A PETROLOGICAL STUDY OF THE ENCOUNTER BAY GRANITES

ABSTRACT

The petrological features of the Encounter Bay granites are described from the Port Elliot, Granite Island, and Rosetta Head localities. In relation to the field and petrographical evidence, the following problems are discussed.

a. The Modal Variation of the Encounter Bay Granites.
b. The Sequence of Crystallisation of Minerals.
c. Albitisation.
d. The Modified Hornfelses.
e. Porphyroblastic Growth.
f. The Relative Ages of the Encounter Bay Granites.

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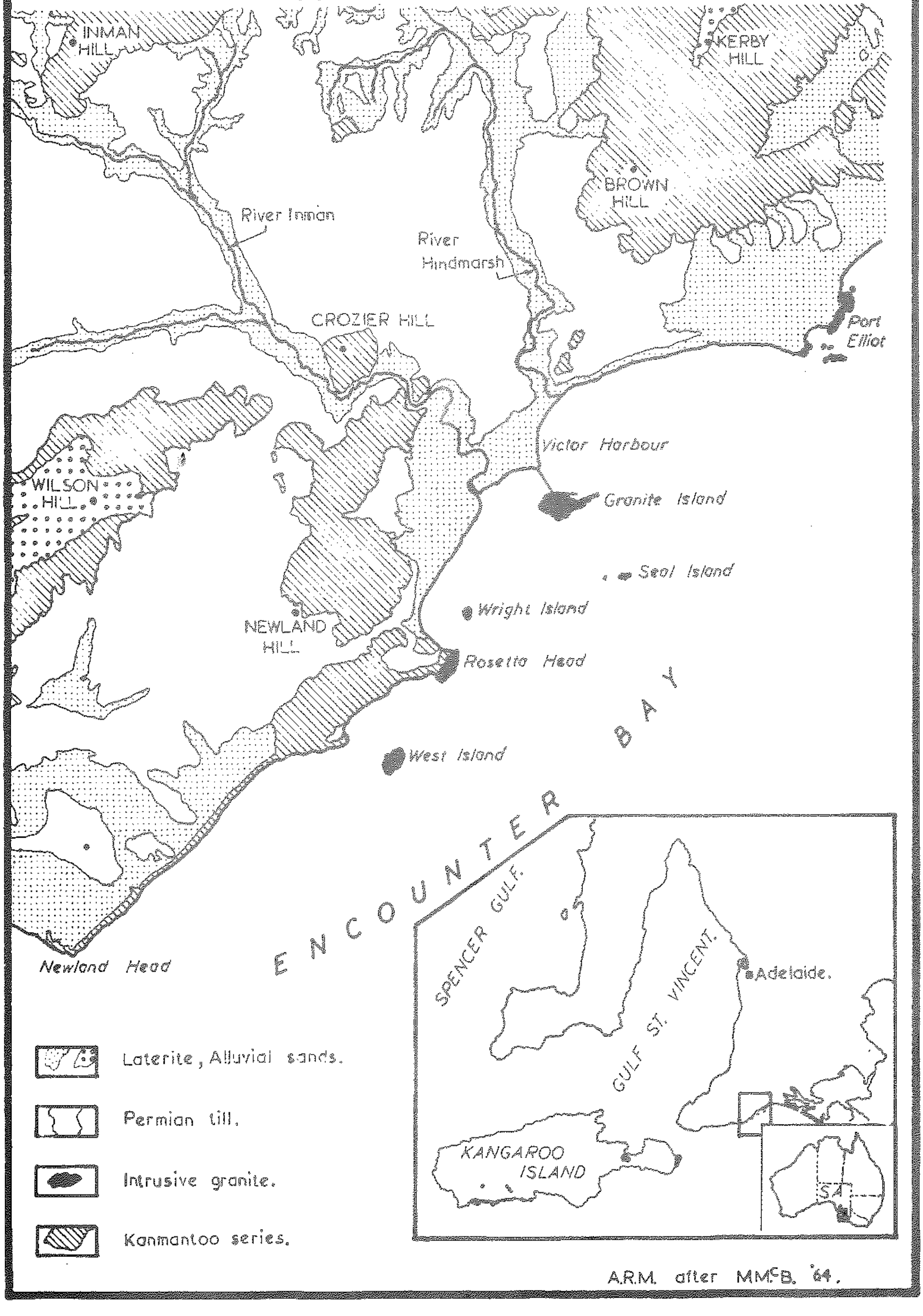
LOCALITY MAP
ENCOUNTER BAY GRANITES.



A.R.M. after McB. '64.

INTRODUCTION.

The "Encounter Bay granites" is the term used in this paper to discuss collectively the discontinuous outcrops of granitic rocks that occur along the coastline and on the adjacent islands of Encounter Bay, which lies 50 miles south of Adelaide. The locality map indicates the outcrops at Rosetta Head and Port Elliot, and on West, Wright, Granite, Seal and Pullen Islands. The contact between the granites and the country rock is exposed along the landward sides of West Island, Rosetta Head, and Wright Island, and is thought to exist close to the landward side of Granite Island. There is no indication of the contact at Port Elliot.

The textural and mineralogical similarities of the main granite phases from the different localities suggest that they were derived from a common source. However, there are certain unique features of the Port Elliot granites, in particular the uncontaminated nature of the Porphyritic Granite, and the extensive development of late stage granitic phases. These are thought to be evidence that the Port Elliot granites on the one hand, and the West Island, Rosetta Head, and Granite Island granites on the other, represent different levels of the same intrusion. According to Tilley (1919), the Cape Willoughby granites (Kangaroo Island) closely resemble the Port Elliot granites. The detailed petrography of the granites has been included in the Appendix at the end of the paper.

To facilitate mapping of the isolated granite outcrops, the Encounter Bay area was divided into seven localities. The most important of these viz. Port Elliot (locality number 4), Granite Island (locality number 3) and Rosetta Head (Locality number 7) were mapped in detail at a scale of 1" = 300', and are the main subject of this paper.

Specimens were collected from all the phases of the granites mapped. Slabs were cut from each specimen and stained to aid identification of the feldspars, and to reveal the textural relationships of the constituent minerals. At least one thin section was cut from each specimen.

Modal analyses of individual specimens were achieved by macro-point counting a number of stained slabs by a technique devised for this study and described later (see p. 3).

PREVIOUS WORK.

The earliest investigations of the Encounter Bay granites include brief petrological descriptions of a "biotite granite" from Granite Island, and an "axinite amphibolite" from Rosetta Head (Moulden, 1894), and a "uralitic diabase" from Port Elliot (Chewings, 1894). Subsequently, Gartrell (1903) measured the chemical and optical properties of feldspar megacrysts from the porphyritic adamellite of Granite Island.

Detailed descriptions of the Encounter Bay granites were later given by Browne (1920), and Mawson (1926).

Kleeman (1937) discussed the origin of the so-called "diorite" and associated inclusions in the porphyritic adamellite of Granite Island.

More recently, Bowes (1953, 1958) discussed the metamorphic and igneous history of Rosetta Head, and presented a very brief description of the main granite phases at Port Elliot.

D. B. Asthana (1958), of the Department of Mines, South Australia, studied the jointing in the granites and associated metamorphic schists at Port Elliot.

Mapping at a scale of 1:63360 was carried out in the Encounter Bay area by Crawford (1959). Brief field descriptions of the main granite phases appear in the legend of the S.A. Mines Department map illustrating his work.

Trends in potash and soda content of potash feldspar megacrysts across the contact between the porphyritic adamellite and a basic inclusion within the adamellite on Granite Island, were investigated by P. G. Slade (1962).

Two radioactive age determinations on the Encounter Bay granites produced ages of approximately 420 my. (Fander, 1961. Pb-α method) and 457 my. (Evernden and Richards, 1962. K-Ar on biotites).

J. M. Worden (1965) measured the uranium and thorium contents of porphyritic granite specimens from Granite Island and Port Elliot, and of a xenolith within the Granite Island adamellite.

TECHNIQUES USED IN EXAMINING SAMPLES.

Slabs cut from samples of the granites were stained by the standard Na-cobaltinitrite method (Chayes, 1939; Broch, 1961) to reveal the potassium feldspar. When a comprehensive study of macro-point counting theory (see Chayes, 1956; Solomon, 1963), and a number of experiments undertaken with stained slabs of porphyritic granite, failed to produce a simple mathematical equation on which to base modal analyses, a special technique was devised for this purpose. This consisted of point counting at 5 mm. intervals on transparent 1-centimetre grids which were taped onto stained granite slabs. The 5 mm. grid interval was selected following a suggestion from Dr Kleeman (pers. comm.) that the grid interval should be at least twice the average grain diameter of the "critical" mineral, biotite. An arbitrary standard deviation (counting error) of 1% was selected. According to the graph of Van der Plas and Tobi (1966), a 1% standard deviation for a mineral present at 5% abundance requires 1600 counts, and for a mineral present at 50% abundance, considerably more than 5000 counts. As a 1% standard deviation is more significant for the 5% constituent than the 50% constituent, 1600 counts for each specimen at 5 mm. intervals was considered to be adequate for purposes of modal analysis.

A sampling variation can only be detected when it is of greater magnitude than the counting error. In the case of the Porphyritic Granite at Port Elliot, there is a considerable sampling variation, as seen in Table 1. However, there is no significant sampling variation in the case of the Porphyritic Adamellite on Granite Island, as seen in Table II.

TABLE I

Porphyritic Granite

Port Elliot.

Sample number Constituent.	480	478	481	479	455	461
K-feldspar.	40.9±2.5%	39.2±2.3%	40.4±2.5%	35.6±2.3%	31.1±2.2%	38.5±2.4%
Plagioclase	17.7±1.9%	21.2±2.2%	16.5±1.7%	23.3±2.0%	25.1±2.3%	21.2±2.2%
Quartz	33.9±2.4%	30.8±2.3%	34.2±2.3%	32.1±2.3%	31.3±2.2%	29.4±2.1%
Biotite	7.5±1.2%	8.9±1.4%	8.9±1.4%	8.9±1.4%	12.4±1.5%	10.9±1.4%

(errors quoted are counting errors at the 95% probability level, measured from the graph of Van der Plas and Tobi, op. cit.).

TABLE II

Porphyritic Adamellite.

Granite Island.

Sample number Constituent.	335.	[illegible]	324.	326.
K-feldspar.	27.2±2.2%	27.4±2.3%	29.0±2.6%	28.5±2.3%
Plagioclase	26.5±2.2%	28.2±2.3%	25.9±2.5%	25.0±2.2%
Quartz	32.1±2.3%	30.9±2.4%	27.8±2.5%	32.4±2.4%
Biotite	14.3±1.7%	13.5±1.7%	17.3±2.1%	14.2±1.8%

(errors quoted are counting errors at the 95% probability level, measured from the graph of Van der Plas and Tobi, op. cit.).

PLATE 1.

Oblique aerial photograph of Boomer Beach (bottom right), Green Bay and Rocky Cove. Looking towards the east.

THE PETROLOGY OF THE MAJOR LOCALITIES.

1. PORT ELLIOT (see Plate 2).

General.

The Encounter Bay granites can be seen along the coastline, and on a small island and rocky islets at Port Elliot. The inland extent of the granite outcrop is rarely more than 400'. A covering of Permian, and Pleistocene to Recent sediments obscures the country rock - granite contact, which is thought to be less than 500 yards inland from the coastline.

West of Green Bay, the granite disappears beneath sub-horizontally bedded Permian glacial varves, which were deposited in a small basin produced by glacial scour. The granite surfaces along the bottom of this basin, where exposed, are smoothed and striated. A large faceted erratic has weathered out of these varves (Plate 7, fig.1). Further outcrops of glacial varves, unconformably overlying the granite, are exposed along portions of the headland between Green Bay and Horseshoe Bay. Stratigraphically above the Permian glacials are consolidated, large scale cross-bedded, Pleistocene (?) dune sands, capped by kunkar (Plate 7, fig.2). These sands form cliffs up to 80' high at Boomer Beach, near the western-most extremity of the granite outcrop, and extend from Boomer Beach to Horseshoe Bay. The sands are even grained aggregates of well-rounded quartz grains (colorless to opalescent blue) with minor feldspar, tourmaline, and garnet, cemented by finely crystalline calcium carbonate (Guppy, 1943). Their extent is indicated by the expanse of kunkar west of Horseshoe Bay.

North-west of Horseshoe Bay, the granite outcrop disappears beneath a cover of Recent dune sands and soil. At the eastern-most limit of the granite, the outcrop is covered by a boulder beach and the beach sands of Fisherman's Bay.

Typical of the more weathered portions of the Porphyritic Granite at Port Elliot, and characteristic of rapakivi granites as a whole, is the disintegration of the granite into "moro"[1] The disintegration of rapakivis has been described by many authors including Eskola (1930) Savolahti (1956, 1962) and Volborth (1962).

Footnote 1 ("Moro" - Finnish = "disintegrating rock"). The disintegration product of rapakivis, induced by weathering.

Porphyritic Granite

This is the dominant phase at Port Elliot. It is a medium to coarse grained, porphyritic biotite rapakivi-type granite, with large ovoid megacrysts of potash feldspar, many of which contain multiple zones and mantles of plagioclase (Plate 7, fig. 3).

The Porphyritic Granite, which is intruded by other minor igneous (?) phases, is contaminated by many xenoliths of heterogeneous size and nature, and intersected by abundant aplite dykes and late stage schorl-rock pods and nests.

The xenolithic contaminants are of two types..........

(1) Inclusions of country-rock in varying stages of alteration.

(2) Pod-like inclusions of aplitic and schorl material and fine grained granitic material. The micro-granitic inclusions contain medium to coarse grained opalescent blue quartz megacrysts, but the other inclusions do not. These inclusions have a mineralogy similar to that of the granite, and they may be regarded as "cognate".

Assimilated country rock inclusions which have undergone little or no modification, have sharp boundaries with the Porphyritic Granite host. Xenoliths of this type are found in the vicinity of Green Bay. One is approximately 15' in diameter, and the granite is distinctly finer grained within one inch of the contact. Well preserved layering is evident in all of these inclusions.

Between Green Bay and Horseshoe Bay, and north-east of Commodore Point, the Porphyritic Granite contains assimilated country rock inclusions which have been partially modified by the granite. Layering in these inclusions is no longer well preserved, and the host rock-inclusion contacts are generally rather diffuse. Some of these inclusions have a distinctive knotted texture, the "knots" corresponding to segregations of muscovite and biotite. These inclusions show a marked similarity to the altered andalusite-cordierite schists adjacent to the adamellite at Rosetta Head. On the eastern side of Rocky Cove, this material is "splattered" through the granite as small, irregular patches.

Inclusions of igneous (?) origin are common throughout the Porphyritic Granite. Fine grained aplitic and micro-granitic types have relatively sharp contacts with the host rock over Icm., and rounded to sub-rounded shape. The Icm. contact zone shows an intermingling of both rock-type constituents.

Pods and nests of schorl material (quartz-tourmaline intergrowths) are common, and often occur in association with a zone of albitisation (Plate 9, fig. 1). Limonite pseudomorphing pyrite(?) may be found in the cores of many of these pods or nests.

Aplite dykes up to 2' wide transect the Porphyritic Granite in many localities. At 14 (plate 2), a number of 2-4" aplo-granite dykes intersect the granite, and, being more resistant to weathering, stand out as ridges, producing a banding effect (Plate 8, fig. 3). The junction between the two rock types is generally gradational over a distance of 1".

A former potash aplite dyke at 27 and 33 (Plate 2) has been albitised. The orientation of this dyke is such that it lies approximately parallel to the main joint direction in the granites.

A 6" wide soda aplite dyke, with a central zone of predominantly massive blue quartz, transects the granite immediately east of Green Bay (54, Plate 2).

Only one pegmatite was observed at Port Elliot, and this occurs within the Porphyritic Granite, ~~west~~ east of Green Bay, as an iregular pinch-swell veinlet containing blue quartz, and large euhedral feldspar megacrysts. The rarity of pegmatites is a feature characteristic of rapakivis, and has been noted by many authors.

Layering, due to concentrations of biotite, occurs in parts of the Porphyritic Granite (Plate 9, fig. 1). The biotite individuals have a preferred orientation in the plane of the layers, and there are small xenoliths oriented parallel to the biotites. Harry and Emeleus (1960) described similar layering from certain Greenland granite intrusions

Even Grained Granite

The Porphyritic Granite is flanked by a medium, even grained granite west of Green Bay, and approximately 600 yards north-east of Commodore Point. West of Green Bay, the Porphyritic Granite - Even grained Granite contact is well exposed. The contact is gradational over 2', and the transition from Even grained to Porphyritic Granite is marked by an increase in grain size, and an increase in the abundance of feldspar and quartz megacrysts (Plate 10, fig.1) East of the contact, in the Porphyritic Granite, there are sinuous bands and irregular bodies of Even grained Granite, with diffuse, swirling contacts (Plate 10, fig.2). The Even grained Granite as a whole tends to envelop the Porphyritic Granite, and these irregular bodies may be remnants of the Even grained Granite mass.

North-east of Commodore Point, the Even grained Granite - Porphyritic Granite contact is similar to that west of Green Bay, but gradational over approximately 30'.

No country rock xenoliths were observed in the even grained phase.

Red Aplite

North of the latter exposure of Even grained Granite, a fine grained, brick-red aplite crops out over some 900' of coastline as far as Fisherman's Bay. The Red Aplite - Even grained Granite contact, although not well exposed, appears to be gradational over some 20'. A decrease in biotite content, and a decrease in grain size, from granite to aplite, characterises the contact. The biotite content decrease is the most distinctive change, and is accompanied by a marked increase in potash feldspar, the colour of which changes from pink in the granite to brick-red in the aplite. The grain size does not change appreciably until well into the aplite. The grain size of this aplite indistinctly coarser than that of the numerous aplite dykes which have intruded the Porphyritic Granite.

Albitisation

The Red Aplite has been albitised to white soda aplite along closely jointed zones in the main joint system (N.30-40°, vertical), resulting in the development of a red and white banded effect in outcrop. Albitised Aplite bands are up to 75' wide. Their contacts with the un-albitised aplite are transitional over 1-2". Within the albitised zones, parallel to the Red Aplite - Albitised Aplite contacts, there is a number of thin, dark coloured bands or layers (each approximately 1" wide). They also occur around remnant, un-albitised Red Aplite lenses in the albitised zones (Plate 11, figs. 3 and 4). The Even grained Granite and the Porphyritic Granite have been albitised along similar joint zones (Plate 11, figs. 1 and 2), but these are generally not as wide, nor the albitisation as extensive as in parts of the aplite.

Miarolitic Granophyre

In a small quarry inland from the Red Aplite, and on the beach at the foot of the sandhills which rim Fisherman's Bay, a greisenised miarolitic granophyre crops out. The field relations of this phase with other phases of the granite are obscured by Recent sand and alluvium. A striking feature of this rock is the presence of medium to coarse grained, euhedral quartz, "booklets" and radiating aggregates of muscovite, and euhedral albite, which have crystallised in small cavities or miaroles, giving the rock a "knotted" appearance.

Minor Phases.

A Fine grained grey alkali Granite, apparently intrusive into the Porphyritic Granite, occurs as an irregular body with intersecting dyke-like off-shoots at 52 (Plate 2; Plate 12, fig. 2). Accumulation of mafic material within the Fine grained Granite characterises the junction between this body and the Porphyritic Granite. The dykes of Fine grained Granite have gradational contacts with the Porphyritic Granite, over 1-2 cm.

At 51 (Plate 2), there is a fine grained dyke-like phase with medium to coarse grained megacrysts of quartz and plagioclase, and small biotite clots. On the western side, it has an extremely sharp straight line contact with the Porphyritic Granite, trending in a north-west-south-east direction. The contact completely cuts off the Fine grained Granite at 52 (Plate 12, fig.3). On the eastern side, it appears to grade into Porphyritic Granite. The material on the western side of the dyke, in sharp contact with the Porphyritic Granite, is distinctly finer grained than that on the eastern side. The dyke material has

PLATE 3.

Vertical aerial photograph of
Granite Island (cf. PLATE 4).

been albitised as a result of being sub-parallel to the main joint direction in the granite.

Amphibolite

A medium grained, dark green-black coloured amphibolite ("uralitic diabase" - Chewings, op. cit.), crops out in Rocky Cove. Its field relations with the Porphyritic Granite have been obscured by boulders. Similar, but finer grained amphibolites have been intruded into the Porphyritic Adamellite along particular joint (?) directions at Rosetta Head (see p.19).

2. GRANITE ISLAND (see Plate 4).

General.

Granite Island is composed predominantly of medium to coarse grained Porphyritic Adamellite, which crops out particularly well around the edges of the island, but is obscured beneath Recent sand and soil over much of the central part. The occurrence of minor patches of kunkar on parts of the island may indicate the presence of consolidated, calcareous Pleistocene (?) dune sands in these areas, analogous to the dune sand - kunkar capping association west of Horseshoe Bay, Port Elliot.

The Porphyritic Adamellite weathers differently on the northern and southern edges of the island. Exposure to continual prevailing wind and wave action along the southern edge has prevented much of the mechanical and chemical destruction affecting the adamellite exposed along the northern leeward edge. The outcrop along the northern edge has a rough, knobby appearance, due to the prominence of feldspar megacrysts, which are apparently less easily removed from the rock by weathering than the groundmass minerals.

Along the north-eastern edge of the island, the adamellite has been extensively quarried for use in building the breakwater, and in the construction of approaches to the screwpile jetty and the boatshed. Quarrying has exposed magnificent sets of finely slickensided "joint" faces, parallel to the main joint system.

Porphyritic Adamellite.

This is essentially a coarse grained, biotite-rich adamellite, of similar texture to the Port Elliot Porphyritic Granite, but slightly coarser grained. It contains large amounts of xenolithic material of two main types.

(1) Assimilated country rock, essentially unmodified quartz-plagioclase-biotite hornfels, which has well preserved layering and sharp contacts with the adamellite (Plate 13, figs. 1 and 2).

(2) Modified Hornfelses of variable texture, which occur as large irregular bodies, and small, rounded to sub-rounded inclusions. Browne (op. cit.) named this phase the "Quartz-mica diorite".

Less commonly, fine grained aplitic inclusions occur within the Porphyritic Adamellite, as small, sub-rounded pods and some larger, irregular bodies (e.g. 20, 21, 17, Plate 4). Contacts with the adamellite are quite sharp (less than 5 mm.).

