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THE PETROLOGY OF TWENTY NINE ROCKS FROM THE FAR WEST COAST AND FROM NUYTS ARCHIPELAGO, SOUTH AUSTRALIA

GEOLOGICAL SURVEY

by

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ABSTRACT

Twenty nine granitoids from the Far West Coast and from Nuyts' Archipelago were examined in thin section. The composition of some rocks has been modified by the assimilation of more basic material from xenoliths. The texture of many samples has been radically modified by granulation during tectonic activity and by subsequent recrystallisation. The possible effect of this on age determination is discussed. The possibility that one amphibolite may represent a differentiated basic intrusive is raised because of the economic implications. A rock which is unique in the writer's experience consists almost entirely of myrmekite.

INTRODUCTION

Twenty nine rock specimens 5333 RS 12-13, 5433 RS 6, 5532 RS 43-48, 5583 RS 70-84, 89-99 were selected from a collection made for petrological examination and for geochronology. They are significant in providing an indication of the possible nature of the concealed basement of the Eucla Basin as well as in dating events in the Archaean and Proterozoic.

The rocks were collected by R.B. Flint from a seventy kilometre length of the South Australian coast between Ceduna and Cape Adieu at the Head of the Great Australian Bight, and from islands on the Continental Shelf in the St Francis Isles group of the Nuyts Archipelago. R.B. Flint also supplied the field observations.

PETROGRAPHY

5333 RS 12, TS C 33137

Locality. Cape Adieu

Field observations. Banded amphibolites, medium to coarse-grained, garnetiferous, foliated. Numerous thin quartz and feldspar veinlets, isoclinally folded.

Rock name. Gneissic, garnetiferous granodiorite.

Hand specimen. The rock is medium grained and dark in colour for a granitoid. At one end of the specimen the rock is foliated. The other end consists of a rounded mass of dark, fine-grained rock, containing visible coarse-grained garnets in a green and brown ground mass.

Thin section

a) Leucocratic Facies

The lighter coloured rock consists mainly of coarse quartz, plagioclase, microcline and biotite.

Garnet is a minor constituent and accessory zircon and opaque minerals are also present.

Quartz occurs both as anhedral interstitial grains and as rounded inclusions within feldspar grains. The quartz displays a patchy and undulose extinction which indicates that it remains under stress. The quartz is turbid due to a fairly high density of extremely fine-grained inclusions.

Plagioclase grains are also anhedral and turbid, with a generally ill-defined and weakly developed twinning. Since the feldspars do not display saussuritic alteration, optical distinction between quartz and plagioclase is sometimes uncertain.

Microcline tends to show a sharper twin pattern than plagioclase. It is fresh and tends to be less turbid than plagioclase. Microcline crystals tend to be even less well-shaped than plagioclase and display long interstitial extensions.

Neither quartz nor the feldspar display a preferred orientation. Grains tend to be equidimensional and where they are occasionally elongated, the elongation is not consistently aligned. The remaining major constituent of the granodiorite, the biotite, displays a strong tendency to concentration in bands and to a consistent orientation. It is the biotite which imparts a visible foliation to the rock. It occurs as subhedral to anhedral flakes throughout the rock but is more abundant in gneissic bands.

Garnet occurs both as large irregular grains with a sieve texture and skeletal habit and as finer grains with a more continous structure and more euhedral shape. The former type has probably been acquired from xenoliths as xenocrysts but the latter type tends to occur in bands and has probably been precipitated directly within the granodiorite.

The few zircon grains present are very fine-grained and almost euhedral in shape.

Rare, fine, interstitial grains of opaque material are probably composed of iron or iron-titanium oxide.

b) The melanocratic facies

The melanocratic part of the specimen is composed of two lithologies. In the most abundant lithology the dominant phases are quartz, garnet and biotite. The minor lithology consists of quartz and garnet but with a hornblende and a highly-altered

mineral of high birefringence which is probably muscovite. The minor minerals present are both feldspars, opaque oxides and apatite.

Quartz occurs as rounded to irregular inclusions in both the garnet and the interstitial biotite-feldspar material.

The major part of the dark rock consists of irregular, skeletal and sieve-textured garnet. The large grains are abundant enough to be partly in mutual contact, with little interstitial material. They are faintly coloured with a brownish pink tint and are probably near an andradite composition.

The biotite flakes in the dark band tend to be coarser in grain size than those in the leucocratic granodiorite gneiss. They are irregular in shape and are concentrated in bands which follow the margins of the large garnet porphyroblasts and are often squeezed between them. Other flakes occur within the skeletal garnet crystals but these are relatively rare. Also rare are biotite flakes in the amphibole-rich part of the rock.

The hornblende in the amphibole-rich part is pleochroic from brown to green and has a relatively low birefringence. It may be imperfectly crystalline due to incipient alteration to chlorite and clinozoisite. Some grains are somewhat patchy in colour and pleochroism. Grains are subhedral to anhedral and tend to be aligned around the garnet porphyroblasts in the same way as the biotite flakes.

The mineral tentatively identified as muscovite forms patches of high birefringence in grains of generally weak birefringence. The patches of high interference colour tend to be fibrous, foliated or irregularly prismatic. Some patches have a radiating structure. The host mineral is in places structureless but in places exhibits polysynthetic twinning and

appears to be a relict plagioclase. This suggests that, in some cases at least, the muscovite has developed as an alteration product of plagioclase. It is itself altered to kaolinite.

Irregular grains of unaltered plagioclase are a minor constituent of the dark rock, between the garnet porphyroblasts.

The other minor mineral component of the melanocratic facies is an opaque material, probably iron oxide, which occurs as rounded, lath-shaped and irregular grains included mainly in the garnet but also interstitially to the main phases of the fine-grained part of the rock.

A few fine-grained prisms of apatite are present as inclusions, mainly in quartz, in the finer-grained part of the rock.

Comment

The dioritic appearance of the rock is due more to the presence of biotite than to that of the minor amount of hornblende. The high biotite content and the presence of substantial microcline and quartz identifies the specimen as a granodiorite rather than a diorite.

5333 RS 13, TS C33138

Locality: Cape Adieu

Field observations: as for 5333 RS 12.

Rock name: Amphibolitic diorite with ?hypersthene.

Hand specimen: Most of the specimen consists of coarse-grained, dark green-brown crystals with a preferred orientation. White grains occur between the dark minerals and are occasionally concentrated in a leucocratic band.

Thin section

The major phases in the rock are quartz, plagioclase and hornblende but a most significant minor phase is a pyroxene resembling hypersthene in most respects. Variations in mineral abundances have produced a banding which is probably magmatic rather than metamorphic in origin.

Quartz is most abundant in the light coloured band where it occurs as large, irregular, interstitial grains. Where the quartz has penetrated grain boundaries of other phases, the boundaries are often lobate, suggesting emplacement of the quartz by corrosion of earlier minerals. Small, rounded inclusions of quartz in other minerals are either an early stage in the replacement, or they may represent lobate extensions of quartz grains originally above or below the plane of section. The quartz retains the patchy and undulose extinction which is symptomatic of unrelieved stress. In the amphibole-rich part of the specimen the quartz is restricted to small rounded inclusions or irregular interstitial grains with lobate margins.

Plagioclase compositions, based on maximum symmetrical extinction angles, are consistent throughout the specimen and fall into the sodium-rich end of the labradorite range. This is unlikely to be the original plagioclase of the rock, on the evidence of quartz introduction and the replacement of pyroxene by amphibole. Texturally the plagioclase forms a closely-interlocked mosaic of large, irregular grains in the light coloured band and consists of finer interstitial grains in the dark, amphibole-rich zone.

The amphibole is a hornblende, pleochroic from dark olive green to pale yellow-brown. In the dark zone hornblende occurs as closely-interlocking crystals, some almost euhedral in shape

and others irregular and interstitial both to other hornblende grains and to plagioclase. One relatively rare but significant mode of occurrence of hornblende is as fine replacement patches, euhedral to irregular in shape in large ophitic plates of pyroxene. In the light-coloured band the amphibole occurs as large irregular grains that are interstitial to plagioclase.

