APPENDIX E6: PETROGRAPHIC DESCRIPTIONS

In this appendix, petrographic descriptions, modal mineralogy and thin section photomicrographs are given for individual petrographic samples. Samples are grouped according to the area in which they were collected. For full sample details including assigned stratigraphic units and geochemical groups, refer to Appendix E5.

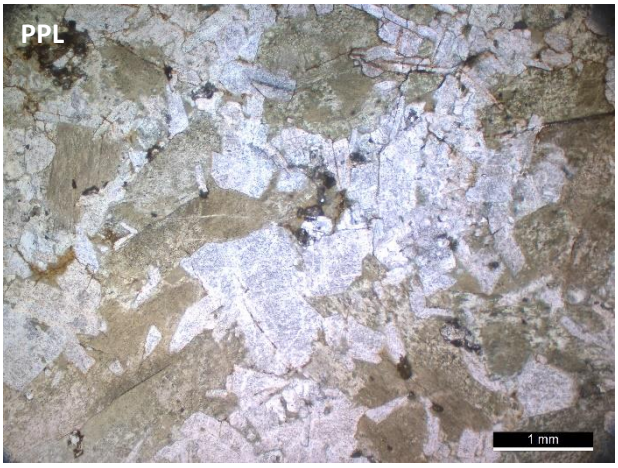
SAMPLE NO: BAD001 **GRID REFERENCE:** 495680 6792411

FIELD DESCRIPTION: Feathery pyroxene crystals and no clear orientation - equivalent also found with a blocky texture.

MAPPED LITHOLOGY: Gabbro

HAND SPECIMEN

Coarse grained mafic metaigneous rock with large 1cm actinolite acicular crystals and 1-4 mm elongate tabular laths of plagioclase, nonmagnetic.



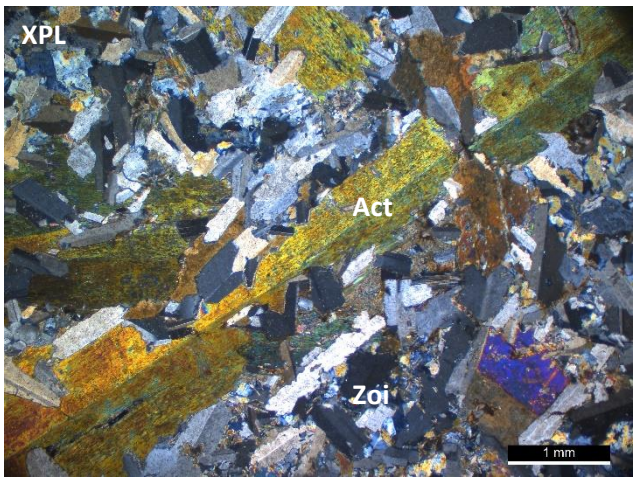
THIN SECTION

PPL/XPL

Actinolite	43%
Plagioclase	35%
Zoisite	15%
Epidote	5%
Leucoxene	2%
Ilmenite	<1%

Coarse grained metaigneous rock consisting of randomly oriented plagioclase and poikilitic actinolite crystals (after pyroxene) displaying an ophitic texture, in addition to leucoxene and ilmenite.

Actinolite crystals are subhedral and acicular and range in size from 1-10mm with many crystals displaying simple twinning, whereas plagioclase occurs as randomly oriented euhedral tabular crystals between 0.8-3 mm in size. In the fine-grained groundmass between these two phases are smaller 0.2-0.6 mm plagioclase crystals, many of which have been altered to fine grained zoisite, actinolite and epidote. The remaining plagioclase crystals are typically stained brown around their margins. Cross cutting crystals of both actinolite and plagioclase demonstrate metamorphic recrystallisation and growth of crystals.



The rock exhibits a poikilitic texture, comprising oikocrysts of actinolite enclosing randomly oriented crystals of plagioclase. The incursion of plagioclase crystals into the margins of actinolite display a sub-ophitic texture.

A very minor amount of ilmenite is present as 0.1 mm crystals, whereas a more significant amount of leucoxene is present (derived from breakdown of ilmenite).

CLASSIFICATION

Cumulate-textured metagabbro

SAMPLE NO: BAD001a **GRID REFERENCE:** 495680 6792411

FIELD DESCRIPTION: Linear crystals aligned and splaying off as roots - clearly linear pyroxenite

MAPPED LITHOLOGY: Linear spinifex textured basalt

THIN SECTION

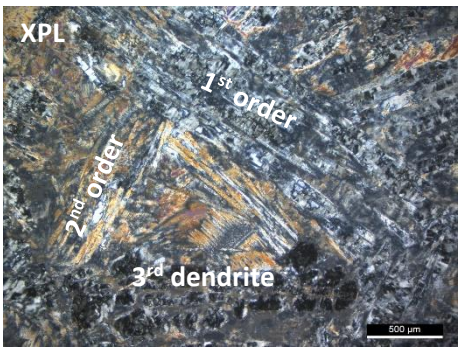
PPL/XPL

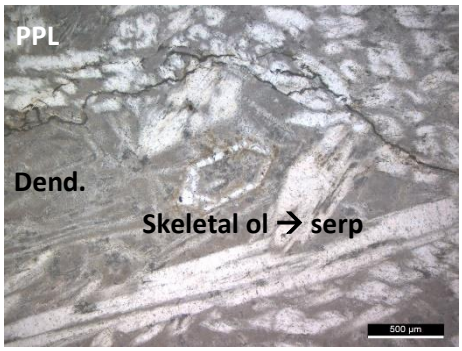
Augite (cpx)
Glassy groundmass
Serpentine
Quartz

Phenocrysts account for 70% of the sample, the rest is interstitial fine grained groundmass and minor pseudomorphed skeletal olivine.

- Thin, elongated crystals of pyroxene (pseudomorphed by secondary minerals) present as sets of parallel crystals with the same orientation – textures are strikingly similar to the aligned platy pyroxene spinifex (A3 zone) described by Lowrey et al. (2017) in the NE Murchison Domain. In which case, many of these apparently elongate crystals have a platy crystal habit.
- Branching slightly in one direction – subvertical-plates spread out downwards, act as way-up criteria.
- Two scales of plate – largest first order plates have widths of 0.1-0.15 mm, occasionally up to 0.2 mm. Lengths of 1-30 mm. These plates are totally replaced by secondary hydrous minerals. Second order plates are confined to interstial areas between larger plates and do not cross cut – dimensions 0.4-1.0 mm, and thicknesses <0.1 mm (~ 50 microns). These plates are composed of cpx and are not replaced by secondary minerals, but are much less abundant than first order plates.
- The first order, largest plates intersect one another at oblique angles of less than 40 degrees.
- Complex dendritic patterns in interstitial spaces, surrounded by dusty very fine material, interpreted as quenched glass.
- Acicular pyroxene crystals also present, and do not cross cut the larger plates – euhedral basal sections visible (and also replaced by hydrous minerals).
- In some instances, multiple basal sections of acicular crystals are aligned with plate – may represent the 'acicular protrusions' into glassy areas as described by Lowrey et al. (2017).
- Skeletal olivine crystals pseudomorphed by quartz and other secondary minerals. Present in interstitial fine grained areas between plates – trapped between plates. 0.5-1 mm in diameter. Always in isolated areas in glassy groundmass between plates.

Lowrey et al. (2017) identified skeletal olivine pseudomorphs within the A2 random zone, however, BAD001a indicates that skeletal olivine is also found in interstitial zones within the aligned platy pyroxene A3 zone – representing trapped olivine crystals that cooled rapidly.





CLASSIFICATION

Aligned platy pyroxene spinifex-textured metabasalt

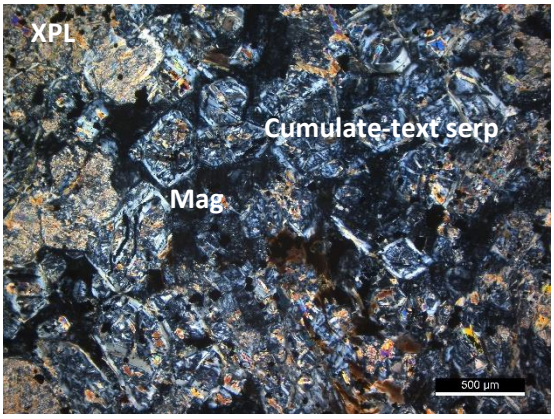
SAMPLE NO: BAD002 **GRID REFERENCE:** 495582 6791719

FIELD DESCRIPTION: Ultramafic cumulate, dense and magnetic. Pink tabular to rounded phenocrysts unidentified.

MAPPED LITHOLOGY: Peridotite

HAND SPECIMEN

Highly magnetic, altered ultramafic unit, with pink, blocky to rounded phenocrysts 3-4 mm in size, groundmass dark and fine grained – ultramafic.

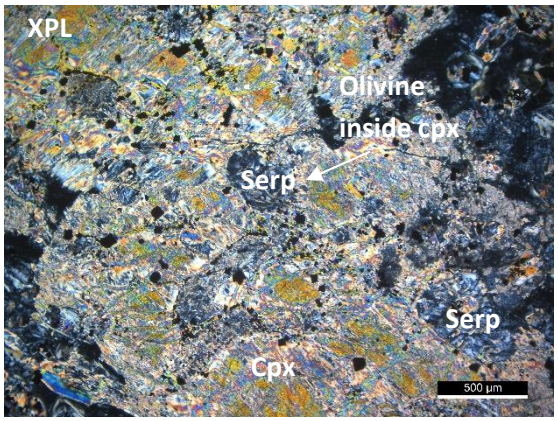


THIN SECTION

PPL/XPL

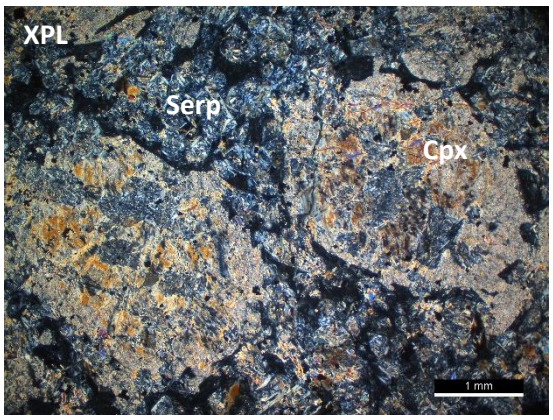
Serpentine	40%
Opaques	10% (incl 6% magnetite, 2% ilmenite, 2% FeOH)
Pyroxene	7.5%
Actinolite	42.5%

Phenocrysts occupy 40% of the unit.



A metamorphosed porphyritic, poikilitic and serpentised ultramafic intrusive rock comprising phenocrysts of pyroxene (predominantly pseudomorphed by actinolite but with minor primary clinopyroxene preserved) containing relic olivine crystals, now replaced by serpentine and magnetite, surrounded by a finer grained groundmass of serpentine, magnetite, actinolite and minor pyroxene.

Phenocrysts of pyroxene vary between 1.5 and 3.5 mm in size with subhedral to euhedral crystal shapes, many of which exhibit 8 sided prismatic crystals. The interior of crystals is typically very ragged and altered to fine grained actinolite, with striations in a single direction (altering along the orientation of cleavage), and portions of the crystals that preserve upper 2nd order birefringence and inclined extinction – the lack of any 120 degree cleavage intersections suggests that these may be preserved clinopyroxene rather than pseudomorphs of secondary actinolite. These phenocrysts display a poikilitic texture, enclosing abundant 0.2-0.3 mm relic rounded olivine crystals now replaced by serpentine and magnetite, demonstrating that olivine crystallised prior to (clino)pyroxene.



The groundmass is comprised of fine-grained mesh-textured serpentine preserving outlines of 0.2-0.4 mm olivine crystals and fine grained actinolite (outlining 0.3-0.5 mm relic pyroxene crystals), both of which preserve a cumulate texture. Opaques are abundant in the unit consist of three phases – highly reflective magnetite grains typically 0.1-0.2 mm closely associated with serpentine and relic olivine, which sometimes contains exsolution lamellae, likely ilmenite. The margins of these grains are not reflective and may indicate breakdown to other iron oxide/hydroxide mineral. In some instances, opaques define the margins and internal fractures of original olivine crystals.

CLASSIFICATION

Serpentinised porphyritic ultramafic cumulate – base of Warriedar Suite intrusion

SAMPLE NO: BAD003 **GRID REFERENCE:** 494961 6796400

FIELD DESCRIPTION: Small finer grained sill intruding larger, coarser grained sill. Not sharp contact but undulating, suggesting a late stage feature.

MAPPED LITHOLOGY: Dolerite-gabbro with late stage, more highly evolved cross cutting feature

THIN SECTION

HOST INTRUSIVE

PPL/XPL

Actinolite	65%
Plagioclase	9%
Zoisite/sericite/clay	21%
Ilmenite	2%
Quartz	3%

Coarse grained metaigneous rock consisting of actinolite crystals in an altered groundmass of plagioclase, zoisite and clays.

Actinolite crystals are subhedral and tabular to acicular in shape, ranging in size from 0.8-3 mm. Some crystals display simple twinning and all display bright interference colours. Some of the larger crystals are more highly altered and broken down into acicular actinolite needles, whereas the smaller crystals tend to be unaltered. The groundmass between actinolite comprises tabular to elongate crystal shapes 0.3-0.5 mm in length reflecting plagioclase that has been altered to blue zoisite, sericite and clays. Inclusions of these crystals within the phenocrysts tend to be less altered and plagioclase remains.

Oxide aggregates up to 0.5 mm in length comprise needles of ilmenite.

CLASSIFICATION

Metadolerite-gabbro

LATE STAGE INTRUSIVE

PPL/XPL

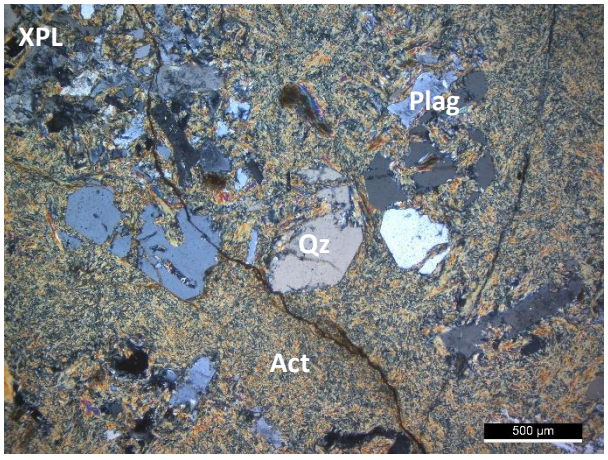
Actinolite	35%
Plagioclase	40%
Quartz	19%
Ilmenite	1%
Chlorite	2%
Zoisite	3%

A medium grained porphyritic textured intrusive sill consisting of fine grained massive actinolite (<0.1mm), subhedral crystals of quartz (0.1-1mm), subhedral tabular crystals of plagioclase (0.1-1mm) feldspar and elongate crystals of actinolite. Minor amounts of zoisite and chlorite, likely derived from alteration of plagioclase. Margins of the sill are not sharp but are gradational and undulating, suggesting a late stage magmatic feature. In general, finer grained than the surrounding host intrusive. Some Fe staining along cleavage planes in actinolite.

Elongate crystals of an oxide, likely ilmenite, are present as ilmenite is present as crystals up to 0.5 mm in length and forming interesting patterns.

CLASSIFICATION

Quartz diorite late stage intrusive



SAMPLE NO: BAD004 **GRID REFERENCE:** 495306 6796930

FIELD DESCRIPTION: Coarse crystals, some long patches of pyroxene reaching several centimetres possibly intrusive features.

MAPPED LITHOLOGY: Gabbro

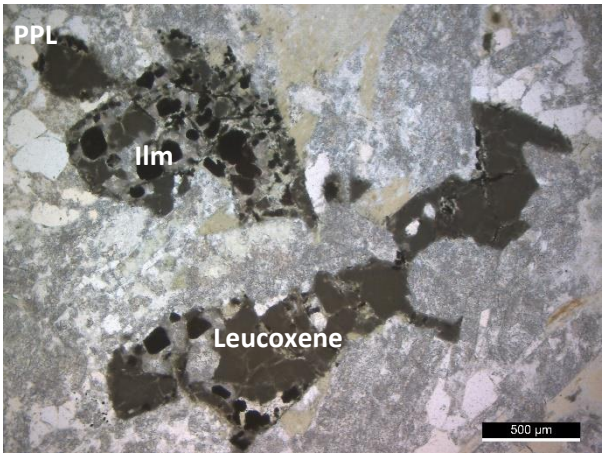
HAND SPECIMEN

Coarse grained mafic metaigneous rock comprising dark grey amphibole and white plagioclase. Nonmagnetic, some elongate amphibole rich patches up to several cm in length and up to 1cm in width present.

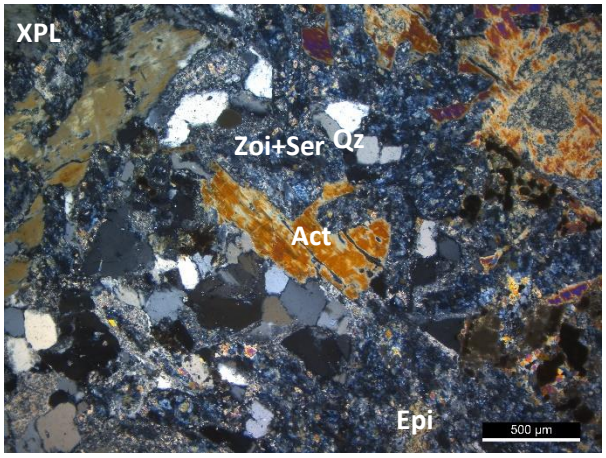
THIN SECTION

PPL/XPL

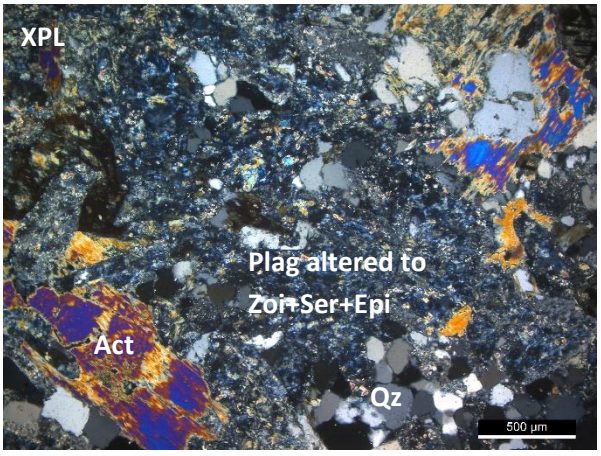
Actinolite	35%
Plagioclase	5%
Sericite	15%
Zoisite	15%
Epidote	5%
Ilmenite	2%
Leucoxene	3%
Quartz	20%



Coarse grained mafic rock comprising altered actinolite crystals and plagioclase crystals almost entirely replaced by a fine-grained assemblage of sericite, actinolite, epidote and zoisite.



Actinolite crystals consists of ragged, anhedral laths 1-4 mm in length, some exhibiting simple twinning. Euhedral to subhedral tabular crystals of plagioclase 0.2-1 mm in size are present, however, a majority of the plagioclase has been replaced by a fine grained assemblage of epidote (high biref), zoisite (blue in xpl), sericite and actinolite, only identifiably by the tabular outlines of crystals that remain. Significant amounts of anhedral quartz crystals are present as clusters and as linear (vein?) features across the unit, some crystals up to 3 mm in size – likely a consequence of fluid flow associated with metamorphism – consistent with the pervasive alteration of plagioclase feldspar.



Elongate needles of ilmenite present, up to 0.5 mm, breaking down to titanite/leucoxene, up to 1.5mm in size and more abundant than ilmenite.

CLASSIFICATION

Hydrothermally altered metagabbro.

SAMPLE NO: CHU001 **GRID REFERENCE:** 502280 6797204

FIELD DESCRIPTION: Some fine veining, greenschist alteration minerals (chl/act/epi)

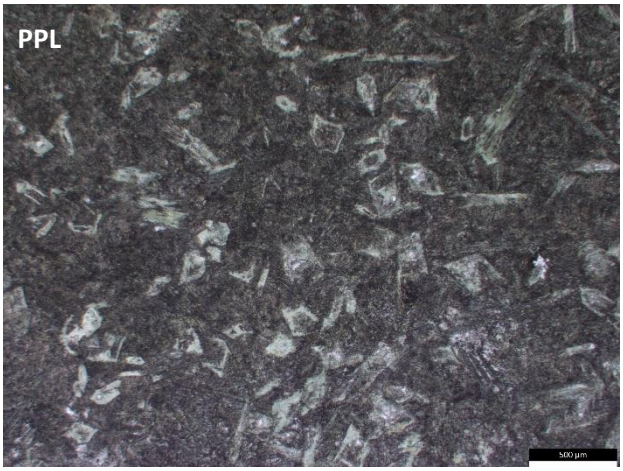
MAPPED LITHOLOGY: Basalt

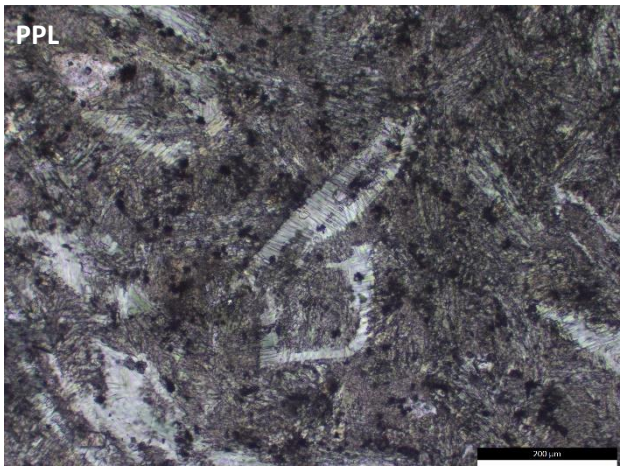
THIN SECTION

PPL/XPL

Tremolite/actinolite/chlorite	55%
Plagioclase	20%
Quartz	2%
Opaque	2%
Epidote	1%

30% phenocrysts.





Fine grained vitrophyric, porphyritic basalt comprising elongate skeletal phenocrysts of fibrous tremolite (after pyroxene) between 0.25-1 mm in length and 0.1 mm in width. Basal sections are skeletal with hollow cores, indicative of rapid cooling. Fine grained groundmass consists of actinolite, tremolite and plagioclase, and chlorite generally <0.1 mm in size.

Very minor subhedral opaques, likely ilmenite are present. Also present are minor amounts of anhedral quartz and stubby crystals of epidote.

CLASSIFICATION

Porphyritic metabasalt with skeletal phenocrysts (proto-spinifex-texture?)

SAMPLE NO: CHU002 **GRID REFERENCE:** 503648 6797276

FIELD DESCRIPTION: Black tourmaline? Found as an outlying 2m boulder within an ultramafic unit.

MAPPED LITHOLOGY: Peridotite

HAND SPECIMEN

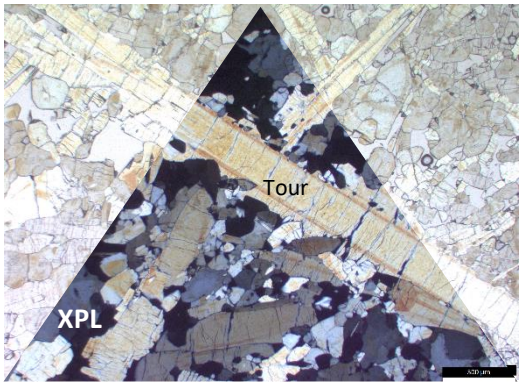
A non-magnetic, medium-coarse grained sample containing black acicular crystals possibly resembling tourmaline, with radial growth in places. The unit is friable, and breaks up easily into grains when pressure is applied.

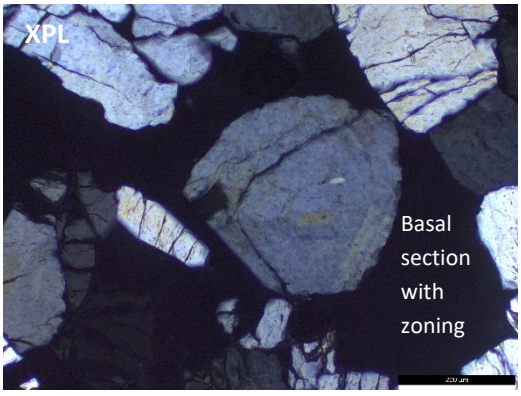
THIN SECTION

PPL/XPL

Black tourmaline 100%

A sample comprising entirely of acicular, subhedral-euhedral, elongate, randomly oriented, prismatic crystals reaching 1-7mm in length. The crystals are strongly pleochroic green-cream, with 2nd order interference colours and a noticeable lack of cleavage. Basal cross sections are triangular to rounded display triangular zoning, and are 0.3-0.5mm in length, with fractures present perpendicular to the long axis of crystals. In some places, there appears to be void space between grains.





CLASSIFICATION

Shorl (black tourmaline), known locally as warrierite, possibly from metasomatism of host rock lithologies or emplacement associated with pegmatites during late granitic intrusion.

SAMPLE NO: CHU003 **GRID REFERENCE:** 502841 6797811

FIELD DESCRIPTION: Highly magnetic, altered ultramafic unit, with dark red veining alteration, white/orange altered phenocrysts and pistachio green groundmass.

MAPPED LITHOLOGY: Peridotite

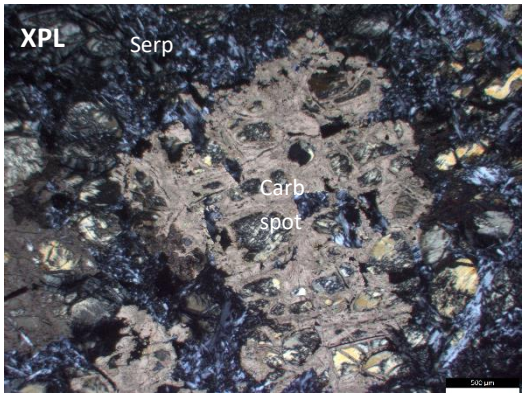
HAND SPECIMEN

Highly magnetic, altered ultramafic unit, with dark red veining alteration, white/orange altered phenocrysts and pistachio green groundmass.

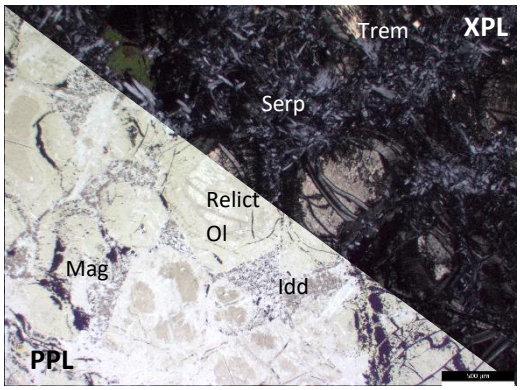
THIN SECTION

PPL/XPL

Serpentine	65%	Carbonate	15%
Magnetite	~10%	Tremolite	5%
Iddingsite	5%		



The sample is a metamorphosed, carbonate altered and serpentinised ultramafic cumulate, consisting primarily of the alteration products of olivine; serpentine, magnetite, carbonate and minor tremolite and iddingsite. Relict olivine crystals are visible and highlighted by alteration phases, typically 0.5-1 mm in size, and with the characteristic anhedral, rounded and fractured appearance of olivine. The cumulate texture is estimated to have been ortho- to mesocumulate prior to serpentinisation, with most crystals touching one another and isolated interstitial areas between.



Magnetite is present along fractures within relict crystals and along grain boundaries, with fibrous, low birefringence serpentine replacing a majority of the cumulate crystals with a mesh texture, in addition to minor fibrous tremolite (higher birefringence). Poikiloblastic carbonate (most likely magnesite) is present as spots 1-3 mm in size (most ~2mm) and dispersed throughout the sample, with inclusions of serpentine.

Based on cumulate crystal morphology, the sample originally consisted of about 80% cumulate olivine (plausibly all olivine).

CLASSIFICATION

Serpentinised and carbonate altered ultramafic cumulate (originally peridotitic).

SAMPLE NO: CHU004 **GRID REFERENCE:** 502030 6801161

FIELD DESCRIPTION: Highly magnetic, altered ultramafic unit, with minor dark red alteration, more common green alteration and significant white (carbonate?) alteration.

MAPPED LITHOLOGY: Peridotite

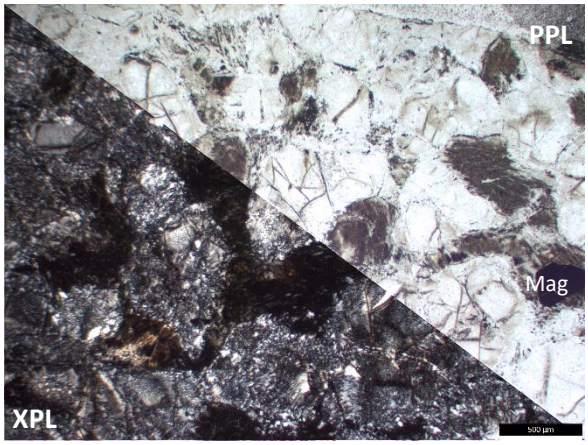
HAND SPECIMEN

Highly magnetic, altered ultramafic unit, with minor dark red alteration, more common green alteration and significant white (carbonate?) alteration.

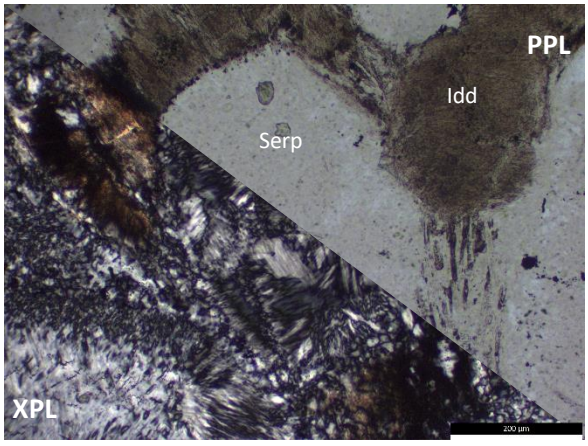
THIN SECTION

PPL/XPL

Serpentine	70%
Magnetite	10%
Iddingsite	20%



The sample is a highly altered ultramafic cumulate, consisting primarily of the alteration products of olivine; serpentine, iddingsite and magnetite. Relict rounded olivine crystals are visible and highlighted by alteration phases, predominantly 0.2-0.5 mm in size, with a few larger crystals up to 1-2 mm in diameter.



Magnetite is present along fractures within grains and along grain boundaries, defining the characteristic morphology of olivine – demonstrating magnetite is derived from the breakdown of olivine. Some euhedral, larger crystals of magnetite are also present. The cumulate crystals are replaced by mesh textured, fibrous low birefringence serpentine, in some instances replacing cumulate grains in a radial manner.

Based on cumulate crystal morphology, the sample originally consisted of about 70% cumulate olivine crystals and 10-15% of another cumulate phase (likely pyroxene).

CLASSIFICATION

Serpentinised ultramafic cumulate (originally peridotitic, almost dunite?).

SAMPLE NO: CHU005 **GRID REFERENCE:** 505163 6801906

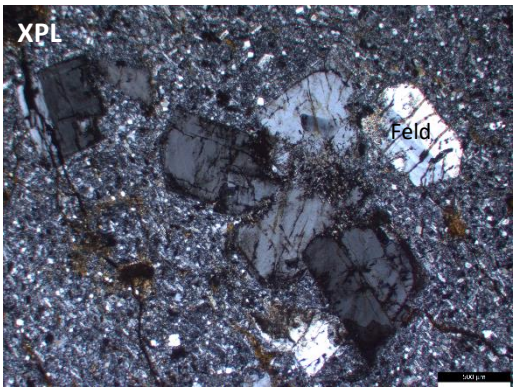
FIELD DESCRIPTION: Porphyritic felsic porphyry with quartz and feldspar phenocrysts

MAPPED LITHOLOGY: Felsic porphyry (cross cutting stratigraphy)

HAND SPECIMEN

A porphyritic, crystalline felsic igneous rock containing visible phenocrysts of quartz and feldspar (possibly plagioclase and K-feldspar) in a fine grained brown-cream groundmass. Also minor black submillimetre specks present, non-magnetic. Although it has the appearance of a porphyritic lava, the cross cutting nature of the unit suggests it is a shallow intrusive associated with intrusion of late stage granitoids in the area.

THIN SECTION

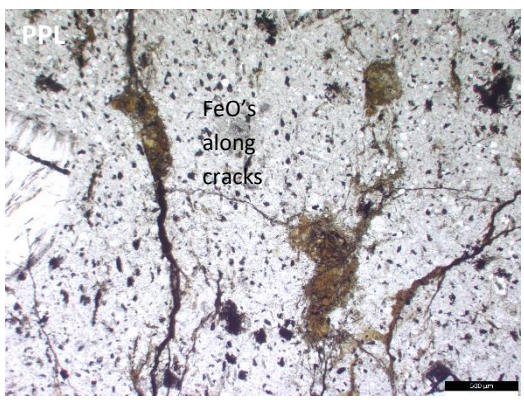


PPL/XPL

Plagioclase/K-feld	65%
Quartz	10%
Biotite	3%
Sericite	10%
Opaques (incl goethite)	12%

A porphyritic rock comprised of feldspar (90%) and quartz (10%) phenocrysts, with a fine grained crystalline groundmass. Plagioclase phenocrysts are euhedral, 0.2-2 mm, and show clear polysynthetic twinning and also compositional zoning. About 20% of feldspar phenocrysts are speckled with a dusty appearance and do not show polysynthetic twinning, suggesting they may be K-feldspar. Further, a portion of the plagioclase feldspar phenocrysts show moderate sericite alteration, resulting in a cloudy appearance typically around margins and along twinning planes.

Quartz phenocrysts are less common, and differ in that they are typically anhedral to subhedral and large in size (up to 1.2mm). Some crystals have embayments and etching that could suggest some degree of resorption. Biotite is also present (pleochroic brown-cream in PPL, high birefringence masked in XPL).



Some feldspar phenocrysts are bound together as glomerocrysts of 3-4 crystals.

Minor amounts of opaque mineral (< 0.1mm), including goethite, principally focussed along cracks.

CLASSIFICATION

Quartz-feldspar porphyry associated with late granitic intrusion, classified as a (leuco)tonalite.