Accumulations of large numbers of very coarse grained potash feldspar megacrysts, to the exclusion of the groundmass, occur in localised zones in the Porphyritic Adamellite, particularly in association with xenoliths.

Albitisation.

Albitisation of the Porphyritic Adamellite along strongly jointed zones parallel to the main joint system (W. 126°, vertical) has produced Porphyritic Albite-Quartz-Biotite Phases, similar to those at Port Elliot (see pp.8 and 9). The albitisation is particularly evident along the southern edge of the island, in the less weathered adamellite. The Porphyritic Adamellite - Porphyritic Albite-Quartz-Biotite Rock transition is characterised by a change in colour of feldspar megacrysts from pinkish-grey, to creamish-white or bright orange.

Porphyritic Albite-Quartz-Chlorite Phase.

On the western side of Granite Island, a Porphyritic Albite-Quartz-Chlorite Phase crops out in a strongly jointed and fractured zone, just above normal sea level. Texturally, it is identical to the Porphyritic Adamellite.

The contact between the Porphyritic Adamellite and the albitised phase is transitional over 2-3", and the transition from the adamellite into the albitised phase is characterised by a sharp decrease in quartz content, a change in colour of the quartz from opalescent blue to colourless, the albitisation of pre-existing potash feldspar and plagioclase, and the decomposition of biotite to chlorite. Albitisation has also affected the feldspars in the adamellite marginal to the contact.

Phases similar to the Porphyritic Albite-Quartz-Chlorite Rock in mineralogy and texture, crop out at Rosetta Head, and have been described in the literature by Browne (op.cit.) and Bowes (op.cit.)

Modified Hornfelses.

The petrology and field relations of these phases have been described in detail by Kleeman (op. cit.). The major portion of the Modified Hornfelses crop out as a broad (400-500' wide), irregular, dyke-like body on the northern and southern parts of the island, but is obscured in the central portion by Recent cover. Large, irregular bodies and small, sub-rounded inclusions of the Modified Hornfelses also occur within the Porphyritic Adamellite. Inclusions of similar material occur within the porphyritic granitic types of Port Elliot and Rosetta Head. A peculiar characteristic of the phases is the large collection of heterogeneous xenoliths which occur within it. The xenoliths are particularly difficult to see in the finer grained varieties of Modified Hornfelses unless a careful field study is made. A consequence of the presence of xenoliths within these phases is the enigmatic xenolith-within-xenolith relationship.

Browne (op.cit.) described six varieties of the Modified Hornfelses. Kleeman (op. cit.), on the basis of petrological data, grouped these six varieties into three types: the "hornblende diorite"; the"quartz-mica diorite"; and the "adamellite porphyry". For ease of description, the terms "Porphyroblastic Hornfels" and "Granitised Hornfels" will be used here as they are representative of the two main textural varieties of the Modified Hornfelses.

1. Porphyroblastic Hornfels

On the northern edge of Granite Island, between the causeway and the boatshed, the Porphyroblastic Hornfels crops out as the major portion of the broad dyke-like band. Texturally, it is a dense, dark grey, aphanitic rock, with a small number of coarse grained porphyroblasts of blue opalescent quartz, potash feldspar (which may be mantled by plagioclase), plagioclase, and some biotite clots. The Granitised Hornfels occurs as isolated inclusions in the Porphyritic Adamellite, to the north-east and east of the dyke-like band (Plate 4).

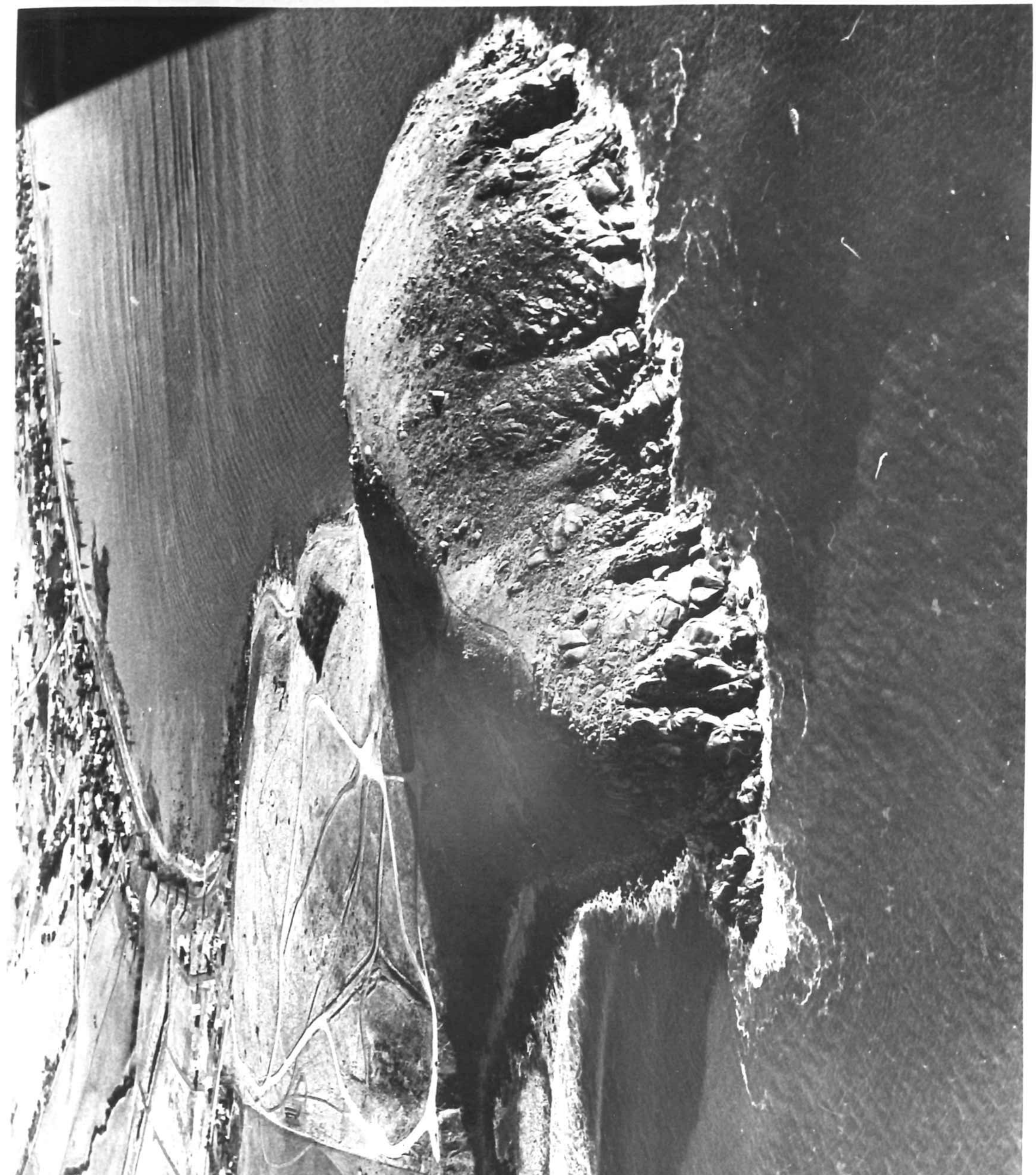
On the southern side of the island, the Porphyroblastic Hornfels crops out along the eastern portion of the dyke-like band (Nature's Eye locality, Plate 4), and grades into the Granitised Hornfels to the west over some 200'. The Porphyroblastic Hornfels contains a small number of potash feldspar, quartz and plagioclase porphyroblasts, and a relatively large number of dark coloured aphanitic xenoliths, which areooften difficult to see. The contact between the Porphyroblastic Hornfels and the Porphyritic Adamellite is well exposed at Nature's Eye. Browne (op. cit.) found that determination of relative age from the field relations was difficult. Kleeman (op.cit.) described the contact as "having all the appearance of a normal intrusive contact, in which the granite (= Porphyritic Adamellite) intrudes the diorite (= Porphyroblastic Hornfels)". The contact, however, at which the Porphyritic Adamellite and the Porphyroblastic Hornfels commonly "tongue" into one another, is somewhat diffuse (1-2 cm.), with biotite-rich segregations in the marginal adamellite phase (Plate 13, figs. 3 and 4). There are potash feldspar porphyroblasts "straddling" the contact in some instances.

2. Granitised Hornfels

Texturally, this is a fine grained, light grey coloured rock with many coarse potash felspar, plagioclase, quartz and biotite porphyroblasts, and abundant xenoliths, many of which show well preserved layering (Plate 14, figs. 1 and 2). Some of the potash feldspar porphyroblasts may be mantled by plagioclase. At Nature's Eye,

PLATE 5.

Oblique aerial photograph of Rosetta Head, looking towards the north-west.



there is a gradation between the Granitised Hornfels and the Porphyroblastic Hornfels to the east. West of this locality, however, the Granitised Hornfels occurs as discrete inclusions within the Porphyritic Adamellite. Their contacts with the Porphyritic Adamellite are 2-3 cms. wide.

3. Xenoliths

Xenoliths within the Modified Hornfelses include layered quartz-biotite hornfels fragments, which appear to be slightly modified equivalents of the layered country rock inclusions within the Porphyritic Adamellite; inclusions with relict ophitic texture; and colourless quartz blebs, some 2-3" in length. The size of these xenoliths never exceeds 1' in diameter. They vary in shape from sub-rounded to sub-angular, and their contacts with the host rock tend to be relatively diffuse because of the approximate accordance in grain size between host and inclusion. Quartz or feldspar porphyroblasts within these xenoliths are extremely rare.

Medium, Even grained Adamellite

An even grained, medium-coarse adamellite crops out along the cliff-top above the quarry face at 22 (Plate 4), but its contacts are obscured by Recent cover and therefore its relationship with the Porphyritic Adamellite is difficult to define.

Aplites

Aplitic material occurs as small pods and irregular bodies within the porphyritic adamellite. They are characterised by the presence of colourless quartz, in the place of the blue opalescent quartz of the host rock, and have reasonably sharp contacts with the host.

Mineralogically and texturally, these are almost identical to the aplites of similar field occurrence at Port Elliot.

3. ROSETTA HEAD (see Plate 6).

General

Rosetta Head, known locally as "The Bluff", is a 325' high promontory which juts out into the Southern Ocean, some 3 miles south-west of Victor Harbour. According to Howchin (1926), the promontory is a roche moutonnee, the result of ice-smoothing during the Permian glaciation.

The seaward portion of Rosetta Head is composed predominantly of coarse grained, buff coloured Porphyritic Adamellite, the best exposure occurring along the shoreline. Due to soil cover, only isolated groups of adamellite boulders are exposed on the summit and seaward slopes.

The contact of the Porphyritic Adamellite with the country rock quartz-biotite, and andalusite-cordierite schists is exposed along the landward side of Rosetta Head. The country rocks themselves outcrop along the shoreline platform on its north-western and south-western flanks.

Along the "saddle" of the promontory, an extensive deposit of Permian glacial till effectively obscures country rock outcrop. The till typically consists of clay, sand, and pebble and boulder erratics of locally derived country rock and granitic material, as well as exotic rock types, which include gneisses, migmatites, marble, white quartzite and granite porphyry. The beach to the north west of Rosetta Head is strewn with boulders of granitic material, which have apparently weathered out of the Permian till. The till appears to have been deposited in a glacial basin in the country rock schist.

Above the Permian, along the "saddle" of the promontory, there are isolated deposits of kunkar, which may cover Pleistocene(?) dune sands (analogous to the kunkar-dune sand association mapped at Port Elliot). However, field relations are generally obscured by Recent soil and pasture grass.

Country Rock

The rocks into which the Porphyritic Adamellite has been intruded, are part of a monotonous series of fine grained quartz-biotite schists and impure quartzites, known as the Kanmantoo Series, reputed to be of Cambrian age. In the immediate vicinity of the intrusion, there are andalusite-cordierite schists (in which andalusite and cordierite occur as porphyroblasts), quartz-biotite schists, impure sandy quartzites, albite-chlorite schists, and meta-dolerite dykes. The rocks are tightly folded, and have a number of well developed metamorphic layering types (Plate 15, fig. 4), which all but obscure the bedding in many localities. The outcrop pattern along the shoreline platform southwest of Rosetta Head, where the metamorphic layerings are best developed, is controlled by the S_2 foliation, whereas that along the northwestern flank is controlled by original sedimentary layering.

trolled by original sedimentary layering.

The albite-chlorite schists are the result of albitisation of the above country rock types. This evidently occurred at the same time as albitisation of certain parts of the Porphyritic Adamellite. Although the field relations are not clear, the andalusite-cordierite schists appear to have no relationship to the intrusive Porphyritic Adamellite There is no evidence for prograde metamorphism in the country rock, marginal to the Porphyritic Adamellite; however the fact that the andalusite in this zone has been altered to chlorite and muscovite suggests that slight retrograde metamorphism has been produced during intrusion of the adamellite. The andalusite-cordierite assemblage is evidently a regional metamorphic assemblage, its occurrence controlled by bulk composition in the region of a geothermal high. The geothermal high may have been produced by heat loss from an underlying granite mass, from which the Encounter Bay granites (and the Rosetta Head adamellite in particular) were derived at some later stage.

Porphyritic Adamellite

This is essentially a coarse grained, biotite-rich adamellite of very similar texture and composition to the Granite Island variety. The xenolithic material within the adamellite is of two types...

(1) Abundant inclusions of layered country rock quartz-biotite schist, which have sharp contacts with the host. Two of these are very large, and appear to have the same structural orientation as the country rock. Bowes (op. cit.) considered these to be roof pendants which remained in situ during the porphyritic adamellite intrusion. The northern-most "pendant" is connected with the country rock by a thin peninsula of quartz-biotite schist.

(2) Minor inclusions of Granitised Hornfels.

Fine grained aplitic inclusions, and accumulations of large numbers of very coarse grained potash feldspar megacrysts also occur within the Porphyritic Adamellite (Plate 15, fig.1).

Contact Relations

The contact of the Porphyritic Adamellite and the country rock is a typical intrusive breccia, in which there are distorted and disoriented fragments of schist in an adamellite groundmass. The best exposures of the intrusive breccia are in the vertical cliff sections adjacent to the jetty, on the northern side of Rosetta Head, and near the south-western tip. The plane of the contact has an approximate average dip of 45° towards the east, such that the intrusion actually overlies the country rock. The average foliation trend in the country rock schists adjacent to the contact is N10°, 35-60°E. Bowes suggested that the intrusion of the magma was "structurally controlled by the schistosity, as the direction of the main contact corresponds with the strike of the schistosity". However, on a minor scale, the Porphyritic Adamellite is generally discordant, although it does parallel the schistosity in places. In detail, the contact is serrated, with a 1-2 mm., fine grained biotite rim in the country rock, marginal to the adamellite (Plate 15, fig.3).

On Wright Island, the adamellite-country rock contact is concordant with the foliation in the country rock, on both major and minor scales. In addition, there are several concordant bands of Porphyritic Adamellite, up to 3' wide, within the country rock. A distinct gneissic foliation is characteristic of the adamellite bands, and the adamellite border zone, marginal to the main contact. On a fine scale, ptygmatic-type veinlets of granitic material discordantly intrude the country rock adjacent to the adamellite bands (Plate 15, fig.2). As described at Rosetta Head, a thin biotite rim occurs along the contact, in the country rock marginal to the adamellite.

Albitisation

Albitisation of the Porphyritic Adamellite along strongly jointed zones, has produced Porphyritic Albite-Quartz-Biotite types. The field relations of similar phases at Port Elliot, and on Granite Island have been described above.

Porphyritic Albite-Chlorite-Quartz Phase.

Browne (op.cit.) called this the "albite-mica syenite", which he considered to be an intrusive phase, distinct from, and later than the Porphyritic Adamellite. Later, Bowes (op. cit.) referred to the varieties of this phase as "coarse albite-chlorite rocks of igneous aspect". He believed these were derived from the albite-chlorite schists "by recrystallisation and partial mobilisation during, and because of the intrusion of the granite"[1].

The Porphyritic Albite-Chlorite-Quartz Phase, which is very similar to the Porphyritic Albite-Quartz-Chlorite Phase on Granite Island, occurs in deformed zones, especially between the Porphyritic Adamellite and the country rock, along portions of the main contact. On the south-western tip of Rosetta Head, the Albite-Chlorite Rock (the name given to the Porphyritic Albite-Chlorite-Quartz Phase in the remainder of this paper), and the Porphyritic Adamellite, interfinger along a direction parallel to the joint system in which albitisation has occurred (see P.17). Texturally, the Albite-Chlorite Rock is strikingly similar to the Porphyritic Adamellite. Xenoliths within the Albite-Chlorite Rock are albite-chlorite schist and hornfels, and not quartz-biotite schists.

Where the Albite-Chlorite Rock occurs along the main contact zone, the country rock has been albitised. However, the Albite-Chlorite Rock - albite-chlorite schist contact is identical to the Porphyritic Adamellite - country rock contact. The contact between the Porphyritic Adamellite and the Albite-Chlorite Rock has been described above, in relation to Granite Island.

On the south-western tip of Rosetta Head, there is a notable development of thin (less than 1 cm. wide), fine grained, white albite veinlets, transecting the Albite-Chlorite Rock. They have no apparent preferred orientation, and are often intersecting.

Medium, Even grained Adamellite.

A small mass of medium, even grained adamellite occurs within the country rock, on the land-ward side of the main adamellite - country rock contact, (the unornamented body just north-east of 21, Plate 6).

Footnote 1. "granite" - Bowes = Porphyritic Adamellite.

A preferred orientation of the biotite in this phase is reminiscent of the gneissic foliation in the Porphyritic Adamellite bands within the country rock on Wright Island. The Medium grained Adamellite appears to be generally discordant with the country rock foliation, however the field relations are not clear, due to the poor outcrop.

Aplites and Pegmatites.

Aplites occur in minor amount as pod-like inclusions in the porphyritic adamellite. As at Port Elliot, and on Granite Island, they are characterised by colourless quartz, and have reasonably sharp contacts with the host rock (over some 5 mm.).

Two lense-shaped pegmatite bodies, some 10-15' in length, occur within the country rock, on the landward side of the main contact. They consist of pinkish coloured chess-albite, with abundant quartz-filled fractures.

Amphibolites.

Two uralitised dolerite (amphibolite) dykes intrude the porphyritic adamellite along joint (?) directions (Plate 6). The northern-most amphibolite crops out well in a 100' high cliff section, notched into the seaward face of Rosetta Head. It is coarser grained and has a more distinct ophitic texture than the southern most amphibolite. In general, the amphibolites are by no means well exposed. Their field relationships near the adamellite - country rock contact are obscured by cover, and it has not been possible to trace them into the country rock.

SUMMARY AND DISCUSSION.

1. Modal Variation of the Encounter Bay Granites.

The Port Elliot Porphyritic Granite and the Granite Island and Rosetta Head Porphyritic Adamellite are thought to represent the initial intrusive phase of the Encounter Bay granites. The Porphyritic Granite has a considerably greater variation in modal composition than the Porphyritic Adamellite (see Figure 2). The higher plagioclase and biotite contents of the latter can be attributed to contamination by large numbers of country rock inclusions. The biotite in the Porphyritic Adamellite is titanium-rich (see p.23), compared with that in the Porphyritic Granite, and has evidently been derived from the country rock contaminants.

The modal compositions of the Encounter Bay granites have been plotted on a triangular Quartz (Q)-Potash feldspar (Kf)-Plagioclase (P1) diagram (Figure 4). The plots show a distinct elongation through which a line of best fit has been drawn. The trend of the line from the position of the average Porphyritic Granite towards the Q-Kf face represents an increase in potash feldspar content, relative to quartz and plagioclase. This is considered to be a crystallisation sequence. The trend of the line in the opposite sense, from the position of the average Porphyritic Granite towards the Q-P1. face, is apparently the result of country rock contamination.

Figure 1., which is a diagrammatic representation of the modal variation of the Port Elliot granitic phases, is a further indication of the crystallisation sequence. There is a marked increase in potash feldspar content relative to plagioclase, and a significant decrease in biotite content from the Porphyritic Granite into the Even grained Granite and the Red Aplite.

2. Sequence of Crystallisation of Minerals.

A detailed sequence of crystallisation of mineral phases in the porphyritic granites and adamellites is difficult to determine. Biotite generally occurs as interstitial aggregates of laths, or as individual laths, with abundant accessory mineral inclusions, and is considered to be the first major mineral to crystallise. Plagioclase occurs as subhedral grains which are complexly oscillatorily zoned. Progressive zoning may be superimposed on oscillatory zoning. It is suggested that oscillatory zoning is the result of variation in water vapour pressure (P_{H_2O}) which caused fluctuation in the position of the Ab-An field boundary, and thus alternating deposition of sodic and calcic plagioclase. Progressive zoning represents a gradual environmental enrichment in sodium relative to calcium. Potash feldspar is present in two habits: as coarse subhedral and ovoid-shaped megacrysts, and as fine, anhedral interstitial material. Quartz occurs as medium to coarse, subhedral and euhedral grains, and as fine anhedral inclusions in feldspars. In the case of potash feldspar, the two habits are thought to represent different "generations" of mineral growth. In addition, the subhedral megacrysts and the ovoid-shaped megacrysts may be of different generations (see p. 27).

Plots of normative quartz, plagioclase and potash feldspar of the Porphyritic Adamellite from Granite Island (after Kleeman, op. cit.), Rosetta Head and West Island (after Bowes, op. cit.) on a Q-P1-Kf triangular diagram (see Figure 4a) fall either in the quartz or the plagioclase fields. However this is apparently a result of contamination, and cannot be directly related to any crystallisation sequence. A plot of normative quartz, plagioclase and potash felspar for the uncontaminated Even grained Granite, Port Elliot, falls in the potash feldspar field. Although there is no data available for the Port Elliot Porphyritic Granite, it would probably plot in a similar position. This is thought to be evidence that potash felspar crystallised next after biotite.

See An-Ab-Or plots.

A simplified sequence of crystallisation of mineral phases proposed for the rapakivi granites of Maine (Elders, 1966. Pers. comm.) is compared with that proposed for the Encounter Bay granites in tabular form below.

