

## 4.2 Petrographical sampling of artefacts and in situ rocks from Sark: petrographical descriptions

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Detailed petrographical descriptions were performed using standard polished thin sections using transmitted and reflected light petrography. The latter technique using x8air, x16oil and x40oil immersion lenses

### *Artefacts*

SEN 215 Stone Axe.

An amphibolitised, ophitic, fine-grained meta-dolerite.

#### Macroscopical description.

#### Hand specimen

The axe-head is made from a dense, homogeneous, fine-grained, basic igneous rock that is rough to the touch. The surfaces are a dusky yellow green (5GY 5/2 on the Geological Society of America rock-color chart) and show fine-grained intergrowths between pale-coloured feldspar and 0.5mm long, dark, mafic minerals. The freshly cut surface is a medium bluish grey (5B 5/1).

#### Thin section.

The rock is a greenish grey (5GY 6/1) and fine-grained but carries up to 1mm long, feldspar micro-phenocrysts in a matrix comprising abundant, thin, acicular feldspar laths 1.0mm x 0.1mm in size within green amphibole.

#### Microscopical description

The rock is very ophitic. Rare micro-phenocrysts of plagioclase have altered to coarse-grained, white mica (low relief and high interference colours) within a groundmass of simply twinned feldspar that has partially altered to fine-grained clinozoisite intergrown with pale brown to green pleochroic amphibole and equant, altered, iron titanium oxide minerals. Trace amounts of calcite and relict clinopyroxene are present, the latter in the cores of some amphibole. The plagioclase is relatively unaltered.

Ilmenite laths up to 40µm in length are altered to fine-grained intergrowths of haematite and TiO<sub>2</sub> minerals with white internal reflections. Locally, blebby, ilmenite aggregates, 60 x 40µm in size occur.

Altered titanomagnetite, 10 - 40µm in diameter, now comprises thin, ilmenite oxidation exsolution lamellae within sphene or void spaces.

Wispy, 10 - 20µm long sphene is widespread in silicates but it also forms 10 – 80 but up to 120µm diameter pseudomorphs after skeletal magnetite.

Euhedral, chrome spinel is 5 - 40µm in diameter within a 1 - 2µm wide ferrochromit rim and very orange internal reflections.

Sulphides include 20 – 200µm diameter, poorly crystalline pyrite some enclosing 20µm diameter chalcopyrite. Discrete chalcopyrite 2 – 10 but up to 40µm in size is present about iron titanium oxide minerals. Elsewhere, 1 - 2µm diameter chalcopyrite forms patches up to 100µm across in silicates.

SEN 217 Stone axe

A uniform, amphibolitised, ophitic meta-dolerite.

The rock has a strong ophitic texture. Coarse-grained clinopyroxene has altered extensively to green amphibole (actinolite-tremolite) but occurs as relict cores; it encloses altered plagioclase laths. Plagioclase has altered to fine-grained white mica and possible clinozoisite showing first order interference colours; typically, highly altered cores lie within unaltered rims. Locally, bladed amphibole forms clusters within possible chlorite, these infill void spaces or have replaced earlier mafic minerals. Minor amounts of very dark blue-green amphibole showing low birefringence are present. Trace amounts of highly altered biotite may be present.

Lobate ilmenite laths are 50 – 200 x 80µm in size and are altered to fine-grained intergrowths of sphene and TiO<sub>2</sub> minerals with white internal reflections. Locally, blebby, ilmenite aggregates are altered to 5µm diameter, white sphene and TiO<sub>2</sub> minerals cemented by 5 - 20µm diameter chalcopyrite.

Altered titanomagnetite, 120 - 200µm in diameter, now comprises 2 – 10 but up to 20µm wide, ilmenite oxidation exsolution lamellae, themselves partially altered to fine-grained mixtures of TiO<sub>2</sub> minerals and sphene, within void spaces.

Wispy, 10 - 20µm long sphene is widespread in silicates but it also forms 10 – 80 but up to 120µm diameter pseudomorphs after skeletal magnetite.

Rounded to euhedral chromite/chrome spinel is 30 - 60µm in diameter and typically has a 2 - 10µm diameter, grey chrome-rich core within a paler and browner, 20 – 40µm wide margin and an outer, 2µm wide magnetite rim. Some of the spinel is brown rather than grey suggesting that it is a chrome-rich spinel rather than chromite.

Sulphides are common and include 10 – 30µm diameter, euhedral, cubic pyrite; 100 – 200 x 100µm size, skeletal pyrite; and 120µm diameter patches of pyrite associated with 20 x 2µm size marcasite. Marcasite occurs as an alteration product after pyrrhotite; here, 60 – 200 x 40µm size marcasite enclosing 2 - 5µm diameter pyrite forms tabular aggregates of fine-grained crystals that are cemented by 2 - 5µm wide chalcopyrite. Very little unaltered pyrrhotite occurs but 10µm diameter grains are intergrown with 1 - 2µm wide pentlandite. Discrete chalcopyrite 5 – 20 but up to 120 x 40µm in size is present in silicates. Elsewhere, 2 - 5 or 20 - 80µm diameter chalcopyrite form patches up to 200µm across. A little limonite replaces sulphides.

SEN 220 Stone Axe/hammer.

An amphibolitised, sub-ophitic, fine-grained meta-dolerite.

Macroscopical description.

Hand specimen

The axe-head is made from a dense, homogeneous, fine-grained, basic igneous rock that is rough to the touch. The surfaces are speckled but have an overall light olive grey (5Y 7/1 on the Geological Society of America rock-color chart) colour and show fine-grained intergrowths between 0.5mm long, pale-coloured feldspar and 1mm long, dark, mafic minerals.

Thin section.

The rock is a greyish yellow green (5GY 7/2) colour and is fine-grained but carries up to 1mm long, stubby feldspar crystals and 0.5mm size, altered mafics in a blue-green matrix.

Microscopical description

Very altered, stubby plagioclase laths are replaced by fine-grained clinozoisite, white mica, carbonate and trace amounts of epidote with high interference colours. Plagioclase rims are less altered than their cores. Very locally plagioclase-quartz have myrmekitic intergrowths. It is intergrown with green to brown, pleochroic amphibole with minor, relict clinopyroxene in its cores and sphene replacing titanomagnetite. Amphibole is both pale and deep blue-green. Long, acicular apatite laths and very rare, euhedral zircon within plagioclase and minor

amounts of pale brown possible biotite with high interference colours are also present. Secondary minerals include short, fibrous, green amphibole and quartz mosaics infilling void spaces about plagioclase laths.

Ilmenite laths are up to 40µm in length and are altered to fine-grained intergrowths of haematite; locally ilmenite is mantled by thin, 2µm wide sphene.

Altered titanomagnetite, 120 - 300µm in size now comprises thin, 2 - 10µm wide ilmenite oxidation exsolution lamellae within pale-coloured sphene.

Sulphides include 30 – 140µm diameter pyrite with poorly crystalline margins. Discrete chalcopyrite 2 – 10µm in size, some within patches up to 80µm across, is present in amphibole. Very rare, 10µm diameter chalcopyrite is enclosed within altered titanomagnetite.

Notes

Neither chlorite nor epidote are present.

SEN 221 Stone axe

A very fine-grained ophitic amphibolitised meta-dolerite.

Macroscopical description.

Hand specimen

None

Thin section

The rock is a light greenish grey (5G 7/1) colour and is fine-grained but carries rare, up to 1mm long, stubby feldspar crystals and 0.5mm size, altered mafics in a matrix with 0.3 x 0.1mm size plagioclase laths.

Microscopical description

The dolerite is ophitic with altered plagioclase laths within unaltered to altered clinopyroxene. Clinopyroxene has altered along grain boundaries and crystal edges to green amphibole (actinolite-tremolite) but much is unaltered. It forms ophitic intergrowths with highly altered plagioclase, which has altered to fine-grained white mica, calcite and epidote/clinozoisite with low interference colours. The rims to plagioclase laths and smaller, euhedral, zoned, stubby plagioclase crystals are sodic and unaltered (albite). Locally calcite is present in the groundmass. Pale-coloured, acicular amphibole within possible chlorite is late-stage and present about the altered primary minerals.

Ilmenite laths, 60 – 180 x 30µm in size are altered to TiO<sub>2</sub> minerals or more rarely to sphene that carries small, relict ilmenite. Equant, euhedral titanomagnetite is altered and now comprises 2µm wide, ilmenite oxidation exsolution lamellae plus thin sphene margins within void spaces. All the original magnetite has been lost. Locally some titanomagnetite consists of 5 - 10µm diameter ilmenite blebs in void spaces rather than lamellae.

Euhedral to subhedral pyrite, 10 - 60µm in diameter has vuggy cores within clean margins or more commonly crystalline cores with fine-grained, vuggy rims. Larger pyrite 150 - 200µm in size encloses 2 - 5µm diameter pyrrhotite or very rare, mixed pyrrhotite-chalcopyrite and chalcopyrite up to 30µm in size. Discrete chalcopyrite is 20 - 30µm in diameter or forms patches 120 - 200µm in diameter of 2 - 5µm size crystals.

SEN 225 Partially perforated pebble.

An altered, fine-grained, microporphyritic, basic rock.

Macroscopical description.

Hand specimen

The pebble is made from a dense, homogeneous, fine-grained, micro-porphyritic, basic igneous rock. The surfaces are a light olive grey (5Y 6/1 on the Geological Society of America rock-color chart) and show 4mm long, pale cream laths/equant crystals in a very fine-grained groundmass. The freshly cut surface is a medium bluish grey (5B 5/1).

### Thin section.

The rock is a greenish grey (5GY 5/1) and fine-grained but carries up to 1mm long, feldspar micro-phenocrysts and 0.5mm long, green mafics in a fine-grained green matrix.

### Microscopical description

The rock is non-ophitic. Microporphyritic, twinned plagioclase and amphibole are present in a fine-grained plagioclase-amphibole groundmass. Zoned plagioclase has altered to fine-grained clinozoisite, white mica together with trace amounts of calcite and epidote showing high interference colours. Green-brown, pleochroic amphibole is accompanied by very minor amounts of possible biotite and euhedral sphene. Late-stage quartz occurs as patches about plagioclase and as very thin, cross-cutting veinlets.

Ilmenite laths are up to 10µm in length and euhedral, 10 - 40µm diameter magnetite, some enclosing 2 - 5µm pyrite, is extensively altered to haematite including martite.

Titanomagnetite, 20 - 30µm in size with up to 0.5µm wide ilmenite oxidation exsolution lamellae is little altered to highly altered and so replaced by haematite and very, very fine-grained TiO<sub>2</sub> minerals. Large, 120 - 160µm diameter sphene carries small, 2 - 5µm diameter, relict magnetite.

Sulphides are very rare but include 2µm diameter chalcopyrite and bornite.

## ***In situ country rocks***

Sark 1 Port à la Jument - coastal outcrop.

Altered, fine-grained meta-dolerite.

