muscovite, chlorite, FeTi oxide (now altered) and zircon. It is likely that an interstitial matrix component would have been minor. From the preserved primary characteristics, the rock is interpreted as a fine to medium grained, quartzofeldspathic sandstone, transitional to siltstone.

b) Alteration and structure: The clastic sedimentary rock could have initially been subject to low grade metamorphism, causing partial recrystallization of detrital grains. There could have also been patchy silicification (i.e. replacement by quartz), and emplacement of a single sub-planar quartz vein up to 0.4 mm wide. Strong pervasive hydrothermal alteration was imposed subsequently, with alteration reflected in patchily abundant fine grained, low-birefringent clay (e.g. kaolinite) and sericite (Fig. 48), with a little leucoxene, derived from replacement of original FeTi oxide grains. The distribution of clay versus sericite is heterogeneous, with zones rich in one or the other. These layer silicates have replaced interpreted prior detrital feldspar and lithic material, as well as matrix. In parts of the rock where there is strong clay development, it is possible that detrital/hydrothermal quartz has been partly replaced by clay. The alteration in the rock is consistent with argillic type, but in places, transitional to phyllic type.

c) Mineralisation: Generally, no sulphide minerals are observed, but along one side of the section, there are a few small (<0.2 mm) grains of pyrite that could be part of the alteration.

Mineral Mode (by volume): quartz 55%, clay (kaolinite) 30%, sericite (including muscovite) 14% and traces of zircon, leucoxene, chlorite and pyrite.

Interpretation and comment: It is interpreted that the sample represents a strongly hydrothermally altered fine to medium grained sandstone, tending to siltstone. Relict texture is moderately preserved and it is apparent that the protolith had a largely grain-supported texture, with abundant detrital quartz and subordinate amounts of feldspar, probable fine grained lithics and traces of muscovite, chlorite, FeTi oxide (now altered) and zircon. An original matrix component was probably minor. The rock could have experienced low grade metamorphism, resulting in partial recrystallization as well as local silicification and emplacement of a single, thin sub-planar quartz vein. Subsequently, strong alteration of transitional argillic-phyllic type was imposed, causing destruction of detrital feldspar, lithic material and any matrix, and replacement by clay (e.g. kaolinite) and sericite, with trace leucoxene developed from FeTi oxide. In parts of the sample, clay alteration is strongly prevalent, with possible dissolution of detrital quartz.

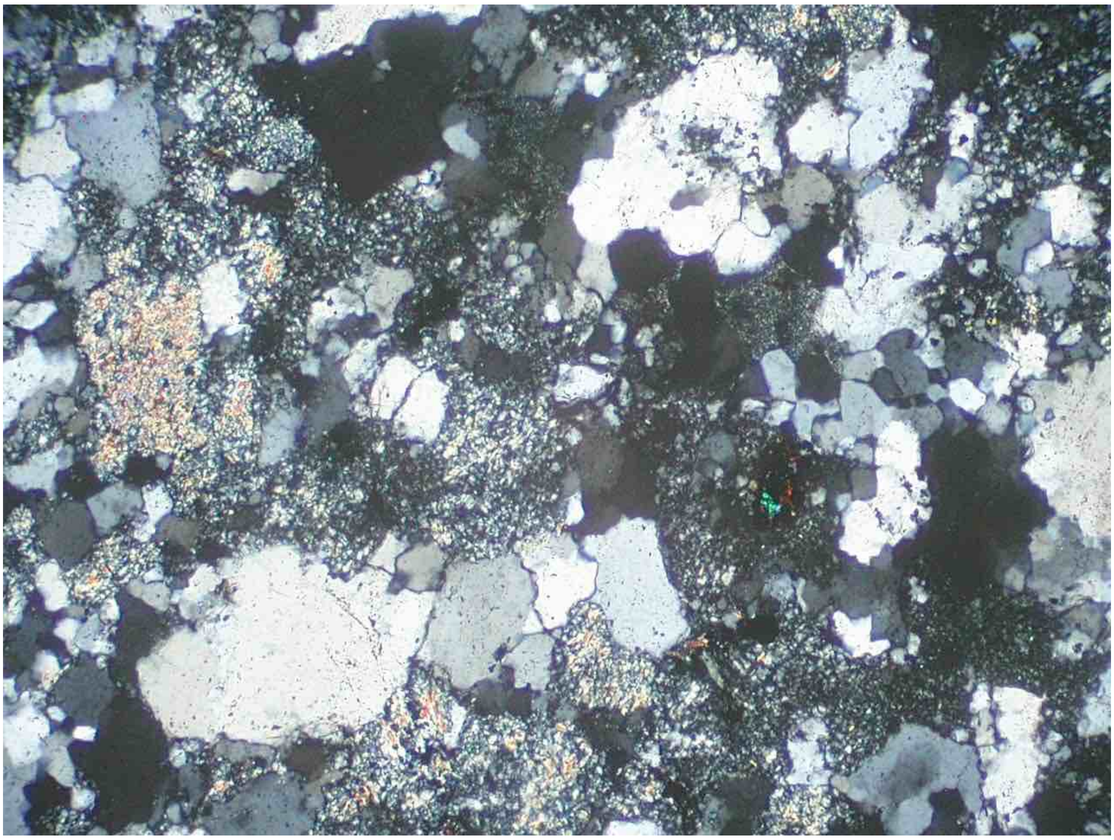


Fig. 48: Strongly altered and partly recrystallised sandstone, cut by a diffuse quartz vein (upper right). Relict quartz and sericitised feldspar/lithic grains are enclosed and perhaps partly replaced by fine grained sericite and clay (grey). At centre-right is a small relict grain of zircon (green/dark red). Transmitted light, crossed polarisers, field of view 2 mm across.

SMD008 207.0 m TS

Summary: Fine to medium grained sandstone, tending to siltstone, displaying strong hydrothermal alteration and minor veining. The rock has moderate preservation of relict detrital grain texture. It contained abundant detrital quartz and less common detrital feldspar and/or fine grained lithic material, hosted in a relatively large matrix component, such that the rock has a matrix-supported texture. It is likely that the rock initially underwent partial recrystallization due to metamorphism and development of considerable interstitial metamorphic biotite, as well as quartz and muscovite-sericite. Emplacement of a couple of quartz-rich veins could have coincided with extensive retrograde alteration, interpreted to be of transitional propylitic-argillic type, with this resulting in replacement of metamorphic biotite and any prior feldspar, and formation of patchily abundant low-birefringent clay (e.g. kaolinite), chlorite, sericite and traces of leucoxene and pyrite.

Handspecimen: The drill core sample is composed of a weakly fractured and locally quartz-veined, fine to medium grained clastic sedimentary rock, e.g. sandstone, perhaps transitional to siltstone. It contains abundant small detrital grains of quartz up to 0.5 mm and abundant interstitial pale creamy coloured clay/sericite, probably as an alteration product. In places, the rock has a pale greenish colour, maybe due to the presence of chlorite and there is also a trace of disseminated pyrite. A couple of sub-planar, pale grey quartz veins up to 1 mm wide occur. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock is strongly hydrothermally altered, but relict detrital grain texture is moderately preserved (Fig. 49). The rock originally had a largely matrix-supported texture, with abundant sub-rounded to angular quartz grains up to 0.7 mm, as well as possible detrital feldspar and/or fine grained lithic detrital grains (Fig. 49). Other possible detrital grain components include a trace of zircon and FeTi oxide (now altered). A finer grained matrix component, maybe originally of silty character, occurred interstitial to the detrital grains, but it has been recrystallised. From the preserved primary characteristics, the rock is viewed as a relatively quartz-rich sandstone, transitional to siltstone.

b) Alteration and structure: It is interpreted that the clastic sedimentary rock was initially metamorphosed, causing considerable recrystallization, mainly of the original matrix, but there was also some granulation of detrital quartz grains. The recrystallised component could have contained considerable fine grained metamorphic biotite, along with quartz, sericite-muscovite and maybe feldspar. Locally, a weak foliation developed. A couple of sub-planar quartz-rich veins up to 0.8 mm wide were emplaced, containing fine to medium grained quartz and a little chlorite and a clay phase (e.g. kaolinite). This event could be related to widespread retrograde alteration of the rock, such that detrital feldspar and lithics and recrystallised (metamorphic) matrix, was strongly altered. The resulting alteration assemblage is dominated by fine grained, low-birefringent clay (e.g. kaolinite), pale green chlorite and sericite (Fig. 49). Chlorite and sericite, with traces of accompanying leucoxene could be developed from alteration of metamorphic biotite. The three major alteration products (clay, chlorite, sericite) are irregularly distributed, and one or the other can dominate. Former detrital FeTi oxide grains were replaced by leucoxene, and in a small part of the sample, a few pyrite aggregates have formed as part of the alteration. The retrograde alteration is viewed as being transitional between propylitic and argillic types.

c) Mineralisation: In a small portion of the section there are a few aggregates of pyrite up to 0.3 mm across that appear to be part of the alteration.

Mineral Mode (by volume): quartz 35%, clay (kaolinite) 30%, sericite (including muscovite) 20%, chlorite 19% and traces of zircon, leucoxene and pyrite.

Interpretation and comment: It is interpreted that the sample is a strongly altered sandstone, tending to siltstone. It has moderate preservation of relict detrital grain texture and evidently contained abundant detrital quartz and less common detrital feldspar and/or fine grained lithic material, occurring in a relatively large matrix component, such that the rock has a matrix-supported texture. There was initial partial recrystallization due to metamorphism and development of considerable interstitial metamorphic biotite, as well as quartz and muscovite-sericite. Emplacement of a couple of quartz-rich veins could have coincided with extensive retrograde alteration of transitional propylitic-argillic type, with this resulting in replacement of metamorphic biotite and any prior feldspar, and formation of patchily abundant low-birefringent clay (e.g. kaolinite), chlorite, sericite and traces of leucoxene and pyrite.