Pyroxene occurs as large, irregular crystals in the light band and as large ophitic plates in the dark zone. It is much less common than amphibole in the latter zone but of similar abundance in the former band. The pyroxene has a distinctive green to pink-brown pleochroism and in some sections displays fine repeated schiller planes. These features are diagnostic of hypersthene. However, the mineral is optically positive, the birefringence is somewhat high for hypersthene and in some sections it displays oblique extinction. It is probably a "clinohypersthene" which has a positive sign and a higher birefringence than orthorhombic hypersthene. The occurrence of this mineral with rounded to euhedral hornblende inclusions raises the possibility that the amphibole in this situation is replacing the pyroxene and, by extension, that all the original ferromagnesian component of the rock may have been pyroxene rather than amphibole.

The only other mineral present is opaque and occurs as round grains and irregular interstitial patches. Some grains are red-brown and translucent under condensed illumination and are demonstrably iron oxide. The remaining material is probably of the same composition.

Comment

Identification of the specimen as a diorite is based on the intermediate plagioclase and abundant hornblende. The abundance of the amphibole is sufficient to justify the term 'amphibolite' for the dark part of the specimen.

However, there has been a demonstrable introduction of quartz and a suggestion that the amphibole is, at least in part, the product of alteration of pyroxene. The plagioclase may have originally been more calcium-rich. The possibility that the original composition of the rock may have been that of a hypersthene gabbro (rather than a norite if the pyroxene is a clinohypersthene) is canvassed because of the significance of its economic implications. The rock is apparently differentiated by gravity stratification and is a potential host for nickel, copper, chromium and platinoid concentrations.

5433 RS 6, TS C33139

Locality: Point Sinclair

Field observations: Greyish granite; massive to a very weak biotite foliation. Aggregates (up to 10 mm) of muscovite, biotite, quartz and garnet are common.

Rock name: Microcline granite

Hand specimen: The specimen is a coarse, even grained and massive granite with a faintly brown feldspar.

Thin section:

The rock contains quartz, microcline, muscovite, a little plagioclase, a few flakes of biotite and a few fine opaque grains. There are two grains of garnet in the thin section.

Quartz occurs as large, irregular grains which are interstitial to the other phases. The quartz shows little sign of post-consolidation deformation and smaller grains are almost completely strain-free.

Microcline is the most abundant phase present. It displays well-developed twinning and is almost free of alteration. It is slightly perthitic in places and occasionally shows a marginal myrmekite when in contact with plagioclase. These contacts are often embayed and rounded inclusions of plagioclase remain within microcline.

Muscovite occurs as large, irregular flakes which are fresh but are marginally corroded by both quartz and microcline. There is no apparent preferred orientation in the muscovite flakes.

Plagioclase is much less abundant than microcline and differs from it in that it is altered to a fine-grained felt of sericite. Originally it formed an interlocked mosaic of moderately well-shaped laths. Alteration and corrosion has changed this into isolated groups of irregular grains.

Biotite occurs as relatively fine-grained flakes usually grouped with muscovite flakes. In some cases a single mica flake consists of two micas but there is no textural evidence as to whether one mica is replacing the other or whether they were crystallised together in stable equilibrium.

Opaque material, probably iron oxide, occurs as rare, scattered, fine, rounded to cubic grains and irregular patches associated with biotite and one of the grains of garnet.

The two irregular grains of garnet are relatively close together, associated with biotite flakes and of a brown rather than a pink colour. One grain is associated with opaque oxide patches.

Comment

The granite is potash-rich, probably due to the introduction of a late magmatic eutectic of quartz and microcline, and incorporates biotite and garnet, probably from metamorphic country rock. Muscovite was atypically a relatively early magmatic phase.

5533 RS 70, TSC 33140

Locality: Point Peter

Field observations: Massive leucocratic porphyry.

Rock name: Silicified microcline alkali granite.

Hand specimen: The rock consists of coarse poorly-defined crystals of quartz and a brownish white felspar.

Thin section:

Under magnification the specimen is seen to consist of two main minerals, microcline and quartz, and three minor minerals, biotite, plagioclase and opaque oxides.

The microcline occurs as coarse crystals, the initial euhedral shape of which has been corroded by quartz replacement. Relict microcline is visible in areas of quartz granules as a discontinuous background in optical continuity. The microcline is coarsely perthitic, very lightly altered, well-twinned and slightly turbid due to finely-granular iron oxide.

Quartz is highly granulated and forms a chaotic mosaic between microcline crystals. Granules are very variable in size and irregular in shape with complex inter-granular sutures. A process of crystallisation, or recrystallisation, has been arrested at a point long before equilibrium has been

established. The quartz mosaic has penetrated grain boundaries of microcline crystals and in many places has invaded the microcline itself, mainly at the margins of crystals and along fractures.

Biotite occurs as occasional small inclusions in microcline but more commonly as ragged, irregular and altered flakes in the quartz mosaic between the microcline crystals.

Plagioclase occurs as small patches exsolved from the microcline. In some places it is restricted to irregular perthite patches but elsewhere it forms an almost continuous zone of exsolution at the margins of microcline grains.

Opaque oxides occur as small scattered grains and as irregular grains and patches associated with altered biotite. Some opaque material forms rhombic shapes and is probably pseudomorphic, possibly after sphene.

Comment

The specimen has been tentatively correlated with a pegmatite, 5533RS94, from the St Francis Isles. In the St Francis Isles rock, quartz and microcline are crystallised in equilibrium together as a graphic intergrowth which is typical of pegmatitic or very late magmatic conditions. The randomly-distributed, non-equilibrium crystallisation of silica also occurs in the St Francis Isles example but does not obscure the ultimate origin.

5533 RS 71, TSC 33141

Locality: Point Bell

Field observations: Principal rock types are foliated porphyritic adamellite (with tabular feldspars up to 2 cm) and foliated adamellite. Foliation and contact between the phases have been folded.

Rock name: Microcline granite

Hand specimen: The rock is coarse grained with quartz, biotite and a brownish white felspar. The texture is massive in the chip from which the section was cut.

Thin section:

The rock consists mainly of microcline and quartz with minor plagioclase, muscovite and biotite and accessory opaque oxide.

The microcline is partly present as crystals somewhat coarser in grain size than the average, but not coarse enough to justify the classification of porphyritic, and partly as a finer-grained constituent of the average part of the rock. In both cases the grain shapes are poor but there is very little alteration. Twinning is variable in development, some grains are virtually untwinned, and perthitic alteration occurs, also to a variable extent. Some of the microcline crystals contain irregular, largely resorbed inclusions of plagioclase and rounded inclusions of quartz. The microcline is also distinguished by a substantial development of myrmekite.

Quartz occurs as a mosaic of irregular and rather fractured grains and as round inclusions in other grains, including the longer quartz grains. A moderate amount of strain remains in the larger grains but the small grains are well-annealed.

Intergranular sutures are generally complex and the absence of regular triple junctions indicates that equilibrium has not been attained.

Plagioclase is much less abundant than microcline and occurs as irregular, rather strongly-altered grains which are closely crystallised with quartz and the finer-grained microcline.

The two micas occur as scattered, irregular flakes which show evidence of corrosion and, in the case of biotite, of alteration. The biotite displays a strong, but not perfect, preferred orientation. The muscovite is randomly oriented.

Iron oxide is present as a few scattered grains, often with a cubic outline, and irregular patches associated with altered biotite.

Comment

The dominance of potash feldspar over plagioclase identifies the rock as a granite. What appears to be a second generation of quartz has affected this specimen to a lesser extent than the specimen last described. However, the episode of silicification may be common to all the plutonic rocks of this Proterozoic province. The rock is weakly gneissic.