	Maine Rapakivi granites	Encounter Bay Porphyritic granites.
1.	Mafic minerals	Biotite
2.	Potash feldspar and quartz.	Subhedral potash feldspar metacrysts.
3.	Potash feldspar, plagioclase and quartz.	Quartz and plagioclase
4.	Some potash feldspar partially resorbed.	Interstitial potash feldspar.
5.	Rim plagioclase.	Ovoid-shaped megacrysts of potash feldspar.
6.	Potash feldspar resorbed a second time.	Deuteric phenomena, including myrmekite and sausseritisation of feldspars. etc.

(Stages of the crystallisation sequences have been numbered, but are not necessarily equivalent in status or time).

3. Albitisation.

Albitisation has taken place in strongly jointed and fractured and deformed zones within various phases of the Encounter Bay granites, evidently as the result of infiltration of late stage soda-rich volatiles. The Porphyritic Albite-Quartz-Biotite (Phlogopite) Phase occurs in such strongly jointed zones at Port Elliot, Granite Island and Rosetta Head. The Porphyritic Albite-Chlorite Phase occurs in albitised fractured and deformed zones, especially along the Porphyritic Adamellite - country rock contact at Rosetta Head. The Porphyritic Albite-Quartz-Biotite (Phlogopite) Phase is thought to represent an intermediate stage of albitisation, between the Porphyritic Adamellite and the Porphyritic Albite-Chlorite Phase. Texturally, both phases are identical to the Porphyritic Adamellite. The Porphyritic Albite-Chlorite Phase contains relict mantled, ovoid-shaped megacrysts, originally plagioclase-mantled potash feldspar, which occur as albite-mantled chlorite-sericite cores.

The processes involved in the albitisation are...

(1) Potash feldspar $\xrightarrow[+Na]{-K}$ chess albite

Chess albite completely pseudomorphs the megacryst and interstitial habit of the pre-existing potash feldspar (Plate 20, fig. 1; Plate 21, fig. 6).

(2) Oligoclase-andesine $\xrightarrow{-\ Ca}$ lamellar twinned albite.

(3) Quartz $\xrightarrow[+Na,\ Al]{}$ albite

There is considerably less quartz in the Porphyritic Albite-Chlorite Phase than in the Porphyritic Adamellite, evidently due to replacement by albite. Certain textures in the albitised phases appear to be evidence of such a replacement (Plate 21, fig.7).

(4) Biotite $\underline{-K,Fe}$ phlogopite $\underline{-K}$ chlorite.

As distinct from that at Rosetta Head and Granite Island, alteration of biotite to chlorite during albitisation of phases of the Port Elliot granites does not involve formation of the intermediate product phlogopite. This is thought to be due to the difference in composition of the biotite.

Rutile occurs as abundant inclusions in altered biotite, Phlogopite and chlorite when the original biotite was titanium-rich. The altered biotite in the albitised equivalents of the relatively uncontaminated Port Elliot granites rarely contains rutile inclusions.

In general terms, the albitisation involves introduction of soda (Na) and loss of potash (K). The fate of the potash is not known.

Within the Albitised Aplite, at Port Elliot, there are numbers of dark coloured bands or layers, parallel to the Red Aplite-Albitised Aplite contact (see p.8, Plate 11, Appendix p.3 and figs. 3 and 4). They consist of fine grained biotite and dark coloured clay minerals (?), which may represent the mafic constituents expelled from the Red Aplite during albitisation. The recurrence of these bands in a series, progressively disappearing into the Albitised Aplite, suggests a number of distinct replacements, rather than a continuous albitisation process.

4. Chess-albite

Chess-albite is distinguished by a characteristic development of twinning on the albite law, resulting in a complex pattern of short, alternating twin lamellae which do not pass through the entire cyrstal (Plate 20, figs. 2 and 3). Many authors consider chess-albite to be of secondary origin, arising by replacement of microcline (e.g. Becke, 1906; Anderson, 1928; Exner, 1949). However, in the Encounter Bay granites, chess-albite always occurs within albitised fractured and deformed zones (see p.44). Starkey (1959) has also recognised a close connection between the development of chess-albite and zones of deformation. These observations are in accordance with the view held by Voll (1960), that chess-albite results from two processes; metasomatism of microcline to give albite, and deformation is the later of the two processes, whereas in the case of the Encounter Bay granites, deformation is thought to precede albitisation, or at least be contemporaneous with it.

It is of interest that albitisation of oligoclase-andesine, in the Encounter Bay granites, produces lamellar twinning (spindle-type) albite, and not chess-albite (see p.22, also Plate 20, fig. 2).

5. Modified Hornfelses, Granite Island

The Modified Hornfelses (see pp. 12-14, and Appendix pp. 16 - 20) are thought to represent country rock material, which has been metasomatised and recrystallised after inclusion into the parent Porphyritic Adamellite magma. The Porphyroblastic Hornfels appears to represent an early stage of this modification, and the Granitised Hornfels, a later stage. Table 10 shows a comparison of the relative abundances of porphyroblasts with respect to groundmass in the hornfelses.

According to Slade (op. cit.), there is a steady increase in K_2O/Na_2O in potash feldspar across the contact from the Porphyritic Adamellite into the Porphyroblastic Hornfels. This was interpreted as an indication of the preferential migration of potash into the Porphyroblastic Hornfels, and the outward migration of soda. Little change was found in the K_2O/Na_2O ratio over the major part of the Porphyroblastic Hornfels. A comparison of chemical analyses of unmodified country rock, the Porphyroblastic Hornfels, the Granitised Hornfels, and the Porphyritic Adamellite is presented in Table 15. A significant feature of this comparison is the increase in potash (K_2O) with the proposed increasing degree of modification. Additional oxide variations have been underlined, but their significance is not clear at this stage.

TABLE 15

	Unmodified country rock	Porphyroblastic Hornfels	Granitised Hornfels	Porphyritic Adamellite
SiO_2	72.90	68.60	69.06	68.20
Al_2O_3	13.74	14.30	14.28	15.99
Fe_2O_3	0.04	0.79	0.71	0.89
FeO	$\underline{3.29}$	$\underline{4.70}$	$\underline{3.23}$	$\underline{2.58}$
MgO	1.85	1.24	1.46	0.80
CaO	$\underline{2.12}$	$\underline{2.88}$	$\underline{2.11}$	$\underline{2.61}$
Na_2O	$\underline{3.02}$	$\underline{3.40}$	$\underline{2.69}$	$\underline{2.85}$
K_2O	$\underline{1.99}$	$\underline{2.28}$	$\underline{4.59}$	$\underline{4.60}$
H_2O	0.46	0.87	0.46	0.64
H_2O	0.11	0.24	0.11	0.21
TiO_2	0.56	0.59	0.70	0.58
sub-totals	100.10	100.09	99.30	99.99

(analyses after Kleeman, op.cit.
Note: Porphyroblastic Hornfels = "Quartz-mica diorite".
Granitised Hornfels = "Adamellite porphyry".)

In addition to metasomatism and recrystallisation, there is some evidence that the parent Porphyritic Adamellite magma may have induced at least partial mobilisation in the Modified Hornfelses as indicated by:

(1) The interfingering, somewhat diffuse nature of the contact between the Porphyritic Adamellite and the Porphyroblastic Hornfels (see p.13).

(2) The presence of randomly oriented, country rock xenoliths, which themselves have been partially modified, within the Modified Hornfels phases (see p. 14).

The nature of the contact is thought to represent an intermingling of two mobile phases. The country rock xenoliths appear to have been incorporated into the mobilised hornfelses in the same manner as into the Porphyritic Adamellite magma. Their subsequent modification may principally have been a result of metasomatism. Slade (op. cit.) concluded from the compositions of the potash feldspar porphyroblasts, that the Porphyroblastic Hornfels, was at one time cooler than the Porphyritic Adamellite. In addition, triclinicity values from the hornfels were found to fall within the range commonly noted for feldspars from xenoliths. According to Dietrich (1961), feldspars from xenoliths have obliquities less than 0.65, whereas granite feldspars have obliquities greater than 0.65.

<u>Hornblende and sphene</u> are specific to the Porphyroblastic Hornfels (see Appendix pp. 16-20). They do not occur in the unmodified country rock, nor do they persist into the Granitised Hornfels. Kleeman (op.cit.) considered that hornblende was formed from the reaction..

calcite + biotite ⟶ hornblende

and was eliminated at a later stage of metasomatism by reaction with incoming soda to form plagioclase. This hypothesis requires that the original country rock be somewhat calcareous. If this is accepted, then the sphene may have been a by-product of the reaction...

calcite + biotite ⟶ hornblende,

since the biotite in the country rock is titanium rich. The mechanism for the elimination of sphene during later stages of metasomatism is obscure.

Complex oscillatory zoning in plagioclase porphyroblasts in the Modified Hornfelses is ubiquitous. The individual zones are thin, and have euhedral outlines (see Appendix pp. 17 and 19; and Plate 26, figs. 8 and 10). Groundmass plagioclase grains are commonly progressively zoned, and may contain inclusion-filled inner zones (see Appendix pp. 17 and 19: and Plate 27, fig 1). Progressive zoning is commonly superimposed on oscillatory zoning in the porphyroblasts. Zoning of both types has been discussed on p. 20.

6. Porphyroblastic Growth

A number of potash feldspar porphyroblasts from the Porphyroblastic Hornfels can be arranged into what is considered to be a sequence of growth stages. The mechanisms of growth, however, are not clear.

1. The first stage involved nucleation of potash feldspar at particular sites in the groundmass of the hornfels, and migration of potash feldspar material into the site from the surrounding environment. This stage is represented in stained slabs by vague concentrations of potash feldspar, with considerable numbers of groundmass mineral inclusions.
2. As the potash feldspar concentration increased, growth of the porphyroblasts began with the structural alignment of potash feldspar crystallites. Plagioclase groundmass inclusions, having a similar lattice-type to potash feldspar, became aligned as well. Other mineral inclusions, such as quartz, sphene, hornblende and biotite, were "forced" into the interstitial spaces between the aligned crystallites, producing the "quilt-work" texture described on Appendix p. 17.
3. With subsequent growth, the innermost zones of the porphyroblasts freed themselves of all groundmass mineral inclusions. The outer zones, however, were still considerably poikilitic. Porphyroblasts representing this growth stage comprise perthitic, Carlsbad twinned potash feldspar cores, with "quilt-work" patterned, plagioclase-rich outer zones.

4. During the last stages of growth, the potash feldspar freed itself from almost all inclusions. Some however were trapped in structural (?) zones in the porphyroblasts. There are many porphyroblasts in the Porphyroblastic Hornfels which represent these stages. They have perthitic potash feldspar cores with plagioclase mantles of varying thickness. The thickness of the mantle is thought to be related to the amount of groundmass plagioclase included during the initial nucleation and growth stages of the porphyroblast.

Potash feldspar porphyroblasts in the Granitised Hornfels are all in the last stages of growth. This is probably related to the fact that the Granitised Hornfels has been modified to a greater extent than the Porphyroblastic Hornfels (see p.24).

The ovoid-shaped potash feldspar megacrysts in the Porphyritic Granite and the Porphyritic Adamellite have all of the characteristics described for the porphyroblasts in the last stages of their growth. It is suggested that these ovoid-shaped megacrysts, some of which have plagioclase mantles, and inner zones of plagioclase and/or biotite inclusions, are the result of nucleation and growth of potash feldspar in the same way and at the same time as the porphyroblasts in the hornfelses. The inner zones of inclusions, as in the case of the porphyroblasts, apparently represent structurally (?) trapped material.

7. Relative Ages of the Encounter Bay Granites.

A sequence of relative ages of the Encounter Bay granites is best proposed for the Port Elliot locality, where the greatest number of granitic phases crop out.

1. Porphyritic Granite.
2. Even grained Granite.
3. Red Aplite and Aplite dykes and pods.
4. (?) Fine grained Granite.
5. (?) Porphyritic Microgranite
6. Schorl-rock dykes and pods.
7. Albitisation.
8. Greisen material, with haemetite and tourmaline.
9. Quartz veins.

Country rock xenoliths are confined to the Porphyritic Granite, which is the first intrusive phase. The second and third phases, which do not contain country rock xenoliths, are thought to be related to the Porphyritic Granite (see p.20). The position of the Fine grained Granite and the Porphyritic Microgranite in the sequence is not clear. However, they have intruded the Porphyritic Granite, and have been affected by the relatively late stage albitisation. Apart from the fact that tourmalinisation, greisenisation and quartz veining are normally associated with the later crystallisation stages of granitic intrusions, as in the case of the Encounter Bay granites, the genetic relationships of these phases with the earlier ones in the proposed sequence is not known at present.

The sequence is one of multiple intrusion, and as described by Brown (op.cit.) "the component members ".."have been successively and more or less independently injected into their present positions from an underlying magma reservoir".

8. Other Features which might indicate Genesis

1. Accessory Minerals.

The preferential distribution of zircon and ilmenite in biotite is a notable feature of most phases of the Encounter Bay granites. This is thought to represent a similar crystallisation temperature for these primary accessories and biotite. Schermerhorn (1956) considered this to be an indication of magmatic crystallisation. Apatite is not invariably confined to the biotite.

(ii) Myrmekite

Myrmekite comprises bulb-shaped intergrowths of plagioclase and vermicular quartz, which protrude into k-feldspar from plagioclase-k-feldspar boundaries, quartz-k-feldspar boundaries, or k-feldspar - kOfeldspar boundaries. In the Encounter Bay granites, myrmekite occurs as intergranular growths (Plate 18, fig. 4) and as rims around plagioclase grains (Plate 24, fig. 10). It is not specific to any particular phase, but is common to most. In addition, there is no apparent significant variation in the relative abundance of myrmekite in different phases. An important pre-requisite for the presence of myrmekite is the presence of potash feldspar. Although there are no well developed myrmekite growths in the albitised phases, some relict growths are apparent. Myrmekite in the Encounter Bay granites is thought to represent the eutectic crystallisation of quartz and plagioclase.

Most authors consider myrmekite to be a deuteric phenomenon, derived either by late stage unmixing from potash feldspar (Tuttle and Bowen, 1958; Ramberg, 1962); the replacement of plagioclase by potassic solutions (Drescher-Kaden, 1948); the replacement of potash feldspar by sodic solutions (Schermerhorn, op. cit.); the breakdown of unstable portions of plagioclase under stress (Sarma and Raja, 1959); or the release of silica from the hypothetical silicate $Ca(AlSi_3O_8)_2$, held in solid solution with the feldspars, on reverting to anorthite (Schwantke, 1909; Spencer, 1945). The experimental work of Carman and Tuttle (1963) supports the last hypothesis.

Textures similar to myrmekite have been described in metallurgical texts as eutectic phenomena. A distinctive, two-phase lamellar structure, closely resembling myrmekite, and known as "pearlite", results from relatively slow cooling of eutectoid steel (Brick and Phillips, 1949).

(iii) Perthite

There are several types of perthite apparent in the Encounter Bay granites. Of these, "film" perthite, "vein" perthite, and "patch" perthite are the most common. "Film" and "vein" perthite are generally considered to be the result of exsolution of albite from a potash feldspar host (Alling, 1938; Gates, 1950) "Patch" perthite (Plate 17, figs. 2 and 3; Plate 20, fig. 8) however, is thought to be a replacement phenomenon, since a complete range of "patch" perthite textures, from predominantly potash feldspar with subordinate lamellar twinned albite patches, to predominantly lamellar twinned albite with small, diffuse areas of potash feldspar, occurs in the Encounter Bay granites.

IV. Radioactivity

Rogers and Ragland (1961), as a result of a geochemical study of thorium and uranium in granitic rocks, found that there was no significant difference in Th/U ratio between granites and their metamorphic wall-rocks, although the granites generally contained larger amounts of both thorium and uranium.

J. M. Worden (op. cit.) measured the uranium and thorium contents of specimens of the Granite Island Porphyritic Adamellite, a xenolith within the Granite Island adamellite, and a Porphyritic Granite from Port Elliot. The results of these analyses, which indicate no significant difference in the Th/U ratio between the xenolith and the host adamellite, are presented in Table 14. The granitic rocks however contain higher Th and U than the xenolith.

TABLE 14

ROCK TYPE	Th.(p.p.m.)	U.(p.p.m.)	Th/U
Granite Island adamellite	28.0±2% 29.1±2%	7.11±2% 6.07±2%	3.94 4.80
Xenolith from Granite Island	20.9±2% 21.2±2%	4.24±2% 4.25±2%	4.94 5.00
Port Elliot granite	27.7±2% 28.4±2%	5.80±2% 6.43±1%	4.77 4.42

Radiogenic heat values ...

Granite Island Porphyritic Adamellite . . . 11.27 cal./gm./yr.
Port Elliot Porphyritic Granite . . . . . 12.26 cal./gm./yr.
Average granite - Barth, Theoret.Pet. . . . 6.646 cal./gm./yr.

The uranium and thorium are thought to be confined to the abundant primary accessory minerals zircon and apatite, in the Encounter Bay granites. Radioactive haloes around zircon inclusions in biotite are common. Worden considered that the uranium and thorium to a lesser extent, were entrapped in lattice imperfections, and in liquid inclusions, deposited along fractures as films with iron minerals, or adsorbed on crystal surfaces.

(V) Sulphide and Oxide Mineral Phases

The sulphide minerals pyrrhotite, pyrite and marcasite occur in abundance in parts of the Porphyritic Granite at Port Elliot. It is interesting to note that the mineralised host rocks tend to be of monzonitic composition, but where the mineralisation is not quite so intense, the rocks are of adamellitic or granitic composition. Pyrrhotite occurs as fine to medium subhedral grains, many of which have been partly replaced by marcasite. The borders of many pyrrhotite grains are in fact mantled by marcasite. (Plate 19, figs. 2 and 3). Medium grained pyrite euhedra are common (Plate 19, figs. 5)

The oxide minerals, ilmenite and haemetite occur as needle and lath-like inclusions along cleavages in biotite in most phases of the Encounter Bay granites. Haemetite is invariably acicular, whereas ilmenite tends to be lath-like (Plate 19, fig.8).

The amphibolites, which intrude the Encounter Bay granites, also contain ilmenite and haemetite, the former being generally the most abundant. Exsolution lamellae of haemetite and rutile (?) are common in the ilmenite of the Port Elliot amphibolite (Plate 24, figs. 1 and 2).

Haemetite occurs in the Miarolitic Granophyre at Port Elliot, and is always associated with late stage quartz and muscovite. It has been extensively altered to limonite, and persists only as skeletal remnants (Plate 23, figs. 1, 2 and 3).

SUGGESTIONS FOR FURTHER RESEARCH

It is thought that the localities are adequately known at the scale at which they have been mapped, and that the petrological features of the granite phases have been dealt with sufficiently. However, the granites lend themselves to detailed chemical investigations, both of the whole rocks, and of the individual mineral phases, which have not been considered in this paper. Such investigations should be oriented such that they apply to the problems outlined in the Summary. The tectonic environment of the granites, and a gravity study of the contact between the granites and the country rock, are two further possibilities for future research.

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APPENDIX

Detailed Petrography of the Major Localities.

(1) PORT ELLIOT

Porphyritic Granite

This is principally a medium to coarse grained, blue-grey coloured, biotite-bearing rapakivi-type granite, with abundant megacrysts of potash feldspar (up to 3" in length), quartz (1" diameter), and plagioclase (1" in length). Potash feldspar megacrysts are generally ovoid-shaped, and may be mantled by plagioclase. This particular feature is typical of the rapakivi texture known as Wiborgite (Wahl, 1925).

Potash feldspar is grey coloured when fresh, but is pink when weathered. It occurs as coarse megacrysts and as fine to medium groundmass material. Many megacrysts are ovoid-shaped and may contain numbers of elliptical or ovoid-shaped zones of fine grained, subhedral plagioclase and/or biotite inclusions. Frasl (1954), Schermerhorn (op. cit.) and Hibbard (1965) have described similar zonal arrangements of inclusions in microcline megacrysts, which they explain as the result of magmatic crystallisation.

Mantling of ovoid-shaped megacrysts is a relatively common feature, but in addition to the mantled ovoids, non-mantled ovoids and subhedral megacrysts occur. Both mantled and non-mantled megacrysts rarely show euhedral outlines. Non-mantled megacrysts generally have outgrowths of fine grained potash feldspar, which tends to trail off into the interstitial spaces between groundmass minerals. Similar outgrowth textures have been described by other authors (eg. Exley and Stone, 1964). Fine to medium groundmass potash feldspar has a distinct interstitial habit, especially in relation to quartz (plate 17, fig. 1). Many authors consider the two habits (megacrysts and interstitial groundmass material) as two generations of potash feldspar (Wahl, op. cit.; Eskola, 1928, 1956; von Eckermann, 1937; Turner and Verhoogen, 1962; Volborth, op. cit.; and Dawes, 1966).

A preliminary investigation of the structural states of potash feldspar in both habits indicates that the megacrysts are intermediate between orthoclase (monoclinic) and microcline (triclinic), but that the groundmass material is distinctly microcline.

Microscopically, potash feldspar may be cross-hatched or twinned according to the Carlsbad Law. It is typically perthitic and commonly occurs as "film" or "vein" perthite. Coarse "patch" perthite textures are also a common feature, the patches comprising lamellar twinned albite (Plate 17, figs. 2 and 3). Incipient clay mineral alteration is responsible for the dustiness, and in some cases extensive clouding, of feldspar grains.

Megacrysts invariably contain fine grained, randomly distributed quartz, plagioclase, and less commonly biotite inclusions. (Plate 16, all figs.) The shape of the quartz and plagioclase inclusions is quite variable, a feature attributed by Voll (op.cit.) to the degree of misfit of host and inclusion lattices. Popoff (1928) considered the indefinite shaped, curved-sided quartz inclusions (aussenkonkave quartz - Vogt, 1921) as eutectic quartz. Erdmannsdorffer (1949) thought they were partly metasomatic, and Terzaghi (1940) described them as replacement veinlets. Plagioclase inclusions are generally subhedral, and comprise clear albite mantles around clouded cores. Biotite inclusions are invariably euhedral, and are rimmed partly by quartz and partly by fine sericite (Plate 17, fig.5). This may represent a "reaction" rim.

In some specimens, potash feldspar may be replaced to a minor extent by skeletal "late" muscovite, generally along cleavages (Plate 17, fig.6). This type of replacement is common in the miarolitic granophyre, where the host rock has been subject to extensive greisenisation (see p. 8).