SAMPLE NO: CHU006 **GRID REFERENCE:** 506825 6802308

FIELD DESCRIPTION: Fine grained, green alteration minerals in patches

MAPPED LITHOLOGY: Basalt

HAND SPECIMEN

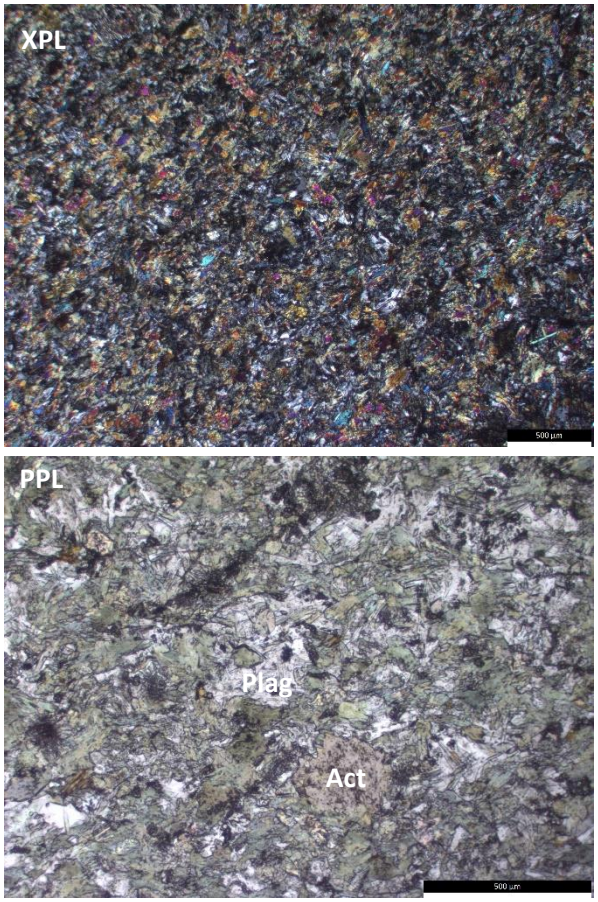
THIN SECTION

PPL/XPL

Actinolite	58%
Chlorite	10%
Plagioclase	28%
Biotite	2%
Quartz	2%

A fine-grained basalt comprising a groundmass of euhedral-subhedral plagioclase crystals (100-200 microns, showing polysynthetic twinning) interlocking with actinolite and minor chlorite (~200 microns). Some quartz is present, likely secondary as it is associated with increased metamorphism and alteration. Some larger actinolite crystals are larger and reach 0.8-1 mm in size. These actinolite crystals have pleochroic colours that very from light green to light brown.

A zone of increased alteration is associated with larger crystals of actinolite, quartz crystals and some brown biotite – corresponding to patches of green alteration in hand specimen.



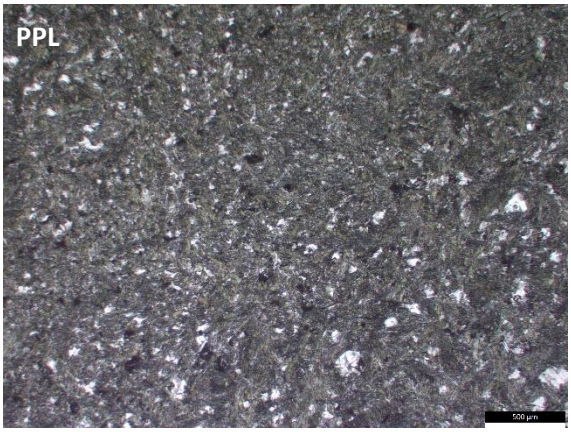
CLASSIFICATION

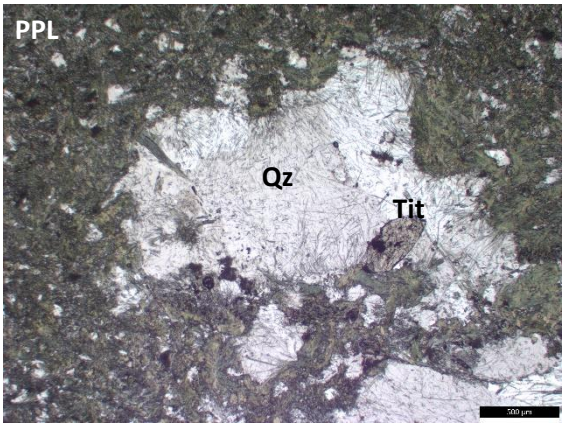
Metabasalt

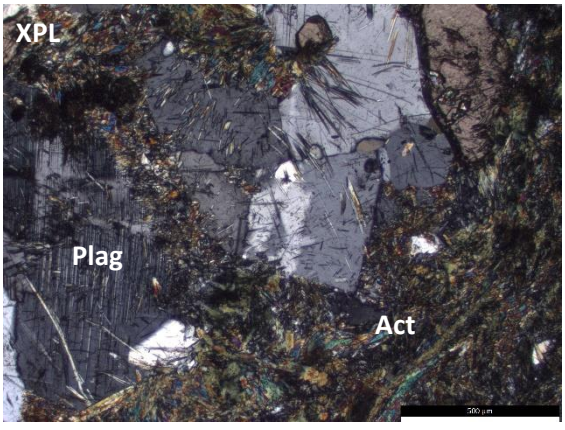
SAMPLE NO: CHU008 **GRID REFERENCE:** 505392 6798795

FIELD DESCRIPTION: Fine grained, patches of green alteration minerals. Possible faint varioles?

MAPPED LITHOLOGY: Basalt







THIN SECTION

PPL/XPL

Actinolite	70%
Quartz	27%
Plagioclase	10%
Chlorite	2%
Titanite	1%

A fine grained equicrystalline mafic rock consisting of actinolite, plagioclase and minor quartz and chlorite. Actinolite is pleochroic light green-dark green and typically lath-shaped, varying in size from 0.1-0.4 mm. Plagioclase is present as <0.1 mm fine crystals, whereas quartz is 0.1-0.2 mm in size and in some instances has surrounding amphiboles growing into it, indicating it is secondary in origin. Minor quartz veining cross cuts the sample and silica-rich patches (affecting 5-10% of the sample), up to 3-4 mm in size comprise quartz with acicular crystals from the surrounding mass, in addition to high relief, often wedge-shaped titanite. Most of these quartz patches are 100-200 microns in size and irregularly shaped, potentially infilled and deformed vesicles??

CLASSIFICATION

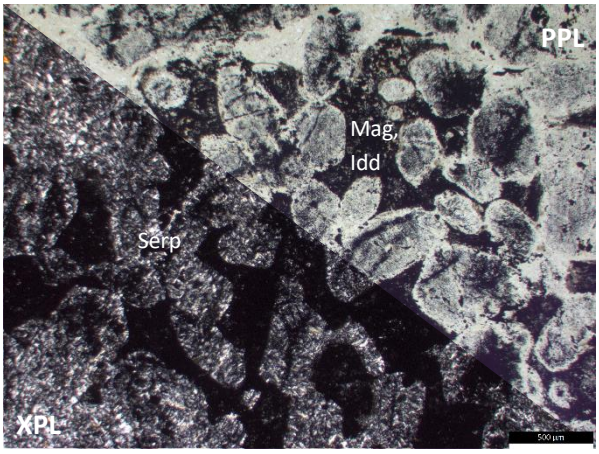
Porphyritic metabasalt (potentially with deformed and modified amygdales?)

SAMPLE NO: CHU009 **GRID REFERENCE:** 505552 6799362

FIELD DESCRIPTION: Highly magnetic, altered ultramafic unit. On mapped fault, highly magnetic, not as altered as previous peridotites.

MAPPED LITHOLOGY: Peridotite

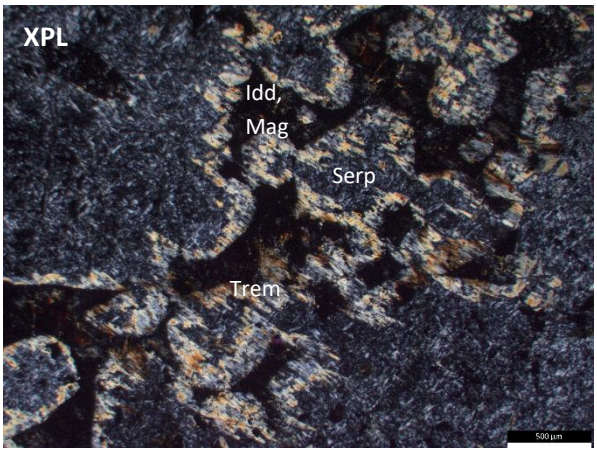
THIN SECTION



PPL/XPL

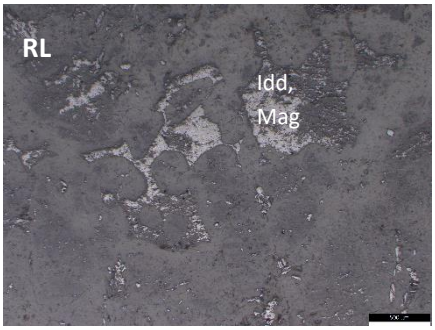
Serpentine	70%	Tremolite	10%
Magnetite	10%	Iddingsite	10%
Carbonate	Trace		

The sample is a highly altered ultramafic cumulate, consisting primarily of the hydrothermal alteration products of olivine; serpentine, magnetite, tremolite, iddingsite and trace carbonate. The unit displays an orthocumulate texture, with round, originally olivine crystals replaced by serpentine with characteristic mesh texture (colourless-pale green in PPL), and some tremolite at grain margins (higher birefringence, fibrous), as well as trace carbonate (3rd order birefringence, most likely magnesite). Tremolite crystals are all aligned and go into extinction at the same time, suggesting that they were subject to pressure when alteration occurred.



Relict cumulate olivine crystals account for about 75% of the unit, and vary in size from 0.25-2 mm, though most are on the order of 0.5-1 mm. In addition to typical rounded relict olivine, some crystal shapes are more tabular and elongate with an apparent bastite texture, suggesting minor pyroxene may have also been present.

Magnetite is present as euhedral crystals along fractures within grains and also as a fine grained assemblage with iddingsite in the interstitial areas between cumulate crystals (see reflected light image). Best example of cumulate texture in rocks from the area.



CLASSIFICATION

Serpentinised ultramafic cumulate (originally peridotitic, dunite?).

SAMPLE NO: CHU014 **GRID REFERENCE:** 502041 6793576

FIELD DESCRIPTION: Variolitic and amygdaloidal basalt, qz amygdales up to 2mm in size, varioles up to 1cm in size. Amygdales conc around rim of sample - edge of flow/pillow and decrease inwards to massive basalt.

MAPPED LITHOLOGY:

Amygdaloidal basalt

HAND SPECIMEN

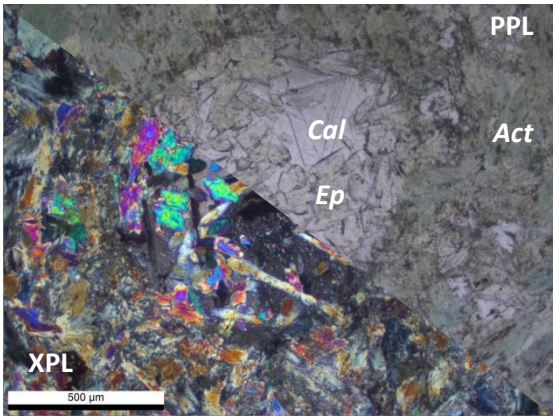
Dark, fine-grained mafic metaigneous rock containing 1mm rounded amygdales composed primarily of zeolite and lesser epidote-calcite (fizz with HCl).

THIN SECTION

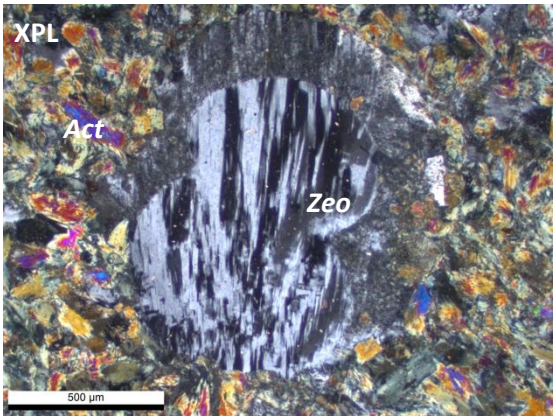
PPL/XPL

Gmass

Actinolite	60%
Plagioclase	27.5%
Quartz	2.5%
Epidote	5%
Zeolite	5%

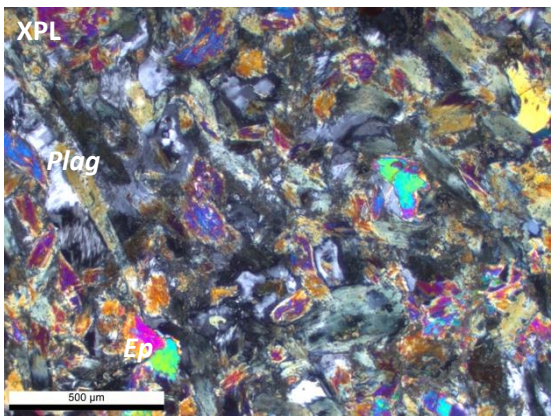


Amygdales – 20% sample, 75% of which are zeolite, 25% calcite-epidote.



Fine grained amygdaloidal metavolcanic rock consisting of calcite-epidote, quartz and zeolite amygdales amongst a groundmass of actinolite, epidote and plagioclase feldspar.

The amygdales are evenly distributed and account for ~20% of the sample (pillow margin sampled) and have varying mineralogy – most amygdales zeolite, with some twinning and cross-hatch twinning. Many of these amygdales are surrounded by an altered rim, suggesting that the current mineralogy is secondary are replacement of original infilling minerals resulted during metamorphism and recrystallisation. However, about a quarter of the amygdales consist of epidote and calcite. Epidote has been identified as a filling in vesicles in mafic volcanic rocks elsewhere in the Yilgarn Craton (e.g., Fetherston et al., 2017). Amygdales are 0.8-1.2 mm in size and through usually rounded, some amygdales are conjoined and up to 4-5 mm in size, representing larger integrated vesicles.



The groundmass is dominated blocky to fibrous actinolite crystals that are subhedral to euhedral, exhibit green-green pleochroism and range in size from 0.1-0.6 mm. The groundmass also contains with in plagioclase feldspar crystals typically 0.2-0.4 mm in size, lesser epidote and minor quartz.

CLASSIFICATION

Amygdaloidal metabasalt

SAMPLE NO: MUL001 **GRID REFERENCE:** 497759 6774882

FIELD DESCRIPTION: Larger feldspar crystals in a fine-grained pyroxene rich groundmass - upper part of sill? Granophyric?

MAPPED LITHOLOGY: Porphyritic dolerite

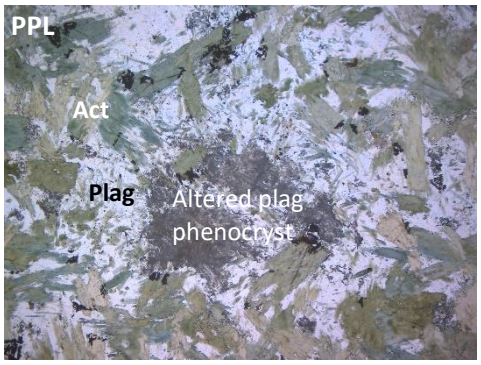
HAND SPECIMEN

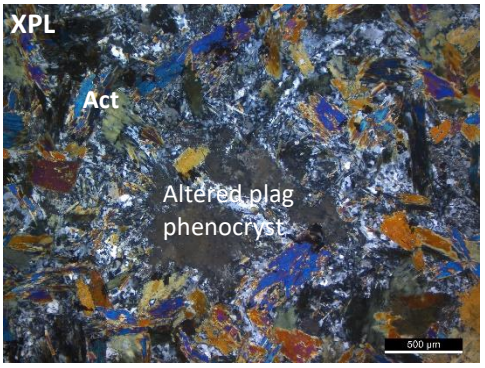
Porphyritic unit composed of white-pink phenocrysts 1-2 mm in size surrounded by a groundmass dominated by equigranular amphibole (after pyroxene) and minor interstitial white feldspar. Nonmagnetic.

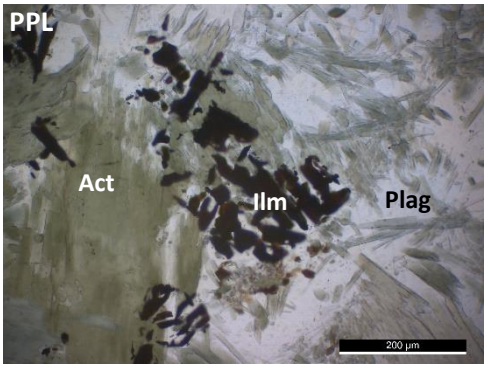
THIN SECTION

PPL/XPL

Plagioclase	34%
Actinolite	60%
Zoisite	<1%
Epidote	<1%
Ilmenite	2%
Sericite	6%







Phenocrysts occupy ~8% of the sample

A medium to fine-grained porphyritic metaigneous rock comprising altered micro-phenocrysts of plagioclase in a groundmass of actinolite, plagioclase and quartz, with abundant disseminated ilmenite and leucoxene.

Phenocrysts are anhedral, 1-2 mm in size and have been heavily altered to a fine-grained cloudy assemblage of sericite with trace epidote, zoisite and carbonate. Minor amount of plagioclase remains, in particular as fine crystals around the margins of the phenocrysts. The effects of sausseritisation are not as evident in this sample compared to others nearby and stratigraphically lower.

The groundmass of the unit is composed of lath-like to fibrous acicular crystals of actinolite (green-green pleochroism) 0.2-1mm in size with subhedral shapes, often with irregular ragged margins. Some acicular actinolite crystals form clusters that radiate outwards in the form of star-like shapes. Interstitial to these crystals are mottled anhedral 0.5 mm plagioclase crystals (some showing polysynthetic twinning) and a finer grained (0.1-0.2 mm) groundmass of plagioclase and minor quartz.

Opaques are abundant in this sample and consist of disseminated laths and clusters of ilmenite crystals, focussed largely at the margins of actinolite crystals. Notably, they are not surrounded by leucoxene haloes – this suggests a link between leucoxene development and sausseritisation of plagioclase, both of which are minimal to non-existent in this sample, but prevalent elsewhere.

Finer grained, more feldspar and less altered than underlying sample MUL003. Consistent with way-up criteria.

CLASSIFICATION

Porphyritic metadolerite (partly sericitised feldspar phenocrysts).

SAMPLE NO: MUL002 **GRID REFERENCE:** 497821 6774374

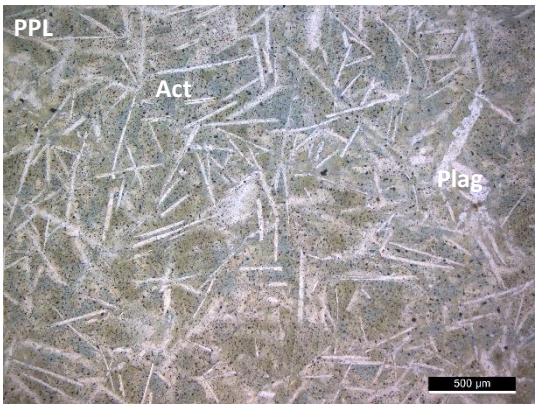
FIELD DESCRIPTION: Fine grained mafic rock, very little alteration

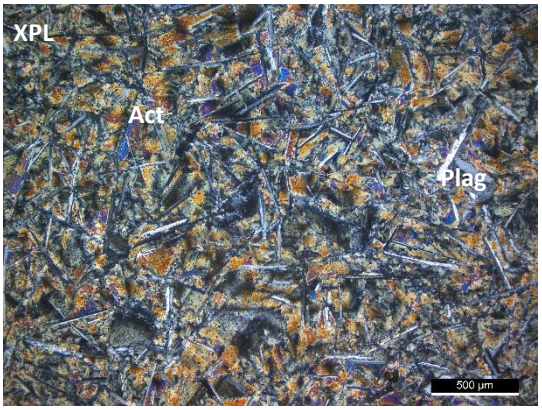
MAPPED LITHOLOGY: Basalt

THIN SECTION

PPL/XPL

Actinolite	56%
Quartz	3%
Plagioclase	40%
Opaque	1%





A fine grained crystalline porphyritic metaigneous rock consisting of randomly oriented acicular plagioclase crystals surrounded by fine laths of actinolite, with rare subhedral tabular plagioclase phenocrysts and minor secondary quartz.

Rare larger phenocrysts of subhedral plagioclase crystals are 0.5-0.8 mm in size, with characteristic tabular crystal shape. In contrast, the groundmass is dominated by randomly oriented acicular crystals of plagioclase, 0.1-0.8 mm in length and typically 50 microns in width, with no preferred alignment. Interstitial to these crystals are 0.1-0.2 mm anhedral actinolite laths (green-green pleochroism), which occasionally are acicular and up to 0.8 mm in length, in addition to less common interstitial plagioclase. Minor quartz is present in patches up to 0.8 mm, with a granoblastic texture – possibly secondary.

Disseminated oxides are present – predominantly elongate 0.1 mm needles of ilmenite, with minor magnetite.

CLASSIFICATION

Porphyritic metabasalt (rare phenocrysts)

SAMPLE NO: MUL003 **GRID REFERENCE:** 497907 6774721

FIELD DESCRIPTION: Large mound of 1m+ boulders, outcrop. Medium grained dolerite with rounded white-pink crystals up to 5mm+ in size surrounded by smaller pyroxene (likely now amph) crystals. Could be granophyric dolerite near top of sill?

MAPPED LITHOLOGY: Porphyritic dolerite

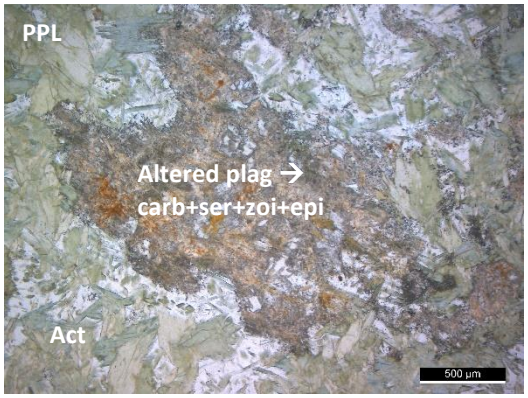
HAND SPECIMEN

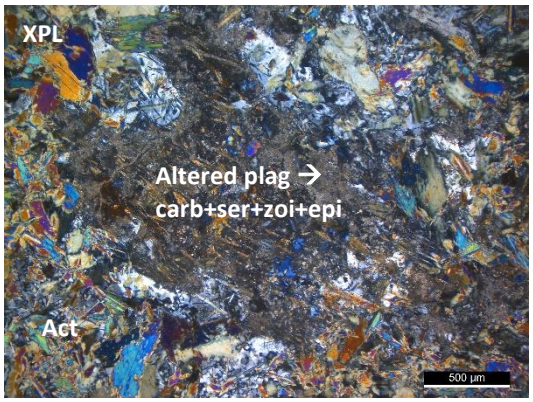
Porphyritic unit composed of white-pink phenocrysts 2-4 mm in size surrounded by a groundmass dominated by equigranular amphibole (after pyroxene) and interstitial white feldspar. Very weakly magnetic.

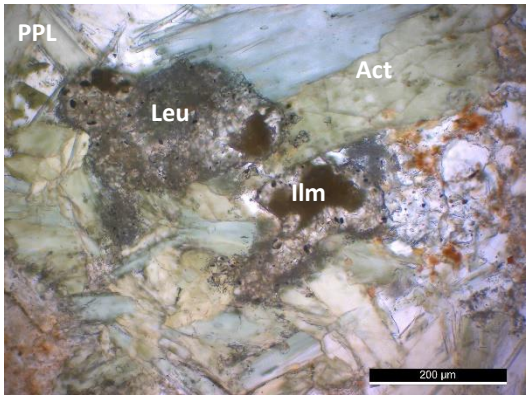
THIN SECTION

PPL/XPL

Plagioclase	30%
Actinolite	55%
Zoisite	5%
Epidote	3%
Ilmenite	<1%
Leucoxene	1%
Magnetite	<1%
Carbonate/sericite	5%
Apatite	1%







Phenocrysts occupy ~15% of the sample

A medium-grained porphyritic metaigneous rock comprising sausseritised phenocrysts of plagioclase feldspar in a groundmass of actinolite (after pyroxene) and plagioclase.

Phenocrysts are sub-anhedral, 1-2.5 mm in size and consist of an assemblage of zoisite, epidote, actinolite, fine grained cloudy sericite and carbonate as well as minor relic plagioclase and possible apatite. Some phenocrysts are replaced by increased amounts of cloudy brown fine-grained sericite/carbonate than others. These are the products of sausseritisation of plagioclase – indicating alteration via hydrothermal fluids. This also explains the pink/white discolouration of the phenocrysts in hand specimen.

The surrounding groundmass consists of euhedral-subhedral laths of actinolite 0.3-1.2 mm in length, in addition to single acicular crystals of actinolite on the order of 0.1-0.4 mm in length. Actinolite laths are frequently cross cutting, suggesting metamorphic overgrowth rather than just simple metamorphic replacement. The groundmass also contains anhedral plagioclase laths up to 1.2 mm in size, usually with a mottled appearance and some exhibiting polysynthetic twinning.

Minor ilmenite is disseminated through the sample as 0.1-0.2 mm laths, invariably surrounded by a 0.2-0.5 mm halo of fine-grained leucoxene (alteration product) – some ilmenite grains have been completely converted to leucoxene. Accessory magnetite is also present.

CLASSIFICATION

Porphyritic metadolerite (sausseritised feldspar phenocrysts).

SAMPLE NO: MUL004 **GRID REFERENCE:** 496935 6776065

FIELD DESCRIPTION: Fine grained mafic rock

MAPPED LITHOLOGY: Basalt

THIN SECTION

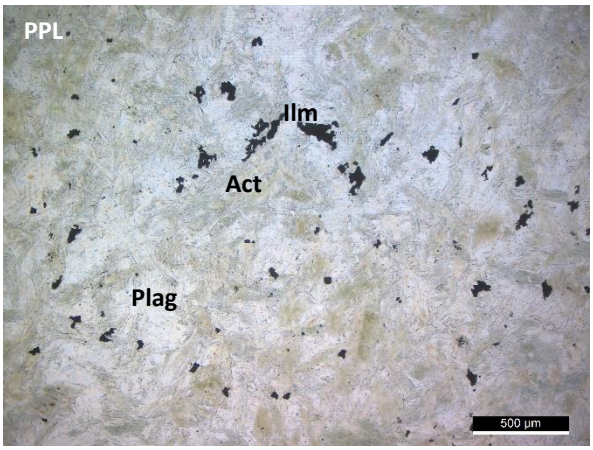
PPL/XPL

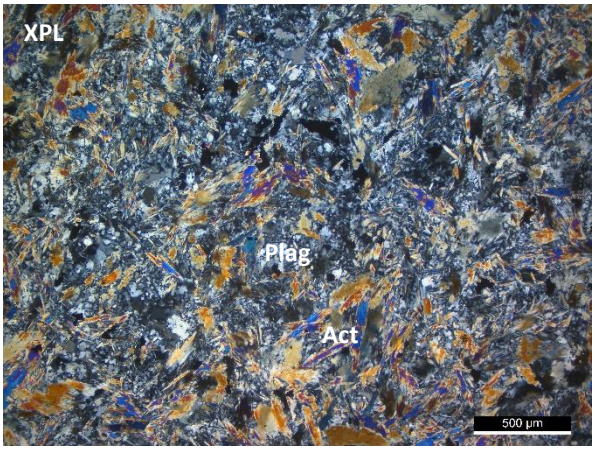
Actinolite	55%
Quartz	1%
Plagioclase	40%
Opaque	1%
Biotite	2%

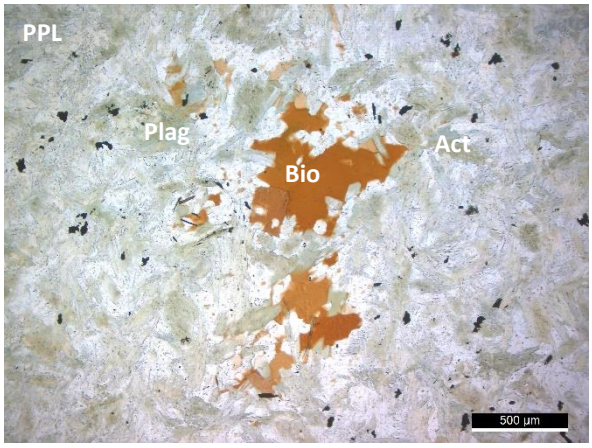
A fine grained crystalline aphyric metaigneous rock consisting of laths of actinolite, mottled plagioclase, minor quartz and biotite. Actinolite laths are sized between 0.2-0.8 mm and interstitial mottled anhedral plagioclase crystals are 0.1-0.2 mm in size, in a very fine groundmass of plagioclase and actinolite.

Several patches of secondary quartz and biotite occur in the unit, with biotite crystals up to 0.5 mm and anhedral quartz crystals 0.1-0.2 mm, likely resulting from metamorphism.

Anhedral opaque crystals, likely iron oxide (magnetite), are disseminated and up to 0.2 mm in size. There is a lack of any elongate/needle-like crystal shapes, suggesting ilmenite is absent.







CLASSIFICATION

Metabasalt

SAMPLE NO: MUL 005 **GRID REFERENCE:** 499817 6779392

FIELD DESCRIPTION: Porphyritic dolerite with large actinolite phenocrysts and less common white (plag?) phenocrysts.

MAPPED LITHOLOGY: Porphyritic dolerite

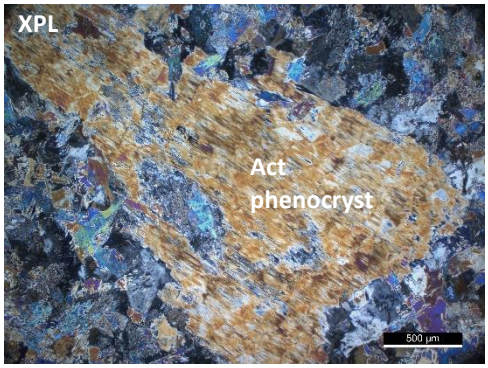
HAND SPECIMEN

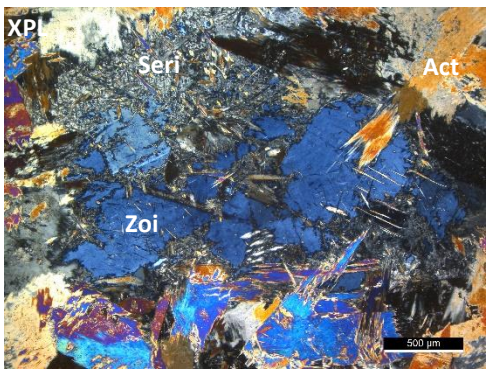
Porphyritic unit composed of grey actinolite phenocrysts up to 8 mm in size and lesser white-pink phenocrysts 1-3 mm in size surrounded by a groundmass dominated by equigranular amphibole (after pyroxene). Nonmagnetic.

THIN SECTION

PPL/XPL

Plagioclase	8%
Actinolite/tremolite	82%
Zoisite	4%
Epidote	2%
Ilmenite/magnetite	<1%
Leucoxene	<1%
Carbonate/sericite	4%





Phenocrysts occupy ~25% of the sample

A porphyritic metaigneous rock comprising actinolite phenocrysts and sausseritised phenocrysts, in a medium-grained groundmass dominated by actinolite with minor plagioclase feldspar.

Actinolite phenocrysts are 3-8 mm in size with an anhedral, ragged and irregular crystal shapes, occasionally hosting inclusions of smaller actinolite or plagioclase crystals. Plagioclase phenocrysts have subhedral lath-shaped crystal outlines 2-3 mm in size, which have been replaced entirely by zoisite, carbonate, actinolite and epidote, indicating complete sausseritisation of plagioclase phenocrysts. The zoisite occurs either as fine grained (0.1-0.2 mm) crystals or massive 1mm crystals, usually at the core of the phenocrysts, whereas fine grained carbonate occurs towards the margins.

The surrounding groundmass consists of interlocking, randomly orientated subhedral laths of actinolite/tremolite, which frequently cross cut one another. In PPL, these crystals are colourless, in contrast to green actinolite observed elsewhere – may be tremolite? Subhedral laths of plagioclase are also present in the groundmass, however these are less common than actinolite and are largely altered, either giving a cloudy mottled appearance or with partial replacement by epidote, zoisite and actinolite.

Intergrowths of ilmenite and magnetite are present as 0.1-0.2 mm anhedral grains, surrounded by leucoxene, derived from breakdown of ilmenite.

SIMILAR TO ROTH007 and ROTH077.

CLASSIFICATION

Porphyritic metapyroxenite (sausseritised feldspar phenocrysts).

SAMPLE NO: MUL006 **GRID REFERENCE:** 499578 6780169

FIELD DESCRIPTION: Pyroxene rich medium grained intrusive igneous rock, grey colour with interlocking crystals, very hard, few if any white feldspars visible. Minor grey veinlets crosscut sample

MAPPED LITHOLOGY: Pyroxenite/dolerite

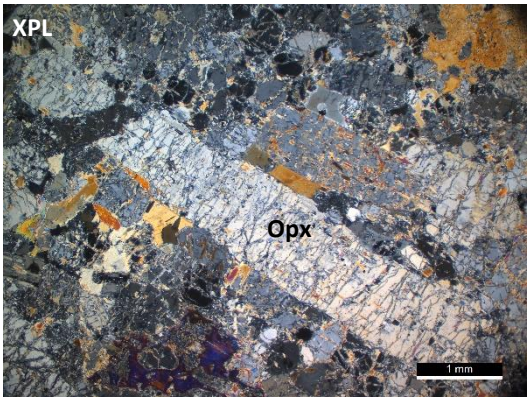
HAND SPECIMEN

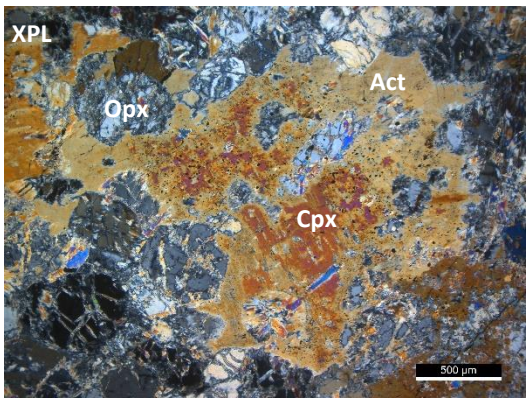
Weakly magnetic, grey medium grained unit – dominated by pyroxene with no feldspar visible, possible cumulate texture demonstrated by rounded grey crystals – pyroxene?

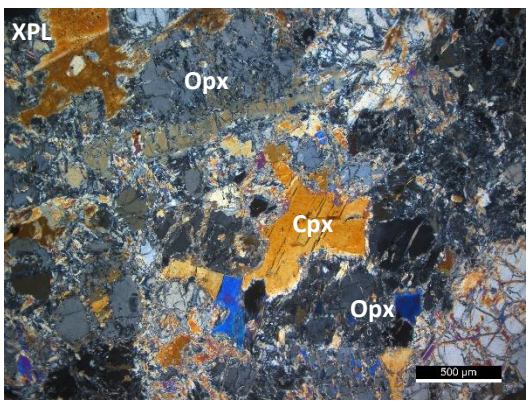
THIN SECTION

PPL/XPL

Orthopyroxene	65%
Actinolite	18%
Clinopyroxene	5%
Serpentine	10%
Opaques	2%
Sulphides	<<1%







A medium grained, orthocumulate textured ultramafic rock dominated by cumulate orthopyroxene and minor serpentinised olivine, occurring in intercumulus oikocrysts of clinopyroxene (which are partially pseudomorphed by actinolite).