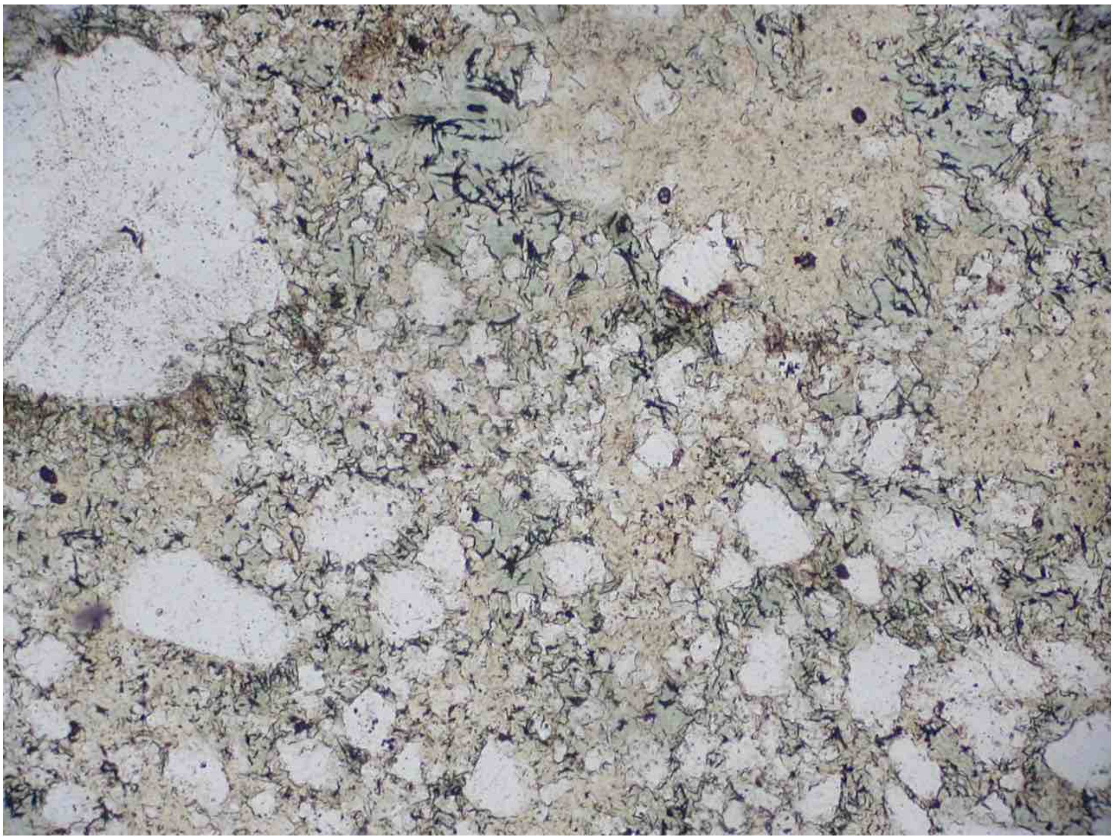


Fig. 49: Relict detrital grains of quartz occurring in a fine grained matrix that could have contained metamorphic biotite (as well as quartz, feldspar and sericite) and with strong retrograde alteration overprinting that has produced pale creamy coloured clay ± sericite, and pale grey-green chlorite. Plane polarised transmitted light, field of view 2 mm across.

SMD008 225.0 m TS

Summary: Fine grained, matrix-supported siltstone, showing local veining and a strong retrograde alteration overprint. Relict detrital grain texture is moderately preserved and it is indicated that the rock had small detrital quartz grains and probably, a subordinate amount of detrital fine grained lithics and feldspar (plagioclase) in a fine grained matrix, now considerably recrystallised. It is proposed that the rock experienced initial metamorphism resulting in development of fine grained metamorphic biotite in the matrix, together with recrystallization of quartz. Veins emplaced are quartz-dominated, but also locally contained plagioclase and possible biotite. The imposition of retrograde alteration of transitional propylitic-argillic type led to destruction of all interpreted biotite and some of the feldspar, and formation of abundant fine grained clay (e.g. kaolinite), chlorite and sericite, and a trace of leucoxene. A single thin vein was emplaced during the retrograde stage and contains chlorite, sericite and pyrite.

Handspecimen: The drill core sample is composed of a weakly fractured and quartz-veined, fine to medium grained clastic sedimentary rock, e.g. sandstone, perhaps transitional to but otherwise massive, fine grained, grey-green altered clastic sedimentary rock, e.g. siltstone. Although rather quartz-rich, the rock probably has pervasive development of fine grained chlorite and sericite, and is cut by a few locally intersecting whitish quartz veins up to 2 mm wide, occurring at varying angles to the core axis. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, it is evident that the rock is strongly hydrothermally altered, but relict fine grained, matrix-supported detrital grain texture is moderately preserved (Fig. 50). The rock has disseminated small detrital quartz grains up to 0.2 mm across, a few small plagioclase grains and a minor proportion of alteration aggregates that could represent sites of lithic detrital grains, occurring in a fine grained, altered and recrystallised matrix (Fig. 50). A trace of relict zircon occurs in the matrix, which might have formerly been of silty character. From the preserved primary characteristics, the rock is interpreted as a fine grained, matrix-supported siltstone.

b) Alteration and structure: It is interpreted that the fine grained clastic sedimentary rock experienced initial metamorphism, causing considerable fine grained recrystallization of the large matrix component, plus some of the prior detrital lithic and feldspar grains. It is likely that rather abundant fine grained metamorphic biotite developed, accompanied by quartz and feldspar. Perhaps during or following the metamorphic event, significant quartz-rich veining was emplaced, with the veins being mostly sub-planar, locally intersecting and up to 1.5 mm wide (Fig. 50). They contain fine to medium grained quartz, and in places, minor plagioclase, chlorite and trace sericite. It is speculated that chlorite and sericite in these veins could be retrograde, having replaced earlier biotite. Subsequently, strong retrograde alteration was imposed, causing replacement of interpreted metamorphic biotite, as well as replacement of some feldspar, and development of abundant fine grained, low-birefringent clay (e.g. kaolinite) and chlorite, and generally minor, but patchily abundant sericite and a trace of leucoxene (Fig. 50). Plagioclase in quartz-rich veins was albitised and flecked by sericite. A single later vein was emplaced, perhaps related to the retrograde alteration. It is sub-planar, up to 0.2 mm wide, cuts quartz-rich veining and contains chlorite, sericite and pyrite. The retrograde alteration assemblage is interpreted to be of transitional propylitic-argillic type.

c) Mineralisation: Generally the sample contains no sulphides, but a single narrow vein, probably related to the retrograde alteration, contains a few elongate aggregates of pyrite up to 1 mm long, associated with chlorite and sericite.

Mineral Mode (by volume): quartz 50%, clay (kaolinite), sericite and chlorite each 15%, plagioclase (albite) 4% and traces of zircon, leucoxene and pyrite.

Interpretation and comment: It is interpreted that the sample represents a strongly altered and locally veined, matrix-supported siltstone. Relict detrital grain texture is moderately preserved, indicating that the rock contained small detrital quartz grains and probably, a subordinate amount of detrital fine grained lithics and feldspar (plagioclase) in a fine grained matrix, now considerably recrystallised. The rock appears to have undergone initial metamorphism, causing formation of metamorphic biotite in the matrix, together with recrystallization of quartz. Veins emplaced are quartz-dominated, but originally also contained plagioclase and possible biotite. The imposition of retrograde alteration of transitional propylitic-argillic type caused replacement of biotite and some of the feldspar, and formation of abundant fine grained clay (e.g. kaolinite), chlorite and sericite, and a trace of leucoxene. A single thin vein was emplaced during the retrograde stage and contains chlorite, sericite and pyrite.

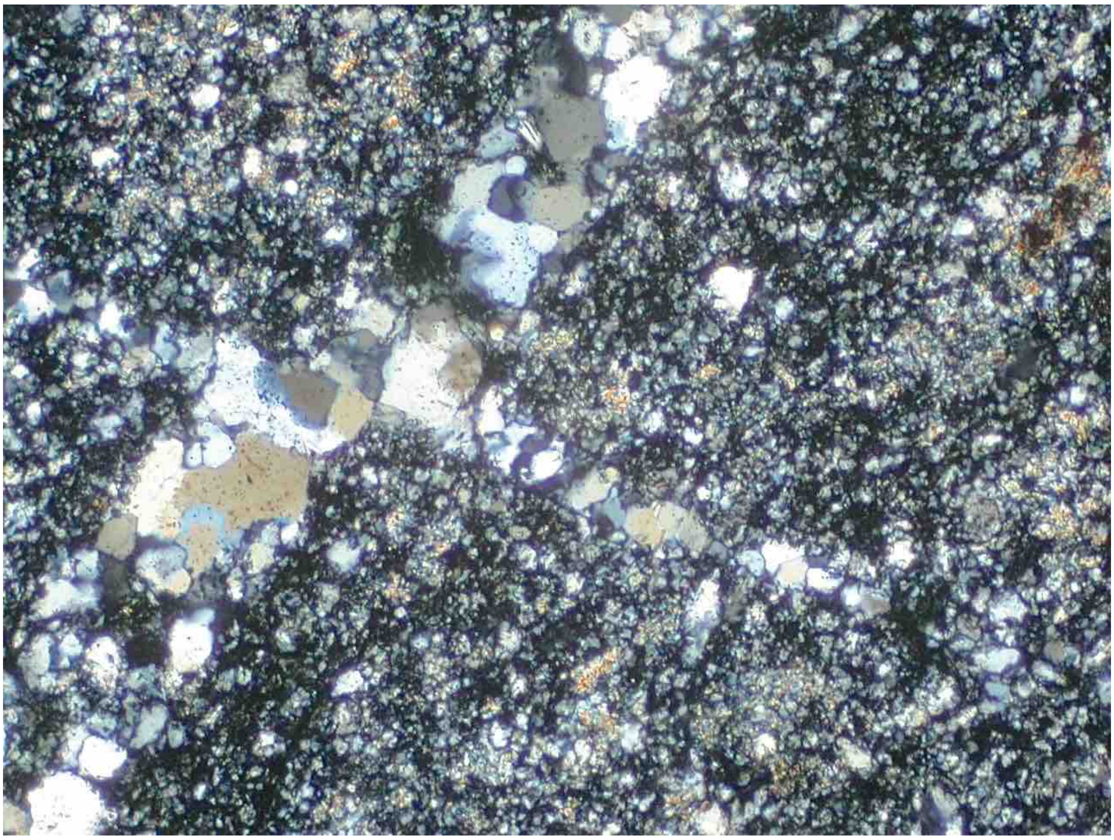


Fig. 50: Narrow, intersecting quartz veins cutting strongly altered siltstone. The latter has a few small relict detrital quartz grains, but the matrix is now recrystallised and replaced by fine grained quartz, clay, sericite and chlorite. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD008 233.8 m TS

Summary: Very strongly hydrothermally altered and locally veined porphyritic felsic igneous rock, perhaps originally of dacite type. Relict texture is poorly to moderately preserved, but there are scattered relict quartz phenocrysts and pseudomorphs after former feldspar and ferromagnesian phenocrysts in a fine grained altered groundmass. Alteration is largely of phyllic type, but in part transitional to propylitic, with the dominant alteration minerals being quartz and sericite. In part of the sample, chlorite is more prevalent at altered ferromagnesian and feldspar sites, and there are small amounts of clay (e.g. kaolinite), leucoxene-rutile and pyrite. A few quartz-rich veins cut the altered rock and they appear to be post-dated by a couple of thin veins of quartz, pyrite and sericite.

