PETROGRAPHIC REPORT ON TWELVE DRILL CORE SAMPLES FROM THE AILERON PROSPECT, WA

For

Encounter Resources Limited

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Introduction

A suite of twelve (12) drill core samples from the Aileron prospect area, Northern Territory, was submitted for petrographic section preparation, description and interpretation. The samples, labelled in a discontinuous series between EALP001 and EALP026, were all relatively fresh with only a little indication of supergene alteration. They were taken from drill holes EAL002 (7 samples) and EAL005 (5 samples) at downhole depths between 79.75 m and 214.6 m. Field logging identifications were provided for each sample, which were stated to include rather felsic granitoid and possible syenitic igneous rocks, as well as apparent intermediate, mafic and ultramafic igneous rocks (including lamprophyric types) and possible carbonatite, with some having evident imposed deformation and alteration effects.

Petrographic preparation was performed by Geochempet Services in Brisbane, with standard thin sections (TS) being prepared from eleven samples, and a polished thin section (PTS) from the remaining sample. Subsequently, the TS were examined microscopically in transmitted and oblique reflected light, and the PTS in transmitted and reflected light. All samples were measured for magnetic susceptibility and many sample offcuts were tested with dilute HCl to check carbonate speciation. Representative photomicrographs of textural and mineralogical characteristics were taken from each sample.

The purpose of the petrographic work was to identify the primary rock types and nature of imposed processes (e.g. deformation, hydrothermal influx).

Summary descriptions of the samples are listed following:

EALP001 TS

Summary: Medium to coarse grained hornblende norite-gabbro, with an overprint due to metamorphic recrystallisation and subsequent local fracture-controlled veining and associated retrogression. The rock is composed of abundant inequigranular plagioclase, interlocking with clinopyroxene (e.g. diopside), brown-green hornblende, orthopyroxene and minor magnetite. There is a tendency for mineralogical banding to occur, with diffuse concentrations of clinopyroxene ± magnetite, or hornblende. There are traces of interstitial biotite, quartz and pyrrhotite. Imposed metamorphism, perhaps at least to medium grade, has led to development of a polygonised texture. Later minor veining is carbonate-rich, with a little tremolite, talc and pyrrhotite, and with adjacent rock showing local replacements by tremolite, carbonate, sericite, talc and magnetite.

EALP005 TS

Summary: Garnet-bearing coarse grained granitic or gneissic rock, cut by a lamprophyre vein and with both rock types having subsequent strong alteration. The granitic/gneissic rock was composed of abundant quartz and plagioclase, with subordinate biotite (locally defining a weak gneissosity), minor K-feldspar, garnet (porphyroblastic almandine) and a little FeTi oxide (ilmenite) and apatite. There is a sharp, sub-planar contact against an apparent lamprophyric rock that might have initially contained phenocrysts of a ferromagnesian phase (speculatively clinopyroxene) in a biotite-rich groundmass that

also contains a few small chromite grains. The original phenocrystal phase was replaced by a fine to medium grained, very pale bluish amphibole (e.g. glaucophane-crossite), with biotite being degraded to chlorite and a little carbonate. In the granitic/gneissic rock, there is apparent initial patchy alteration of feldspars by a fine to medium pale green amphibole (e.g. tremolite), followed by an overprinting effect of fenite-like alteration, whereby feldspars, biotite and pale green amphibole are locally replaced and veined by fine grained aggregates of a blue amphibole (e.g. crossite), with a little associated ilmenite. Further retrograde alteration was imposed, with extensive replacement of plagioclase by sericite ± carbonate, pale green and very pale blue amphibole by carbonate, and garnet by chlorite. A trace of pyrite is also observed as part of the retrograde alteration.

EALP006 TS

Summary: Porphyritic mafic to ultramafic igneous rock, possibly transitional in composition between a lamprophyre and carbonatite. Originally, it contained scattered olivine phenocrysts, enclosed in a fine to medium grained groundmass of abundant carbonate (calcite), biotite and less common clinopyroxene and granular magnetite, with a few grains of chromite. Textures imply that at least some of the carbonate represents a primary igneous phase as it is intergrown in apparent equilibrium with biotite. Interpreted olivine phenocrysts were altered to biotite (and associated imposed retrograde chlorite and a little magnetite), commonly enclosed by rims of fine grained tremolite ± carbonate ± chlorite ± magnetite. Elsewhere in the rock, there is minor development of tremolite and chlorite, typically intergrown with carbonate.

EALP008 PTS

Summary: Medium grained microsyenite, initially dominated by slightly hematite-pigmented K-feldspar, with overprinting effects of pervasive fracturing and local zones of micro-cataclasis, and associated strong alteration to fine to medium grained carbonate (calcite), subordinate chlorite and a little pyrite. There are some calcite-rich patches that might represent veins, and one of the micro-cataclastic zones hosts a sub-planar vein of calcite and chlorite. The few pyrite aggregates present are fractured and associated with a trace of chalcopyrite. There is no evidence in the sample for the occurrence of any mafic (lamprophyric) or carbonatitic rock.

EALP009 TS

Summary: Medium to coarse grained hornblende gabbro, with partial recrystallisation (polygonization) due to imposed metamorphism, and with later mild to moderate retrograde alteration. The original rock contained abundant brown hornblende and plagioclase, with minor clinopyroxene and a little possible orthopyroxene. Imposed metamorphism led to grain boundary equilibration and could have occurred at medium grade. Subsequently, there was interpreted initial replacement of orthopyroxene by biotite, followed by patchy retrograde alteration and minor veining, perhaps occurring under lower greenschist facies metamorphic conditions. This process led to variable replacement of plagioclase by sericite and carbonate, replacement of most biotite by chlorite, and development of a little bluish amphibole (maybe actinolite-riebeckite type), chlorite and carbonate from clinopyroxene, and emplacement of a few veins containing carbonate, chlorite and trace quartz. The alteration assemblage also contains a trace of pyrite.

EALP010 TS

Summary: Lamprophyre, perhaps of minette type, with pervasive strong alteration and considerable carbonate (calcite) veining. The rock originally contained scattered phenocrysts of clinopyroxene, enclosed in a fine to medium grained groundmass of K-feldspar, biotite, clinopyroxene and minor disseminated magnetite. It is possible that minor carbonate also occurred, e.g. interleaved with biotite. There is no evidence for the occurrence of carbonatite in the sample. Imposed alteration led to complete replacement of clinopyroxene phenocrysts by fine grained tremolite, carbonate, chlorite and magnetite. Alteration in the groundmass formed a turbid, fine grained aggregate of tremolite, chlorite, carbonate

and a little magnetite and pyrite. Veins contain medium to coarse grained calcite, with minor chlorite and trace pyrite.

EALP011 TS

Summary: Medium grained biotite tonalite, with slight overprinting granulation of primary texture and subsequent mild retrograde alteration and veining. The igneous rock was composed of abundant inequigranular plagioclase, with relatively minor interstitial quartz and biotite, a little FeTi oxide (ilmenite) and trace apatite and zircon. Imposed alteration could have developed albite and minor sericite from plagioclase, and chlorite from biotite. A few thin early veins of quartz and albite were emplaced, followed by a few discontinuous veins of carbonate and minor chlorite.

EALP019 TS

Summary: Recrystallised, slightly porphyritic microdiorite. The rock formerly contained a few phenocrysts of plagioclase enclosed in a fine to medium grained mass of ferromagnesian material (could have included biotite and minor pyroxene and/or amphibole) and plagioclase, with minor quartz and FeTi oxide (ilmenite). Recrystallisation was such that relict texture is only poorly to moderately preserved and the rock was largely reconstituted into an assemblage of plagioclase (probably largely albitic), biotite and carbonate (calcite), with minor epidote-clinozoisite, quartz and chlorite, and cut by a few thin, sub-planar veins of calcite and minor chlorite. The rock could have had hydrothermal CO_2 influx as well as metamorphism to biotite grade.

EALP021 TS

Summary: Deformed and partly recrystallised micromonzogranite. The original rock was composed of abundant interlocking sodic plagioclase, K-feldspar and quartz, probably with minor disseminated biotite and trace ilmenite. The imposed deformation led to partial polygonization of the original minerals and development of a weak foliation, defined by alignment of former biotite grains. There was considerable associated development of finely granular feldspar-quartz recrystallised masses, in places accompanied by sericite aggregates, and formation of elongate to veinlike masses of chlorite ± sericite from former biotite. A little carbonate and trace pyrite are dispersed, and the rock is cut by a few discontinuous veins of carbonate, with local minor quartz.

EALP023 TS

Summary: The sample exhibits a sharp, sub-planar contact between two compositionally different protoliths, both of which have strong alteration of Na-Ca-K type, possibly of fenite affinity. One primary lithology was of a medium grained granitic type containing abundant feldspars and lesser amounts of quartz and possible biotite. The other lithology (possibly intrusive into the granitic rock) might have been of lamprophyric type, perhaps initially containing biotite and maybe phenocrysts of minerals whose identity is obscured by complete replacement. The interpreted lamprophyre was replaced by abundant biotite, pale blue amphibole (maybe a Na-Ca type, but with significant glaucophane component), carbonate (calcite), minor ilmenite and titanite. The granitic rock, although retaining some quartz, was replaced by abundant albite, with small amounts of blue amphibole (e.g. riebeckite-glaucophane), aegirine, stilpnomelane, titanite, sericite, carbonate and trace pyrite.

EALP025 TS

Summary: The sample exhibits two types of ultramafic lamprophyre showing a rather sharp, sub-planar contact. One is dark and the other paler in handspecimen. The darker rock is dominated by fine to medium grained, inequigranular brown hornblende, with minor interstitial carbonate (dolomite) and a little biotite. The other contains medium to coarse grained green-brown hornblende and biotite, with interleaved carbonate (dolomite) in biotite, as well as interstitial carbonate, and a little magnetite, tending to be associated with hornblende. No primary feldspar was recognised in the sample. It is possible that at least some carbonate represents an igneous phase (e.g. that interleaved with biotite),

but some is hydrothermal, where it is associated with minor disseminated pyrite, and also occurring in several veins, mostly in the darker rock. A little gypsum and traces of quartz and sericite are associated with the carbonate veining.

EALP026 TS

Summary: Original possible micromonzogranite, with adjacent fenite zone bordering on to a carbonate-rich rock. The latter could be a carbonatite and contains medium grained, inequigranular calcite, with minor blue amphibole, albite, microcline and a trace of biotite. The possible fenite zone is composed of varying proportions of albite, microcline and blue amphibole, with minor aegirine and ?xenotime. It abuts the partially reconstituted micromonzogranite that is dominated by sodic plagioclase (albite) and lesser amounts of microcline and quartz. Apparent retrograde alteration is observed in each of the compositional zones, with minor patchy sericite-muscovite, carbonate, stilpnomelane and trace blue amphibole and pyrite in the micromonzogranite, local replacement of ?xenotime by carbonate and blue amphibole in the possible fenite zone, and local replacement of feldspars by chlorite and carbonate in the carbonate-rich rock. Minor disseminated pyrite occurs in the fenite zone and the carbonate-rich rock, and the micromonzogranite is cut by a couple of thin carbonate veins.

Interpretation and comment

Primary rock types

The sample suite consists of a diverse group of mainly igneous rocks (although some could have been metamorphosed and re-textured), ranging from felsic to ultramafic in composition, and with a variety of apparent alteration types. Relationships between the different composition rocks are commonly obscure, but there are probable local intrusive contacts, with apparently associated unusual alteration of fenite type, i.e. metasomatic replacement by assemblages rich in alkalis ± Ca and Fe.

There is a group of samples that contain rocks that are tentatively considered to be "older/paragenetically earlier" and another group that could be "younger" and maybe intrusive. The "older" rocks have indications of at least local metamorphic recrystallisation, and in some, imposed deformation. These rocks include EALP001 (partly recrystallised hornblende norite-gabbro), portion of EALP005 (garnet-bearing quartzofeldspathic gneissic or granitic rock), EALP008 (microsyenite), EALP009 (hornblende gabbro), EALP011 (biotite tonalite), EALP019 (microdiorite), EALP021 (micromonzogranite), portion of EALP023 (possible micromonzogranite) and portion of EALP026 (micromonzogranite). The other group of potentially "younger" intrusive rocks include lamprophyric (mafic to ultramafic) and carbonatitic types (portions of EALP005, EALP023 and EALP026, and samples EALP006, EALP010 and EALP025).

In the "older" group of rocks, there are those that are intermediate to mafic in composition, and which are medium to coarse grained, containing phases including plagioclase, clinopyroxene and hornblende, and in some, small amounts of orthopyroxene (e.g. EALP001), magnetite, biotite, ilmenite and quartz. There are also

more felsic igneous composition rocks that are dominated by plagioclase and/or K-feldspar (both can be hematite-pigmented and pinkish in handspecimen), as well as quartz, and locally with biotite and a little ilmenite. Sample EALP005 could be gneissic in character and contains minor, rather coarse porphyroblastic garnet (almandine). In some of the "older" rocks, there is textural indication of imposed metamorphic polygonization (e.g. in EALP001, EALP009, EALP019) and deformation (fracturing, micro-cataclasis, foliation development, grain boundary recrystallisation; e.g. in EALP005, EALP008, EALP021).

The "younger" group of rocks have some preservation of primary textural and mineralogical characteristics, but with varying degrees of overprinting by alteration. From the primary characteristics, it is interpreted that there is a range of compositions from a mafic type of lamprophyre, through ultramafic, to transitional to carbonatite, and to carbonatite. A possible minette-type lamprophyre occurs in EALP010, formerly containing clinopyroxene phenocrysts in a fine to medium grained groundmass of biotite, K-feldspar, clinopyroxene and magnetite. A more altered version of the same rock type might have occurred in EALP023, in contact with a medium grained granitic rock. In EALP005 and EALP006, possible mafic to ultramafic composition lamprophyres are recognised, possibly having contained phenocrystal grains of clinopyroxene and maybe olivine, with groundmass biotite, clinopyroxene, magnetite, calcite and a few small grains of chromite (attesting to an original mantle origin). Relatively abundant possibly primary (magmatic) calcite in EALP006 could infer a transitional composition between lamprophyre and carbonatite. In EALP025, there are apparently two different types of ultramafic lamprophyre, with a relatively sharp contact in-between. One type is essentially hornblende-rich, with minor dolomite and a little biotite, and the other, possibly transitional to a dolomitic carbonatite, contains hornblende, biotite, dolomite and minor magnetite. In sample EALP026, a reaction zone (see below) separates a largely reconstituted granitic rock (micromonzogranite) from an interpreted calcite-rich carbonatite (sövite) that also contains smaller amounts of blue amphibole, K-feldspar and albite.

Alteration

Samples in the suite are interpreted to display two major types of alteration (with minor associated veining). One type is associated with the lamprophyre-carbonatite group, and the other is of pervasive retrograde character, affecting most samples.