Orthopyroxene crystals exhibit typical low birefringence and straight extinction, are subhedral, usually highly fractured and range in size considerably from 0.3-7 mm, typically 1-1.5 mm. In rare instances, crystals are elongate with axial ratios of up to 7:1. Relict rounded olivine crystals are present but rare and have been replaced entirely by fine grained serpentine, which has a dusty/cloudy appearance in PPL. The orthopyroxene and pseudomorphed olivine define an orthocumulate texture, together occupying 75% of the rock. Clinopyroxene is present as an intercumulus phase (upper 2nd order biref, inclined extinction) and some crystals show simple twinning, but much of the clinopyroxene has been pseudomorphed by actinolite, from the margins inwards. These clinopyroxene/actinolite crystals are typically 1.5-2 mm in size and act as oikocrysts enclosing orthopyroxene crystals and rarely, serpentinised olivine crystals. Crystals enclosing the latter are pervaded by opaques focussed along cleavage planes, likely derived from the breakdown/serpentinisation of the enclosed olivine. The altered groundmass surrounding cumulate minerals is composed of fine-grained (<0.1 mm) serpentine and actinolite, derived from the alteration of olivine and clinopyroxene, respectively. Opaques are fine (<0.1 mm) and disseminated throughout the groundmass – they include sulphides (chalcopyrite, pyrrhotite, pyrite) and minor magnetite, and likely Cr-spinel.

The sample is cross cut by two veinlets 1-1.5 mm in width and consisting of fibrous amphibole crystals oriented perpendicular to the veinlet margins – actinolite/tremolite, suggesting the veinlet formed during alteration.

CLASSIFICATION

Cumulate metaorthopyroxenite

SAMPLE NO: MUL007 **GRID REFERENCE:** 499401 6780245

FIELD DESCRIPTION: Coarser grained crystals, pyroxenes pseudomorphed by amphiboles, interstitial white/yellow mineral.

MAPPED LITHOLOGY: Dolerite-gabbro

HAND SPECIMEN

Coarse grained, nonmagnetic metaigneous rock consisting of equicrystalline crystals of amphibole, surrounded by plagioclase and minor yellow leucoxene.

THIN SECTION

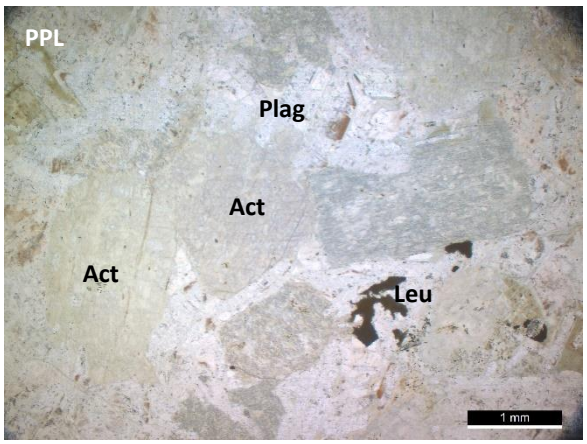
PPL/XPL

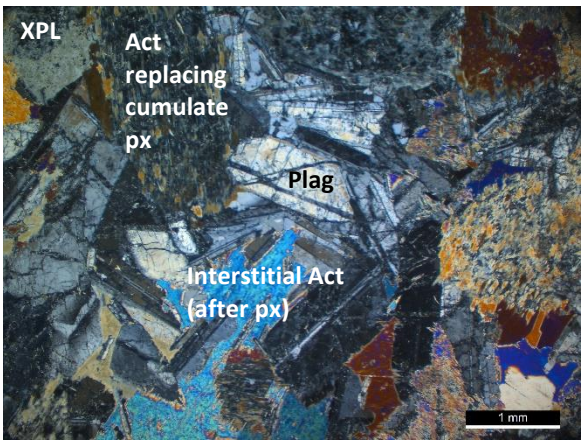
Actinolite	55%
Plagioclase	45%
Leucoxene/ilmenite	<1%

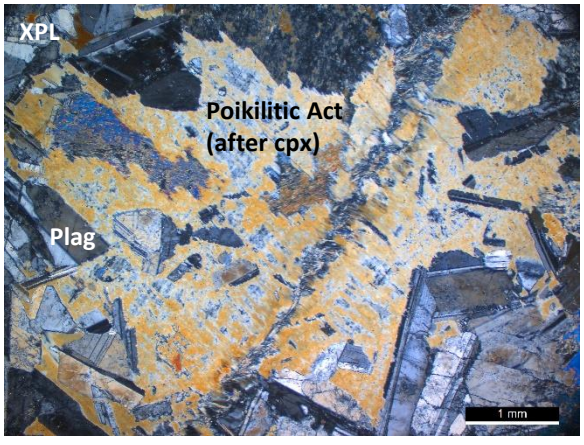
Coarse grained metaigneous rock consisting of interlocking pyroxene (pseudomorphed by actinolite), plagioclase and poikilitic actinolite crystals (after pyroxene) displaying an ophitic texture, in addition to leucoxene.

The large tabular actinolite crystals range in size from 2-5 mm, are subhedral to anhedral and have a ragged appearance. Many of these crystals are altered and composed of an array of small 0.1 mm fibrous actinolite crystals, aligned in the orientation of cleavage. These actinolite crystals are surrounded by interlocking euhedral to subhedral plagioclase feldspar laths that range in size between 0.5-3 mm. Plagioclase crystals are interlocking and do not crosscut one another. Whilst plagioclase crystals are typically randomly oriented, they are often aligned parallel to the actinolite phenocryst phases, suggesting that they are a primary magmatic feature. Further large actinolite crystals up to 8mm in size define a poikilitic/ophitic texture, with oikocrysts (probably after cpx) enclosing randomly oriented plagioclase crystals. These textures demonstrate the order of crystallisation; pyroxene was an early cumulate phase, followed by crystallisation of plagioclase (which may have been in situ when pyroxene phenocrysts settled) and then subsequent poikilitic pyroxene (likely cpx) crystallised between these phases.

Several 1-2 mm grains of leucoxene are present (yellow in hand specimen) derived from the breakdown of Ti bearing oxide, likely ilmenite. The sample is cross cut by a single 1mm veinlet of actinolite, which may be infilling a fracture.







CLASSIFICATION

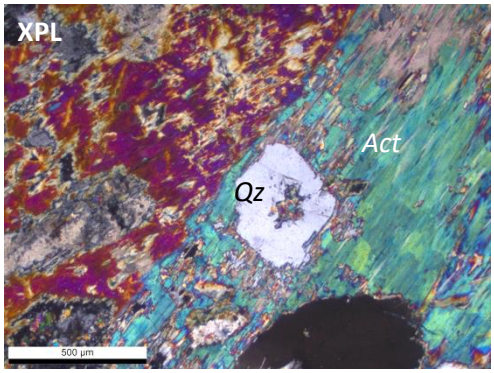
Cumulate-textured metagabbro

SAMPLE NO: MUL007a **GRID REFERENCE:** 499085 6780563

FIELD DESCRIPTION: Highly magnetic, granophyric quartz diorite comprising coarse amphibole (after pyroxene) crystals, with feldspars and possibly quartz. Patches of a green mineral (epidote?) present, with lots of magnetite visible under hand lens. 0.1ppm Au

MAPPED LITHOLOGY:

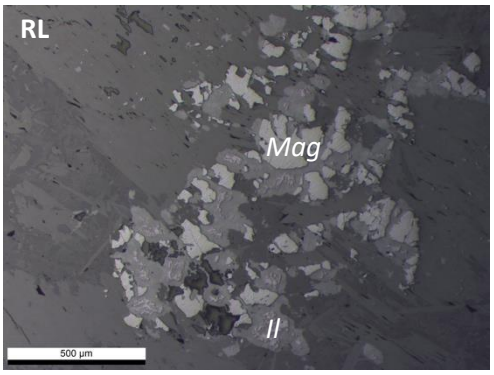
Granophyric dolerite



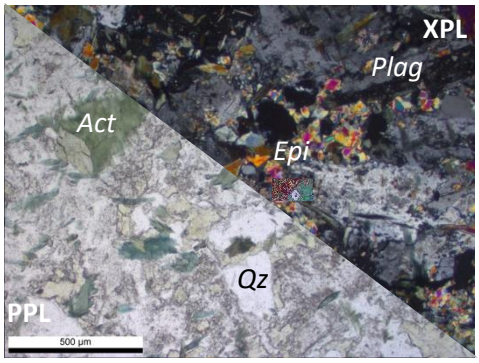
THIN SECTION

PPL/XPL

Amphibole (hornblende)	*40%*
Plagioclase feldspar	*30%*
Quartz	*15%*
Epidote	*5%*
Magnetite	*6%*
Ilmenite	*2%*
Leucoxene	*2%*
Zircon?	*<<1%*



A coarse-grained inequicrystalline intrusive metaigneous rock consisting of large, elongate amphibole porphyroblasts, surrounded by finer-crystals of quartz, plagioclase feldspar, epidote and abundant opaque minerals (predominantly magnetite) breaking down into a non-opaque phase.



Amphibole crystals exhibit elongate, subhedral crystals between 1 and 17 mm in size (on average 2-3 mm), typically displaying ragged and irregular margins and are randomly oriented, often cross-cutting one another, consistent with metamorphic recrystallization. The amphibole crystals show characteristic 120-degree cleavage intersections, exhibit simple twinning along long axes and some show simple twinning along long axes. Quartz is present as anhedral to subhedral crystals varying in size from 0.2-1.5 mm in size, that form aggregates in some parts of the sample. Epidote (characteristically high relief, high birefringence) occurs as 0.2-0.3 mm irregular crystals usually in contact or close proximity to quartz. Plagioclase feldspar occurs as randomly oriented euhedral (occasional) to anhedral (typical) laths between 0.5-1.5 mm in length and contain lots of inclusions (of both small amphibole/plagioclase crystals) and quartz – some defining a granophyric texture as identified in other evolved sill tops in the area.

Opaque oxide phases are abundant and occur as 0.5-3 mm composite grains that are typically fragmented and fractured. In RL, oxides comprise two phases; less reflective ilmenite that is breaking down to form non-opaque haloes of fine-grained leucoxene around most oxide composites, and highly reflective subhedral crystals of magnetite, some of which contain < 0.1 mm exsolution lamellae of ilmenite. Most oxide composites contain all three phases.

CLASSIFICATION

Evolved sill top – (granophyric) magnetite-bearing quartz diorite.

SAMPLE NO: MUL008 **GRID REFERENCE:** 499369 6782213

FIELD DESCRIPTION: Small sample, fine grained, some tremolite needles?

MAPPED LITHOLOGY: Basalt

THIN SECTION

PPL/XPL

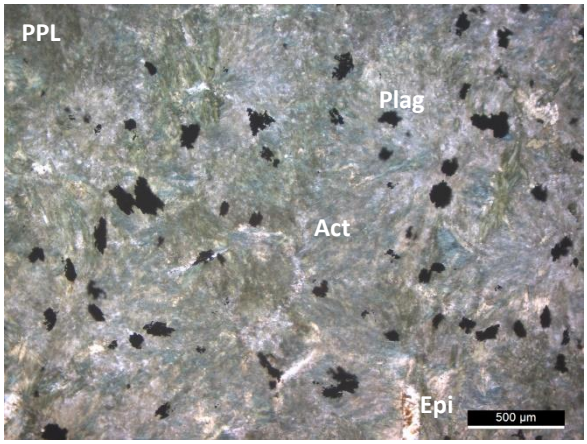
Actinolite	55%
Quartz	8%
Plagioclase	20%
Epidote	15%
Oxides	2%

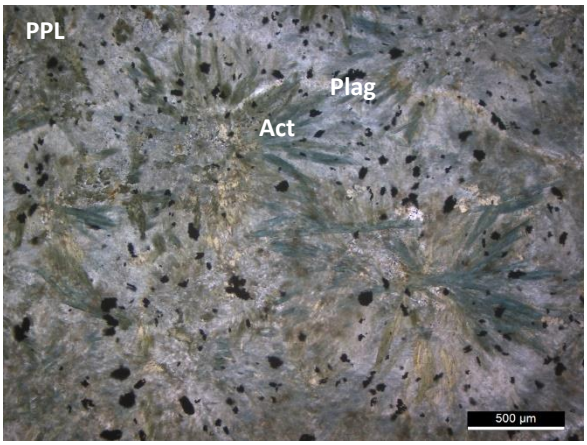
Phenocrysts comprise 1% of the rock.

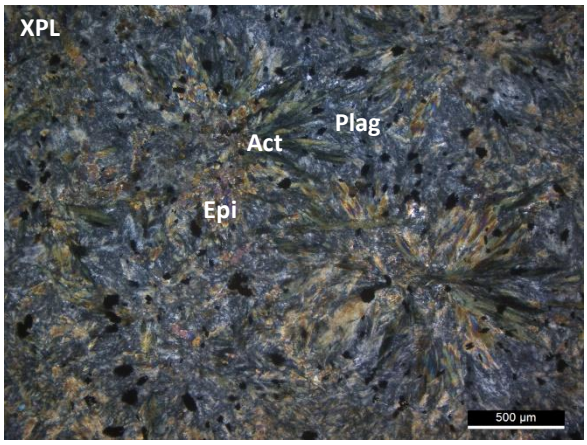
A fine grained vitrophyric metaigneous rock consisting of tabular phenocrysts of plagioclase in a fine grained glassy groundmass containing metamorphic sheaths of actinolite and epidote in addition to abundant disseminated oxides.

Plagioclase phenocrysts are subhedral, 0.2-0.5 mm and are partially replaced by quartz, actinolite, epidote and iron oxide. The surrounding groundmass is fine grained, and also contains radiating sheaths of acicular actinolite crystals up to 1 mm in size, in addition to epidote. Rare acicular crystals of actinolite are up to 4mm in length.

Irregularly shaped oxides 0.1-0.2 mm in size containing rounded silicate inclusions.







CLASSIFICATION

Metabasalt (strong greenschist meta alt)

SAMPLE NO: MUL009 **GRID REFERENCE:** 498324 6783381

FIELD DESCRIPTION: Spinifex-textured basaltic unit – needles of pyroxene, randomly oriented.

MAPPED LITHOLOGY: Random spinifex-textured basalt

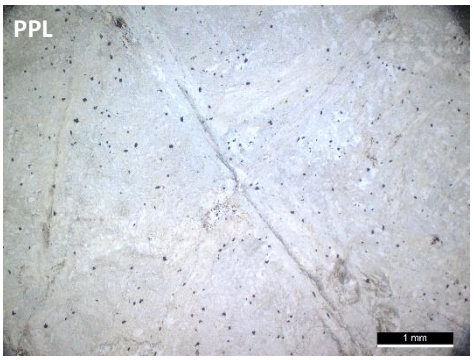
THIN SECTION

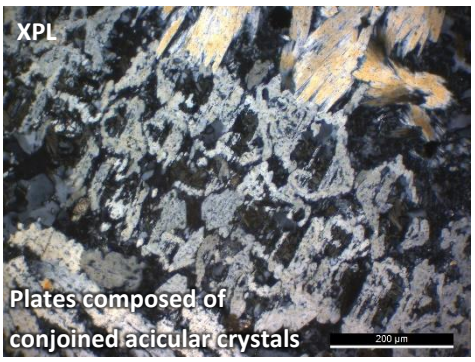
PPL/XPL

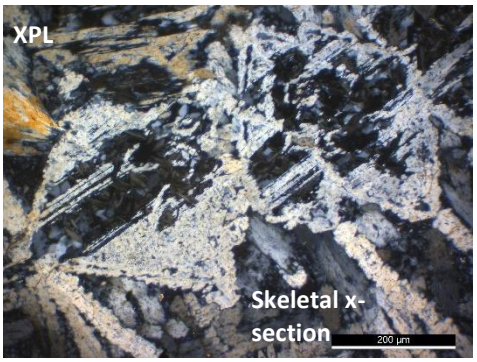
Vitrophyric texture – phenocrysts randomly oriented in a very fine grained groundmass.

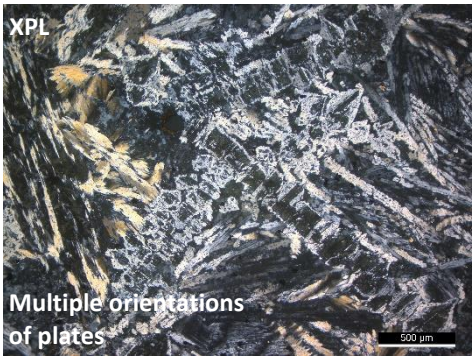
Phenocrysts account for 45-50% of the sample.

- Skeletal crystals in basal section, typically 300-500 microns wide, occurring as clusters of crystals attached and in optical continuity, with altered/replaced cores. In longitudinal section, these crystals are acicular, and also have dark cores and rims that are in optical continuity, between 1.5-9 mm long. Sometimes skeletal basal sections are aligned and in optical continuity (go into extinction at same time) and are essentially defining plates of adjoined acicular crystals. Other unusual shapes possible, including J-shape.
- In fine grained interstitial areas between phenocrysts, dendritic patterns present, including sinusoidal central chains with crystals oriented perpendicular in both directions – similar morphology shown by dendritic crystals and skeletal crystals (as seen in Lowrey et al., 2017)
- The mineral replacing pyroxene phenocrysts and in the gmass has a faint green-colourless pleochroism and a low birefringence (grey-weak yellow), may be actinolite but thin section is thin? Or an alternative mineral – SEM to check.
- No clear evidence for platy crystals present – all appear to be these conjoined acicular skeletal pyroxene crystals, instead of having sets of parallel plates.
- Evidence for conjoined skeletal crystals in basal section, both as stacked crystals and as plates, and images for these crystals cut at progressively more oblique angles, all the way to longitudinal cut, where they form largest phenocrysts…. No evidence for any true 'platy' pyroxene in this sample.
- *This sample appears to represent an **intermediate stage** between aligned acicular spinifex-texture and platy spinifex-texture, whereby skeletal acicular crystals develop as conjoined crystals, often defining a plate – with appearance of honeycomb (honeycomb spinifex/platy acicular spinifex). Not previously documented? And may help to explain the development of platy pyroxene……*









Some euhedral tabular oxides, breaking down into an orange-brown mineral (iddingsite clays?).. could it be ilmenite? Disseminated oxides, probably hematite, as fine <0.15 mm anhedral grains.

Groundmass too fine to identify other than actinolite. Glassy.

CLASSIFICATION

Conjoined acicular platy pyroxene spinifex-textured metabasalt (new form of spinifex? - 'honeycomb spinifex')

SAMPLE NO: MUL010 **GRID REFERENCE:** 498145 6782938

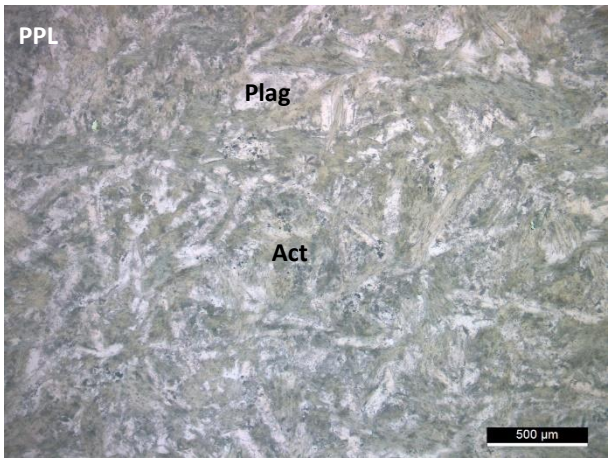
FIELD DESCRIPTION: Fine to medium-grained mafic rock, lighter in colour

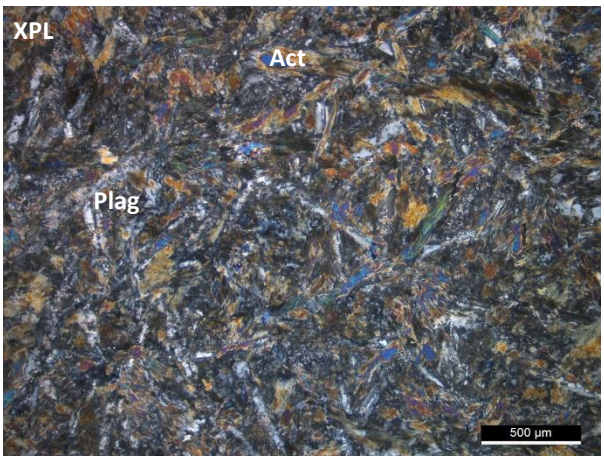
MAPPED LITHOLOGY: Basalt

THIN SECTION

PPL/XPL

Actinolite	52%
Quartz	1%
Plagioclase	45%
Zoisite/chlorite	2%
Oxides	<1%
Sulphide	<1%





A fine grained crystalline metaigneous rock consisting of interlocking assemblage of randomly oriented acicular subhedral plagioclase crystals and elongate fibrous laths of actinolite crystals, with a fine grained interstitial groundmass.

Plagioclase crystals are 0.2-0.8 mm in length and 0.1-0.2 mm in width, whereas actinolite crystals are lath-like to acicular and 0.4-1.0 mm in length. The interstitial groundmass appears to contain finer grained (<0.1 mm) actinolite and plagioclase. Minor blue alteration of plagioclase is likely zoisite/chlorite and minor quartz is also present in the groundmass.

Disseminated anhedral pyrite grains up to 0.5 mm are disseminated in the groundmass. Rare < 0.1 mm magnetite grains are also present.

CLASSIFICATION

Metabasalt

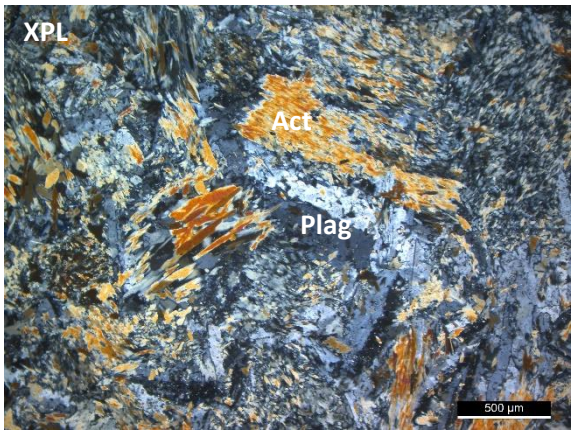
SAMPLE NO: MUL011 **GRID REFERENCE:** 494198 6774632

FIELD DESCRIPTION: Fine to medium grained, visible feldspar crystals

MAPPED LITHOLOGY: Dolerite

HAND SPECIMEN

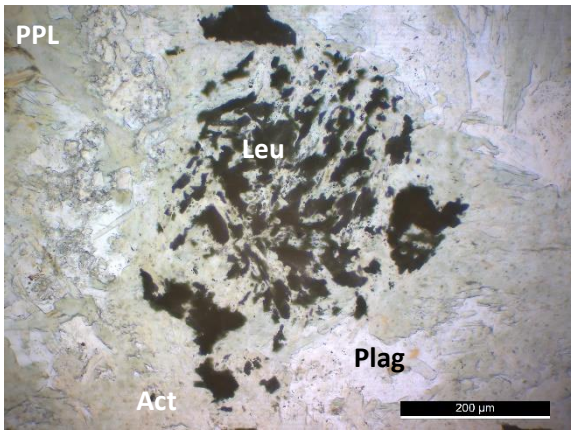
Medium grained metaigneous rock with a quartz bearing veinlet, nonmagnetic.



THIN SECTION

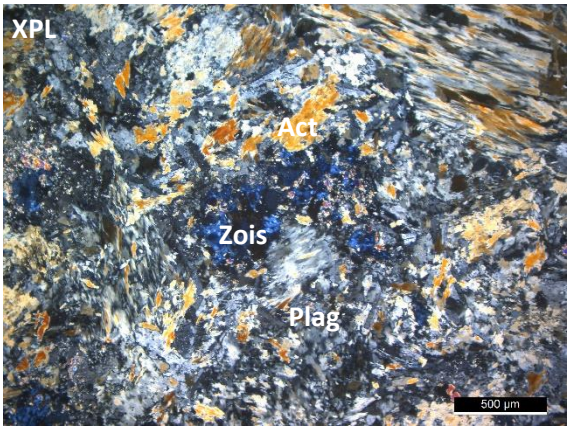
PPL/XPL

Actinolite	45%
Hornblende/biotite	5%
Plagioclase	35%
Zoisite	4%
Epidote	1%
Quartz	9%
Leucoxene/ilmenite	1%



Medium grained metaigneous rock consisting of interlocking actinolite and plagioclase crystals, with an irregular cross cutting portion comprising quartz, feldspar and actinolite crystals.

Actinolite crystals are anhedral and fibrous, ranging in size from 0.1-0.8 mm in size. Crystals typically display green-green pleochroism and are frequently disaggregated into an array of individual actinolite fibrous crystals. Patches of crystals have brown-brown pleochroism, but otherwise similar crystal shapes and characteristics as actinolite – may indicate the development of hornblende, or alternatively biotite. Plagioclase crystals are 0.1-0.3 mm, anhedral crystals with a typical mottled appearance. Some larger tabular plagioclase crystals (up to 0.8 mm) have been sausseritised and now consist of fine grained zoisite, actinolite and epidote.



Opaques are scattered throughout, 0.1-0.2 mm, and comprise primarily of ilmenite, with minor magnetite.

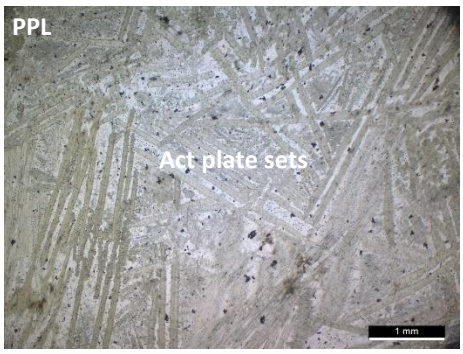
CLASSIFICATION

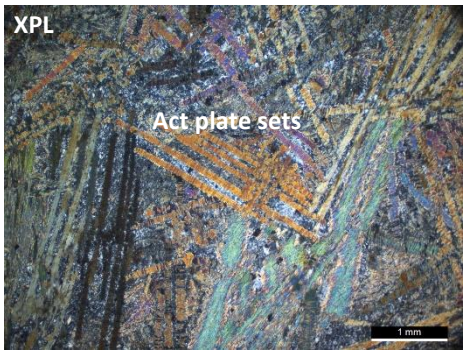
Metadolerite

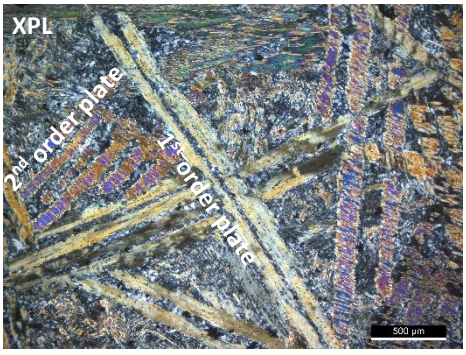
SAMPLE NO: MUL017 **GRID REFERENCE:** 504797 6777701

FIELD DESCRIPTION: Spinifex-textured basaltic unit – needles of pyroxene, randomly oriented, up to 5-6 mm in size.

MAPPED LITHOLOGY: Random spinifex textured basalt







THIN SECTION

PPL/XPL

Actinolite (after augite)	75%
Glassy groundmass	25%

Phenocrysts account for 60% of the sample, the rest is interstitial fine grained groundmass, quartz and single acicular actinolite crystals.

- Thin, elongated crystals of pyroxene (pseudomorphed by secondary actinolite) present as sets of parallel crystals with the same orientation – typically 2-6 parallel plates per set. Widths range from 80-250 microns. Lengths range from 0.5 mm to 13 mm.
- Largest crystals in some cases cross cut one another, but mostly terminate against one another.
- Some of the large plates actually consist of a row of conjoined acicular skeletal crystals (as in MUL009)
- Internal texture to large plates – radial growth perpendicular to margins (could be due to meta?)
- Interstitial to these large plates are smaller plates, also in sets of 2-7 parallel crystals.
- Some complex interaction of plate sets, with up to 3 smaller interstitial sets in addition to largest crystal set. Crystallisation started with the largest phenocrysts, then progressively shorter plates (but same width – first order) in subsequent interstitial spaces, followed by 2nd order smaller crystals, and finally dendritic growth which was presumably succeeded by quenching to form the fine grained (glassy – originally?) groundmass.
- '2nd order' crystals comprise acicular actinolite crystals up to 0.8 mm in length and <50 microns in width, interstitial to larger crystal sets.
- For some plates, acicular crystals present parallel to plate and remain in crystallographic continuity – formed at same time as plates. This also happens between plate sets, with acicular basal sections between parallel plates – potential protrusions?
- Dendritic patterns present in interstitial spaces between plate sets – have branching pattern, identical in appearance to BAD001a.
- Less frequent acicular pyroxene (now actinolite) crystals also present, with subhedral-euhedral basal sections visible.
- The groundmass is fine grained and comprises acicular actinolite crystals up to 0.2 mm in length, in a fine grained matrix (quartz/plag/act?), likely quenched glass.
- Multiple 0.25 mm quartz veinlets dissect the sample, and pockets of quartz 0.25 mm in size are present in interstitial spaces – clearly secondary.
- Scattered irregular shaped opaques ranging up to 0.2 mm disseminated throughout groundmass, typically at boundaries of actinolite – probably ilmenite?

CLASSIFICATION

Random platy pyroxene spinifex-textured metabasalt

SAMPLE NO: MUL019 **GRID REFERENCE:** 504846 6777718

FIELD DESCRIPTION: Originally olivine spinifex? Different appearance to other spinifex textured units, acicular crystals, randomly oriented.

MAPPED LITHOLOGY: Spinifex-textured basalt/komatiite

HAND SPECIMEN

Porphyritic spinifex-textured igneous rock with randomly oriented grey phenocrysts (originally pyroxene) in a fine grained aphyric groundmass.

THIN SECTION

PPL/XPL

Phenocrysts occupy 50% of the sample.

Porphyritic metaigneous rock with randomly oriented elongate phenocrysts in a finer grained fibrous groundmass. Mineralogy dominated by actinolite and tremolite, with fine gmass, ilmenite and minor suphides.

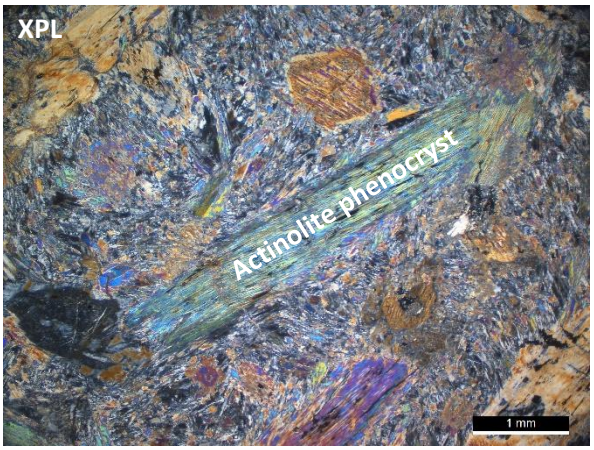
Actinolite basal section 800 microns, euhedral, with 50 micron rim of different composition. Some crystals perfectly resemble skeletal pyroxene crystals, but cores are still present.. Are all crystals with rims exhibiting skeletal-like characteristics, signifying rapid cooling??

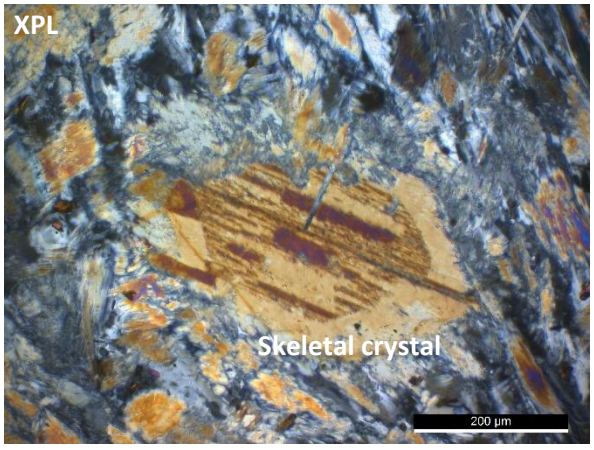
Phenocrysts of actinolite are elongate laths (not really acicular) and have lengths of typically 3-10 mm and widths of 0.5-1 mm, more stubby than previous samples. Randomly oriented with no preferred alignment. Some brown staining of phenocrysts – particularly along cleavage planes.

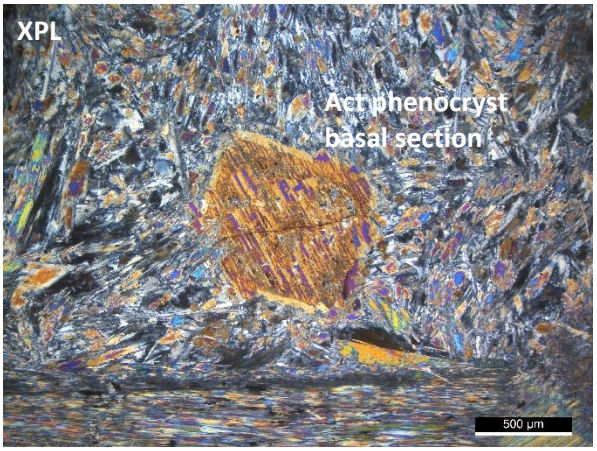
Minor disseminated pyrite present, and opaques are fine (<0.1 mm) and composed of ilmenite needles primarily.

Groundmass is composed of fibrous crystals of actinolite and tremolite up to 1mm in length, but typically finer, in a fine grained gmass.

No sign of any dendrites, plates or conjoined acicular crystals.







CLASSIFICATION

Random 'acicular' or elongate pyroxene spinifex-textured metabasalt

SAMPLE NO: ROTH001 **GRID REFERENCE:** 488853 6770342

FIELD DESCRIPTION: Well developed random spinifex as thin interflows between high-magnesium basalt flows

MAPPED LITHOLOGY: Spinifex-textured basalt

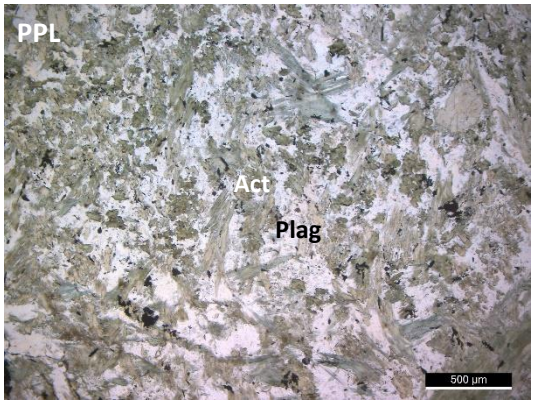
HAND SPECIMEN

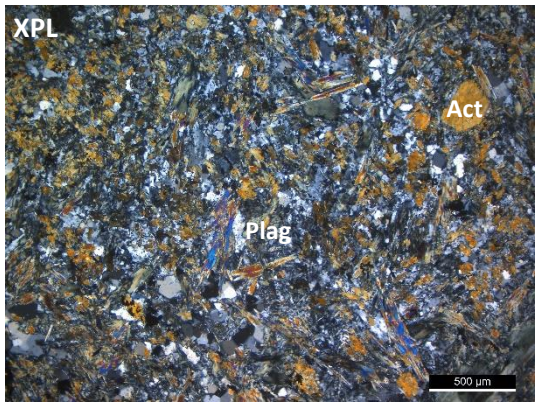
Porphyritic spinifex-textured igneous rock with randomly oriented grey phenocrysts (originally pyroxene) up to 5 cm in size, in a finer grained groundmass

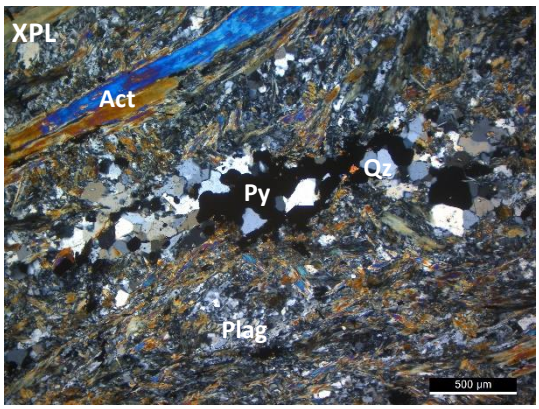
THIN SECTION

PPL/XPL

Actinolite	55%
Plagioclase	30%
Quartz	12%
Chlorite	2%
Oxides	<1%
Sulphides (Py > Po > Ccp)	1%







Phenocrysts occupy ~15% of the unit

Porphyritic spinifex-textured rock consisting of coarse randomly oriented acicular phenocrysts of pyroxene (pseudomorphed by actinolite) ranging in length from 1 to >2.5 cm in length and 0.4-2.0 mm in diameter. These phenocrysts have subhedral- ragged appearance and are not as well formed as in other samples – in many instances, phenocrysts are present as irregular fragments that remain in optical continuity. Basal sections are subhedral-anhedral and often have altered cores comprising plagioclase and minor chlorite.