### Macroscopical description.

#### Hand specimen

A uniform, very fine-grained, altered dolerite cut by quartz-calcite-chlorite and muscovite-quartz veinlets.

#### Thin section

The rock is a greenish grey (5GY 6/1 on the Geological Society of America rock-color chart) with a 1.5mm thick, oxidised, dusky-yellow rim (5Y 6/4). It is uniformly very fine-grained but carries rare up to 0.7 x 0.3mm size, feldspar micro-phenocrysts; the matrix has abundant feldspar microliths but few opaques. It is cut by 0.1mm wide, colourless veinlets.

### Microscopical description

The rock comprises fine-grained, acicular plagioclase and amphibole. Primary plagioclase crystals, including rare micro-phenocrysts, have cores that have altered to fine-grained white mica (+/- epidote?) within narrow, unaltered rims. Most clinopyroxene is pale brown and is rimmed by blue-green amphibole (probably tremolite-actinolite). Much clinopyroxene encloses plagioclase laths within a sub-ophitic texture. Locally, void spaces are infilled with acicular/tabular, deep blue-green amphibole crystals growing into green chlorite showing brown interference colours.

Quartz-40µm diameter calcite-chlorite and prehnite-quartz veins cross-cut the altered dolerite.

All primary iron titanium oxide minerals have been altered. Very rare, 20µm long, ilmenite laths have altered to very fine-grained mixtures of TiO<sub>2</sub> minerals and haematite, and small, 10 - 40µm diameter, magnetite cubes have been replaced by pale-coloured sphene. Larger, up to 200 x 40µm size, sphene aggregates with trace amounts of 2 - 5µm diameter, relict ilmenite are also present.

Sulphides include 5 - 40 but up to 200 x 100µm in size, cubic pyrite that encloses 2 - 20µm diameter chalcopyrite. Elsewhere, 20 - 60µm diameter patches of 1 - 5µm size chalcopyrite and 30µm diameter patches of 1 - 5µm pyrrhotite occur. Discrete, subhedral to euhedral chalcopyrite crystals are 10- 20µm in size and some are associated with epidote.

Limonite has replaced sulphides on the edge of the sample.

Notes

This is probably from the same 2 metre wide dyke sampled in Sark 15. It is slightly coarser grained than Sark 15.

Sark 2 Port du Moulin (north dyke) coastal outcrop.

Fine-grained, sub-ophitic, altered meta-dolerite.

Macroscopical description.

Hand specimen

The very fine-grained meta-dolerite has been extensively metamorphosed and is cut by thin calcite veinlets.

Thin section

The rock is a light grey (N7 on the Geological Society of America rock-color chart). It is uniformly very fine-grained but carries rare, up to 1.0mm size, feldspar micro-phenocrysts; the matrix comprises feldspar laths, altered green mafics and 0.1mm diameter opaques.

Microscopical description

Primary plagioclase laths have altered to fine-grained white mica and epidote showing low order interference colours; larger plagioclase micro-phenocrysts are altered to white mica-epidote. Later, smaller plagioclase (probably albite) is unaltered and forms a local groundmass. Primary clinopyroxene shows a sub-ophitic texture with plagioclase but most clinopyroxene is now replaced by pale green amphibole (tremolite-actinolite). Rare, orange, pleochroic phlogopite is present. No chlorite was recognised.

Primary iron titanium oxide minerals are totally altered. Short, 10 – 20 but up to 200 x 40µm size, lobate ilmenite laths have been pseudomorphed by pale-coloured sphene. Equant, 40 – 60 but up to 120µm diameter ex-titanomagnetite now comprise 2µm wide, ilmenite oxidation exsolution lamellae (themselves, locally, altered to fine-grained TiO<sub>2</sub> minerals) within void spaces where all the original magnetite has been removed. Chromite forms rare, 20 - 60µm diameter, rounded grains within thin, 1 - 2µm wide, pale ferrochromit rims.

Sulphides include 10 - 60µm diameter, euhedral pyrite that locally forms 200µm patches and 40 - 80 but up to 120µm diameter patches of 2 – 5µm chalcopyrite locally with 2 - 5µm diameter, pale-coloured sphalerite or pyrite. Discrete, 10 - 20µm diameter chalcopyrite also is associated with pale sphalerite. Pyrrhotite, if present, is rare.

Limonite replaces pyrite on the edges of the specimen.

Sark 3 Port du Moulin (valley dyke - edge) coastal outcrop

Altered felsite/microdiorite.

Macroscopical description.

Hand specimen

None

Thin section

The rock is mottled with greenish-grey (5GY 7/1 on the Geological Society of America rock-color chart) and colourless areas. Up to 2.0mm diameter, cloudy-white feldspar micro-phenocryst occur within a green matrix.

Microscopical description

Coarse-grained plagioclase has altered to fine-grained white mica and is surrounded by mosaics of smaller, stubby plagioclase (albite) and quartz associated with euhedral apatite crystals. Some feldspar has untwinned cores within plagioclase rims.

Pale green-brown or blue-green, acicular amphibole (200 x 2µm in size) is abundant and some encloses rare, equant amphibole crystals. Minor to trace amounts of chlorite; 30 – 50µm

diameter, euhedral, unzoned zircon; and epidote are present. Primary iron titanium oxide minerals, mainly ilmenite, have altered to sphene and TiO<sub>2</sub> minerals.

Ilmenite is present as short, 10 – 40 x 1 - 2µm size laths in small domains or as bigger aggregates, 50 - 200µm in length, comprising 5 - 20µm long, sub-grains that have been totally replaced by pale-coloured TiO<sub>2</sub> minerals or more commonly by pale-coloured sphene enclosing TiO<sub>2</sub> minerals. Most TiO<sub>2</sub> is present as small inclusions in sphene. Small, 20µm diameter ex-titanomagnetite crystals now consist of altered ilmenite lamellae.

Sulphides include minor amounts of 5 - 10µm diameter chalcopyrite and pyrite but the majority of the sulphides have been replaced by limonite that forms 10 – 60µm patches. Some limonite with very red internal reflections may have replaced chalcopyrite rather than pyrite.

Remarks.

It is unlike any of the artefacts. It is unlike the meta-dolerites and is an altered felsite

Sark 4 Eperquerie coastal outcrop

An epidotised microdiorite

Macroscopical description.

Hand specimen

None

Thin section

The rock is fine-grained and mottled with dark mafics in a yellowish grey (5Y 7/2 on the Geological Society of America rock-color chart) matrix. The uniform grain size is 0.5mm and comprises altered feldspar, opaques and mafics. It is cut by a 1.5mm wide, pale yellow-grey veinlet.

Microscopical description

A microdiorite comprises altered plagioclase intergrown with altered iron titanium oxide minerals and blue-green amphibole.

Feldspar is relatively unaltered but plagioclase has altered to chlorite and fine-grained epidote showing low order interference colours and is intergrown with zoned and twinned amphibole showing paler cores and dark green margins. No clinopyroxene was recognised. Locally, altered iron titanium oxides and amphibole have brown rims and long, acicular apatite is present. Elsewhere, medium-grained myrmekite lies between plagioclase and quartz and quartz-epidote infill void spaces. Wide epidote and thinner epidote-chlorite veins cross-cut the rock. Epidote crystals are 2- - 60 but up to 160µm in diameter and some enclose 20 - 40µm long, euhedral, sphene crystals.

Iron titanium oxides are extensively altered. Large, 150 – 300µm diameter ex-titanomagnetite now comprise 2 - 4µm wide, ilmenite oxidation exsolution lamellae often within 5µm wide, sphene rims and void spaces after dissolved magnetite. Elsewhere, more extreme alteration has produced sphene pseudomorphs after titanomagnetite. Locally, 10 - 40µm wide ilmenite laths surround titanomagnetite in an external sandwich. Rare, small, 20µm diameter martite grains after magnetite are also present. Sulphides are rare but include 5 - 10µm diameter, cubic pyrite itself enclosing 2µm diameter pyrrhotite.

Limonite is more common than sulphides; much is irregular and up to 200µm in size; it has deep red internal reflections and encloses small, 1 - 5µm diameter cuprite crystals, hence has probably replaced chalcopyrite.

Sark 5 Eperquerie coastal outcrop.

A porphyritic felsite.

Macroscopical description.

### Hand specimen

None

### Thin section

The rock varies from mid dark grey (N4 on the Geological Society of America rock-color chart) in the rounded, possible finer grained autolith to light grey (N7) for the main phenocrystic host. The fine-grained rock has 0.1 - 0.2mm long, altered feldspar and mafics in a quartz-rich groundmass, the main rock has 0.4 – 0.5mm diameter, altered mafics and zoned feldspar laths in a pale groundmass plus up to 4.0 x 1.0mm size, rounded, altered feldspar phenocrysts.

### Microscopical description

Large, euhedral to subhedral, simply twinned feldspar phenocrysts, now totally altered to fine-grained white mica and minor calcite and chlorite, are enclosed within a quartz-zoned plagioclase-biotite matrix. Plagioclase-quartz intergrowths show abundant, fine-grained myrmekitic textures/crypto-myrmekitic groundmass. Stubby plagioclase show altered cores within less altered margins.

Apatite, chlorite, 80 - 200µm diameter epidote and 50µm diameter, zoned zircon are present in minor to trace amounts.

Iron titanium oxide minerals are largely unaltered. Equant, 50 – 60 but up to 180µm diameter ilmenite carries very thin, <1 - 2µm wide haematite lamellae, some intergrowths resemble haemoilmenite. Euhedral, 20 – 60µm diameter, very, very fine-grained titanomagnetite is enclosed within 10µm wide sphene rims. Locally, 150 – 200µm diameter sphene aggregates enclose 1 - 2µm diameter, relict ilmenite or TiO<sub>2</sub> minerals, and 70µm diameter patches of 2 - 10µm long possible TiO<sub>2</sub> are present. Biotite encloses 10 - 40µm long, rhombic crystals or 40 - 140µm long, wispy sphene aggregates.

Sulphides include 10 – 20 but up to 120µm diameter, euhedral pyrite enclosing chalcopyrite. Elsewhere, 200µm diameter patches of 5 - 10µm size chalcopyrite are associated with 5 - 50µm size, pale-coloured sphalerite carrying fine-grained chalcopyrite disease. Trace amounts of 2µm diameter bornite are intergrown with chalcopyrite, as is very rare, pale blue CuS.

Sark 6 Eperquerie Landing. Minor east-west dyke south of main porphyritic dyke.

A very fine-grained, epidotised, altered, micro-porphyritic meta-dolerite

### Macroscopical description.

#### Hand specimen.

The cut surface shows a very homogeneous rock with small, up to 2mm long, euhedral feldspar laths showing a pale green core within pale rims set within a very fine-grained, uniform, dark matrix. The rock is a light bluish grey (5B 6/1 on the Geological Society of America rock-color chart).

#### Thin section.

The rock is a pale olive (10Y 6/2). Euhedral to subhedral, zoned feldspar micro-phenocrysts, up to 5.0mm in diameter, with cloudy cores within clear margins, are set within a fine-grained matrix.