5533 RS 72, TSC 33142

Locality: Point Bell

Field observations: as for 5533 RS 71.

Rock Name: Gneissic granite.

Hand specimen: The only difference between this specimen and the last specimen described is that the feldspars are sharply outlined by a dark rim of quartz and micas.

Thin section:

The proportion of plagioclase relative to microcline is higher in this specimen than in specimen RS 71 and the mica content is higher. One grain of garnet is present. Apart from these differences the two rocks are virtually identical in mineralogy.

Texturally, a type of preferred orientation is imposed on the rock by the concentration of both micas into arcuate lines which appear in the hand specimen to outline coarse grains of feldspar. In thin section this is seen to be only approximately true. Quartz is also included in the areas outlined. The dark lines visible in hand specimen are seen in thin section to consist of fine-grained quartz and feldspar and a high concentration of myrmekite as well as the two micas.

Flakes of the two micas are closely interlocked in clusters with an alignment following the arcuate bands. The micas appear to be later than the quartz and feldspars.

The single crystal of garnet in the section is of a brown rather than pink colour, of a coarse grain size and of a good shape with euhedral crystal faces.

Comment

Much of the crystallisation of the rock was probably accomplished under non-directional hydrostatic pressure. The crystallisation of the micas, however, occurred under a regime of directed stress. The extent to which stress relieved by shearing was involved in the crystallisation of quartz is difficult to assess on petrographic evidence but it is reasonable to suppose that at least the quartz within the mica bands was stressed, probably to the point of shearing.

5533 RS 73, TSC 33143

Locality: Rocky Point

Field observations: Migmatitic gneisses with numerous xenoliths of diorites (RS 73).

Rock name: Amphibolite

Hand specimen: The dominant constituent is a dark ferromagnesious mineral with a strong preferred orientation. A vitreous mineral of neutral colour is the other main constituent.

Thin section:

The rock is almost a two-phase system composed of hornblende and plagioclase. Apart from alteration products of these two phases the other constituents are restricted to minor sphene apatite, quartz and opaque oxides.

The hornblende is strongly pleochroic from blue green through yellow green to yellow brown. It is mainly anhedral in shape although a few subhedral grains are present. Most grains are elongated with a preferred orientation which is planar rather than linear. The hornblende has undergone substantial alteration, mainly to a pleochroic chlorite with a low birefringence. The grey interference colour is blueish and the chlorite is probably of penninite type. A few patches of alteration consist of a colourless mineral with a high birefringence which is probably an epidote.

The plagioclase consists of a closely interlocking mosaic of irregular grains, interstitial to the hornblende, of varying grain size and with a high degree of alteration. Most grains are completely covered by a fine-grained felt of saussuritic alteration but a few are only partly altered.

Sphene occurs as subhedral to anhedral grains either included in hornblende or closely associated with clusters of hornblende crystals. The sphene is pleochroic from pale yellow brown to darker, slightly reddish brown. It is relatively coarse-grained.

Apatite occurs as fine prismatic crystals included within altered plagioclase.

Quartz is very rare and consists of occasional irregular inclusions and interstitial grains.

Opaque grains, probably iron oxides, are more common and occur as patches which are closely associated with, or included in, hornblende crystals.

Comment

The restricted mineralogy, in particular the almost complete absence of quartz, suggests that the amphibolite originated by alteration of a basic igneous rock, probably basalt or dolerite. It is very unlikely to have been derived from a sedimentary parent. An origin as a primary dioritic or amphibolitic magma is possible but the presence of sphene and apatite usually indicates alteration from a more calcium-rich parent rock.

5533 RS 74, TSC 33144

Locality: Rocky Point

Field observations: Migmatitic gneisses vary from pinkish fine-grained gneisses (RS 74) to grey granodiorite gneisses (RS 75) to granitic geisses (RS 76).

Rock name: Microgranite

Hand specimen: The rock is moderately fine grained and consists of red and white felspar, quartz and biotite.

Thin section:

The rock consists of a closely interlocking mosaic of quartz, microcline and plagioclase, with minor biotite and iron oxide. Intergranular sutures are for the most part highly complex.

The quartz is very clearly shown to comprise two generations as one type is slightly turbid and the other is clean and forms rounded inclusions in the first type. The older quartz is closely interlocked with felspar along complex grain boundaries and forms irregular crystals of a size comparable with that of the felspars. The younger quartz is superimposed on the interlocked mosaic as rounded to irregular inclusions in the two felspars as well as the older quartz.

Microcline is somewhat more abundant than plagioclase and occurs as irregular, interstitial grains. The mineral is completely fresh.

Plagioclase is almost completely without alteration. It also forms a mosaic with complex intergranular margins for the most part but in a few examples groups of plagioclase grains meet along simple boundaries.

Biotite occurs as fine-grained, well-shaped to poorly-shaped flakes without any obvious preferred orientation.

Opaque grains of presumed iron oxide are either fine dispersed crystals or larger, irregular patches.

One very fine-grained, well-shaped prism of zircon is present.

Comment

Any origin for the rock other than magmatic appears unlikely but the precise nature of the intrusion would be difficult to define. The rock has been subject to a recrystallisation which

has not gone to equilibrium and to a late silicification. It is possible that some of the microcline is of later date than some of the plagioclase. The rock may originally have been an aplite.

5533 RS 75, TSC 33145

Locality: Rocky Point

Field observations: as for 5533 RS 74.

Rock name: Gneissic granodiorite

Hand specimen: The specimen is a medium to coarse-grained rock with a gneissic foliation marked by biotite-rich and feldspar-rich bands.

Thin section:

Both plagioclase and quartz are of coarse grain size in this rock. The much less abundant microcline tends to be finer in grain size. Minor hornblende and biotite are present, together with accessory sphene, apatite and opaque iron oxide.

Plagioclase occurs as large, irregular and highly corroded crystals as well as smaller, better-shaped grains which fit together along simple, often straight, margins sometimes meeting in 120° triple junctions. Patches of alteration are present in most grains and vary considerably in intensity.

Myrmekite also occurs frequently in rounded to irregular patches in plagioclase.

Quartz occurs as extremely large areas of coarse, irregular grains which are fractured and sometimes strained. It also occurs as fine, rounded and irregular inclusions in plagioclase and older quartz.

Microcline is present as relatively small, interstitial, highly irregular crystals. The mineral is entirely fresh and unaltered, but contains small, rounded inclusions of quartz.

Hornblende grains are generally of poor shape and occur in clusters, often with the more abundant biotite. The clusters tend to be preferentially aligned.

Biotite flakes also occur in clusters with a preferred orientation. They are generally of moderately good shape and are more abundant than the hornblende.

Sphene occurs as rounded to irregular grains, generally associated with the clusters of biotite and hornblende.

Fine prisms of apatite have the same association and often occur as inclusions in biotite flakes.

Opaque oxide material occurs in fine and coarse irregular patches, concentrated in the bands of ferrogmagnesium minerals.

Comment

There is barely enough microcline in the sample to justify the classification of granodiorite and it is partly on the high quartz content that the identification is based. The rather limited extent of the directional fabric suggests that the term "gneissic granodiorite" is preferable to that of "granodiorite gneiss". If the outcrop has the appearance of a well-banded and foliated rock, which the thin section lacks, the latter term may be justified.

5533 RS 76, TSC 33146

Locality: Rocky Point

Field observations: as for 5533 RS 74.

Rock name: Granodioritic gneiss

Hand specimen: Specimen RS 76 has a more strongly marked preferred orientation than RS 75, largely because it is finer grained and the biotite is more evenly distributed. Compositionally the two rocks appear to be identical.

Thin section

In thin section it is apparent that the directional fabric is due as much to quartz as to biotite. Quartz-rich bands are more regularly concentrated than in RS 75 and are more clearly the product of metamorphic seggregation. The grain size of the quartz and both felspars is more even than in the specimen last described, which enhances the foliated appearance by producing more regular banding.