Alteration associated with the lamprophyre-carbonatite group can affect the interpreted intrusives as well as the (generally felsic composition) host rocks via marginal reaction zones. In the lamprophyres in EALP023 and EALP006, considerable biotite has developed, perhaps by replacement of earlier phenocrystal clinopyroxene and/or olivine. Biotite (plus albite) alteration is also observed in microdiorite sample EALP019, and there is biotite replacement of interpreted orthopyroxene in gabbro

EALP009, even though lamprophyre is not observed in either of these two samples. Blue amphiboles occur in several samples, including in interpreted intrusives (e.g. EALP005, EALP026) and as part of the alteration of the "older" host rocks rocks (e.g. in EALP005, EALP009, EALP023, EALP026). In the intrusives, blue amphiboles (fine through to medium grained) occur with biotite and/or carbonate, and in EALP005, might have replaced former ferromagnesian phenocrysts. Blue amphiboles are observed in the host rocks in association with albite, microcline, calcite, aegirine and tremolite, as part of replacement assemblages. There is a wide range of colour (and pleochroism) in these amphiboles, from very pale to dark blue, and to greenish, suggesting a wide range of composition, e.g. glaucophane to riebeckite (including the intermediate form, crossite), and maybe arfvedsonite and NaCa amphibole types. In samples EALP005 and EALP026, blue amphiboles are locally concentrated into veinlike and banded aggregates. Strong development of albite ± microcline has occurred in several samples of originally dioritic to granitic composition (EALP019, EALP021, EALP023, EALP026) and together with the occurrence of blue amphiboles and local calcite and aegirine, the resulting assemblages in these rocks are consistent with fenitisation and have involved significant metasomatic transfer of alkalies, Ca and Fe.

Some of the fenite alteration minerals were further affected by retrograde alteration, e.g. development of carbonate and sericite-muscovite from albite, a little stilpnomelane from aegirine, together with local development of chlorite and pyrite. Veining by carbonates (dolomite in EALP025, calcite in EALP026) has also occurred in intrusives and host granitic rocks.

Minor to more extensive retrograde alteration occurs in several of the other rocks that are not (obviously) associated with the lamprophyre-carbonatite group. In the norite-gabbro sample EALP001, minor vein-related alteration has formed a little tremolite, carbonate, sericite, talc and magnetite from primary igneous minerals. Other samples with initial granitic, diorite or gabbro compositions have typically formed minor sericite, chlorite, carbonate and a little pyrite, together with emplacement of a few small carbonate veins. Retrograde alteration in these rocks and overprinting the fenite development probably occurred under low grade (e.g. chlorite grade) metamorphic conditions with minor flux of CO_2 and S.

Mineralisation

A few samples in the suite contain minor magnetite (up to 5 %), with this being both as an interpreted primary igneous mineral (e.g. in norite-gabbro EALP001, and in some lamprophyres) as well as a product of alteration of primary ferromagnesian silicates (e.g. in EALP006, EALP010). Small grains of relict igneous chromite occur in the lamprophyric rocks in EALP005 and EALP006.

Small amounts of pyrite occur in several samples, apparently mostly as part of the retrograde alteration. Pyrite amounts range from a trace up to an estimated 3% (in microsyenite EALP008). A trace of pyrrhotite (perhaps initially deposited as a magmatic phase) is observed in EALP001, and there is a trace of chalcopyrite associated with pyrite aggregates in EALP008. Sample EALP026 contains up to an estimated 1% of a disseminated "unknown" phase in fenite-altered rock. This mineral is tentatively identified as xenotime, but other possibilities are evident. For example, if sample material contains high REE values, it is recommended that this phase be subject to better characterisation, e.g. by electron microprobe analysis.

Comments

The sample suite appears to contain possible intrusive rocks of lamprophyre to carbonatite character, albeit with some overprinting by biotite-rich, fenite and retrograde alteration. Lamprophyres are of mafic to ultramafic type and there could be a transition to carbonatite. A diverse range of possible older host rocks occur, ranging from granitic to gabbroic in character. Although primary igneous features are commonly preserved, some samples have considerable overprinting by fenitisation and later retrograde alteration. Fenitisation (and associated biotite alteration) appears to have involved significant metasomatic transfer of alkalis, Ca and Fe. There is only a small amount of sulphide mineralisation observed (pyrite formed during the retrograde alteration stage). The lamprophyre and carbonatite association could have potential for REE mineralisation, so if geochemical analyses of the rocks (including fenite altered host rocks) demonstrate strongly elevated values of REE, it is recommended that detailed assessment by QEMSCAN and electron microprobe analysis be performed.

Detailed sample descriptions

EALP001 TS

Summary: Medium to coarse grained hornblende norite-gabbro, with an overprint due to metamorphic recrystallisation and subsequent local fracture-controlled veining and associated retrogression. The rock is composed of abundant inequigranular plagioclase, interlocking with clinopyroxene (e.g. diopside), brown-green hornblende, orthopyroxene and minor magnetite. There is a tendency for mineralogical banding to occur, with diffuse concentrations of clinopyroxene ± magnetite, or hornblende. There are traces of interstitial biotite, quartz and pyrrhotite. Imposed metamorphism, perhaps at least to medium grade, has led to development of a polygonised texture. Later minor veining is carbonate-rich, with a little tremolite, talc and pyrrhotite, and with adjacent rock showing local replacements by tremolite, carbonate, sericite, talc and magnetite.

Handspecimen: The drill core sample is composed of a massive to incipiently layered, medium to coarse grained mafic igneous rock. It is dark grey to grey-green and evidently contains abundant feldspar (e.g. plagioclase) and ferromagnesian material, e.g. hornblende and pyroxene. Possible diffuse layering on a centimetre scale occurs, with local concentration of pyroxene + minor black magnetite, and with layering at a high angle to the core axis. The rock appears to be largely fresh, but a single thin carbonate vein is observed at a low angle to the core axis. The sample is strongly magnetic, with susceptibility up to 5950 x 10^{-5} SI, due to the presence of magnetite.

Petrographic description

a) Primary rock characteristics: In the section, much of the rock is fresh, with it having a medium to coarse grained, inequigranular texture and a slight tendency for the occurrence of mineralogical layering (Figs 1, 2). It contains abundant plagioclase in grains up to 1.5 mm across, intergrown with characteristic polygonization texture with pale green clinopyroxene (e.g. diopside, in grains up to 2.5 mm), brown-green hornblende (up to 2 mm) and minor magnetite (individual grains up to 0.5 mm and elongate aggregates up to 2 mm) (Figs 1, 2). There are rare small interstitial grains of quartz, biotite and pyrrhotite. Local concentrations of hornblende, and of clinopyroxene ± magnetite occur, forming diffuse bands up to several millimetres thick (Fig. 2). It could be interpreted that the rock formerly had a cumulate texture (although magnetite can locally be intercumulus), but modified by the imposition of metamorphic polygonization. The mineralogy of the rock is consistent with it representing a hornblende norite-gabbro.

b) Alteration and structure: It is interpreted that the initial mafic igneous rock experienced metamorphism, perhaps at least at moderate grade, leading to development of a partly polygonised texture (Figs 1, 2). Much of the assemblage has little or no alteration of the primary minerals, but the rock is cut by a few narrow, sub-planar fractures, along which there was emplacement of narrow veins (up to 0.3 mm wide) containing carbonate and traces of near-colourless tremolite, talc and pyrrhotite. About the veins, there are narrow alteration selvedges in which the primary silicates have local retrograde replacement by fine grained tremolite (from clinopyroxene), talc + magnetite (from orthopyroxene) and sericite (from plagioclase). These minerals and the veining could reflect the imposition of local effects of low grade metamorphism. Locally, there are traces of a fine grained khaki-coloured smectite phase (e.g. nontronite) that might be due to effects of deep supergene alteration.

c) Mineralisation: The igneous rock contains minor disseminated magnetite, locally occurring in more concentrated form in bands associated with clinopyroxene (Fig. 2). Individual magnetite grains are up to 0.5 mm across. There is also a trace of associated pyrrhotite, and this phase is also observed in one of the retrograde carbonate veins.

Mineral Mode (by volume): plagioclase 50%, clinopyroxene 20%, hornblende 15%, orthopyroxene 6%, magnetite 4%, carbonate 2%, tremolite and talc each 1% and traces of quartz, biotite, pyrrhotite, sericite and smectite.

Interpretation and comment: It is interpreted that the sample represents a hornblende norite-gabbro, perhaps overprinted by effects of metamorphic recrystallisation and subsequent local fracture-controlled veining and associated retrogression. The rock contains abundant inequigranular plagioclase, interlocking with clinopyroxene (e.g. diopside), brown-green hornblende, orthopyroxene and minor magnetite. There is a tendency for mineralogical banding to occur, with diffuse concentrations of clinopyroxene ± magnetite, or hornblende. There are traces of interstitial biotite, quartz and pyrrhotite. Imposed metamorphism, perhaps at least to medium grade, caused development of a polygonised texture. Later minor veining is carbonate-rich, with a little tremolite, talc and pyrrhotite, and with adjacent rock showing local replacements by tremolite, carbonate, sericite, talc and magnetite.

Fig. 1: Characteristic partly polygonised texture in norite-gabbro, containing plagioclase (clear), orthopyroxene (pale brown, upper), clinopyroxene (pale green), hornblende (dark brown) and magnetite (black, near centre). Plane polarised transmitted light

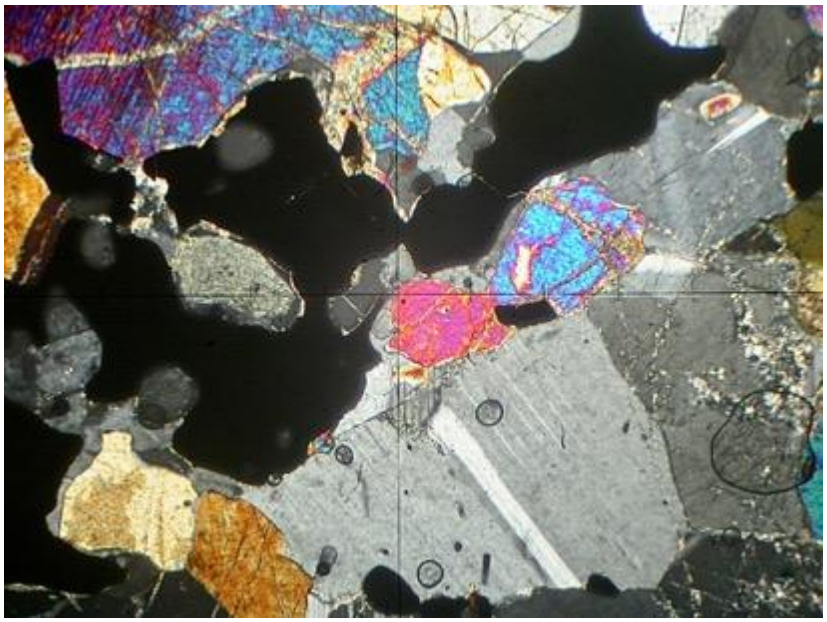


Fig. 2: Portion of a band rich in clinopyroxene (bright colours) and magnetite (black) adjacent to plagioclase (lower right). Transmitted light, crossed polarisers, field of view 2 mm across

EALP005 TS

Summary: Garnet-bearing coarse grained granitic or gneissic rock, cut by a lamprophyre vein and with both rock types having subsequent strong alteration. The granitic/gneissic rock was composed of abundant quartz and plagioclase, with subordinate biotite (locally defining a weak gneissosity), minor K-feldspar, garnet (porphyroblastic almandine) and a little FeTi oxide (ilmenite) and apatite. There is a sharp, sub-planar contact against an apparent lamprophyric rock that might have initially contained phenocrysts of a ferromagnesian phase (speculatively clinopyroxene) in a biotite-rich groundmass that also contains a few small chromite grains. The original phenocrystal phase was replaced by a fine to medium grained, very pale bluish amphibole (e.g. glaucophane-crossite), with biotite being degraded to chlorite and a little carbonate. In the granitic/gneissic rock, there is apparent initial patchy alteration of feldspars by a fine to medium pale green amphibole (e.g. tremolite), followed by an overprinting effect of fenite-like alteration, whereby feldspars, biotite and pale green amphibole are locally replaced and veined by fine grained aggregates of a blue amphibole (e.g. crossite), with a little associated ilmenite. Further retrograde alteration was imposed, with extensive replacement of plagioclase by sericite ± carbonate, pale green and very pale blue amphibole by carbonate, and garnet by chlorite. A trace of pyrite is also observed as part of the retrograde alteration.

Handspecimen: The drill core sample is composed of a massive, but heterogeneous rock. Much is dark grey, with small amounts of paler grey and pinkish feldspar and quartz, and it merges (sharply) into a zone ~1.5 cm across of rather coarse grained pink feldspar and pale grey quartz. This rock has a granitic appearance and in the dark grey zone evidently contains minor biotite as well as being diffusely veined by a fine grained dark bluish-grey phase. The granitic-appearing rock is cut at a low angle to the core axis by a dark grey to khaki-coloured, apparently altered porphyritic mafic igneous rock. The contact is sharp and sub-planar. The sample is essentially non-magnetic, with susceptibility of $<10 \times 10^{-5}$ SI.

Petrographic description

a) Primary rock characteristics: In the section, two different rock types are present, with a sharp, sub-planar contain in-between, but with both types being altered (Fig. 3). Relict textures in both rock types are generally moderately preserved, despite the overprint of alteration. The majority lithology is interpreted as a garnet-bearing, rather coarse granitic or gneissic rock. There is some preservation of primary quartz and plagioclase (grainsize up to a few millimetres), with subordinate flaky biotite (grains up to 1.5 mm), minor K-feldspar and garnet (probably almandine, typically fractured and with porphyroblastic grains up to a few millimetres), plus a little FeTi oxide (ilmenite, in elongate aggregates up to 1.5 mm), disseminated apatite and rare zircon (Fig. 4). In places, a weak gneissosity is apparent, defined by preferred orientation of biotite grains. The other rock type was of mafic to ultramafic character and formerly had a crowded porphyritic texture. There are pseudomorphs after a blocky to sub-rounded ferromagnesian phase (perhaps originally clinopyroxene) and a fine grained groundmass that was formerly biotite-rich and which contained a few small chromite grains (Fig. 3). It is considered that this rock type represents a lamprophyre, perhaps of minette variety, and which was intrusive into the granitic-gneissic rock.

b) Alteration and structure: Both rock types experienced strong alteration. It appears that there was initial patchy replacement of feldspar ± biotite in the granitic-gneissic rock by zones of fine to medium grained, pale green amphibole (e.g. tremolite). This type of alteration could have preceded more extensive replacement of the granitic-gneissic rock, and the lamprophyre. The latter has total replacement of interpreted ferromagnesian (e.g. clinopyroxene) phenocrysts by aggregates of fine to medium grained, very pale blue amphibole (e.g. glaucophane-crossite) and development in the granitic-gneissic rock of patchy replacement and veining by fine grained aggregates of blue amphibole (e.g. crossite) and trace FeTi oxide (ilmenite). In this rock type, it appears that feldspars and biotite were replaced (Figs 3, 5, 6). The formation of the blue amphibole alteration is considered to be a type of fenitisation (i.e. Na-Fe metasomatism). Subsequently, pervasive retrograde alteration was imposed, maybe overlapping temporally with blue amphibole development. Original feldspars in the granitic-

gneissic rock were rather strongly sericitised, as well as having minor carbonate development. Garnet is variably replaced by chlorite, and in the lamprophyre, biotite is largely replaced by chlorite and a little carbonate (Fig. 3). Pale green amphibole alteration in the granitic-gneissic rock and the pale blue amphibole in the lamprophyre are mildly overprinted by carbonate. A trace of pyrite is observed as a part of the alteration of the granitic-gneissic rock.

c) Mineralisation: A few grains of relict chromite (up to 0.1 mm) occur in the altered lamprophyre. As part of the alteration in the granitic-gneissic rock, a few grains of pyrite up to 0.2 mm across have formed.