#### Microscopical Description

Plagioclase phenocrysts show extensive alteration to fine-grained clinozoisite accompanied by muscovite or more locally by minor amounts of epidote with high interference colours, amphibole and chlorite. Plagioclase is zoned with clinozoisite-rich margins and less altered cores with relict plagioclase. Some phenocrysts carry high relief, highly birefringent epidote or have chlorite rims. Rare, large, plagioclase micro-phenocrysts are altered to fine-grained epidote with ?relict feldspar or to muscovite. Smaller, euhedral, mafic micro-phenocrysts (perhaps altered clinopyroxene) now comprise chlorite-rich cores within clinozoisite margins.

The groundmass is composed of fine-grained, green-brown, pleochroic amphibole intergrown with plagioclase showing the same alteration as its phenocrysts. Orange-brown, pleochroic biotite is present in small clusters and is partially altered to chlorite.

Secondary minerals include muscovite, chlorite and rare, discrete, coarse-grained epidote showing high interference colours, they are often intergrown. Thin quartz veins cross-cut the rock.

Small, 10 - 20µm diameter, equant magnetite has been replaced by pale-coloured sphene; locally, 10µm long ilmenite occurs within sphene.

Pyrite is the main sulphide as 10 - 40µm diameter, poorly crystalline, cubic crystals, locally forming patches up to 80µm across and enclosed within thin, 2 - 5µm wide limonite rims.

Larger pyrite crystals, up to 180µm in size, enclose trace amounts of 1- 2µm diameter chalcopyrite or mixed chalcopyrite-pyrrhotite blebs.

Most chalcopyrite is present within epidote as 5 - 100µm diameter grains that have altered extensively to blue CuS minerals, themselves within 2 - 20µm wide covellite rims.

Up to 200µm diameter limonite has replaced pyrite.

Sark 7 Eperquerie. In front of (N) defences on neck.

A felsite.

Macroscopical description.

Hand specimen.

The cut surface shows 2mm long, very light grey (N8) feldspar laths within a dark fine-grained matrix. Overall the homogeneous rock is a medium light grey (N6) on the Geological Society of America rock-color chart.

Thin section.

The rock is a dusky yellow (5Y 6/4) with 1 – 2mm diameter, dark brown patches and up to 3mm diameter, cloudy feldspar in a fine-grained, feldspar-mafic-rich matrix.

Microscopical description.

The felsite comprises altered plagioclase intergrown with biotite and minor amounts of quartz. Zoned plagioclase has altered to fine-grained, epidote-rich cores (with high interference colours) surrounded by very fine-grained clay minerals; the outermost rims are unaltered. Elsewhere plagioclase has altered to muscovite and an unidentified, moderate relief mineral with high interference colours (probably epidote). Fibrous, brown biotite, partially altering to chlorite, intergrown with fine-grained epidote and quartz mosaics surrounds the feldspar. Minor amounts of apatite, coarse-grained, up to 120µm long, tabular epidote with low interference colours and very rare, 150µm diameter tourmaline occur; chlorite-epidote intergrowths have replaced a lath-shaped mineral. Chlorite is present as rare patches of quartz-plagioclase myrmekite. The felsite is cut by thin quartz veinlets. Ilmenite laths, 5 – 80 but up to 200µm in length and mainly associated with biotite, have altered to pale-coloured or orange TiO<sub>2</sub> minerals or locally to fine-grained mixtures of carbonate and TiO<sub>2</sub>.

Sulphides are uncommon but include 20µm diameter, pentagonal dodecahedral pyrite, and 10µm diameter pyrrhotite within 200µm diameter limonite. Limonite as 40 - 120µm diameter patches has replaced euhedral pyrite, lies along the cleavage planes of biotite or forms thin, 10 - 20µm wide rims infilling void spaces. Trace amounts of wad (manganese oxides/hydroxides) are present.

Notes

Labelled as a porphyritic felsite on the Guernsey geological map. No amphibole but significant amounts of biotite are present.

Sark 8 Eperquerie. The Butts.



A pale-coloured, uniform, granophyric felsite.

Macroscopical description.

Hand specimen.

The cut surface shows a homogeneous rock with 2 – 3.0mm long, feldspar laths set in a darker matrix. The rock has a feint fabric and looks granular. It is a light brownish grey (5YR 7/1 on the Geological Society of America rock-color chart).

Thin section.

The rock is a uniform light brown (5YR 6/4) with up to 3.0mm long, euhedral, lath-shaped feldspar micro-phenocrysts set in a fine-grained matrix.

Microscopical description.

Feldspar phenocrysts are present within a finer grained feldspar-quartz groundmass including some unaltered albite. Feldspar micro-phenocrysts are altered to fine-grained white mica, and an unidentified mineral with moderate relief and high interference colours (probably epidote) or, are cloudy due to the presence of very fine-grained clay minerals. Most feldspar is untwinned or simply twinned and shows alteration within its cores but has unaltered feldspar or quartz rims. Locally, quartz replaces feldspar. Tabular plagioclase laths are surrounded by myrmekite, itself within a quartz rim. Apatite and acicular zircon are present in trace amounts. Biotite altering to chlorite is present in minor amounts but very thin, limonite-stained, acicular crystals that may be much altered biotite or limonite-stained muscovite are abundant. Radiating muscovite laths intergrown with quartz occurs in voids spaces and appear to be late.

Opaque minerals are rare but include 5µm diameter, cubic possible magnetite. Biotite/altered biotite cleavage planes carry 1 - 2µm long, haematite pigment and 20 x <1 to 20 x 2µm size haematite laths often associated with 1 - 2µm but up to 20µm long, pale-coloured TiO<sub>2</sub> minerals. Zircon normally associated with TiO<sub>2</sub> phases, occurs as 10 – 40 but up to 60µm long crystals, zoned zircons have dark cores and pale rims. Discrete TiO<sub>2</sub> minerals are present as 5 – 40µm diameter, pale-coloured crystals some within 200µm diameter aggregates or as lath-shaped crystals up to 200µm in length with pale-coloured or orange internal reflections.

Sark 9 Eperquerie. Scree north side of the Butts.

An epidotised microdiorite.

Macroscopical description.

Hand specimen.

The rock displays fine scale speckling. The cut surface shows 1mm long, pink-white feldspar laths set in a dark matrix. The rock is homogeneous and has an overall light bluish grey (5G 6/1 on the Geological Society of America rock-color chart) colour.

Thin section.

The rock is mottled with greyish orange-pink (10R 8/2), cloudy feldspar laths up to 2.0mm in length intergrown with 1.0mm diameter, equant, opaque minerals and 1.0mm diameter, dusky yellow-green (5GY 5/2) mafic minerals.

Microscopical description.

The epidotised microdiorite rock comprises plagioclase-amphibole-biotite-quartz intergrowths with the local development of quartz-plagioclase myrmekite. Stubby, zoned plagioclase laths have altered cores within thin, unaltered rims. They have altered to fine-grained clay minerals, white mica and fine-grained epidote showing high interference colours. Minor amounts of quartz-plagioclase shows cuneiform to graphic, myrmekitic intergrowths. Long apatite laths are present in plagioclase. Amphibole laths, some with simple twins are pale green to pale brown but are zoned and so locally have deep blue-green rims. Biotite, often in clusters or intergrown with amphibole, is altered to chlorite. Iron titanium oxide minerals are skeletal and equant in shape and locally are enclosed within

biotite. Quartz occurs about plagioclase and late-stage quartz-apatite-coarse-grained epidote with high and low interference colours infills void spaces.

Ilmenite laths, some of which are skeletal, are 120 - 200µm in length, their cores are altered to 10 - 30µm diameter, fine-grained intergrowths of haematite and TiO<sub>2</sub> minerals accompanied by trace amounts of a 2 - 5µm diameter, blue-grey, highly anisotropic phase; this fine-grained alteration is enclosed within an ilmenite zone that carries thin, 4 x <1 up to 20 x 2µm size haematite laths aligned along the c crystallographic axis of the parent ilmenite. Rarely, ilmenite has altered to 40µm diameter, radiating pale-coloured TiO<sub>2</sub> aggregates. Pale-coloured sphene rims, up to 20µm wide, mantle many ilmenite laths and discrete, 40 - 180µm long, sphene pseudomorphs ilmenite. Locally, blebby, ilmenite aggregates form external sandwiches with titanomagnetite.

Magnetite, up to 200µm in size and lacking ilmenite oxidation exsolution lamellae has altered to martite. Altered titanomagnetite, 120 – 400 x 200µm in size, now comprises thin, 2 – 5 but up to 10µm wide ilmenite oxidation exsolution lamellae within haematite/martite or void spaces after magnetite. Locally, ilmenite lamellae are altered to fine-grained, pale-coloured TiO<sub>2</sub> minerals and both magnetite and ilmenite in some titanomagnetite grains have been replaced by sphene.

Sphene forms 5 - 40µm wide rims to altered ilmenite; larger sphene grains, up to 200µm across, enclose 40µm long, relict ilmenite.

Sulphides are rare but include 2 – 20µm diameter chalcopyrite within epidote. Limonite as 5 – 80 but up to 200µm diameter masses has replaced sulphides, probably pyrite. Trace amounts of cuprite are associated with blue CuS.

Sark 10 Eperquerie. North-South dyke. One metre from Sark 11.

A fine-grained altered, non-ophitic dolerite.

#### Macroscopical description.

#### Hand specimen.

The rock has a typically fresh basaltic look and locally is sulphide-rich. The cut surface shows a poorly developed, porphyritic texture with 1.5mm long, pale green/pink feldspar laths in a very dark matrix. The homogeneous rock is a medium bluish grey (5B 6/1 on the Geological Society of America rock-color chart).

#### Thin section.

The meta-dolerite is fine-grained and mottled. Up to 1.0mm long, greyish orange-pink (10R 8/2) feldspar is intergrown with 0.5mm diameter, dusky yellow-green (5GY 6/2) mafic minerals.

#### Microscopical description.

Altered plagioclase is intergrown with lath-shaped amphibole and quartz. Zoned plagioclase has altered cores within unaltered, albite-rich rims and is replaced by very fine-grained 20 - 40µm diameter clinozoisite and locally by 120 - 160µm diameter epidote with high interference colours. Long, acicular apatite crystals are present within plagioclase.

Plagioclase-quartz forms cuneiform to graphic myrmekitic intergrowths. Twinned, zoned, lath-shaped amphibole showing green-brown pleochroism is associated with opaque phases; some amphibole is a deep blue-green and has pseudomorphed clinopyroxene. Minor amount of biotite are altered to chlorite. Iron titanium oxide minerals are skeletal. Later fine-grained, felted green amphibole (possibly chlorite or less likely pumpellyite) infills void spaces in association with coarse-grained, euhedral quartz. Quartz shows strained extinction; some is associated with epidote showing high interference colours and biotite plus opaque phases infilling void spaces. Late-stage, quartz-epidote veinlets, up to 160µm wide, cross-cut the rock.