The surrounding groundmass consists of 0.1-0.5 laths of actinolite, 0.2-0.3mm mottled crystals of plagioclase and 0.1-0.3 anhedral quartz crystals, many of which have a granoblastic texture.

Oxides are present as needle-shaped crystals typically 0.1 mm in length indicative of ilmenite.

Sulphides aggregates up to 1.5mm in size are present in association with ~3mm quartz patches. The sulphide assemblage is dominated by pyrite, with lesser amounts of pyrrhotite and chalcopyrite.

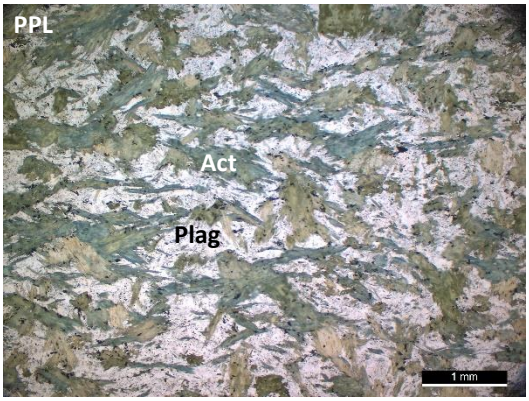
CLASSIFICATION

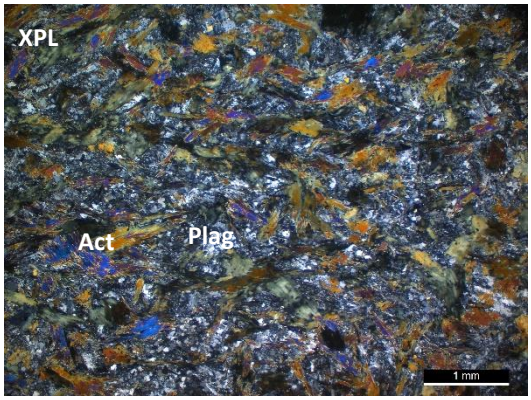
Random acicular spinifex-textured metabasalt

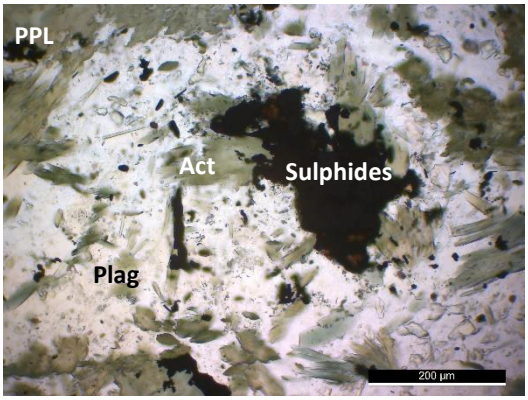
SAMPLE NO: ROTH002 **GRID REFERENCE:** 487153 6769587

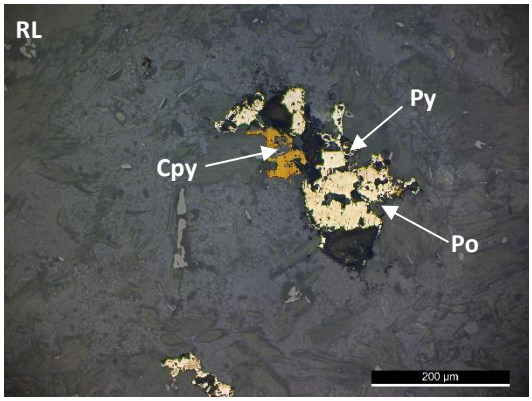
FIELD DESCRIPTION: Slightly coarser grained basalt – crystals are just about visible – cooled more slowly than some other local flows?

MAPPED LITHOLOGY: Basalt









THIN SECTION

PPL/XPL

Actinolite	40%
Plagioclase	44%
Quartz	15%
Oxides	<1%
Sulphides (Po > Py > Ccp)	1%

A medium grained crystalline metaigneous rock consisting of actinolite laths (green-brown, verging on hornblende) 0.2-1.0 mm in length amongst a finer grained groundmass of mottled anhedral plagioclase crystals up to 0.5 mm, 0.1-0.2 anhedral quartz crystals and single acicular actinolite crystals up to 0.2 mm in length.

Oxides present as <0.1 mm elongate crystals disseminated in the groundmass – predominantly ilmenite. Sulphide aggregates up to 0.2 mm also disseminated throughout the groundmass consisting of pyrrhotite, pyrite and chalcopyrite. Sulphides are present in a 0.5mm wide quartz veinlet which dissects the sample, suggesting that sulphides are largely hydrothermal in origin.

CLASSIFICATION

Metabasalt

SAMPLE NO: ROTH003 **GRID REFERENCE:** 486969 6769258

FIELD DESCRIPTION: Pyroxene spinifex textured basalt – randomly oriented needles in fine grained groundmass

MAPPED LITHOLOGY: Spinifex-textured basalt

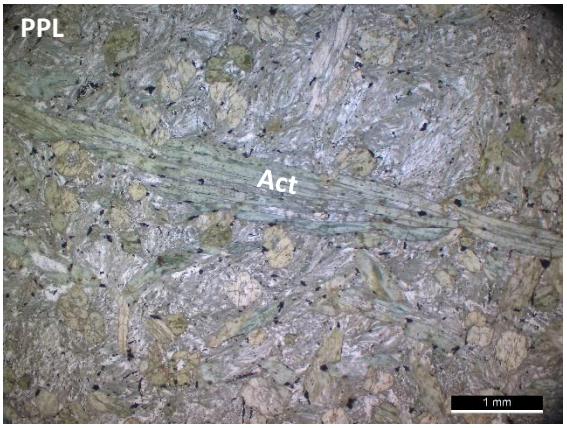
HAND SPECIMEN

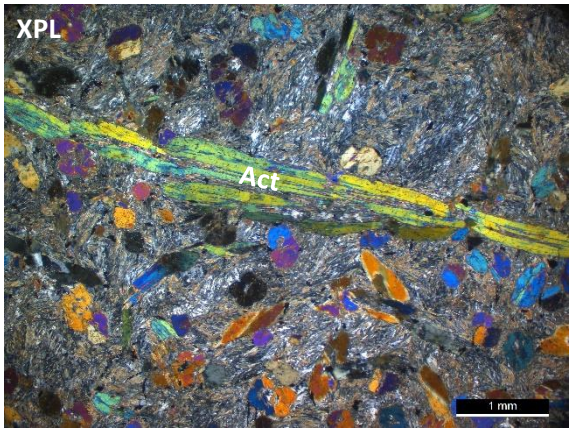
Porphyritic spinifex-textured igneous rock with randomly oriented grey phenocrysts (originally pyroxene) in a fine grained aphyric groundmass.

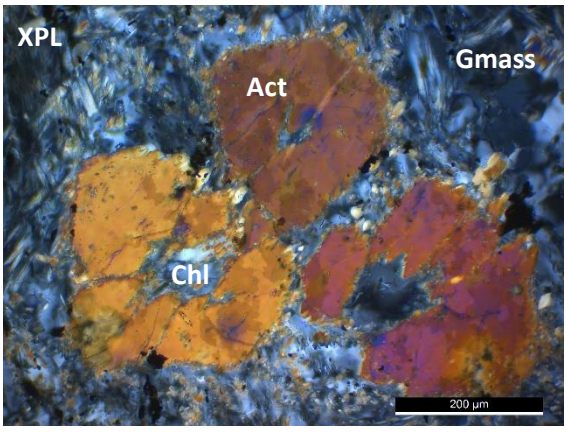
THIN SECTION

PPL/XPL

Actinolite	62%
Quartz	2%
Plagioclase	22%
Chlorite	10%
Opaques	2%







Phenocrysts occupy ~35% of the unit

Porphyritic spinifex-textured rock characterised by abundant, acicular, randomly oriented pyroxene phenocrysts (pseudomorphed by actinolite) in a plumose-textured groundmass of fine grained, intergrown plagioclase feldspar and acicular actinolite crystals.

The randomly oriented, acicular pyroxene phenocrysts range in length between 1-8 mm, and have euhedral basalt sections between 0.5-1 mm in diameter. Many crystals are zoned with actinolite rims and irregular cores of chlorite or plagioclase (apparently replacing an original phase?), also observed in the cores of crystals oriented along their long axis. The pyroxene crystals frequently display simple twinning, and occasionally phenocrysts display cruciform shapes.

Minor recrystallised quartz is present as 0.2 mm patches.

The surrounding groundmass consists of fine (<0.2 mm) plumose/feathery textured acicular crystals of actinolite intergrown with fine grained plagioclase, for which individual crystals cannot be distinguished. Oxides are present as irregular grains typically <0.1 mm but up to 0.2 mm in size and likely comprise magnetite and minor ilmenite.

Almost identical to sample T1.

CLASSIFICATION

Random acicular pyroxene spinifex-textured metabasalt

SAMPLE NO: ROTH004 **GRID REFERENCE:** 486997 6769136

FIELD DESCRIPTION: Fine grained mafic rock, coarser patches of white minerals.

MAPPED LITHOLOGY: Basalt

THIN SECTION

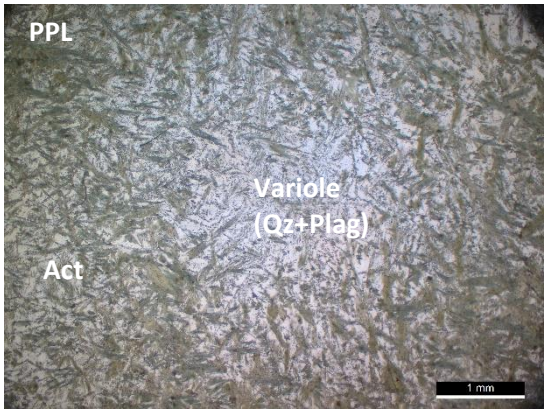
PPL/XPL

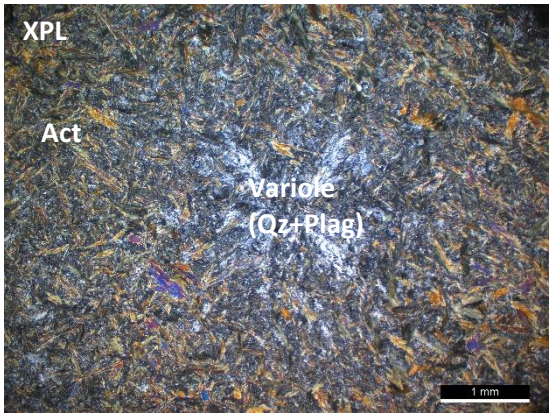
Groundmass

Actinolite	65%
Quartz	10%
Plagioclase	23%
Carbonate	2%

Varioles

Actinolite	20%
Quartz	30%
Plagioclase	50%
Carbonate	0%





A fine grained crystalline rock consisting of fibrous to acicular actinolite crystals 0.2-0.8 mm in size, randomly oriented, with interstitial subhedral-anhedral fine grained mottled-textured plagioclase feldspar (0.2-0.3 mm) and minor anhedral crystals of quartz (0.1 mm).

The rock displays a weakly variolitic texture, whereby plagioclase and quartz are concentrated in spherical patches 2-3 mm in width and typically contain less actinolite than intervening areas. In some varioles, the plagioclase crystals are oriented radially around the central part of the variole.

Disseminated crystals of a carbonate mineral are scattered throughout the sample and up to 1 mm in size. No opaques are present in the sample.

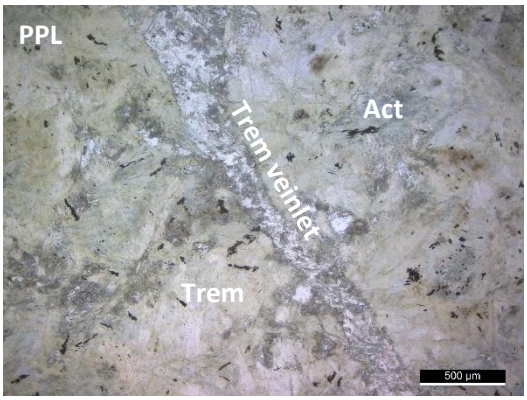
CLASSIFICATION

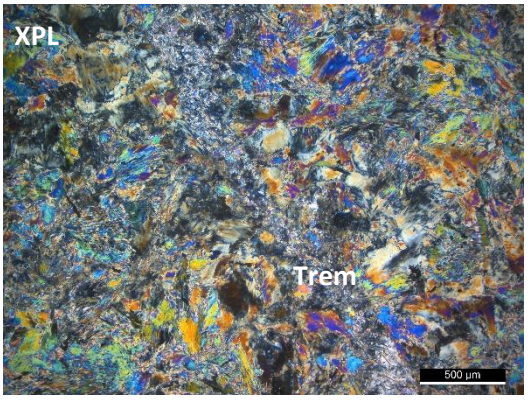
Weakly variolitic metabasalt

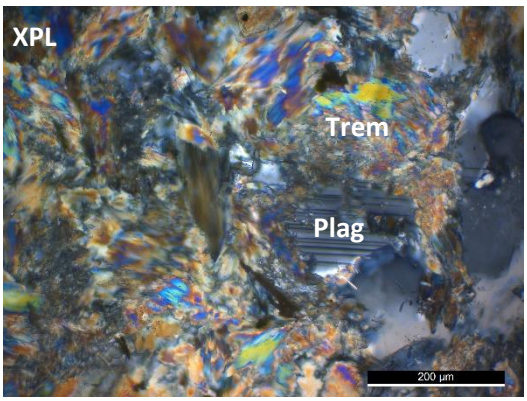
SAMPLE NO: ROTH005 **GRID REFERENCE:** 487905 6767104

FIELD DESCRIPTION: Fine grained, green alteration minerals

MAPPED LITHOLOGY: Basalt







THIN SECTION

PPL/XPL

Tremolite	70%
Actinolite	14%
Plagioclase/sericite	10%
Quartz	5%
Oxides	1%

A fine to medium grained crystalline metaigneous rock dominated by fibrous anhedral broadly equidimensional tremolite crystals 0.2-1 mm in size (colourless-pale green, very high birefringence), with minor plagioclase and actinolite. Plagioclase has a distinctive dusty appearance, suggesting it is moderately altered and sericitized.

A number of euhedral hexagonal crystal outlines now consist of quartz, but with surrounding acicular amphiboles penetrating the margins and suggesting the original mineral has been replaced. These may be euhedral/skeletal crystals of olivine or pyroxene that have been pseudomorphed by quartz.

Oxides are abundant and consist predominantly of elongate needles, signifying ilmenite.

Several 0.2-0.3 mm thick veinlets comprising tremolite and quartz cross cut the sample.

No sign of spinifex development.

CLASSIFICATION

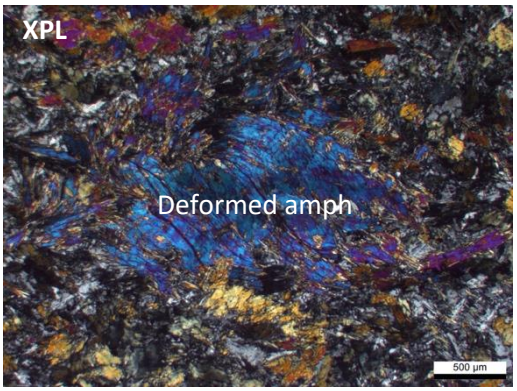
High Mg metabasalt.

SAMPLE NO: ROTH 006 **GRID REFERENCE:** 487905 6766786

FIELD DESCRIPTION: Rounded Pyroxenite as found in Rothsay mapping 2014

MAPPED LITHOLOGY: Honeycomb-textured gabbro

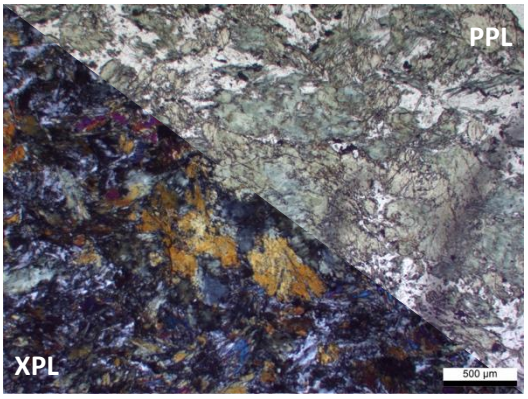
THIN SECTION



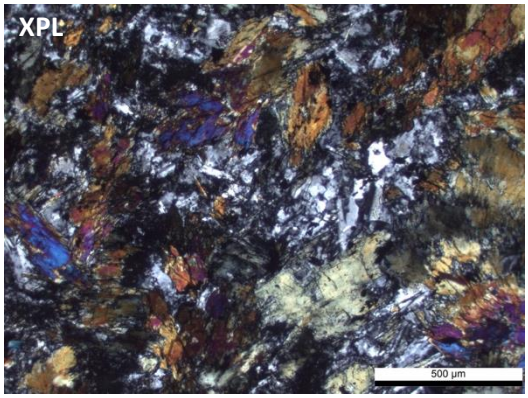
PPL/XPL

Amphibole (Hornblende)	*37%*
Amphibole (Actinolite?)	*28%*
Plagioclase (labradorite)	*28%*
Quartz	*2%*
Opaques- ilmenite	*5%*

A porphyroblastic textured metaigneous intrusive rock composed of rounded/blocky porphyroblasts of amphibole (actinolite and hornblende) 0.8-1.5 mm in size, with finer grained interstitial plagioclase, quartz, actinolite and opaque minerals. This unit has an almost identical texture and mineral assemblage to sample T2 taken 3.5 km along strike, but is generally finer grained. The rounded, dark amphibole crystals and interstitial lighter plagioclase and quartz give the rock a characteristic honeycomb-textured appearance, which is particularly prominent on weathered surfaces.



The large amphibole porphyroblasts appear to consist of two phases; at the core of grains, a higher relief mineral with 120 degree cleavage, strong brown-green pleochroism and high birefringence suggesting hornblende, which is typically anhedral and fragmented (with all pieces going into extinction at same time). These cores are surrounded by another amphibole mineral with moderate relief, weak blue green-green pleochroism and lower birefringence, potentially actinolite. Simple twinning is consistent across both phases. This may demonstrate the partial conversion of hornblende to actinolite during metamorphic retrogression from amphibolite to greenschist facies. These large porphyroblasts are strongly deformed, displaying undulose extinction with some crystals shaped as sheared sigma clasts.



Plagioclase feldspar crystals are lath shaped and up to 0.5 mm in size, and compositions vary between 55-70% Anorthite, classifying as labradorite. Quartz is very minor, occurring interstitial to porphyroblasts with a granoblastic texture and grains <0.2 mm. The opaques present are ilmenite, also occur interstitially with feldspar and quartz, and are typically 0.1-0.2 mm. Subordinate (<<1%) apatite also identified in the groundmass.

SEM Work

Confirmed hornblende as dominant amphibole, determined Ca/Na proportions as that of labradorite, also confirmed ilmenite.

CLASSIFICATION

Honeycomb-textured porphyritic metagabbro

SAMPLE NO: ROTH007 **GRID REFERENCE:** 487822 6767371

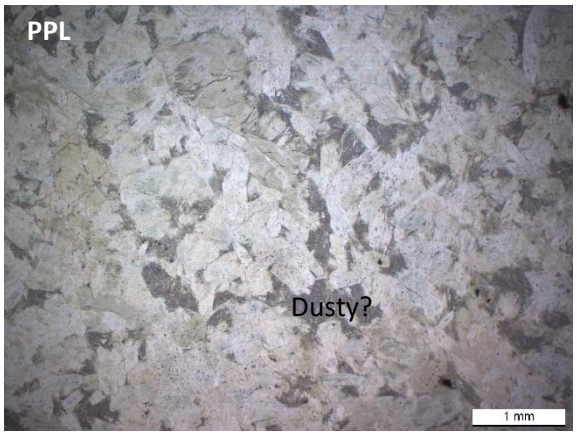
FIELD DESCRIPTION: Large outcrop on top of large peak – medium grained mafic, pyroxene rich with some white minerals visible. Weathers to rounded,hard boulders, typical of mafic intrusive.

MAPPED LITHOLOGY: Dark pyroxene-rich dolerite

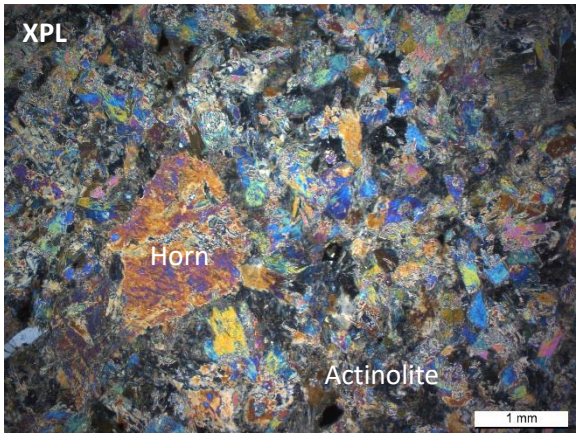
THIN SECTION

PPL/XPL

Actinolite	*75%*
Hornblende	*15%*
Fine grained dusty alt	*20%*
Ilmenite + leucoxene	*6%*
Albite	*2%*
Apatite	*2%*
Cu sulphides	*<1%*

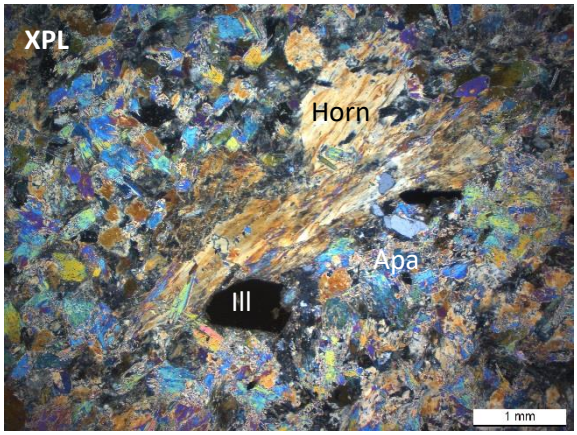


A medium grained porphyroblastic metaigneous rock dominated by amphiboles, in addition to minor ilmenite, leucoxene, apatite, copper sulphides and possible altered plagioclase,



The unit is dominated by randomly oriented 0.4-0.8 mm laths of low relief, colourless, non-pleochroic amphibole, with distinctive 1-5mm porphyroblasts (phenocrysts?) of a coloured, pleochroic amphibole. Though the amphibole present is difficult to identify, it looks like the groundmass consists of interlocking actinolite crystals, and the porphyroblasts comprise hornblende. This has partially been confirmed by SEM analysis. The amphibole grains display what appears to be a relict igneous cumulate texture, with interstitial areas consisting of a dusty, fine grained assemblage including the other accessory phases; apatite, ilmenite and minor albite.

Apatite is present as anhedral, often rounded crystals (low birefringence, high relief, colourless), up to 0.6 mm and scattered throughout the interstitial portions. Albite crystals are only observed rarely, however, the fine grained dusty interstial areas may represent some altered plagioclase content. Opaque mineral identified as ilmenite ($FeTiO_3$), occurring as anhedral 0.2-1 mm crystals, usually with a rim of leucoxene (fine grained Fe-Ti alteration minerals). Ilmenite crystals contain inclusions of chalcopyrite and bornite up to 0.1 mm in length. Bornite typically occurs as a rim on chalcopyrite, but occasionally occurs as single crystals.



CLASSIFICATION

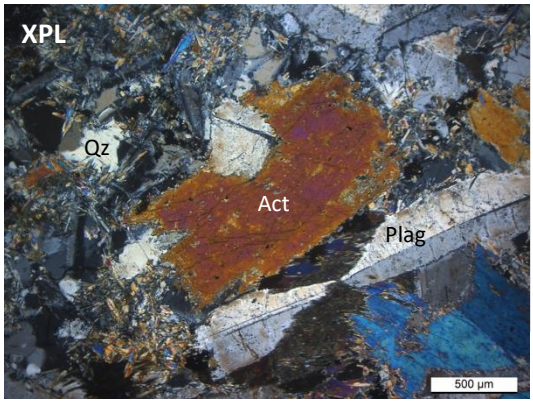
Porphyritic metapyroxenite (now dominated by actinolite – aka amphibolite)

SAMPLE NO: ROTH008 **GRID REFERENCE:** 487094 6768820

FIELD DESCRIPTION: Relatively dark medium to coarse grained mafic intrusive, small amounts of sulphides visible through hand lens.

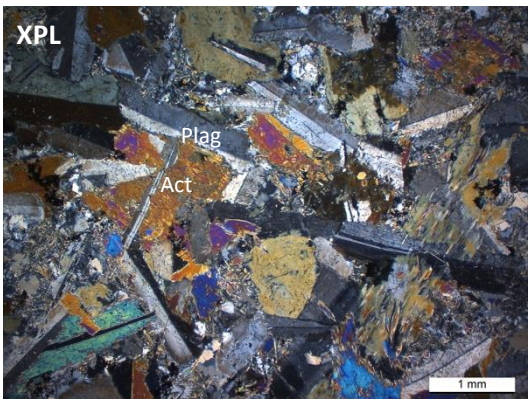
MAPPED LITHOLOGY: Dolerite-gabbro

THIN SECTION



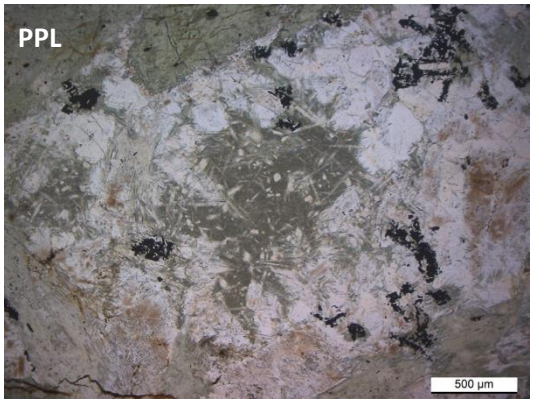
PPL/XPL

Actinolite (amph)	48%	(10% fine needles)
Plagioclase	38%	
Opaques	5%	
Quartz	7%	
Clays?	2%	



A medium to coarse grained crystalline metaigneous rock, composed primarily of randomly oriented elongate crystals of amphibole (actinolite) and plagioclase feldspar. Amphibole crystals (48%; pale-green weak to moderately pale-green pleochroic, classified as actinolite) are subhedral and typically 5 mm in size but reach 9 mm in places, with some crystals displaying simple twinning. *Numerous crystals are also breaking down…* Plagioclase (38%) is euhedral to subhedral, 2-4 mm in size, and display the onset of sericitisation with a brown-orange staining to the margins of crystals.

An opaque mineral (5%) is concentrated at the margins of actinolite crystals, and is usually with or closely associated to anhedral quartz crystals (7%), 0.5 – 1mm in size. Within the finer groundmass between large crystals, small <1mm acicular needles of actinolite are present. Finally, small patches of dusty grey, fine grained clays (?) are present, bearing acicular actinolite crystals.



Large plagioclase laths tend to cross-cut amphibole crystals, and in some instances are completely surrounded by actinolite indicating the preservation of a sub-ophitic original igneous texture.

CLASSIFICATION

Partially sericite-clay altered greenschist facies metagabbro.

SAMPLE NO: ROTH009 **GRID REFERENCE:** 487373 6770901

FIELD DESCRIPTION: Medium to coarse grained dolerite gabbro, relatively dark, possibly silicified, very hard to break.

MAPPED LITHOLOGY: Dolerite

THIN SECTION

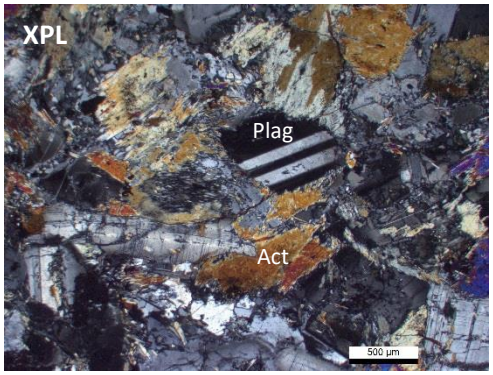
PPL/XPL

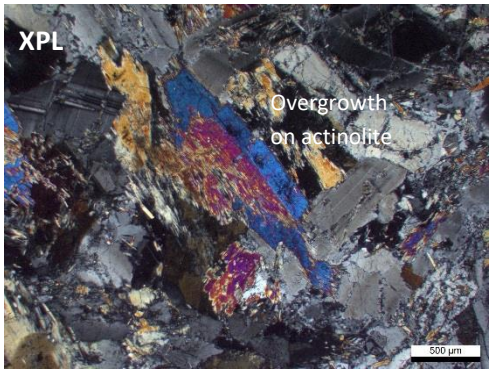
Actinolite (amph)	45%
Plagioclase	50%
Opaques (ilmenite)	2%
Quartz	<1%
Epidote	2%

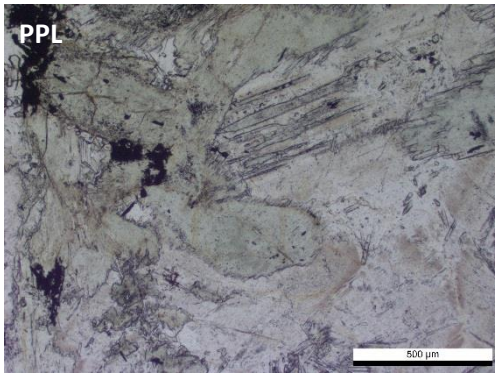
A medium-grained equicrystalline metaigneous rock, consisting largely of interlocking actinolite and plagioclase feldspar, with minor quartz, epidote and opaques. Actinolite crystals have an average grain size of 1.5-2mm (max 4mm) and are weakly pale-green - colourless pleochroic, with inclined extinction. Numerous actinolite crystals have an overgrowth marked by zonation in birefringence colours, developed during metamorphic crystallisation.

Plagioclase grains (1-2 mm) have a brown dusty appearance to their outer margins in plane polarised light (onset of alteration?) and display both polysynthetic and simple twinning, with evidence of compositional zoning in some crystals. Multiple examples of intimate growth of actinolite needles along twinning planes in plagioclase are observed. Aggregates of an opaque mineral are found at the margins of actinolite crystals, on the order of 0.2-0.3 mm in size and are elongate and silver grey in reflected light – likely ilmenite.

Minor high relief epidote and subordinate amounts of chlorite and quartz are identified, interstitial to the major phases.







CLASSIFICATION

Metadolerite

SAMPLE NO: ROTH010 **GRID REFERENCE:** 487133 6771278

FIELD DESCRIPTION: Very little if any white minerals. Seems to be fine grained and have the appearance of basalt.

MAPPED LITHOLOGY: Basalt

THIN SECTION

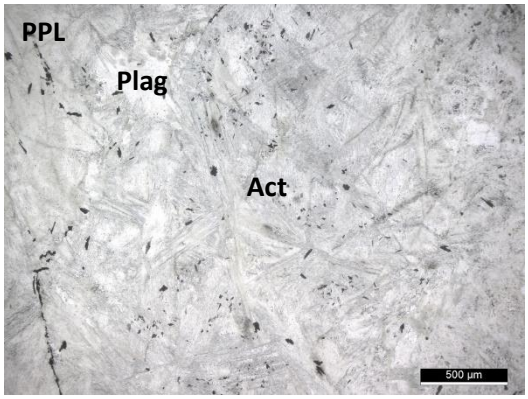
PPL/XPL

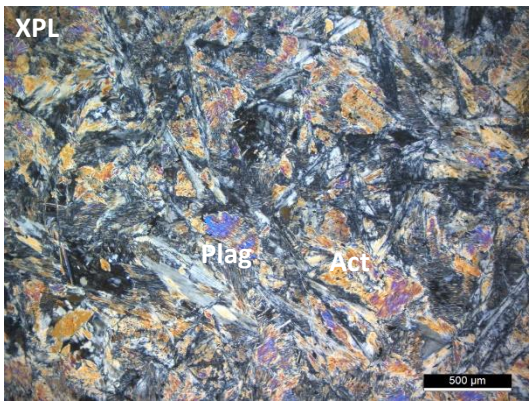
Actinolite	70%
Tremolite	20%
Plagioclase	9%
Oxides	1%

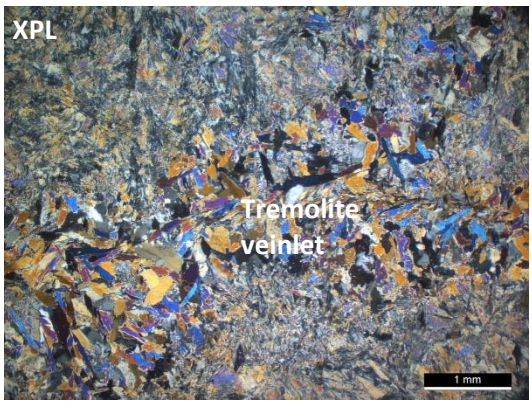
A fine grained crystalline mafic rock dominated by actinolite and tremolite with minor plagioclase.

The unit consists of anhedral fibrous laths of actinolite 0.2-0.5 mm in size (colourless-light green) and finer grained tremolite (0.1-0.3 mm). These crystals preserve traces of needle/acicular crystal outlines (up to 1.5 mm in length and <20 microns wide, however the mineralogy is not clear, likely due to metamorphic overprinting minerals. These features likely reflect randomly oriented acicular pyroxene crystals, since replaced by actinolite and tremolite. Lesser amounts of altered/mottled plagioclase are also present.

Acicular oxide needles are present up to 0.15 mm in length and randomly oriented. Multiple veinlets of actinolite/tremolite dissect the sample and are a product of metamorphism and alteration.