Handspecimen: The drill core sample is composed of a very strongly hydrothermally altered porphyritic felsic igneous rock. It ranges from pale creamy to grey in colour and contains scattered relict quartz phenocrysts up to 3 mm across and pseudomorphic aggregates after probable former feldspar and ferromagnesian phenocrysts, in a fine grained altered groundmass. The rock appears to be altered to abundant fine grained sericite/clay and quartz, with the grey coloured zone possibly containing a higher proportion of quartz, as well as having chlorite. A little fine grained disseminated pyrite occurs throughout and there is a single quartz vein ~1 mm wide. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, relict texture is poorly to moderately preserved, due to the imposition of strong alteration. There are scattered relict quartz phenocrysts up to 3 mm across and pseudmorphs after other former phenocryst phases (Fig. 51). Relict shapes of the latter suggest that there were blocky feldspar grains up to 7 mm across, probable ferromagnesian phenocrysts up to 3 mm across and a few microphenocrysts of FeTi oxide up to 0.6 mm across. The phenocryst phases occurred in a fine grained groundmass, probably of quartzofeldspathic composition, but with small amounts of ferromagnesian material and traces of FeTi oxide and apatite. The preserved primary characteristics of the rock indicate that it was a porphyritic felsic igneous type, perhaps dacite.

b) Alteration and structure: Very strong hydrothermal alteration was imposed and a few veins emplaced. Original feldspar and ferromagnesian material were replaced mostly by fine grained sericite aggregates (Fig. 51), but with a little leucoxene-rutile at ferromagnesian sites, and in places a little low-birefringent clay (e.g. kaolinite) at feldspar sites. In part of the sample, very pale green chlorite has also developed at former feldspar and ferromagnesian sites, and FeTi oxide was replaced by leucoxene-rutile ± chlorite. The groundmass was replaced by abundant finely granular quartz, with subordinate sericite (Fig. 51), and in part of the sample, minor chlorite. A little pyrite is irregularly distributed as part of the alteration assemblage, which overall is of phyllic type, but transitional to propylitic where chlorite becomes more common. A few sub-planar quartz veins up to 1 mm wide were emplaced, locally containing a little sericite, and there are a couple of thin (<0.2 mm) sub-planar and apparently later-emplaced veins of quartz, pyrite and sericite.

c) Mineralisation: Minor, irregularly distributed pyrite, forming aggregates up to 1 mm across occur as part of the alteration, and a little pyrite is also present in a couple of thin veins.

Mineral Mode (by volume): quartz and sericite each 45%, chlorite 7%, clay, leucoxene-rutile and pyrite each 1% and a trace of apatite.

Interpretation and comment: It is interpreted that the sample is a former porphyritic felsic igneous rock, perhaps originally of dacite type that has experienced very strong hydrothermal alteration and local veining. There are scattered relict quartz phenocrysts, but other components were completely replaced, resulting in formation of pseudomorphs after former feldspar and ferromagnesian phenocrysts in a fine grained altered groundmass. Alteration is largely of phyllic type, but in part transitional to propylitic, with the dominant alteration minerals being quartz and sericite. In part of the sample, chlorite is more prevalent at altered ferromagnesian and feldspar sites, and there are small amounts of clay (e.g. kaolinite), leucoxene-rutile and pyrite. A few quartz-rich veins cut the altered rock and they appear to be post-dated by a couple of thin veins of quartz, pyrite and sericite.

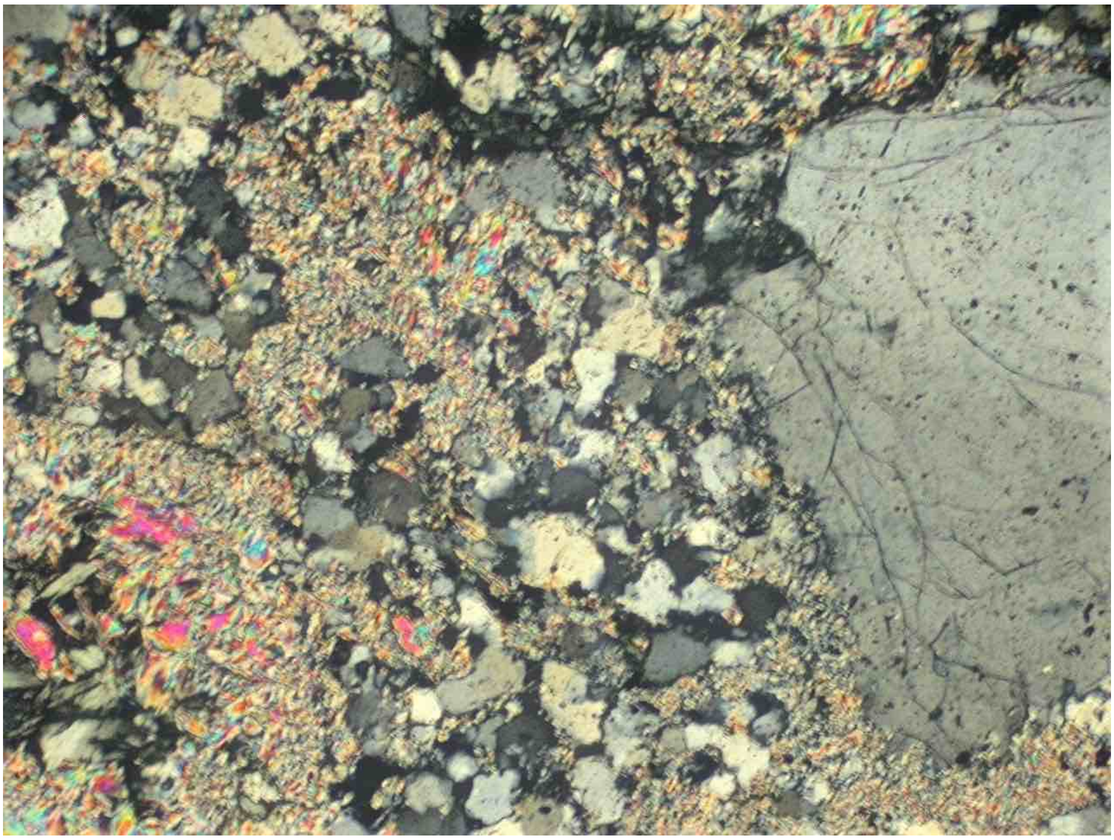


Fig. 51: Strongly altered rock exhibiting a relict quartz phenocryst (right) and aggregates of sericite (and minor chlorite) after former feldspar phenocrysts, in a groundmass now replaced by granular quartz and minor sericite. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD008 238.0 m PTS

Summary: Former fine grained siltstone, with strong hydrothermal alteration and replacement by varying proportions of quartz and sericite, with trace rutile and pyrite. The altered siltstone is fractured and has small irregular veins of sericite, pyrite and quartz. A major quartz-pyrite vein abuts the altered siltstone, originally containing medium to coarse grained quartz and disseminated to semi-massive pyrite. Coarser pyrite grains host sparse small inclusions of chalcopyrite and bornite. Subsequently, the vein was strongly brecciated, developing fragments of quartz, pyrite and a small proportion of strongly altered siltstone. Breccia fragments are thinly encrusted by banded chalcedonic silica.

Handspecimen: The drill core sample is composed of a fractured and veined, strongly altered pale creamy-grey fine grained rock, possibly of clastic sedimentary type, e.g. siltstone, but strongly replaced by fine grained sericite/clay and quartz, and a little pyrite. A network of veins up to 1 cm wide is present, with these containing pale grey quartz and medium to coarse grained pyrite. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, about half of the sample is interpreted as strongly altered and locally brecciated host rock, with the remainder being brecciated vein material. In the host rock, it is apparent that the rock was originally fine grained and probably recrystallised, but there are a few small relict quartz detrital grains up to 0.2 mm across. The recrystallised assemblage contains varying proportions of sericite and quartz, with traces of rutile and pyrite, and this is considered to be consistent with it originally being of psammopelite (siltstone) composition.

b) Alteration and structure: Strong hydrothermal alteration was imposed on the fine grained clastic sedimentary rock, along with emplacement of a major quartz-pyrite vein, and subsequent brittle deformation (brecciation) occurring. The interpreted siltstone was finely recrystallised, with it ranging from sericite-rich to quartz-rich and also containing a trace of rutile and pyrite (Fig. 52). Fractures in the altered siltstone were sites of deposition of slightly coarser grained sericite and local quartz and pyrite. Adjacent to the main quartz-pyrite vein, the host siltstone shows patchy stronger alteration to domains rich in fine to medium grained quartz, or in sericite (Fig. 52). The boundary against the major vein is relatively sharp, with the vein being at least 1.5 cm thick and originally containing abundant medium to coarse grained quartz and pyrite (disseminated to semi-massive). Brecciation was imposed on the vein, with brittle deformation effects locally extending into the adjacent altered host rock. In the brecciated zones, there are angular fragments of pyrite and quartz, each up to 3 mm across, with a small amount of strongly sericitised host rock (Fig. 52). The breccia is clast-supported and there is a minor infill component of fine grained, colloform texture chalcedonic quartz.

c) Mineralisation: In the altered siltstone, there are sparse pyrite grains up to 0.6 mm across, mainly in fracture-fill positions. Disseminated to semi-massive pyrite occurs in the main vein, with pyrite being locally fractured, as well as containing sparse small (<0.1 mm) inclusions of chalcopyrite and bornite, in places outlining internal zoning in pyrite (Fig. 53). No molybdenite was observed in the sample.

Mineral Mode (by volume): quartz 45%, pyrite 30%, sericite 20%, chalcedonic silica 5% and traces of rutile, chalcopyrite and bornite.

Interpretation and comment: It is interpreted that the sample represents a strongly hydrothermally altered siltstone, now replaced by varying proportions of quartz and sericite, with trace rutile and pyrite, and containing small irregular veins of sericite, pyrite and quartz. A major quartz-pyrite vein abuts the altered siltstone, with medium to coarse grained quartz and disseminated to semi-massive pyrite showing effects of imposed brecciation. Coarser pyrite grains host sparse small inclusions of chalcopyrite and bornite. The brecciated vein has fragments of quartz, pyrite and altered host rock that are thinly encrusted by banded chalcedonic silica.