Plagioclase is green coloured in unweathered specimens, and creamish-white when weathered Plagioclase megacrysts are commonly subhedral and may show pronounced oscillatory zoning, even in hand specimens (Plate 17, fig. 7). The cores of such grains may be strongly kaolinised. Removal of the clay mineral by weathering processes leaves holes in the exposed surface of the rock, producing a peculiar pitted texture (Plate 10, fig. 3). Rare ovoid megacrysts comprise an inner intergrowth of bleb-like and vermicular quartz with plagioclase, surrounded by a quartz-free outer zone of plagioclase (Plate 17, fig. 8).

Microscopically, plagioclase is commonly lamellar twinned, and may be oscillatorily zoned. In some grains there is preferential sericitisation along cleavages (Plate 17, fig. 9). Many apparently unzoned grains have clear albite mantles against potash feldspar but not against other minerals. Schermerhorn (op. cit.) and Ramberg (op. cit.) have reported similar textures.

Browne (op. cit.) reported a range in composition from An_{40} in the core, to An_{15} in the outer zones of many zoned grains. In some, the margins were determined to be as sodic as An_{10}.

The <u>quartz</u> of the Porphyritic Granite (and other phases of the Encounter Bay granites) has a distinctive opalescent blue colour. It occurs as subhedral or euhedral megacrysts and groundmass grains, and is invariably free from all inclusions but what are thought to be fluid bubbles. Fine, interstitial potash feldspar occupies the spaces between quartz (Plate 18, fig. 3). Many grains show undulose extinction, and some are cross-fractured.

<u>Biotite</u> occurs predominantly as coarse individuals, but also as interstitial aggregates of fine to medium randomly oriented laths, and as fine inclusions in feldspar megacrysts. Many individual laths have a skeletal appearance, and contain fine, euhedral muscovite inclusions, which are often aligned parallel to the biotite cleavage (Plate 18, fig. 5). Schermerhorn (op. cit.) described muscovite of similar habit an "early" muscovite, as distinct from "late" muscovite which occurs as a product of late stage greisenisation.

Chlorite appears as an alteration product at the edges of some of the biotite laths. The extent of chloritisation varies with different specimens of the Porphyritic Granite.

Fine rutile granules, which may be by-products of the chloritisation process, are often associated with the altered biotite. Oxidation of ilmenite inclusions in biotite, according to the equation...

$$\underset{\text{ilmenite}}{3FeO.TiO_2} + \tfrac{1}{2}O_2 \longrightarrow \underset{\text{magnetite}}{Fe_3O_4} + \underset{\text{rutile}}{3TiO_2}$$

may be responsible for at least part of the rutile present. Schermerhorn (op.cit.) reported large numbers of rutile granules, and segregation of sphene granules and aggregates along the cleavage in decomposing biotite.

Accessory minerals include fine zircon and apatite, ilmenite, haemetite, muscovite, chlorite and rutile.

"Early" muscovite occurs as euhedral laths and needles in biotite, whereas "late" muscovite is interstitial in habit, and occurs as flakey aggregates at grain boundaries and as skeletal replacement growths in potash feldspar grains. Zircon and apatite commonly occur as subhedral inclusions in biotite. Fine sericite is a frequent alteration product of feldspar. Sangenetic ilmenite is developed along biotite cleavages, and may cluster around fine zircon inclusions. It sometimes forms a rim around individual biotite laths. Acicular haemetite may occur along biotite cleavages.

Certain sulphide minerals, including pyrite and pyrrhotite, are accessory minerals in most parts of the Porphyritic Granite, but are present in greater abundance in certain localities (see p.31). X

There is considerable variation in texture and mineralogy of the Porphyritic Granite at Port Elliot, as demonstrated in Table I and Figure I. Specimens collected near 55 (Plate 2) are monzonitic in composition, compared with those of adamellitic and granitic compositions collected from other areas. However, there is a predominance of granitic compositions (see Table I).

In the vicinity of Green Bay, in association with Even grained Granite, the Porphyritic Granite has a markedly finer grain size than elsewhere, although the distinct porphyritic texture persists. (Plate 18, figs. 7 and 8). The Porphyritic Granite adjacent to the Even grained Granite north-east of Commodore Point does not have a particularly fine grain size. Microscopically, the granite at the former locality (eg. sample 461) shows an abundance of coarse myrmekitic - fine micrographic quartz-feldspar intergrowths, which often form sharply bounded zones about euhedral feldspar cores (Plate 18, fig.1). Savolahti (1956) and Shelley (1966) have reported similar textures.

TABLE I

Porphyritic Granite

Sample numbers Constituent.	480	478.	481.	479.	455.	461.
K-feldspar	40.9	39.2	40.4	35.6	31.1	38.5
Plagioclase	17.7	21.2	16.5	23.3	25.1	21.2
Quartz	33.9	30.8	34.2	32.1	31.1	29.4
Biotite.	7.5	8.9	8.9	8.9	12.4	10.9

In certain parts of the Porphyritic Granite there is a marked abundance of ore minerals (see p. 31; Plate 19, all figs.). These areas can be distinguished by the presence of iron-stained blotches, which are the result of alteration of the ore minerals. Most of these areas have at some time been quarried.

Albitised Porphyritic Granite

Specimens of this phase of the Porphyritic Granite commonly show evidence of deformation, in the form of corroded mineral boundaries and peripheral granulation, and fractures and undulose extinction in quartz grains. Biotite occurs as interstitial aggregates of fine, ragged laths, which are notably free from inclusions. Albite, the only feldspar present, is characterised by both spindle-type lamellar twinning and chess-board twinning (Plate 20, figs. 1, 2 and 3).

Chess-albite grains are only very slightly dusted by clay mineral alteration.

Lamellar twinned albite grains are generally considerably altered to clay mineral and sericite. In some instances, the spindle-shaped twins are kinked or bent.

Even Grained Granite

Mineralogically, the Even grained Granite is quite uniform (Table 2), but there are slight textural differences between specimens from different outcrops. In the vicinity of Green Bay, the granite contains distinctly granular quartz (approximately 1mm. diameter) which is not apparent in that north-east of Commodore Point. At the latter locality, the quartz tends to be anhedral and coarser grained, and there are megacrysts of it and potash feldspar sparsely distributed through the granite

Here, the Porphyritic Granite - Even grained Granite, and the Red Aplite - Even grained Granite contacts are gradational over some 30-40'. Specimens collected from the transition zone between the Even grained Granite and the Red Aplite show a development of micrographic quartz potash feldspar intergrowths.

The potash feldspar in the Even grained Granite has many of the textural features of that in the Porphyritic Granite. It occurs as medium grained euhedra as well as fine grained material of interstitial habit. Clouding by a clay mineral is ubiquitous, and there are commonly small opaque mineral grains associated with the clay. Mymekitic growths are common (Plate 20. fig. 9). Small, often disjointed albite grains, occurring at potash feldspar - potash feldspar boundaries (Plate 21, fig. 3) may be the result of migration of exsolved albite to grain boundaries (see Ramberg, op. cit.). Irregular, fine quartz inclusions are common in potash feldspar grains. In some instances, there are skeletal growths of "late" muscovite replacing potash feldspar (Plate 20, fig. 7).

Plagioclase occurs as fine to medium anhedral grains, which are generally finer than quartz and potash feldspar. Many grains are oscillatorily zoned, with clear rims surrounding sericitised inner zones (Plate 21, fig. 2). Sericitisation is mainly confined to the cores of such grains, but may affect alternate zones towards the periphery. Some plagioclase grains have albitic mantles where in contact with potash feldspar. This phenomenon has been attributed to the decalcification of the plagioclase (Drescher-Kaden, op.cit.; Schermerhorn, op. cit.) and to the growth of plagioclase at the expense of the adjacent potash feldspar (Watt, 1965). The composition of the plagioclase in the Even grained Granite varies from An_{25} to An_{30}.

Megascopically, quartz occurs as granular anhedra (especially in the granite in the vicinity of Green Bay), and as fine anhedral inclusions in feldspar grains. In thin section, quartz grains are generally anhedral with sutured borders, but in contact with potash feldspar, they may have euhedral outlines.

Biotite is present as interstitial fine to medium aggregates, with which sangenetic ilmenite, and laths and needles of muscovite are commonly associated. Skeletal, individual biotite plates are less common. The primary accessories, zircon, ilmenite and apatite appear to be always associated with biotite (Plate 21, fig. 5). In one instance, a complexly zoned, euhedral apatite grain was observed (Plate 21, fig. 4). There is only minor alteration of biotite to chlorite.

TABLE II

Even grained Granite

Sample number	410	453	459
Constituent			
K-feldspar	42.5	47.9	42.9
Plagioclase	19.4	17.7	19.3
Quartz	32.9	31.1	33.4
Biotite	5.2	3.3	4.4

Albitised Even grained Granite

The Albitised Even grained Granite is texturally identical with the un-albitised Even grained Granite. Mineralogically it consists of quartz, chess- and lamellar twinned albite, and interstitial, closely knitted aggregates of fine biotite plates. As in the Albitised Porphyritic Granite, there is abundant evidence of deformation and recrystallisation, in the form of peripheral granulation and sutured boundaries, and undulose extinction in quartz.

Red Aplite.

The aplite, which crops out north-east of Commodore Point, is generally fine to medium grained, although there are some variations in grain size. The brick-red colour of the potash feldspar is a characteristic feature of the phase. White plagioclase, opalescent blue quartz and subordinate to rare biotite also occur, with muscovite and ore minerals present in very minor amount. Graphic intergrowths (which are thought to represent eutectic crystallisation) of quartz and potash feldspar, and less commonly quartz and plagioclase, are also characteristic of the phase. Cross-hatched and perthitic potash feldspar grains are commonly partly replaced along cleavages and twin planes by skeletal growths of "late" muscovite (Plate 22, figs. 1 and 2). "Late" muscovite occurs as interstitial anhedra as well. Quartz grains show undulose extinction, and there are a few which have granulated borders. Plagioclase has a composition of about An_{10}.

TABLE 3

	Porphyritic Adamellite (Granite Island)	Even grained Granite (Port Elliot)		Red Aplite (Port Elliot)
SiO_2	68.20	75.48		76.65
Al_2O_3	15.99	12.99		12.98
Fe_2O_3	0.89	0.25		0.25
FeO	2.58	0.85		0.32
MgO	0.80	0.13		nil
CaO	2.61	0.74		0.40
Na_2O	2.85	2.31		2.64
K_2O	4.60	6.06		6.18
H_2O	0.64	0.60		0.29
H_2O	0.21	0.17		0.17
TiO_2	0.58	0.12		0.11
sub-totals	99.95	99.70	total	99.99

(analyses after Browne op. cit.)

Note: Significant oxide variations have been underlined.

Chemically, the aplite is almost identical with the Even grained Granite (Table 3), but mineralogically, the two phases are quite distinct. A comparison of the chemistry (Table 3) and the mineralogy (Table 4) of the Porphyritic Granite, the Even grained Granite and the Red Aplite, north-east of Commodore Point, indicates a close relationship between the three, probably of the form of a crystallisation differentiation sequence.

TABLE 4

	Porphyritic Granite	Even grained Granite	Red Aplite
Sample numbers	480	410	49
Constituent			
K-feldspar	40.9	42.5	53.1
Plagioclase	17.7	19.4	21.0
Quartz	33.9	32.9	24.4
Biotite	7.5	5.2	1.5

Albitised Red Aplite

Mineralogically, the Albitised Aplite consists predominantly of albite, with quartz and subordinate biotite. The quartz is a bleached, pale opalescent colour, and the biotite a dull yellow-brown. The unusual colours of these minerals is evidently a result of the albitisation. Albite occurs as both chess- and lamellar twinned grains, which may be clouded by clay minerals. Lamellar albite grains may be extensively sericitised . Both albite and quartz have highly sutured grain boundaries, and quartz especially, shows undulose extinction and peripheral granulation. Biotite, when present, occurs as interstitial aggregates of fine laths.

The dark coloured bands or layers within the Albitised Aplite (see pp.9,23) consist of fine biotite and dark coloured clay minerals(?).

A comparison of modal analyses of the Red Aplite and the Albitised Aplite is presented in Table 5.

TABLE 5.

	Red Aplite	Albitised Aplite
Sample number	49	48
Constituent.		
K-feldspar	53.1	nil.
Plagioclase	21.0	75.5
Quartz	24.4	24.5
Biotite	1.5	nil.

Greisenised Miarolitic Granophyre.

Texturally, this buff-coloured , fine grained phase is similar to the Red Aplite, except for the presence of miarolitic cavities, and the abundance of quartz-potash feldspar graphic intergrowths. The miaroles have been filled with euhedral aggregates of quartz, muscovite and minor albite, as a result of late stage greisenisation (Plate 22, figs. 5). Less commonly, tourmaline and ore minerals (see p. 31) occur within the miaroles.

Muscovite occurs as skeletal growths replacing potash feldspar along cleavages and twin-plane boundaries (Plate 22, fig.6), and as coarse, radiating aggregates within miarolitic cavities. This is "late" muscovite, which is associated with biotite in the Porphyritic and Even grained Granites as fine, euhedral laths (Schermerhorn, op.cit.)

Adjacent to some miaroles, muscovite has replaced potash feldspar to such an extent that a quartz-muscovite graphic intergrowth occurs, in place of the original quartz-potash feldspar intergrowth. In the latter, the quartz has a typically irregular grain shape, whereas in the former it tends to be quite rounded (Plate 22, fig. 7). The change in grain shape is evidently an effect of interfacial surface tensions.

Plagioclase grains are clouded by both clay minerals and sericite. They are invariably lamellar twinned, rarely intergrown in graphic fashion with quartz, and may have myrmekitised borders. Textures suggesting corrosion and replacement of plagioclase by quartz, in step-like fashion, parallel to twin boundaries, were noted in thin section. Watt (op. cit.) described similar textures from granites in Quaersuassak, South Greenland. The composition of the plagioclase in the granophyre is approximately An_6.

Haemetite, the predominant ore mineral in this phase, has been extensively altered to limonite, and persists only as skeletal remnants (Plate 23, figs. 1, 2 and 3). It is always associated with late stage quartz and muscovite. Fine pyrite occurs much less commonly.

Minor Phases.

1. Potash Aplite Dykes

These are buff-coloured, fine grained dyke rocks, distinctly finer grained than the Red Aplite, with medium grained megacrysts of feldspar and blue opalescent quartz, and a characteristic granular texture. Their contacts with the Porphyritic Granite are sharp. (1-2 mm.)

The aplite dyke at 21 (Plate 2) has a distinctive fine graphic texture. A particularly interesting feature of this dyke is the "cauliflowering" of fine quartz-potash feldspar intergrowths into the dyke from its contacts with the porphyritic granite (Plate 23, fig.4). In addition, there is a notable occurrence of interstitial muscovite. Graphic textures are lacking in other aplite dykes (60, 65 etc; Plate 2). All, however, have abundant myrmekite, and are mineralogically very similar. Potash feldspar and plagioclase are invariably dusted by clay mineral alteration, and plagioclase grains may be extensively sericitised. Biotite occurs as interstitial aggregates of fine laths, which are commonly partly chloritised. Fine muscovite anhedra are associated with these aggregates.

A former Potash Aplite at 27, 33 (Plate 2) has been albitised (see p. 7). Texturally it is identical to the aplites described above, but mineralogically, it consists only of albite and quartz. Albite occurs as both chess-and lamellar twinned grains, which are dusted by clay mineral lateration. Quartz is typically anhedral, with extensively sutured and granulated boundaries, and biotite occurs in minor amount as bleached, yellow-brown interstitial aggregates, with zircon and rutile inclusions, and associated fine muscovite laths. The rutile appears to be a by-product of biotite alteration initiated during albitisation.

2. Potash Aplite Pods

These are fine grained, pink coloured, potash feldspar-rich inclusions in the Porphyritic Granite. They have a characteristic fine graphic texture, colourless quartz, and sharp contacts with the Porphyritic Granite (less than 5 mm.)

Potash feldspar is the most abundant mineral constituent, and occurs as corss-hatched, perthitic grains, invariably clouded, and with small subhedral quartz inclusions. Plagioclase occurs as lamellar twinned grains with considerably sericitised cores. Quartz may be quite euhedral against potash feldspar. Biotite, as interstitial aggregates, has fine ilmenite inclusions, and may be extensively chloritised. Numbers of fine rutile (?) needles are commonly associated with the chloritised biotite. Quartz-potash feldspar graphic intergrowths are abundant. Many of the aplite pods contain interstitial "late" muscovite.

3. Fine grained Intrusive Granite

As described on p.9, this Fine grained Granite crops out east of Green Bay. It is a grey coloured, generally fine grained phase, but near its borders contains medium grained feldspar and quartz megacrysts, due to contamination by the Porphyritic Granite. Microscopically, both plagioclase and potash feldspar grains are heavily kaolinised, and many plagioclase grains are considerably sericitised as well. Biotite occurs as aggregates of laths, with inclusions of fine zircon and sangenetic ilmenite (Plate 23, figs. 7 and 10). Fine muscovite-sericite tends to form rims around many biotite flakes. Quartz grains are invariably anhedral and have undulose extinction.

4. Dyke-like Albitised Porphyritic Microgranite.

The field relations of this phase have been described on p. 9. It is a pinkish-white, albitised phase, with a fine grained groundmass containing coarse sub-rounded megacrysts of blue opalescent quartz and white albite. It is difficult to know whether the megacrysts are the early crystallisation products of the phase, or the result of contamination by the Porphyritic Granite. Biotite is present in minor amount as aggregates of fine flakes.

Albite is the predominant constituent, and occurs microscopically as fine and medium to coarse chess- and lamellar twinned albite grains. The chess-twinning in the albite megacrysts is very coarse. Quartz megacrysts have sutured borders, and in some cases, inwardly protruding "tongues" of groundmass material. Many of the quartz megacrysts are quite dusty due to clay mineral inclusions. Biotite occurs as interstitial aggregates of fine laths, which may be partially chloritised. Many plates contain limonitised opaque mineral, and fine zircon inclusions. Groundmass quartz and albite grains are quite anhedral, and have very irregular borders.

Xenoliths

1. Microgranitic Inclusions

Although these have been grouped with aplitic and schorl-rock pods as "cognate" xenoliths in the preceding section (see p. 6) many of the microgranitic inclusions may be modified quartzitic country rock inclusions. Much of the country rock adjacent to the granites, at Middleton Beach and in the quarries in the hills behind Port Elliot, is in fact quartzitic. The inclusions are pink-red coloured and fine grained, and may contain megacrysts of blue quartz, plagioclase, and potash feldspar. There is considerable variation in grain size between different microgranitic inclusions.

The microscopic features of the mineral constituents are common to most of the phases described so far. Potash feldspar is typically perthitic, and many grains show cross-hatched twinning. "Patch" perthite is common (Plate 23, fig. 9). Plagioclase grains are lamellar twinned, and quartz occurs as fine and medium anhedra. Biotite is present as aggregates of fine to medium skeletal laths, which may be extensively chloritised. Inclusions of zircon, apatite and ilmenite are common in biotite, and acicular muscovite may be present along biotite cleavages. There are also rare euhedral inclusions of tourmaline.

2. Layered Hornfels Inclusions

Where essentially unmodified, these consist mineralogically of quartz, plagioclase and biotite, and are fine and even grained. The layering is due to an alternation of biotite-rich and biotite-poor bands, and may represent original sedimentary compositional differences.

Amphibolite

The amphibolite is fine to medium grained, and has an ophitic texture comprising euhedral plagioclase laths in a matrix of amphibole. The amphibole occurs both as plates showing good cleavage, and dark green to pale green pleochroism, and as bunches of green fibres. Ragged, anhedral grains of opaque ilmenite and haemetite occur in random arrangement through the rock. In many instances, haemetite and rutile are present as exsolution lamellae in ilmenite grains (Plate 24, figs. 1 & 2).

Ilmenite is the most abundant of the three, and may be completely free of exsolution textures (Plate 24, fig. 3). In some parts of the thin section, there are relict pyroxene grains in which ilmenite has grown along cleavages, producing a cross-hatched texture. Anhedral zircon is quite abundant, and commonly associated with the opaque minerals.

(2) GRANITE ISLAND

Porphyritic Adamellite

Texturally, this is very similar to varieties of the Porphyritic Granite east of Rocky Cove, Port Elliot, except that it tends to be coarser grained. Mineralogically, it contains considerably higher biotite and plagioclase than the Port Elliot granite.

The modal variability of the Porphyritic Adamellite is represented in Table 6. An analysis of one variety of the Port Elliot Porphyritic Granite has been included for comparison.

TABLE 6.

	Granite Island Porphyritic Adamellite				Port Elliot Porphyritic Granite
Sample numbers	333	330	328	326.	478
Constituents					
K-feldspar.	27.2	27.4	29.0	28.5	39.2
Plagioclase	26.5	28.2	25.9	25.0	21.2
Quartz	32.1	30.9	27.8	32.4	30.8
Biotite	14.3	13.5	17.3	14.2	8.9

Potash feldspar occurs as coarse, perthitic megacrysts, and fine interstitial material, which may form outgrowths from the megacrysts. Many megacrysts have outer zones of quartz inclusions, and may be mantled by plagioclase. In those examples where the mantle is a single crystal of plagioclase, the potash feldspar core is considerably poikilitic, with fine plagioclase inclusions. These are distinct from other mantled megacrysts, in which the mantle comprises a number of plagioclase grains. The significance of these two mantling types is not clear. "Patch" perthite occurs at the edges of some megacrysts, and may represent replacement by plagioclase.

Cross-hatched twinning is not a feature of potash feldspar megacrysts, but is confined to smaller grains and interstitial material. This may be related to the fact that many of the megacrysts are structurally intermediate between microcline and orthoclase, and that the interstitial material is triclinic microcline, as in the Port Elliot Porphyritic Granite (see p. 1).

Fine inclusions of quartz, plagioclase and biotite are common in the megacrysts, and are generally randomly oriented. They may also occur in zonal arrangement. Fine plagioclase inclusions have sericitised cores and clear borders which may be myrmekitised. Quartz inclusions seem to be more abundant than in megacrysts from the Port Elliot Porphyritic Granite, and may be bleb-like, vermicular, or string-like in shape. "String" quartz is commonly developed along irregular simple-twin composition planes (Plate 24, fig. 5).

Plagioclase grains are mostly subhedral or euhedral, and may have fine biotite and quartz inclusions. Microscopically, many plagioclase grains are oscillatorily zoned and untwinned, or have very fine lamellar twinning (Plate 24, fig. 8) . This is in agreement with the observations of Emmons and Mann (1950), who concluded that polysynthetic twinning replaces, and is consequent on oscillatory zoning. Several of the intermediate zones of oscillatorily zoned grains have fine bleb-like and vermicular quartz inclusions.