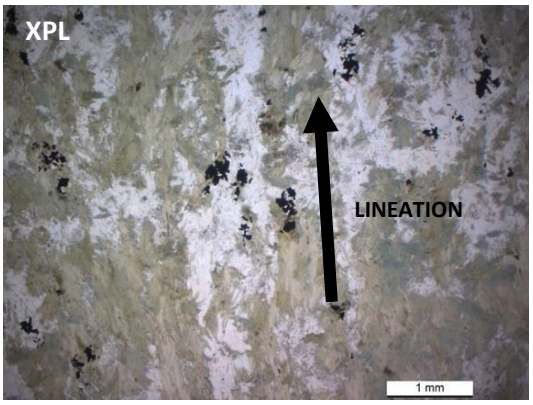
CLASSIFICATION

High Mg metabasalt (traces of random acicular pyroxene spinifex)

SAMPLE NO: ROTH011 **GRID REFERENCE:** 486684 6768805

FIELD DESCRIPTION: Medium grained dolerite with strong lineation of feldspar minerals, same as found in 2014 mapping as amphibolite in same area of Rothsay/Mulga Garden.

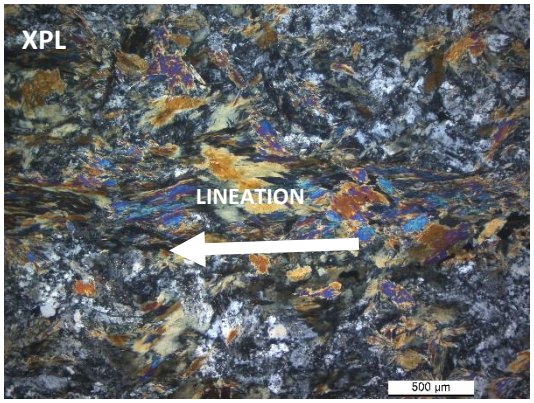
MAPPED LITHOLOGY: Dolerite



THIN SECTION

PPL/XPL

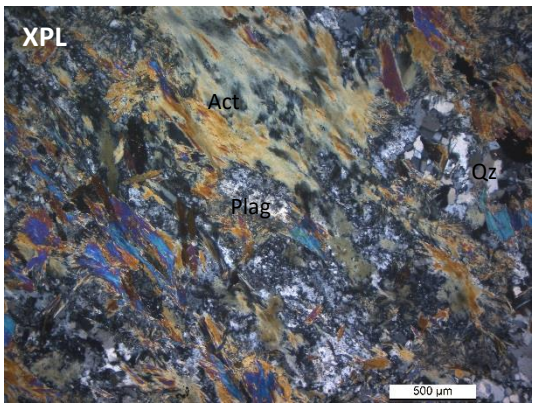
Plagioclase	*24%*
Amphibole (actinolite)	*58%*
Quartz	*13%*
Opaques	*5%*



A medium grained metamorphosed mafic rock possessing a strong linear fabric, composed of actinolite (54%), plagioclase feldspar (24%), quartz (15%) and an opaque mineral, probably ilmenite (5%).

Actinolite crystals are elongate to fibrous and aligned to define the lineation. Crystals are subhedral to anhedral and 0.25-1.5 mm (most frequently 0.5-1 mm), with moderate green-green pleochroism and second order birefringence. Quartz is common throughout the unit, occurring as anhedral grains up to 1 mm, typically with a granoblastic texture. Individual crystals do not align with strong linear fabric, but bands of quartz do.

Plagioclase feldspar crystals are anhedral, 0.5-1 mm and are moderately altered, probably sericitised, giving them a cloudy appearance. An opaque phase consists of elongate crystals 0.1-0.2 mm in length – likely ilmenite due to crystal form. They occur with feldspar and quartz, typically at the margins of actinolite crystals as seen in several other samples.



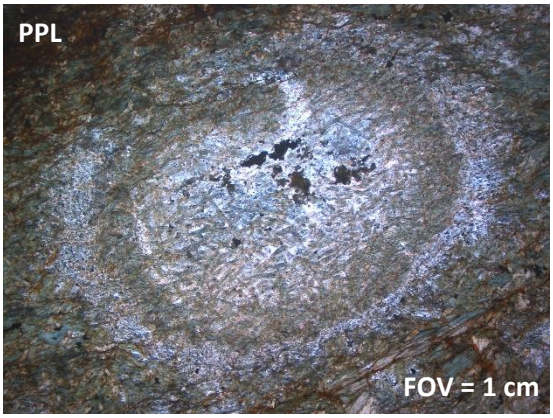
CLASSIFICATION

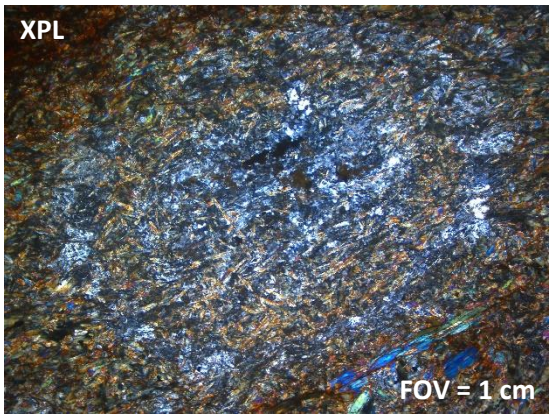
Metadolerite with a strong linear fabric (amphibolite).

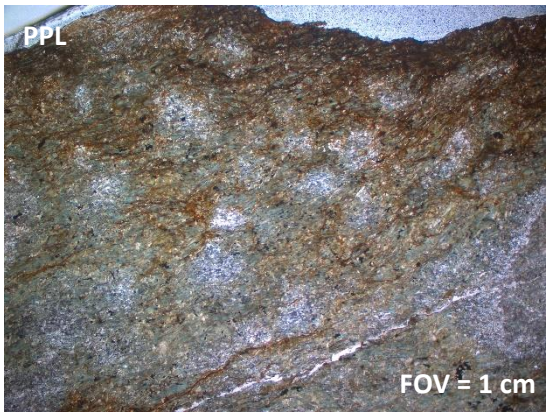
SAMPLE NO: ROTH012 **GRID REFERENCE:** 486673 6769150

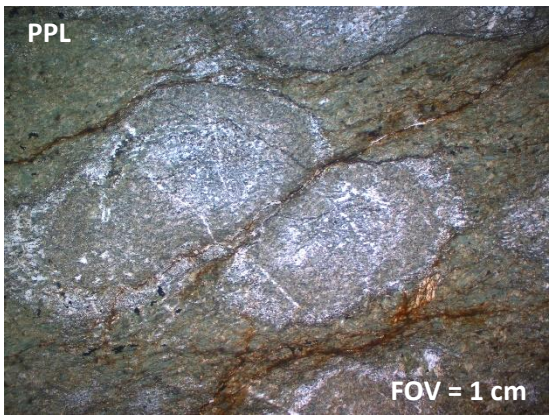
FIELD DESCRIPTION: Variolitic basalt, with varioles ranging in size between <1 mm and >1 cm.

MAPPED LITHOLOGY: Variolitic basalt









THIN SECTION

** Three thin sections containing different sized spherulitic structures have been taken from the same locality, and together described as part of ROTH012***

A fine to medium grained crystalline variolitic basalt containing spherulitic features that range in diameter from 1 mm to 12 mm.

The spherulitic features consist of increased plagioclase and quartz content relative to the interstitial groundmass between spherules. The smallest varioles are 0.5 mm in diameter – these have diffuse contacts.

In one sample, varioles are 2 mm in diameter and have cores that consist of ~75% plagioclase and quartz and 25%, relative to a surrounding matrix which comprises 85% actinolite and 15% plagioclase and quartz. The contacts between overlapping varioles are sharp and concavo-complex.

Some variolitic sample contain acicular crystals of amphibole 0.1-0.2 mm in length in addition to mottled plagioclase laths up to 0.2 mm in length. Disseminated ilmenite is often found in the core of varioles and is otherwise scattered in the groundmass. Elongate amphibole crystals are often aligned; however this alignment is not consistent across the sample, but varies in relation to spherules.

Large varioles reach ~12mm in diameter, with sharp contacts – cores consist of 60% plagioclase and quartz and 40% actinolite, whereas matrix consist of 80% actinolite and 20% plagioclase.

CLASSIFICATION

Variolitic metabasalt

SAMPLE NO: ROTH013 **GRID REFERENCE:** 482935 6771919

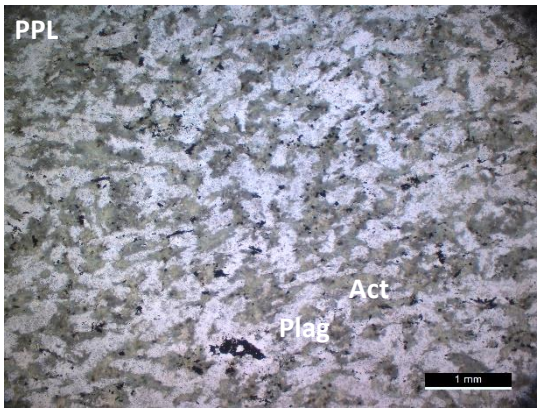
FIELD DESCRIPTION: Elongate white crystals visible, possibly a faint lineation?

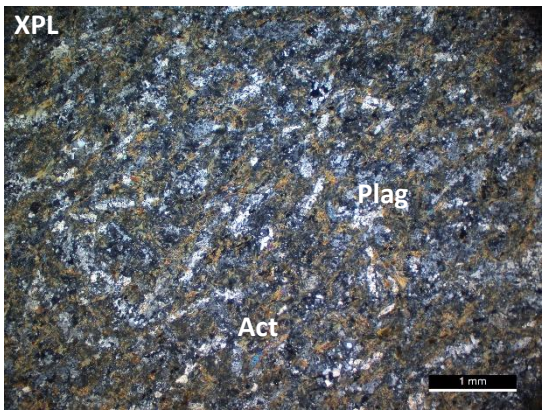
MAPPED LITHOLOGY: Basalt/dolerite

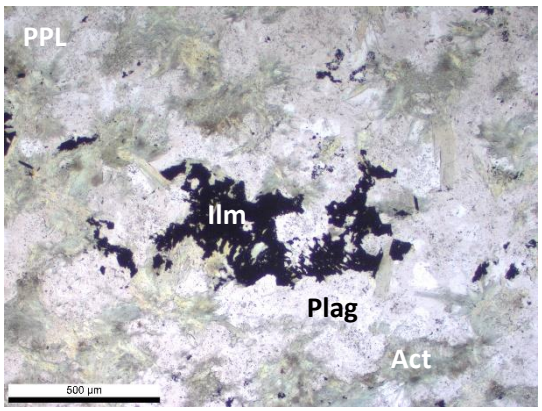
THIN SECTION

PPL/XPL

Actinolite	44%
Quartz	13%
Plagioclase	33%
Opaque (ilmenite?)	6%
Zoisite?	2%
Sulphides (Py, Po, Asp, Ccp)	2%







A fine-grained crystalline metaigneous rock consisting of a groundmass comprising actinolite, plagioclase and quartz.

Actinolite (after pyroxene) crystals are <0.3 mm in length, and have fibrous to elongate crystal shapes, with sheaths of acicular crystals common. A weak foliation is defined by the alignment of actinolite crystals. Plagioclase occurs as lath-like crystals 0.1-1 mm in size, however they appear to be moderately altered, with ragged, irregular edges and very little polysynthetic twinning evident. Quartz is abundant and occurs as aggregates exhibiting a granoblastic texture, with individual crystals up to 0.2 mm in size.

A colourless mineral with moderate relief and distinctive blue interference colours is present as clusters of crystals 0.2-0.6 mm in size, that in some instants mimic the tabular shape of plagioclase; this mineral is likely zoisite, a product of saussurutusation of Ca-rich plagioclase resulting from interaction with hydrothermal fluids.

An opaque phase, probably ilmenite/magnetite, has a bimodal distribution, consisting of small, elongate, anhedral 0.1 mm crystals dispersed amongst the groundmass at the margins of actinolite crystals, and larger 0.4-1.4 mm irregular crystals, generally associated with quartz. Sample is mineralised with disseminated sulphide assemblage including pyrite, chalcopyrite, pyrrhotite and arsenopyrite (good indicators for gold) – individual sulphide aggregates range in size from <0.1 mm to 0.4 mm.

CLASSIFICATION

Meta-andesite (or possibly silicified metabasalt).

SAMPLE NO: ROTH 014 **GRID REFERENCE:** 483846 6767183

FIELD DESCRIPTION: Found on Lexie Shear - Fine grained bands and coarser grained bands. Looked like sediments on first appearance. Purple mineral identified that could represent a Li- or Cs- bearing mineral, previously unidentified in this area. The pegmatite is discordant to the other lithologies and trending NE-SW, with a variable measured thickness of 5-15 metres.

MAPPED LITHOLOGY: Felsic Pegmatite

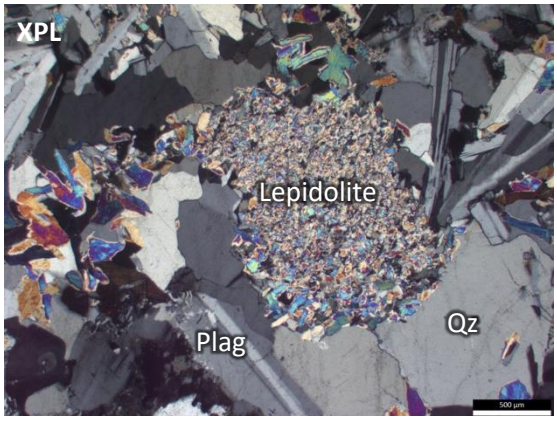
HAND SPECIMEN

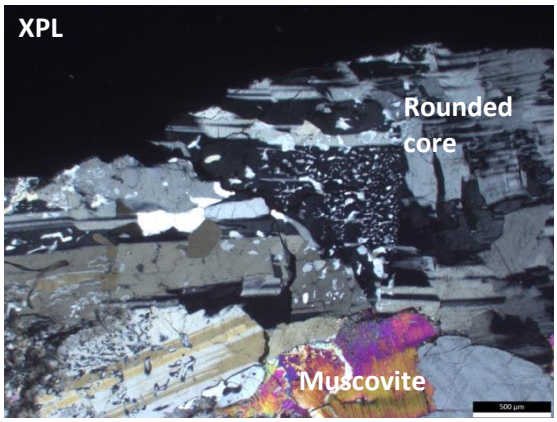
A coarse-grained felsic crystalline unit with banding defining finer and coarser portions. Minerals present include quartz, muscovite, plagioclase, K-feldspar and a pink-purple, finer grained micaceous mineral.

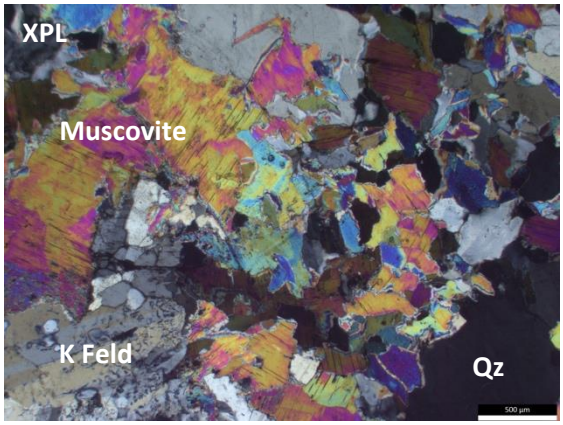
THIN SECTION

PPL/XPL

Plagioclase Feldspar	*42%*
K-Feldspar	*10%?*
Muscovite Mica	*10%*
Lepidolite Mica	*8%*
Quartz	*30%*







A coarse-grained lithium-bearing granitic pegmatite containing interlocking crystals of plagioclase and K- feldspar, quartz, muscovite mica and lepidolite mica. Tabular to prismatic plagioclase crystals are euhedral and vary from 0.5-4 mm in size, typically ~2 mm. Some crystals show granophyric texture, a form of graphic texture, with rounded intergrowths of quartz enclosed within feldspar crystals. Quartz crystals are generally anhedral and located interstitial to feldspar, frequently displaying a poikilitic texture containing inclusions of feldspar and mica and are 2-3 mm in size with few crystals reaching 5 mm.

Lepidolite mica occurs as fine grained (~0.1-0.25 mm) anhedral crystals that coalesce as rosettes 1 to 2 mm in diameter nestled between other phases. Lepidolite tends to occur with or in close proximity to quartz. Muscovite occurs as euhedral-subhedral crystals 0-5-1.5 mm in size.

Potential for presence of Amblygonite – grey feldspar-looking mineral in hand specimen….?

CLASSIFICATION

Felsic Li-bearing pegmatite

SAMPLE NO: ROTH019 **GRID REFERENCE:** 487938 6768480

FIELD DESCRIPTION: Coarse grained mafic with elongate feathery pyroxene crystals and plagioclase – superficial appearance of spinifex texture.

MAPPED LITHOLOGY: Dolerite-gabbro

HAND SPECIMEN

Coarse grained mafic metaigneous rock comprising elongate crystals of amphibole and plagioclase up to 1cm in size, nonmagnetic, superficial appearance of spinifex textured komatiitic rock, but significant plagioclase present.

THIN SECTION

PPL/XPL

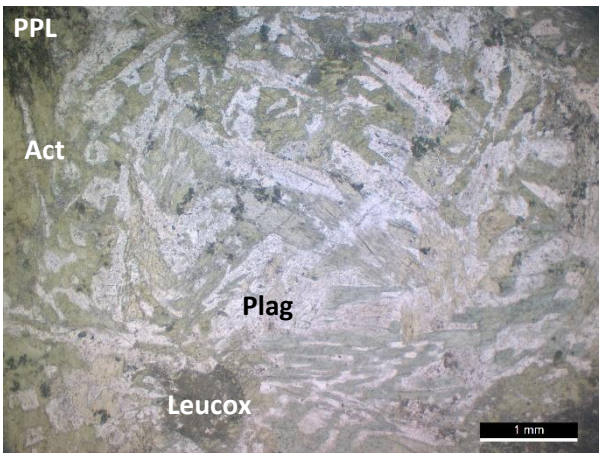
Actinolite	50%
Plagioclase	35%
Sericite	8%
Zoisite	5%
Leucoxene	2%

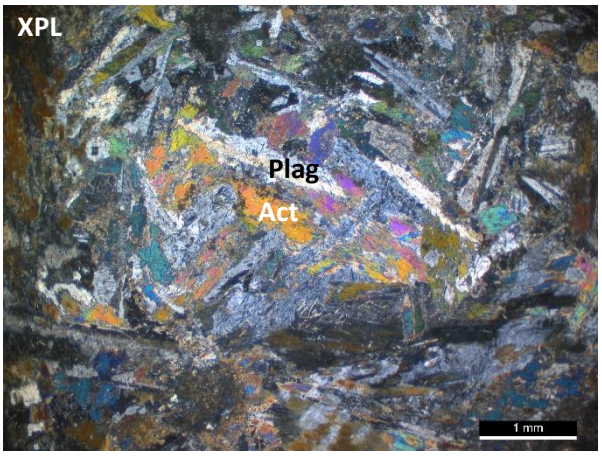
Coarse grained mafic rock consisting of acicular, elongate feathery crystals of amphibole and plagioclase, randomly oriented.

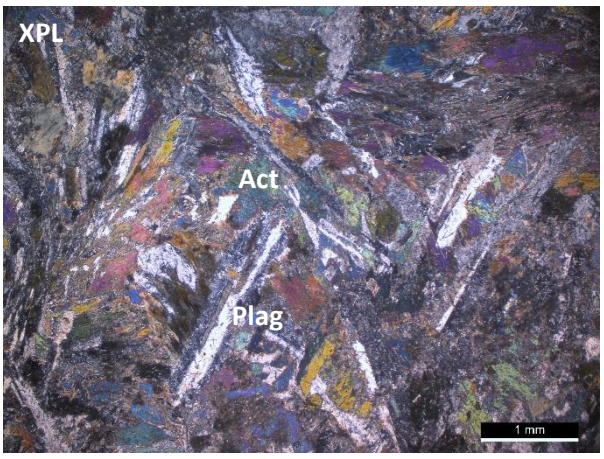
Amphibole crystals are actinolite with green-green pleochroism, present as subhedral, elongate laths up to 1 cm in length, frequently with simple twinning shown along longitudinal planes. Plagioclase crystals are interlockingwith actinolite and are also present as elongate crystals upto 2 cm in length – many still display polysynthetic twinning, however, a minority of the crystals are altered in patches to sericite, epidote and zoisite. In heavily altered crystals, randomly oriented, single acicular crystals of actinolite are present in a fine-grained altered groundmass.

The ambiguous cross cutting nature of the elongate actinolite and plagioclase crystals is indicative of metamorphic recrystallisation and growth.

Altered Ti oxides are present, likely leucoxene, but no opaque mineral phase.







CLASSIFICATION

Harrisitic-textured metagabbro (feathery-textured elongate crystals)

SAMPLE NO: ROTH023 **GRID REFERENCE:** 487317 6768951

FIELD DESCRIPTION: Thin 5m bedded unit, consisting of fine grained grey ash with laminations and larger clasts/lapilli concentrated on some horizons. Foliation present at angle to bedding. Mapped at the base of a thick 2km+ basalt pile and immediately overlying BIF and an intrusive dolerite sill. Oriented sample taken.

MAPPED LITHOLOGY: Intermediate Tuff

HAND SPECIMEN

THIN SECTION

PPL/XPL

A thinly bedded, ash-bearing metavolcaniclastic unit consisting of 5-15 mm thick beds of grey, intermediate composition ash, with alternating layers of fine to medium grained quartz bearing units, and very fine grained lapilli-bearing units.

The grey groundmass is too fine to distinguish individual mineral content, but SEM-EDS analysis shows its chemistry to consist primarily of Al and Si, with minor Fe and Mg. Coarser beds are poorly sorted, contain angular to sub-angular <0.05 to 0.3 mm quartz clasts (30%), fine grained ash groundmass (60%), granular iron oxide (8%), and rare 0.2 mm sub-rounded cherty lithic clasts (2%). These quartz-rich layers typically have erosive bases, including the erosion of originally rounded lithic clasts, suggesting a degree of sedimentary reworking of volcanic material.

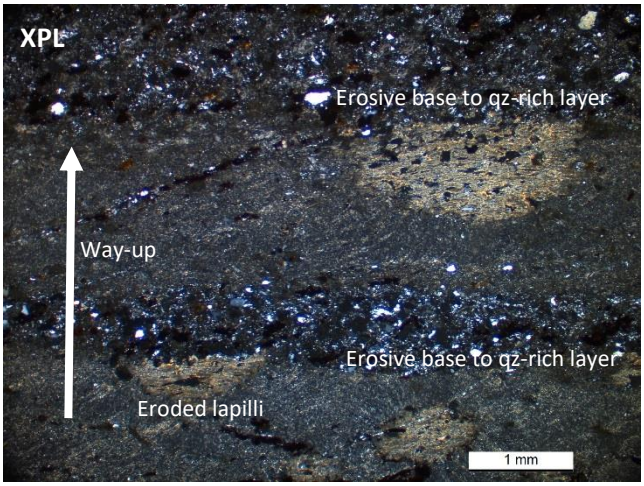
Fine grained intervals are moderately to well sorted, consist of ash (70%) and rare <0.05 mm angular quartz clasts (2%), opaque iron oxide (8%) in addition to rounded volcanic lithic clasts (20%). These lithic clasts are typically 1-3 mm in size and comprise quartz crystals, sericitised feldspar crystals, fine ash and minor magnetite and rutile, though smaller 0.2-1 mm equivalents are observed in one layer. These clasts are concentrated along specific bedding horizons, are slightly elongate in the direction of bedding (compaction?), often exhibit a relict crystal/cavity at their core and display fining upwards graded bedding. These features are interpreted as lapilli, and likely represent eruptive episodes between periods of reworking.

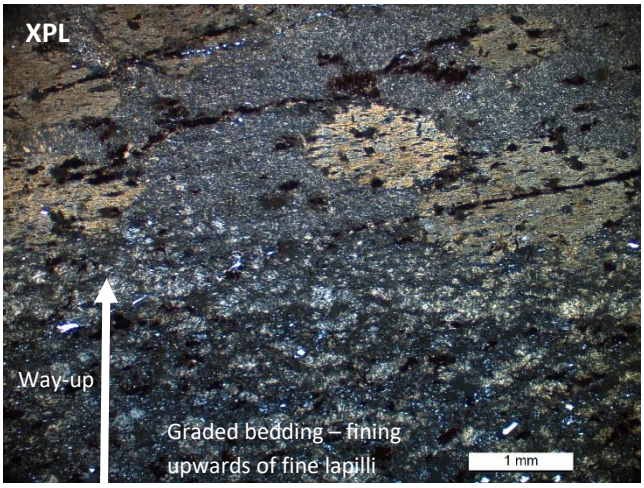
Accessory minerals in the groundmass include slightly rounded, 0.15-0.2 mm rutile and 0.1 mm ilmenite crystals, and 10-80 µm zircon crystals. A number of elongate/rod-shaped shards of quartz about 0.2 mm in length are found, that may represent relic shards of volcanic glass. Zircon distribution in layers demonstrates crypto-graded bedding, with grains concentrated at the base of units and decreasing in abundance towards the tops, acting as way-up criteria. This is confirmed by grading of lapilli and erosive bases of coarser intervals.

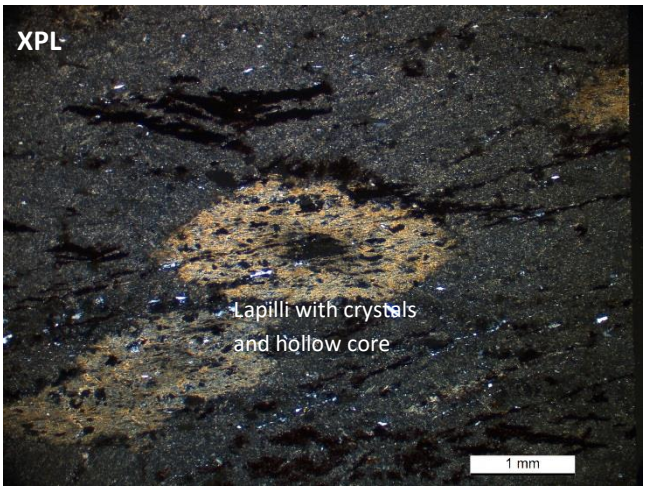
The unit is cross cut by secondary quartz veinlets up to 0.3 mm in width, and minor iron oxide, probably hematite.

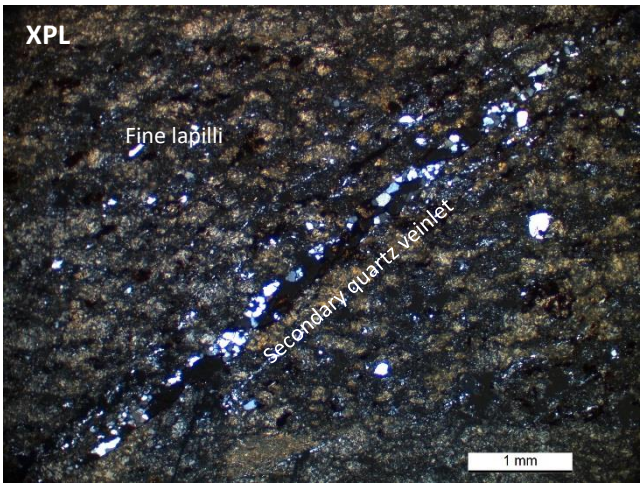
CLASSIFICATION

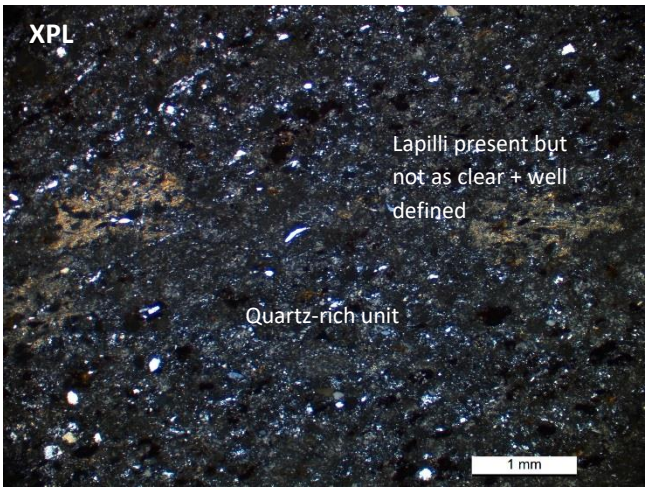
Thinly bedded andesitic lapilli tuff

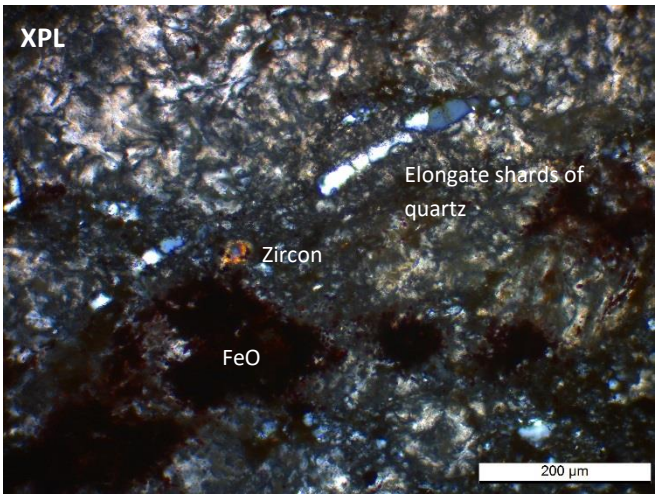

XPL
Erosive base to qz-rich layer
Way-up
Erosive base to qz-rich layer
Eroded lapilli
1 mm

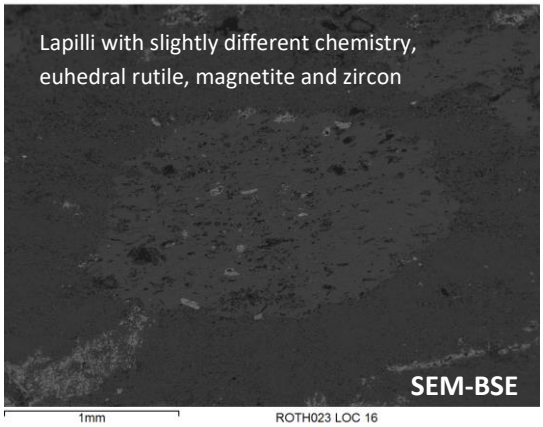

XPL
Way-up
Graded bedding – fining upwards of fine lapilli
1 mm


XPL
Lapilli with crystals and hollow core
1 mm


XPL
Fine lapilli
Secondary quartz veinlet
1 mm


XPL
Lapilli present but not as clear + well defined
Quartz-rich unit
1 mm


XPL
Elongate shards of quartz
Zircon
FeO
200 µm


Lapilli with slightly different chemistry, euhedral rutile, magnetite and zircon
SEM-BSE
1mm
ROTH023 LOC 16

SAMPLE NO: ROTH 024 **GRID REFERENCE:** 486478 6766296

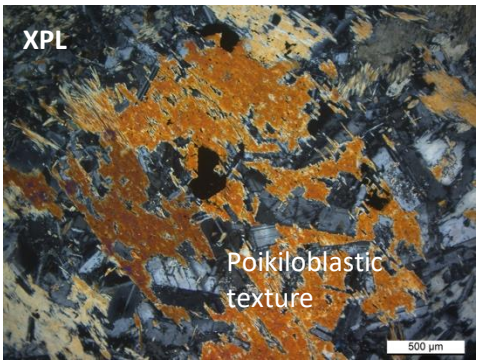
FIELD DESCRIPTION: 10 metre outcrop of coarse grained mafic – gabbro, with tabular crystals up to 1cm in size. Relatively dark, with only about 20-25% white minerals visible – could be pyroxenite. Subcrop surrounding outcrop.

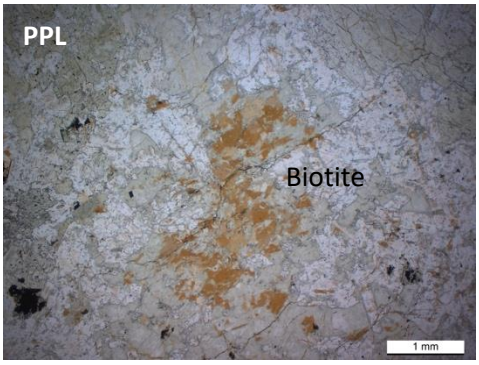
MAPPED LITHOLOGY: Tabular metapyroxenite

THIN SECTION

PPL/XPL

Amphibole (actinolite)	*58%*
Plagioclase	*35%*
Biotite	*5%*
Opaques	*2%*





A coarse-grained plutonic metaigneous rock displaying a strong poikiloblastic texture, comprising large 3-8 mm, often fragmented anhedral to subhedral actinolite crystals that contain inclusions of euhedral plagioclase crystals 0.75-1 mm in size.

Actinolite oikoblasts show characteristic weak green-green pleochroism, and in addition to forming poikiloblasts, also show sub-ophitic textures – both examples of relic original igneous textures. Biotite is identified in some portions of the sample (brown pleochroic, straight extinction, high birefringence) primarily in highly altered grains (where it occurs enclosed in actinolite – relic?) or in close proximity to fractures.

Crystals appear randomly oriented, with no clear alignment or foliation present. No quartz has been identified in the unit.

Opaques are focussed at the margin of actinolite crystals, as has been the case for similar samples from intrusive mafic rocks in the area.

CLASSIFICATION

Coarse grained poikiloblastic metagabbro.

SAMPLE NO: ROTH026 **GRID REFERENCE:** 486613 6768948

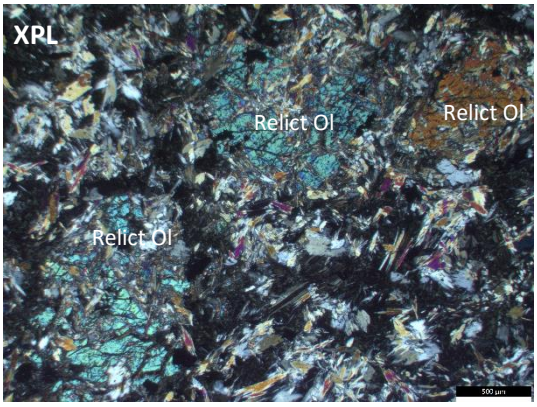
FIELD DESCRIPTION: Not the typical appearance of peridotite, highly magnetic, rounded boulders.