Mineral Mode (by volume): plagioclase 35%, quartz 15%, pale blue and blue amphibole (dominantly crossite) 12%, sericite 10%, chlorite 8%, biotite 7%, pale green amphibole (tremolite) 5%, garnet (almandine) 3%, K-feldspar and carbonate each 2%, FeTi oxide (ilmenite) 1% and traces of apatite, pyrite, chromite and zircon.

Interpretation and comment: It is interpreted that the sample contains a coarse grained granitic to gneissic rock, cut by a lamprophyre vein and with both rock types having subsequent strong alteration. The granitic/gneissic rock has abundant plagioclase and quartz, with subordinate biotite (locally defining a weak gneissosity), minor K-feldspar, garnet (porphyroblastic almandine) and a little FeTi oxide (ilmenite) and apatite. There is a sharp, sub-planar contact against an apparent lamprophyric rock that might have initially contained phenocrysts of a ferromagnesian phase (speculatively clinopyroxene) in a biotite-rich groundmass that also contains a few small chromite grains. The original phenocrystal phase in the lamprophyric rock (e.g. minette type) was replaced by fine to medium grained, very pale bluish amphibole (e.g. glaucophane-crossite), with biotite being degraded to chlorite and a little carbonate. In the granitic/gneissic rock, there is apparent initial patchy alteration of feldspars by a fine to medium pale green amphibole (e.g. tremolite), followed by an overprinting effect of fenite-like alteration, whereby feldspars, biotite and pale green amphibole are locally replaced and veined by fine grained aggregates of a blue amphibole (e.g. crossite), with a little associated ilmenite. Further retrograde alteration was imposed, with extensive replacement of plagioclase by sericite ± carbonate, pale green and very pale blue amphibole by carbonate, and garnet by chlorite. A trace of pyrite is also observed as part of the retrograde alteration.

Fig. 3: Sharp contact between altered porphyritic lamprophyre (upper) and altered granitic-gneissic rock (lower). In the lamprophyre, interpreted ferromagnesian phenocrysts were replaced by very pale blue amphibole, and groundmass biotite is partly altered to chlorite. Small black grains are chromite. In the granitic-gneissic rock, there is minor residual feldspar and biotite, with replacement by blue amphibole and khaki

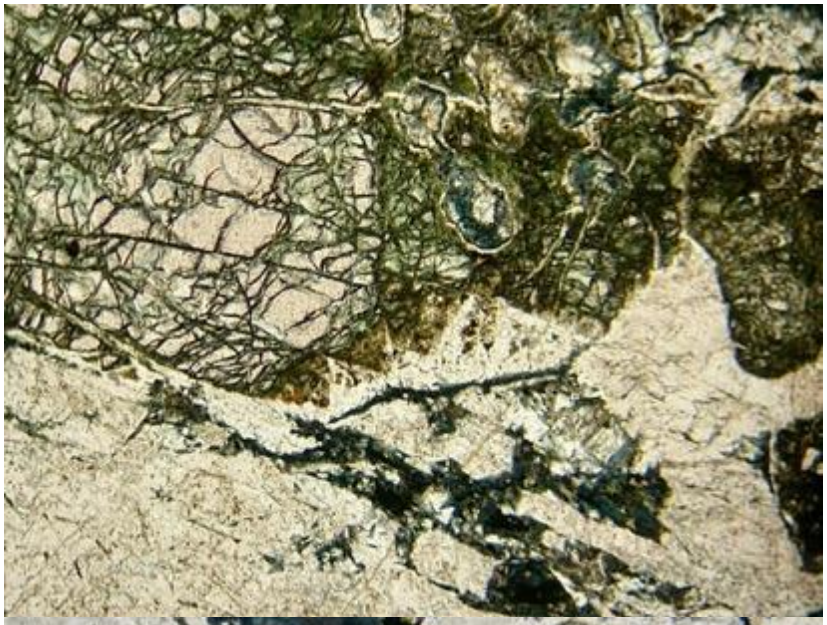


Fig. 4: Fractured garnet, partly replaced by retrograde chlorite (dark khaki-green). Adjacent quartz and feldspar (lower) are thinly veined by dark blue-grey amphibole. Plane polarised transmitted light, field of view 2 mm

Fig. 5: Veinlike mass of blue amphibole cutting and replacing feldspar and adjacent pale green-grey amphibole aggregate (centre right). Plane polarised transmitted light, field of view 2 mm across

Fig. 6: Irregular mass of blue amphibole replacing feldspars and biotite. Residual feldspar is partly sericitised. Plane polarised transmitted light, field of view 2 mm across

EALP006 TS

Summary: Porphyritic mafic to ultramafic igneous rock, possibly transitional in composition between a lamprophyre and carbonatite. Originally, it contained scattered olivine phenocrysts, enclosed in a fine to medium grained groundmass of abundant carbonate (calcite), biotite and less common clinopyroxene and granular magnetite, with a few grains of chromite. Textures imply that at least some of the carbonate represents a primary igneous phase as it is intergrown in apparent equilibrium with biotite. Interpreted olivine phenocrysts were altered to biotite (and associated imposed retrograde chlorite and a little magnetite), commonly enclosed by rims of fine grained tremolite ± carbonate ± chlorite ± magnetite. Elsewhere in the rock, there is minor development of tremolite and chlorite, typically intergrown with carbonate.

Handspecimen: The drill core sample is composed of a massive, apparently porphyritic, mafic igneous rock. It is dark grey to grey-brown in colour, with a few scattered pale grey carbonate aggregates, mostly <2 mm across, but locally up to several millimetres. The rock appears to contain scattered altered blocky ferromagnesian phenocrysts up to 3-4 mm across in a fine grained groundmass that evidently contains abundant biotite and interstitial carbonate. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite, including the aggregates and a single, 2 mm wide vein. The sample is strongly magnetic, with susceptibility up to 7160 x 10^{-5} SI, indicating the presence of minor disseminated magnetite.

Petrographic description

a) Primary rock characteristics: In the section, relict porphyritic texture is evident, but original blocky to elongate phenocrysts (up to 4 mm) are altered. Phenocrysts occurred in a fine to medium grained groundmass that has considerable preservation of primary minerals. The groundmass contains abundant small flakes of orange-brown biotite (up to 1 mm) and less common blocky to elongate grains of pale pink to pale yellow-brown clinopyroxene up to 1.5 mm; these could be a slightly titanian augite in composition, with disseminated granular magnetite (up to 0.4 mm) and uncommon small grains of chromite (rimmed by magnetite and up to 0.3 mm), all enclosed by fine to medium grained carbonate (calcite) (Fig. 7). Carbonate locally forms aggregates up to a few millimetres across and the fact that it is intergrown in apparent equilibrium with biotite and clinopyroxene (Fig. 8), suggests that it could represent a late magmatic (igneous) product. No feldspar is recognised in the sample. The scattered pseudomorphs after the ferromagnesian phenocryst phase are interpreted to be after former olivine, based on relict shapes of the pseudomorphs and the Mg (-Fe)-rich nature of the alteration (replacement) assemblage (i.e. biotite, chlorite, tremolite, magnetite and carbonate). The interpreted primary mineralogical constitution of the rock is interpreted to indicate that it has strong affinities to a lamprophyre (perhaps of ultramafic type) and could be transitional to a carbonatite.

b) Alteration and structure: Apparent moderate pervasive alteration was imposed. This is most obvious in the replacement of the interpreted former olivine phenocrysts, which were initially replaced by a khaki-orange phase that could have initially been biotite but was variably degraded to chlorite, and which also contain a little magnetite and carbonate. Commonly enclosing these pseudomorphic masses are rims of colourless fine grained tremolite, carbonate, disseminated magnetite and in places, a little pale blue-green chlorite (Fig. 9). There is no significant textural indication for groundmass biotite, clinopyroxene or magnetite to be altered, although biotite can have local thin rims of chlorite. Groundmass carbonate shows local minor intergrowth with fine grained tremolite and pale blue-green chlorite.

c) Mineralisation: The rock contains disseminated granular magnetite throughout, in grains up to 0.4 mm, interpreted as a magmatic product. There are also a few grains of chromite up to 0.3 mm, locally thinly rimmed by magnetite. A trace of magnetite has formed by alteration of the interpreted olivine phenocrysts. No sulphide minerals were recognised.

Mineral Mode (by volume): carbonate (calcite), biotite 35%, chlorite 10%, clinopyroxene, magnetite and tremolite each 5% and a trace of chromite.

Interpretation and comment: It is interpreted that the sample could represent an igneous rock that was transitional between an ultramafic composition lamprophyre and a carbonatite. Originally, it contained scattered olivine phenocrysts, enclosed in a fine to medium grained groundmass of abundant carbonate (calcite), biotite and less common clinopyroxene and granular magnetite, with a few grains of chromite. Textures imply that at least some of the carbonate represents a primary igneous phase as it is intergrown in apparent equilibrium with biotite. Interpreted olivine phenocrysts were altered to biotite (and associated imposed retrograde chlorite and a little magnetite), commonly enclosed by rims of fine grained tremolite ± carbonate ± chlorite ± magnetite. Elsewhere in the rock, there is minor development of tremolite and chlorite, typically intergrown with carbonate.

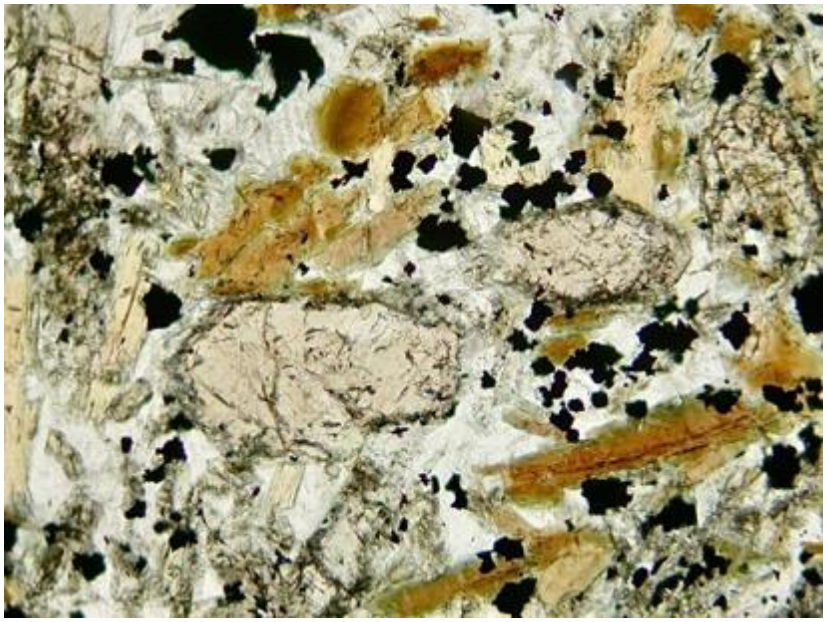


Fig. 7: Fresh grains of clinopyroxene (pale pinkish), biotite (orange-brown) and magnetite (black) hosted in carbonate (calcite; clear). Plane polarised transmitted light, field of view 1 mm

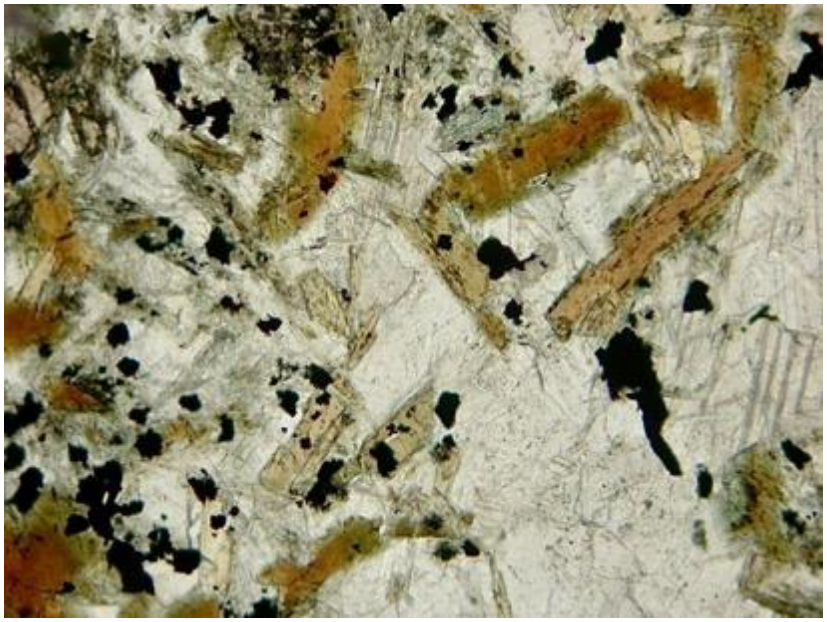


Fig. 8: Apparent primary interstitial medium grained calcite, enclosing biotite and magnetite. Trace acicular tremolite occurs in carbonate. Plane polarised transmitted light, field of

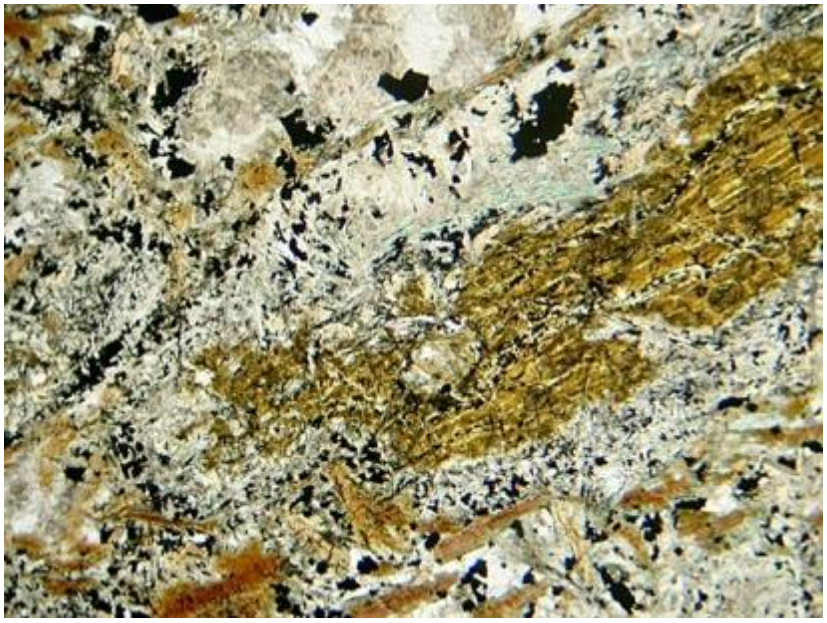


Fig. 9: Portion of a large pseudomorph after an interpreted former olivine phenocryst. It was replaced by biotite + retrograde chlorite (khaki) surrounded by a rim of fine grained tremolite, pale blue-green chlorite, carbonate and finely disseminated magnetite (black). Plane polarised transmitted light, field of

EALP008 PTS

Summary: Medium grained microsyenite, initially dominated by slightly hematite-pigmented K-feldspar, with overprinting effects of pervasive fracturing and local zones of micro-cataclasis, and associated strong alteration to fine to medium grained carbonate (calcite), subordinate chlorite and a little pyrite. There are some calcite-rich patches that might represent veins, and one of the micro-cataclastic zones hosts a sub-planar vein of calcite and chlorite. The few pyrite aggregates present are fractured and associated with a trace of chalcopyrite. There is no evidence in the sample for the occurrence of any mafic (lamprophyric) or carbonatitic rock.