Lamellar twinned, progressively zoned grains are also common, Progressive zoning is also superimposed on many oscillatorily zoned grains. Relict zoning of both types is reflected by preferential sericitisation of portions of the grains, usually the more calcic portions. Sericitisation may also take place along particular twin bands of lamellar twinned grains.

Many plagioclase grains in contact with potash feldspar, have myrmekitised borders which rim euhedral, lamellar twinned cores (Plate 24, fig.10).

Quartz occurs as opalescent blue grains, which are remarkably euhedral against potash feldspar (Plate 24, fig. 4). Many grains have granulated borders, and distinctive undulose extinction. Areas of granulated quartz, in which the grains have highly sutured borders, may be interstitial between feldspars (Plate 24, fig. 7).

Biotite is present as interstitial aggregates of medium to coarse laths. Inclusions of ilmenite are common, and may occur in zones in individual laths, as partial rims, or along the boundaries between laths. Zircon and apatite are abundant as euhedral inclusions in biotite, Fine muscovite laths commonly rim biotite laths.

Numbers of fine, colourless needles of rutile (?) are associated with some biotites, and may be by-products of the alteration of the biotite (Plate 25, figs. 1, 2 and 3).

Albitised Porphyritic Adamellite

The textural and mineralogical features of this phase are almost identical to those of the Albitised Porphyritic Granite at Port Elliot, except in the case of biotite. In the albitised adamellite, biotite occurs as interstitial aggregates of fine laths, and as medium to coarse individuals. Abundant fine rutile grains are by-products of the partial chloritisation of the biotite of both habits (Plate 25, figs. 5, 6 and 7). These were rarely apparent in the biotites of the albitised phases at Port Elliot, evidently due to the lower titanium content of these biotites.

Porphyritic Albite-Quartz-Chlorite Phase.

This is a whitish-green, coarse grained, porphyritic phase, with white albite megacrysts, pale opalescent blue to colourless quartz (a marked change from the distinctive blue opalescent quartz of the Porphyritic Adamellite), and interstitial aggregates of fine chlorite.

Microscopically, albite occurs as chess- and lamellar twinned grains. The cores of some lamellar twinned grains are clouded by fine grained chlorite and clay mineral. Kinking of lamellar twin bands in albite grains is a common feature (Plate 25, fig.8).

There is considerably less quartz in this phase than in the Porphyritic Adamellite, and there are abundant quartz-albite intergrowths of peculiar appearance. These are thought to be replacement textures. Fracturing, undulose extinction, and peripheral granulation are features of many quartz grains.

Chlorite is interstitial and often developed in fractures in quartz and chess-albite. Zircon and apatite are commonly associated with chlorite. Relict biotite laths occur in minor amount. These may be extensively chloritised, or less commonly, altered completely to rutile (Plate 25, fig. 9).

Layered Country Rock Hornfels Inclusions

These are dark grey coloured, fine grained layered inclusions, in which the layers consist of an alternation of biotite-rich and biotite-poor bands of 1-2 mm. thickness. Mineralogically, the inclusions contain quartz, plagioclase, and randomly oriented biotite (and subordinate muscovite). The few plagioclase grains which are lamellar twinned have a composition of An_{25}. Of interest is the fact that some layers appear to reflect sedimentary (?) ripple marks, and fine scale current bedding.

Modified Hornfelses (See Plate 30)

1. Porphyroblastic Hornfels

This is a massive, dark grey, fine grained phase, with medium to coarse porphyroblasts of plagioclase, blue opalescent quartz, potash feldspar, and less commonly biotite. It also contains a number of dark coloured aphanitic inclusions. Kleeman (op.cit.) recognised two varieties: the "hornblende diorite", and the "quartz-mica diorite". Petrologically, both varieties are identical except for the presence or absence of hornblende, but chemically, there are significant differences between the two, as shown in Table 9.

The proportion of porphyroblasts to groundmass in the Porphyroblastic Hornfels is approximately 1:10 (see Table 8).

TABLE 8.

Sample number	Porphyroblastic Hornfels	
	331	329
Constituent		
Porphyroblasts..		
K-feldspar	1.4	1.0
Plagioclase	8.9	6.9
Quartz	0.3	1.3
Biotite	1.0	1.7
Groundmass..	88.4	89.0

Plagioclase porphyroblasts are either lath-shaped, or equidimentional, whereas fine groundmass plagioclase occurs as lath-shaped grains. Most porphyroblasts are complexly oscillatorily zoned. There is no evidence of resorption on the inner sides of the zones. According to Emmons and Mann (op. cit.), the origin of this type of oscillatory zoning is unknown. Progressive zoning occurs in many groundmass plagioclase grains, most of which are lamellar twinned. Progressive zoning appears to be superimposed upon oscillatorily zoned grains as well. Some oscillatorily zoned grains are untwinned. The average composition of the plagioclase is An_{35}.

The diversity in habit of potash feldspar is a feature peculiar to the Porphyroblastic Hornfels. It occurs as fine, generally untwinned groundmass grains, cross-hatched anhedra, slightly coarser than the groundmass, and in the cores of coarse, extremely poikilitic and non-poikilitic plagioclase mantled porphyroblasts. Microscopically, the extremely poikilitic porphyroblasts consist of a "quilt-work" pattern of structurally aligned potash feldspar and plagioclase crystallites, which are commonly rimmed by anhedral, interstitial quartz (Plate 26, fig.6). Patches of this quartz are in optical continuity. Anhedral sphene may mantle the feldspar in the same fashion as the quartz. Inclusions of hornblende and biotite, and the accessory minerals sphene, apatite and zircon are common. These inclusions are considerably coarser grained than the same material in the groundmass. In addition, there are small areas of quartz-potash feldspar graphic intergrowth within the porphyroblasts. Non-poikilitic porphyroblasts have cores of perthite potash feldspar, surrounded by an intermediate zone of "quilt-work" texture. Plagioclase mantles which surround both types of porphyroblasts, grade into the inner zones of the porphyroblasts.

Quartz porphyroblasts are generally sub-rounded, with finely corroded borders (Plate 26, fig.7). They invariably have thin mantles of potash feldspar, parts of which may protrude into the porphyroblasts.

Groundmass minerals include biotite, hornblende and sphene. Biotite commonly contains ilmenite, zircon and rutile inclusions. Hornblende is commonly twinned, and may contain sphene and zircon inclusions.(Plate 26, fig.4). It is less abundant than biotite. Anhedral sphene is abundant (Plate 26, figs. 2 & 3), and shows distinct pleochroism. The accessory minerals apatite, zircon and ilmenite are not restricted to the biotite, as in the Porphyritic Adamellite, but are quite common in the groundmass.

Table 9 comprises a comparison of chemical analyses of the two varieties of the Porphyroblastic Hornfels, after Kleeman (op.cit.).

2. Granitised Hornfels

This is a light grey coloured, fine to medium, uneven grained phase with abundant medium to coarse porphyroblasts of potash feldspar, plagioclase quartz and biotite. In addition, there are a number of xenoliths which include slightly modified, layered quartz-plagioclase-potash feldspar-biotite country rock fragments. The Granitised Hornfels is similar in appearance to the Porphyroblastic Hornfels, but it is coarser

TABLE 9

Porphyroblastic Hornfels

	"Quartz-mica diorite".	"Hornblende diorite".
SiO_2	68.60	67.10
Al_2O_3	14.30	14.32
Fe_2O_3	0.79	1.51
FeO	4.70	2.84
MgO	1.24	1.50
CaO	2.88	3.26
Na_2O	3.40	3.05
K_2O	2.28	3.26
H_2O	0.87	0.56
H_2O	0.24	0.04
TiO_2	0.59	0.89
sub-totals	100.09	99.30

(sub-totals are used because the analyses presented are incomplete)

Note: Significant oxide variations have been underlined.

in texture and contains many more porphyroblasts. The porphyroblast to groundmass ratio is considerably greater than in the Porphyroblastic Hornfels, as can be seen in Table 10.

TABLE 10.

	Porphyroblastic Hornfels	Granitised Hornfels
Sample number	329.	327.
Constituent		
Porphyroblasts.		
K-feldspar	1.0	10.4
Plagioclase	6.9	8.9
Quartz	1.3	6.5
Biotite	1.7	4.1
Groundmass	89.0	70.1

The lack of hornblende, and the paucity of sphene are conspicuous microscopic features of the Granitised Hornfels.

Potash feldspar occurs as both porphyroblasts and groundmass grains, most of the latter being untwinned. The porphyroblasts are generally ovoid-shaped and may be mantled by plagioclase. They are cross-hatched, and contain quartz inclusions, some of which form a graphic intergrowth with the potash feldspar. Biotite and lamellar twinned plagioclase inclusions also occur within the porphyroblasts.

Plagioclase porphyroblasts are invariably subhedral or euhedral, and may be oscillatorily zoned with fine lamellar twinning, or in some cases, no twinning at all (Plate 26, figs. 8 and 9). They are very similar in appearance to the plagioclase porphyroblasts in the Porphyroblastic Hornfels. Groundmass plagioclase grains are lath-shaped, and may be considerably sericitised. These commonly show progressive zoning. The average composition of the plagioclase is An_{38}.

Biotite is fine to medium grained, and generally lath-shaped, with no preferred orientation. Opaque mineral and zircon inclusions are relatively common. However, in contrast with the biotite in the Porphyroblastic Hornfels, no rutile inclusions were observed.

The common accessory minerals include apatite, zircon and opaque mineral. Apatite occurs in abundance in the groundmass as fine euhedral laths. Anhedral sphene and skeletal tourmaline are rare accessories.

The xenoliths are generally fine and even grained, with oriented biotite laths, and optically oriented patches of anhedral quartz, which resemble graphic growth. Zoned and twinned plagioclase grains, cross-hatched microcline, and accessory zircon and apatite are present as well. Fine grain-boundary myrmekite occurs in the xenoliths as well as in the groundmass of the host phase (Plate 27, fig.2).

Chemical analyses of the Granitised Hornfels and a variety of the Porphyroblastic Hornfels are presented for comparison in Table 11.

TABLE 11.

	Porphyroblastic Hornfels ("Quartz-mica diorite")	Granitised Hornfels ("Adamellite Porphyry")
SiO_2	68.60	69.06
Al_2O_3	14.30	14.28
Fe_2O_3	0.79	0.71
FeO	4.70	3.23
MgO	1.24	1.46
CaO	2.88	2.11
Na_2O	3.40	2.69
K_2O	2.28	4.59
H_2O	0.87	0.46
H_2O	0.24	0.11
TiO_2	0.59	0.70
sub-totals	100.09	99.60

(sub-totals are used because the analyses presented are incomplete).

There is a significant increase in potash (K_2O) with what is proposed as an increase in the degree of modification of the hornfelses (see pp 24 and 25): that is from the Porphyroblastic Hornfels to the Granitised Hornfels. Other oxide variations (underlined), although not as great as the variation in potash, are also thought to be related to the degree of modification.

Medium, Even grained Adamellite

This is a distinctly quartz-biotite rich adamellite, with fine interstitial potash feldspar, and medium, subhedral plagioclase grains. Many of the textural features of this phase are quite common to the Porphyritic Adamellite. However, it is quite distinct, both in mineralogy and texture, from the medium, even grained granites at Port Elliot. A comparison of modal analyses of the adamellite and one variety of the Even grained Granite from Port Elliot, is presented in Table 7.

TABLE 7.

	Even grained Adamellite Granite Island	Even grained Granite Port Elliot.
Sample number	322.	459.
Constituent		
K-feldspar	19.5	42.9
Plagioclase	20.0	19.3
Quartz	40.5	33.4
Biotite	20.0	4.4

(3) ROSETTA HEAD

Porphyritic Adamellite.

Texturally and mineralogically, this is identical to the Porphyritic Adamellite on Granite Island. It has been contaminated by inclusions of country rock to the same extent as the Granite Island adamellite. Table 12 is a comparison of modal analyses of specimens of the Granite Island and Rosetta Head Porphyritic Adamellites. Chemical analyses of specimens or Porphyritic Adamellite from both localities, are presented for comparison in Table 13 (after Bowes, op.cit.). Significant differences between the two occur only in MgO and CaO (as underlined

TABLE 12

	Granite Island Porphyritic Adamellite	Rosetta Head Porphyritic Adamellite
sample number	330	752
Constituent		
K-feldspar	27.4	30.7
Plagioclase	28.2	27.2
Quartz	30.9	26.0
Biotite	13.5	16.1

TABLE 13

	Granite Island Porphyritic Adamellite	Rosetta Head Porphyritic Adamellite
SiO_2	68.20	71.45
Al_2O_3	15.99	13.78
Fe_2O_3	0.89	0.80
FeO	2.58	2.79
MnO	0.04	0.01
MgO	0.80	1.11
CaO	2.61	1.86
Na_2O	2.85	2.74
K_2O	4.60	4.35
H_2O	0.64	0.48
H_2O	0.21	0.11
TiO_2	0.58	0.54
sub-totals	99.99	100.02

(sub-totals are used here because the analyses presented are incomplete).

As distinct from the potash feldspar megacrysts in the Port Elliot Porphyritic Granite, and in the Granite Island Porphyritic Adamellite, those in the Rosetta Head Porphyritic Adamellite are almost invariably rimmed by a quartz-potash feldspar graphic intergrowth (Plate 27, fig. 3). In addition, graphic growths are common within the megacrysts (see Browne, op.cit. and also Plate 27, fig. 4). Edelman (1949) has described similar phenomena in microcline porphyroblasts in "granitised" gneissic granites and diorites. Many megacrysts are perthitic, and show cross-hatched twinning. Some are mantled by plagioclase, in which case they do not have a graphic border.

Bowes considered the megacrysts to be intermediate in composition between microcline and anorthoclase. Optic axial angle determinations (single axis stage) indicate that at least parts of some megacrysts may be anorthoclase (see Gates, op. cit.).

Potash feldspar also occurs as fine, cross-hatched, interstitial material, with which is associated abundant grain boundary myrmekite (Plate 27, figs. 9 and 10).

Plagioclase generally occurs as subhedral, lamellar twinned grains, some of which show traces of oscillatory zoning (Plate 27, fig.8). The average composition of the plagioclase is An_{14}. In some instances, the borders of plagioclase grains are myrmekitised.

Quartz is present as opalescent blue, subhedral or anhedral megacrysts and groundmass grains. Fine anhedral quartz may be interstitial between feldspar megacrysts. Many grains have lines of fluid bubble inclusions, and show undulose extinction.

Biotite is fine to medium grained, and may occur in aggregates or as individual flakes. Fine muscovite laths, opaque mineral, apatite, and zircon are common as inclusions in biotite flakes. A peculiar feature of the biotite is its red-pale straw-brown pleochroism.

With the exception of apatite, the accessory minerals described above are preferentially associated with biotite . Apatite is commonly associated with biotite, but not invariably. Sericite and clay minerals are alteration products of feldspars, and are responsible for the clouding of feldspar grains. Chlorite occurs in minor amount as an alteration product of biotite.

Albitised Porphyritic Adamellite

Varieties of this phase have been described in relation to Port Elliot and Granite Island. The characteristic features of this phase at Rosetta Head are..

(1) Colourless to very pale opalescent quartz, compared with the distinctive opalescent blue colour of the host phase quartz.

(2) Chess-albite.

(3) Colourless to pale brown phlogopite, which is littered with pale yellow to colourless rutile needles and granules. (Plate 28, figs. 1 and 2)

(4) Alteration of phlogopite to pennine (which has anomalous blue birefringent colours).

(5) An abundance of fine to medium grained, red-brown rutile.

Quartz is invariably anhedral, and occurs in mosaics and as individual grains. Undulose extinction is a common feature. Fine grained anhedra and present as inclusions in chess-albite megacrysts.

Chess-albite megacrysts and groundmass grains are common. Lamellar twinned albite, of average composition An_9, is present as well.

Phlogopite occurs as interstitial aggregates of fine grained plates and laths, which have very pale pleochroic colours. The numbers of rutile inclusions within the plates is remarkable. Acicular inclusions are commonly aligned parallel to the cleavages. Zircon inclusions, with pleochroic haloes, are quite abundant.

Porphyritic Albite-Chlorite-Quartz Phase.

Although albite is the major constituent, there are variations in relative abundance of constituents from one locality to another. Where chlorite is the major constituent, the rock is generally medium, even grained. Chlorite albite phases are evidently the result of albitisation of country rock inclusions within the Porphyritic Adamellite. The characteristic features of the Porphyritic Albite-Chlorite-Quartz Phase are ...

(1) Chess-albite, and lamellar twinned albite, which occur as megacrysts and groundmass grains. Many grains are fractured and granulated, and some have bent twin lamellae. (plate 28, fig. 3).

(2) Chlorite, as interstitial aggregates of laths, with inclusions of rutile, apatite and zircon (Plate 28, fig. 5).

(3) Subordinate phlogopite, commonly littered with fine rutile needles and granules (Plate 28, fig. 4). Phlogopite may be absent in some samples.

(4) An abundance of fine to medium, red-brown rutile grains, which are invariably associated with chlorite.

(5) Colourless quartz, which occurs in only minor amounts.

Amphibolites

These fine grained dyke-rocks have distinctive relict ophitic textures. Mineralogically, they consist predominantly of hornblende, and plagioclase (composition An_{60}), with rare biotite. Ilmenite haematite and apatite are accessory constituents.

Hornblende occurs as a dense mass of green pleochroic plates and laths, filling the interstitial spaces between lamellar twinned plagioclase laths. Many plagioclase laths are dusted by clay mineral alteration. Ilmenite is common, and occurs as discrete grains, or as fine inclusions in hornblende (Plate 28, fig. 9). Haematite is commonly associated in ilmenite. Apatite is present as fine needles.

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ANITES

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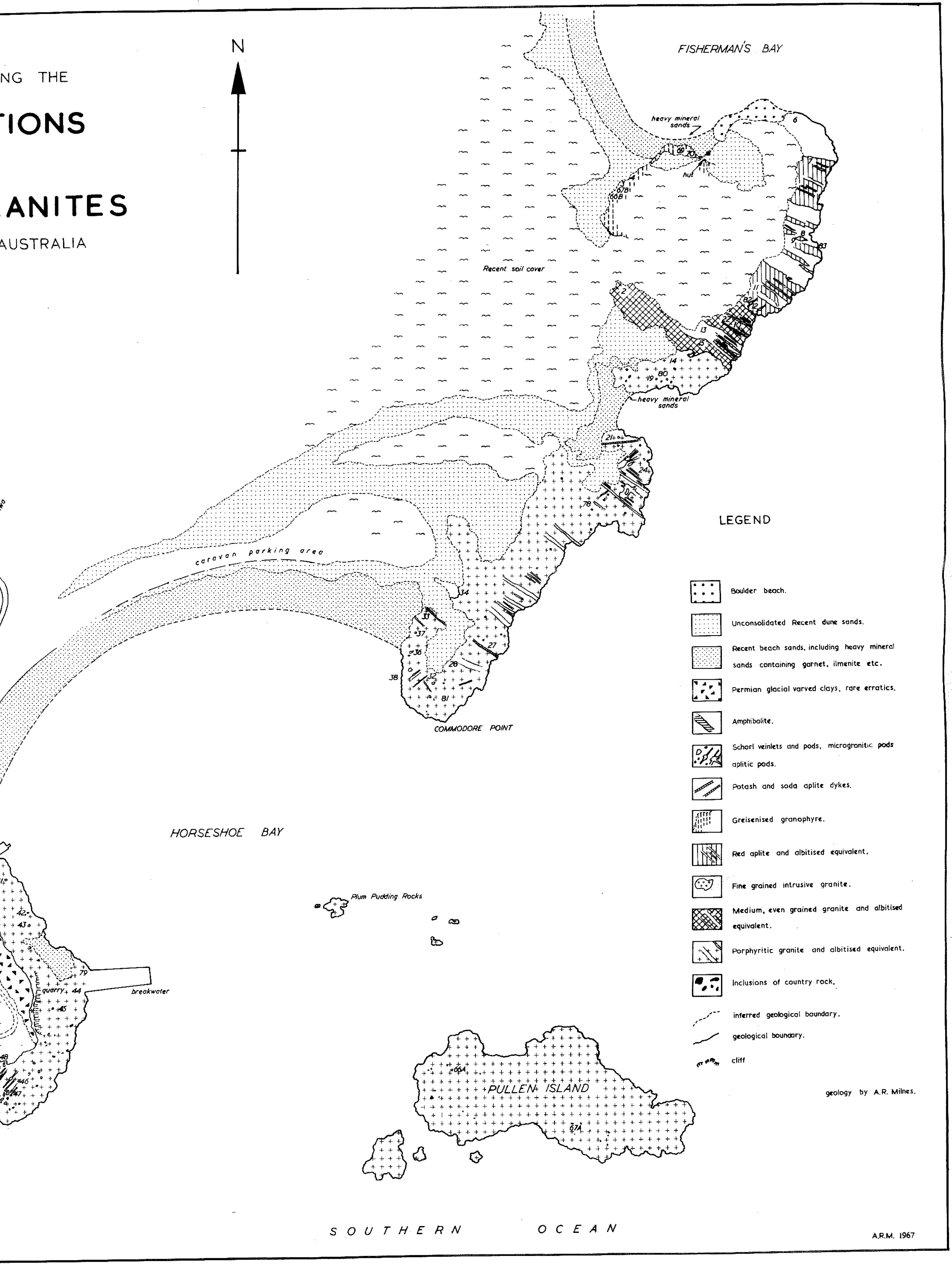