MAPPED LITHOLOGY: Peridotite

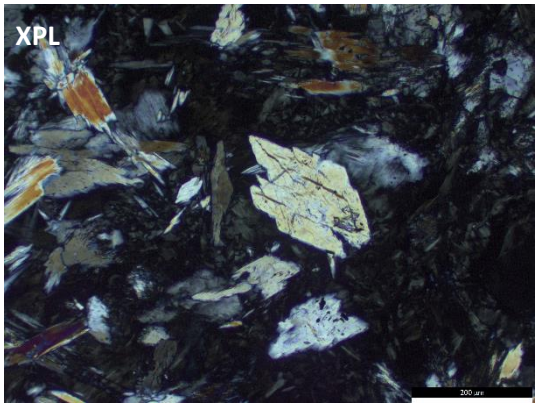
THIN SECTION

PPL/XPL

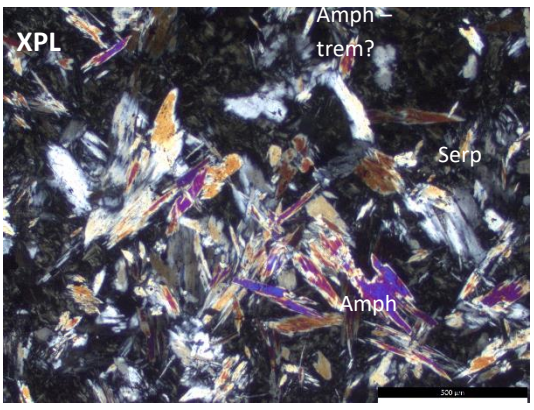
Olivine	28%
Serpentine	30%
Magnetite	7%
Tremolite	35%



A partially-serpentinised ultramafic rock containing altered cumulate olivine crystals in a groundmass comprised of serpentine, tremolite and magnetite.



Olivine phenocrysts are 1-4 mm in size, highly fragmented and ragged and in several instances, forms glomerocrysts of 3-4 crystals showing a relict igneous texture. Some olivine crystals have broken down to the extent that only a single 0.3 mm fragment remains. Subhedral grains of magnetite <0.1-0.25mm are associated with olivine, either enclosed within or at the margin of grains.



A colourless, fibrous, amphibole with 120 degree cleavage intersection and 2nd order interference colours is abundant, likely tremolite and is present as randomly oriented 0.1-0.7 mm crystals. Serpentine shows a mesh texture and forms the low-birefringence groundmass between tremolite and remnant olivine. A sub-poikilitic texture is apparent, with amphibole crystals frequently enclosed within olivine crystals – may be due to metamorphism.

CLASSIFICATION

Serpentinised ultramafic extrusive olivine cumulate (associated with spinifex textured komatiitic flow).

SAMPLE NO: ROTH027 **GRID REFERENCE:** 486554 6768974

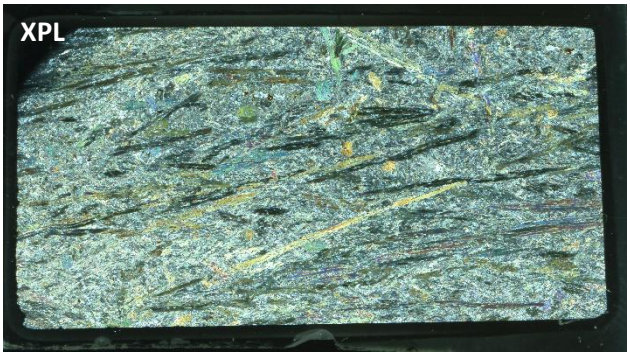
FIELD DESCRIPTION: Well developed linear spinifex texture, rooting laths of pyroxene, way up criteria.

MAPPED LITHOLOGY: Spinifex-textured basalt

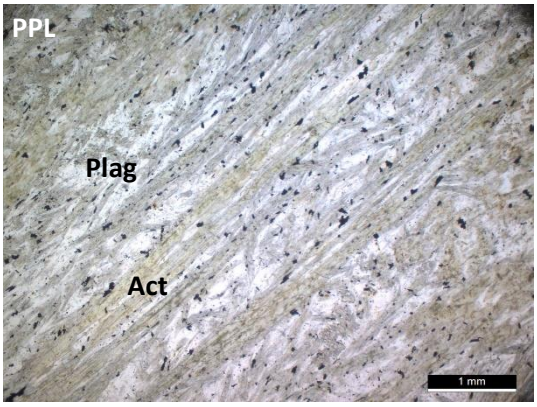
THIN SECTION

PPL/XPL

Actinolite	56%
Quartz	7%
Plagioclase	30%
Biotite	2%
Ilmenite	5%

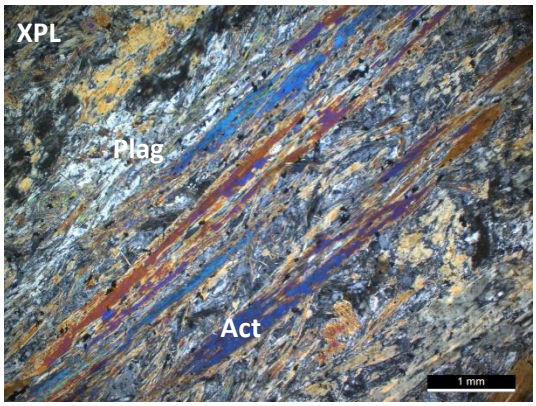


Phenocrysts occupy ~40% of the unit – increases to 65% in sample T3 – more tightly packed.



Porphyritic aligned acicular spinifex-textured rock.

Acicular pyroxene phenocrysts are generally aligned and vary between 0.5-1.0 mm in width, and 1-35 mm in length – they are typically subhedral with ragged irregular margins, and occasionally show simple twinning. The acicular phenocrysts branch outwards in one direction (way-up criteria). In some instances, composite acicular phenocrysts are present as parallel sets that remain in optical continuity (go into extinction at same time), present both in long section and a basal sections. Basal sections are frequently zones, with actinolite rims and irregular cores replaced by quartz or chlorite.



The surrounding groundmass consists of intergrown plagioclase (<0.3 mm) and acicular actinolite crystals (<0.2mm) defining a feathery/plumose texture. Some anhedral quartz is also present up to 0.3 mm in size. Localised biotite is present in association with quartz, including in the cores of phenocrysts.

Minor recrystallised quartz is present as 4mm discontinuous veinlets associated with increased alteration and oxidation of iron oxides.

Oxides are abundant in interstices and consist of a single phase, often as elongate needles, suggestive of ilmenite.

Almost identical to T3.

CLASSIFICATION

Aligned acicular pyroxene spinifex-textured metabasalt (String Beef)

SAMPLE NO: ROTH029 **GRID REFERENCE:** 488997 6767579

FIELD DESCRIPTION: Coarse gabbro, pyroxene dominant, grains up to 1cm, taken from large outcrop.

MAPPED LITHOLOGY: Gabbro

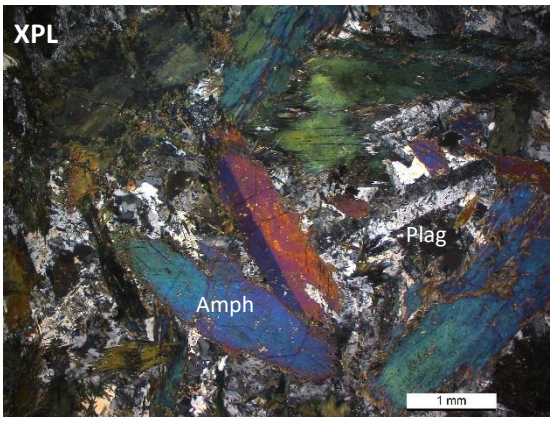
THIN SECTION

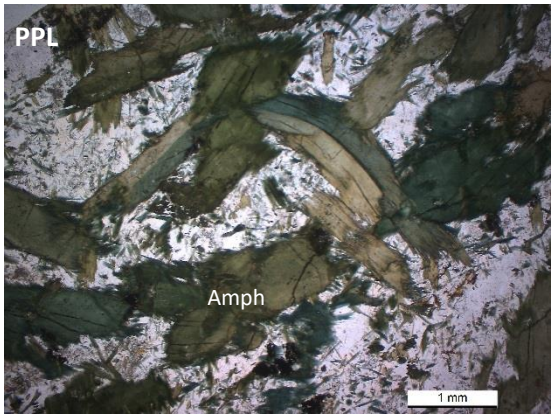
PPL/XPL

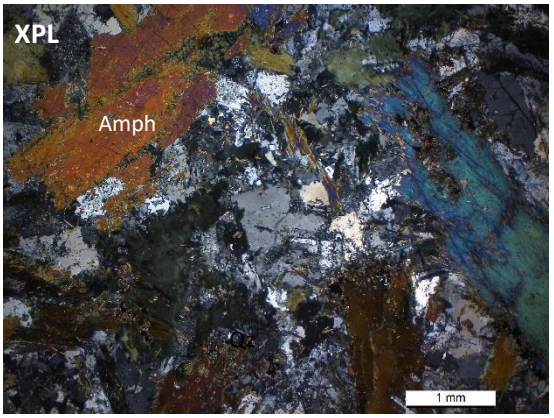
Plagioclase	*25%*
Amphibole (horn)	*45%*
Amphibole (act?)	*10%*
Quartz	*~15%*
Opaques	*5%*
Chlorite	*< 1%*

A coarse-grained, inequicrystalline plutonic metaigneous rock, with an interlocking texture composed of large, elongate crystals of subhedral to euhedral hornblende amphibole crystals up to 6mm in size, and 3.5-1.5 mm subhedral laths of plagioclase feldspar. Hornblende is strongly green-green to brown-yellow-green pleochroic, with basal sections showing 120 degree cleavage intersections and sometimes simple twinning. Several acicular grains are deformed (see adjacent image) such that cleavage planes are bent and extinction is somewhat undulose. Plagioclase has a corroded appearance, with lots of inclusions of greenschist metamorphic alteration minerals, primarily acicular needles of actinolite (?).

Quartz is present in significant amounts, interstitial to larger amphibole grains with a granoblastic texture, reaching a maximum of 1mm in size. Opaque mineral content (~5%; up to 0.6mm in size) includes pyrite and an oxide (possibly ilmenite), are focussed around the margins of hornblende grains, and are typically surrounded by a fine grained phase displaying a corona texture. Subordinate chlorite is present (<1%) as evidenced by anomalous blue birefringence.







CLASSIFICATION

Porphyritic metagabbroic diorite with coarse, acicular amphibole porphyroblasts.

SAMPLE NO: ROTH034 **GRID REFERENCE:** 491580 6767737

FIELD DESCRIPTION: 20 metre subcrop in all directions of a medium to coarse grained mafic rock – can see plagioclase and quartz and also small yellow dots 1mm in size – may be leucoxene. Could be an evolved dolerite near the top of a sill – quartz diorite?

MAPPED LITHOLOGY: Gabbro

THIN SECTION

PPL/XPL

Plagioclase (andesine)	*40%*
Amphibole (hornblende)	*37%*
Quartz	*16%*
Opaques (ilmenite)	*4%*
Leucoxene (titanite/perovskite)	*3%*
Zircon	*<<1%*

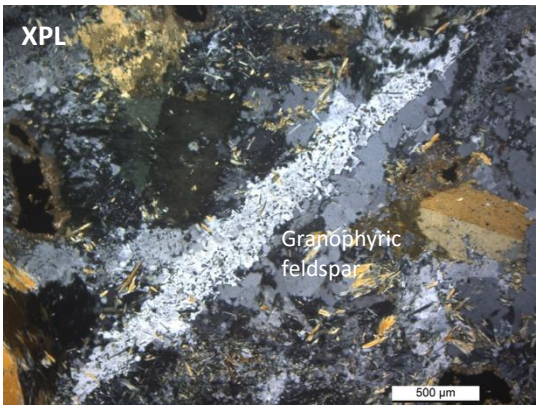
A coarse grained, inequicrystalline metaigneous intrusive rock comprising amphibole porphyroblasts, anhedral grains/aggregate of quartz with very irregular margins, plagioclase feldspar (with possible granophyric texture), and an opaque mineral breaking down into a non-opaque phase.

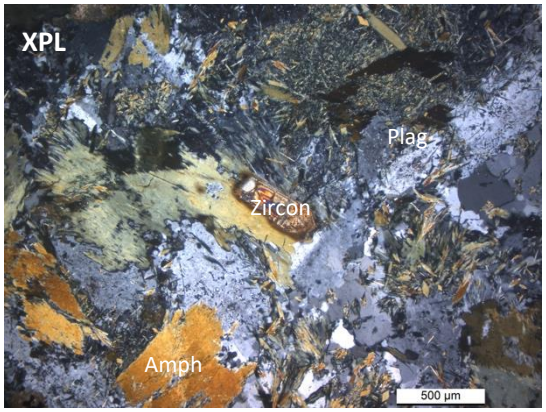
Amphibole is typically elongate – acicular in shape, with simple twinning along long axes. The crystals are green-green to brown-green pleochroic (hornblende). Acicular crystals are 2-6 mm in length, and 0.5-1 mm in width. Crystals are randomly oriented, with finer grained acicular crystals of same mineral as the porphyroblasts – hornblende – found in the groundmass. Plagioclase feldspar present appears altered, 1-4 mm in size and appear to contain an array of blob-like inclusions of quartz, defining a granophyric texture, and with simple twinning (no polysynthetic twinning). This confirms that the sample is from the evolved top of one of the differentiated sills. The plagioclase is andesine in composition, with 35-45% Ca/Anorthite. Quartz grains are quite large, 0.25-2 mm, with a slight undulose extinction. Often, large crystals are in fact aggregates actually split into many crystals with a granoblastic texture – indicative of recrystallisation. A significant amount of quartz is present compared to other samples from the intrusive sills of the area.

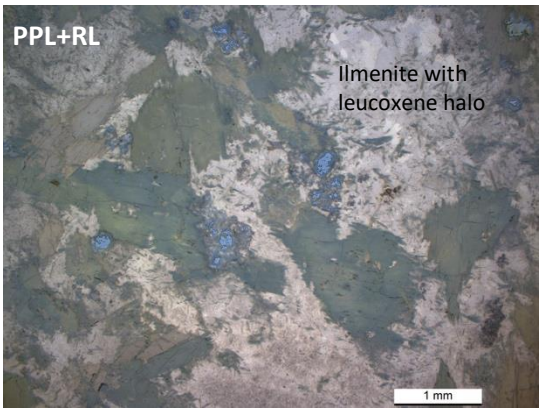
Oxides (0.5-1 mm) are abundant and composed of ilmenite, with a halo of fine grained non-opaque mineral surrounding them – comprising leucoxene from breakdown of the ilmenite (titanite/perovskite). In several cases, ilmenite has completely converted to leucoxene. A number of large (up to 450 μm) zircon crystals identified, with high relief and minor zoning.

SEM WORK

Amphiboles confirmed as hornblende (phenocrysts and gmass), opaques ilmenite surrounded by leucoxene, lots of quartz, large zircon crystals present, and plag contains more Na than Ca.







CLASSIFICATION

Metamorphosed, granophyric quartz metadiorite.

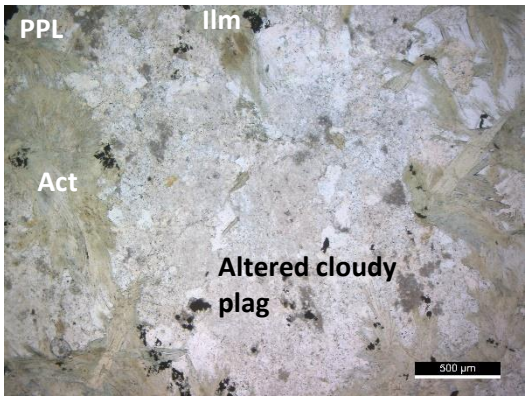
SAMPLE NO: ROTH035 **GRID REFERENCE:** 486172 6769022

FIELD DESCRIPTION: 7m OC, blocks up to 70cm in size, there has been increase in plag content from previous loc and OC further S, now 50:50 or ever 40:60. Evolved top of mafic sill.

MAPPED LITHOLOGY: Gabbro

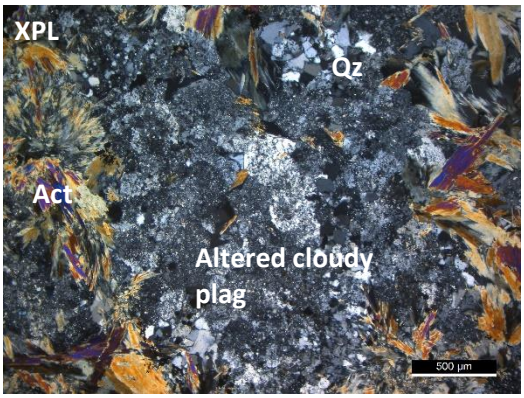
HAND SPECIMEN

THIN SECTION

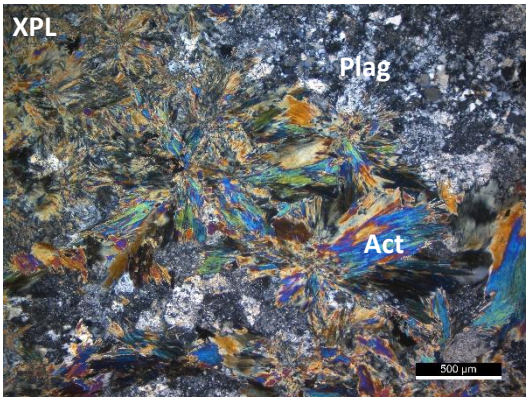


PPL/XPL

Plagioclase (altered)	*45%*
Actinolite	*35%*
Quartz	*15%*
Opaques (ilmenite)	*5%*



A coarse grained, inequicrystalline metaigneous intrusive rock comprising actinolite, highly altered plagioclase, quartz, and an opaque phase. Actinolite crystals are fibrous to acicular in shape and range in size from 0.2-1 mm in size. In many instances, fibrous actinolite crystal radiate outwards away from a point, defining sheaths of crystals. Plagioclase feldspar occurs as highly altered crystals 0.3-0.5 mm in size that in some instances maintain a tabular shape, but are very dusty, contain abundant inclusions and lack twinning – likely composed of sericite and altered as a consequence of saussuritization (during late magmatic crystallisation??). This is consistent with other samples from the evolved tops of thick Warriedar Suite sills. The abundance of plagioclase relative to actinolite is also considerably higher than elsewhere in the Gardner sill.



Quartz is present both as minor 1 mm veinlets and in the altered groundmass alongside plagioclase as assemblages of anhedral crystals 0.2-0.4 mm in size, typically with a granoblastic texture (indicating recrystallisation). Quartz also occurs as single anhedral crystals amongst actinolite and altered plagioclase, suggesting that primary quartz may be present in addition to secondary quartz from hydrothermal alteration.

Oxides (0.5-1 mm) are abundant, 0.1-0.6 mm in size and consist of a composite of minor elongate ilmenite and magnetite crystals that are typically located at the margins of actinolite – however, this unit lacks the leucoxene halo around oxides that many other (particularly evolved) mafic intrusives in the area display.

CLASSIFICATION

Hydrothermally altered (+saussuritized) quartz metadiorite.

SAMPLE NO: ROTH036 **GRID REFERENCE:** 487728 6770392

FIELD DESCRIPTION: Map 8 Basalt - elongate crystals - spin textured basalt?

MAPPED LITHOLOGY: Spinifex textured basalt

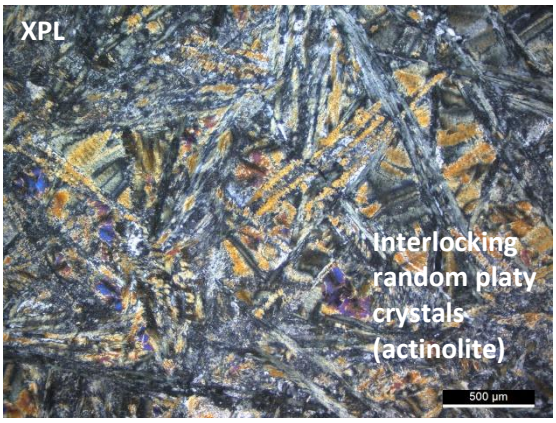
THIN SECTION

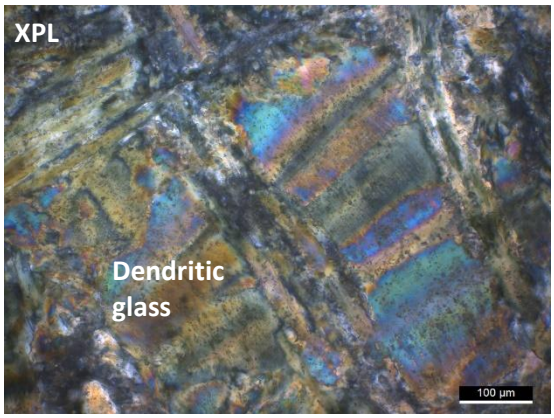
PPL/XPL

Augite (cpx) → actinolite	69%
Glassy groundmass	23%
Quartz	7%
Epidote	1%

Phenocrysts comprise 65% of the sample

- Thin, elongated crystals of pyroxene (pseudomorphed by actinolite) present as sets of parallel crystals with the same orientation – same texture as platy pyroxene (BAD001a).
- Random orientation of sets of pyroxene crystals (plates), smaller crystals terminate against larger crystals.
- Interstitial areas between elongate phenocrysts are comprised of actinolite, but patterns are very similar to dendritic patterns in BAD001a.
- Phenocrysts range in length from 0.5-6 mm and range in thickness from 50 microns to 200 microns.
- Also acicular single phenocrysts present – some basal sections visible
- Multiple minor 0.2 mm quartz veinlets cross cut the sample, irregularly.
- Granoblastic quartz is present in patches throughout the groundmass, typically <0.5 mm.
- Groundmass very fine grained – quenched glass? Also minor epidote in places.
- Strong green discolouration - greenschist facies metamorphism.





CLASSIFICATION

Random platy/acicular pyroxene spinifex-textured metabasalt

SAMPLE NO: ROTH041 **GRID REFERENCE:** 490232 6768970

FIELD DESCRIPTION: Komatiite? Spinifex texture and siliceous appearance, very hard, in east, previously mapped as dolerite.

MAPPED LITHOLOGY: Komatiite/spinifex-textured basalt

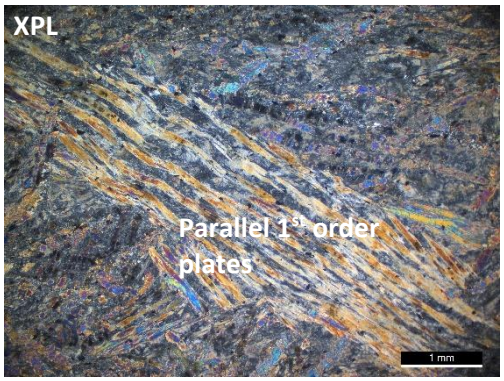
THIN SECTION

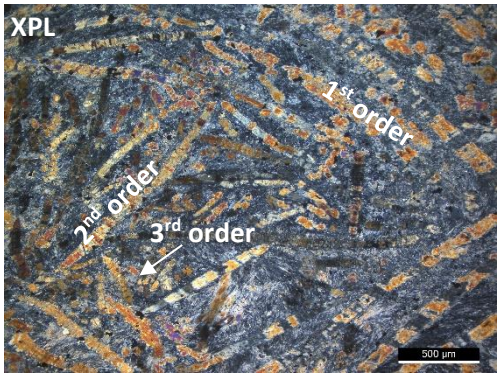
PPL/XPL

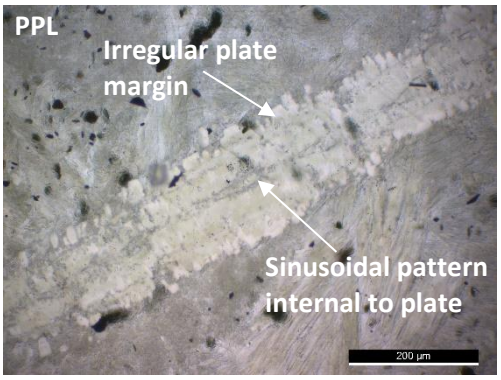
Augite (cpx)
Glassy groundmass
Quartz

Phenocrysts account for 30% of the sample.

- Parallel plates of actinolite (after pyroxene) – up to 16 plates in a set and have lengths varying from 0.8 mm to 10 mm and widths varying from 80-200 microns. Sets are randomly oriented, and terminate against other sets.
- Some plates sets are widely spaced, up to 1mm apart.
- Sample quite highly altered – groundmass and phenocryst.
- When zoomed in, plates have irregular crystal development at their margins, zoning with a <50 micron rim of a different composition, and lozenge shaped skeletal features along the core of crystals (exactly like that described by lowrey).
- Development of sets of smaller plates in interstitial spaces between plates in a set.
- Also some acicular crystals present, with subhedral basal sections. Tend to terminate against plates.
- Groundmass is very fine grained, and has a plumose texture, with single needles of acicular actinolite up to 100 microns in length within a grey glassy groundmass – cooled very rapidly.
- No trace of dendritic patterns in interstitial areas – the sample is generally quite highly altered, so may have been lost.
- Several patches of recrystallised quartz, up to 0.8 mm in size.
- Opaques disseminated throughout, consist of elongate ilmenite needles primarily, perhaps minor chromite?







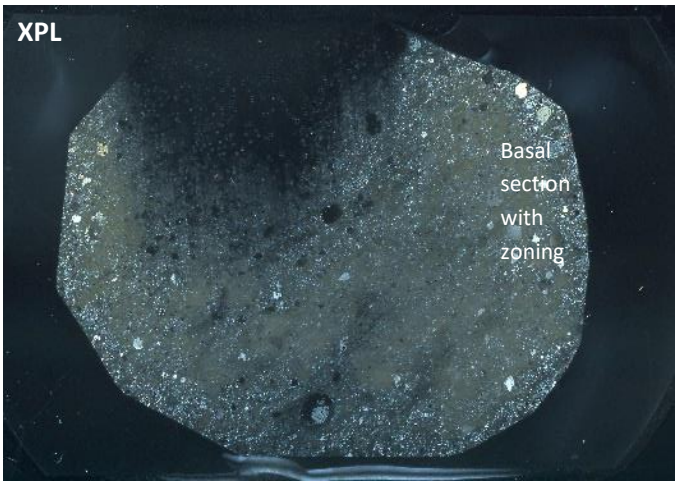
CLASSIFICATION

Random platy pyroxene spinifex-textured metabasalt

SAMPLE NO: ROTH044 **GRID REFERENCE:** 490297 6771622

FIELD DESCRIPTION: White and soft, composed of very fine quartz-feldspathic groundmass, containing sub-angular to sub-rounded clasts up quartz up to 2-3mm in size.

MAPPED LITHOLOGY: Felsic Volcaniclastic



THIN SECTION

PPL/XPL

Quartzofeldspathic groundmass	50%
Quartz clasts	19%
Lithic clasts – cherty	30%
Iron Oxide	1%
Barite	<1%
Rutile	<1%
Zircon	<1%

This unit is a highly altered, moderately foliated felsic volcaniclastic metasandstone, consisting of a fine grained, clay-altered quartzofeldspathic groundmass, with quartz clasts, lithic clasts and accessory rutile, pyrite and zircon.

The groundmass is composed of fine (<0.1 mm) quartz grains, and a very fine light brown matrix – too fine to distinguish mineral content, though EDS analysis indicates it consists primarily of aluminosilicates. Clay is likely present in this fine matrix, supported by the soft, friable nature of the sample, with the bright white colour suggesting this is possibly kaolinite.

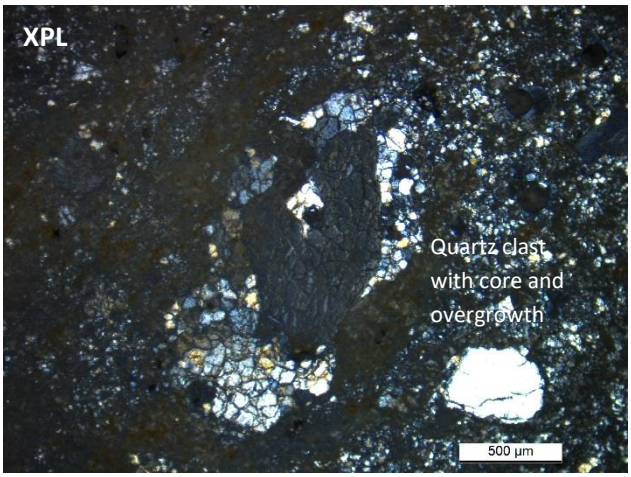
Sub angular 0.2-1.2 mm quartz grains are dispersed throughout the matrix, often highly fractured. Lithic clasts are sub-rounded, 0.5-2 mm in size and invariably cherty, consisting of microcrystalline quartz. Some clasts display some sort of overgrowth texture, with a central sub-rounded quartz clast surrounded by finer microcrystalline quartz.

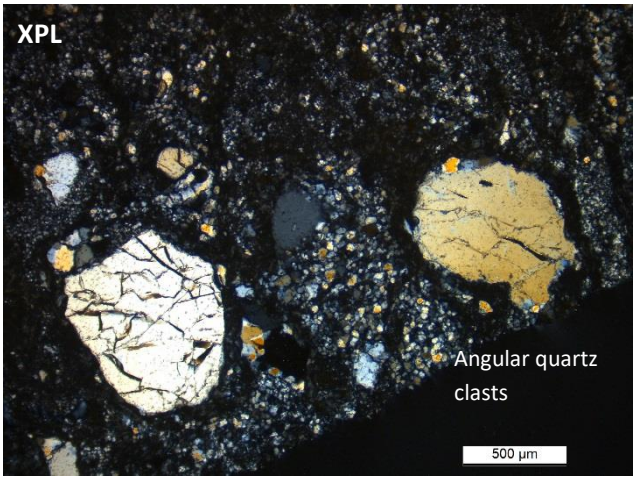
Sparse opaque iron oxide crystals up to 0.2 mm are found in the matrix, probably secondary limonite, with accessory rutile, barite and subhedral zircon crystals also present.

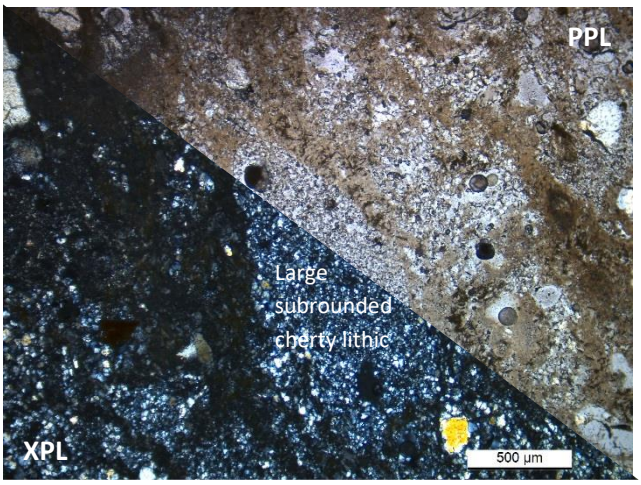
The unit is weakly to moderately foliated, defined by the alignment of elongate lithic clasts.

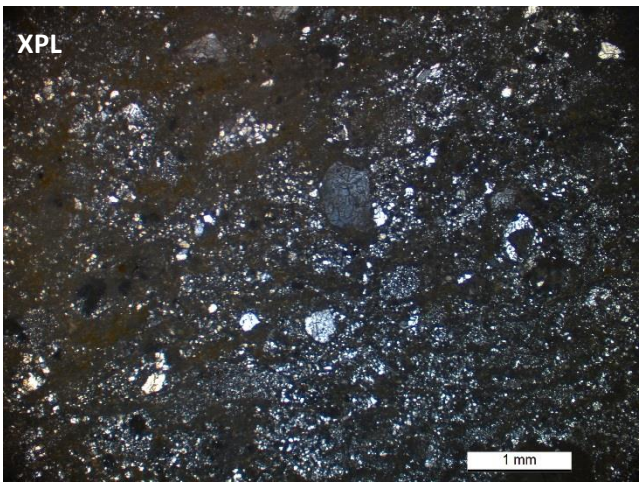
CLASSIFICATION

Felsic volcaniclastic rock


XPL
Quartz clast with core and overgrowth
500 µm


XPL
Angular quartz clasts
500 µm


PPL
Large subrounded cherty lithic
XPL
500 µm


XPL
1 mm

SAMPLE NO: ROTH047 **GRID REFERENCE:** 485732 6765490

FIELD DESCRIPTION: Porphyritic basalt with euhedral plagioclase phenocrysts.

MAPPED LITHOLOGY: (Meta)basalt

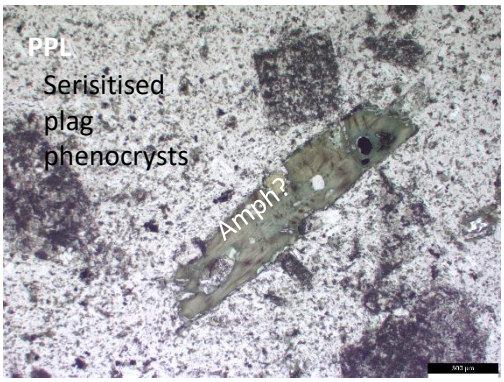
HAND SPECIMEN

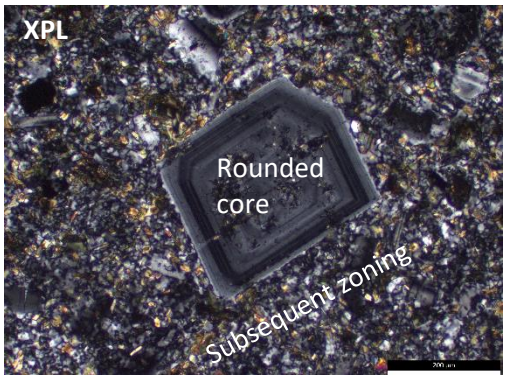
Crystalline, porphyritic lava containing two phenocryst phases – one white and euhedral (plagioclase) and another phase of elongate crystals darker to black in colour (amph/cpx). Groundmass is black and fine grained.

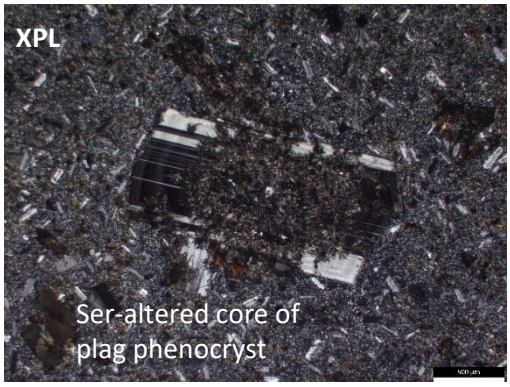
THIN SECTION

PPL/XPL

Groundmass		***Phenocrysts***	
Plagioclase	*65%*	*Plagioclase*	*75% (45% Sericite altered)*
Hornblende Amphibole	*22%*	*Hornblende Amphibole*	*25%*
Biotite	*6%*		
Axinite?	*4%*		
Quartz	*2%*		
Zircon	*1%*		







A fine grained, crystalline, porphyritic volcanic rock with evidence of three stage cooling, with large phenocrysts 0.5-3.5 mm in size, microphenocrysts typically 0.1-0.15mm in size and a fine grained <0.1 mm (~10µm) groundmass.

Two phenocryst phases are present; plagioclase and amphibole.

Plagioclase phenocrysts are typically subhedral to euhedral, prismatic, vary from 0.6-2 mm in size and in addition to polysynthetic twinning, display well-developed zoning within crystals, many comprising rounded cores and euhedral rim overgrowths suggesting resorption during crystallisation. Some plagioclase crystals are partially to completely replaced with a high birefringence, fine grained mineral, suggestive of sericite alteration. In some cases, alteration is focused in the centre of crystals, or at the resorbed crystal contact, likely as these zones were more Ca-rich than the Na-rich margins. Other crystals appear to have been completely altered, such that only euhedral relic grain outlines are present (possibly Ca-rich grains?).