Handspecimen: The drill core sample is composed of a massive to locally fractured and sheared, pink through to grey-green, variably altered, medium grained feldspathic rock, appearing to have initially been of igneous type. It is dominated by weakly hematite-pigmented feldspar (probably K-feldspar), with apparent variable replacement by fine grained chlorite and ale grey carbonate, culminating in development of intense alteration zones of chlorite and carbonate up to several millimetres wide and which have a weak foliation. These zones are also veined by white to pale grey carbonate, with locally associated pyrite aggregates up to several millimetres across. 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, there are vestiges of a medium grained, strongly feldspathic rock with possible relict igneous texture that is strongly fractured and invaded and replaced by alteration minerals (Fig. 10). The original rock was dominated by inequigranular, slightly hematite-pigmented K-feldspar (grains up to 1 mm), with a little sodic plagioclase and quartz. The rock could represent a type of microsyenite. There is no evidence for the occurrence of any mafic (e.g. lamprophyric) or carbonatitic rock in the sample.

b) Alteration and structure: It is interpreted that an original possible microsyenite experienced pervasive strong fracturing and development of elongate zones of micro-cataclasis up to several millimetres wide (Figs 10, 11). The fractured and micro-cataclastic zones were the focus for subsequent strong to complete replacement of feldspar by minor to abundant, fine to medium grained carbonate (calcite) and subordinate chlorite, with a little irregularly distributed pyrite (aggregates up to several millimetres) and a trace of accompanying chalcopyrite (Figs 10, 11, 12). In places, abundant carbonate could form irregular to veinlike replacement or infill masses up to several millimetres across. A single sub-planar vein containing sheared chlorite, fine grained carbonate and trace pyrite, is up to 0.4 mm wide, and cuts a major zone of micro-cataclasis (Fig. 11). It is interpreted from textural relations, that the extensive calcite-chlorite (-pyrite) alteration and veining occurring during and following deformation.

c) Mineralisation: The calcite-rich veining and replacement masses contain a few aggregates of medium grained pyrite up to several millimetres across, commonly having fracturing and being associated with trace grains of chalcopyrite up to 0.2 mm across (Fig. 12).

Mineral Mode (by volume): K-feldspar 45%, carbonate (calcite) 35%, chlorite 15%, pyrite 3%, plagioclase 2% and traces of quartz, chalcopyrite and hematite.

Interpretation and comment: It is interpreted that the sample is a deformed and strongly altered, medium grained microsyenite. It was initially dominated by slightly hematite-pigmented K-feldspar, but demonstrates overprinting effects of pervasive fracturing and local zones of micro-cataclasis. There was also associated strong alteration to fine to medium grained carbonate (calcite), subordinate chlorite and a little pyrite. Some calcite-rich patches might represent veins, and one of the micro-cataclastic zones hosts a sub-planar vein of calcite and chlorite. The few pyrite aggregates present are fractured and

associated with a trace of chalcopyrite. There is no evidence in the sample for the occurrence of any mafic (lamprophyric) or carbonatitic rock.

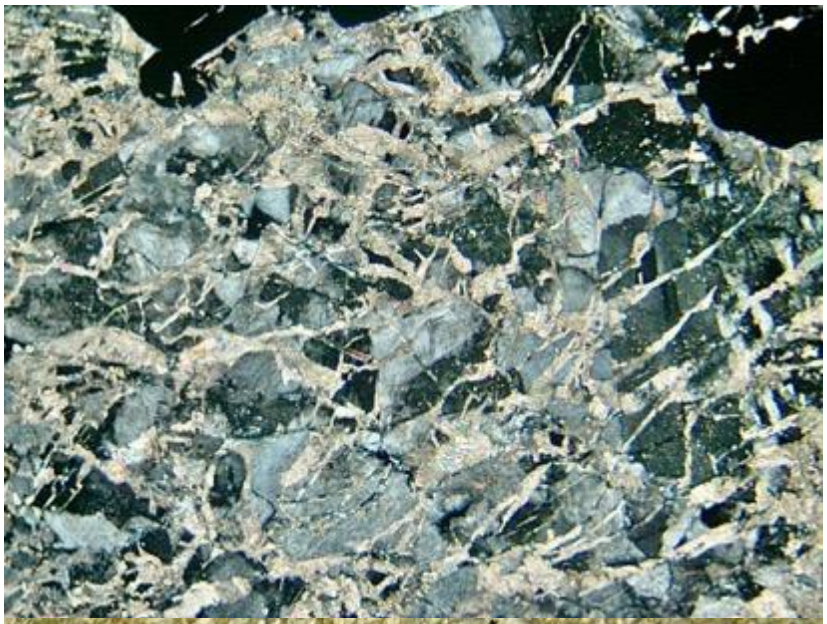


Fig. 10: Strongly fractured medium grained micro-syenite dominated by K-feldspar and cut by fine scale network veining of calcite. Black grains at top are pyrite. Transmitted light, crossed polarisers, field of view 2 mm

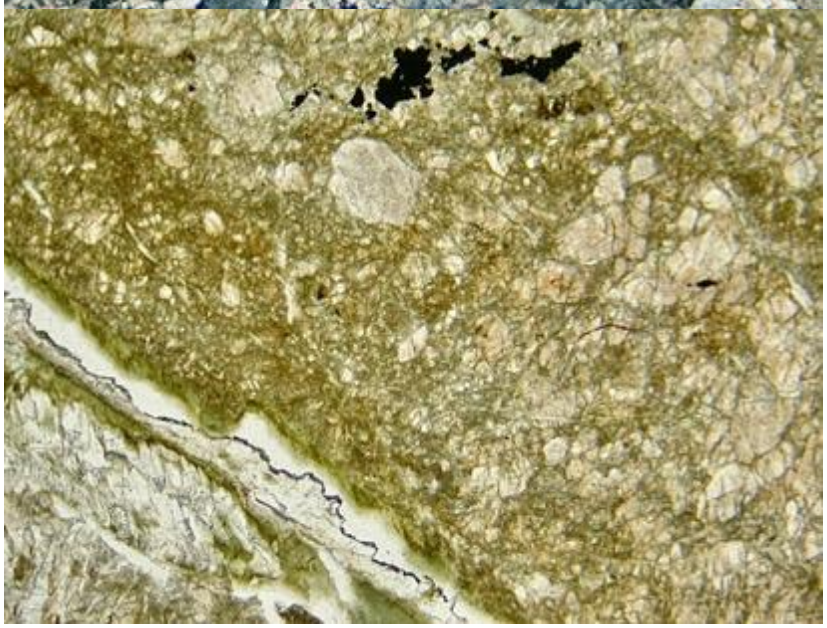
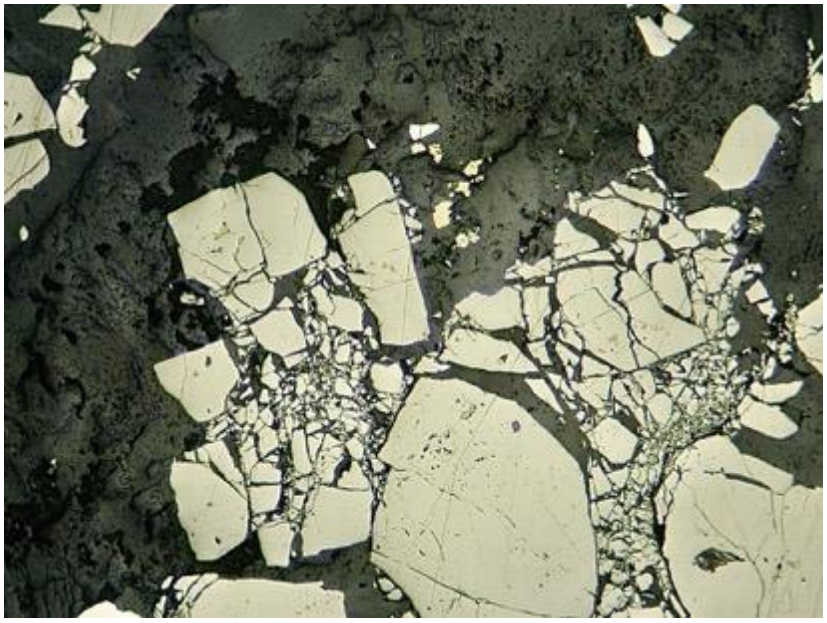


Fig. 11: Micro-cataclastic zone with small feldspar grains that are invaded and replaced by fine grained khaki chlorite, calcite and a little pyrite (black). At lower left is a sheared chlorite-calcite vein. Plane polarised transmitted light, field of view

Fig. 12: Fractured pyrite aggregate (pale creamy) with a trace of associated chalcopyrite (upper centre) hosted in calcite and fractured K-feldspar remnants. Plane polarised reflected light, field of view 2



EALP009 TS

Summary: Medium to coarse grained hornblende gabbro, with partial recrystallisation (polygonization) due to imposed metamorphism, and with later mild to moderate retrograde alteration. The original rock contained abundant brown hornblende and plagioclase, with minor clinopyroxene and a little possible orthopyroxene. Imposed metamorphism led to grain boundary equilibration and could have occurred at medium grade. Subsequently, there was interpreted initial replacement of orthopyroxene by biotite, followed by patchy retrograde alteration and minor veining, perhaps occurring under lower greenschist facies metamorphic conditions. This process led to variable replacement of plagioclase by sericite and carbonate, replacement of most biotite by chlorite, and development of a little bluish amphibole (maybe actinolite-riebeckite type), chlorite and carbonate from clinopyroxene, and emplacement of a few veins containing carbonate, chlorite and trace quartz. The alteration assemblage also contains a trace of pyrite.

Handspecimen: The drill core sample is composed of a massive, medium to coarse grained, mafic igneous rock, with an inequigranular texture suggestive of partial recrystallisation due to imposed metamorphism (i.e. an amphibolitic appearance). The rock contains abundant dark grey-green ferromagnesian material (e.g. hornblende) and pale grey feldspar (e.g. plagioclase), with grainsize up to 2.5 mm. The rock appears to be little-altered, except for development of a couple of small veinlets and irregular aggregates of white carbonate, and narrow shear veins containing dark grey-green chlorite. The sample is very weakly magnetic, with susceptibility up to 25 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, there is considerable preservation of primary minerals and the texture suggests that the rock was formerly of medium to coarse grained igneous type, but with effects of overprinting metamorphism, leading to grain boundary equilibration and partial development of polygonization (Fig. 13). The original igneous rock was of mafic igneous type, consisting of abundant interlocking brown hornblende and plagioclase (each with grainsize up to 2.5 mm), with minor clinopyroxene (up to 1.5 mm) and pseudomorphs after a few grains of possible former orthopyroxene (Fig. 13). A trace of quartz occurs interstitial to hornblende and plagioclase. From the interpreted primary mineralogy, the original rock is interpreted as a hornblende gabbro.

b) Alteration and structure: The original gabbro was evidently subject to partial recrystallisation due to imposed metamorphism, which must have been at medium grade (e.g. stability of brown hornblende) and leading to variable polygonization of the primary texture (Fig. 13). Subsequently, there was interpreted initial retrograde alteration imposed, causing former orthopyroxene to be replaced by biotite. This was followed by more pervasive retrograde alteration that caused minor to locally strong replacement of plagioclase by fine grained sericite and patchy carbonate (aggregates up to 2 mm) (Fig. 13), with much biotite being partly altered to chlorite, and formation of a little blue-green amphibole (e.g. possible actinolite-riebeckite), chlorite and carbonate from clinopyroxene. A few grains of pyrite occur as part of the alteration and these are speculated to have potentially replaced earlier traces of pyrrhotite. The rock is cut by a couple of diffuse veins up to 0.4 mm wide of carbonate ± chlorite ± quartz, and there is a sharply defined, sub-planar vein 0.2 mm wide of chlorite. The retrograde alteration and veining could have occurred under lower greenschist facies metamorphic conditions.

c) Mineralisation: The sample contains a trace of pyrite, in aggregates up to 0.2 mm across, as part of the retrograde alteration.

Mineral Mode (by volume): plagioclase and hornblende each 40%, clinopyroxene 8%, sericite 5%, carbonate and chlorite each 3% and traces of quartz, biotite, blue-green amphibole and pyrite.

Interpretation and comment: It is interpreted that the sample represents a former hornblende gabbro, having imposed partial recrystallisation (polygonization) due to medium grade metamorphism. The rock

contained abundant medium to coarse grained brown hornblende and plagioclase, minor clinopyroxene and a little possible orthopyroxene. Subsequently, there was initial replacement of interpreted former orthopyroxene by biotite, followed by patchy retrograde alteration and minor veining, perhaps occurring under lower greenschist facies metamorphic conditions, leading to variable replacement of plagioclase by sericite and carbonate, replacement of most biotite by chlorite, and development of a little bluish-green amphibole (maybe actinolite-riebeckite type), chlorite and carbonate from clinopyroxene, and emplacement of a few veins containing carbonate, chlorite and trace quartz. The alteration assemblage also contains a trace of pyrite.