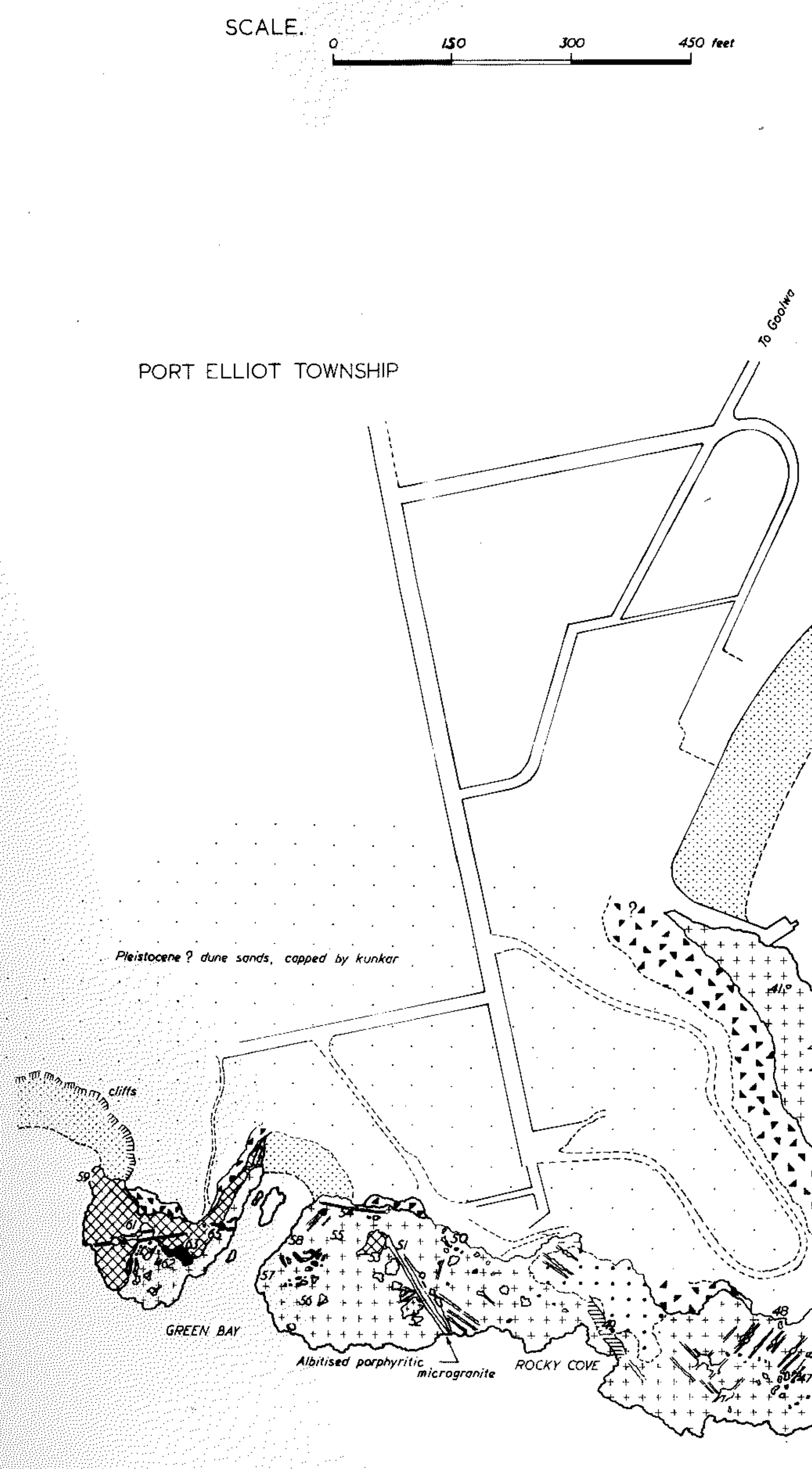
GEOLOGICAL MAP SHOWIN

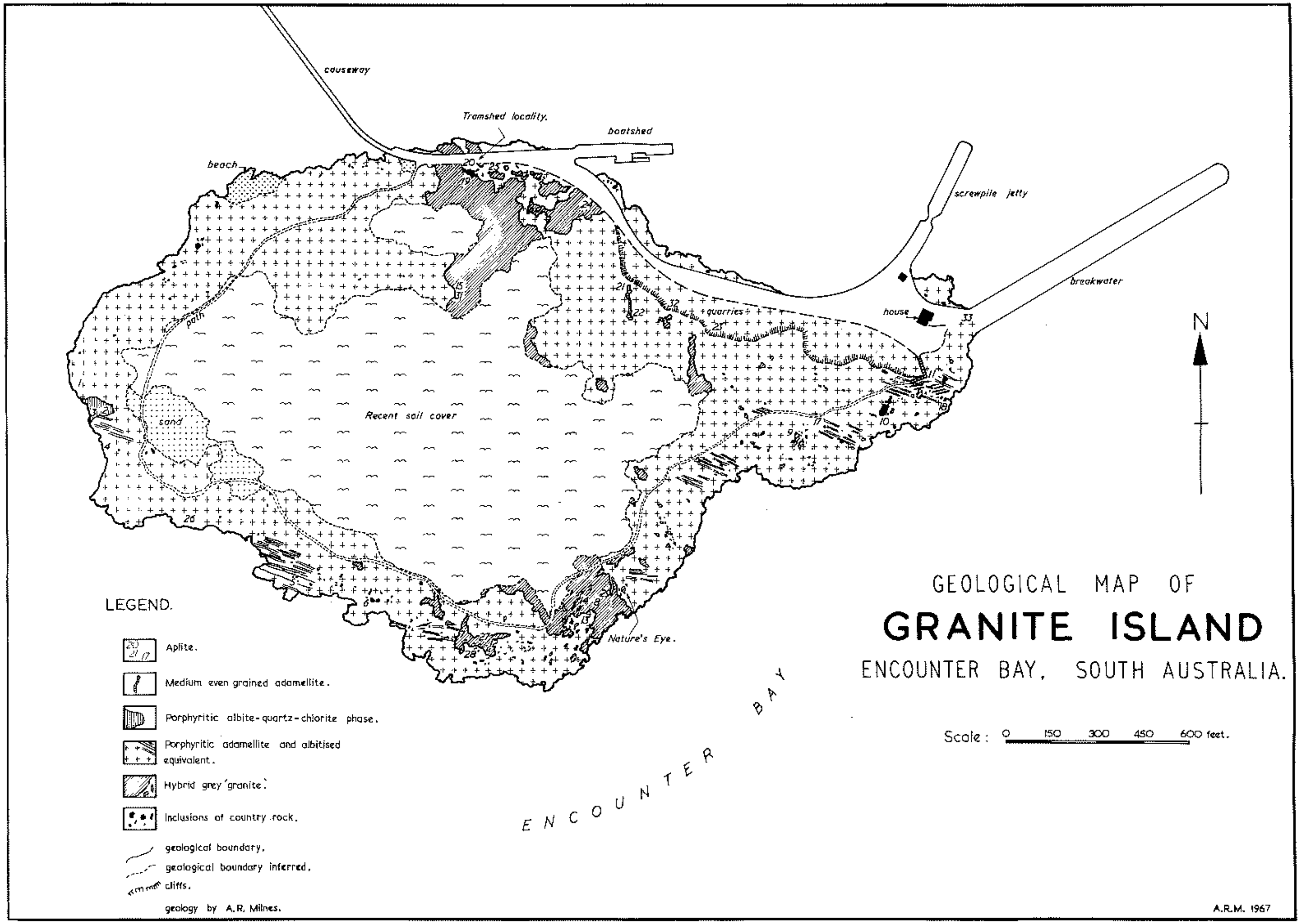
FIELD RELAT

OF THE

PORT ELLIOT GR

ENCOUNTER BAY SOUTH A

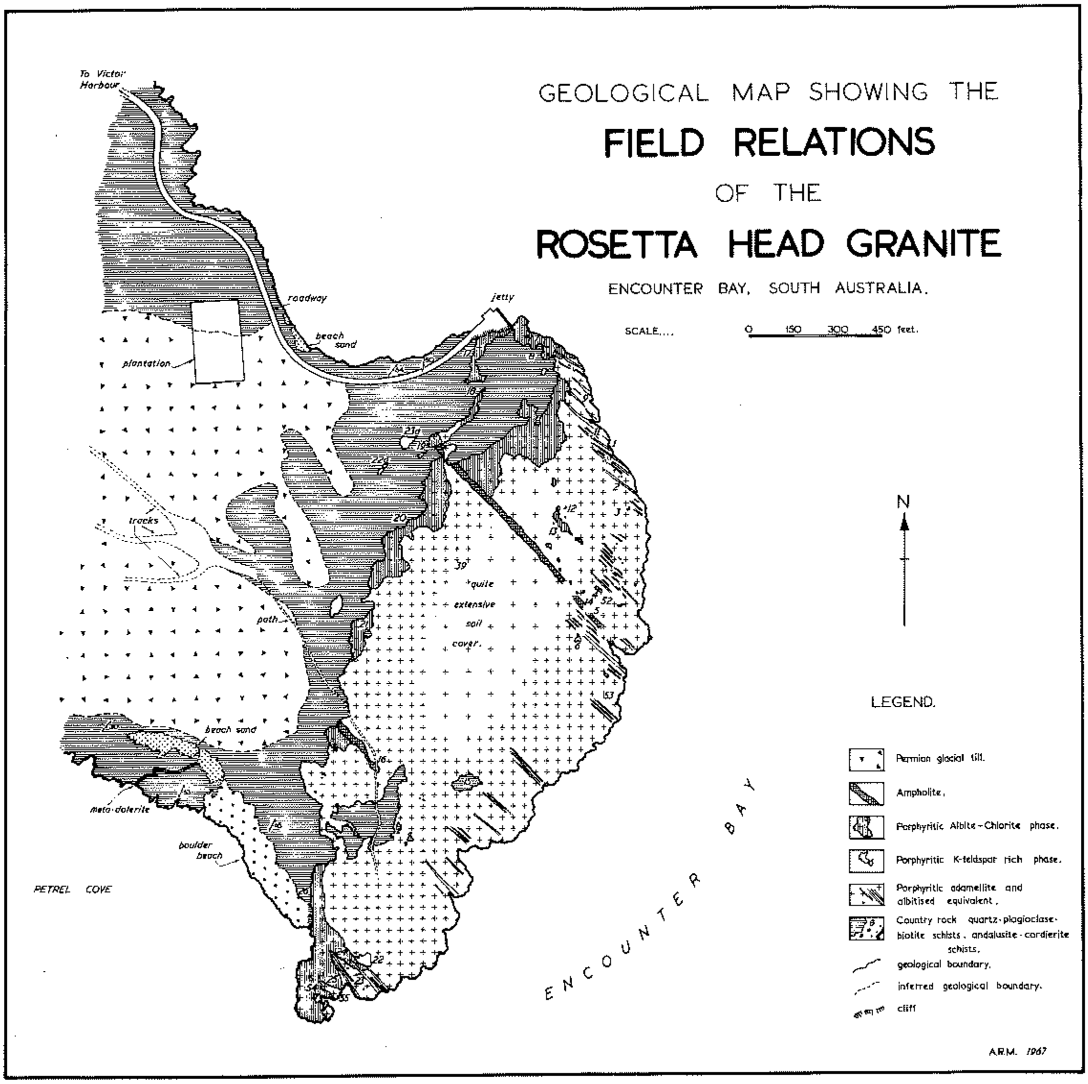




GEOLOGICAL MAP OF

GRANITE ISLAND

ENCOUNTER BAY, SOUTH AUSTRALIA.



GEOLOGICAL MAP SHOWING THE
FIELD RELATIONS
OF THE
ROSETTA HEAD GRANITE
ENCOUNTER BAY, SOUTH AUSTRALIA.

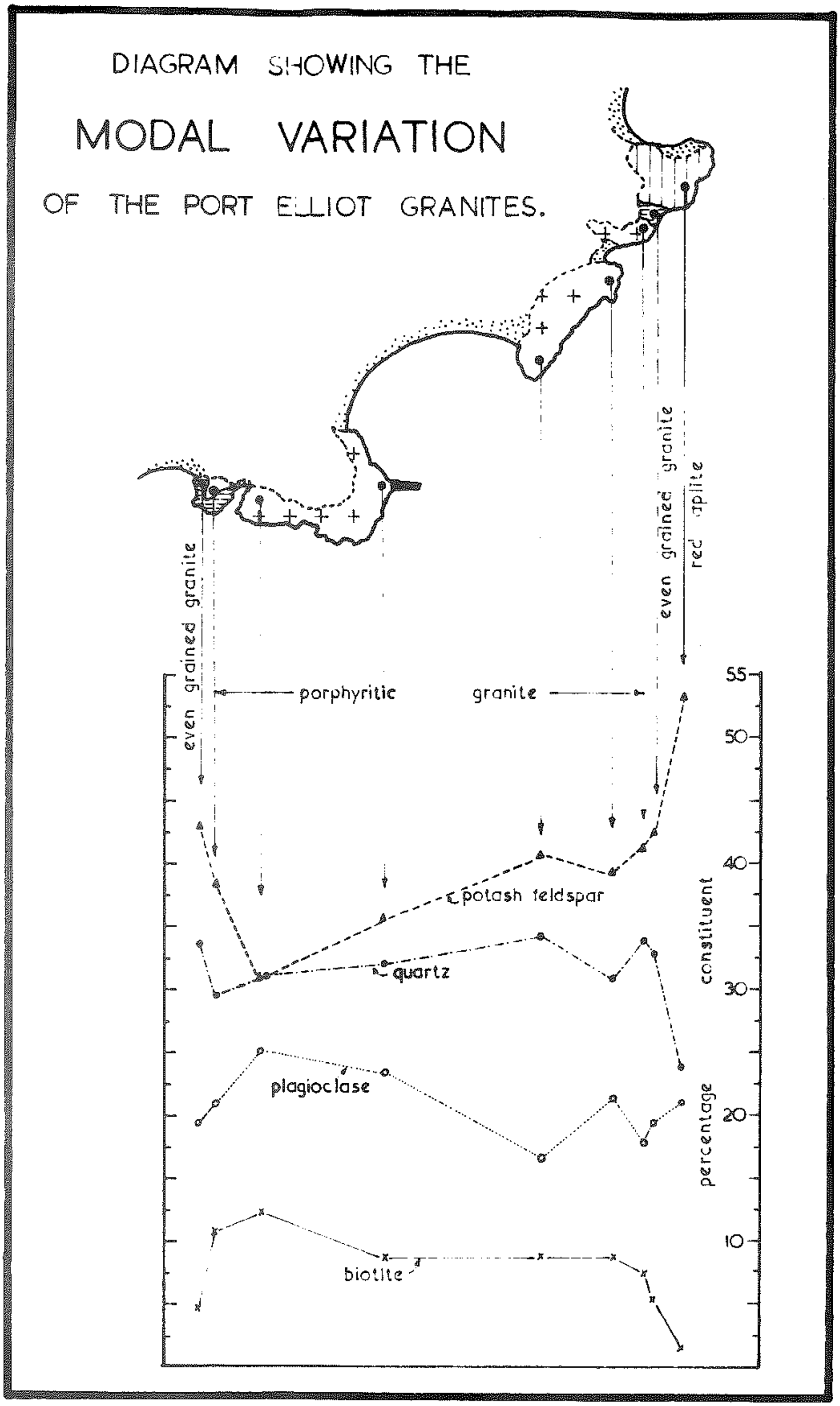


DIAGRAM SHOWING THE
MODAL VARIATION
OF THE PORT ELLIOT GRANITES.
even grained granite
even grained granite
red aplite
porphyritic
granite
potash feldspar
quartz
plagioclase
biotite
percentage constituent
55
50
40
30
20
10

FIG. 1

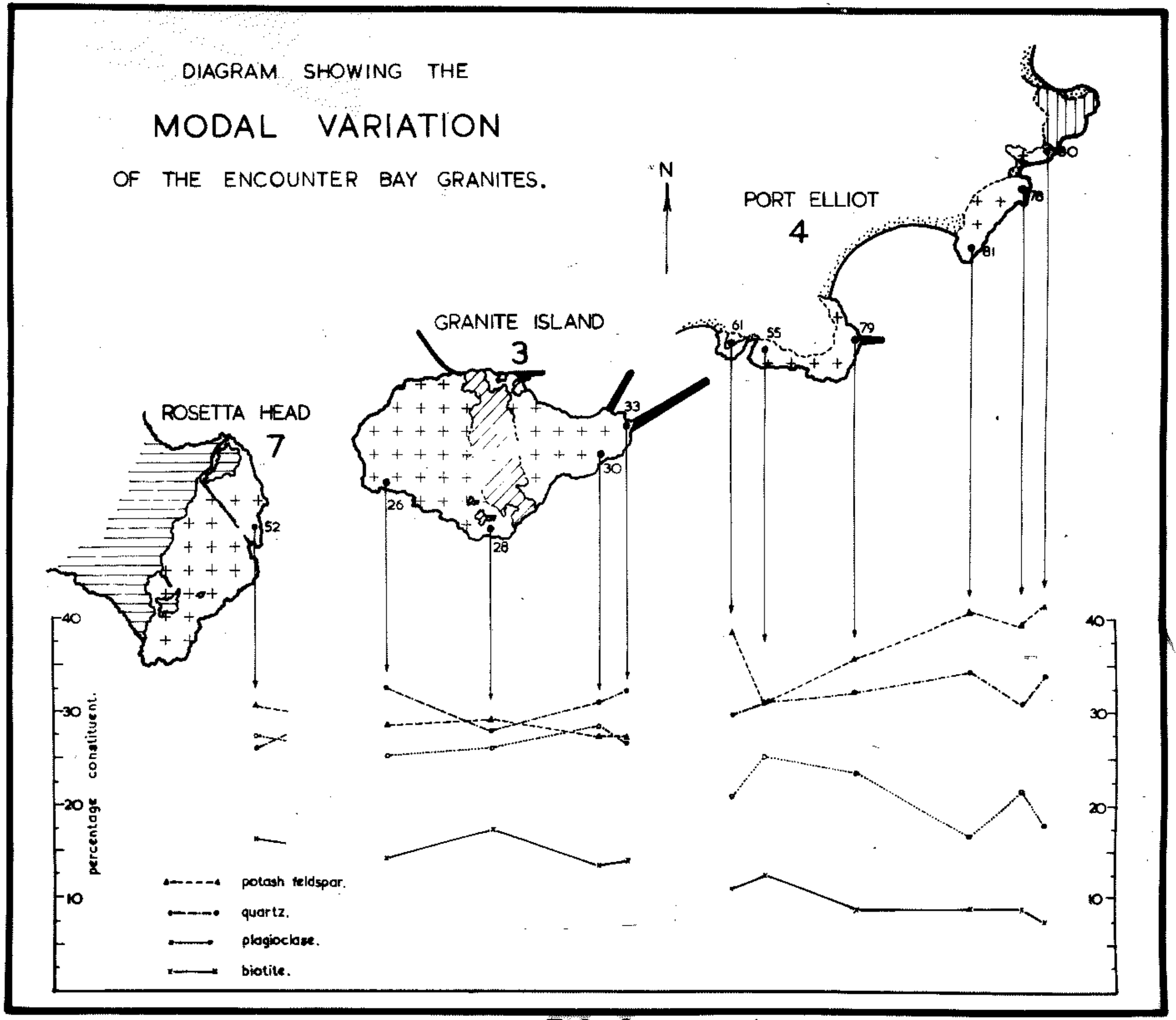


DIAGRAM SHOWING THE
MODAL VARIATION
OF THE ENCOUNTER BAY GRANITES.

FIG. 2

FIG. 4.

FIG. 4a.

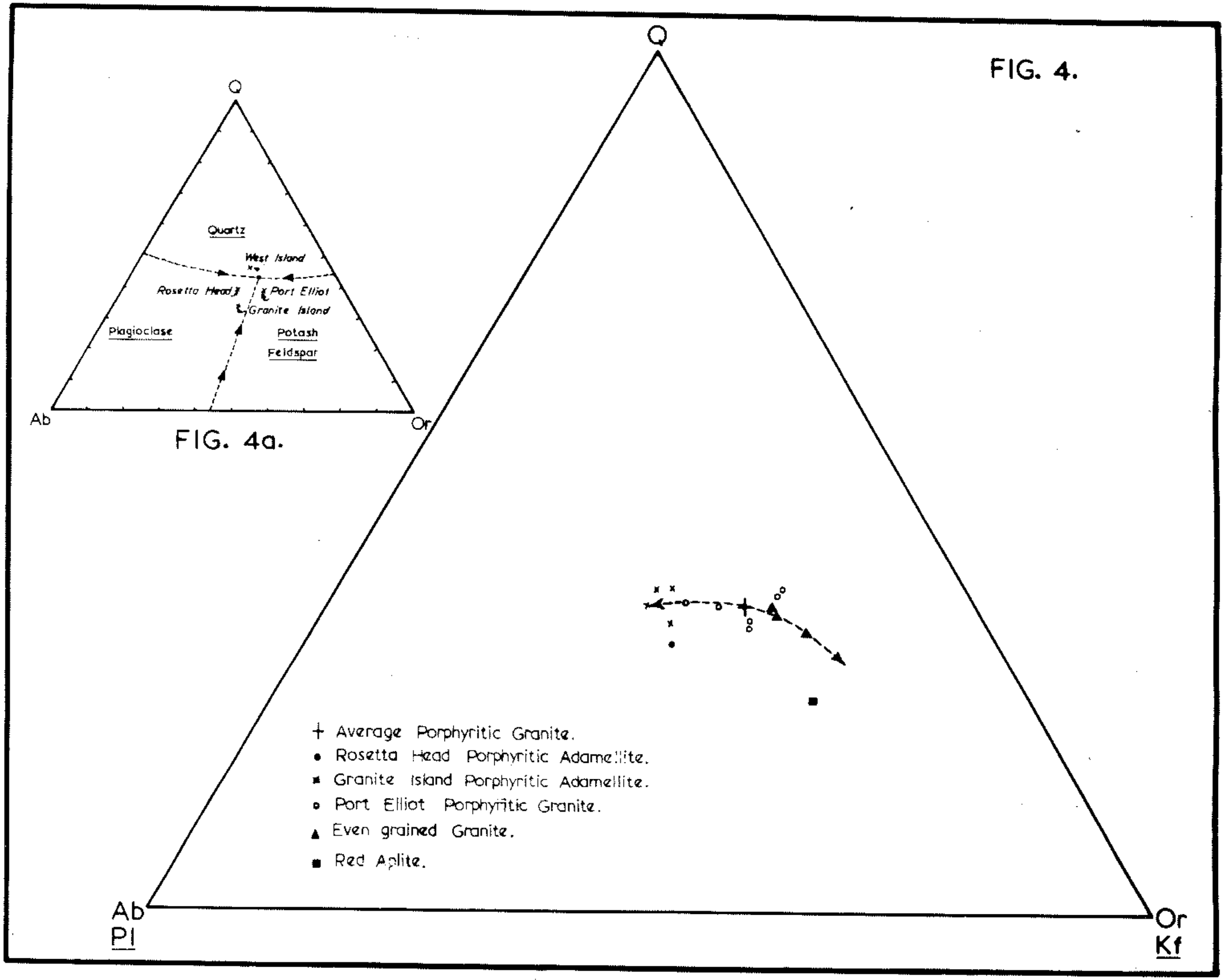

Q
Ab
Pl
Or
Kf
+ Average Porphyritic Granite.
● Rosetta Head Porphyritic Adamellite.
× Granite Island Porphyritic Adamellite.
○ Port Elliot Porphyritic Granite.
▲ Even grained Granite.
■ Red Aplite.
Q
Ab
Or
Quartz
West Island
Rosetta Head
Port Elliot
Granite Island
Plagioclase
Potash
Feldspar

Plate 7.