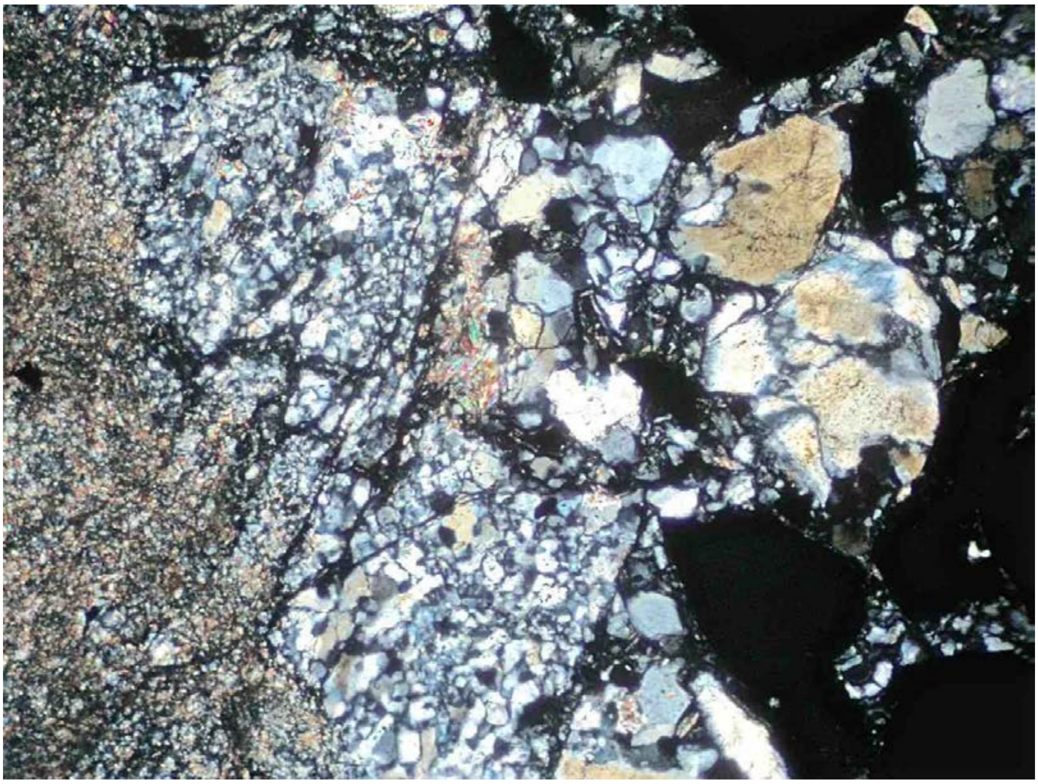


Fig. 52: Fine grained, sericite-quartz-altered siltstone at left, showing a more quartz-rich (silicified) border against the brecciated quartz-pyrite vein at right. Transmitted light, crossed polarisers, field of view 2 mm across.

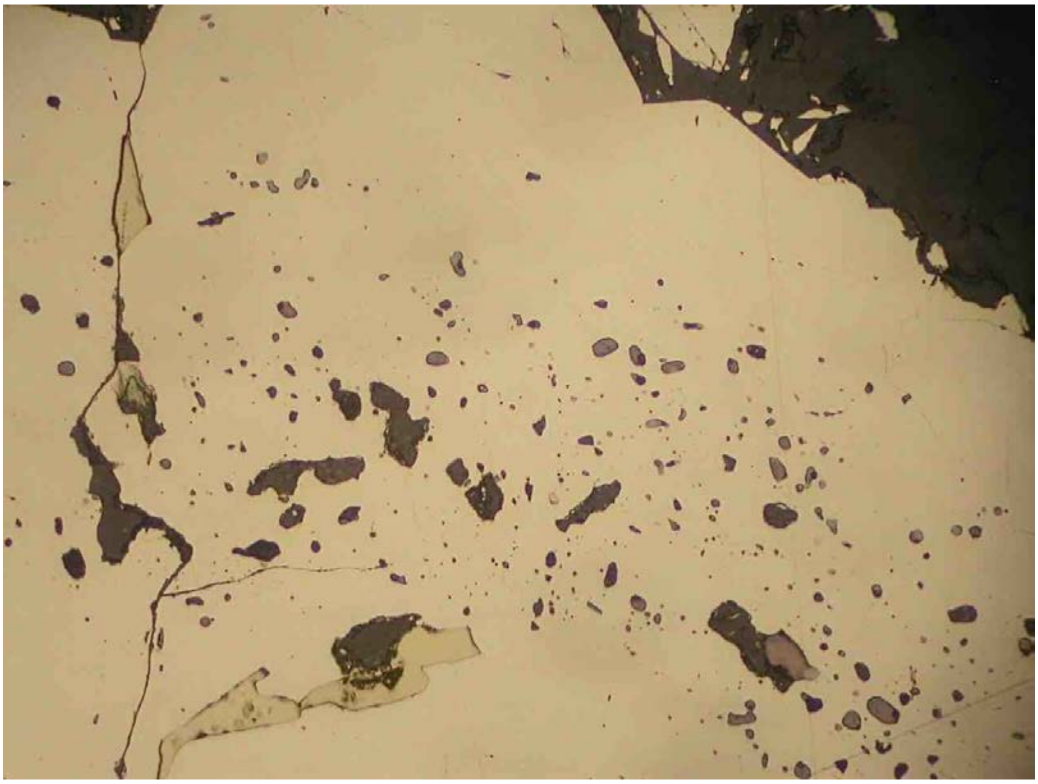


Fig. 53: Portion of a large, weakly zoned pyrite grain in the brecciated vein. Within pyrite are small inclusions of chalcopyrite (yellow), bornite (dark red-blue at lower right) and silicates (dark grey). Plane polarised reflected light, field of view 0.5 mm across.

SMD009 43.0 m TS

Summary: Rather coarse sedimentary breccia, with a generally matrix-supported texture and containing angular to sub-rounded fragments of fine grained porphyritic mafic to intermediate volcanic rock and fine grained siltstone, hosted in a fine grained siltstone matrix that is pigmented by carbonaceous material and contains minor disseminated pyrite. Relict texture is well preserved and demonstrates that the volcanic fragments contained scattered plagioclase phenocrysts in a fine grained groundmass. Siltstone fragments had a minor proportion of detrital muscovite and quartz grains, but are dominated by fine grained matrix. Similarly, the breccia matrix is fine grained siltstone, containing sparse grains of plagioclase (disaggregated from volcanic fragments) as well as minor quartz. It is likely that the rock has experienced low grade alteration (e.g. burial metamorphism), with development of abundant fine grained clay phases (maybe illite-smectite and kaolinite) and less common chlorite and sericite, along with minor disseminated pyrite.

Handspecimen: The drill core sample is composed of a dark grey, generally matrix-supported breccia, perhaps of sedimentary type. Fragments in the breccia are up to 2.5 cm across, are angular to sub-rounded and paler grey than the matrix. Fragments appear to be composed of fine grained rock, some of which appears to be a porphyritic volcanic, and other material might be fine grained sedimentary material (e.g. pelitic). The dark grey colour of the fine grained matrix (maybe siltstone) could be due to finely dispersed carbonaceous material. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the sample is a breccia with a largely matrix-supported texture (although locally clast-supported). Angular to sub-rounded fragments are up to 2 cm across and they constitute 50-60% of the rock. Two major types of lithic fragment are apparent. The more abundant, and larger fragment type is composed of sparsely porphyritic mafic to intermediate volcanic rock (e.g. basalt to andesite), containing small plagioclase phenocrysts in a fine grained groundmass (Fig. 54). The other fragment type is composed of fine grained siltstone, commonly with small (<0.1 mm) detrital grains of muscovite and quartz, in a fine grained matrix (Fig. 54). Disaggregation of the volcanic fragments led to liberation of a few isolated plagioclase grains and they are accompanied in the breccia matrix by a few small grains of quartz and traces of muscovite and biotite. The breccia matrix is essentially a fine grained siltstone, variably pigmented brown to opaque by finely dispersed carbonaceous material (Fig. 54). From the preserved primary characteristics, the rock is interpreted as a rather coarse sedimentary breccia, with a generally matrix-supported texture and containing fine grained volcanic and sedimentary fragments.

b) Alteration and structure: It is likely that the coarse clastic sedimentary rock underwent low grade alteration, e.g. due to burial metamorphism. In volcanic fragments, there was some albitisation of plagioclase, along with replacement by sericite, but a more common alteration type of small plagioclase grains and groundmass was by a fine grained clay phase (e.g. illite-smectite) and locally by chlorite-rich aggregates. Siltstone fragments and the breccia matrix again probably contain significant fine grained clay (e.g. illite-smectite and maybe kaolinite), with lesser amounts of quartz, sericite and chlorite, and in the breccia matrix, dispersed carbonaceous material. Sparsely distributed pyrite occurs throughout the breccia matrix, and there are also traces of pyrite in some of the altered fragments.

c) Mineralisation: Minor pyrite occurs as an alteration product, mainly in the breccia matrix, but in traces in some of the fragments. There are aggregates up to 1.5 mm across in the breccia matrix, although most pyrite is <0.3 mm across.

Mineral Mode (by volume): clay phases (illite-smectite, kaolinite) 60%, chlorite, plagioclase (includes albite) and quartz each 10%, sericite + muscovite 8%, pyrite and carbonaceous material each 1% and a trace of biotite.

Interpretation and comment: It is interpreted that the sample is a low grade altered, coarse sedimentary breccia. It has a generally matrix-supported texture, although locally it is clast-supported. Fragments of porphyritic mafic to intermediate volcanic rock are the more common and there is a subordinate population of siltstone fragments, hosted in a fine grained siltstone matrix that is pigmented by carbonaceous material and contains minor disseminated pyrite. Volcanic fragments contained scattered plagioclase phenocrysts in a fine grained groundmass and siltstone fragments had a minor proportion of detrital muscovite and quartz grains, but are dominated by fine grained matrix. The breccia matrix is composed of fine grained siltstone, with sparse grains of plagioclase (disaggregated from volcanic fragments) as well as minor quartz. It is likely that the rock has experienced low grade alteration (e.g. burial metamorphism), with development of abundant fine grained clay phases (maybe illite-smectite and kaolinite) and less common chlorite and sericite, along with minor disseminated pyrite.