The impression from the hand specimen that the biotite is finer-grained than in RS 75 is re-inforced in thin section but a difference in composition is apparent. There is no hornblende, sphene or apatite in specimen RS 76.

In other respects there appears to be no significant difference between the two specimens RS 75 and RS 76.

Comment

Despite a more markedly foliated appearance, specimen RS 76 is no more severely metamorphosed than RS 75. The apparent difference is due to a more even grain size which has produced a more regular preferred orientation in quartz and biotite.

5533 RS 77, TSC 33147

Locality: Rocky Point

Field observations: Pinkish granite, weak foliation, contains xenoliths of diorites, pegmatites and gneisses (as above RS 73-76).

Rock name: Microcline granite

Hand specimen: The rock is even-grained and of a coarse grain size. It contains quartz, a pink feldspar and biotite and has a weak preferred orientation.

Thin section

Quartz and microcline are by far the most abundant constituents of the rock. Plagioclase and biotite are minor phases and there is accessory sphene and opaque oxides with very rare hornblende.

The quartz occurs both as coarse-grained, interlocking crystals and as fine, rounded inclusions in both felspars. The quartz appears to be of a single generation in this specimen and even coarse grains often have a corrosive relationship towards adjacent minerals.

The microcline is coarsely perthitic. In some cases, patches of exsolved plagioclase amount to half the felspar grain. In other grains a coarse vein perthite grades into patches of irregular exsolution. Microcline grains are interstitial in habit. They are virtually unaltered.

Plagioclase is restricted to fine grains of irregular shape. The shape is largely produced by embayment from quartz and, in many cases, by microcline. In many instances the plagioclase consists of relict inclusions in quartz and microcline grains. Some plagioclase is very lightly altered but most grains are without appreciable alteration.

Biotite flakes are not abundant, are ragged and irregular in shape and are often altered.

Fine grains of sphene and patches of opaque oxide material are closely associated with each other and with clusters of altering biotitic flakes.

Hornblende is present as very rare, ragged and irregular fine grains.

Comment

The rock is a potash-rich member of the calc-alkali suite which makes up most of the outcrop at Rocky Point. Rocks in the suite differ both in composition and in metamorphic texture but passes an overall similarity, apart from the xenolithic amphibolite of RS 73.

5533 RS 89, TSC 35553

Locality: Rocky Point

Field observations: Agmatite; Grey, mafic-rich granodiorite-diorite (RS 90) with abundant diorite xenoliths (RS 89).

Rock name: Amphibolite

Hand specimen: The rock is dark and fine-grained with occasional coarser, light-coloured feldspars.

Thin section:

Specimen RS 89 is a less-altered version of RS 73. It consists almost entirely of hornblende and plagioclase with frequent grains of iron oxide and rarer biotite and apatite. There is no obvious directional texture.

The hornblende in this specimen is similar, but somewhat less altered, than that of specimen RS 73. It is pleochroic from blue-green through yellow-green to yellow-brown. Chlorite alteration is present but not widespread. Birefringence tends to be higher than for the hornblende in RS 73 and occasional colourless patches with a high birefringence in green hornblende grains may be relict tremolite.

The plagioclase, in contrast to that of RS 73, carries only a light alteration apart from a few grains. Many grains are completely fresh. Maximum symmetrical extinction angles give a composition within the andesite range but immersion in a granitic

host has probably resulted in a change towards compositional equilibrium with dioritic plagioclase. The presence of apatite inclusions suggests the rejection of calcium.

Iron oxide is abundant as irregular patches, often as coarse in grain size as the hornblende.

Biotite occurs as rather whispy flakes in clusters of hornblende crystals, and may be a product of reaction between hornblende and a dioritic host rock.

Apatite occurs as fine-grained, rounded prims included in plagioclase and, less commonly, in hornblende grains.

Comment

Examination of this rock adds evidence to the identification of RS 73. The plagioclase as well as the ferromagnesium mineral is of intermediate composition. The suggestion that it was originally of basic composition is still largely conjectural but the presence of biotite and apatite and the possible presence of relict tremolite supports a reaction between basic material and a granitic magma.

5533 RS 90, TSC 35554

Locality: Rocky Point

Field observations: as for 5533 RS 89.

Rock name: Diorite

Hand specimen: The rock is coarse-grained and consists of feldspar, quartz and ferromagnesian minerals which are mainly brownish black but include greenish black grains.

Thin section:

The rock consists mainly of plagioclase, quartz and biotite with minor hornblende. Opaque oxide is present but not abundant and there are a few grains of zircon and apatite.

No potash feldspar was recognised. The plagioclase includes large, euhedral to subhedral grains which are usually zoned and smaller, anhedral, closely interlocked grains. A light alteration occurs in scattered grains. Maximum symmetrical extinction angles suggest the composition of a sodic andesine.

Quartz forms large, irregular grains with margins which penetrate the contacts of other mineral grains.

The embayed and ragged margins of some minerals adjacent to quartz grains suggest a replacive relationship. Some quartz grains enclose corroded fragments of other minerals. Quartz also occurs as round and irregular inclusions in other minerals, more often those adjacent to larger quartz masses.

Biotite occurs as coarse, irregular grains with a random orientation. The mineral is little altered and exhibits a clear pleochroism from dark brown through pinkish brown to a pale straw yellow.

Occasional grains of hornblende occur within clusters of biotite flakes. The hornblende grains are poorly shaped and sometimes skeletal.

Irregular grains of opaque oxides are usually found as inclusions in biotite flakes or within clusters of biotite flakes.

Round to irregular grains of zircon and apatite occur as inclusions in biotite flakes.

Comment

The dioritic composition of the host rock may be a result of assimilation of basic xenoliths by a more granitic magma but petrographic evidence does not permit a conclusion on this matter.

5533 RS 91, TSC 35555

Locality: Rocky Point

Field observations: as for 5533 RS 89.

Rock name: Xenolithic diorite

Hand specimen: The host rock consists of quartz, light brownish feldspar and dark ferromagnesian minerals. The xenolith consists almost entirely of dark minerals.

Thin section

The specimen combines the host rock and the amphibolitic xenolith which have been examined separately in specimens (RS 89 and RS 90) described earlier. The presence of the margin of the xenolith in the section permits examination of the changes taking place across the margins.

Little change is identificable in the plagioclase since equilibrium appears to have been reached in the marginal xenolith and marginal diorite.

A change in the ferromagnesian minerals may be followed from dominant hornblende and subordinate biotite in the xenolith to the contrary situation in the host rock. The only half-way stage, since there is no phase intermediate between hornblende and biotite, is shown by grains which are part hornblende and part biotite. Otherwise the change is marked by an increase in grains of one mineral relative to the other.

As far as quartz is concerned, visual estimates suggest that the mineral is more abundant in the host rock than the xenolith but grain size differences introduce a subjective factor and point counting would be necessary to establish a quantitative relationship.

Opaque oxides appear to diminish from xenolith to host rock but the same considerations apply.

Accessories such as zircon and apatite do not appear to differ significantly in host rock and xenolith but are too rare to furnish a statistically reliable sample.

Comment

The question of whether the assimilation of xenolithic material has converted a granitic magma to a diorite still remains open. On petrographic examination the conversion of hornblende to biotite is evident and must have absorbed a considerable amount of potassium. It may be suggested that this has involved the depletion of potential potash feldspar but only its absence is observable in thin section. A chemical investigation might be instructive.

5533 RS 78, TSC 33148

Locality: Point James

Field observations: Massive adamellite containing abundant pink feldspar phenocrysts (RS 78) varying to pinkish adamellite with quartz phenocrysts (RS 79).

Rock name: Microcline granite

Hand specimen: The specimen is a coarse-grained granitic rock with lage pink porphyritic feldspars. No preferred orientation is apparent.