Fig. 1. Glaciated granite surface (right, bottom) on headland, west of Green Bay, Port Elliot. Small black pen on surface as scale. Faceted granite erratic (right, top), is weathering out of Permian varves.

Fig. 2. Pleistocene (?) large-scale cross-bedded aeolianites, capped by kunkar. Near Rocky Cove, Port Elliot.

Fig. 3. Exposed Porphyritic Granite surface, showing Wiborgite-type Rapakivi texture, i.e. plagioclase (white) mantling ovoid-shaped potash feldspar (light grey) megacrysts. West of Green Bay, Port Elliot.

PLATE 7

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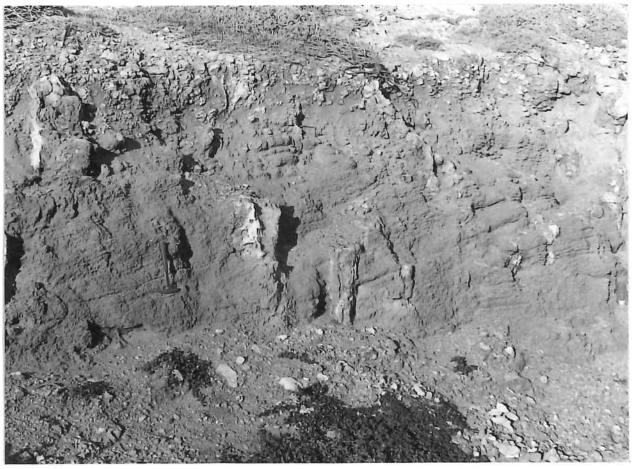

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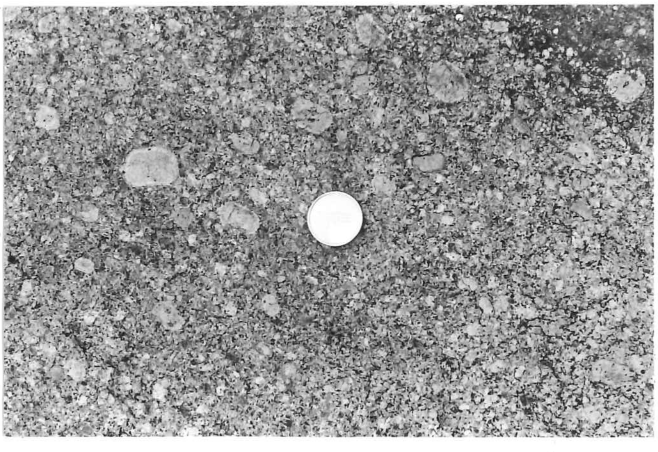

Plate 8.

Fig. 1. Schorl rock pod, east of Rocky Cove, Port Elliot. Innermost zone of pod has been removed. White quartz intermediate zone. Outermost zone of black tourmaline and white albite. Surrounded by albitised Porphyritic Granite.

Fig. 2 Potash aplite dyke (2" wide) cross cutting aplo-granite bands in Porphyritic Granite. Near 14. (Plate 2), Port Elliot.

Fig. 3. Aplo-granite bands in Porphyritic Granite. At 14. (Plate 2), Port Elliot.

PLATE 8

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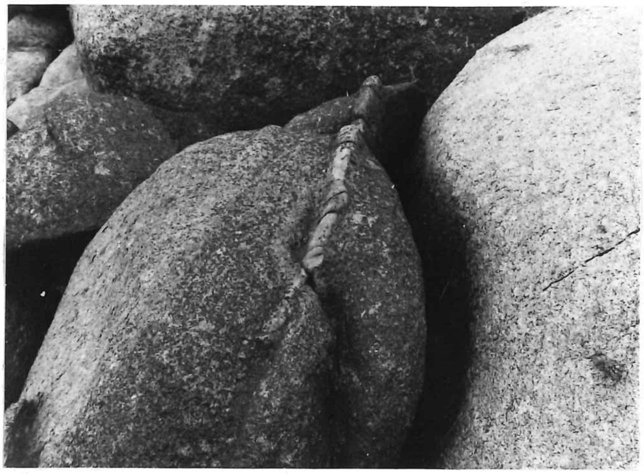

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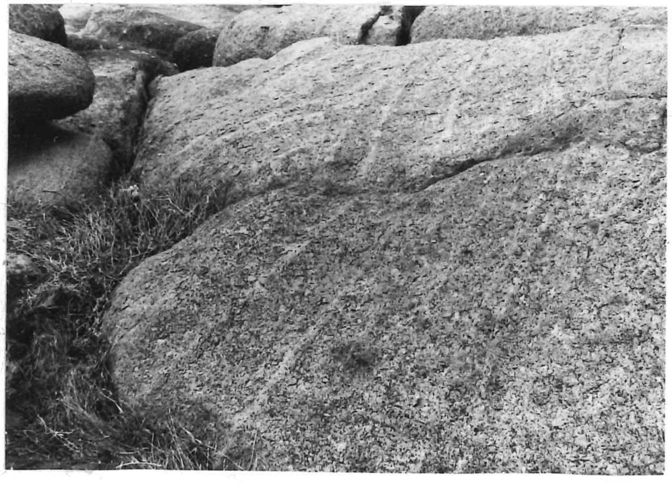

Plate 9.

Fig. 1. Biotite layering in Porphyritic Granite. Northeast of Commodore Point, Port Elliot.

Fig. 2. Layered country rock xenolith in Porphyritic Granite, just east of Green Bay, Port Elliot.

Fig. 3. Large, layered country rock xenolith (approximately 15' diameter), just west of Green Bay, Port Elliot.

PLATE 9

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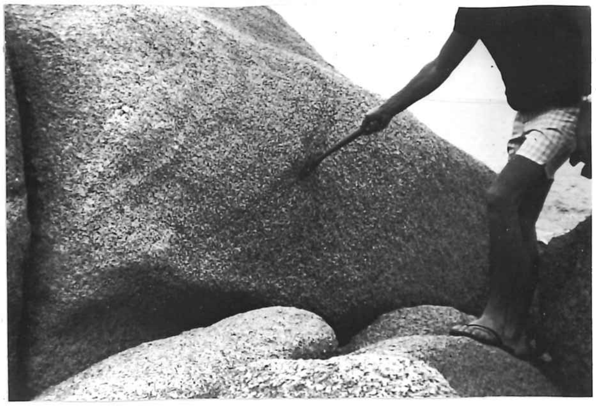

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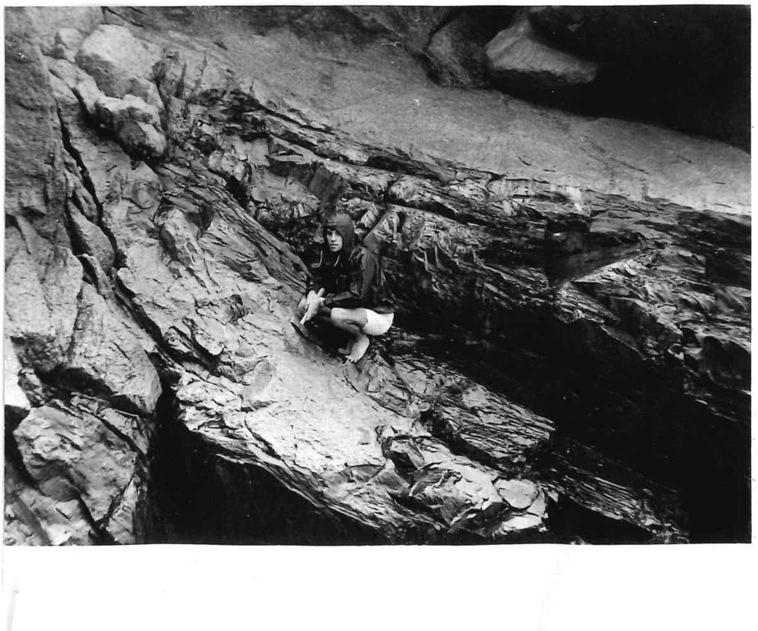

Plate 10.

Fig. 1. Contact between Porphyritic Granite and Even grained Granite (gradational over approximately 18") west of Green Bay, Port Elliot. Porphyritic Granite on right. Note small aplitic vein crossing.

Fig. 2. Remnants of Even grained Granite, with diffuse swirling contacts in Porphyritic Granite, just east of contact, Fig. 1.

Fig. 3. Comparison of fresh and weathered surfaces of Porphyritic Granite, weathered surface showing pitted texture due to weathering out of plagioclase. East of Green Bay, Port Elliot.

PLATE 10

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Plate 11.

Fig. 1. Contact between Albitised Even grained Granite (on left) and unalbitised Even grained Granite (on right), north-east of Commodore Point, Port Elliot. Dark band (centre) marks the contact.

Fig. 2. Albitisation of Porphyritic Granite along intersecting joints accentuated by weathering (iron-stainings, etc.). North-east of Commodore Point, Port Elliot.

Fig. 3. Dark coloured, biotite-clay mineral bands in Albitised Aplite, parallel to the contact with Red Aplite (on right). North-east of Commodore Point, Port Elliot.

Fig. 4. Dark coloured, biotite-clay mineral bands in Albitised Aplite parallel to the borders of an unalbitised Red Aplite lense. North-east of Commodore Point, Port Elliot.

PLATE 11

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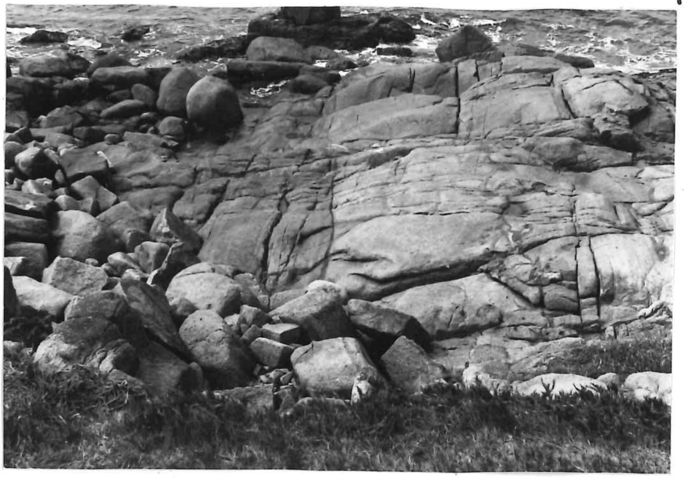

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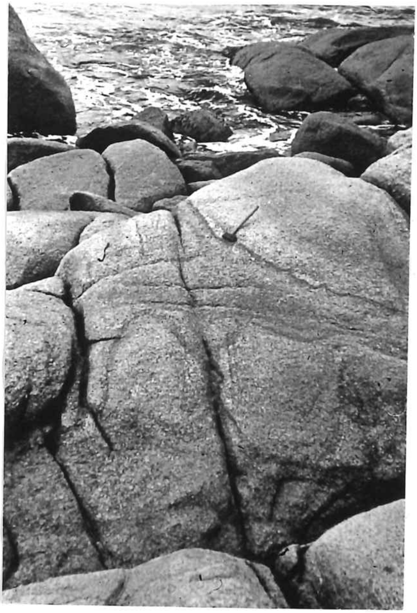

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Plate 12.

Fig. 1. Contact between Fine grained Granite (bottom) and Porphyritic Granite (top). Mafic segregations can just be discerned in Fine grained Granite marginal to contact. West of Rocky Cove, Port Elliot.

Fig. 2. Dyke-like offshoots of Fine grained Granite from the main mass. Fig. 1. shows contact near position of hammer.

Fig. 3. Sharp contact between Albitised Porphyritic Microgranite (on right) and Porphyritic Granite (on left). Contact cuts of Fine grained Granite dykes transecting Porphyritic Granite. West of Rocky Cove, Port Elliot.

PLATE 12

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2

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Plate 13.

Fig. 1. Layered country rock xenoliths in Porphyritic Adamellite, Granite Island. (Tramshed Locality, see Plate 4). Note sharp contacts.

Fig. 2. Country rock hornfels xenoliths intruded by vein Porphyritic Adamellite. Near Breakwater, Granite Island.

Figs. 3 & 4. Diffuse contact zone between Porphyroblastic Hornfels and Porphyritic Adamellite. Nature's Eye locality, Granite Island.

PLATE 13

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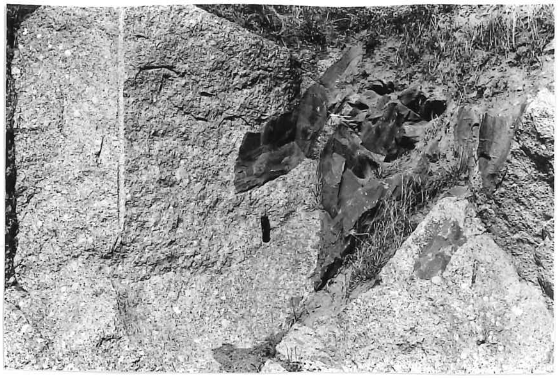

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Plate 14.

Fig. 1. Xenoliths in Granitised Hornfels. Just east of Tramshed locality, Granite Island. Note potash feldspar porphyroblasts.

Fig. 2. Porphyroblasts and xenoliths in the Granitised Hornfels. Photo taken near that in Fig. 1.

Fig. 3. Extremely well layered country rock (?) inclusiom in Granitised Hornfels, east of Tramshed locality, Granite Island.

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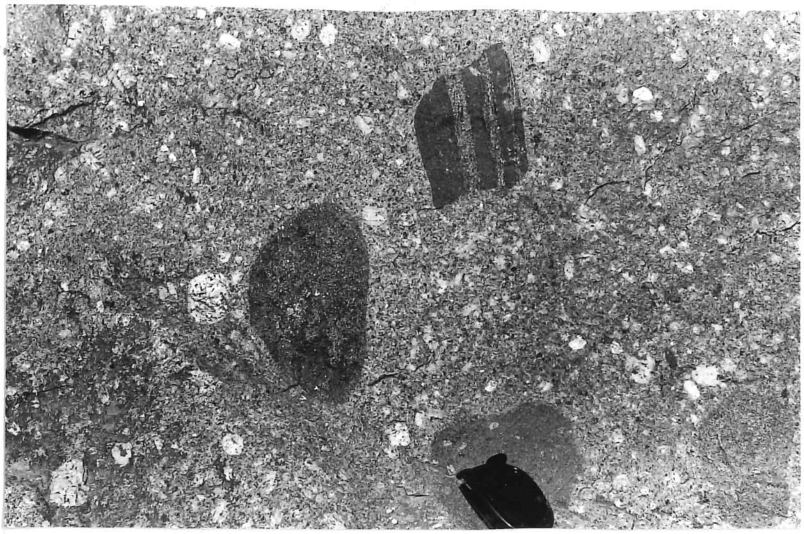

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Plate 15.

Fig. 1. Accumulation of coarse potash feldspar megacrysts in the vicinity of country rock xenoliths in Porphyritic Adamellite, Rosetta Head.

Fig. 2. Ptygmatic-type granitic veinlets intruding country rock at the contact between the Porphyritic Adamellite and the country rock, Wright Island.

Fig. 3. Contact between the Porphyritic Adamellite and the country rock, Wright Island. Note the thin, dark biotite rim in the country rock marginal to the contact. The country rock is an even grained, quartz-plagioclase-biotite hornfels.

Fig. 4. Some of the metamorphic layering in the country rock, Petrel Cove. The small spots are andalusite. Sedimentary bedding is at right angles to the metamorphic layering (parallel to the scale edge).

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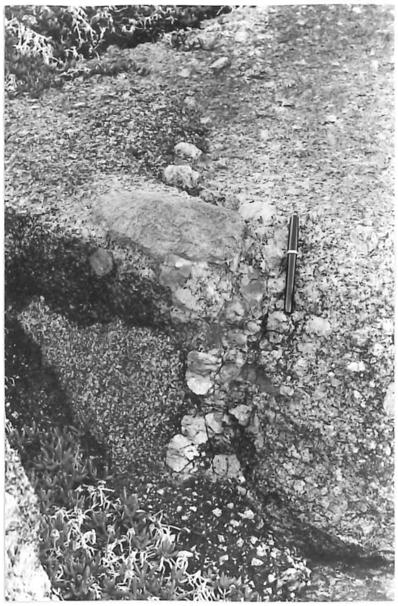

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PLATE 15

Plate 16.

Fig. 1. Sample 481. Potash feldspar megacryst containing zonally arranged plagioclase inclusions (white, plag.) and randomly arranged quartz (q) and biotite (bi) inclusions. Scale is 1" long. Stained slab.

Fig. 2. Sample 481. Potash feldspar megacryst, containing zonally arranged plagioclase (white) and quartz and biotite inclusions. Scale is 1" long. Stained slab.

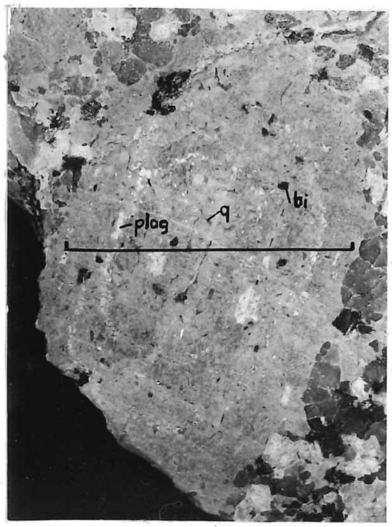
Fig. 3. Plagioclase-mantled poikilitic potash feldspar megacryst. Sample 461. Inclusions in potash feldspar are anhedral quartz. Scale is in m.m. Stained slab.

Fig. 4. Sample 455. Potash feldspar megacryst containing zonally arranged plagioclase inclusions. Scale is $\frac{1}{2}$" long. Stained slab.

Fig. 5. Sample 481. Potash feldspar megacryst containing zonally arranged plagioclase and biotite inclusions. Scale is $\frac{1}{2}$" long. Stained slab.

PLATE 16

1



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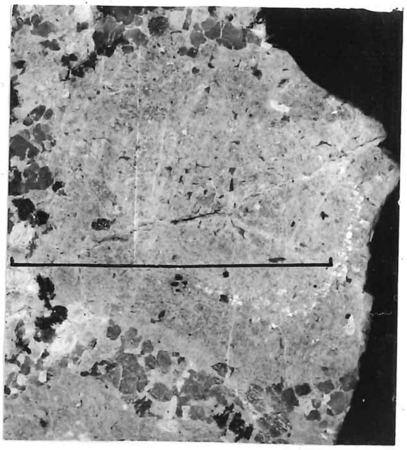

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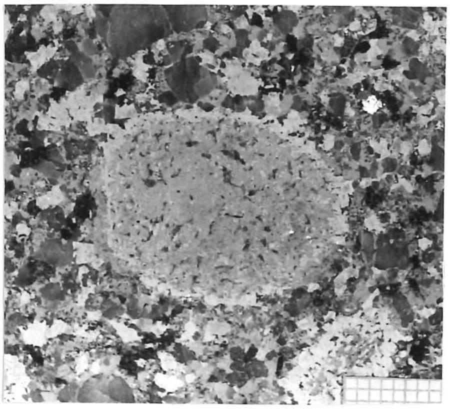

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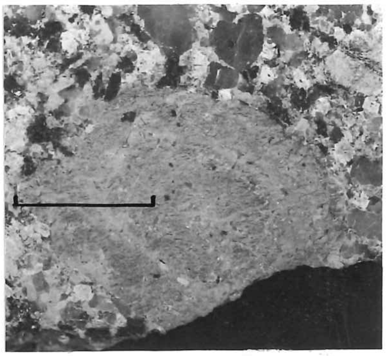

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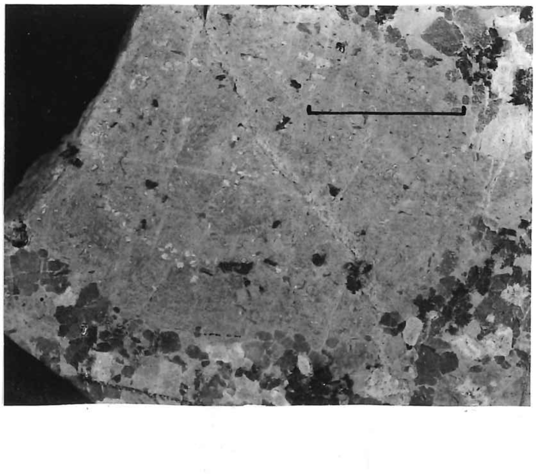

Plate 17.

Fig. 1. Potash Feldspar (clouded) filling interstitial spaces around a subhedral quartz grain. (Sample 442. X28. Crossed nicols).

Fig. 2. "Patch" perthite, in the interstitial spaces between quartz grains (top left and right corners). "Patches" are lamellar-twinned albite in potash feldspar host. (Sample 442. X28. Crossed nicols).

Fig. 3. "Patch" perthite (Sample 442. X28. Crossed nicols).

Fig. 4. Anhedral quartz inclusions in potash feldspar. (Sample 4.46. X28. Crossed nicols).

Fig. 5. Fine grained sericite rimming biotite inclusion in potash feldspar grain. (Sample 444. X28. Crossed nicols).

Fig. 6. Skeletal muscovite replacing microcline. (Sample 4 11. X80. Crossed nicols).

Fig. 7. Oscillatorily zoned plagioclase subhedra in stained slab. Sample 4 81.

Fig. 8. Ovoid-shaped plagioclase megacryst, containing vermicular quartz in inner zones. Scale is 5 mm. Sample 481.

Fig. 9. Sericitisation of plagioclase preferentially along cleavages. (Sample 442. X80. Crossed nicols).