The other phenocryst phase is subhedral, up to 3.5mm in size, green-brown pleochroic with a masked birefringence and inclined extinction. Crystals are elongate in long section, and hexagonal in basal section, though 120° cleavage is only occasionally observed.These phenocrysts also display irregular margins consistent with resorption. Minor amounts of a brown mineral with chemistry CaFeAlSiO (Axinite?) is found as an alteration mineral surrounding amphibole crystals – from metasomatism? Also present in the groundmass with hornblende and plagioclase are crystals of biotite, quartz and significant amounts of zircon crystals.

SEM WORK

Green phenocrysts are hornblende, some alteration to CaFeAlSiO – Axinite? In gmass, biotite, lots of zircon, quartz and plag. Plag phenocrysts are Ca dominant, with no clear difference in chemistry between core and rims.

CLASSIFICATION

Porphyritic metadacite containing plagioclase and amphibole phenocrysts, with pervasive sericitisation of plagioclase crystals.

SAMPLE NO: ROTH049 **GRID REFERENCE:** 478983 6766916

FIELD DESCRIPTION: Coarse grained gabbro with large feathery px (now amphibole) crystals and lots of white plagioclase (~40%).

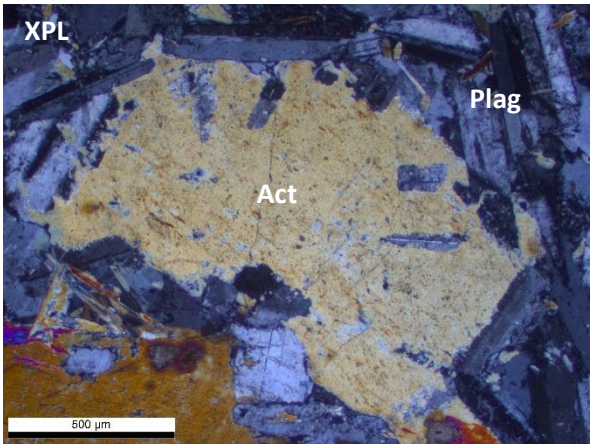
MAPPED LITHOLOGY:

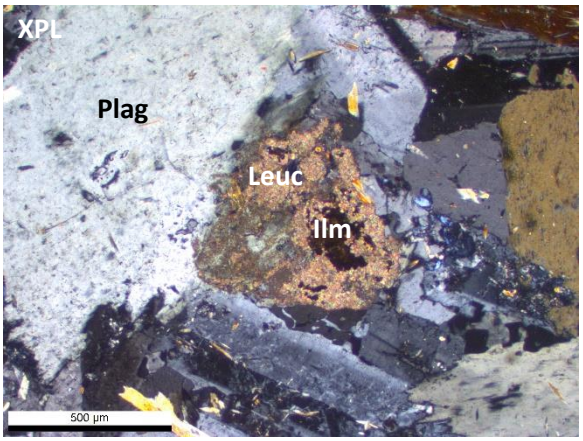
Gabbro

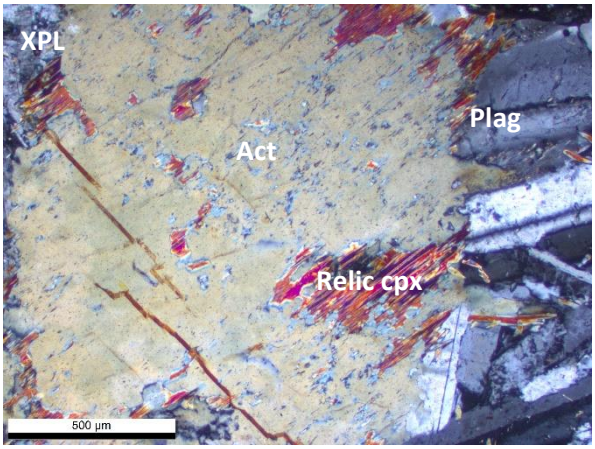
THIN SECTION

PPL/XPL

Actinolite	*42%*
Plagioclase	*47%*
Quartz	*3%*
Zoisite	*2%*
Epidote	*2%*
Ilmenite	*1%*
Leucoxene	*3%*
Sulphides	*<1%*







Coarse grained metaigneous rock consisting of actinolite porphyroblasts and randomly oriented plagioclase crystals, some of which have been subject to sausseritisation.

Actinolite porphyroblasts (after clinopyroxene) are typically subhedral to anhedral elongate laths up to 4-4.5 mm in length and are interspersed with randomly oriented subhedral plagioclase laths that range in size between 1-2.5 mm and exhibit abundant polysynthetic twinning. Minor interstitial quartz (0.2-0.3 mm) is also present. Some actinolite crystals show simple twinning, which may be inherited from the pyroxene precursor. Sub-ophitic textures are displayed by randomly oriented plagioclase crystals penetrating or enclosed within actinolite; however, this may be due to metamorphic recrystallisation rather than an original magmatic feature. There is potentially some minor primary clinopyroxene present as minor altered inclusions within actinolite porphyroblasts.

Patches of sausserite alteration comprising zoisite (colourless, distinctive blue birefringence) and epidote (colourless-yellow, high biref), focussed at the margins and interior of plagioclase, some of which have been completely broken down into alteration products. Tends to occur near leucoxene (after ilmenite).

Opaques comprise laths or needles of ilmenite that are almost entirely converted into a fine-grained cloudy halo of leucoxene. Minor disseminated sulphides (py) are present as fine (0.1 mm) grains throughout the sample.

CLASSIFICATION

Metagabbro

SAMPLE NO: ROTH050 **GRID REFERENCE:** 478533 6766821

FIELD DESCRIPTION: Light -medium grey volcaniclastic unit with 4mm lapilli, some laminations/bedding. Minor red speck, almost identical to ROTH023 on map 8. Unit is quite thick at >50m.

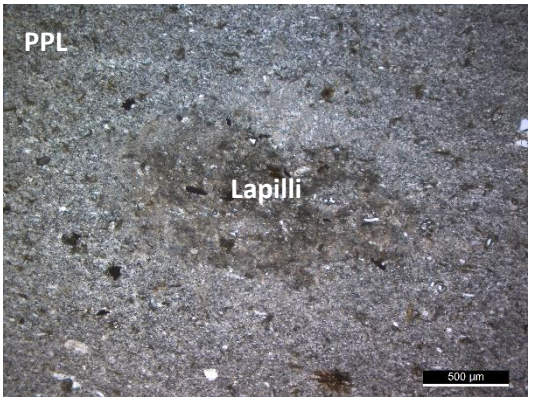
MAPPED LITHOLOGY: Intermediate lapilli tuff

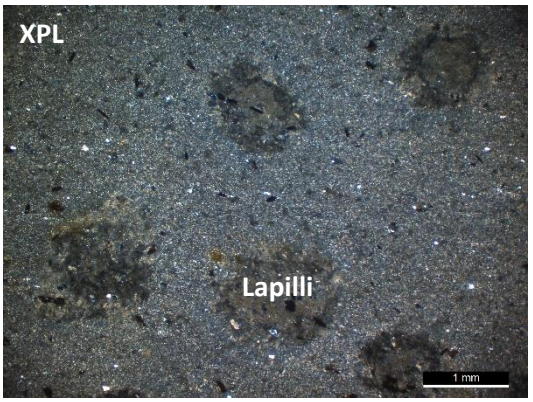
THIN SECTION

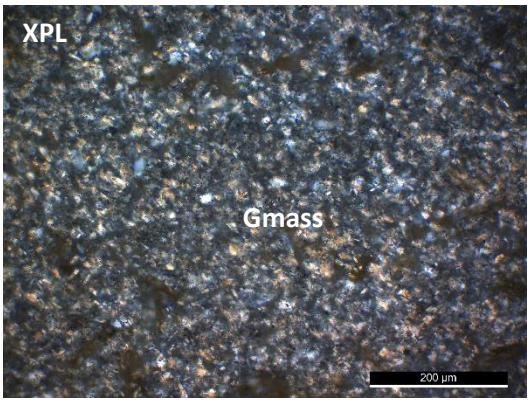
PPL/XPL

Lapilli = 15% of unit.

Hematite	<1%
Zircon	<1%
Quartz	5%
Ilmenite	1%
Gmass	79%







A massive, ash-bearing metavolcaniclastic unit consisting of a fine-grained matrix of intermediate composition, containing rounded clasts interpreted as lapilli.

The grey groundmass consists of a fine grained (<0.1 mm) aluminosilicate matrix containing abundant laths of feldspar in addition to quartz. Lithic clasts ranging from 1-3 mm in diameter are distributed throughout this matrix, are subrounded, circular to ovoid in cross section and display no preferred alignment. This indicates that the elongation of clasts is an original feature, and not caused by subsequent deformation. The lithic clasts consist of randomly oriented laths of plagioclase feldspar (displaying polysynthetic twinning and partially sericitized), with minor magnetite and rutile in a finer grained, aluminosilicate matrix not dissimilar to the surrounding fine-grained matrix. These lithic clasts frequently exhibit a relict crystal/cavity at their core are consequently are interpreted as lapilli. Scattered quartz clasts are also present in the fine-grained matrix, generally anhedral and up to 0.1-0.2 mm in diameter.

The sample displays very similar characteristics is sample ROTH023, however this sample is more massively bedded and does not contain quartz-rich intervals, indicating less sedimentary reworking/input.

Subhedral zircon crystals identified.

Accessory minerals in the groundmass include elongate needles of ilmenite 0.1-0.3 mm in length (randomly oriented and also found in lithic clasts), in addition to minor muscovite and rare subhedral 0.1 mm zircon crystals.

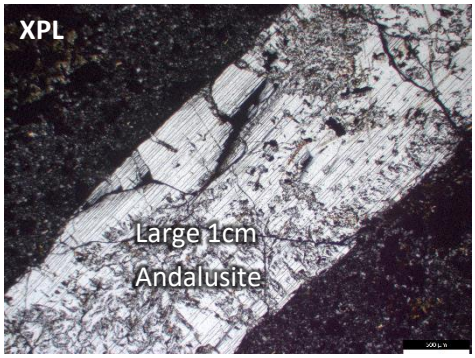
CLASSIFICATION

Massive andesitic lapilli tuff

SAMPLE NO: ROTH053 **GRID REFERENCE:** 478122 6766769

FIELD DESCRIPTION: A vesicular lava with 6-10mm elongate euhedral crystals in fine grained groundmass - pyroxene phenocrysts in a vesicular lava? Found in SC with bomb like pieces east of ridge. Derived from inter tuff as large clasts?

MAPPED LITHOLOGY: Felsic Volcaniclastic



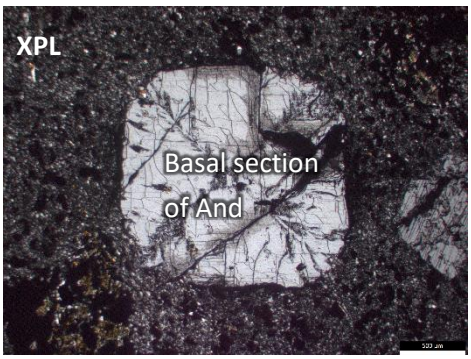
HAND SPECIMEN

Not actually vesicular – when cut, realised it is actually a porphyroblast phase altered to clay and then weathered away. Porphyroblasts consist of euhedralcrystals of andalusite.

THIN SECTION

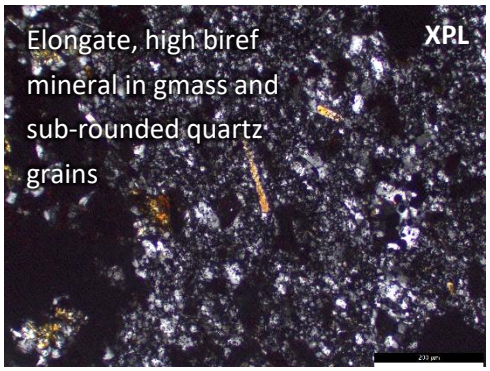
PPL/XPL

Quartz	*70%*	***Phenocrysts – relative proportions***	
Magnetite	*5%*	*Andalusite*	*35%*
Pinitized cordierite	*12%*	*Cordierite*	*65%*
Andalusite	*8%*		
Muscovite	*2%*		
Plagioclase	*1%*		
Elongate in gmass	*2%*		



Porphyroblastic texture with two porphyroblast phases present. First, rounded, anhedral 1-2mm crystals, highly altered/weathered to clays comprising an orange-brown mineral (?chlorite - chemistry FeAlSiO), muscovite mica and iron oxide, primarily magnetite. The mineral grains and now largely hollowed out (friable, soft material observed in hand specimen but removed during thin section making). This matches the description of pinitized pseudomorphs of original cordierite. (Cordierite readily alters to mica, yellow-green chlorite, serpentine and iron oxides – these alteration products are collectively called pinite and the process of alteration is termed pinitization.)

The second phenocryst phase is typically euhedral and prismatic, elongate in longitudinal section and square in basal section, up to 1 cm in size, with two well developed cleavages at 90° (basal section), mostly parallel extinction (some inclined?) and low grey first order birefringence. The chemistry returned by SEM analysis is Al_2SiO_5, consistent with andalusite. There is proportionally more of the smaller rounded phenocryst phase (cordierite; 65%) than the larger, euhedral phase (andalusite; 35%).



The groundmass is fine grained (20-60 µm) comprising subrounded to rounded clasts of a low birefringence mineral lacking cleavage (quartz), with minor plagioclase (with polysynthetic twinning) and an acicular mineral, up to 200 µm in length with high birefringence and parallel extinction (appearance of sillimanite?). There are also 80-100 µm pore spaces that likely represent smaller equivalents of the larger, weathered-out cordierite porphyroblasts, and lath-shaped ilmenite crystals are randomly oriented.

CLASSIFICATION

Contact-metamorphosed porphyroblastic andalusite-cordierite metapelite

SAMPLE NO: ROTH061 **GRID REFERENCE:** 490378 6772361

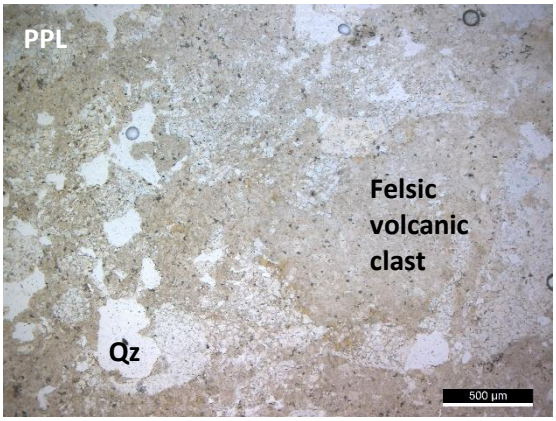
FIELD DESCRIPTION: Fine grained felsic volcaniclastic with quartz grains visible and black minerals? Quite altered.

MAPPED LITHOLOGY: Felsic Volcaniclastic

THIN SECTION

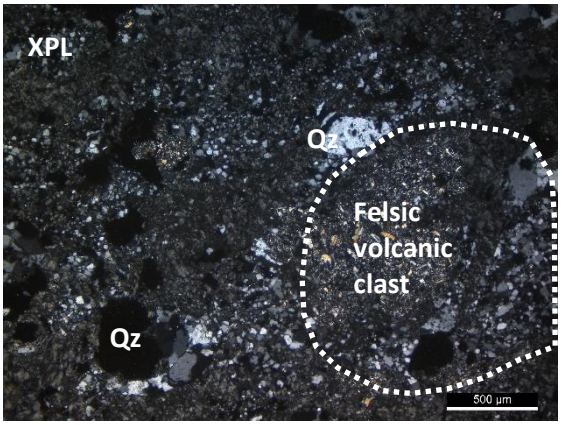
PPL/XPL

Quartzofeldspathic groundmass	45%
Quartz clasts	24%
Lithic clasts – cherty	25%
Lithic clasts – felsic?	5%
Iron Oxide	1%
Zircon	<1%

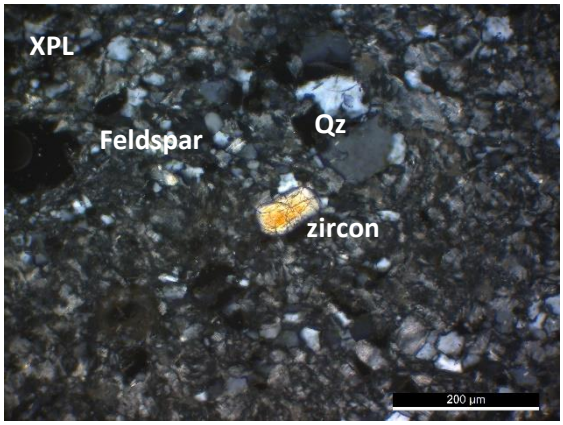


This unit is a highly altered, moderately foliated felsic volcaniclastic metasandstone, consisting of a fine grained, clay-altered quartzofeldspathic groundmass, with quartz clasts, lithic clasts and accessory rutile

The microcrystalline groundmass comprises fine grained (<0.1 mm) angular to sub-angular quartz crystals, relict feldspar crystals with elongate crystal shapes and traces of complex twinning, likely plagioclase. The groundmass also contains sericite, in addition to localised fibrous crystals of actinolite (0.1-0.2 mm).



The groundmass contains sub-angular quartz clasts up to 1.2 mm in size, some of which have a recrystallised, granoblastic texture. Other clasts include sub-rounded to sub-angular clasts consisting of microcrystalline quartz, up to 1.2 mm in size, and likely represent cherty clasts. Several sub-rounded lithic clasts up to 1.4mm in size are present and consist of an aluminosilicate groundmass including randomly oriented plagioclase crystals and secondary actinolite crystals – likely representing some sort of felsic lithic clast. Quartz, chert and lithic clasts are frequently elongated and aligned in the fabric direction.



Sparse opaque aggregates up to 0.5 mm are found in the matrix, probably a secondary iron oxide such as limonite. Abundant euhedral zircon crystals and crystal fragments are present, up to 0.1-0.2 mm in size and displaying oscillatory zoning in XPL.

Sample crosscut by multiple minor 0.3mm thick quartz veinlets. The unit is weakly to moderately foliated, defined by the alignment of elongate quartz clasts and lithic clasts. Very similar, almost identical appearance to sample MOU002 in the Mougooderra Formation.

CLASSIFICATION

Felsic volcaniclastic metasandstone.

SAMPLE NO: ROTH062 **GRID REFERENCE:** 489567 6765430

FIELD DESCRIPTION: Fine grained grey mafic unit, appears porphyritic with euhedral tabular plag phenocrysts. Dacite? Directly underlying BIF as 15m SC.

MAPPED LITHOLOGY: Porphyritic metadacite

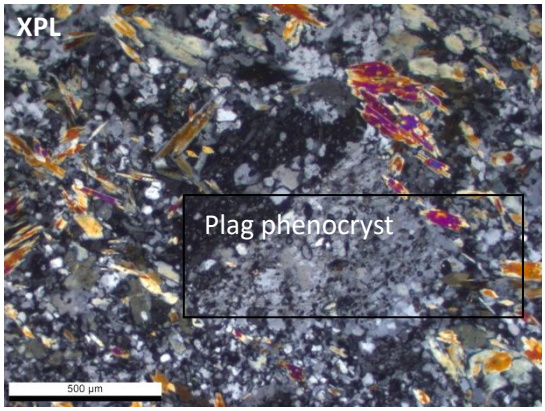
HAND SPECIMEN

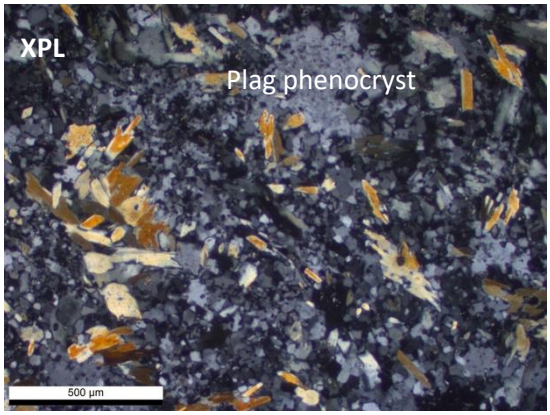
Dark, fine grained metavolcanic unit, weakly magnetic, some quartz phenocrysts visible amongst the very fine groundmass.

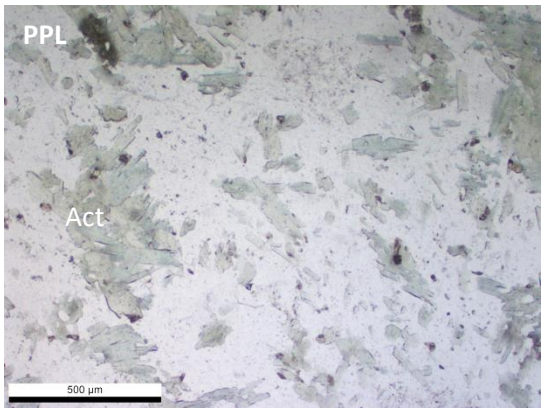
THIN SECTION

PPL/XPL

Feldspar phenocrysts	*15%*
Quartz phenocrysts	*2.5%*
Actinolite	*25%*
Magnetite	*<< 1%*
Quartz gmass	*12.5%*
Feldspar gmass	*45%*
Apatite	*< 1%*







A porphyritic fine-grained metadacite comprising feldspar phenocrysts and rare quartz phenocrysts in a fine-grained groundmass of actinolite, quartz and feldspar.

In total, phenocrysts occupy approximately 17.5% of the sample. Feldspar phenocrysts are subhedral to anhedral, 0.5-1.2 mm in size and have a mottled appearance, with only traces of twinning identified in some crystals. Quartz phenocrysts are anhedral and typically 0.5-0.8 mm in size but are rare in this sample. The groundmass is dominated by fine-grained (<0.1 mm) quartz and feldspar, some of which shows polysynthetic twinning, in addition to randomly oriented fibrous actinolite crystals 0.1-0.8 mm in length. Some actinolite crystals are acicular and form fan shaped clusters and all are green-green pleochroic. Accessory magnetite is present as rare, small anhedral grains ~0.1 mm in size. The sample is crosscut by multiple quartz-apatite veinlets between 0.2-1.0 mm in thickness.

CLASSIFICATION

Porphyritic metadacite

SAMPLE NO: ROTH067 **GRID REFERENCE:** 486433 6763276

FIELD DESCRIPTION: Medium-grained mafic intrusive - outcrop had strong bedding fractures so oriented sample taken - SSI possible in thin section?

MAPPED LITHOLOGY: Dolerite-gabbro

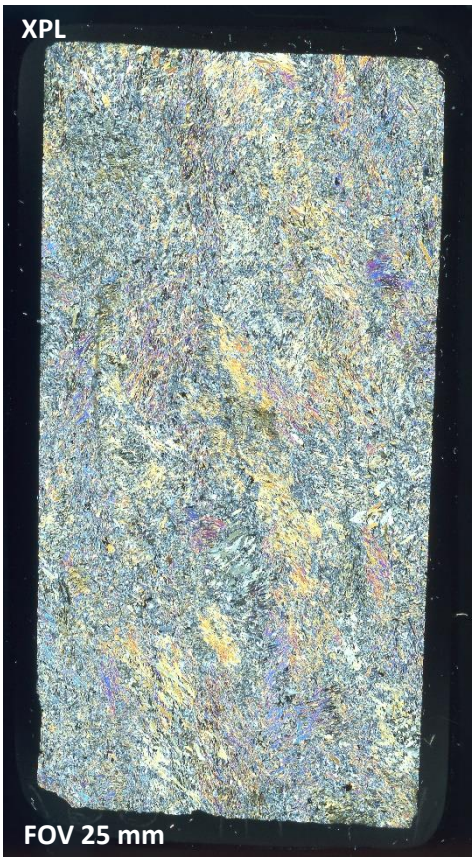
HAND SPECIMEN

Medium grained metaigneous rock consisting of oriented acicular needles (actinolite?) aligned largely in the direction of S3 foliation. Some white patches – plagioclase feldspar- visible. Weakly magnetic.

THIN SECTION

PPL/XPL

Actinolite	53%
Plagioclase	34%
Chlorite	7%
Biotite	1%
Epidote	2%
Zoisite	2%
Magnetite	1%



Medium grained mafic rock comprising sheaves of aligned elongate actinolite crystals, in addition to minor chlorite and biotite, with interstitial feldspar, zoisite and epidote and disseminated opaque oxides, primarily magnetite.

Individual actinolite crystals are relatively small at 0.1-1mm, however, they combine to form sheaves of aligned crystals up to 3mm in size. Interstitial plagioclase has a mottled texture, preserves some twinning and is partially altered to epidote and zoisite in some parts of the sample. Original igneous outlines of feldspar crystals are euhedral, tabular and typically 1-1.5mm in size.

Minor brown biotite is present, in addition to likely chlorite, with lower birefringence and lower extinction angles than actinolite.

Magnetite is present as anhedral grains up to 0.5 mm in size, and are typically located interstitial to actinolite in association with feldspar.

CLASSIFICATION

Foliated metadolerite.

SAMPLE NO: ROTH068 **GRID REFERENCE:** 485576 6763774

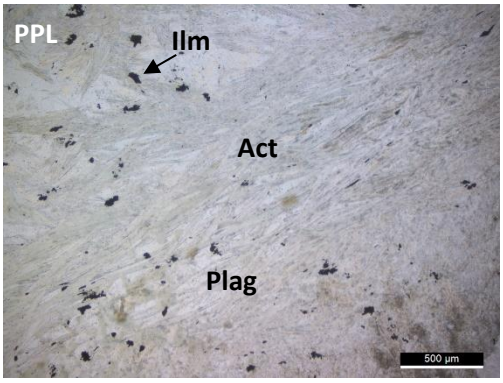
FIELD DESCRIPTION: Spinifex bearing unit with needle acicular spinifex up to 10cm in size. Parts of outcrop have aligned crystals, other parts random (as this sample). Underlying BIF and overlying blocky px honeycomb gabbro.

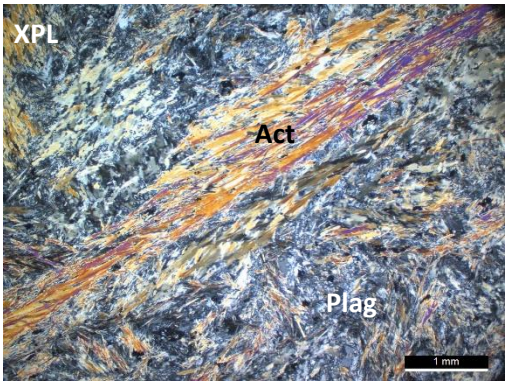
MAPPED LITHOLOGY: Spinifex-textured basalt

THIN SECTION

PPL/XPL

Actinolite	46%
Quartz	10%
Plagioclase	40%
Opaques (ilmenite)	4%





Phenocrysts occupy 35% of the sample.

Porphyritic spinifex textured basalt with randomly oriented acicular pyroxene (now actinolite) phenocrysts in a finer grained groundmass of actinolite, quartz and plagioclase.

Elongate phenocrysts of actinolite range in length from 1.5-14 mm and width from 0.7-1.2 mm, however these phenocrysts are broken down into many fibrous actinolite crystals (metamorphic recrystallisation/breakdown?). Phenocrysts are randomly oriented with many subhedral, ragged basal sections evident.

The interstitial groundmass is composed of plagioclase with a mottled appearance and minor preservation of twinning (0.1-0.6 mm) and quartz crystals (up to 0.25mm), typically in patches up to 0.5 mm. These phases are joined by acicular single crystals of actinolite up to 0.5 mm in length.

Abundant subhedral oxides are present, up to 0.3 mm in size and almost entirely localised within the groundmass. All consist of a single phase, some elongate needles indicate ilmenite, and some have rounded silicate inclusions. Many of the oxide crystals have a non-reflective halo – may represent leucoxene/titanite from breakdown of ilmenite.

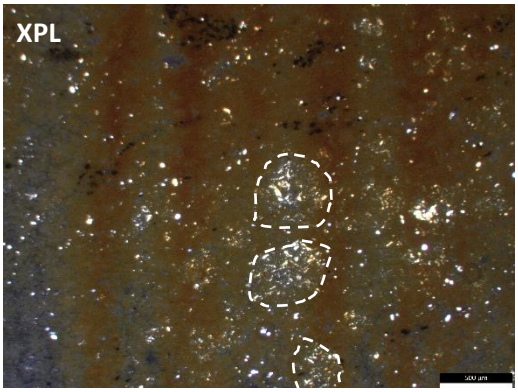
CLASSIFICATION

Random acicular pyroxene spinifex textured metabasalt

SAMPLE NO: ROTH074 **GRID REFERENCE:** 487675 6762309

FIELD DESCRIPTION: Oxidised, orange banded unit with millimetre scale layering, as clast within white matrix - banded felsic volcaniclastic? Friable and relatively soft – banding in outcrop is same orientation as bedding nearby, so likely represent bedding. Can be traced for ~10km along strike.

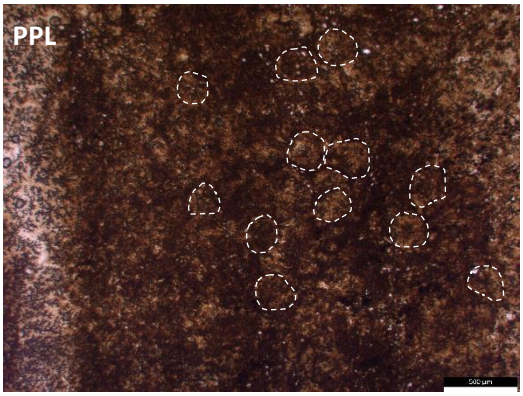
MAPPED LITHOLOGY: Felsic volcaniclastic



THIN SECTION

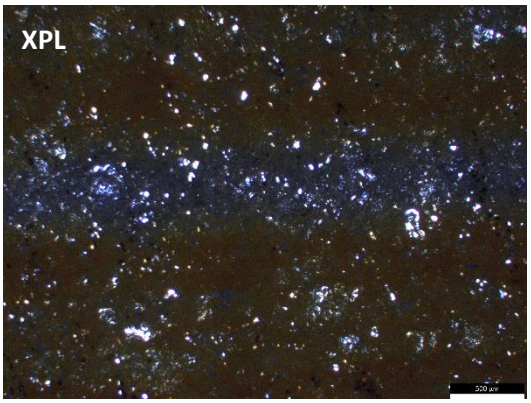
PPL/XPL

This thin section was very difficult to make due to the porous nature of the sample and resistance to polishing.

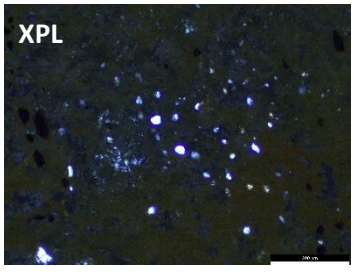


This sample comprises a fine grained bandedmeta(volcano?) sedimentary rock, containing recognisable sub-roundedto sub-angular grains of quartz 0.05-0.1 mm in size and relic rounded particles thought to represent volcanic particles/ash.

Banding is picked out by yellow-orange, cloudy, fine grained iron oxides/hydroxides. The lighter-coloured bands tend to contain more quartz clasts than the darker bands. The larger particles vary across the sample between 0.25 and 0.4 mm in size, and are estimated to be quartzo-feldspathic in composition, due to the presence of quartz and more tabular, prismatic crystals present. Some crystals within the relic clasts display undulose extinction. These clasts are concentrated along some horizons parallel to banding.



Opaques are dispersed throughout the sample, white-grey and moderately to highly reflective in reflective light. Tend to be aligned at a steep angle (60-70°) to banding. In plane polarised light, a dendritic black mineral is observed, with quartz clasts between, though it is not known whether this is a product of weathering.



CLASSIFICATION

A highly altered and oxidised banded, ash-bearing felsic metavolcaniclastic rock

SAMPLE NO: ROTH077 **GRID REFERENCE:** 487091 6761347

FIELD DESCRIPTION: Pyroxenite with feldspar? phenocrysts, part of layered mafic sill at Rothsay mine, repeated 3 times due to shear.

MAPPED LITHOLOGY: Feldspar porphyritic pyroxenite

HAND SPECIMEN

Porphyritic pyroxenite consisting of white-green-pink tabular phenocrysts of plagioclase feldspar (altered?) amongst an equigranular medium grained pyroxene-rich groundmass.

THIN SECTION

PPL/XPL

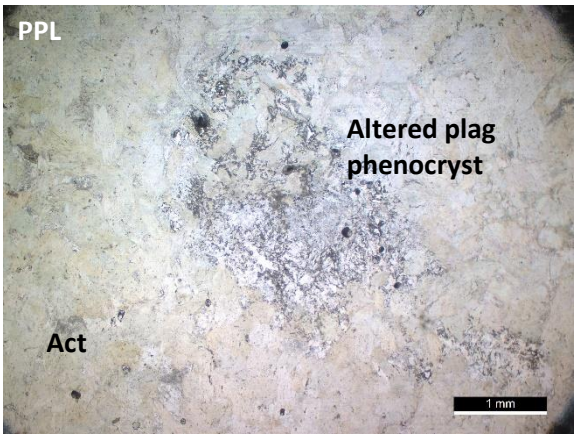
Plagioclase	*5%*
Actinolite	*76%*
Quartz	*5%*
Zoisite	*7%*
Epidote	*7%*
Titanite	*<1%*

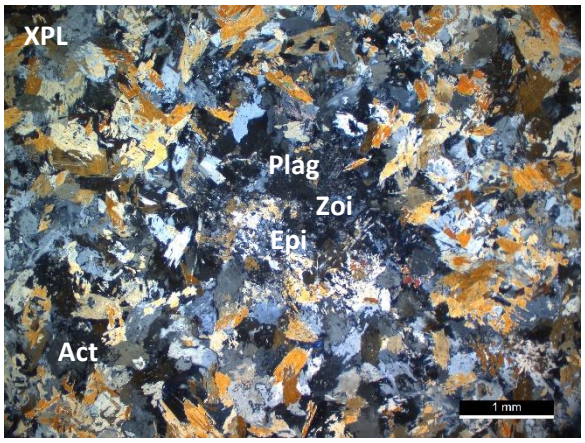
Phenocrysts occupy ~20% of the sample

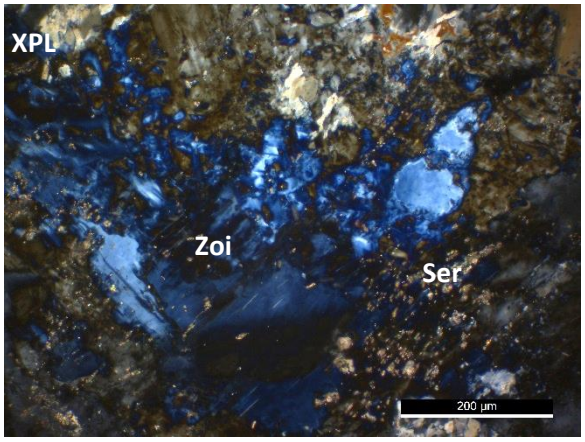
A medium-grained porphyritic metaigneous rock comprising sausseritised phenocrysts of plagioclase feldspar in an equigranular groundmass of actinolite (after pyroxene).