Thin section

In the section the potash feldspar is abundant enough to justify the classification of "granite" but this may not apply to the whole outcrop. Both potash feldspar and plagioclase are very coarse grained and a single thin section does not constitute a representative sample. The rock consists of two feldspars and quartz with minor muscovite, biotite altered to a chlorite, and accessory garnet.

The microcline is anhedral, very coarse-grained, strongly twinned, coarsely perthitic and only lightly altered. Microcline grains contain corroded fragments of plagioclase and muscovite but is invaded along fractures by quartz which also forms marginal embayments and rounded inclusions in the feldspar.

Plagioclase is also coarse grained but is altered to a fine felt of prismatic to irregular minerals and scattered irregular, fine to medium grained flakes of a pale mica. Plagioclase grains tend to be better shaped than those of microcline, mainly forming subhedral laths.

Quartz occurs as coarse mosaics of fractured and strained crystals, often with margins showing evidence of a corrosive relationship to adjacent minerals, including microcline. Quartz also occurs as rounded to irregular inclusions and small interstitial grains. There is no clear evidence of two generations of quartz.

The mica present is a pale, almost colourless muscovite but it is closely interlocked with a strongly pleochroic chlorite of low birefringence. The pleochroism ranges from a blue green to a biotite brown through a pale greyish, almost neutral colour. In places it is seen to be an alteration product of biotite.

Garnet is not common and occurs in the thin section as two medium sized, very fractured and fragmentary anhedral grains.

Comment

The specimen is a calc-alkali granite which has incorporated some metamorphic material. Microcline and quartz make up a low temperature eutectic replacing earlier minerals.

5533 RS 79, TSC 33149

Locality: Point James

Field observations: as for 5533 RS 78.

Rock name: Adamellite

Hand specimen: The specimen is a pale beige-coloured, granitic rock containing quartz, a pink feldspar and a white feldspar. Grain size appears coarse to medium without porphyritic crystals. There is no apparent preferred orientation.

Thin section:

The rock consists of quartz, microcline and plagioclase, in about equal proportions, a little muscovite and a larger proportion of garnet than was present in specimen RS 78. Some opaque oxide is present.

The coarse quartz grains are less abundant in the thin section of this specimen than in the section of RS 78. The amount of fine grained quartz is greater, however, and the total is probably similar. The same kind of corrosive textures are evident in specimen RS 79 as were displayed in RS 78.

Some of the microcline is fine grained in this specimen but, apart from this, the two feldspars are similar in both specimens.

Muscovite is less abundant in this specimen than in RS 78 and the chloritic alteration is much rarer.

The garnet is a more intense pink brown colour, is much more widely distributed and is finer-grained than in RS 78. It is less fragmentary and is somewhat better shaped than in RS 78.

The opaque material, which was absent from RS 78, is associated with garnet and mica in RS 79, as irregular patches and grains.

Comment

The specimen represents a slightly more calcium rich facies of the granitic suite and has incorporated a greater proportion of metamorphic material. The two factors are probably related.

5533 RS 80, TSC 33150

Locality: Point James

Field observations: Pink, well-banded, fine-grained granitoid, gradational contact with a pink porphyry (RS 82 & 84). 1 m wide - ?chilled margin.

Rock name: Microgranite

Hand specimen: The specimen is a fine-grained, pink coloured, foliated rock with occasional quartz veins along the foliation.

Thin section:

The rock is essentially a roughly equigranular mosaic of plagioclase and quartz with less abundant microcline and minor mica and opaque oxide. A little accessory apatite is present.

The plagioclase grains are tightly interlocked but with roughly equidimensional, often rounded shapes. The plagioclase is not strongly twinned and is lightly altered.

Quartz grains are abundantly distributed throughout the mosaic and often are almost perfectly spherical. The foliation of the rock is due to trains of quartz grains.

Microcline tends to be less rounded and somewhat coarser in grain size. It is more distinctly twinned than the plagioclase and less altered. It is sparsely, though widely distributed throughout the rock.

Ragged and fragmented mica is brown to yellow in colour but this is due to chloritic alteration, not to a biotite composition. Pleochroism is weak to absent. The foliation of quartz grains is not related to mica which has no apparent preferred orientation.

Rounded to irregular opaque oxide grains are scattered throughout the rock with no apparent regularity of disposition or of orientation.

Apatite occurs as a few fine grained prisms included in plagioclase.

A vein cuts the section diagonally and contains relatively coarse grained quartz, microcline and muscovite.

Comment

The rock is compositionally similar to RS 79 but its finer grained texture could be ascribed to rapid cooling in either a marginal zone or in a minor intrusive, or to tectonic granulation and annealing. If the latter is the case the specimen may be more akin to RS 82. The foliation would be due to flow lines in the former case and to post-consolidation stress in the latter. Field evidence may be more effective than petrographic evidence in determining this question.

5533 RS 81, TSC 33151

Locality: Point James

Field observations: Pink, banded granitoid (RS 80) grades (away from porphyry) to white, grey and black banded, fine-grained granitoid (1 m wide).

Rock name: Microgranite

Hand specimen: Grain boundaries are poorly defined and only the mica is seen to be fine grained at one end of the specimen. The other end appears to be coarse grained with mica-rich bands.

Thin section:

The composition of this rock is essentially similar to that of RS 80. The appearance of coarser-grain in part of the hand specimen is belied by the thin section. There is no systematic variation from one end of the section to another but scattered patches and bands of coarser-grain are distributed within a rock of mainly fine grain. The overall grainsize of the plagioclase-quartz mosaic is somewhat finer than that of RS 80 and microcline tends to stand out more in a relatively coarser grain size.

Both plagioclase and mica are less altered in RS 81 than in RS 80 and the mica is partly a biotite. The dark bands visible in hand specimen are composed of lenticular concentrations of mica including both muscovite and biotite. The fine dark grains seen in hand specimen are small grains of biotite with a strong preferred orientation.

A small quartz-muscovite vein cuts a corner of the specimen.

Comment

The presence of biotite is the only significant difference from RS 80. The origin of the rock is little clearer but a metamorphic origin is possibly more strongly supported by the evidence of this specimen.

5533 RS 82, TSC 33152

Locality: Point James

Field observations: Pink porphyry with abundant (greater than 50%) feldspar phenocrystsl.

Rock name ?Porphyry. ?Brecciated and recrystallised granitoid.

Hand specimen: Pink and white feldspar crystals several milimetres long are contained in a grey fine-grained groundmass. The feldspars are rounded and several are pink in the centre and white around the margins.

Thin section:

The nature of the rock is hard to determine since the porphyritic crystals are of plutonic type but the groundmass consists of fine grained quartz, plagioclase and microcline.

The feldspar of the porphyritic grains includes both microcline and plagioclase with the latter the more abundant. The microcline is coarsely perthitic and the plagioclase, including that exsolved in perthite, is heavily altered with both coarse and fine-grained alteration products. The feldspars are identical to those in the undoubtedly plutonic rocks of the suite. The probability that the porphyritic crystals are of plutonic origin is increased by the presence of coarse grains consisting of more than one crystal and in some cases more than one phase. Some grains which appear in hand specimen as phenocrysts are seen in thin section to be fragments of granitic rock.

The few porphyritic quartz grains are mainly compound. As is the case with the coarse feldspars, the large quartz grains are invaded along grain boundaries and along fractures by the fine grained material which makes up the groundmass of the rock.