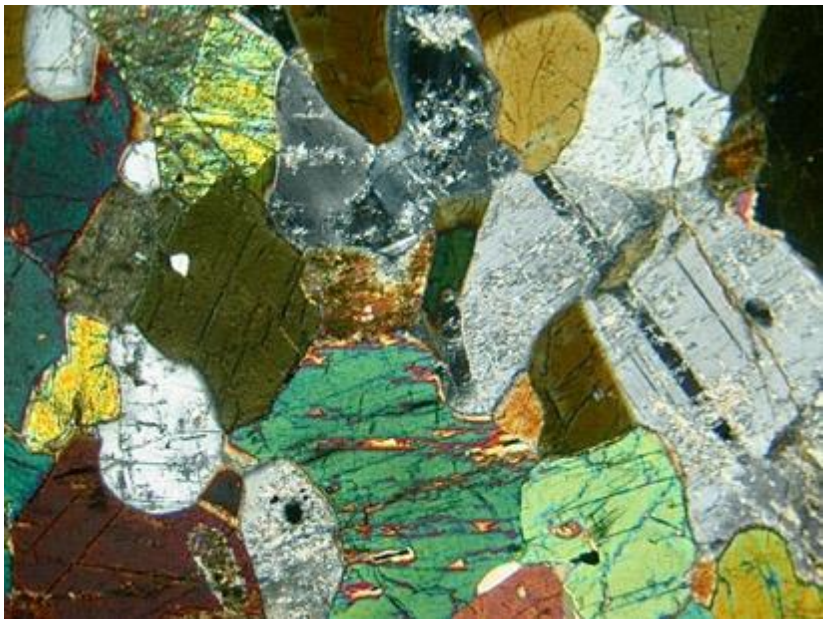


Fig. 13: Partly polygonised texture of gabbro, with interlocking plagioclase and brown hornblende and a couple of grains of clinopyroxene (yellow shades) at left. Plagioclase is slightly sericitised. Transmitted light, crossed

EALP010 TS

Summary: Lamprophyre, perhaps of minette type, with pervasive strong alteration and considerable carbonate (calcite) veining. The rock originally contained scattered phenocrysts of clinopyroxene, enclosed in a fine to medium grained groundmass of K-feldspar, biotite, clinopyroxene and minor disseminated magnetite. It is possible that minor carbonate also occurred, e.g. interleaved with biotite. There is no evidence for the occurrence of carbonatite in the sample. Imposed alteration led to complete replacement of clinopyroxene phenocrysts by fine grained tremolite, carbonate, chlorite and magnetite. Alteration in the groundmass formed a turbid, fine grained aggregate of tremolite, chlorite, carbonate and a little magnetite and pyrite. Veins contain medium to coarse grained calcite, with minor chlorite and trace pyrite.

Handspecimen: The drill core sample is composed of a massive, but commonly veined, dark khaki-grey, fine grained rock, perhaps of mafic igneous type and containing sparse dark pseudomorphs after a former ferromagnesian phase up to 2 mm across in a finer grained groundmass that evidently contains considerable biotite. Strong pervasive alteration to carbonate and chlorite is apparent and the rock hosts several sub-planar to irregular white veins of medium grained carbonate up to a few millimetres wide. Testing of the section offcut with dilute HCl gave a strong reaction on vein and alteration carbonate, indicating that it is calcite. The sample is strongly magnetic, with susceptibility up to 5140 x 10^{-5} SI, indicating the presence of minor disseminated magnetite.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock is strongly altered and veined, but relict porphyritic texture is moderately preserved and there is local retention of primary igneous minerals (Figs 14, 15). The rock formerly contained scattered blocky phenocrysts of a ferromagnesian phase up to 2 mm across, interpreted to have been clinopyroxene, enclosed in a fine to medium grained groundmass consisting of biotite (flakes up to 0.5 mm), clinopyroxene, disseminated magnetite and interstitial K-feldspar (Fig. 14). Minor carbonate might have occurred, e.g. interleaved with biotite. Based on preserved primary characteristics, the rock is considered to be a lamprophyre, of minette type. There is no evidence in the sample for occurrence of carbonatite.

b) Alteration and structure: The original igneous rock experienced strong pervasive alteration and emplacement of considerable carbonate (calcite) veining. All former clinopyroxene phenocrysts were replaced by varying proportions of fine grained, near-colourless amphibole (tremolite), carbonate, a little magnetite and chlorite (Figs 14, 15). In the groundmass, there is considerable preservation of biotite and igneous magnetite, as well as local retention of clinopyroxene and K-feldspar, but there was also much replacement by a turbid, fine grained aggregate that includes tremolite, chlorite, carbonate, minor magnetite and a little pyrite (Figs 14, 15). The rock is cut by a few veins up to 8 mm wide containing medium to coarse grained carbonate (calcite), minor chlorite and trace pyrite (Fig. 14).

c) Mineralisation: The sample contains disseminated magnetite, some of which is likely to be relict igneous (grains up to 0.3 mm across), but other magnetite has formed by alteration of clinopyroxene phenocrysts and in the groundmass (Figs 14, 15). A little pyrite (grains up to 0.2 mm) has also formed as part of the pervasive alteration, as well as occurring in the calcite-rich veining.

Mineral Mode (by volume): carbonate (calcite) 40%, tremolite 20%, biotite 15%, chlorite 12%, K-feldspar and magnetite each 5%, clinopyroxene 3% and a trace of pyrite.

Interpretation and comment: It is interpreted that the sample is a pervasively altered and calcite-veined lamprophyre, of minette type. It formerly contained scattered phenocrysts of clinopyroxene, enclosed in a fine to medium grained groundmass of K-feldspar, biotite, clinopyroxene and minor disseminated magnetite. It is possible that minor carbonate also occurred, e.g. interleaved with biotite. There is no evidence for the occurrence of carbonatite in the sample. Imposed alteration caused complete

replacement of clinopyroxene phenocrysts by fine grained tremolite, carbonate, chlorite and magnetite. Alteration of the groundmass formed a turbid, fine grained aggregate of tremolite, chlorite, carbonate and a little magnetite and pyrite. Veins contain medium to coarse grained calcite, with minor chlorite and trace pyrite.

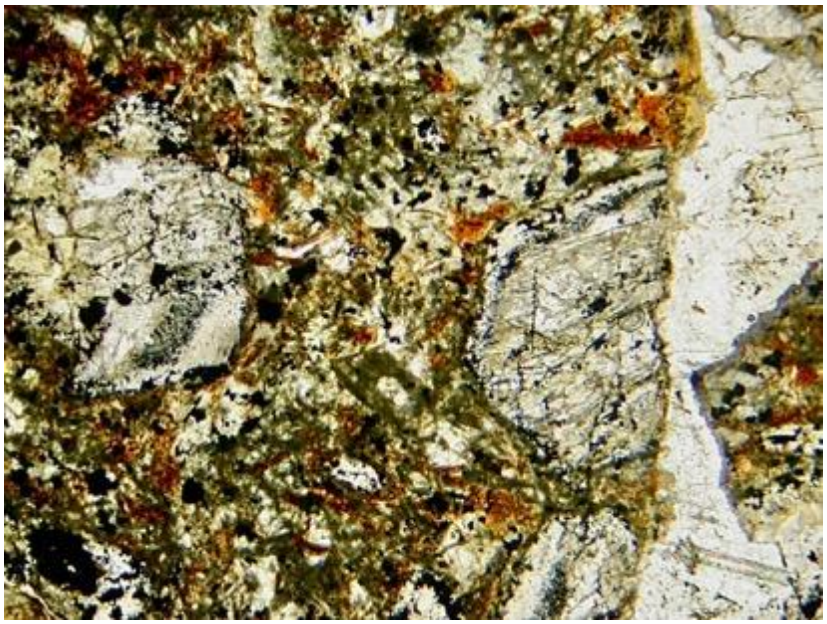


Fig. 14: Pseudomorphs of tremolite and carbonate after former blocky clinopyroxene phenocrysts in a partly altered groundmass of K-feldspar, biotite, clinopyroxene and magnetite. At right, the rock is cut by a calcite vein. Plane

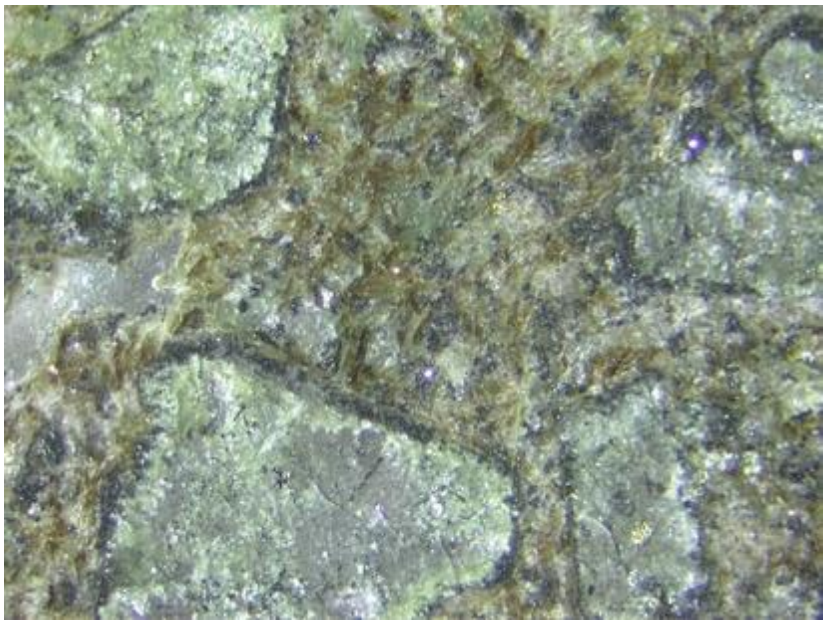


Fig. 15: Magnetite-outlined pseudomorphs after former blocky clinopyroxene phenocrysts (replaced by tremolite and carbonate) in a groundmass containing biotite (brown) and alteration-derived tremolite, chlorite, carbonate and magnetite. Plane polarised oblique reflected light, field

EALP011 TS

Summary: Medium grained biotite tonalite, with slight overprinting granulation of primary texture and subsequent mild retrograde alteration and veining. The igneous rock was composed of abundant inequigranular plagioclase, with relatively minor interstitial quartz and biotite, a little FeTi oxide (ilmenite) and trace apatite and zircon. Imposed alteration could have developed albite and minor sericite from plagioclase, and chlorite from biotite. A few thin early veins of quartz and albite were emplaced, followed by a few discontinuous veins of carbonate and minor chlorite.

Handspecimen: The drill core sample is composed of a pale grey to pinkish, medium to coarse grained, inequigranular quartzofeldspathic rock, possibly of granitoid type. It is relatively massive, although evidently locally fractured, with anastomosing to sub-planar veinlike and sheared coatings of dark grey-green chlorite. The original rock appears to have contained abundant pinkish feldspar and subordinate quartz and minor disseminated biotite, probably partly replaced by chlorite. A few white sub-planar carbonate veins occur, at a low 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, the rock has an inequigranular texture, evidently originally igneous, but slightly modified by partial polygonization (Fig. 16). The rock is medium grained, with abundant sodic plagioclase (up to 1.5 mm), with smaller amounts of quartz (generally interstitial to plagioclase), biotite (aggregates up to 1.5 mm and individual grains up to 0.8 mm), with a little FeTi oxide (e.g. ilmenite, grains up to 0.5 mm) and trace apatite and zircon (Fig. 16) . Plagioclase is slightly turbid, perhaps due to hematite pigmentation. A couple of possible grains of K-feldspar (microcline) occur, but generally, K-feldspar is absent. The texture and mineralogy of the rock accord with it representing a biotite tonalite.

b) Alteration and structure: The original igneous rock might have experienced a mild metamorphic overprint that led to some granulation of the primary texture. Mild retrograde alteration was imposed on the igneous protolith. Plagioclase could be partly albitised, as well as being lightly flecked by fine grained sericite (Fig. 16). Biotite is locally replaced by chlorite. The rock was cut by a few narrow (<0.2 mm wide) sub-planar, discontinuous veins of quartz and albite, as well as by later, discontinuous veins up to 0.6 mm wide containing medium grained carbonate and a few patches of chlorite. Alteration in the rock is of mild propylitic type, but might simply be the result of imposition of low grade metamorphism.

c) Mineralisation: No sulphide minerals were observed.

Mineral Mode (by volume): plagioclase (includes albite) 75%, quartz 12%, biotite 8%, carbonate 2%, sericite, chlorite and FeTi oxide (ilmenite) each 1% and traces of apatite, zircon, K-feldspar and hematite.

Interpretation and comment: It is interpreted that the sample represents a biotite tonalite, with slight overprinting granulation of primary texture and subsequent mild retrograde alteration and veining. The igneous rock was composed of medium grained interlocking plagioclase, with relatively minor interstitial quartz and biotite, a little FeTi oxide (ilmenite) and trace apatite and zircon. Imposed alteration might have been due to low grade metamorphism could forming possible albite and minor sericite from plagioclase, and chlorite from biotite. A few thin early veins of quartz and albite were emplaced, followed by a few discontinuous veins of carbonate and minor chlorite.

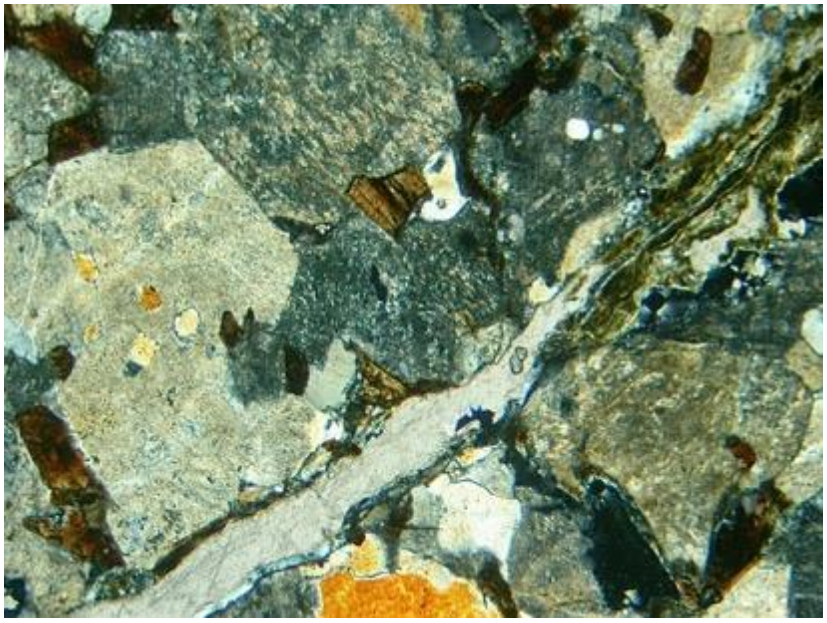


Fig. 16: Interlocking blocky grains of sodic plagioclase, with minor quartz (white to yellow) and biotite (dark to brown), with slight clouding of plagioclase due to sericite development, and with the rock cut by a vein of carbonate and chlorite (khaki). Transmitted light, crossed polarisers, field of

EALP019 TS

Summary: Recrystallised, slightly porphyritic microdiorite. The rock formerly contained a few phenocrysts of plagioclase enclosed in a fine to medium grained mass of ferromagnesian material (could have included biotite and minor pyroxene and/or amphibole) and plagioclase, with minor quartz and FeTi oxide (ilmenite). Recrystallisation was such that relict texture is only poorly to moderately preserved and the rock was largely reconstituted into an assemblage of plagioclase (probably largely albitic), biotite and carbonate (calcite), with minor epidote-clinozoisite, quartz and chlorite, and cut by a few thin, sub-planar veins of calcite and minor chlorite. The rock could have had hydrothermal CO_2 influx as well as metamorphism to biotite grade.