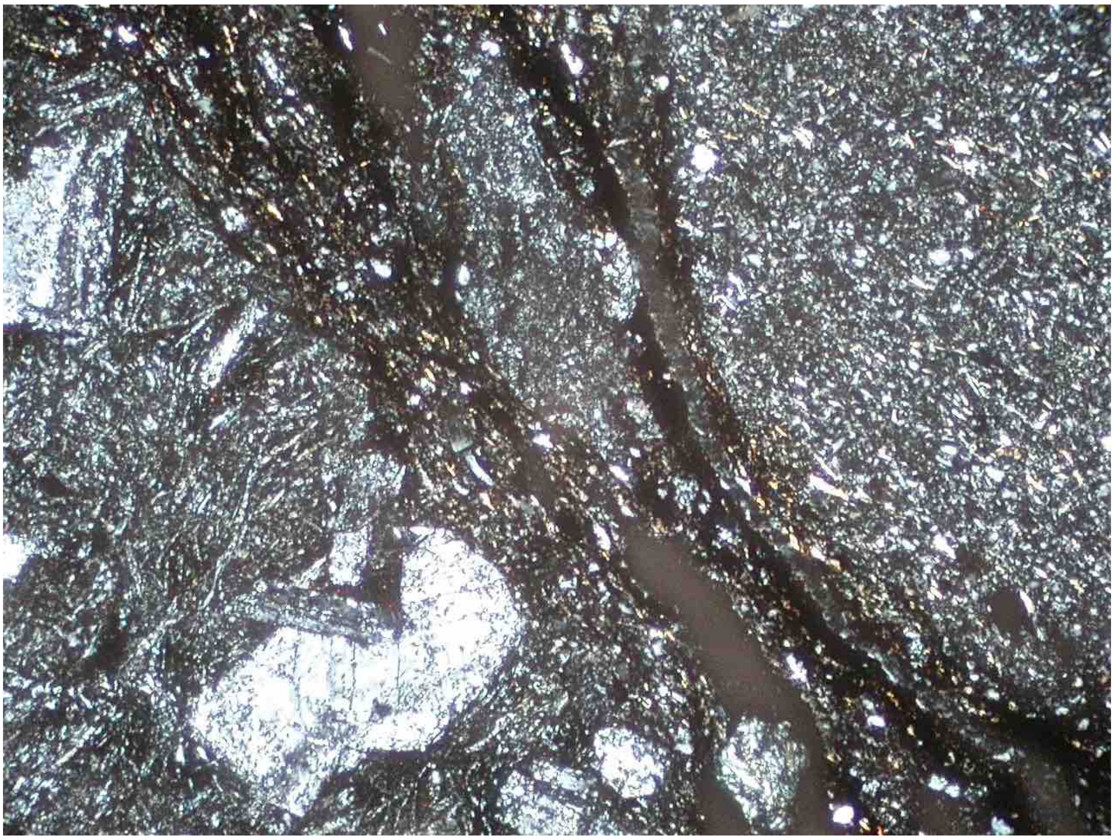


Fig. 54: Portion of an altered porphyritic mafic volcanic fragment at left, and a fine grained siltstone fragment at right. The breccia matrix (dark diagonal mass at centre) is composed of slightly carbonaceous fine grained siltstone. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD009 59.4 m PTS

Summary: Relatively massive serpentinite showing effects of overprinting hydrothermal alteration and associated veining. Relict textures in the serpentinite suggest that it was derived from an olivine-rich peridotite protolith (e.g. harzburgite) also containing a few former pyroxene grains and retaining a few chromite grains. Imposed alteration led to development of irregular and veinlike masses of fine grained carbonate (e.g. ferroan magnesite) along with minor associated sulphides and talc. A few aggregates of chlorite developed elsewhere in the rock. Sulphides include fine grained pyrite and a trace of pyrrhotite, and they are most common in veins and small aggregates hosted in carbonate.

Handspecimen: The drill core sample is composed of a relatively massive, dark khaki-grey serpentinite. In places, it contains zones of veining and associated micro-brecciation (fragments up to ~1 cm), with infill of narrow veins by pale creamy-grey carbonate. A few grains of black chromite up to 2.5 mm across are apparent, and small aggregates of pyrite occur in some of the carbonate veins. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI, most unusual for a serpentinite.

Petrographic description

a) Primary rock characteristics: In the section, the rock is a relatively massive serpentinite, although cut by many narrow veins. Mesh texture after formerly abundant olivine occurs in places and there are a few pseudomorphic aggregates ("bastite") after former pyroxene grains (Fig. 55). The rock also retains a few chromite grains up to 2.5 mm across (Fig. 56) some of which are fractured. The relict textures indicate that the serpentinite has been derived from a peridotite protolith, e.g. harzburgite.

b) Alteration and structure: It is interpreted that a peridotite protolith was serpentinised, forming an initial massive serpentinite, probably dominated by lizardite, and cut by a few thin serpentine veins. The rock subsequently experienced partial recrystallization and imposed effects of hydrothermal alteration and significant vein emplacement. Hydrothermal alteration caused local replacement of the serpentinite host by aggregates of very pale green chlorite, development of relatively abundant irregular to veinlike aggregates of fine grained carbonate (e.g. ferroan magnesite), with minor associated talc and sulphides, and emplacement of a few well defined veins up to 0.5 mm wide of carbonate and minor sulphides (Figs 55, 56). In irregular and veinlike masses of carbonate, fine grained pyrite is the dominant sulphide, with traces of fine grained pyrrhotite (± pyrite) occurring in some of the small aggregates. The occurrence of carbonate and Fe sulphides indicates hydrothermal introduction of CO_2 and S into the host rock, with this precluding the stability of the magnetite (which would be typically expected in a serpentinite).

c) Mineralisation: Relict grains of chromite up to 2.5 mm across are preserved in the serpentinite host (Fig. 56). Minor sulphides developed during hydrothermal alteration, typically associated with carbonate in veins and small irregular masses (Fig. 56). Largest sulphide aggregates are composed of pyrite (up to several millimetres long) in carbonate veins (Fig. 56), but in some of the small carbonate aggregates, there are included grains of fine grained pyrrhotite (as well as pyrite).

Mineral Mode (by volume): serpentine minerals (probably mostly lizardite) 85%, carbonate (e.g. ferroan magnesite) 10%, chlorite 2%, chromite, talc and pyrite each 1% and a trace of pyrrhotite.

Interpretation and comment: It is interpreted that the sample represents a serpentinite, derived from a peridotite (e.g. harzburgite) protolith, with effects of overprinting hydrothermal alteration and veining. The serpentinite retains a few relict chromite grains. Imposed alteration caused formation of irregular and veinlike masses of fine grained carbonate (e.g. ferroan magnesite) along with minor associated sulphides and talc. A few aggregates of chlorite developed elsewhere in the rock. Sulphides include fine grained pyrite and a trace of pyrrhotite, and they are most common in veins and small aggregates hosted in carbonate.

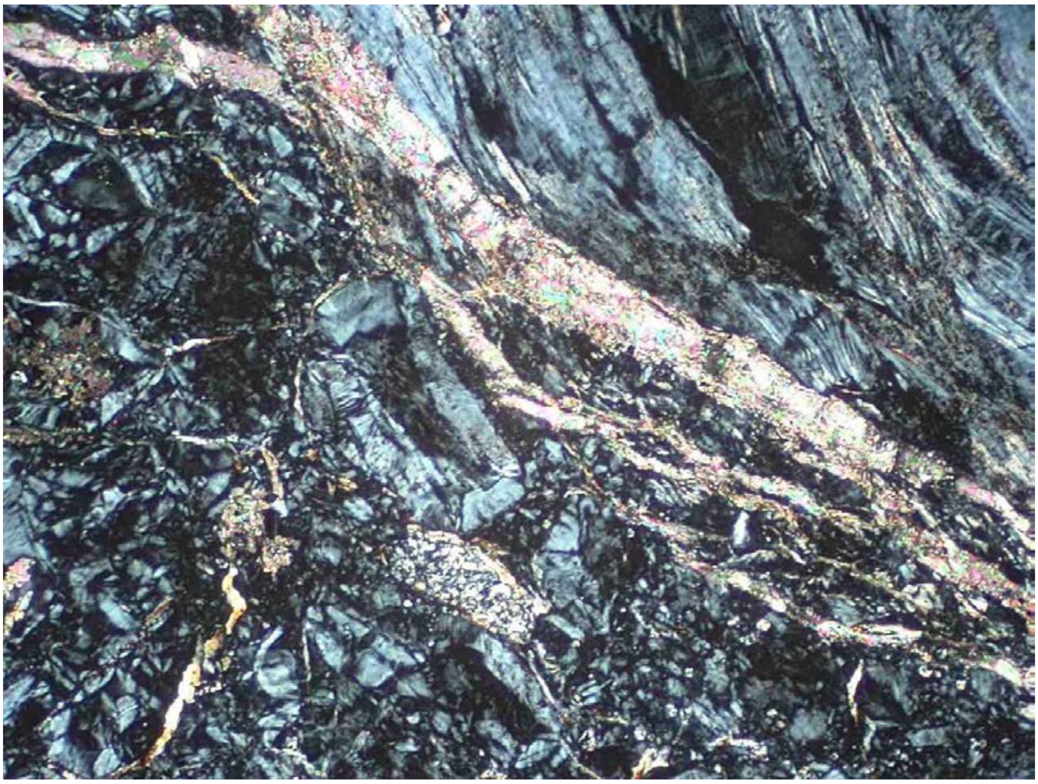


Fig. 55: Serpentinite showing mesh texture after former olivine (lower) and a bastite pseudomorph after orthopyroxene (upper right), and cut by a few thin carbonate veins. Transmitted light, crossed polarisers, field of view 2 mm across.

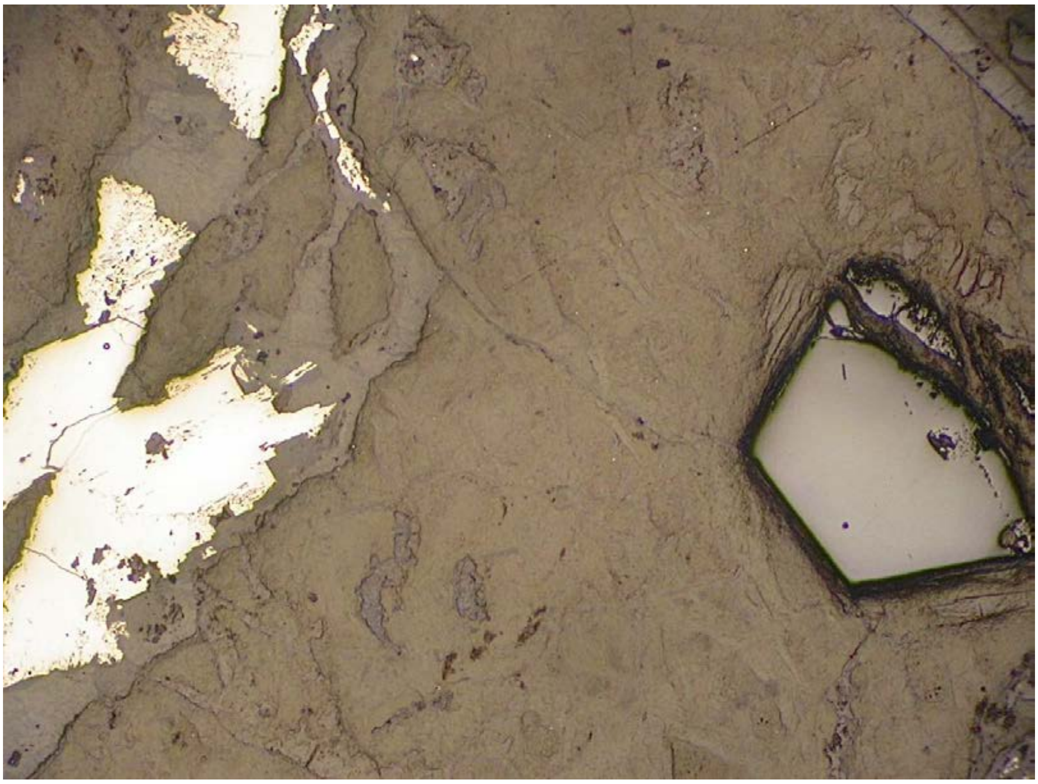


Fig. 56: Relict chromite grain (right) hosted in lizardite (smooth) that is cut at left by an irregular carbonate vein containing aggregates of pyrite (pale creamy). Plane polarised reflected light, field of view 2 mm across.