This material, which would be called the groundmass if the rock were a volcanic or hypabyssal type, consists of fine grained quartz and two feldspars in a tightly interlocked mass of rounded grains. The material is undoubtedly the product of recrystallisation and the process has proceeded far enough to conceal completely the original material which has been

recrystallised. The main reason for suggesting that the original material was not the microcrystalline or glassy groundmass of a lava or minor intrusive is that the recrystallisation has proceeded further than what might originally have been groundmass. The cause of the rounding of porphyritic grains which is visible in hand specimen is due to marginal replacement by the fine-grained facies which goes beyond the corrosive embayment of phenocrysts typical of hypabyssal intrusives and some lavas. The replacement has proceeded inwards along fractures and grain boundaries to the extent that parts of coarse grains have been physically separated but remain in optical continuity. Invasion of the main body of a coarse crystal has taken place not just by coherent masses of fine grains, as might be the result of replacement by a magmatic melt, but in places by individual scattered grains such as might be produced by a fluid pervading the whole mass of rock under high temperature and confining pressure.

Other minerals present are a pale and highly-altered mica, which occurs as tattered flakes and clusters of flakes, and rounded to poorly defined grains and patches of opaque and semi-opaque material which are probably iron and titanium oxides.

Comment

Evidence has been described that suggests the specimen may not be from a minor intrusive or lava flow as the hand specimen might lead one to suppose. An alternative explanation of the textures, and of the similarity in the coarser grains to the suite of plutonic rocks already described, is that the specimen is in fact of plutonic origin. It may then have been subjected to replacement by a fine grained granitic material which may be recrystallised from the original rock. The environment and mode

of occurrence which is supposed by this explanation is one of shearing which brecciated the plutonic rock. Fluid pervading the shear zone effected a recrystallisation of the finely granulated material and, to a lesser extent, of the coarser fragments. If this is so, the interval sampled at Point James is a traverse across a substantial shear zone. Fine-grained recrystallisation has frequently been encountered in the specimens examined from this area and may indicate considerable crustal rupture in the coastal zone. It is not inconceivable that this may be related to the opening of the Southern Ocean.

This is significant not only to the tectonics of the area but also to the dating of the samples. Isotopic clocks would have been reset in the recrystallised material, particularly if the chosen method is by potassium:argon ratios, and the dating would be a compromise between the 1500 Ma expected and the 55 Ma which is the date of the separation of Australia from Antarctica.

5533 RS 83, TSC 33152

Locality: Point James

Field observations: Yellowish, medium-grained granite with numerous aligned biotite-rich xenoliths. Relationship to other phases (RS 78-84) not known.

Rock name: Intermediate xenolith in granitoid host.

Hand specimen: A dark, medium-grained xenolith with rounded margins is included in a pale brown granitic rock. The xenolith contains poorly-defined, porphyroblastic feldspars.

Thin section:

Little of the host rock is represented in the section but from the portion available it is a quartz diorite with a little microcline.

The quartz occurs as a coarse grained mosaic with simple grain margins and frequent 120° triple junctions.

Plagioclase occurs as coarse, subhedral, strongly zoned and relatively fresh grains.

The small amount of microcline present occurs as fine, irregular, interstitial grains.

The main constituents of the xenolith are plagioclase, biotite and quartz. Minor constituents are opaque minerals and apatite.

The plagioclase occurs both as medium-grained subhedral to anhedral crystals which are a major constituent and coarse, rounded crystals which are probably porphyroblasts. The latter crystals are strongly zoned and contain inclusions of biotite. The outer zone of the porphyroblasts is often divided off by a zone just in from the margin which is crowded with fine inclusions and in some cases appears to be strongly different in composition from the main parts of the grain each side of it. Twinning is not well enough developed for optical determination of composition.

Biotite is abundant as medium-grained, irregular but fresh flakes, mainly in clusters, without any marked preferred orientation.

Quartz occurs in the xenolith as small, irregular, interstitial grains and patches. It is more strongly developed in zones near the margins of the xenolith.

Opaque material, probably oxides, is widely distributed as irregular grains and patches, often associated with biotite.

Apatite occurs as fine to medium grained prisms included in plagioclase.

Comment

The specimen provides another example of reciprocal reaction between a xenolith, probably of basic origin, and a granitoid.

5533 RS 84, TSC 33154

Locality: Point James

Field observations: Pink porphyry - see also 5533 RS 82.

Rock name: Recrystallised granitoid

Hand specimen: The specimen is a paler pink colour than RS 82 but is essentially similar, with rounded porphyritic grains in a finer-grained groundmass.

Thin section

The rock is almost identical to specimen RS 70 from Point Peter. Coarse microcline crytals are separated by a fine-grained mosaic of recrystallised quartz and feldspar and relicts of partly replaced microcline. One coarse grain of plagioclase and a very little altered mica and opaque oxide are present.

The microcline is a vein perthite and is almost without alteration. Crystals are rounded and partly replaced along fractures and internally by the finer grained material. Carlsbad twins are relatively common and cross-hatched twinning is comparatively weakly developed.

Quartz occurs as part of the recrystallised material between the porphyritic grains. Recrystallisation has proceeded further than in RS 82 and part of the quartz has formed relatively coarse mosaics with simple intergranular sutures and triple junctions which often approach 120°. Where the quartz has invaded the margins of coarse microcline crystals, the shape and disposition

of quartz inclusions are sometimes regular enough to approach the texture of graphic granite. In this case the texture is apparently not indicative of a pegmatitic origin unless there are two generations of quartz.

Plagioclase occurs occasionally in the mosaic of recrystallised grains and as a single porphyritic crystal. In the latter case it is euhedral, zoned, coarsely antiperthitic with exsolved microcline and almost untwinned.

The margin of the grain may be a poorly-twinned microcline.

Ragged flakes of a non-pleochroic and highly-altered mica and irregular grains of opaque oxide are sparsely distributed in the rock.

Comment

The concentration of potash feldspar and quartz suggests a late stage granitic eutectic, if not necessarily a pegmatite. The coarser grain of the "ground mass" underlines the progressive nature of the process and supports the suggestion that it is a replacement recrystallisation.

5533 RS 92, TSC 35556

Locality: Dog Island

Field observations: Coarse-grained granite containing bluish quartz and feldspar phenocyrsts (up to 10 mm).

Rock name: Microcline adamellite

Hand specimen: The rock is a coarse grained granitoid with quartz, a pink felspar and a white felspar.

Thin section:

The rock consists of quartz, microcline and plagioclase in about equal proportions with a minor proportion of highly altered mica and a little opaque oxide.

The quartz exhibits evidence of a strongly corrosive relationship with all other minerals. There is some evidence that there are two generations of quartz and that one is corrosive to the other. Some quartz occurs as a mosaic in which grains meet along simple grain boundaries and triple points are close to 120°. Other quartz extends along and between grain boundaries, embays adjacent grains and meets along complex grain boundaries. Round inclusions of quartz in other minerals sometimes extinguish in continuity with interstitial quartz outside the mineral grains.

Microcline grains are highly irregular in shape and interstitial in habit. The microcline is perthitic, slightly turbid and some has little or no twinning.

Plagioclase grains tend to be better shaped than microcline grains and are much more strongly altered. Alteration is often rather patchy and includes well-shaped flakes of highly birefringent muscovite as well as areas of formless felt. Crystals are often strongly zoned.

The mica is strongly altered to a green and brown pleochroic chlorite and to epidote which is included within the chlorite pseudomorph. From traces which remain it seems that the original mica was, at least in part, biotite rather than muscovite but the evidence is not certain.

Irregular patches of opaque iron oxide are distributed sparsely throughout the rock.

Comment

The adamellite is neither garnet-bearing nor myrmekitic. If these characteristics are diagnostic of affinity, the rock may not be related to any of the granitoids from the mainland which have been described above.

5533 RS 93, TSC 35557

Locality: Egg Island

Field observations: 3 m wide dyke of grey, fine-grained ?granite - in turn intruded by white aplites.

Rock name: Myrmekite rock

Hand specimen: The rock is dark in colour with occasinal poorly-defined lighter patches. No structures, including grain boundaries, are visible in hand specimen.

Thin section:

By far the most abundant constituent of the rock is myrmekite. Quartz and two feldspars occur in irregular patches. A few fragmentary grains of sphene and ragged flakes of biotite are present, with trains of fine opaque oxide grains giving a directional texture to the rock.