Handspecimen: The drill core sample is composed of a massive, medium grained, grey to dark brownish-grey igneous rock, perhaps of mafic to intermediate type and evidently containing considerable biotite. The rock appears to be relatively fresh, except for the occurrence of scattered small elongate aggregates and veins of pale grey carbonate up to a few millimetres wide. Testing of the section offcut with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. The sample is very weakly magnetic, with susceptibility up to 30 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the rock is significantly recrystallised, but there is poor to moderate preservation of relict texture indicating that it was formerly mildly porphyritic. It had sparse elongate plagioclase phenocrysts up to 1.5 mm long, enclosed by a groundmass that would have contained abundant ferromagnesian material (probably including biotite, as well as possible pyroxene and/or amphibole) and plagioclase, with minor quartz and FeTi oxide (ilmenite, in grains up to 0.3 mm) (Fig. 17). From the interpreted primary texture and mineralogy, the original rock is interpreted as a slightly porphyritic microdiorite, perhaps of relatively high-K type. The rock does not represent a lamprophyre as it is plagioclase-phyric.

b) Alteration and structure: The original igneous rock is interpreted to have been largely replaced and recrystallised due to imposition of metamorphism (perhaps at biotite grade) and hydrothermal influx. Plagioclase could have been at least partly albitised, as well as being replaced by carbonate (calcite) and biotite, with original ferromagnesian material being replaced by biotite (up to 1 mm, with some possibly representing relict primary igneous grains), epidote-clinozoisite (e.g. at former pyroxene and/or amphibole sites), carbonate (calcite) and minor chlorite (Figs 17, 18). The altered rock is cut by a few sub-planar veins of carbonate (calcite) ± chlorite, up to 0.4 mm wide. The presence of significant carbonate in the rock attests to likely hydrothermal CO_2 flux prior to, or during metamorphism.

c) Mineralisation: No sulphide minerals were observed.

Mineral Mode (by volume): plagioclase (includes albite) 40%, biotite 30%, carbonate (calcite) 17%, clinozoisite-epidote 7%, quartz, chlorite and FeTi oxide (ilmenite) each 2%.

Interpretation and comment: It is interpreted that the sample is a mildly porphyritic microdiorite that experienced metamorphism and hydrothermal flux. There were a few phenocrysts of plagioclase enclosed in a fine to medium grained mass of ferromagnesian material (could have included biotite and minor pyroxene and/or amphibole) and plagioclase, with minor quartz and FeTi oxide (ilmenite). Relict texture is poorly to moderately preserved due to recrystallisation and the rock was largely reconstituted into an assemblage of plagioclase (probably largely albitic), biotite and carbonate (calcite), with minor epidote-clinozoisite, quartz and chlorite, and cut by a few thin, sub-planar veins of calcite and minor chlorite. The rock could have had hydrothermal CO_2 influx and metamorphism to biotite grade.

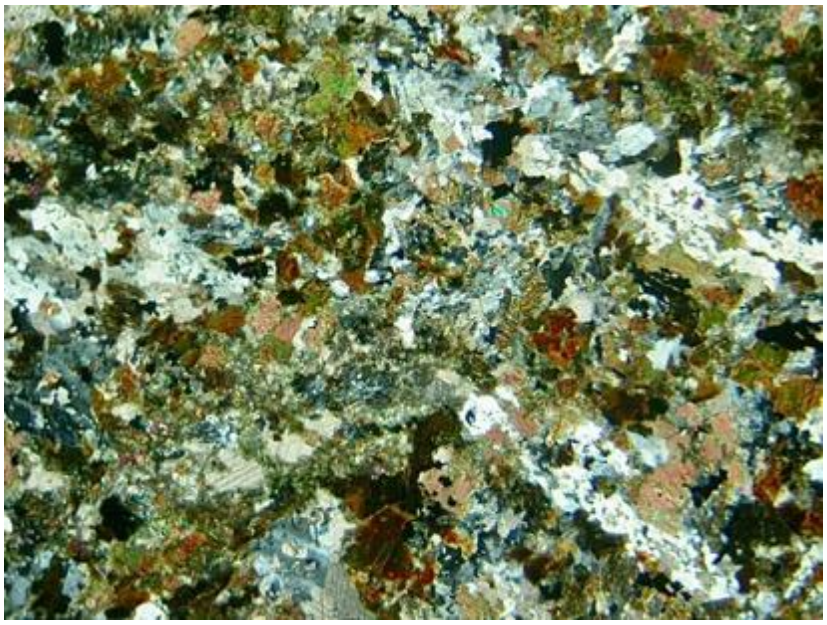


Fig. 17: Vaguely preserved relict porphyritic texture, with elongate, partly recrystallised plagioclase phenocrysts (whitish) in a mass of biotite (brown shades), plagioclase and minor quartz and ilmenite (black). Transmitted light, crossed polarisers, field of view 2 mm across.

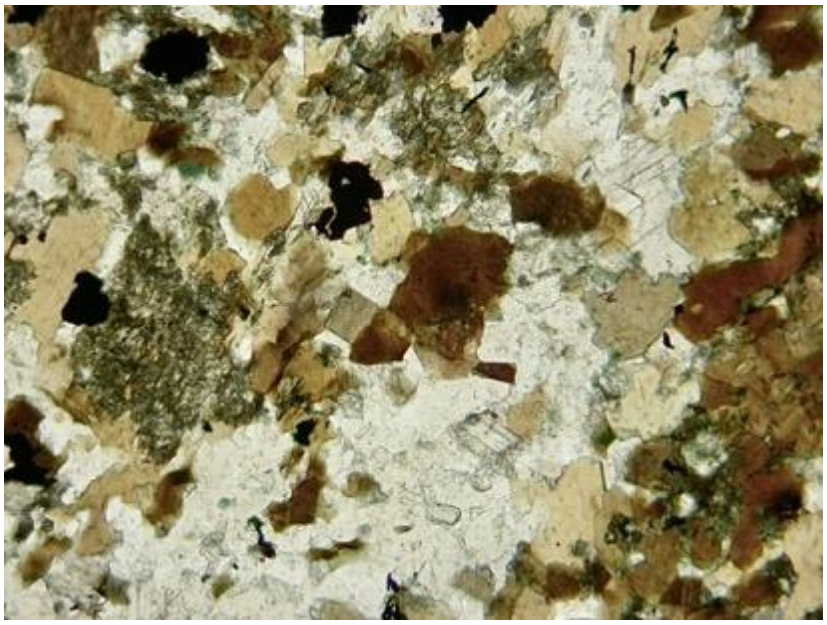


Fig. 18: Detail of recrystallised assemblage of biotite (brown shades), epidote-clinozoisite (turbid, high relief), carbonate and albite (clear) and a few grains of ilmenite (black). Plane polarised transmitted light, field of view 2 mm

EALP021 TS

Summary: Deformed and partly recrystallised micromonzogranite. The original rock was composed of abundant interlocking sodic plagioclase, K-feldspar and quartz, probably with minor disseminated biotite and trace ilmenite. The imposed deformation led to partial polygonization of the original minerals and development of a weak foliation, defined by alignment of former biotite grains. There was considerable associated development of finely granular feldspar-quartz recrystallised masses, in places accompanied by sericite aggregates, and formation of elongate to veinlike masses of chlorite ± sericite from former biotite. A little carbonate and trace pyrite are dispersed, and the rock is cut by a few discontinuous veins of carbonate, with local minor quartz.

Handspecimen: The drill core sample is composed of a pink to pale grey, apparently deformed, medium to coarse grained granitic rock. There is abundant feldspar (pinkish) and quartz, with a minor proportion of dark grey-green chlorite that could have replaced original ferromagnesian material. Elongate concentrations of chlorite are weakly aligned, defining a foliation which is at a moderate angle to the core axis. Minor white carbonate veining is also observed. 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 rock is of quartzofeldspathic composition and has an inequigranular, medium grained igneous texture, but modified by effects of deformation and recrystallisation (Figs 19, 20). The original rock contained abundant sodic plagioclase, K-feldspar (now microcline) and quartz that were interlocking and had a grainsize of up to 1.5 mm across. It also appears to have contained minor biotite and a trace of FeTi oxide (e.g. ilmenite). Feldspars are slightly turbid, perhaps due to a little hematite pigmentation.

b) Alteration and structure: The igneous rock experienced considerable strain and recrystallisation, due to imposed deformation. In much of the rock, there was development of polygonization of original texture and formation of patchy irregular to veinlike zones of finely granular recrystallised feldspars and quartz, locally with patchy sericite aggregates up to a few millimetres across. Most original biotite was apparently replaced by fine grained aggregates of chlorite ± sericite, and there is a tendency for formation of elongate, anastomosing and veinlet aggregates of chlorite ± sericite that are aligned and define a weak foliation (Fig. 19). Small amounts of carbonate and a trace of pyrite are locally present. The rock is cut by a few discontinuous sub-planar to irregular veins up to 0.5 mm wide containing carbonate and local quartz (Fig. 20). Alteration in the rock could have formed under low grade metamorphic conditions.

c) Mineralisation: A trace of pyrite, in grains up to 0.1 mm across, is observed in an altered and finely recrystallised domain.

Mineral Mode (by volume): plagioclase (sodic), K-feldspar (microcline) and quartz each 30%, chlorite 5%, sericite 3%, carbonate 2% and traces of FeTi oxide (ilmenite), biotite, pyrite and hematite.

Interpretation and comment: It is interpreted that the sample represents a formed micromonzogranite that was affected by deformation and partial recrystallisation as well as alteration that might have occurred under low grade metamorphic conditions. The protolith was composed of abundant interlocking sodic plagioclase, K-feldspar and quartz, probably with minor disseminated biotite and trace ilmenite. Imposed deformation resulted in partial polygonization of the igneous minerals and development of a weak foliation, defined by alignment of former biotite grains. There was considerable associated development of finely granular feldspar-quartz recrystallised masses, in places accompanied by sericite aggregates, and formation of elongate to veinlike masses of chlorite ± sericite from former biotite. A little carbonate and trace pyrite are dispersed, and the rock is cut by a few discontinuous veins of carbonate, with local minor quartz.

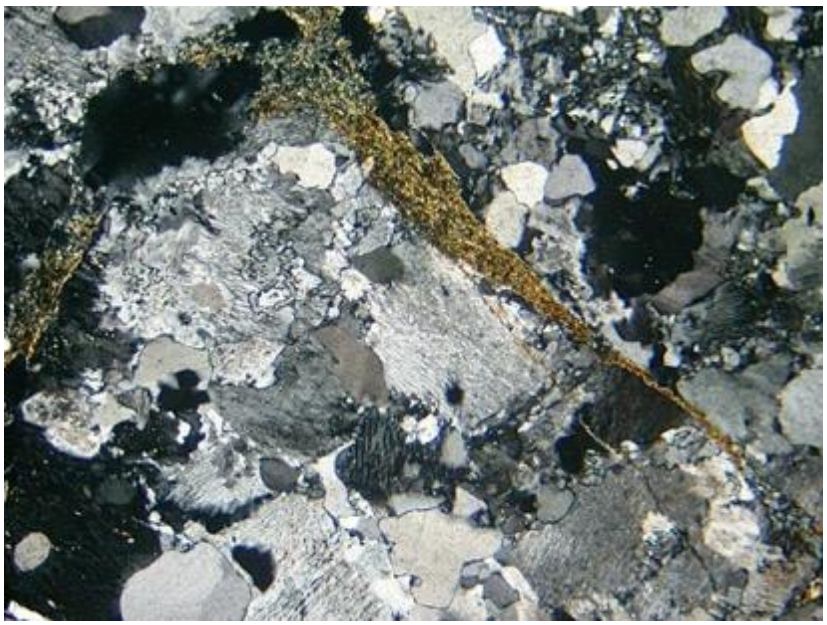


Fig. 19: Strained and partly recrystallised micromonzogranite, with veinlike concentrations of chlorite ± sericite. Transmitted light, crossed polarisers, field of view 2 mm across.

Fig. 20: Partly recrystallised feldspars and quartz in micromonzogranite, cut by thin veins of carbonate and minor quartz. Transmitted light, crossed polarisers, field of view 2 mm across.

EALP023 TS

Summary: The sample exhibits a sharp, sub-planar contact between two compositionally different protoliths, both of which have strong alteration of Na-Ca-K type, possibly of fenite affinity. One primary lithology was of a medium grained granitic type containing abundant feldspars and lesser amounts of quartz and possible biotite. The other lithology (possibly intrusive into the granitic rock) might have been of lamprophyric type, perhaps initially containing biotite and maybe phenocrysts of minerals whose identity is obscured by complete replacement. The interpreted lamprophyre was replaced by abundant biotite, pale blue amphibole (maybe a Na-Ca type, but with significant glaucophane component), carbonate (calcite), minor ilmenite and titanite. The granitic rock, although retaining some quartz, was replaced by abundant albite, with small amounts of blue amphibole (e.g. riebeckite-glaucophane), aegirine, stilpnomelane, titanite, sericite, carbonate and trace pyrite.