A coarse-grained, low relief but high birefringent mineral (muscovite/prehnite) is rare and late.

Ilmenite laths are 100 - 200µm in length and locally are unaltered, elsewhere, smaller 20 - 60µm long laths are altered to sphene. Trace amounts of magnetite are oxidised to blue haematite. Altered titanomagnetite, 80 – 180µm in size, now comprises thin, 2 – 5µm wide ilmenite oxidation exsolution lamellae within pale-coloured magnetite or haematite or void spaces. Ilmenite lamellae are altered to sphene and both magnetite and ilmenite occurring within small, 20 - 60µm diameter titanomagnetite grains have been replaced by sphene.

Sphene forms 10 - 20µm long, wispy laths along amphibole cleavage planes.

Sulphides include 20 – 80 but up to 200µm diameter pyrite intergrown with rare, 10 - 20µm long marcasite; some pyrite has 50µm wide, poorly crystalline rims. Pyrite encloses 2 - 5µm diameter pyrrhotite and chalcopyrite and 5 - 10µm diameter mixed pyrrhotite-chalcopyrite or chalcopyrite-sphalerite. A larger, 10µm diameter pyrrhotite encloses rare pentlandite and locally chalcopyrite has altered to covellite.

Limonite as 20 – 80µm diameter masses has replaced sulphides, probably pyrite.

Sark 11 Eperquerie. North-South dyke. One metre from Sark 10.

A very fine-grained, amphibolitised meta-dolerite.

Macroscopical description.

Hand specimen.

A very fine-grained meta-dolerite with thin cross-cutting veinlets. The rock is uniform and the cut surface is a medium bluish-grey (5B 6/1 on the Geological Society of America rock-color chart).

Thin section.

The meta-dolerite is fine-grained with an average grain size of 0.1 to 0.2mm. It is cut by 0.2mm wide, orange epidote veinlets but has an overall dark greenish grey (5GY 4/1) colour.

Microscopical description.

The very fine-grained, altered dolerite comprises intergrowths between altered plagioclase and green to blue-green amphibole and equant opaques. Minor amounts of epidote and quartz and sulphides are also present. Plagioclase laths have altered to fine-grained clinzoisite within unaltered margins, they carry very thin apatite crystals.

Green to deep blue-green pleochroic amphibole is intergrown with the feldspar. Quartz and epidote with high interference colours form small knots in the groundmass or cross-cutting veinlets. Epidote forms rims about sulphides.

Ilmenite laths are 10 - 40µm in length and locally form subparallel domains. Larger ilmenite laths are rare, but are up to 180 x 60µm in size. Magnetite crystals, 10 - 40µm in diameter, are equant or skeletal in shape and are oxidised to martite.

Altered titanomagnetite, 20 – 60µm in size, now comprises thin, 1 – 2µm wide ilmenite oxidation exsolution lamellae within haematite; some lamellae are enclosed within a thin, 2 - 5µm wide sphene rim. Complex magnetite-ilmenite intergrowths are 40 - 80µm in size.

Sulphides include 20 – 80 but up to 200µm diameter pyrite intergrown with rare, 10 - 20µm long marcasite; some pyrite is poorly crystalline. Pyrite encloses 1 - 20µm diameter pyrrhotite or chalcopyrite, 10 - 20µm diameter magnetite/martite and 2 - 5µm long haematite. A larger, 10µm diameter, pyrrhotite encloses rare pentlandite and locally 10 - 40µm diameter chalcopyrite has altered to fine-grained covellite.

Limonite as 30 – 100µm diameter, banded masses has replaced sulphides, probably pyrite although some 120µm diameter limonite carries 50µm diameter, relict chalcopyrite in its core. Locally limonite has stained 20 - 60µm diameter epidote crystals pale brown.

Sark 12 Eperquerie. East-West dyke a few metres south of the porphyritic dyke.

A fine-grained, microporphyratic meta-dolerite

Macroscopical description.

Hand specimen.

The cut surface shows up to 3mm long, pale-coloured, euhedral, feldspar micro-phenocrysts in a homogeneous matrix. Overall the rock is a medium bluish-grey (5B 6/1 on the Geological Society of America rock-color chart) colour.

Thin section.

The rock is an olive (10Y 5/2) colour. Up to 4mm long, euhedral to subhedral, zoned feldspar laths with cloudy cores within clear margins are present within a very fine-grained matrix.

Microscopical description.

Euhedral, zoned plagioclase phenocrysts, some with a sieve-like texture are almost totally altered to muscovite and an unidentified, moderate relief mineral with high interference colours, accompanied by minor amounts of chlorite, amphibole and calcite. Alteration is controlled by plagioclase zoning with some zones being amphibole-rich and others muscovite rich; thin rims are unaltered. Groundmass plagioclase, altered to white mica within unaltered rims, is intergrown with small, lath-shaped or rhombic, zoned amphibole showing orange-brown to green pleochroism. Minor amounts of quartz form small mosaics about plagioclase and amphibole and some is associated with chlorite. Small, radiating epidote (with high interference colours) knots are present and locally, coarse-grained calcite occurs, some calcite replaces plagioclase.

Euhedral epidote crystals are 10 - 80µm in diameter or form 120 - 200µm diameter, often radiating, aggregates of 20 - 40µm diameter crystals.

Small, euhedral magnetite crystals, some of which are skeletal are 30 - 60µm across and are pseudomorphed by sphene; ilmenite laths 10 x 1 to 60 x 5µm in size are unaltered or have thin, 1 - 5µm wide sphene rims.

Trace amounts of 1 - 5µm diameter pyrrhotite (some with very thin pentlandite lamellae); 5µm diameter galena and 2 - 10µm diameter, pale-coloured sphalerite are associated with 2 - 50µm diameter chalcopryrite. Elsewhere, 100µm diameter aggregates of 1 - 5µm pyrrhotite/chalcopryrite and 10 - 20µm diameter limonite after sulphides are present as are 4 - 10µm diameter crystals of a white, slightly zoned, cubic ?CoNiFe sulpharsenide. Small, 10 - 30µm diameter pyrite encloses 1 - 2µm diameter magnetite, sphene and pyrrhotite. All sulphides are present as inclusions within epidote.

Sark 13 Eperquerie. North of The Butts. West side beyond scree.

A fine-grained, altered, non-ophitic, epidotised meta-dolerite

Macroscopical description.

Hand specimen.

The rock has a feint fabric and the cut surface shows a uniform rock cross-cut by 0.5mm thick, yellow epidote and up to 3mm thick, blue-green silicate veinlets, the latter veinlet looks crushed. Overall the rock is a medium bluish grey (5B 6/1 on the Geological Society of America rock-color chart) colour.

Thin section.

The rock is a dusky yellow-green (5GY 5/2) but is cut by 1mm wide, greyish yellow (5Y 8/4) epidote and 0.8mm thick, darker veinlets. The darker veinlets carry very small 'clasts' of the country rock. Within the meta-dolerite the main grain size is 0.1 to 0.2mm diameter.

Microscopical description.

Large plagioclase laths, some collected into clusters, are intergrown with tabular green to brown amphibole and biotite. There is some variation in grain size. Locally, zoned plagioclase is little unaltered, carries thin, acicular apatite or forms cuneiform to graphic,

myrmekitic intergrowths with quartz. Patches of unaltered plagioclase, probably albite, surround coarse-grained feldspar laths. Lath-shaped amphibole showing green-brown pleochroism is surrounded by epidote or biotite altering to chlorite; some amphibole is deep blue-green. Quartz mosaics show serrated edges and are associated with epidote and feldspar. Epidote with high interference colours forms large patches and cross-cutting veins/veinlets where the epidote is 20 - 30µm in diameter and is associated with 60µm diameter pyrite. Thicker, later veins comprise albite-epidote but earlier ones are very fine-grained clinzoisite in a fine-grained epidote with high interference colours matrix. Ilmenite laths, 40 - 180µm in length are locally collected into subparallel domains; their cores are altered to 1 - 5µm diameter, fine-grained intergrowths of haematite and TiO<sub>2</sub> minerals all within a very thin haematite rim. Ilmenite is enclosed within 2 - 5µm wide sphene rims. Altered titanomagnetite, 60 - 200µm in size, now comprises thin, densely packed, 1 - 2µm wide ilmenite oxidation exsolution lamellae within sphene after magnetite. Magnetite, up to 20µm in size and lacking ilmenite oxidation exsolution lamellae is enclosed in pyrite. Chalcopyrite, in clusters up to 80µm across, is 2 - 10µm in diameter and alters to blue CuS minerals and covellite. Most chalcopyrite occurs within epidote. Pyrite up to 200µm across carries few inclusions but is enclosed in thin, 5 - 20µm wide covellite and blue CuS rims. Limonite after pyrite encloses 2 - 20µm diameter, relict ilmenite.

Sark 14 Derrible Bay. Top where the footpath starts to descend. (close to Gibbon's 1)

An altered non-ophitic meta-dolerite.

Macroscopical description.

Hand specimen.

The rock weathers to a speckled appearance. The cut surface shows feldspar laths within a darker matrix. The rock is homogeneous and is a light bluish grey (5B 7/1 on the Geological Society of America rock-color chart) colour.

Thin section.

The rock is a greyish olive (10YR 4/2) and has an average grain size of 0.2 to 0.4mm. It is mottled with pale feldspars intergrown with darker mafics.

Microscopical description.

The meta-dolerite comprises altered plagioclase intergrown with green-brown amphibole, equant opaques and quartz. Zoned plagioclase laths have cloudy cores within clear, unaltered margins and have altered to very fine-grained clay minerals/white mica plus minor epidote with high interference colours; plagioclase carries long, acicular apatite crystals and is enclosed in later feldspar. Zoned amphibole laths are simply twinned and show brown cores within greener rims. Minor amounts of biotite altering to chlorite surround some amphibole. Quartz showing strained extinction and associated with apatite and chlorite with purple interference colours surrounds and replaces plagioclase; elsewhere chlorite replaces biotite and amphibole. Sphene replaces iron titanium oxide minerals or forms discrete, euhedral crystals. Locally epidote with high interference colours forms small knots of 20 - 60µm diameter crystals in the groundmass and perhaps late-stage, acicular amphibole occurs in chlorite.

Ilmenite laths are 100 - 200µm in length; their cores are altered to 1 - 5µm diameter, fine-grained intergrowths of haematite and TiO<sub>2</sub> minerals accompanied by trace amounts of a blue-grey, highly anisotropic phase; this alteration is enclosed within an ilmenite zone that carries thin, up to 20 x <<1µm size haematite laths aligned along the c crystallographic axis of the parent ilmenite.

Magnetite, up to 30µm in size and lacking ilmenite oxidation exsolution lamellae has altered to martite. Altered titanomagnetite, 60 - 200µm in size, now comprises thin, densely packed, 1 - 2µm wide ilmenite oxidation exsolution lamellae within martite after magnetite. Locally

both magnetite and ilmenite in titanomagnetite grains have been replaced by sphene but elsewhere titanomagnetite is unaltered.