SMD009 78.7 m TS

Summary: Massive serpentinite, derived from a peridotite (harzburgite) protolith. Relict mesh texture after olivine, and bastite texture after orthopyroxene grains occur, and there are a few preserved primary chromite grains. The protolith was replaced by lizardite and a little magnetite (outlining mesh texture) and then cut by an array of thin serpentine (maybe chrysotile) veins and subsequently by serpentine + magnetite veining. A little disseminated and veinlet carbonate formed later.

Handspecimen: The drill core sample is composed of a massive, pale khaki-green serpentinite, with probable mesh texture after formerly abundant olivine, and with strong development of a network vein system containing fine grained serpentine minerals and magnetite. Most veins are dark grey, due to finely dispersed magnetite, but a few contain white serpentine (maybe chrysotile). A few black grains of chromite up to 1 mm across are evident. Due to the presence of magnetite, the sample is very strongly magnetic, with susceptibility up to 1110 x 10^{-4} SI.

Petrographic description

a) Primary rock characteristics: In the section, relict mesh texture after formerly abundant olivine is moderately preserved (Fig. 57). There are also a few relict grains of chromite up to 2.5 mm across (Fig. 57), as well as a few bastite pseudomorphs after former orthopyroxene grains. The relict characteristics suggest that the protolith peridotite was of harzburgite type.

b) Alteration and structure: The original ultramafic rock was completely serpentinised, although relict chromite is preserved (Fig. 57). Mesh texture serpentine, probably dominated by lizardite, was formed after original olivine, with the "mesh" outlined by narrow concentrations of fine grained magnetite (Fig. 57). An array of thin, sub-parallel and sub-planar serpentine veins (probably chrysotile) was emplaced and these are cut at moderate to high angles by veins up to 1 mm wide of serpentine + magnetite (Fig. 58). Subsequently, a little fine grained carbonate developed in the serpentinite, forming disseminated grains and aggregates up to 0.3 mm across (Fig. 58), as well as occurring in a few thin veins – perhaps overprinting earlier magnetite-bearing veins.

c) Mineralisation: The sample contains a few irregular relict grains of chromite up to 2.5 mm across (Fig. 57). Fine grained magnetite was formed during serpentinisation, commonly outlining mesh texture and occurring in many sub-planar to irregular veins, accompanying serpentine. Magnetite is fine grained and vein concentrations can attain 0.5 mm in width (Fig. 58). No sulphide minerals were observed in the sample.

Mineral Mode (by volume): serpentine minerals (lizardite >> chrysotile) 95%, magnetite 3%, carbonate and chromite each 1%.

Interpretation and comment: It is interpreted that the sample is a massive serpentinite. Relict mesh texture after olivine, and bastite texture after orthopyroxene grains occur, and there are a few preserved primary chromite grains. These characteristics indicate that the ultramafic protolith was of harzburgite type. The serpentinite is dominated by lizardite and a little magnetite (outlining mesh texture) and it was cut by an array of thin serpentine (maybe chrysotile) veins and subsequently by serpentine + magnetite veining. A little disseminated and veinlet carbonate formed later.

Fig. 57: Mesh texture serpentinite, with thin magnetite concentrations (black), and at right, portion of a relict chromite grain (dark brown-black). Plane polarised oblique reflected light, field of view 2 mm across.

Fig. 58: Thin serpentine veins (white), cutting serpentinite host rock, which at left is also cut by thin magnetite (black) + serpentine veins. At right are a couple of small aggregates of

carbonate (pale grey-brown) and the black grain is chromite. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD009 84.1 m TS

Summary: Porphyritic microdiorite with crowded phenocryst texture, probably intrusive into a former mafic to ultramafic composition igneous rock, and with both subsequently being overprinted by deformation and metamorphic recrystallization. The interpreted microdiorite had abundant plagioclase phenocrysts and subordinate ferromagnesian material. The mafic to ultramafic rock appears to have contained a few large plagioclase grains and it retains sparsely scattered small grains of FeCr spinel. The remainder of this rock type was presumably rich in ferromagnesian minerals. The imposition of metamorphism and deformation led to extensive recrystallization of the mafic-ultramafic rock, with replacement by weakly to moderately foliated fine through to coarse amphibole (tremolite-actinolite or magnesio-hornblende) and locally common interstitial fine grained talc. In the microdiorite, plagioclase was locally overgrown by amphibole, and there was also development of a little sericite and chlorite. Metamorphic conditions imposed on the protolith materials could have ranged from greenschist to (lower) amphibolite.

Handspecimen: The drill core sample is composed of two distinct rock types. A strongly porphyritic, mottled whitish to grey-green, medium to coarse grained intermediate igneous rock appears to have intruded a finer grained, darker grey-green, weakly foliated rock od amphibolitic appearance. The latter is rich in fine to medium grained amphibole and may have minor feldspar, perhaps representing a metamorphosed mafic igneous rock. The strongly porphyritic rock has altered feldspar phenocrysts up to a few millimetres across and a subordinate amount of interstitial ferromagnesian material. In the central part of this compositional domain, there is a zone of coarser grainsize (approaching pegmatoidal). Generally, the sample is non-magnetic, with susceptibility of <10 x 10^{-5} SI, but in part of the paler, porphyritic rock, it is weakly magnetic, with susceptibility up to 90 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, two different rock types are evident. There is a central zone~3 cm wide displaying medium to coarse grained, crowded porphyritic texture, with abundant blocky plagioclase grains up to 3.5 mm across (Fig. 59). These could have been intergrown with subordinate interstitial ferromagnesian material (maybe amphibole) and a little FeTi oxide (e.g. ilmenite). This rock type is deformed and overprinted by metamorphic effects, but preserved relict characteristics suggest that it represents a porphyritic microdiorite. The other rock type, occupying the remainder of the section and bordering the microdiorite, has been strongly recrystallised due to deformation and metamorphic effects, and relict texture is poorly preserved or completely destroyed. There are indications for it to have contained a few medium to coarse plagioclase grains and sparsely scattered small individual grains and aggregates up to 0.2 mm across of dark brown to opaque FeCr spinel. The metamorphic assemblage in this rock type is now dominated by amphibole, with locally common talc (Fig. 60) and together with the occurrence of relict plagioclase and FeCr spinel, could imply an ultimately ultramafic to mafic igneous protolith for the amphibolitic rock.

b) Alteration and structure: Both rock types in the sample have been affected by deformation and metamorphism. Plagioclase in both rock types is variably overgrown (minor to complete) by fine through to coarse grained, near-colourless to pale green prismatic-acicular and twinned amphibole (e.g. tremolite-actinolite or magnesio-hornblende), as well as being locally clouded by development of fine grained sericite (Figs 59, 60). In the interpreted microdiorite, original ferromagnesian material was replaced by fine to medium grained amphibole and local near-colourless chlorite, and original FeTi oxide was partly replaced by leucoxene. A weak foliation is developed in places in this rock type. In the amphibolitic rock original interpreted ferromagnesian material, as well as some of the original plagioclase, was replaced by abundant amphibole (up to 3.5 mm long) and commonly, development of abundant fine grained talc occurred interstitially (Fig. 60). A weak to moderate foliation is defined by preferred orientation of amphibole. The metamorphic mineral assemblage in the sample could imply development under greenschist to (lower) amphibolite facies conditions. Although the microdiorite appears to have intruded the now amphibolitic rock, both rock types have experienced the same metamorphic and deformation overprint.

c) Mineralisation: No sulphide minerals are observed. In the amphibolitic rock, there are small amounts of fine grained disseminated FeCr spinel (up to 0.2 mm) and in the microdiorite, there are a few elongate aggregates of FeTi oxide (e.g. ilmenite).

<u>Mineral Mode (by volume)</u>: amphibole (tremolite-actinolite/magnesio-hornblende) 50%, plagioclase 35%, talc 12%, chlorite and sericite each 1% and traces of FeTi oxide, leucoxene and FeCr spinel.

<u>Interpretation and comment</u>: It is interpreted that the sample contains two different rock types. A strongly porphyritic microdiorite has intruded into an amphibolitic rock (with formation of a xenolith of the latter in part of the sample), with both rock types showing effects of later imposed deformation and metamorphism. Porphyritic microdiorite has a crowded phenocryst texture, with abundant plagioclase phenocrysts and subordinate ferromagnesian material. The amphibolitic rock could have developed from a mafic to ultramafic protolith that contained a few large plagioclase grains, probably abundant ferromagnesian material and sparsely scattered small grains of FeCr spinel. The imposition of metamorphism and deformation led to extensive recrystallization of the mafic-ultramafic rock, with replacement by weakly to moderately foliated fine through to coarse amphibole (tremolite-actinolite or magnesio-hornblende) and locally common interstitial fine grained talc. In the microdiorite, plagioclase was locally overgrown by amphibole, and there was also development of a little sericite and chlorite. Metamorphic conditions imposed on the protolith materials could have ranged from greenschist to (lower) amphibolite.