Handspecimen: The drill core sample exhibits a sharp, sub-planar contact between a dark grey-brown, evidently biotite-rich, fine to medium grained igneous rock (possibly lamprophyre) and a medium grained, pink to pale grey granitic rock. The contact is at ~40° to the core axis. The dark rock contains considerable carbonate. Along the contact between the dark rock and the granitic rock, there is a narrow (~1-2 mm), fine grained blue-grey band. The granitic rock appears to contain abundant feldspar and quartz and has patchy alteration to a fine grained blue-grey phase and a little carbonate. Testing of the sample with dilute HCl shows that all carbonate reacts strongly, showing 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, there are approximately equal proportions of two different, originally igneous rock types, with a relatively sharp, sub-planar contact along which strong reconstitution and primary textural destruction of both rock types has occurred (Fig. 21). The dark rock type in handspecimen is totally replaced and recrystallised, but there are possible vestiges of relict porphyritic texture, with scattered pseudomorphic masses up to 2.5 mm across that might represent sites of former phenocrysts, in an apparently recrystallised groundmass (Fig. 21). The nature of the original mineral(s) that formed the pseudomorphs remains obscure. It is speculated that the remainder of this rock type could have contained abundant ferromagnesian material (e.g. biotite), possible feldspar, carbonate and FeTi oxide (e.g. ilmenite) and hence might have represented a type of lamprophyre. The other (pale coloured) rock in handspecimen is of leucocratic quartzofeldspathic type. It was medium grained and inequigranular, perhaps with abundant feldspar, lesser quartz and possible minor biotite. It could have initially been similar to the micromonzogranite in sample EALP021.

b) Alteration and structure: It is interpreted that both primary igneous rock types experienced strong alteration that appears to have involved addition of alkalis, Ca and CO_2 to the protoliths. The possible former lamprophyre was replaced by abundant fine grained biotite (although it is possible that some could represent primary igneous material), with irregularly scattered aggregates up to 2.5 mm and interstitial fine grained, pale blue amphibole (e.g. a type between glaucophane and a NaCa type), lesser carbonate (calcite) and minor titanite that is apparently replacing ilmenite (Figs 21, 22). Aggregates of pale blue amphibole ± biotite form the pseudomorphs mentioned above. In the interpreted original granitic rock, there was considerable replacement of igneous feldspar by fine to medium grained albite (grains up to 1.5 mm, but with significant finely granular recrystallisation), with retention of quartz, but replacement of original ferromagnesian material (e.g. biotite) by aggregates containing one or more of fine to medium grained green aegirine, brown stilpnomelane and blue amphibole (e.g. glaucophane-riebeckite) (Fig. 23). There are also a few aggregates up to 2 mm across of sericite, as well as trace titanite, pyrite, and replacement of albite, aegirine and stilpnomelane by carbonate. Along the contact zone between the two original primary rock types, a band, up to 2 mm wide has formed, containing abundant pale blue amphibole, patchy carbonate and biotite, and minor titanite (Fig. 21). A few thin veins occur, mostly in the altered granitic rock, and contain carbonate. The Na-Ca-K assemblage in the rock as a whole could be considered as a type of fenite alteration.

c) Mineralisation: Rare grains of pyrite up to 0.2 mm across are observed in the altered granitic rock, with one aggregate having been replaced by deep supergene goethite.

Mineral Mode (by volume): plagioclase (albite) 40%, biotite 20%, blue amphiboles 15%, carbonate (calcite) 12%, quartz 6%, titanite and stilpnomelane each 2%, FeTi oxide (ilmenite), aegirine and sericite each 1% and traces of pyrite and goethite.

Interpretation and comment: It is interpreted that the sample contains two different igneous rock types, both of which are strongly reconstituted. There is a sharp, sub-planar contact between two compositionally different protoliths, both displaying strong alteration of Na-Ca-K type that is possibly of fenite affinity. One primary lithology was of a medium grained granitic type containing abundant feldspars and lesser amounts of quartz and possible biotite. The other lithology (possibly intrusive into the granitic rock) might have been of lamprophyric type, perhaps initially containing biotite and maybe phenocrysts of minerals whose identity is obscured by complete replacement. The interpreted lamprophyre was replaced by abundant biotite, pale blue amphibole (maybe a Na-Ca type, but with significant glaucophane component), carbonate (calcite), minor ilmenite and titanite. The granitic rock, although retaining some quartz, was replaced by abundant albite, with small amounts of blue amphibole (e.g. riebeckite-glaucophane), aegirine, stilpnomelane, titanite, sericite, carbonate and trace pyrite.

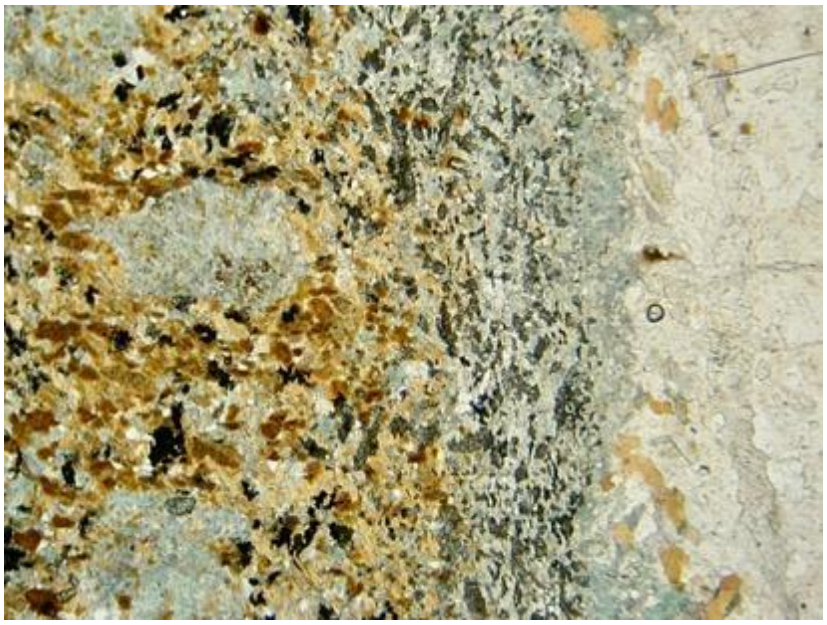


Fig. 21: Interpreted altered lamprophyre at left, consisting of biotite, pale blue amphibole and minor carbonate and ilmenite, bordering a band of pale blue amphibole and minor titanite (grey) and biotite, which in turn abuts altered granitic rock containing albite and carbonate (clear). Plane polarised transmitted light

Fig. 22: Detail of interpreted altered lamprophyre containing abundant biotite, pale blue amphibole, carbonate (clear) and ilmenite (black) partly replaced by titanite. Plane polarised transmitted light, field of view 1 mm across

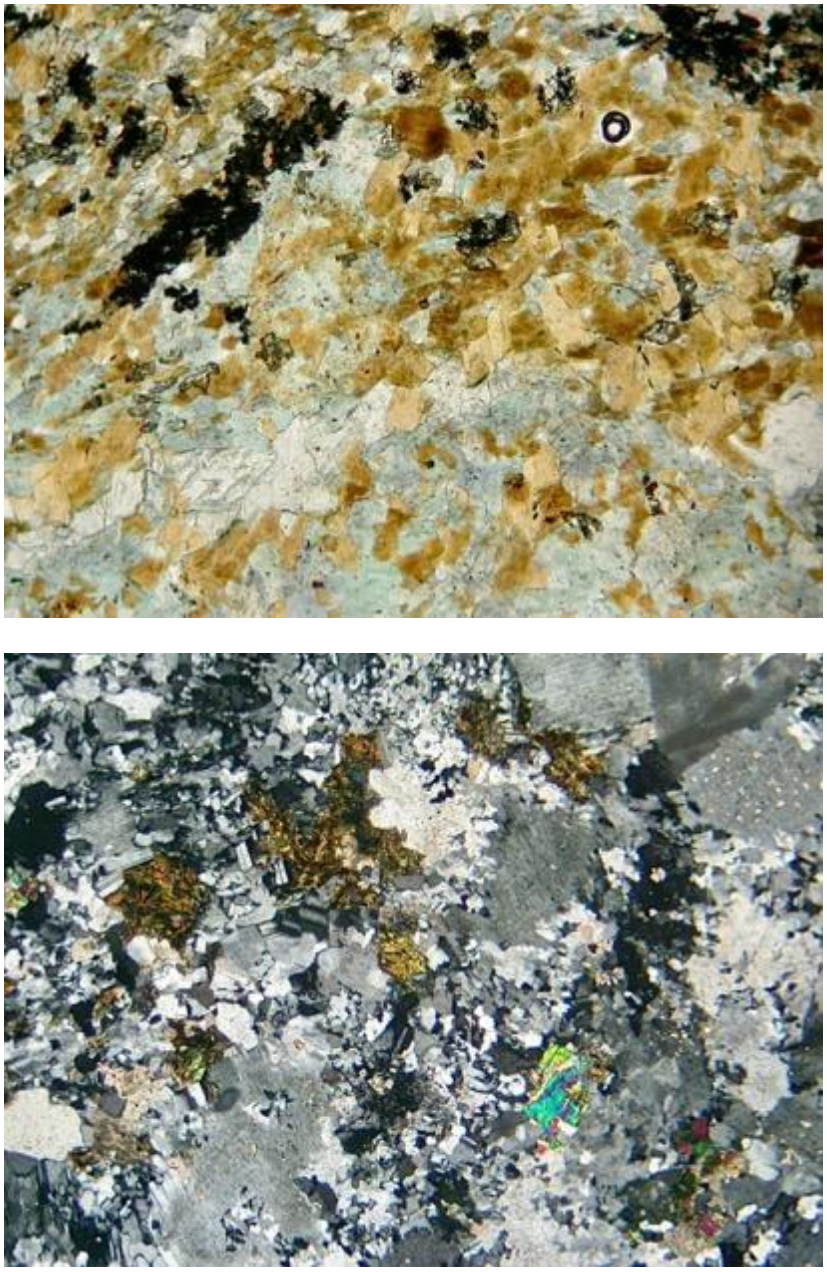


Fig. 23: Altered granitic rock, dominated by medium grained albite that is commonly finely recrystallised, plus minor aegirine (bright colours), stilpnomelane (brown) and carbonate (lower left). Transmitted light, crossed polarisers, field of view 2 mm

EALP025 TS

Summary: The sample exhibits two types of ultramafic lamprophyre showing a rather sharp, sub-planar contact. One is dark and the other paler in handspecimen. The darker rock is dominated by fine to medium grained, inequigranular brown hornblende, with minor interstitial carbonate (dolomite) and a little biotite. The other contains medium to coarse grained green-brown hornblende and biotite, with interleaved carbonate (dolomite) in biotite, as well as interstitial carbonate, and a little magnetite, tending to be associated with hornblende. No primary feldspar was recognised in the sample. It is possible that at least some carbonate represents an igneous phase (e.g. that which is interleaved with biotite), but some is hydrothermal, where it is associated with minor disseminated pyrite, and also occurring in several veins, mostly in the darker rock. A little gypsum and traces of quartz and sericite are associated with the carbonate veining.

Handspecimen: The drill core sample is composed of two different, apparently original igneous rock types, with a sharp, sub-planar contact in-between that is at a high angle to the core axis. The two lithologies are in subequal proportions. One is dark brown-grey in colour and dominated by a fine to medium grained, inequigranular ferromagnesian phase (perhaps hornblende, but could include biotite) and the other is somewhat paler grey in colour, with ferromagnesian mineral grains up to 2-3 mm across (could include biotite) and enclosed in abundant fine grained carbonate. In the darker rock, there are a few sub-planar, pale grey carbonate veins up to 1 mm wide. No diagnostic characteristics are recognised in either rock type, but it is speculated that they could be of mafic-ultramafic composition, with possible carbonate alteration and veining. Testing of the sample with dilute HCl gave little reaction on carbonate, suggesting that it is could be dolomite. The paler component is moderately magnetic, with susceptibility up to 670 x 10^{-5} SI, whereas the darker rock is only weakly magnetic, with susceptibility up to 70 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, the darker rock in handspecimen is dominated by fine to medium grained brown hornblende, with an inequigranular texture and grains up to 0.8 mm long (Fig. 24). Interstitial to hornblende are generally minor amounts of carbonate (dolomite) and a little biotite (brown and green varieties). The other (paler) rock type could be more strongly altered, but appears to retain a medium to coarse grained, inequigranular texture dominated by interlocking grains of biotite and green-brown hornblende up to a few millimetres across (Fig. 25). There is considerable interstitial fine grained carbonate (dolomite), with a little disseminated magnetite, tending to be mostly associated with hornblende. Throughout this compositional domain, there is evidence for an unusual texture between biotite and carbonate, with the two minerals being typically finely interleaved (Fig. 25). Although this texture could be interpreted as an alteration phenomenon, it also occurs in some carbonate-bearing lamprophyres. There is no evidence for the occurrence of primary igneous feldspar in either rock type; if it was formerly present, it must have been completely altered (e.g. to carbonate). Overall, it is not established in the sample as to whether there is primary igneous carbonate present, or that it is a hydrothermal alteration product, or both. The darker rock is interpreted as a hornblendite, maybe representing an ultramafic type of lamprophyre, and the paler rock is perhaps a biotite-hornblende-carbonate lamprophyre, again of ultramafic type.

b) Alteration and structure: Both rock types could have imposed alteration, but it is equivocal as to carbonate could include relict igneous material, or is entirely hydrothermal (see above). There is an association in both rock types between carbonate and minor disseminated pyrite (aggregates up to 0.4 mm) and this type of occurrence is considered to be hydrothermal. Similarly, carbonate is clearly hydrothermal where is occurs in several veins up to 0.6 mm wide (Fig. 24), mostly in the hornblendite. In the veins, carbonate (dolomite) is locally accompanied by gypsum and traces of quartz and sericite.

c) Mineralisation: Minor disseminated pyrite forms aggregates up to 0.4 mm across and occurs in both rock types, but is more common in the hornblendite. Minor magnetite, in grains up to 0.2 mm and also

forming small aggregates, is irregularly distributed in the biotite-hornblende-carbonate rock, mostly associated with hornblende.

Mineral Mode (by volume): hornblende and carbonate (dolomite) each 40%, biotite 17%, magnetite, pyrite and gypsum each 1% and a trace of quartz and sericite.

Interpretation and comment: It is interpreted that the sample contains two types of ultramafic lamprophyre with a relatively sharp, sub-planar contact. One is dark and the other paler in handspecimen. The darker rock is dominated by inequigranular brown hornblende, with minor interstitial carbonate (dolomite) and a little biotite. The other contains green-brown hornblende and biotite, with interleaved carbonate (dolomite) in biotite, as well as interstitial carbonate, and a little magnetite, tending to be associated with hornblende. No primary feldspar was recognised in either rock type. It is possible that at least some carbonate represents an igneous phase (e.g. that interleaved with biotite), but some is hydrothermal, where it is associated with minor disseminated pyrite, and also occurring in several veins, mostly in the darker rock. A little gypsum and traces of quartz and sericite are associated with the carbonate veining. Overall, the darker rock is interpreted as a hornblendite, maybe representing an ultramafic type of lamprophyre, and the paler rock is perhaps a biotite-hornblende-carbonate lamprophyre, again of ultramafic type.