Pyrite has extensively altered to limonite with relict pyrite up to 40µm across enclosed in 100 - 200µm diameter limonite pseudomorphs. Limonite encloses 2 – 20µm diameter, relict pyrrhotite and chalcopyrite; a little 1 - 5µm diameter chalcopyrite occurs within epidote and ilmenite.

Notes

Much chlorite but little epidote and unusual features of this rock.

Sark 15 Port à la Jument, 2m wide dyke. Gibbon's exposure 2. Page 3.

An amphibolitised, ophitic, fine-grained meta-dolerite.

Macroscopical description.

Hand specimen.

The Meta-dolerite is very fine-grained and is sharp to the touch and natural surfaces are limonite stained. The cut surface is a medium bluish grey (5B 5/1 on the Geological Society of America rock-color chart) and shows a non-porphyrific, fine-grained (grain size is 0.1mm in diameter) rock cut by a coarse-grained epidote vein and pod. The epidote displays a paler rim.

Thin section

The rock has an overall dusky yellow-green (5GY 5/2) colour. Groundmass feldspar laths are 0.5 x 0.1mm in size but rare, highly altered plagioclase phenocrysts are up to 2mm in length. The core of these plagioclase phenocrysts has altered to chlorite. Void spaces are infilled with greyish green (10GY 5/2), fine-grained chlorite and coarse-grained, lensoidal, colourless epidote.

Microscopical description.

The very fine-grained, mainly homogeneous meta-dolerite has been extensively altered and is cut by thin calcite, chlorite or amphibole/amphibole-quartz veinlets. Coarse-grained epidote intergrown with chlorite and minor amounts of prehnite and feldspar has infilled a large void space.

Primary plagioclase laths, some in radiating clusters have altered to fine-grained white mica and epidote; larger plagioclase crystals are altered to prehnite or to fine-grained prehnite 10 - 20µm diameter epidote and chlorite intergrowths. Later, smaller, simply twinned albite is unaltered and infills void spaces and associated with acicular amphibole. No primary mafics remain and so altered feldspar is intergrown with green to brown pleochroic, radiating or felted masses of amphibole, much 200 x 50µm in size, or with brown, fibrous amphibole. Locally, small, secondary quartz mosaics surround vermiform chlorite or amphibole; other segregations comprise amphibole-prehnite-epidote. A very large void space is infilled with coarse-grained, pale-green epidote crystals, these have cloudy cores enclosing rare, fine-grained, 10 - 40µm diameter calcite within clear rims; the epidote is surrounded by a fine-grained, 20 - 40µm diameter, chlorite with brown interference colours matrix. Locally, prehnite laths enclose epidote and elsewhere calcite, up to 200µm in diameter, is intergrown with amphibole.

Primary iron titanium oxide minerals are totally altered to sphene, although very rare, 2 - 10µm long, ilmenite laths are enclosed within thin sphene rims. Sphene is abundant as 10 - 30µm long, euhedral, rhombic crystals or as 60 - 120µm size pseudomorphs after equant iron titanium oxide minerals; the latter carry 1 - 2µm long ilmenite relicts. Pale-coloured TiO<sub>2</sub> minerals are 10 - 20 but up to 100µm in length.

Sulphides include 5 - 60µm diameter, euhedral pyrite some with browner cores, other pyrite crystals enclose 1 – 5µm diameter chalcopyrite. Chalcopyrite is abundant as <1 - 5µm diameter crystals in 20 - 200µm diameter patches (often in the cores of amphibole). Larger

chalcopyrite crystals, up to 20µm in size, are rare. Pyrrhotite is rare but occurs as 5µm diameter grains in epidote or is associated with fine-grained pyrite within patches up to 40µm across.

Limonite veinlets are up to 200µm in length and 20µm wide.

Trace amounts of 5µm diameter possible native copper and possible arsenopyrite are present.

Sark 16 Port du Moulin. Lamprophyre. NE corner of bay. Gibbon's exposure 3.

A biotite lamprophyre - a minette.

#### Macroscopical description.

The lamprophyre is rough to the touch and looks highly weathered. Natural surfaces are a pale yellowish brown (10YR 6/2 on the Geological Society of America rock-color chart), vuggy and are mottled with pink feldspar and abundant dark mica. The cut surface is a pale yellowish brown (10YR 6/2) and has pink veinlets cementing dark mica. Void spaces are common and the rock has a grain size of about 0.5 – 1.0mm diameter.

#### Thin section

The minette has an overall orange-pink (5YR 7/4) colour and is uniform with no phenocrysts. Biotite laths are up to 1mm in length and are set in a pale pink matrix. Void spaces, up to 2mm in size, are common.

#### Microscopical description

The minette is much altered and comprises altered biotite laths in untwinned/simply twinned feldspar together with accessory, lath-shaped apatite up to 140µm in length and plagioclase. Minor amounts of quartz and white mica are late-stage minerals.

Orange-brown biotite/phlogopite extensively altered to chlorite is intergrown with altered feldspar showing simple twinning suggesting it is orthoclase; some feldspar forms radiating clusters. Minor amounts of plagioclase are albitised and later quartz mosaics infill void spaces with some perhaps pseudomorphing feldspar.

Opaque minerals are widespread. Small, rounded to euhedral, 2 – 20 but up to 40µm diameter chromite/chrome-spinel crystals with up to 5µm wide ferrochromit and later magnetite rims are typically and characteristically enclosed within titanomagnetite. The cores of the spinels are rounded within euhedral margins.

Small, euhedral magnetite crystals, up to 60µm in diameter, are oxidised to fine-grained haematite-TiO<sub>2</sub> intergrowths but more commonly just to haematite. The larger grains are altered to coarse-grained 'martite'.

Short, 20 – 60 x 5µm size ilmenite laths are altered to fine-grained, haematite-TiO<sub>2</sub> mineral intergrowths.

Classical, 60 - 200µm diameter titanomagnetite comprises <1µm wide ilmenite oxidation exsolution lamellae now replaced by TiO<sub>2</sub> minerals within magnetite that is now altered to haematite or totally has dissolved. With more extreme alteration titanomagnetite has altered to pale yellow, 60 - 180µm diameter leucoxene. Locally, 200µm diameter clusters of 20 - 60µm diameter titanomagnetite associated with 10 - 15µm diameter chromite has dissolved and just comprises voids with thin, haematite rims. Very rare, 1 - 2µm diameter chalcopyrite is enclosed in titanomagnetite

Secondary, lanceolate, 20 - 60µm long haematite surrounds void spaces. Pale-coloured, euhedral TiO<sub>2</sub> is 5 - 20µm in size and includes octahedrite. Elsewhere, 10 - 50µm long TiO<sub>2</sub> minerals lie along altered biotite cleavage planes.

Banded, 20 - 200µm diameter limonite with very red internal reflections has replaced pyrite crystals. Some carry 1 - 2µm diameter, relict chalcopyrite.

Trace amounts of manganese wad are present together with 10 - 20µm diameter native copper and a soft cream metal ?native bismuth.

Notes.

This is nothing like any axe-head.

Sark 17 Port à la Jument. Gibbon's exposure 8, a large dolerite dyke.

An amphibolitised ophitic meta-dolerite

#### Macroscopical description

A coarse-grained meta-dolerite that is sharp to the touch. Freshly broken surfaces are a bluish grey (5B 4/1 on the Geological Society of America rock-color chart) and the cut surface a medium bluish grey (5B 5/1). It shows 2mm diameter, much altered, olive-brown, possible phenocrysts within a dark matrix. The rock has a sub-planar fabric.

#### Thin section

The rock has an overall greenish grey (5GY 6/1) colour and is uniformly medium grained with feldspar laths up to 2mm in length associated with green-blue amphibole and a 1.5mm diameter, green-brown phase.

#### Microscopical description

The meta-dolerite now consists of ophitic intergrowths between altered plagioclase, amphibole and altered iron titanium oxide minerals.

Very altered, zoned plagioclase is replaced by fine-grained white mica and minor amounts of carbonate, but has unaltered, perhaps albite-rich margins. Plagioclase is ophitically intergrown with green or brown, pleochroic amphibole that has trace amounts of relict clinopyroxene in its cores and both are intergrown with altered titanomagnetite and ilmenite. Amphibole is zoned with some laths showing bluer margins and minor amounts of pale brown biotite with high interference colours are also present.

Secondary minerals include euhedral, fibrous/felted, green amphibole growing into chlorite infilling void spaces. Locally amphibole is fibrous and brown or has been replaced by fine-grained, brown carbonate and chlorite but retains relict 120° cleavage. Carbonate replacing earlier pyroxene/amphibole forms 20 - 40µm diameter, orange crystals infilling void spaces between the mafic mineral cleavages and may be limonite-stained.

Euhedral to rounded, 40 - 60µm diameter chromite is speckled or has 2 - 5µm wide ferrochromite rims. Lobate ilmenite laths are up to 100 - 200 x 10 - 20µm in size and are altered, to fine-grained TiO<sub>2</sub> minerals and sphene, this intergrowth carries 10 - 20µm diameter, relict ilmenite; or, to fine-grained, acicular TiO<sub>2</sub> that is crystallographically orientated. Thin, 10 - 20µm long, secondary ilmenite forms partial rims about altered ilmenite. Titanomagnetite and ilmenite are intergrown with symplectite-like ilmenite intergrowths surrounding titanomagnetite.

Altered, euhedral titanomagnetite, 100 - 200µm in size now comprises thin, 1 - 10µm wide, altered ilmenite oxidation exsolution lamellae within pale-coloured sphene and TiO<sub>2</sub> minerals but mainly within silicates/voids. Ilmenite oxidation exsolution lamellae have altered to TiO<sub>2</sub> phases, locally they are surrounded by 10 - 30µm wide chalcopyrite or pyrite rims.

Sulphides are abundant and include 20 - 100µm diameter, euhedral, or 60 - 80µm diameter, poorly crystalline, pyrite and pyrite patches up to 60µm across comprising 5 - 10µm diameter crystals. Up to 200µm diameter void spaces are infilled with 20µm diameter pyrite; very rare intergrowths of pyrite and 5µm diameter marcasite may be pseudomorphs after pyrrhotite.

Pyrite encloses 2 - 5µm diameter chalcopyrite.

Discrete, anhedral chalcopyrite, 20 - 120µm in size, is associated with 20µm diameter pyrite within chlorite and ?carbonate; fine-grained chalcopyrite up to 10µm in size occurs in clusters up to 200µm across.

Notes

There is very little epidote but a good ophitic meta-dolerite. A little more coarse-grained than most.



Sark 18 Derrible Bay. Sample from Gibbon's 3.

A fine-grained, altered meta-dolerite.