The myrmekite is intergrown in lobate patches with no obvious preferred orientation. In other specimens the myrmekite has formed at the margins of plagioclase grains but in this specimen the vermiform intergrowths of plagioclase and quartz occur as a mass of almost continuous myrmekite.

The white patches consist of quartz or of quartz and one or both feldspars. Twinning is not well developed in the feldspars and the nature of a given grain is not always certain. The felspars are not altered but are partly obscured by a finely-granular exsolution of opaque oxides.

Sphene occurs as fragmentary grains with a patchy colouration. It is usually associated with fine, ragged grains of biotite.

The rounded grains of opaque oxide are concentrated in trains which run parallel across the specimen and give it a weakly oriented structure.

Comment

Myrmekitic intergrowths are usually taken as evidence of reaction and, on the evidence of the other specimens in this suite, apparently occurs where silica and microcline are reacting with a calcium-rich plagioclase. However, no suggestion can be made as to the origin of a vein-shaped body of myrmekite rock except that it possibly indicates the former presence of abundant calcium-rich plagioclase.

5532 RS 43, TSC 35558

Locality: West Island

Field observations: Off-white, poorly foliated granite - dominant and youngest rock type on the island.

Rock name: Alkali granite

Hand specimen: The rock is a coarse grained, leucocratic granite with a poorly defined foliation, outlined partly by quartz bands and partly by discontinuous stringers of dark minerals.

Thin section:

The major part of the rock is made up of an alkali feldspar which is coarsely perthitic. The areas of the two exsolved phases are approximately equal but it seems inappropriate to refer to the rock as an alkali adamellite. The feldspar is highly fractured but perfectly unaltered. Quartz has penetrated the fractures, in many cases to the extent of fragmenting the feldspar.

The material which separates the grains and grain fragments of the feldspar is a granular mosaic of variable grain size consisting mainly of quartz but with occasional grains of both microcline and plagioclase. Trends of granulation and recrystallisation within this material display a series of curved shear planes which together make up the poorly-defined foliation. There is evidence of renewed stress, possibly several episodes of granulation, in patches where quartz occurs as relatively coarse grains which are clearly grown by the annealing of finer grains, presumably granulated in an early episode, and which have again been stressed to the point of regranulation at grain boundaries. This has not removed the strain in the grains, which is shown up by undulose extinction. Other areas of quartz consist of fully-annealed grains with only a little residual strain. The feldspar in the intergranular mosaic consists mainly of fine fragments derived from the coarser grains of perthite but includes a few non-perthitic grains of plagioclase. These may have developed by recrystallisation within the intergranular mosaic but much of the plagioclase exsolved from the perthite consists of coarse patches of clean plagioclase at the margins of the coarse perthite.

The ferromagnesian mineral in this rock is sodium-rich. It is presently a riebeckite but may originally have been a pyroxene of aegerine-acmite type. The pleochroism is blue-green to brown and lacks the deep blue typical of riebeckite. The colour varies somewhat in a single grain, often with a blue rim round a green nucleus. This also is typical of aegerine-aegerine augite.

Sphene occurs, often in close proximity to the riebeckite, as coarse to fine, euhedral to anhedral grains. The sphene is a honey yellow colour without strong pleochroism.

Apatite is a rare constituent but is present as coarse subhedral prisms.

Fine grains of zircon occur in a cluster of sphene, iron oxide and riebeckite.

Opaque oxide occurs as irregular patches and stringers of fine grains associated with sphene and riebeckite.

Comment

The specimen is a distinctive granitoid not encountered at the other localities sampled.

5532 RS 44, TSC 35559

Locality: West Island

Field observations: Xenoliths of diorite within off-white granite (RS 43).

Rock name: Xenolith in alkali granite

Hand specimen: Much of the specimen is a pink coloured, quartz rich granitoid. The rest is a dark greenish black, finer grained rock.

Thin section:

The granitoid is a less-highly sheared facies of the alkali granite represented by RS 43. Quartz is less abundant and occurs in interstitial coarse grains rather than a mass of finely-granulated crystals. The sphene is orange coloured rather than yellow-brown and a green epidote is present. The only other difference between the two samples is a greater abundance of iron oxide in RS 44.

The xenolith consists largely of a blue-green to yellow brown pleochroic amphibole and a strongly altered plagioclase. Sphene, apatite and opaque iron oxide are common. Relict

pyroxene, probably diopside, is present as an inclusion in some amphibole grains.

The amphibole is the same as occurred as xenocrysts in RS 43. It is strongly pleochroic from blue-green through yellow-green to yellow-brown. Patchy colour is common. Birefringence varies from low first order, typical of riebeckite, to low second order, typical of hornblende. Occasional ragged inclusions in the amphibole are birefringent up to the top of second order. These inclusions are colourless to vary pale green and weakly pleochroic. A parallel cleavage is aligned with that of the host amphibole. The mineral is probably diopside and suggests that the rock was basic rather than intermediate in origin. Reaction with the alkali granite has converted the pyroxene to an amphibole and introduced sodium into its structure. The suggestion made from evidence in RS 43, that the pyroxene was originally aegerine, is made doubtfully valid by this evidence. The sodium appears more likely to have been introduced to the amphibole than to the original pyroxene.

The plagioclase is not identifiable and occurs as a formless mosaic enclosing the amphibole.

Sphene is abundant as poorly-shaped grains, often with a patchy colour including reddish tints.

Apatite is widely distributed as coarse to fine grained columns which are often broken and bent.

Abundant opaque iron oxides are often well-shaped grains.

Ragged and fragmentary grains of epidote are occasionally encountered.

Comment

Evidence from this specimen has clarified the origin of the alkali-rich amphibole encountered in RS 43. These minerals, together with sphene, apatite and probably iron oxide are xenocrysts derived from xenoliths which are now amphibolites but which were probably of basic origin. Reciprocal reaction has modified the composition of both xenolith and host rock.

5532 RS 45, TSC 35560

Locality. West Island

Field observations: Intrusive plugs and dykes (RS 45) within foliated augen gneisses (RS 47). Restricted to eastern side of the island.

Rock name: ?Aplite. ?Recrystallised granitoid

Hand specimen: The rock is fine grained and generally dark in colour. Towards one end of the specimen a series of pink bands becomes progressively more distinct.

Thin section: Almost the whole rock is composed of a closely-interlocking mosaic of irregular and poorly-defined grains of quartz and feldspar. The feldspar is in general poorly-twinned or entirely without twinning so that optical identification is uncertain.

A few ragged relicts of amphibole and biotite and a weakly pleochroic chlorite are the only ferromagnesian minerals present.

Accessory minerals consist of iron oxides and scattered fine grained apatite in well to poorly shaped grains.

At one end of the section relicts of coarse feldspar grains are partly covered by the fine grained minerals which make up most of the rock. This is the only evidence that the fine-grained mosaic may not be original to the rock.

Comment

The vein-like occurrence of this rock suggests that it is an aplite. Only at one end of the section is there evidence that the fine-grained texture is not only the product of recrystallisation but might have been imposed on a coarse-grained rock. The origin of this rock is not identifiable with confidence on the evidence from the thin section.

5532 RS 46, TSC 35561

Locality: West Island

Field observations: Mylonite zone developed within foliated augen gneisses.

Rock name: Mylonite

Hand specimen: The rock is similar in appearance to RS 96. It is dark and fine grained, with poorly-defined pink bands.

Thin section:

The rock is a clear example of microbrecciation or cataclastic metamorphism. The degree of granulation is more complete and less recrystallisation has taken place than in any of the rocks previously described. Grain sizes range between a few microns to relatively coarse, but highly rounded, fragments of perthitic feldspar.

Grain size variations in coherent bands are responsible for some of the colour banding of the hand specimen. Other, finer bands are due to concentrations of iron oxides in fine layers.