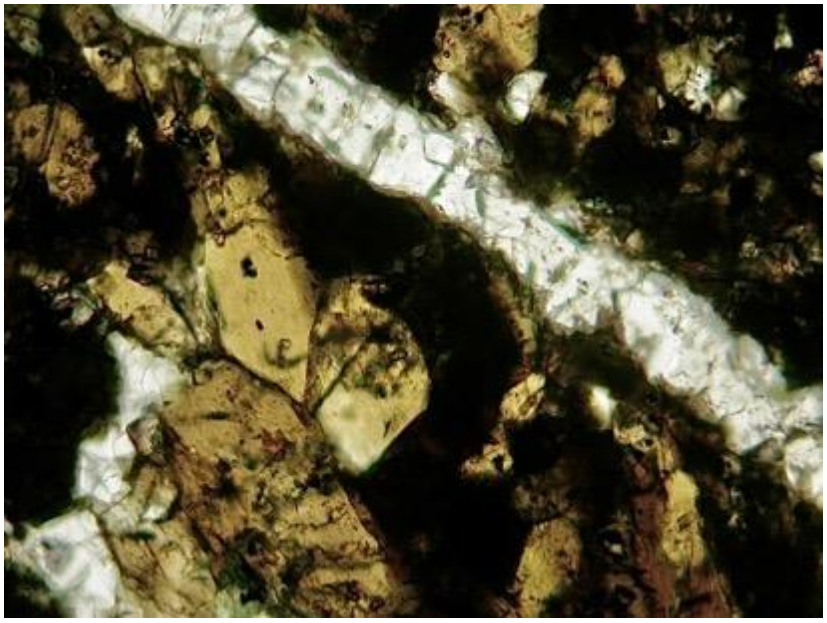
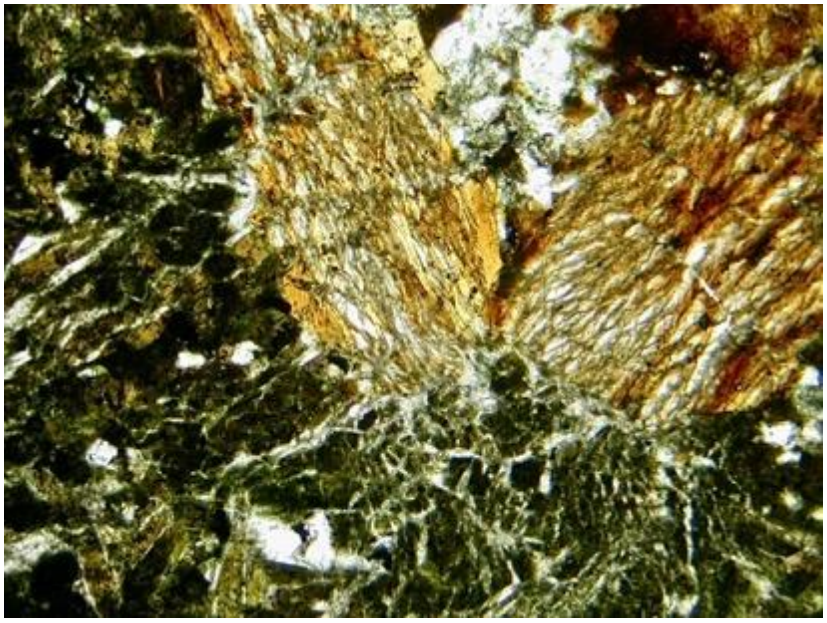


Fig. 24: Carbonate (dolomite) vein cutting dark hornblende-rich lamprophyre, with minor interstitial carbonate. Plane polarised transmitted light,

Fig. 25: Biotite grains (orange-brown) with finely interleaved carbonate, abutting against dark green-brown hornblende, with minor interstitial carbonate (clear). Plane polarised transmitted light, field of view



EALP026 TS

Summary: Original possible micromonzogranite, with adjacent fenite zone bordering on to a carbonate-rich rock. The latter could be a carbonatite and contains medium grained, inequigranular calcite, with minor blue amphibole, albite, microcline and a trace of biotite. The possible fenite zone is composed of varying proportions of albite, microcline and blue amphibole, with minor aegirine and ?xenotime. It abuts the partially reconstituted micromonzogranite that is dominated by sodic plagioclase (albite) and lesser amounts of microcline and quartz. Apparent retrograde alteration is observed in each of the compositional zones, with minor patchy sericite-muscovite, carbonate, stilpnomelane and trace blue amphibole and pyrite in the micromonzogranite, local replacement of ?xenotime by carbonate and blue amphibole in the possible fenite zone, and local replacement of feldspars by chlorite and carbonate in the carbonate-rich rock. Minor disseminated pyrite occurs in the fenite zone and the carbonate-rich rock, and the micromonzogranite is cut by a couple of thin carbonate veins.

Handspecimen: The drill core sample displays a medium to coarse grained, white, inequigranular carbonate-rich rock, also containing disseminated dark grey ferromagnesian grains, abutting a band several millimetres thick that is dominated by dark grey to grey-blue and pinkish minerals (e.g. ferromagnesian material and pink feldspar) and also contains disseminated pyrite, which in turn borders on to a mass of slightly banded, medium grained pink gneissic or granitic rock, evidently containing hematite-pigmented feldspar, minor quartz and blue-grey alteration patches. Contacts and banding in the sample are at a moderate angle to the core axis. Testing of the sample with dilute HCl gave a strong reaction on carbonate, indicating that it is calcite. The sample is weakly to moderately magnetic, with susceptibility up to 150 x 10^{-5} SI.

Petrographic description

a) Primary rock characteristics: In the section, the rock is mineralogically and texturally complex and there are three apparent compositional domains. It is proposed that there were two primary rock types, with a third type occurring in-between that is considered as an intervening reaction zone. The pink rock in handspecimen is evidently partly recrystallised and mineralogically reconstituted, but was likely to be a former medium grained, inequigranular, maybe rather leucocratic granitoid containing faintly hematite-pigmented sodic plagioclase, lesser amounts of quartz and microcline (Fig. 26). It is unsure as to whether there was any ferromagnesian material originally present, due to imposed recrystallisation and alteration. This rock type is interpreted as a former micromonzogranite. The carbonate-rich rock is generally medium grained and probably recrystallised and contains abundant calcite (up to 2 mm), with smaller amounts of blue amphibole (maybe of crossite type), minor albite and microcline, and a trace of biotite (Fig. 27). Texturally, this rock type is not dissimilar to a marble, but the occurrence of blue amphibole would be unexpected in such a lithology and hence it is speculated that it might represent a type of carbonatite. Such a concept might be in accord with the fact that the intervening somewhat banded assemblage is dominated by patchily abundant albite, blue amphibole, with locally common microcline and aegirine, and a little disseminated ?xenotime (Fig. 28). Such an assemblage could represent a fenite reaction zone between the two compositionally unlike primary rock types.

b) Alteration and structure: As described above, the interpreted fenite alteration zone with abundant alkali feldspars, blue amphibole and minor aegirine could represent a product of reaction between micromonzogranite and the carbonate-rich rock. Some of early-formed minerals in the rock (e.g. those formed by igneous crystallisation and those perhaps formed by relatively high-temperature metasomatic replacement), e.g. albite, K-feldspar, aegirine and ?xenotime, show local replacement by apparent retrograde minerals. A little stilpnomelane has formed from aegirine and ?xenotime. In the micromonzogranite, there are a few patches of muscovite-sericite up to 2 mm across that has developed from feldspars, and the latter phases are commonly finely recrystallised. Feldspars are also locally replaced by carbonate. In the carbonate-rich rock and interpreted fenite zone, original feldspars are locally replaced by carbonate and fine grained brownish chlorite, and ?xenotime also has minor replacement by blue amphibole and carbonate. A little pyrite is observed throughout the sample, but is

more common in the interpreted fenite zone and the carbonate-rich rock (Fig. 27). The micromonzogranite is cut by a couple of thin carbonate veins.

c) Mineralisation: Minor disseminated pyrite occurs as part of the interpreted retrograde alteration. It is more common in the interpreted fenite zone and the carbonate-rich rock, where there are sparse aggregates up to 1.5 mm across.

Mineral Mode (by volume): carbonate (calcite) 45%, plagioclase (albite) 20%, blue amphibole 15%, K-feldspar (microcline) 7%, quartz 5%, aegirine and pyrite each 2%, stilpnomelane, chlorite, sericite-muscovite and ?xenotime each 1% and a trace of biotite and hematite.

Interpretation and comment: It is interpreted that the sample displays an apparent fenite reaction zone between a micromonzogranite and a carbonate-rich rock that could represent a carbonatite. The possible fenite zone is composed of varying proportions of albite, microcline and blue amphibole, with minor aegirine and ?xenotime. It abuts the partially reconstituted micromonzogranite that is dominated by sodic plagioclase (albite) and lesser amounts of microcline and quartz. The carbonate-rich rock contains medium grained, inequigranular calcite, with minor blue amphibole, albite, microcline and a trace of biotite. Apparent retrograde alteration is observed in each of the compositional zones, with minor patchy sericite-muscovite, carbonate, stilpnomelane and trace blue amphibole and pyrite in the micromonzogranite, local replacement of ?xenotime by carbonate and blue amphibole in the possible fenite zone, and local replacement of feldspars by chlorite and carbonate in the carbonate-rich rock. Minor disseminated pyrite occurs in the fenite zone and the carbonate-rich rock, and the micromonzogranite is cut by a couple of thin carbonate veins.

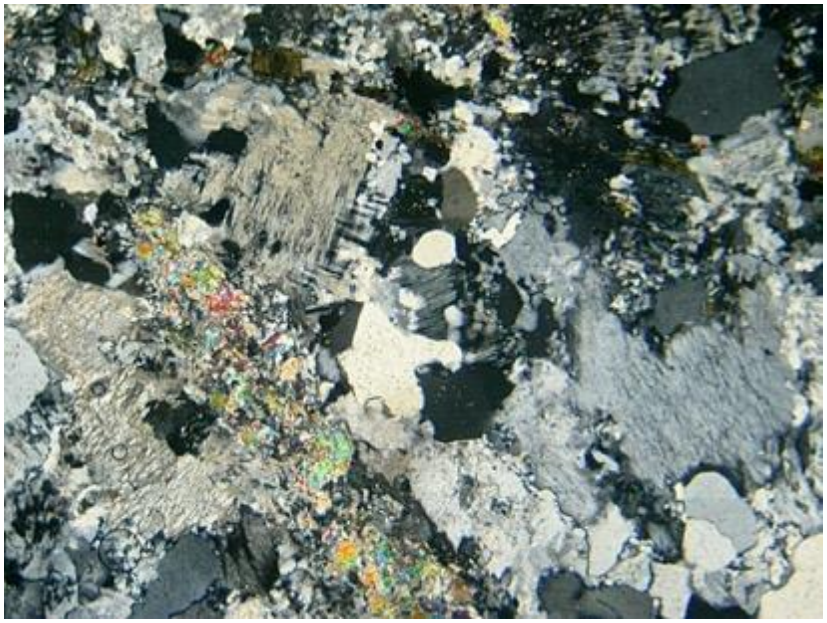


Fig. 26: Partly reconstituted micromonzogranite containing locally finely recrystallised albite, with minor quartz and microcline, and an elongate aggregate of retrograde sericite-muscovite (bright colours). Transmitted light, crossed polarisers, field

Fig. 27: Possible carbonatite containing inequigranular, medium grained calcite, blue (-green) amphibole, K-feldspar (small clear grains) and an aggregate of retrograde pyrite (black). Plane polarised transmitted light, field of view 2 mm

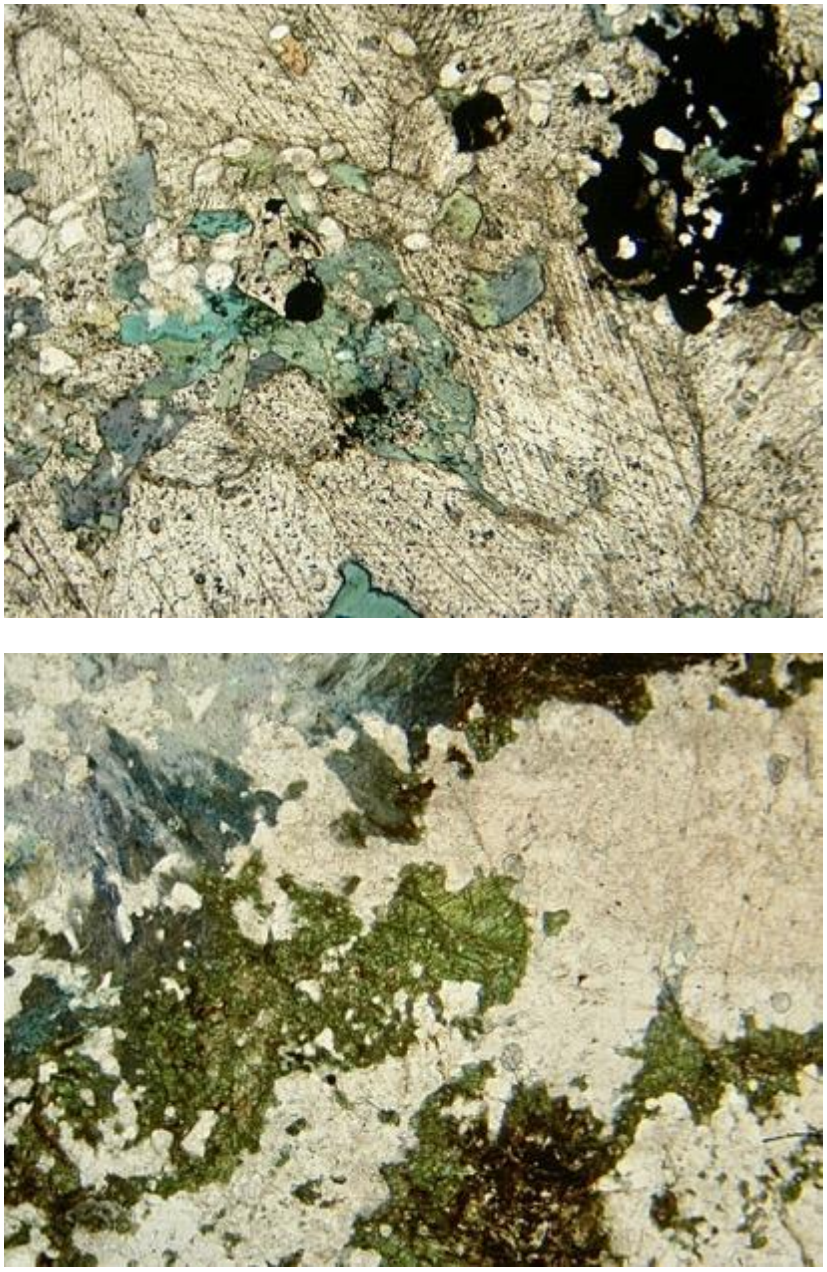


Fig. 28: Zone of possible fenite alteration containing aegirine (green and locally replaced by dark brownish stilpnomelane), blue amphibole, albite (clear) and minor carbonate. Plane polarised transmitted light,