Macroscopical description

The meta-dolerite is dense and uniform with limonite-stained, natural surfaces. Non-limonite-stained surfaces are slightly mottled but have an overall light olive-grey (5Y 5/1 on the Geological Society of America rock-color chart) colour and show a holocrystalline rock with a grain size of about 0.5mm diameter. The cut surface is a medium bluish grey (5B 6/1) and comprises an intergrowth of fine-grained green, grey-green and pale-coloured minerals. The meta-dolerite is cross-cut by thin, up to 1mm wide, limonite-stained veinlets.

Thin section

The meta-dolerite is mottled but has an overall dusky yellow green (5GY 5/2) colour. It is non-porphyrific and is uniform comprising 0.3 – 0.5mm diameter, black, green and colourless minerals. It is cut by very thin, 0.1 – 0.2mm wide, limonite veinlets.

Microscopical description.

The very fine-grained, uniform meta-dolerite has been extensively altered and is cut by thin limonite veinlets. Altered plagioclase is intergrown with amphibole and altered, equant, iron titanium oxide minerals.

Zoned, primary plagioclase laths have altered to fine-grained white mica especially within their cores. Later untwinned feldspar, probably albite, is unaltered and infills void spaces together with minor amounts of strained quartz. No primary mafics are present and hence altered feldspar is intergrown with green to brown, pleochroic felted masses of amphibole. Later amphibole grows into late-stage chlorite showing purple interference colours. Minor amounts of euhedral apatite and trace amounts of brown biotite and epidote associated with chlorite plus rare, 20µm diameter zircon are present.

Titanomagnetite, 100 - 200µm in diameter, comprises 1 - 2µm wide ilmenite oxidation exsolution lamellae in magnetite. Smaller titanomagnetite crystals up to 50µm in diameter are unaltered but most show orange-coloured TiO<sub>2</sub> minerals replacing ilmenite within fine-grained haematite-TiO<sub>2</sub> intergrowths replacing magnetite. Close to limonite veins titanomagnetite has totally altered to 'leucoxene' a trellis work of pale yellow TiO<sub>2</sub> after ilmenite within void spaces after magnetite.

Ilmenite laths, 60 – 200µm in length, locally are altered to pale-coloured sphene but mainly to fine-grained intergrowths of haematite and TiO<sub>2</sub> minerals themselves within thin sphene or orange-coloured TiO<sub>2</sub> rims.

Discrete sphene occurs as 5 - 20µm long, euhedral, rhombic crystals or as 40 - 80µm size masses associated with altered iron titanium oxide minerals.

Sulphides include 40 - 200µm diameter, euhedral pyrite enclosing 20 - 60µm long ilmenite and 1 – 10µm diameter chalcopyrite, pyrrhotite and mixed chalcopyrite-pyrrhotite.

Chalcopyrite locally forms patches of 5 - 20µm diameter, discrete crystals. Very rare, soft, white galena occurs as 2 – 5µm diameter, euhedral crystals in small patches. Most pyrite has altered to banded limonite showing very red internal reflections

Limonite veins are centimetres long and up to 90µm wide and enclose 40 - 200µm diameter areas of poorly polished haematite showing deep red internal reflections.

Sark 19 Derrible Bay. Sample from below Gibbon 1 & 2. biotite gneiss.

A garnet biotite gneiss.

Macroscopical description

Freshly broken surfaces are a greenish grey (5G 5/1 on the Geological Society of America rock-color chart) with centimetre diameter, pale-coloured, quartz-feldspar-rich augen comprising 1 – 2mm diameter crystals. Much biotite is coarse-grained. The cut surface is a

light bluish grey (5B 6/1) with pinkish grey augens (5YR 8/1) that are often lensoidal and with their long axes laying along the main fabric of the gneiss. The augens are cut by thin veinlets that do not penetrate the more micaceous rich bands.

#### Thin section

The gneiss is patchy with colourless areas within a light olive (10Y 5/4) matrix. Pale patches comprise 0.5 – 1.0mm diameter, clear quartz and cloudy, pink feldspar. The pale green matrix is chlorite rich and is much limonite-stained.

#### Microscopical description

The gneiss is weakly banded with coarse-grained quartz-altered acid plagioclase and trace amounts of apatite intergrown in augens surrounded by finer grained intergrowths of chlorite-altered plagioclase-opaques.

Light-coloured augens comprise coarse-grained quartz with serrated edges intergrown with minor amounts of euhedral apatite but mainly with plagioclase that has been replaced by very fine-grained white mica.

The grain size of the phyllosilicate-rich bands is far smaller than in the quartz-feldspar-rich bands. Phyllosilicate-rich bands comprise thin chlorite laths intergrown with altered plagioclase. Some of the chlorite has replaced original biotite but much is neomorphic including coarse-grained, radiating masses. Zircons with pleochroic halos are present within altered biotite. A large, subhedral to rounded garnet enclosing clean quartz and biotite altering to chlorite has altered to chlorite with blue interference colours; thin possibly albite veinlets cross cuts the rock.

Trace amounts of 10 - 60µm diameter, subhedral to rounded, unzoned zircon and 40µm diameter garnet relicts are present.

Iron titanium oxide minerals, 40 – 200 x 20µm in size and including ilmenite laths are altered to very fine-grained intergrowths of haematite and TiO<sub>2</sub> minerals that carry rare, 20µm long ilmenite laths. Some ex-iron titanium oxide minerals have 10 – 30µm yellow to orange TiO<sub>2</sub> minerals in their cores.

Colourless to pale yellow TiO<sub>2</sub> laths, 5 x 1 to 20 x 2µm in size, lie along chlorite (?after biotite) cleavage planes and are not associated with the alteration of ilmenite/magnetite.

Sulphides are rare but include 5 - 100µm diameter, unaltered pyrite enclosing 5µm diameter chalcopyrite; much pyrite is partially or totally altered to limonite with very red internal reflections.

Sark 20 Cliff path Le Coupée towards Dixcart 463743.

An altered, sub-ophitic, fine-grained meta-dolerite.

#### Macroscopical description

A well-jointed, dense, fine-grained meta-dolerite with limonite-stained surfaces. The freshly broken surface is a medium bluish grey (5B 6/1 on the Geological Society of America rock-color chart). The cut surface is slightly mottled but has an overall light bluish grey (5B 7/1 to 5B 6/1) colour. It shows a very uniform, non-porphyrific, basic rock that is very fine-grained comprising 0.1- 0.3mm diameter, pale-, medium- and dark-coloured minerals.

#### Thin section

The rock has an overall dusky yellow-green (5GY 5/2) colour. It is uniform, essentially non-porphyrific and fine-grained with an average grain size of 0.1mm. Feldspar laths are 0.2 – 0.5 x 0.1mm in size but rare altered feldspar phenocrysts are up to 1mm in size. There is a suggestion of amphibole-rich bands in the rock.

#### Microscopical description

Altered plagioclase laths are intergrown with iron titanium oxide minerals and clinopyroxene altering to amphibole. Very altered plagioclase has altered to fine-grained white mica (possible prehnite) and clinozoisite although locally unaltered plagioclase occurs. Colourless

clinopyroxene is extensively altered to green pleochroic amphibole. Secondary minerals include tabular amphibole up to 120µm in length, epidote with high interference colours and quartz mosaics associated with muscovite.

Very rare, 40µm diameter chromite has 5µm wide ferrochromit rims passing out into 1µm wide haematite.

Short, 20 – 80 x 10 - 20µm size, ilmenite laths are extensively altered to fine-grained haematite-TiO<sub>2</sub> mineral intergrowths; some laths have thin, 2 - 5µm wide sphene rims.

Altered titanomagnetite, 10 - 60µm in diameter, comprises thin, 2µm wide, ilmenite oxidation exsolution lamellae now altered to TiO<sub>2</sub> within sphene after magnetite.

Sphene is abundant as 50 – 200 x 120µm size pseudomorphs after iron titanium oxide minerals, some carries 1 - 2µm long, relict ilmenite. Elsewhere, 1 - 5µm diameter sphene crystals form mosaics up to 120µm in diameter. Rare haematite laths 5 – 30 x 2µm in size occur in small clusters.

Sulphides include 20 – 200µm diameter pyrite that carries 5 - 10µm diameter pyrrhotite; 5 – 20µm diameter, mixed chalcopyrite-pyrrhotite; up to 40µm diameter chalcopyrite and rare, 10µm diameter galena; much pyrite has altered to limonite. Poorly polished pyrite is 40 - 60µm in diameter and local pyrite patches up to 200µm in size comprise 20 - 30µm diameter crystals.

Discrete chalcopyrite 2 – 10 but up to 20µm in size has rare, thin, 5µm wide covellite rims or is intergrown with 1µm wide mackinawite. Small chalcopyrite crystals are enclosed in epidote, amphibole and sphene.

Limonite forms 20 - 120µm diameter pseudomorphs after pyrite or thin 20 - 80µm long veinlets.

Notes

There is very little epidote alteration.

Sark 21 Le Petit Beauregard c456757

A fine-grained, epidotised, altered meta-dolerite.

#### Macroscopical description

A dense, limonitically stained rock. Freshly broken surfaces are a medium bluish grey (5B 5/1 on the Geological Society of America rock-color chart). The meta-dolerite is uniform and fine-grained with an average grain size of 0.2 – 0.3mm diameter; a little sulphide is present.

The cut surface is a medium bluish grey (5B 5/1) and shows a non-porphyrific, uniform, igneous rock that is cut by thin, 0.2mm wide, limonite-stained or pale-coloured veinlets.

#### Thin section

The fine-grained meta-dolerite has an overall dusky yellow-green (5GY 5/2) colour. Feldspar laths are 0.5 x 0.1 in size within a green matrix. The rock is cut by thin, 0.2mm wide, colourless quartz/feldspar veinlets.

#### Microscopical description

The uniform, fine-grained meta-dolerite comprises altered plagioclase intergrown with amphibole and altered iron titanium oxide minerals.

Very altered plagioclase is replaced by fine-grained white mica; later, unaltered albite is also present. Plagioclase is intergrown with green pleochroic amphibole, some with possible relict clinopyroxene; both feldspar and amphibole locally form radiating clusters. Secondary minerals included simply twinned albite, epidote and sphene; the rock is cross-cut by albite, epidote and sphene-rich veinlets.

Ilmenite laths are up to 60µm in length and are altered to fine-grained intergrowths of haematite and TiO<sub>2</sub> minerals; locally altered ilmenite is mantled by thin, 5µm wide sphene.

Altered possible ex-magnetite, 120 - 200µm in size, now comprises mosaics of pale-coloured sphene. Other sphene mosaics, 20 - 100µm across, are composed of 2 - 5µm diameter crystals and carry 20µm long, relict ilmenite. Very rare, 40 x 5µm size haematite is present. Sulphides include 30 - 100µm diameter pyrite enclosing 1 - 5µm chalcopyrite, pyrrhotite or up to 10µm diameter mixed chalcopyrite-pyrrhotite. Locally pyrite aggregates are up to 200µm in size and pyrite is partially or totally replaced by limonite. Minor amounts of discrete chalcopyrite have 1µm wide covellite rims. Limonite forms 10 - 40µm wide veinlets or 20 - 60µm diameter pseudomorphs after pyrite or.