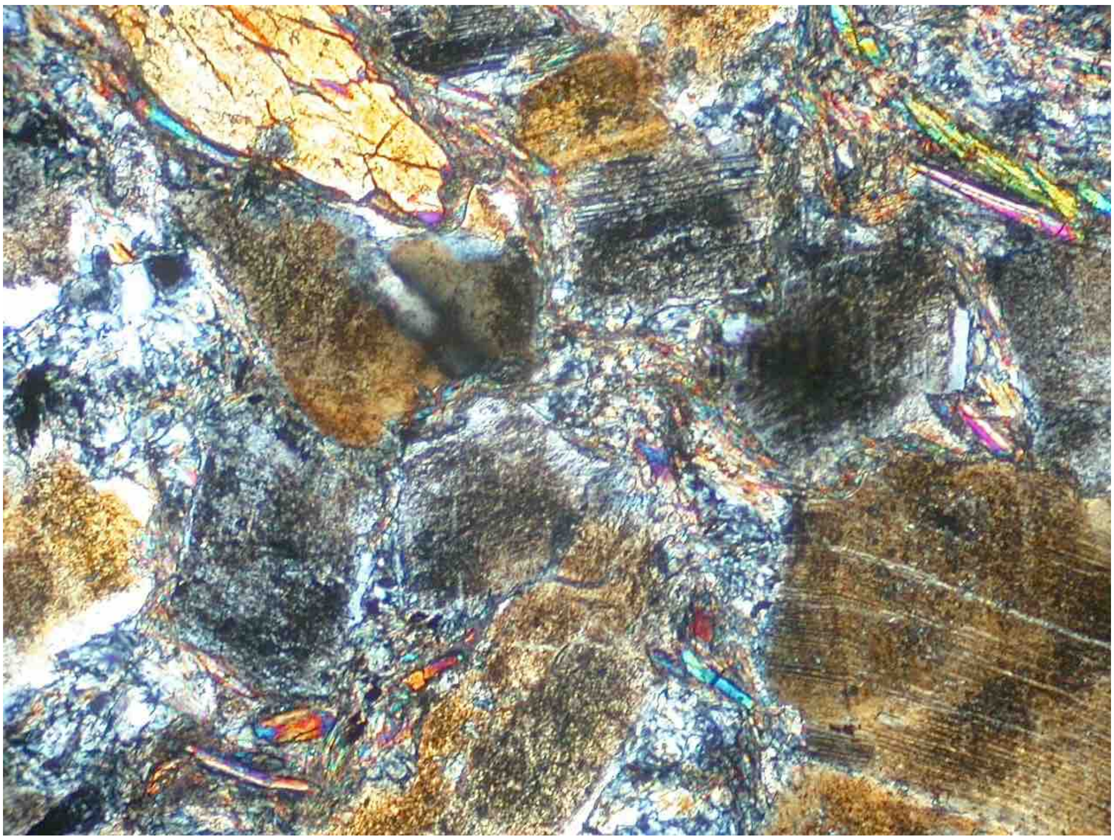


Fig. 59: Deformed and metamorphosed porphyritic microdiorite, showing clouded (turbid) plagioclase phenocrysts and a subordinate proportion of prismatic-acicular amphibole (upper left and upper right). Transmitted light, crossed polarisers, field of view 2 mm across.

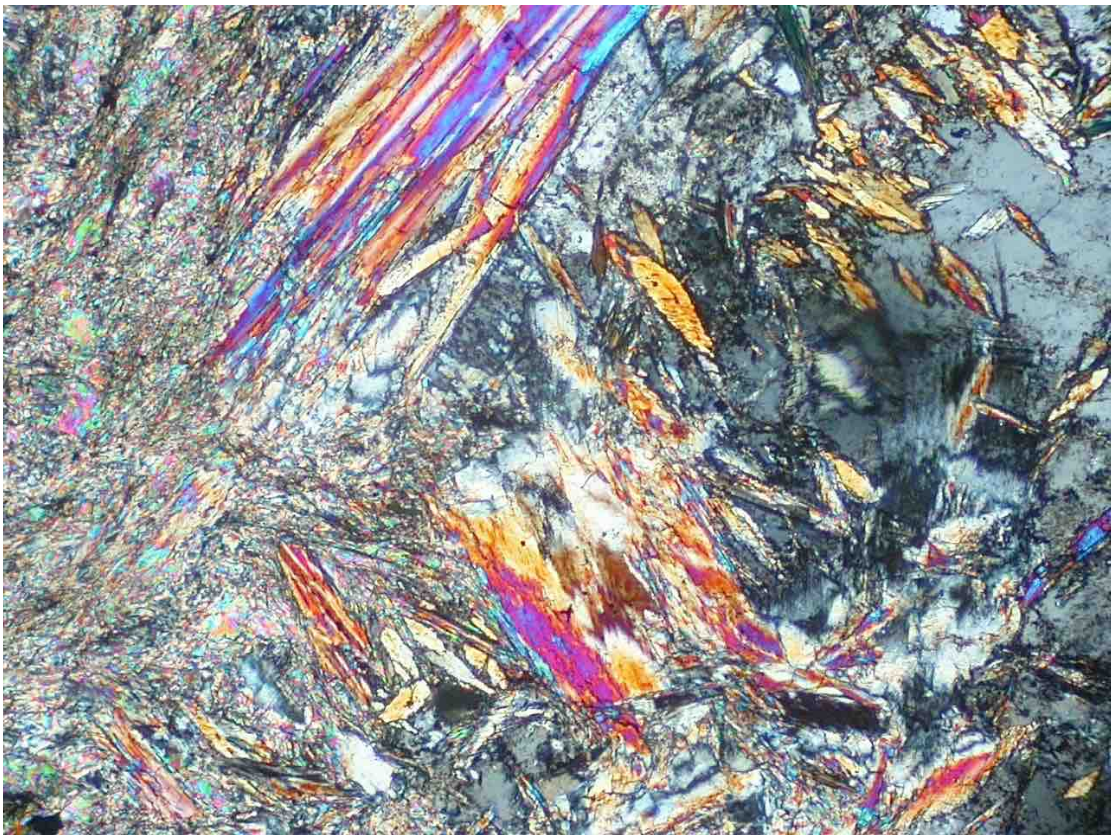


Fig. 60: Metamorphosed mafic to ultramafic rock showing development of abundant prismatic-acicular amphibole and at left, fine grained talc. At right, the grey mass is partly replaced relict plagioclase. Transmitted light, crossed polarisers, field of view 2 mm across.

SMD009 142.0 m TS

Summary: Metamorphosed and deformed coarse grained mafic to ultramafic igneous rock, perhaps ultimately of norite-gabbro to pyroxenitic composition. Although largely replaced, it is considered that the protolith was dominated by pyroxenes (e.g. orthopyroxene and clinopyroxene), plagioclase and possible amphibole, and there is retention of sparse grains of FeCr spinel. There was imposition of metamorphism at greenschist to lower amphibole facies conditions, as well as penetrative deformation. This led to replacement of primary ferromagnesian phases, as well as some primary plagioclase, with development of abundant fine through to coarse grained amphibole (tremolite-actinolite or magnesio-hornblende), with subordinate amounts of interstitial talc and minor phlogopite-biotite. The rock was later cut by irregular zones of micro-cataclasis, with development of microbreccia containing disaggregated host rock in a fine grained amphibole-rich matrix.

Handspecimen: The drill core sample is composed of a relatively massive, medium grained, inequigranular texture intermediate to mafic igneous rock, containing abundant grey-green ferromagnesian material (e.g. amphibole) and pale grey feldspar. The primary texture is blurred by overprinting partial recrystallization, e.g. due to alteration/metamorphism, and the rock is cut by a few diffuse pale grey-green veinlike aggregates up to 3 mm wide. The sample is very weakly magnetic, with susceptibility up to 40 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, it is evident that the sample represents a deformed and metamorphosed rock in which relict texture and mineralogy of a protolith has been strongly modified. There are indications, however, that the protolith was relatively coarse grained (up to several millimetres) and contained considerable plagioclase and abundant ferromagnesian material. None of the latter is preserved due to replacement, but it cold be inferred that primary ferromagnesian material would have included pyroxenes (orthopyroxene and clinopyroxene) and perhaps amphibole. A few small grains of a dark brown to opaque oxide phase (e.g. FeCr spinel) in grains up to 0.6 mm across are sparsely distributed. From the inferences on primary mineralogy and the fact that the metamorphic mineral assemblage is dominated by amphibole (e.g. tremolite-actinolite or magnesio-hornblende), with subordinate talc, it is suggested that the protoiith was of mafic to ultramafic type, e.g. maybe transitional between a norite-gabbro and pyroxenite. It is likely that this rock type was similar to the protolith of the amphibolitic rock in sample SMD009/84.1 m.

b) Alteration and structure: The interpreted original mafic to ultramafic igneous rock was subject to metamorphism and deformation. There was complete replacement of primary ferromagnesian constituents and part replacement of plagioclase, but abundant fine grained through to coarse grained, near colourless to very pale green amphibole (e.g. tremolite-actinolite or magnesio-hornblende), forming prismatic to acicular grains up to 3 mm long, with subordinate interstitial fine grained talc and minor orange-brown phlogopite-biotite (grains up to 1 mm across) (Figs 61, 62). In places, a weak to moderate foliation occurs, defined by preferred orientation of amphibole grains. The rock was subsequently cut by a few sub-planar to irregular masses of micro-breccia up to 3 mm wide. These have developed by cataclasis of the host rock, resulting in disaggregation and enclosure of small fragments in a fine grained, rather turbid matrix of amphibole (Fig. 62). In the sample, relict plagioclase shows slight retrograde replacement by sericite. The observed metamorphic mineral assemblage has probably former under conditions consistent with upper greenschist to lower amphibolite facies.

c) Mineralisation: No sulphide minerals are observed. There are a few grains of relict FeCr spinel up to 0.6 mm across that are preserved from the igneous protolith.

Mineral Mode (by volume): amphibole (tremolite-actinolite/magnesio-hornblende) 70%, plagioclase 20%, talc 8%, phlogopite-biotite 2% and traces of FeCr spinel and sericite.

Interpretation and comment: It is interpreted that the sample represents a former mafic to ultramafic igneous rock, most likely of norite-gabbro to pyroxenite type that has been subject to metamorphism and penetrative deformation. The protolith was probably dominated by pyroxenes (e.g. orthopyroxene and clinopyroxene), plagioclase and possible amphibole, and there is retention of sparse grains of FeCr spinel. Metamorphism took place under greenschist to lower amphibole facies conditions, leading to replacement of primary ferromagnesian phases, as well as some primary plagioclase, with development of a variably foliated mass of abundant amphibole (tremolite-actinolite or magnesio-hornblende), with subordinate amounts of interstitial talc and minor phlogopite-biotite. The rock was later cut by irregular zones of micro-cataclasis, with development of microbreccia containing disaggregated host rock in a fine grained amphibole-rich matrix.