Phenocrysts are anhedral, 1-3 mm in size and consist of an assemblage including fine grained (<0.2 mm) zoisite, epidote and sericite with larger quartz and actinolite crystals (0.2-0.4 mm) and minor less altered plagioclase, indicating partial to complete sausseritisation of Ca-rich plagioclase. The surrounding groundmass is dominated by 0.6-0.8 mm randomly oriented elongate laths of actinolite (green-green pleochroism), some acicular actinolite crystals and rare crystals of plagioclase.

Minor euhedral 0.1 mm titanite crystals are also disseminated in the groundmass.







CLASSIFICATION

Porphyritic metapyroxenite (sausseritised phenocrysts)

SAMPLE NO: ROTH080 **GRID REFERENCE:** 478231 6766791

FIELD DESCRIPTION: Start of OC of same unit, grainy feel of sediment, medium grey in colour. Micas and quartz visible, even biotite mica. Possible greywacke.

MAPPED LITHOLOGY: Greywacke

HAND SPECIMEN

Dark grey to black, fine grained, nonmagnetic metaclastic rock with glittery appearance (indicative of mica), gritty to touch and hard.

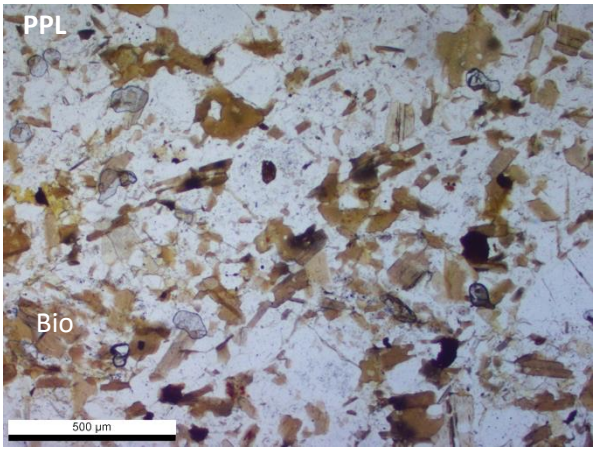
THIN SECTION

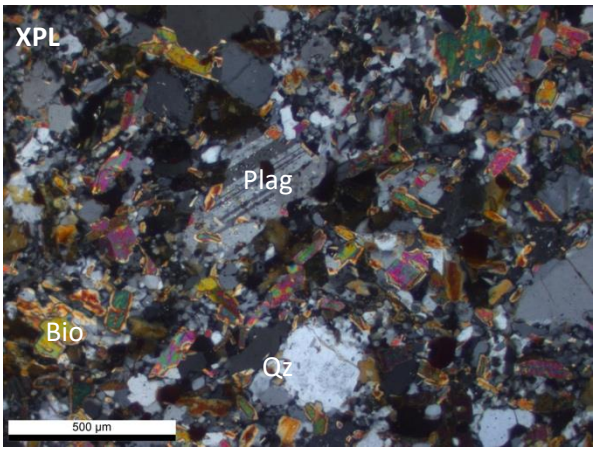
PPL/XPL

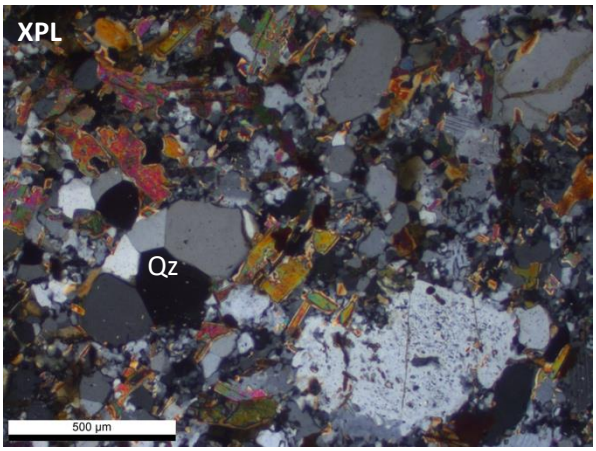
Biotite mica	25 %
Quartz	30%
Plagioclase feldspar	15%
Fine grained matrix	25%
Lithic clasts (granoblastic quartz)	4%
Opaques	1%
Zircon	<1%

A fine grained, immature, poorly-sorted clastic metasedimentary rock composed of angular to sub-angular clasts of quartz, biotite mica, plagioclase feldspar and lithic clasts, surrounded by a finer grained matrix.

Quartz clasts are typically angular to sub-angular and vary in size between 0.1-0.5 mm, whereas plagioclase feldspar occur as 0.2 mm anhedral grains that exhibit clear polysynthetic twinning. Biotite is present as 0.1-0.2 mm randomly oriented laths evenly distributed throughout the unit, with high birefringence and brown-brown pleochroism. Several lithic clasts are present up to 0.6 mm in size, predominantly comprising granoblastic quartz in addition to plagioclase feldspar containing inclusions of quartz and biotite. The fine-grained (<< 0.1 mm) matrix surrounding the aforementioned clasts accounts for about 25% of the sample and appears to comprise quartz and lesser feldspar and minor biotite. Overall, the sample is poorly sorted and as such, both texturally and compositionally immature. Minor amounts of an opaque phase are present as anhedral aggregates showing moderate reflectivity – potentially an iron oxide phase. A single 0.2 mm euhedral zircon crystal was observed amongst the fine-grained matrix. The immaturity of thisunit suggests that it was deposited relatively close to the sourceregion of the sediment (possibly a felsic intrusive source?).







CLASSIFICATION

Metagreywacke

SAMPLE NO: ROTH081 **GRID REFERENCE:** 478190 6766792

FIELD DESCRIPTION: Orange alt pebbly sstn with 1-3mm qz crystals, non mag, rare black min.

MAPPED LITHOLOGY: Pebbly sandstone

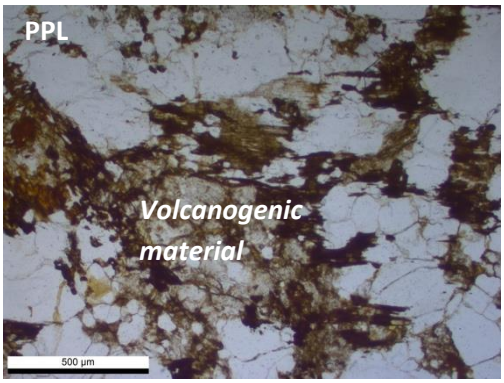
HAND SPECIMEN

Orange medium grained metasedimentary rock consisting of rounded quartz clasts in an orange ferruginous matrix, with rare black clasts.

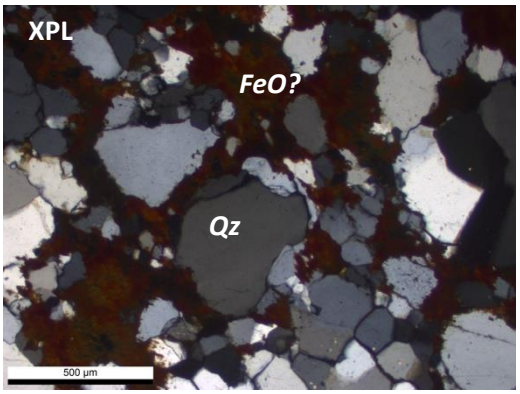
THIN SECTION

PPL/XPL

Quartz	70 %
Fe oxide (Limonite/goethite)	20 %
Fine matrix – volcanogenic	10 %



A medium grained, moderately well sorted quartz-rich clastic metasedimentary rock containing a fine-grained Fe-bearing likely volcanogenic matrix.



Quartz clasts are subrounded and have a bimodal distribution; larger crystals typically ~1 mm in size but several grains reach 2.5-3 mm in size and these clasts often exhibit a granoblastic texture which may have been induced by metamorphic recrystallisation. Surrounding these larger clasts are finer (0.1-0.2 mm) sub-angular quartz clasts suspended in a very fine-grained, light coloured matrix, which includes a mineral with orange-brown discolouration suggestive of significant Fe content (possibly limonite-goethite). This orange-brown mineral possesses a fabric in some places. Although too fine to identify, the matrix likely represents volcanogenic material considering the volcaniclastic units that directly overly this unit.

CLASSIFICATION

Volcanogenic pebbly metasandstone

SAMPLE NO: T1 **GRID REFERENCE:** 486291 6770503

FIELD DESCRIPTION: Pyroxene spinifex textured basalt – randomly oriented needles in fine grained groundmass

MAPPED LITHOLOGY: Spinifex-textured basalt

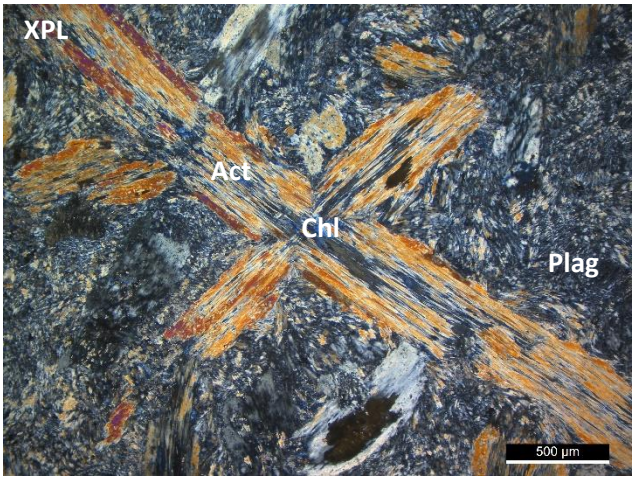
HAND SPECIMEN

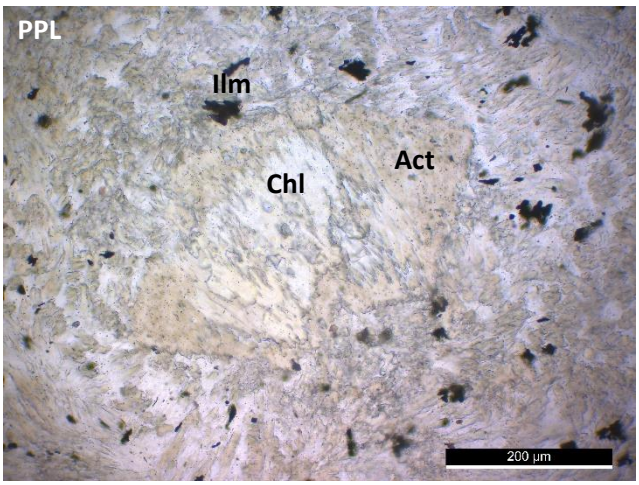
Porphyritic spinifex-textured igneous rock with randomly oriented grey phenocrysts (originally pyroxene) in a fine grained aphyric groundmass.

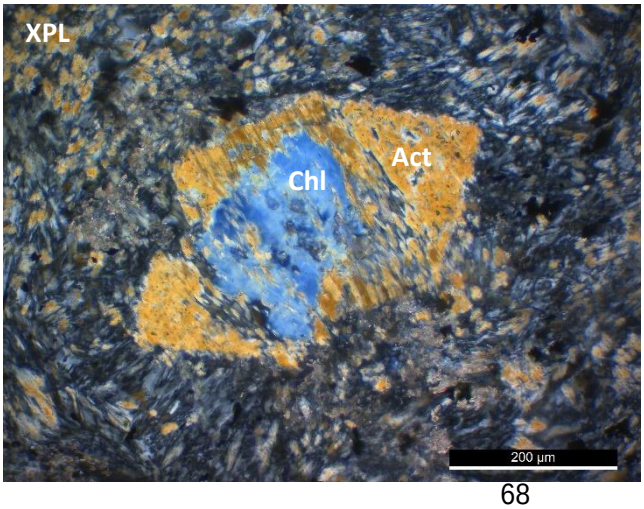
THIN SECTION

PPL/XPL

Actinolite	68%
Plagioclase	17%
Chlorite	12%
Opaques	3%







Phenocrysts occupy ~30% of the unit

Porphyritic spinifex-textured rock characterised by abundant, acicular, randomly oriented pyroxene phenocrysts (pseudomorphed by actinolite) in a plumose-textured groundmass of fine grained, intergrown plagioclase feldspar and acicular actinolite crystals.

The randomly oriented, acicular pyroxene phenocrysts range in length between 1-8 mm, and have euhedral basal sections between 0.2-1 mm in diameter. Many crystals are zoned with actinolite rims and irregular chloritized cores with anomalous blue birefringence. Chlorite cores are often present in the cores of the long axes of some crystals. The pyroxene crystals frequently display simple twinning, and occasionally phenocrysts display cruciform shapes.

The surrounding groundmass consists of fine (<0.2 mm) plumose/feathery textured acicular crystals of actinolite intergrown with fine grained plagioclase, of which individual crystals cannot be distinguished. Oxides are present as irregular grains typically <0.1 mm but up to 0.3 mm in size and are concentrated around the margins of actinolite phenocrysts.

Almost identical to ROTH003.

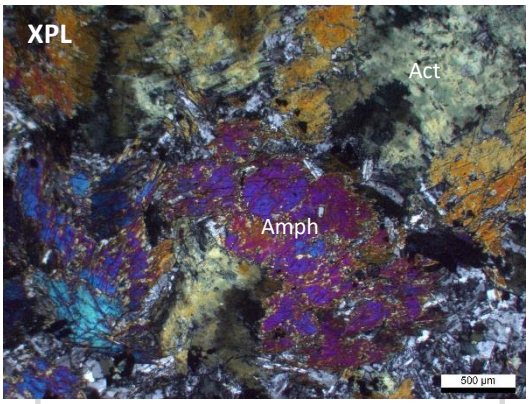
CLASSIFICATION

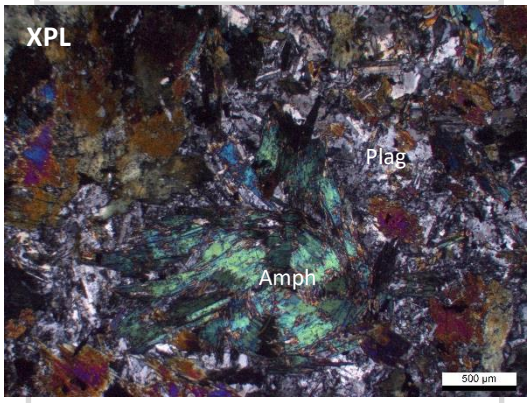
Random acicular pyroxene spinifex-textured metabasalt

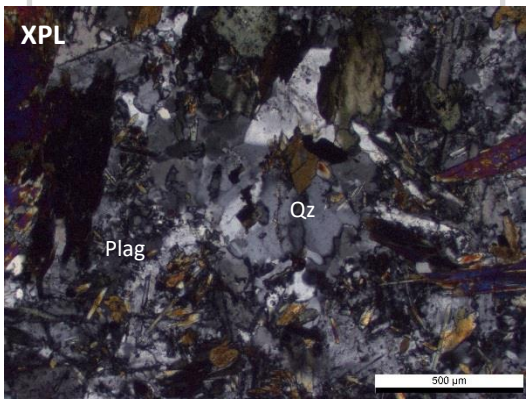
SAMPLE NO: T2 **GRID REFERENCE:** 435350 6766240

FIELD DESCRIPTION: Blocky, honeycomb textured dol-gab continues to here. 20m W, a creek is trending at 192deg. To W of creek is blocks of blocky dol-gab, to east is very fine grained mafic - basalt on steep hills. Creek marks boundary.

MAPPED LITHOLOGY: Honeycomb- textured gabbro (aka Blocky gabbro, blocky px gabbro, rounded px gabbro)







THIN SECTION

PPL/XPL

Hornblende	40%
Actinolite(?)	25%
Plagioclase	27.5%
Opaques	2.5%
Quartz	5%

A medium-grained inequicrystalline metaigneous rock displaying a porphyroblastic texture, comprising characteristically rounded to blocky amphibole crystals, in addition to finer grained plagioclase, quartz, opaques and smaller amphibole crystals. Porphyroblasts vary in size from 1.5-2.5mm, and are strongly deformed, with deformed crystallographic axes such that they exhibit strong undulose extinction, some in a complete circular pattern. The amphiboles variably contain two phases – with fragmented cores of high relief and strong pleochroic hornblende, often surrounded by lower relief/birefringence and green-green pleochroic actinolite. This may be evidence for retrogression from lower amphibolite to greenschist metamorphic facies – with a distinct lack of chlorite.

A number of crystals display simple twinning. The large amphiboles frequently contain plagioclase and quartz inclusions, with a sort of sub-ophitic texture in places.

Interstitial to amphibole crystals is a finer grained assemblage of plagioclase feldspar, quartz, opaque minerals and smaller crystals of amphibole. Grain size of interstitial phases is consistently <1mm, typically 0.4-0.5mm.

No clear penetrative fabric present.

CLASSIFICATION

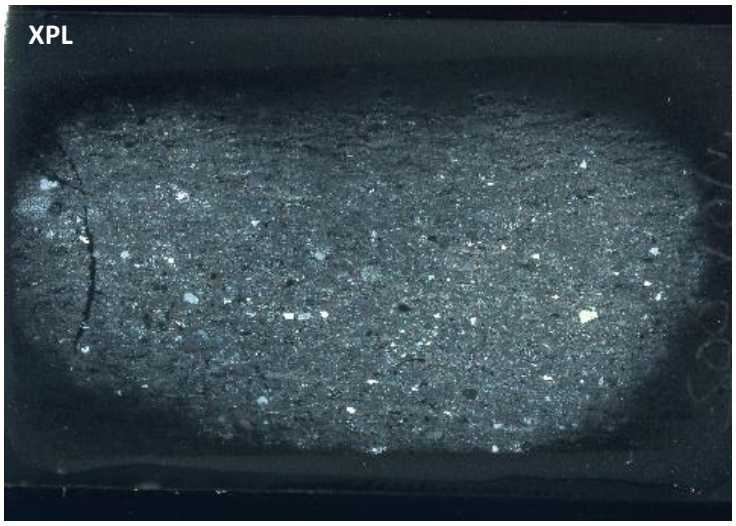
Honeycomb-textured amphibolite/metagabbro

SAMPLE NO: MOU002 **GRID REFERENCE:** 501410 6793790

FIELD DESCRIPTION: A well exposed felsic volcaniclastic unit has been identified in the central part of the Mougooderra Basin, consisting of a fine-grained quartzo-feldspathic groundmass with sub-angular 0.5-1 mm quartz clasts and minor lithic fragments and rutile crystals.

MAPPED LITHOLOGY: Felsic Volcaniclastic

HAND SPECIMEN



THIN SECTION

PPL/XPL

Quartzofeldspathic groundmass	60%
Quartz clasts	12%
Lithic clasts - felsic volcanic	12%
Lithic clasts – cherty	8%
Actinolite	5%
Chlorite	2%
Iron Oxide	1%
Barite	<1%
Rutile	<1%
Zircon	<1%

This sample is a moderately altered and foliated felsic volcaniclastic metasandstone, consisting of a fine grained quartzofeldspathic groundmass (60%), quartz clasts (12%), felsic volcanic lithic clasts (12%), cherty lithic clasts (12%), secondary actinolite (6%) and chlorite (2%), and accessory (<1%) barite, rutile, iron oxide minerals and zircon.

The microcrystalline groundmass contains fine grained (<0.1 mm) quartz, relict feldspar crystals, probably plagioclase, and sericite, likely derived from alteration of primary feldspar, in addition to fibrous actinolite crystals (up to 0.8 mm) and very fine chlorite. Sub-angular quartz clasts 0.5-1 mm in size are pervasive and concentrated along specific horizons.

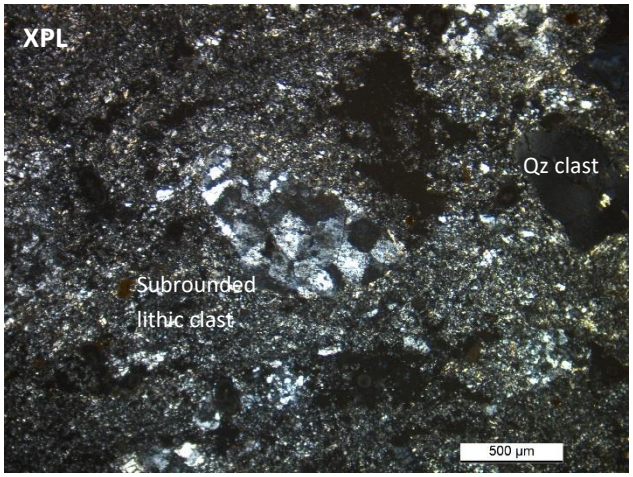
Two types of lithic clast are present – the first are 0.5-1.5 mm in size, sub-rounded, often vesicular and sometimes contain euhedral 0.2-0.4 mm laths of plagioclase, in addition to quartz, sericite and accessory barite, rutile and zircon, representing felsic volcanic lithic clasts. The second type are typically 0.5-2 mm, sub-angular to sub-rounded, predominantly cherty clasts that comprise microcrystalline quartz, and may represent quartz-rich or recrystallized glassy volcanic lithic clasts.

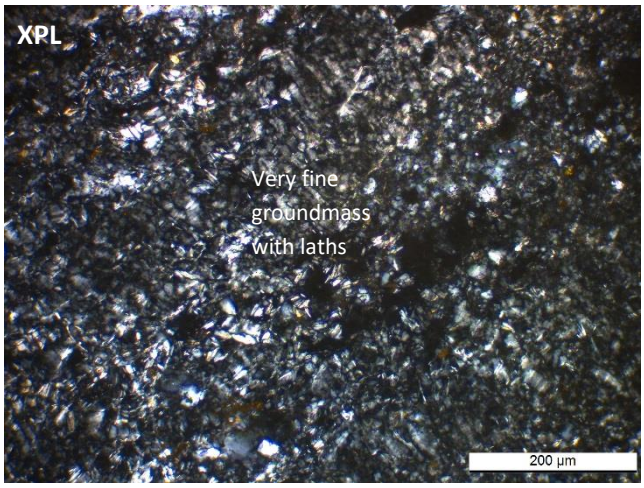
Opaque iron oxide minerals, likely magnetite, are 40 microns in size, with other accessory phases including 0.2 mm subhedral grains of rutile and < 0.1 mm zircon crystals.

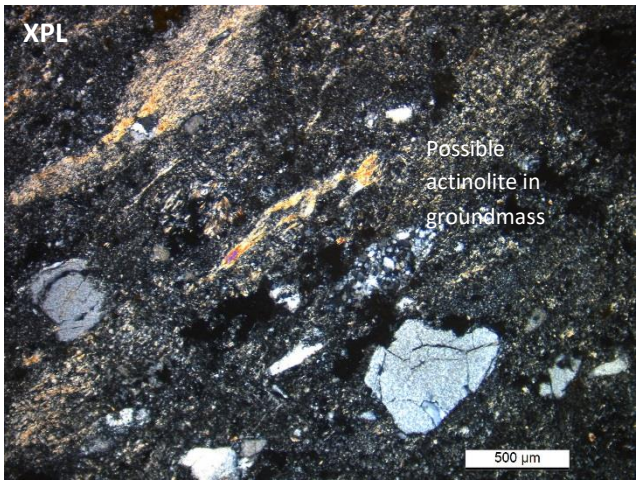
The presence of chlorite and actinolite in the groundmass suggests this unit has been subjected to no higher than greenschist facies metamorphism. A moderately developed foliation is defined by elongate actinolite crystals, and the preferred alignment of lithic clasts.

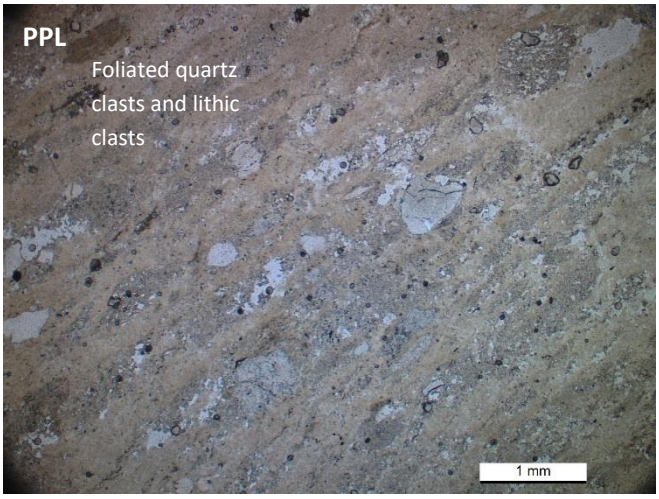
CLASSIFICATION

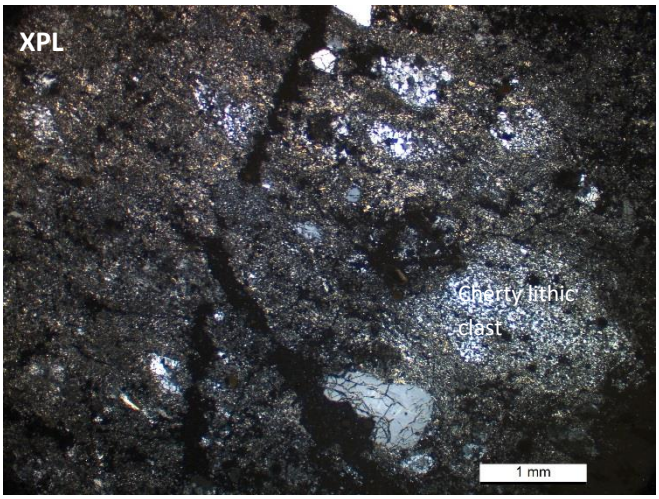
Felsic volcaniclastic rock


XPL
Qz clast
Subrounded
lithic clast
500 µm


XPL
Very fine
groundmass
with laths
200 µm


XPL
Possible
actinolite in
groundmass
500 µm


PPL
Foliated quartz
clasts and lithic
clasts
1 mm


XPL
Cherty lithic
clast
1 mm

SAMPLE NO: MOU003 **GRID REFERENCE:** 496185 6812408

FIELD DESCRIPTION: Poorly sorted, submature pebbly sandstone

MAPPED LITHOLOGY: Pebbly sandstone

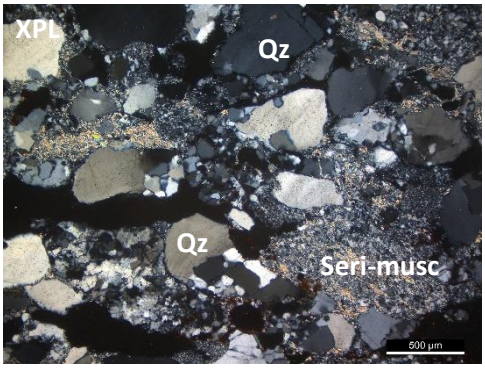
HAND SPECIMEN

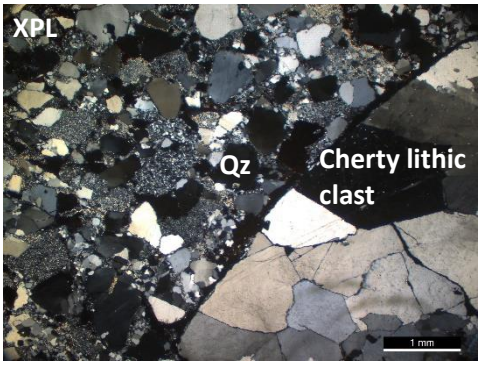
Immature, poorly sorted pebbly sandstone consisting of <1mm to 1cm sub-rounded clasts of quartz, chert, a cream coloured clast (felsic volcanic?) in addition to iron oxides which define original bedding surfaces and display cross-bedding. Individual cm-scale beds also show graded bedding of clasts.

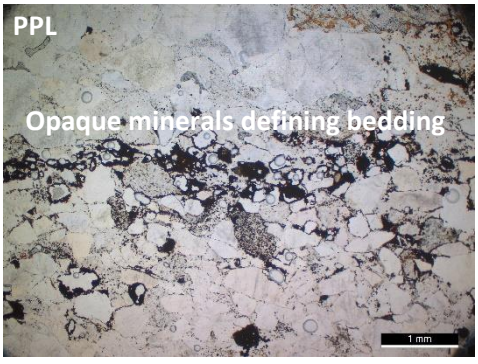
THIN SECTION

PPL/XPL

Quartz clasts	50%
Chert clasts	18%
Lithic clasts	10%
Fe oxide (Limonite/goethite)	5%
Fine matrix, incl sericite, muscovite, quartz	7%
Zircon	<1%







A medium-grained, poorly sorted pebbly quartz sandstone consisting of 50% detrital quartz clasts, 15% lithic chert clasts, 10% lithic clasts (felsic?) and 25% finer grained matrix including detrital muscovite, sericite and quartz, with 3% iron oxides and accessory zircon.

Quarts grains are typically sub-angular to subrounded and often elongate in shape and range in size from 0.2-2 mm, with the average grain size around 0.8-1 mm. The largest quartz clasts are more well-rounded and commonly show undulose extinction. Chert clasts consist of microcrystalline quartz, are more variable in size between 0.5 and >8 mm and are typically subrounded. A second type of lithic clast is subrounded, up to 1.5 mm in size and comprise quartz, sericite (after feldspar?) and a fine grained, cream coloured matrix, interpreted as potential felsic volcanic clasts.

Sericite is fine grained and is found as small patches associated with fine-grained (0.1-0.2 mm) muscovite crystals, as well as the prevalent fine-grained quartz comprising the matrix between clasts. The unit is clast supported, with most clasts in contact with one another. Along with the varied clast mineralogy and size, this indicates the unit is texturally immature. Multiple euhedral-subhedral zircon crystals are present within the matrix.

Opaque phases consist primarily of iron oxides including hematite, limonite and goethite, in addition to rutile. These phases are concentrated along specific horizons, interpreted as relict bedding surfaces, which are not continuous but are truncated by other oxide-concentrate bedding surfaces, demonstrating decimetre-scale cross bedding. Furthermore, individual beds (on order of 5mm to several centimetres) display graded bedding, which matches the way-up direction demonstrated by cross bedding.

CLASSIFICATION

Immature pebbly metasandstone

SAMPLE NO: MOU008 **GRID REFERENCE:** 509503 6780520

FIELD DESCRIPTION: Coarser-grained metadacite than further to southwest, porphyritic with visible quartz crystals.

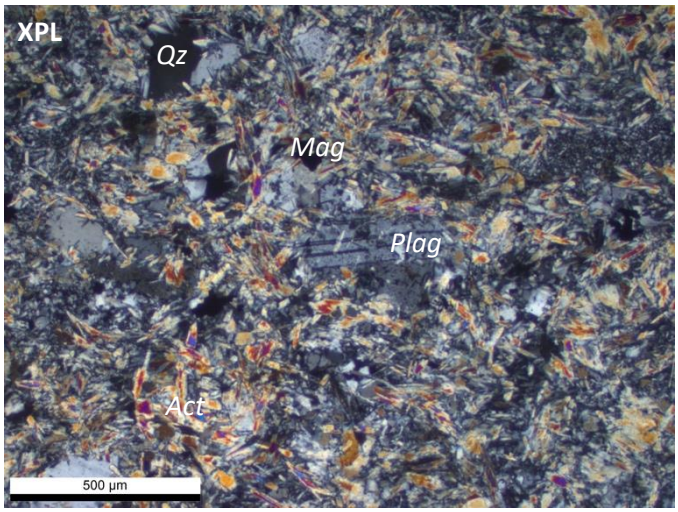
MAPPED LITHOLOGY: Porphyritic metadacite

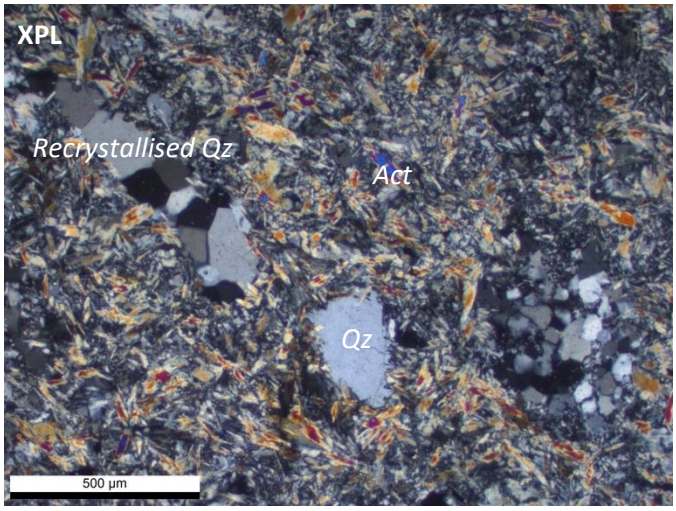
HAND SPECIMEN

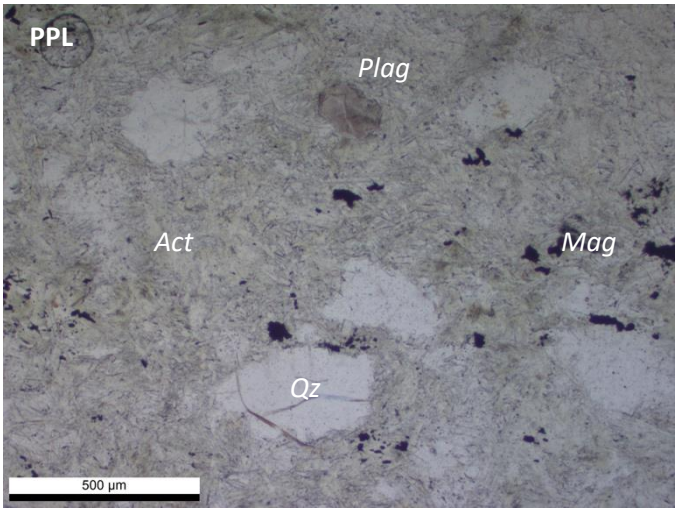
Dark, fine grained metavolcanic unit, weakly magnetic, some quartz phenocrysts visible amongst the very fine groundmass.

THIN SECTION

PPL/XPL	
Quartz phenocrysts	*6%*
Feldspar phenocrysts	*2%*
Recrystallised quartz patches	*5%*
Actinolite	*55%*
Magnetite	*2%*
Quartz-feldspar gmass	*30%*







A porphyritic fine-grained metadacite with phenocrysts of quartz and feldspar, in addition to recrystallised patches of quartz, in a fine-grained groundmass of actinolite, feldspar and quartz.

The groundmass is dominated by randomly orientated fibrous crystals of actinolite up to 0.2 mm in size and fine grained (< 0.1 mm) feldspar and lesser quartz. Opaques, primarily magnetite, are distributed throughout the sample and up to 0.25 mm in size, occurring as anhedral to subhedral crystals and aggregates.

In total, phenocrysts occupy ~8% of the sample and mainly comprise anhedral quartz phenocrysts (6%) that are rounded to ovoid and 0.2-1 mm in size and lesser subhedral feldspar phenocrysts (2%; usually lacking twinning but distinguished by the tabular habit of crystals) typically 0.2-0.6 mm in size and characterised by a cloudy or mottled appearance in PPL. Elongate ovoid to lenticular patches of recrystallised quartz 0.5-1.0 mm in size are also present and elongated in the same direction. The orientation of quartz patches is not displayed by actinolite in the groundmass, suggesting that this may be a primary feature (vesicles?) rather than an induced foliation. These quartz patches display a granoblastic texture and so may represent recrystallised quartz phenocrysts or alternatively recrystallised amygdales.

CLASSIFICATION

Porphyritic metadacite