Sark 22 L'Ecluse. Dykes crossing path to bay.

A biotite gneiss.

#### Macroscopical description

The very micaceous gneiss has a planar fabric and is limonite-stained. Freshly broken surfaces are a light olive-grey (5Y 6/1 on the Geological Society of America rock-color chart). The cut surface is a medium light grey (N6) but is banded with 5mm diameter, quartz-rich clasts and veinlets/bands within a darker, fine-grained matrix containing up to 0.3mm diameter feldspar/quartz crystals.

#### Thin section

The banded gneiss has an overall moderate yellow-brown (10YR 5/2) colour. Clear patches, up to 2mm wide, comprise intergrown clear quartz and cloudy feldspar both with a 0.5 - 1.0mm diameter grain size. Brown areas consist predominantly of 0.2mm diameter feldspar crystals and mafics.

#### Microscopical description

The gneiss is banded with coarse-grained quartz-altered acid plagioclase and trace amounts of apatite alternating with bands of finer grained biotite or biotite altering to chlorite intergrown with altered plagioclase and lesser amounts of quartz. Locally patches of fine- to coarse-grained epidote with high interference colours are present. Folded quartz veins cross-cut the rock.

Later minerals include vermicular chlorite with blue interference colours and patches of 20 - >>200µm diameter epidote associated with muscovite laths.

Light-coloured bands comprise coarse-grained quartz with serrated edges intergrown with unaltered acid plagioclase or plagioclase that has been replaced by very fine-grained, felted white mica. Minor amounts of euhedral apatite occur in the quartz. Untwinned feldspar also altering to fine-grained white mica may be potassium feldspar.

Phyllosilicate-rich bands comprise biotite or biotite altering to chlorite intergrown with altered plagioclase and lesser amounts of quartz. The grain size is far smaller than within the quartz-feldspar-rich bands.

Trace amounts of small tourmaline; 20 - 60µm diameter, euhedral to rounded, unzoned zircon and 10 - 40µm diameter haemilmenite are present in quartz and feldspar.

Discrete, pale-coloured or pink-brown magnetite, 60 - >200µm in diameter, is partially altered to 2 - 10µm wide haematite rims or very rarely to martite. Ilmenite laths, up to 30µm in length, lie along phyllosilicate cleavage planes. Larger ilmenite laths, up to 80µm in length, are altered to 2 - 10µm long TiO<sub>2</sub> minerals and 120 - 200µm diameter, equant ilmenite crystals to fine-grained, 2 - 5µm diameter sphene and TiO<sub>2</sub> phases. Thin, 1 - 2µm wide, alternating haematite and ilmenite laths form mixed crystals up to 60µm in diameter.

Trace amounts of sphene, 10 - 20µm in length, lie along biotite/chlorite cleavage planes or are enclosed within epidote.

Sulphides include 150µm diameter, unaltered pyrite enclosing 5µm diameter pyrrhotite; and rare, 2 - 10µm diameter chalcopyrite within epidote.

Banded limonite pseudomorphs after pyrite carry up to 30µm diameter, relict pyrite. The limonite has very red internal reflections

Sark 23 Port du Moulin Major dyke on N. SW of bay.

A fine-grained meta-dolerite.

Macroscopical description

The meta-dolerite is fine-grained, uniform and non-porphyrific. Where freshly broken it is a bluish grey (5B 4/1 on the Geological Society of America rock-color chart) with an average grain size of 0.1 – 0.2mm diameter, sulphide is present. The cut surface is a light bluish grey (5B 6/1) and shows a uniform, fine-grained rock with an average grain size of 0.1mm, the rock is cut by thin, 0.2mm wide, veinlets.

Thin section

The meta-dolerite has a greenish grey (5G 5/1) colour. The rock is uniformly fine-grained with an average grain size of 0.1mm. It is cut by a thin, 0.2mm wide, pale-coloured veinlet.

Microscopical description.

The rock is a very fine-grained, homogeneous meta-dolerite. Altered, primary plagioclase laths are intergrown with blue-green, green-brown, pleochroic amphibole, equant iron titanium oxide minerals and acicular apatite. Late-stage quartz has infilled void spaces associated with a little biotite; locally, 40 -200µm diameter, zoned epidote with high interference colours forms small knots.

Ilmenite as 10 – 60 but up to 200µm long laths is extensively altered to fine-grained TiO<sub>2</sub>-haematite intergrowths or more locally to sphene. Some ilmenite-silicate intergrowths are symplectite-like.

Discrete magnetite, up to 60µm in diameter, is intergrown with 10 - 20µm long ilmenite; locally magnetite is altered to sphene.

Equant, 40 - 60µm diameter titanomagnetite is slightly altered; 1 - 2µm wide ilmenite oxidation exsolution lamellae are replaced by sphene and magnetite by haematite.

Euhedral, rhombic sphene is 20 – 40µm in length, elsewhere sphene forms anhedral, pale-coloured masses up to 100µm in diameter.

Sulphides include much pyrite as 40 - 200µm diameter, poorly polished masses within well-polished rims that enclose 2 - 10µm diameter chalcopyrite or 5 - 40µm long ilmenite/altered ilmenite. Elsewhere well-polished pyrite is 80 – 100µm across.

Marcasite occurs within pyrite as 5 - 10µm long laths; larger marcasite up to 40µm in diameter is associated with textures suggesting that pyrrhotite has been replaced.

Chalcopyrite is associated with epidote or cements pyrite to give 2 - 30µm wide rims.

Short, 10 - 30µm long limonite veinlets occur.

Notes

In thin section the meta-dolerite is very fine-grained and dark.

Sark 24 Harbour Hill

An altered, fine-grained, ophitic dolerite.

Macroscopical description.

Hand specimen

The rock is made from a dense, homogeneous, fine-grained, altered dolerite. The limonite-stained surfaces are a light brown (5YR 5/6 on the Geological Society of America rock-color chart) but freshly broken surfaces are a dull greenish grey (5GY 4/1) but with fine-scale mottling. A thin, 1.5mm wide, greyish-yellow (5Y 8/4) veinlet cross cuts the rock and the main rock has 1.0mm long feldspar laths and 1.0 – 2.0mm diameter, green mafics. The cut surface is a light bluish-grey (5B 6/1) and slightly mottled with a 1.0mm wide, pinkish-grey

(5YR 8/1) veinlet and a larger 2.0mm wide epidote vein. Tabular, pink feldspars, 1.0 x 0.3mm in size, are set within a fine-grained dark matrix.

#### Thin section

The rock is a light olive-grey to light olive (5Y 6/1 – 10Y 5/4) and uniformly fine-grained but carries up to 1.0 x 0.2- 0.4mm size, colourless to cloudy feldspar laths in a matrix comprising 1.0mm diameter, green amphibole and 0.5mm size opaques. Rare feldspar phenocrysts are 2.5mm in diameter. Thin veinlets, up to 1.5mm in width, cross-cut the rock.

#### Microscopical description

The rock is a meta-dolerite locally with an ophitic texture. Altered, primary plagioclase laths are intergrown with clinopyroxene now altered to green amphibole and with lobate iron titanium oxide minerals and phlogopite. Primary twinned plagioclase laths are altered to fine-grained clinozoisite surrounded by fine-grained muscovite margins but within unaltered, zoned albite rims. Elsewhere, unaltered plagioclase is present or alters to fine-grained muscovite or epidote. Trace amounts of apatite are present within late albite. Large feldspars alter to fine-grained epidote along their cleavage.

Primary clinopyroxene is now replaced by deep green, green-brown, but mainly by pale green amphibole. Twinned amphibole replaces clinopyroxene and also forms pale green, acicular crystals growing into voids; some is altered to chlorite. Rare zircon within pleochroic halos occurs in amphibole. Rare, orange, pleochroic phlogopite is associated with altered iron titanium oxides including titanomagnetite and is altered to chlorite. Sphene is also present.

Epidote is locally abundant and forms thin veins cross cutting the rock. Larger epidote crystals have cores with high interference colours and rims with low order colours.

Sark 25 Port à la Jument. Gibbon's exposure 8, centre of a large dolerite dyke.

An altered meta-dolerite.

#### Macroscopical description

Weathered surfaces are pale green to greenish-grey (5GY 6/1 – 5GY 8/1 on the Geological Society of America rock-color chart). Freshly broken surfaces are a light greenish-grey (5GY 7/1) and the cut surface a light bluish-grey (5B 7/1). The centre shows pitted, dusky yellow (5Y 6/4) areas, 3.0 x 1.0mm in size, within a darker groundmass.

#### Thin section

There are two different rocks, both show very variable alteration; there is no sharp contact between the two. One is a typical, very ophitic dolerite and is a colourless to dusky yellow-green (5GY 6/2) with 1.0 x 0.2mm size, colourless feldspar laths in a matrix comprising 1.0 – 2.0mm diameter colourless to pale green mafics or to brown, cloudy secondary minerals with voids. Opaques are present.

The other rock (inner core) is very pale olive (10Y 7/2) with yellow-grey (5Y 7/2) patches. All the feldspar is highly altered within a very fine-grained pink-grey matrix. Opaques are rare.

#### Microscopical description

Two lithologies appear to be present although there is no sharp junction between the two. One is a highly ophitic, coarse-grained, altered meta-dolerite and the other has very altered plagioclase laths within a fibrous/felted amphibole matrix.

Plagioclase is variably altered, some laths are totally altered to muscovite other have a fine-grained clinozoisite core within a muscovite rich margin both within very rare unaltered albite rims. Elsewhere much feldspar is altered to carbonate and muscovite. A little apatite occurs within plagioclase.

Clinopyroxene is highly ophitic and varies from being slightly altered to altering to amphibole pseudomorphs within acicular amphibole margins. In more extreme alteration it

progressively alters to green amphibole then to brown rhombic carbonate and finally is lost leaving void spaces. Amphibole also forms pale green, acicular, radiating crystals growing into chlorite within ?voids.

Orange-brown, pleochroic phlogopite is widespread and is associated with iron titanium oxides and fibrous amphibole. Much is altered to chlorite. Later thin chlorite veinlets cut clinopyroxene.

Very locally fine-grained epidote clusters are present; very thin, late-stage quartz and later silica-limonite veinlets cut the rock.

Sark 26 Port à la Jument. Gibbon's exposure 8, a large dolerite dyke.

An amphibolitised, ophitic meta-dolerite.

#### Macroscopical description

The limonite-stained surfaces are a medium brown (5YR 4/4 on the Geological Society of America rock-color chart) but freshly broken surfaces are a dark greenish-grey (5G 4/1) and show large, pale-coloured feldspar crystals in a darker, 1.0 – 2.0mm diameter, groundmass including black, shiny mafics. The cut surface is a uniform, medium bluish grey (5B 6/1) with 1.0 – 1.5mm long feldspar laths intergrown with a dark matrix.