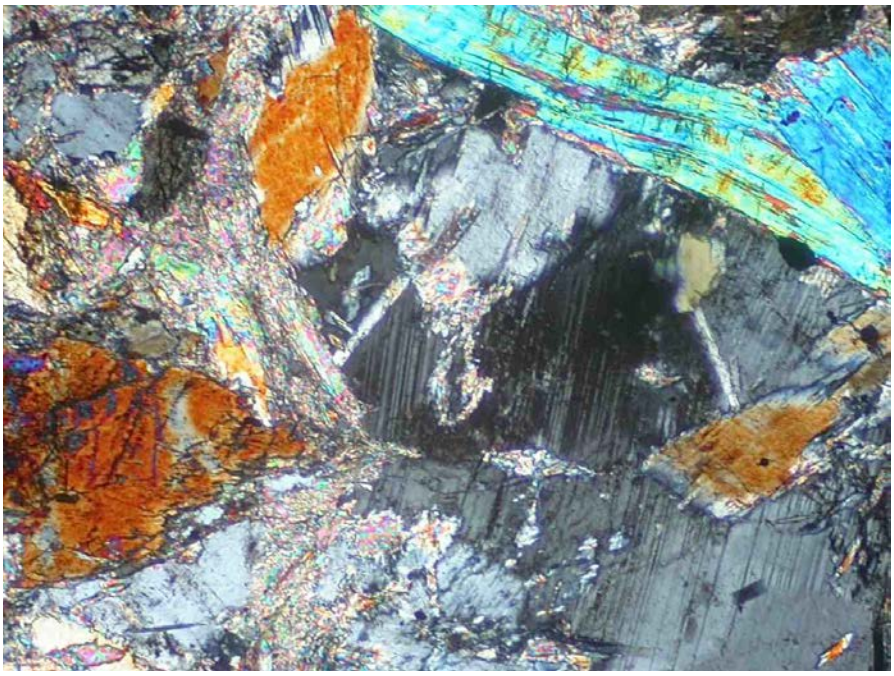


Fig. 61: Relict plagioclase (grey), with adjacent replacive masses of medium grained amphibole and a smaller amount of fine grained talc (paler colours). Transmitted light, crossed polarisers, field of view 2 mm across.

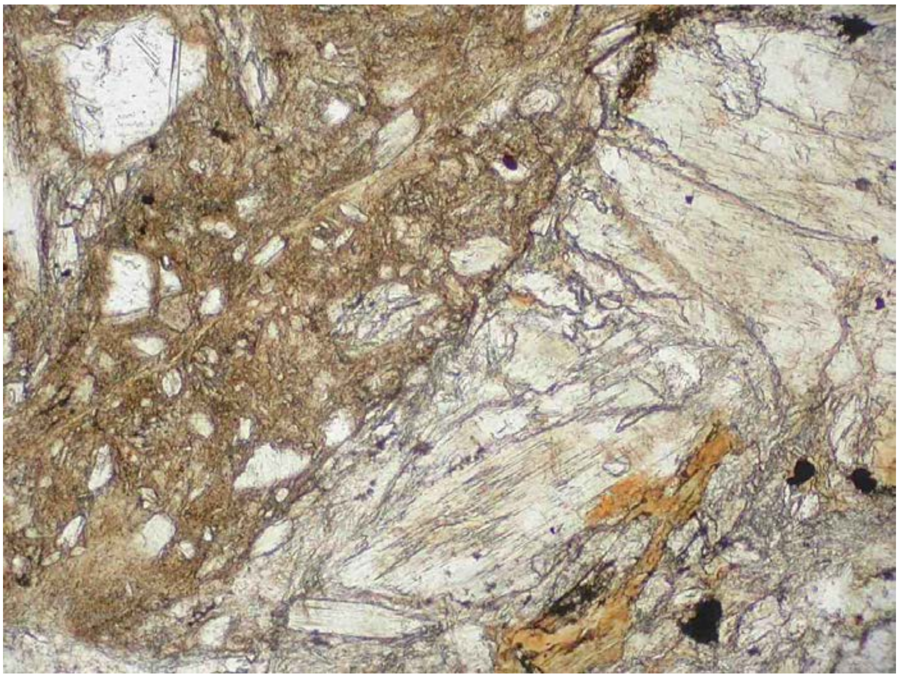


Fig. 62: Zone of microbreccia at left showing small fragments in a fine grained turbid pale brown amphibole-rich matrix. At right is the metamorphic host rock containing coarse amphibole and a little orange-brown phlogopite-biotite. Small black grains are FeCr spinel. Plane polarised transmitted light, field of view 2 mm across.

SMD009 157.5 m TS

Summary: Prehnite-tremolite rock, representing the product of intense calc-silicate alteration of a possible mafic to intermediate igneous composition protolith (e.g. gabbro, diorite). No relict texture is preserved from a protolith, which was replaced by intercalated domains rich in one or the other of amphibole and prehnite. Amphibole is typically near-colourless, but locally pale green, commonly of prismatic form and occurring in sub-radiating aggregates. Prehnite is commonly a little coarser grained and inequigranular to sub-radiating in form. A little titanite occurs irregularly throughout, and there are a couple of weakly foliated chlorite-rich aggregates. The alteration assemblage could have formed under greenschist facies metamorphic conditions and is typical of that found in metasomatic reaction zones associated with serpentinites.

Handspecimen: The drill core sample is composed of a diffusely mottled whitish to pale grey-green, fine to medium grained rock that is massive and noticeably dense. It also contains a few crudely aligned, fine grained dark grey-green chlorite-rich aggregates up to a few millimetres thick and oriented at ~20° to the core axis. Although the rock appears superficially to be of felsic type, it is more likely to be rich in calc-silicate minerals and in fact be an alteration product of a former coarse grained mafic to intermediate igneous rock (e.g. of gabbroic affinity). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, there is no diagnostic relict texture recognised from a protolith and the rock is the product of complete metasomatic replacement. There are a few tiny (<<0.1 mm) relict zircon grains, but they are not diagnostic as to protolith type. The replacement assemblage is dominated by intercalated aggregates rich in amphibole (mostly tremolite) and prehnite, with a little disseminated titanite and a couple of small chlorite-rich aggregates. This calc-silicate-dominated assemblage is considered to be the product of alteration of a former plagioclase-rich igneous protolith of mafic to intermediate type, e.g. gabbro to diorite.

b) Alteration and structure: An interpreted igneous protolith was subject to strong calc-silicate alteration, of the type commonly associated with ophiolitic serpentinite belts, i.e. with analogies to rodingites and related metasomatic reaction zones. The protolith was replaced by intercalated domains up to 1-2 cm across rich in one or the other of fine to medium grained, generally near-colourless prismatic amphibole (mostly tremolite) and fine through to coarse grained prehnite (Fig. 63). Amphibole forms sub-radiating to inequigranular aggregates (Fig. 63), with maximum grainsize up to 2 mm. In a small part of the sample, amphibole has a pale green colour and could be tremolite-actinolite in composition. Prehnite is typically inequigranular and locally sub-radiating, with grainsize up to 3 mm. A little fine grained titanite is irregularly distributed, mostly associated with amphibole-rich domains. There are a couple of chlorite-rich aggregates up to 3.5 mm long, with these being weakly foliated and containing a little included titanite and clinozoisite. Adjacent to these aggregates, amphibole-rich domains are also weakly foliated, but elsewhere in the sample, no significant preferred orientation of amphibole or prehnite occurs. Assuming a mafic to intermediate igneous composition protolith, it can be inferred that there has probably been significant influx of Ca, and possible loss of Na and Fe. The mineral assemblage is also consistent with development under greenschist facies metamorphic conditions. A couple of discontinuous, thin (<0.1 mm) fine grained quartz veins cut the rock.

c) Mineralisation: No sulphide minerals are observed in the sample.

Mineral Mode (by volume): prehnite 50%, amphibole (mostly tremolite) 48%, titanite and chlorite each 1% and traces of clinozoisite, quartz and zircon.

Interpretation and comment: It is interpreted that the sample is a prehnite-tremolite rock. It is interpreted to have formed by intense calc-silicate alteration of a possible mafic to intermediate igneous composition protolith (e.g. gabbro, diorite). The rock has intercalated domains rich in one or the other of amphibole and prehnite. Amphibole is typically near-colourless, but locally pale green, commonly of prismatic form and occurring in sub-radiating aggregates. Prehnite is commonly a little coarser grained and inequigranular to sub-radiating in form. A little titanite occurs irregularly throughout, and there are a couple of weakly foliated chlorite-rich aggregates. The alteration assemblage could have formed under greenschist facies metamorphic conditions and is typical of that found in metasomatic reaction zones associated with serpentinites.

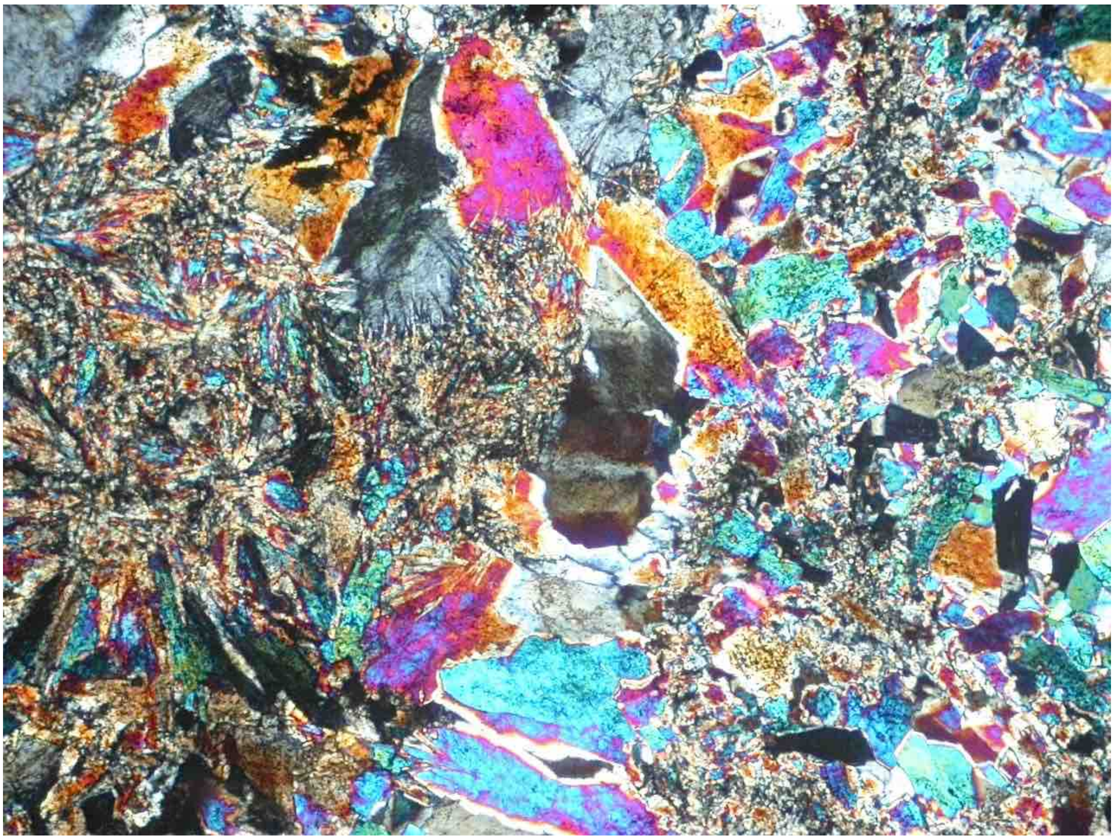


Fig. 63: Sub-radiating aggregate of tremolite at left, abutting a fine to medium grained, inequigranular aggregate of prehnite (centre-right). Transmitted light, crossed polarisers, field of view 2 mm across.