Comment

Evidence from this specimen has re-inforced the identification of previously described specimens as granulated, coarse-grained rocks. This specimen is compositionally almost identical to the orthoclase-bearing granite of RS 47 and its

comminution has not been concealed by recrystallisation as was the case with many specimens described above.

The cataclasis of specimen RS 46 may be the latest in a series and is of younger age than the latest recrystallisation.

5532 RS 47, TSC 35562

Locality: West Island

Field observations: Foliated augen gneisses; major rock type for eastern side of the island. Intruded by ?aplite plugs and dykes (RS 45), diorite dykes, mylonitised and intruded by off-white granite (RS 43).

Rock name: Foliated granite

Hand specimen: The rock consists of coarse rounded pink feldspar grains in a dark, finer grained quartz-rich mass. The specimen displays a preferred orientation.

Thin section:

The rock has been partially brecciated with subsequent resealing of the fragments by silicification and recrystallisation, the quartz has been concentrated into irregular bands, although lines of fractures extend at angles to the bands, and it is this that has imposed a gneissic texture on the rock.

Two types of feldspar are present. One type is strongly altered and consists of fractured and rounded coarse crystals which are probably plagioclase. Fragments occur in the fine grained mass.

The second type of feldspar is a finely-perthitic orthoclase. It occurs as coarse, fractured and fragmented grains as well as fine grains in the granulated part of the rock.

Ragged flakes of biotite and chlorite and irregular grains of a pale green to yellow amphibole make up the sparse ferromagnesian component of the rock. The minerals tend to be concentrated in irregular bands parallel to the foliation delineated by quartz.

Irregular grains and patches of opaque oxide material and rare grains of a rusty brown sphene are also found in the bands marked by ferromagnesian minerals.

Comment

This specimen is distinct from RS 43 and the other alkali granites not only because of its foliated texture but also because of its second felspar. In the latter respect it is similar to granitoids described from mainland localities.

5532 RS 48, TSC 35563

Locality: West Island

Field observations: Gneiss xenolith (RS 48) within foliated augen granite.

Rock name: Granulated alkali granite

Hand specimen: the specimen is coarse-grained and dark grey and medium brown with a banded texture.

Thin section:

The rock is both brecciated and granulated with some degree of recrystallisation. Bands of granulation have produced the foliated texture.

Quartz occurs as elongated masses with strong undulose extinction, often curved in shape. It also occurs as finely granulated bands in which recrystallisation is evident to varying extents.

The main feldspar is a perthitic microcline and occurs as large fractured and fragmented grains and as a jumble of finer fragments in the granulated bands.

Plagioclase occurs as coarsely-exsolved perthitic veins in the microcline and rarely as finer grains in the granulated bands.

A distinguishing feature of this specimen is the high abundance of sphene. Crystals are often euhedral, moderately pleochroic from a pale yellow-brown to a rosy brown and tend to be concentrated in irregular bands, along with abundant irregular patches of opaque oxide. Occasional crystals at an angle to the bands possibly post-date the granulating stress.

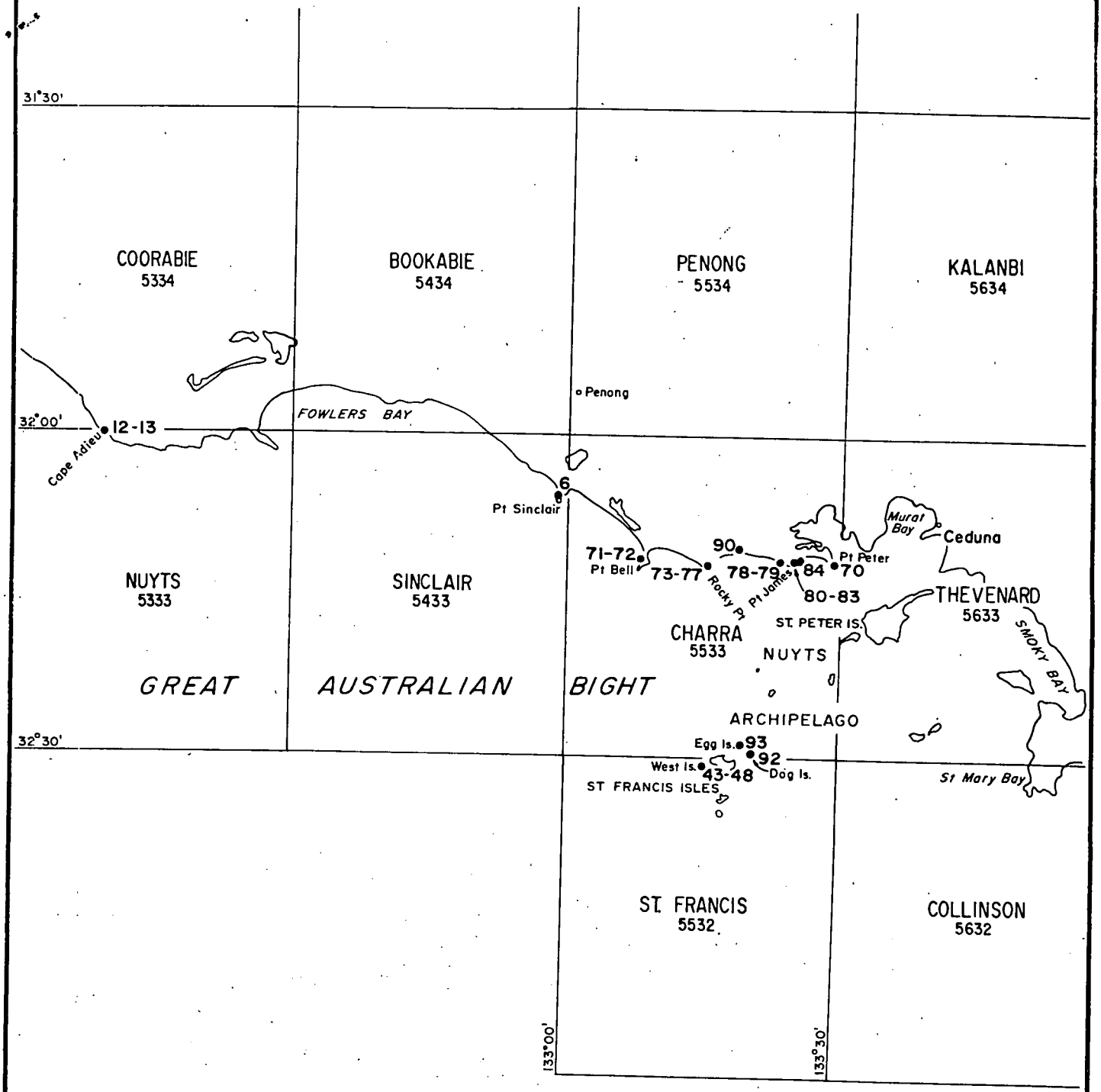
A pale and rather altered biotite occurs in low abundance in patches, usually associated with the sphene and iron oxide. A whispy chlorite is the alteration product of the mica.

Comment

The presence of this rock within the mass of the gneissic granitoid must be due to tectonic forces if, as appears the case, it is identical with the alkali granite of RS 43. The alkali granite contains xenoliths of an amphibolitised basic rock which intrudes the gneissic granitoid. This implies that the alkali granite is the younger.

MGF/GU

M.G. FARRAND



REFERENCE

Sample location and numbers . . . . . • 12-13

1:100,000 map reference . . . . . NUYTS 5333

SCALE IN KILOMETRES

0 10 20 30 40 50

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

COMPILED M. G. Farrand	C.D.O. 30·5·83 DATE
DRAWN E. Calabio	SCALE 1:1,000,000
DATE April, 1983	PLAN NUMBER S 16673
CHECKED	

PETROLOGY OF GRANITOIDS ON FAR WEST COAST

SAMPLE LOCATION PLAN