#### Thin section

The rock is a greenish-grey (5GY 6/1) with rare, darker patches and is uniformly fine-grained. It carries up to 1.0 x 0.2mm size, colourless to cloudy feldspar laths in a matrix comprising 1.0mm diameter, pale to dark yellow-green minerals including amphibole, and 0.4mm size opaques. Some clinopyroxene is colourless. Locally very dark green, secondary minerals enclose plagioclase laths.

#### Microscopical description

The rock is a homogeneous, ophitic meta-dolerite. Altered, primary plagioclase laths are intergrown with coarse-grained clinopyroxene some altered to amphibole and with iron titanium oxide minerals. Primary plagioclase laths are altered extensively to fine-grained muscovite and to brown carbonate (high relief) and possibly to very fine-grained clinozoisite. Clear albite rims to plagioclase are rare.

Primary, coarse-grained clinopyroxene shows an ophitic texture with plagioclase and much is unaltered but with thin, green amphibole rims. Amphibole also forms radiating pale green, acicular crystals growing into minor chlorite within ?voids.

Opaques include altered, equant titanomagnetite and lobate ilmenite often surrounded by orange, pleochroic phlogopite that is altered to chlorite. A little apatite and secondary sphene are associated with opaques...

Amphibole, prehnite-quartz/albite or prehnite-carbonate veinlets cross-cut the rock as do very thin chlorite veins but epidote is absent

Sark 27 Valley to Port du Moulin

An amphibolitised, ophitic meta-dolerite.

#### Macroscopical description

The limonite-stained surfaces are a medium brown (5YR 4/4 on the Geological Society of America rock-color chart) but freshly broken surfaces are a dark greenish-grey (5G 4/1) and look unaltered and the cut surface a medium bluish-grey (5B 6/1). It shows fine-grained, 0.5 - 1.0mm diameter, intergrowths between pale-coloured feldspar and dark mafics. It is sharp to the touch.

#### Thin section

The rock is a pale greyish-green (10GY 6/2) and is uniformly fine-grained. It carries very altered, cloudy feldspar within pale green mafics and 0.1 – 0.2mm size opaques.

#### Microscopical description

The rock is a homogeneous meta-dolerite. Altered, primary plagioclase laths are intergrown with coarse-grained clinopyroxene now altered to amphibole and with iron titanium oxide minerals. Primary plagioclase laths are altered with fine-grained clinozoisite and possibly carbonate cores surrounded by fine-grained muscovite (possibly prehnite) margins but with unaltered, zoned albite rims. Trace amounts of apatite are present within late albite. Large feldspar have fine-grained carbonate alteration in their cores.

Primary clinopyroxene locally shows a coarse-grained ophitic texture with plagioclase but much clinopyroxene is now replaced by twinned, pale green amphibole. Amphibole also forms pale green, acicular crystals growing into minor chlorite within voids. Rare, orange, pleochroic phlogopite is associated with iron titanium oxides and is altered to chlorite.

Prehnite veinlets cross-cut large amphibole crystals and late-stage quartz is associated with amphibole. Epidote is absent and chlorite is rare.

Le Pinnacle 1 Main dolerite 11.05.08 JTR

The rock is an amphibolitised, ophitic, fine-grained meta-dolerite.

Macroscopical description.

Hand specimen

The meta-dolerite is a dense, homogeneous, fine-grained rock. The weathered surfaces are a greenish grey (5GY 5/2 on the Geological Society of America rock-color chart) and show rare, pale-coloured, feldspar phenocrysts 0.5 to 2mm in length. The freshly cut surface is a medium bluish grey (5B 6/1).

Thin section.

The light olive-grey (5Y 6/1) rock is uniform and fine-grained but carries rare, up to 2mm long, feldspar micro-phenocrysts in a matrix comprising 0.3mm diameter crystals.

Microscopical description

Rare, zoned, plagioclase phenocrysts have altered to white mica (low relief and high interference colours) and very fine-grained epidote within a groundmass of altered feldspar; the feldspars are intergrown with lath-shaped ilmenite and pale green, pleochroic amphibole replacing clinopyroxene. Plagioclase phenocrysts display different secondary minerals in their cores and rims and many plagioclase crystals have unaltered, outer margins. Orange-brown biotite altering to chlorite along its cleavage occurs in minor amounts and later amphibole is fine- to coarse-grained and acicular or euhedral in habit. Late-stage chlorite with green-grey interference colours is associated with a phase with low interference colours (probably simply twinned albite) and acicular amphibole. Acicular apatite is widespread. Lobate ilmenite laths, 20 – 120 but up to 200µm in length and very slightly altered to fine-grained intergrowths of <1µm diameter haematite and TiO<sub>2</sub> minerals with white internal reflections, have thin, up to 10µm wide, sphene rims. Locally, fine-grained, 2 - 5µm size ilmenite occurs as patches within amphibole.

Magnetite may be present as small, equant crystals that alter to fine-grained haematite and TiO<sub>2</sub> minerals.

Sphene forms 10 – 60 but up to 140µm long, euhedral, rhombic crystals or thin rims to ilmenite. Very rare, 20µm long, highly zoned zircon and 2µm diameter pyrrhotite are present. Sulphides mainly comprise 5 – 60µm diameter, euhedral, cubic pyrite crystals that are extensively altered to banded limonite.

Le Pinnacle 2 Secondary dolerite 11.05.08 2 JTR

The rock is an amphibolitised, ophitic, fine-grained meta-dolerite.

Macroscopical description.



### Hand specimen

The meta-dolerite is a dense, homogeneous, fine-grained, slightly vuggy rock. The weathered surfaces are a dark greenish grey (5GY 4/1 on the Geological Society of America rock-color chart). The freshly cut surface is a medium bluish grey (5B 6/1) with plagioclase laths up to 1mm in length and pale patches up to 2mm in diameter. Small vughs are present.

### Thin section.

The meta-dolerite is a dusky yellowish green (5GY 5/2). Dark mafics are intergrown with feldspar laths with a uniform grain size of 0.5mm.

### Microscopical description

Plagioclase has altered to fine-grained, white mica ± epidote ± chlorite; feldspar cores are altered before rims. Plagioclase and amphibole display an ophitic relationship. Late-stage probable albite syntaxially overgrows altered plagioclase to give clear rims. Coarse-grained, green amphibole; biotite with pleochroic halos and alteration to chlorite along its cleavage planes; and ilmenite laths are the main 'primary' minerals. Large, subhedral, twinned sphene with abundant fine-grained, euhedral epidote appear to be vugh infilling.

Subhedral amphibole associated with apatite and ?albite infill some vughs and other vughs have epidote rims and radiating chlorite (with both purple and blue interference colours) cores.

Locally patches of fine-grained epidote with high order interference colours are associated with sphene within chlorite rims.

Lobate ilmenite laths are 80 – 200 x 20- 50µm in size and are weakly altered to fine-grained intergrowths of haematite and TiO<sub>2</sub> minerals with white internal reflections. Very locally ilmenite is altered to 5 - 10µm long, pale-coloured TiO<sub>2</sub> minerals but more commonly is enclosed within 5 - 30µm wide sphene rims.

Probable magnetite, 40 - 60µm in diameter, is lightly altered to fine-grained haematite and TiO<sub>2</sub> minerals.

Wispy sphene lies along the cleavage planes of altered biotite; euhedral, rhombic sphene is 40 - 80µm in length but the majority of sphene forms large 100 – 200 but up to 500 x 500µm diameter masses that are inclusion-free or carry abundant, 10 - 20µm long, euhedral silicates (epidote and amphibole). Most sphene is pale-coloured but some is limonite-stained and so is orange. Trace amounts of fine-grained haematite are present as 40µm diameter patches as are 20 - 30µm long zircon grains and 10 - 20µm pale-coloured TiO<sub>2</sub> grains.

Sulphides include 10 – 40µm diameter, euhedral, pentagonal dodecahedral pyrite now almost totally altered to banded limonite with very red internal reflections. Discrete, chalcopyrite and a white, high reflectance, cubic phase, both 2µm in diameter and pale yellow sphalerite up to 20µm in size are present.

Banded limonite 200µm in diameter has replaced aggregates of pyrite crystals.

Le Pinnacle 2 is coarser grained than Le Pinnacle 1.

Sample	Locality	Lithology	Comments
SEN215 axe		Fg meta-dolerite	Unaltered plagioclase
SEN217 axe	N.Chateau Head	Meta-dolerite	Unaltered clinopyroxene
SEN220 axe/hammer		Meta-dolerite	No chlorite or epidote
SEN221 axe/hammer	Near La Maseline	Meta-dolerite	Unaltered clinopyroxene
SEN225 perf pebble		Porphyry. basic rock	'Similar' to Sark 11

Sark 1 (R1)	Port à la Jument	Fg. meta-dolerite	Same Sark 15
Sark 2 (R2)	Port du Moulin	Meta-dolerite	
Sark 3 (R3)	Port du Moulin	Felsite/microdiorite	Very different
Sark 4 (R4)	Eperquerie	Epidotised microdiorite	Very different
Sark 5	Eperquerie	Porphyry. felsite	Very different
Sark 6	Eperquerie	Microporphyry meta-dolerite	Thin dyke
Sark 7	W of Eperquerie	Porphyry. felsite	Biotite Very different
Sark 8	NW of Eperquerie	Granophyric felsite	Biotite Very different
Sark 9	NW of Eperquerie	Epidotised microdiorite	Very different
Sark 10	Eperquerie	Meta-dolerite	Thick dyke
Sark 11	Eperquerie	Fg. meta-dolerite	Chilled margin
Sark 12	Eperquerie	Microporphyry meta-dolerite	
Sark 13	NW of Eperquerie	Meta-dolerite	
Sark 14	Derrible Bay	Meta-dolerite	Chlorite and biotite
Sark 15	Port à la Jument	Fg. meta-dolerite	Same as R1
Sark 16	Port du Moulin	Minette	No match
Sark 17	Port à la Jument	Cg. meta-dolerite	Closest to axeheads
Sark 18	Derrible Bay	Meta-dolerite	Chlorite biotite
Sark 19	Derrible Bay	Garnet biotite gneiss	Country rock
Sark 20	La Coupée	Fg. meta-dolerite	
Sark 21	Le Petit Beau Regard	Meta-dolerite	
Sark 22	L'Eclase	Biotite gneiss	Country rock
Sark 23	Port du Moulin	Meta-dolerite	
Sark 24	Harbour Hill	Meta-dolerite	
Sark 25	Port à la Jument	Meta-dolerite	Two different? lithologies
Sark 26	Port à la Jument	Meta-dolerite	Closest to axe-heads
Sark 27	Port du Moulin	Meta-dolerite	
Jersey Le Pinnacle 1	Le Pinnacle Main dolerite	Fg. meta-dolerite	
Jersey Le Pinnacle 2	Le Pinnacle	Fg. meta-dolerite	Cg. amphibole

Table 49. Summary of stone samples analyzed