PLATE 17

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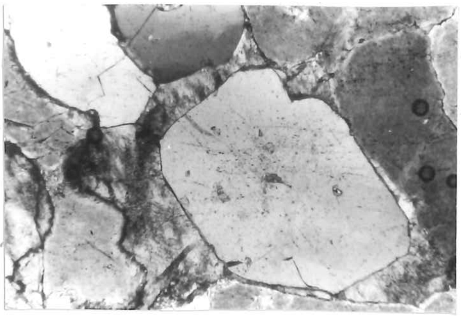

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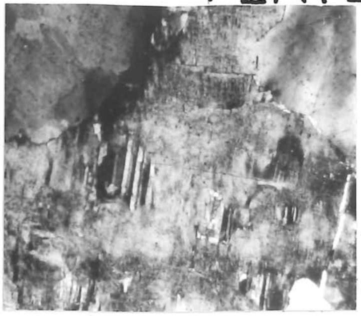

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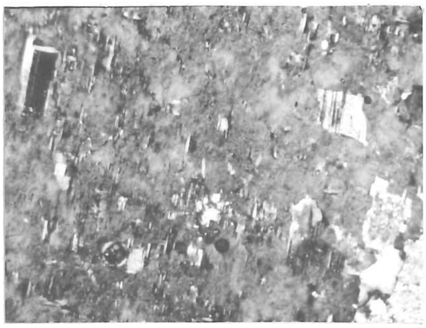

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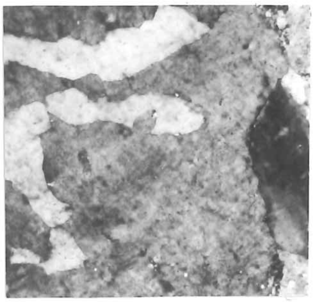

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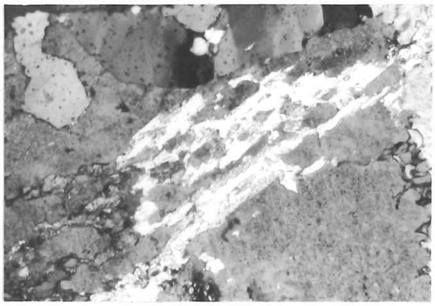

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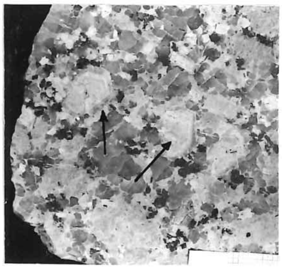

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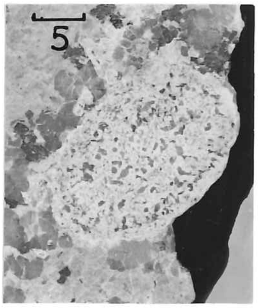

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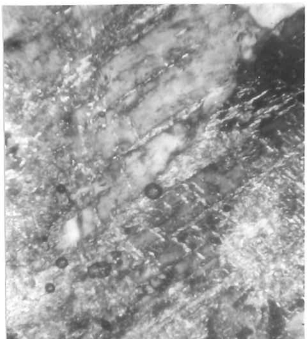

Plate 18.

Fig. 1. Coarse myrmekitic quartz-plagioclase intergrowth rimming euhedral plagioclase grain. (Sample 461. X28. Crossed nicols).

Fig. 2. Small tranverse dislocations crossing lamellar-twinned, oscillatory zoned plagioclase grain. Sericitisation has taken place along these dislocations. (Sample 442. X28. Cross nicols).

Fig. 3. Embayed quartz inclusion in potash feldspar grain. (Sample 445. X80. Crossed nicols).

Fig. 4. Myrmekite at euhedral quartz - microcline grain boundary. (Sample 418. X80. Crossed nicols).

Fig. 5. Acicular muscovite (white) developed along biotite cleavage. (Sample 445 X28. Crossed nicols).

Fig. 6. Fine pseudohexagonal biotite inclusion in basal biotite. (Sample 444. X80. Ordinary light).

Fig. 7. Porphyritic Granite, Port Elliot, with medium to coarse grained groundmass. Stained slab, Sample 479. (Scale is 5 mm. long).

PLATE 18

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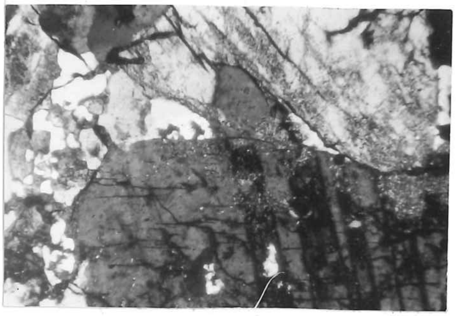

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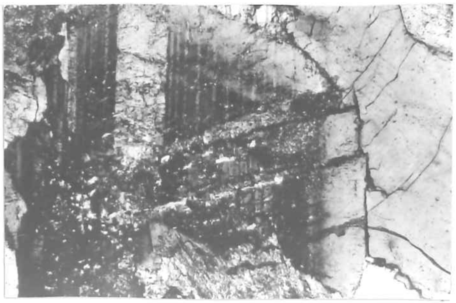

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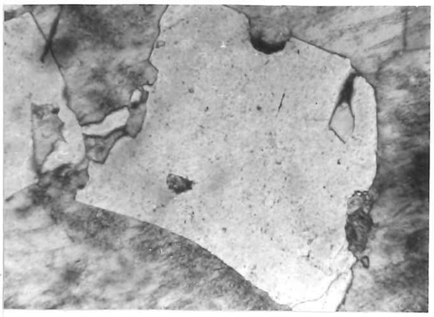

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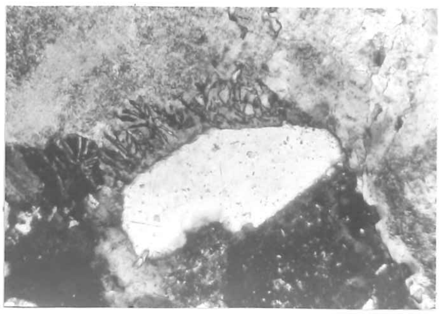

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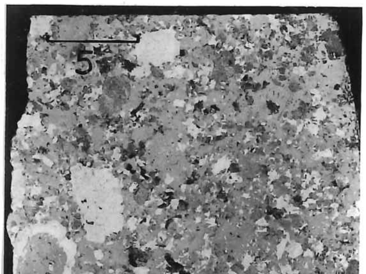

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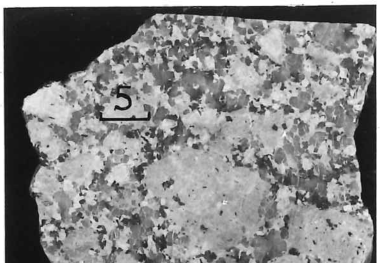

late 19.

Fig. 1.	Lath-like ilmenite parallel to cleavage in biotite. Note euhedral zoned zircon inclusion. (Sample 455. X100. oil immersion Reflected light).
Fig. 2.	Pyrrhotite grains mantled by marcasite. (Sample 455. X100. oil immersion . Reflected light.)
Fig. 3.	Pyrrhotite grains mantled by marcasite (top). Non-mantled pyrrhotite grains bottom right. (Sample 455. X100. oil immersion. Reflected light).
Fig. 4.	Large Pyrrhotite grain replaced by marcasite along fractures. Pyrite grain bottom centre. (Sample 455. X100. oil immersion. Reflected light).
Fig. 5.	Subhedral pyrite grain. Marcasite-mantled pyrrhotite grain top left. (Sample 455. X100 oil immersion. Reflected light).
Fig. 6.	Large pyrite grain (top left), bordered by finer grained chalcopyrite (centre and bottom left). Altered pyrrhotite grain on right. (Sample 455. X100. oil immersion. Reflected light).
Fig. 7.	Anhedral pyrrhotite grains (light coloured) and associated anhedral ilmenite (dark grey). (Sample 455 X100 oil immersion. Reflected light).
Fig. 8.	Acicular haematite (white) and lath-like, anhedral ilmenite developed in biotite cleavage. (Sample 4.55. x100. oil immersion. Reflected light).

PLATE 19

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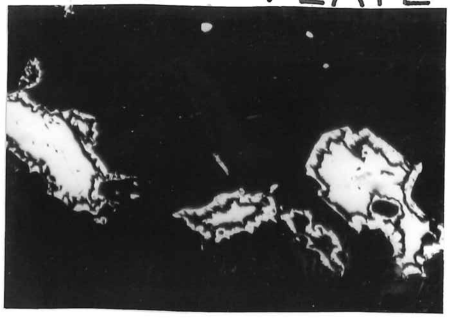

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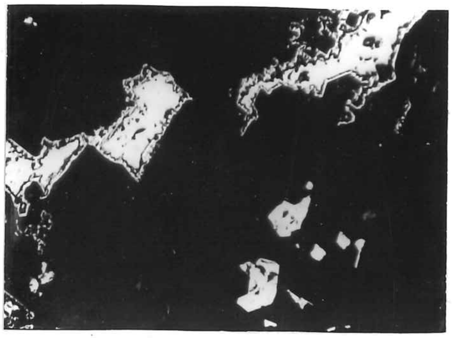

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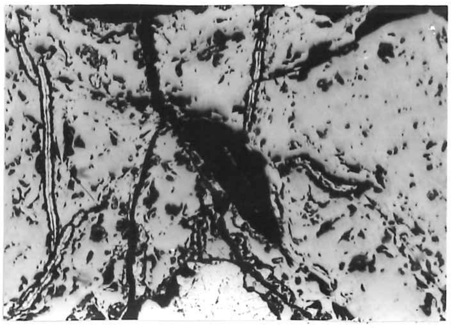

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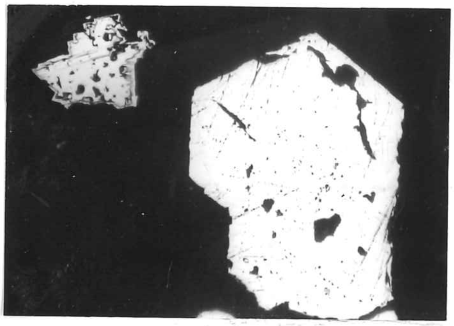

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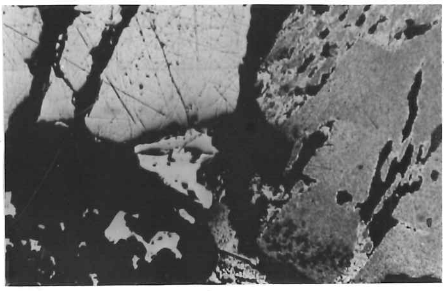

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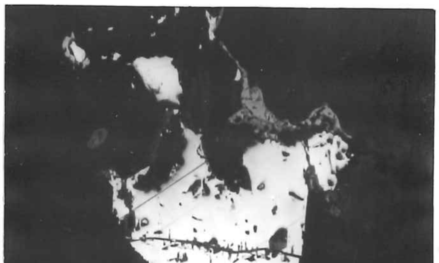

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Plate 20

Fig. 1. Finely twinned chess-albite filling interstitial spaces between anhedral quartz grains. (Sample 426. X80. Crossed nicols).

Fig. 2. Coarsely twinned chess-albite, with a partially included spindle-type lamellar twinned albite grain. (Sample 4.34 X80. Crossed nicols).

Fig. 3. Coarsely twinned chess-albite. Note discontinuity and difference in thickness of twin lamellae. (Sample 434 X80. Crossed nicols).

Fig. 4. Cross-hatched potash feldspar, containing anhedral quartz inclusions (white). (Sample 422. X28. Crossed nicols).

Fig. 5. "Film" perthite. The light coloured generally elongate blebs are of clouded albite. (Sample 4.59 X 28. Crossed nicols).

Fig. 6. "Vein"perthite. 'Veins' are of lamellar twinned albite. (Sample 4.59 X80. Crossed nicols).

Fig. 7. Skeletal muscovite replacing potash feldspar grain. (Sample 4.11X80. Ordinary light).

Fig. 8. "Patch" perthite. Potash feldspar remains as diffuse, clouded areas between lamellar twinned albite patches. (Sample 4.59. X28. Crossed nicols).

Fig. 9. Myrmekite "cauliflowering" into potash feldspar from the borders of a plagioclase grain. (Sample 4.10 X80. Crossed nicols.)

PLATE 20

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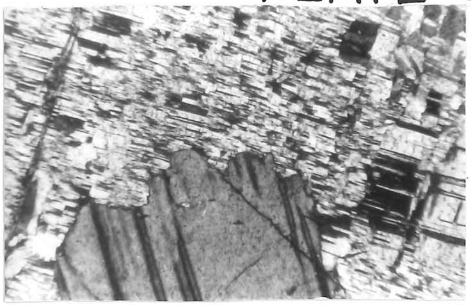

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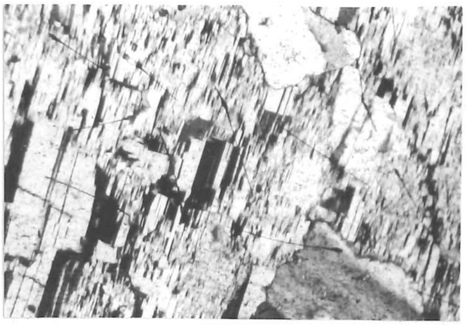

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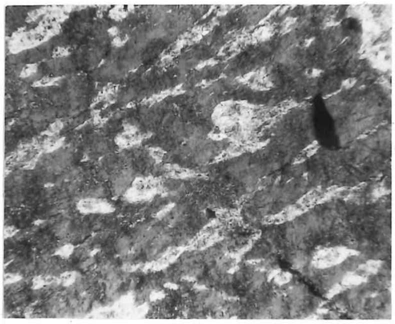

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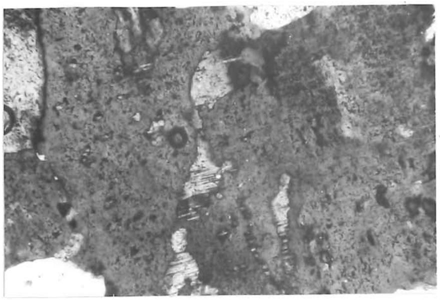

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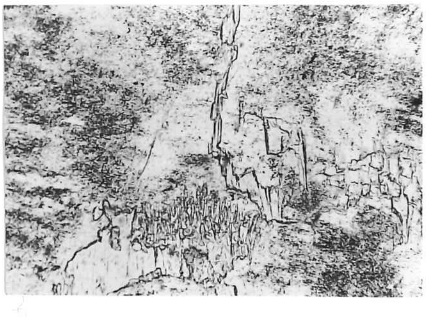

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Plate 21

Fig. 1. Interfingering contact between a potash feldspar grain (on the right) and a lamellar twinned plagioclase grain (on the left). This may represent replacement of plagioclase by potash feldspar. (Sample 4.10. X80. Crossed nicols).

Fig. 2. Progressively zoned plagioclase grain, with an extensively clouded (sericitised) core. (Sample 4.53 X28. Crossed nicols)

Fig. 3. Fine disjointed albite grain at potash feldspar- potash feldspar grain boundary. (Sample 4.10 X 80. Crossed nicols).

Fig. 4. Subhedral, zoned apatite inclusion in biotite. (Sample 4.12. X200. Ordinary light).

Fig. 5. Biotite lath with muscovite developed parallel to biotite cleavage. Abundant zircon and ilmenite inclusions. (Sample 4.22 X28. Ordinary light).

Fig. 6. Finely twinned chess-albite filling interstices between anhedral quartz grains. Sample 4.13. X28. Crossed nicols).

Fig. 7. Quartz-albite intergrowth thought to represent replacement of quartz by albite (Sample 4.13 X80. Crossed nicols)

Fig. 8. Intergrown spindle-type lamellar-twinned albite and quartz (centre) partly included by finely twinned chess-albite megacryst (right). Note corroded nature of quartz grain (centre) when in contact with chess-albite. (Sample 4.13. X28. Crossed nicols).

PLATE 21


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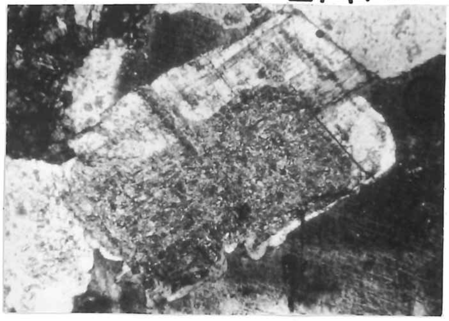
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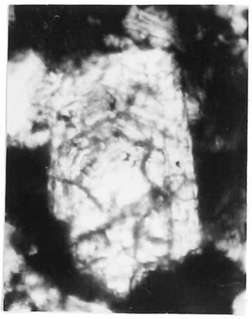
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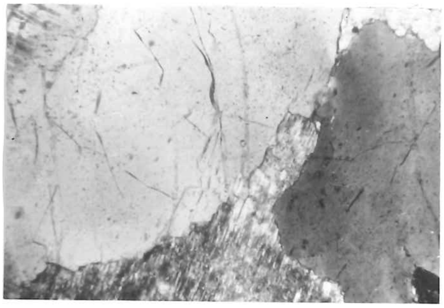
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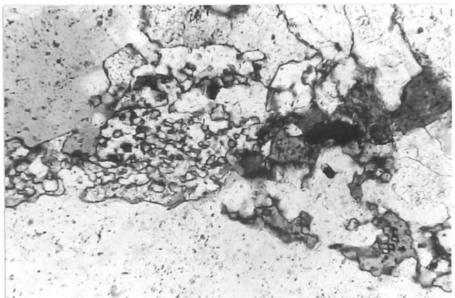
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Plate 22

Figs. 1 & 2. Skeletal muscovite replacing potash feldspar (clouded). (Sample 4.5 X28. Ordinary light).

Fig. 3. Fine grained acicular biotite in fractures in quartz megacryst. (Sample 4.5 X28. Crossed nicols).

Fig. 4. Progressively zoned subhedral plagioclase grain. (Sample 4.83-4 X28. Crossed nicols).

Fig. 5. Stained slab of Miarolitic Granophyre. Granophyric-textured groundmass bottom right corner. Dark patches, with associated white albite are muscovite-quartz infilled miaroles. (Sample 4.67B. Width of slab approximately 1.5")

Fig. 6. Skeletal muscovite (white) replacing potash feldspar. (Sample 4.5. X80. Crossed nicols).

Fig. 7. Portion of graphic (?) quartz (colourless) muscovite (grey) intergrowth. (Sample 4.4 X 80. Crossed nicols).

Fig. 8. Portion of quartz (colourless) - potash feldspar (grey) graphic intergrowth.

Fig. 9. Potash feldspar inclusions and embayments into quartz grain (centre). Muscovite lath on right. (Sample 4.68. X28. Crossed nicols).

PLATE 22

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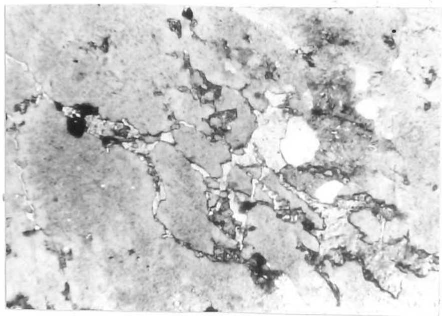

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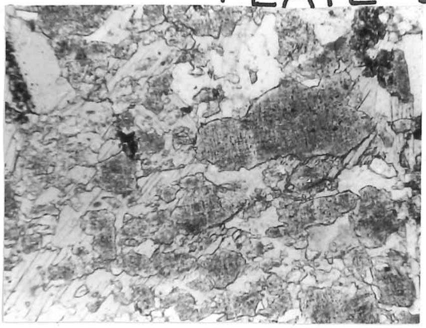

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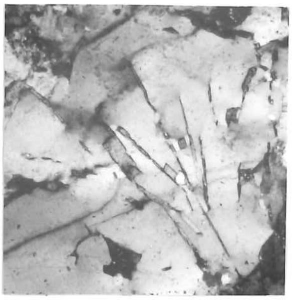

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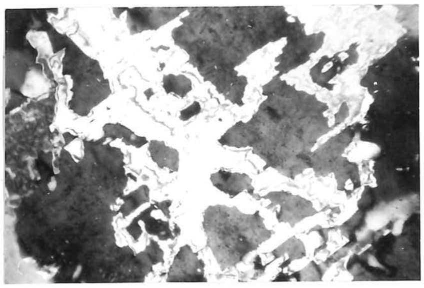

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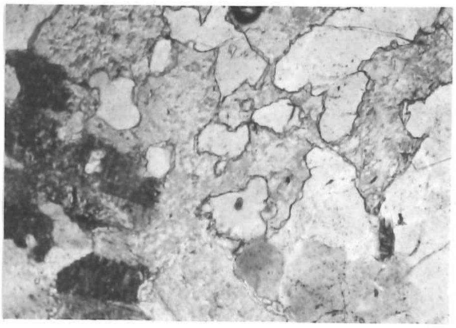

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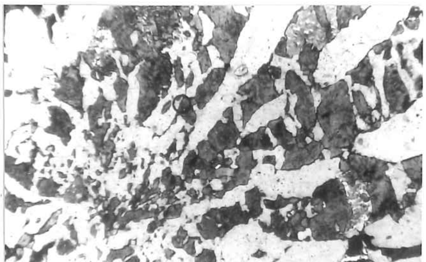

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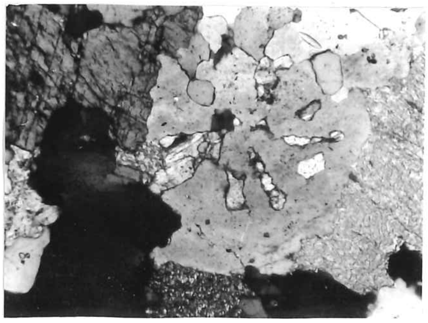

Plate 23.

Fig. 1&2.	Skeletal haematite remnants in Miarolitic Granophyre. Haematite associated with muscovite laths in Fig. 2. (Sample 4.70 X 100, Reflected light).
Fig. 3.	Concentric alteration of haematite in Greisenised Granophyre. (Sample 4.70 X 200. Reflected light).
Fig. 4.	
Fig. 5.	Spindle-type lamellar twinning in albite (Sample 4.27 X 80. Crossed nicols).
Fig. 6.	Enhedral zircon inclusion in biotite. (Sample 4.36 X 80. Ordinary light).
Fig. 7.	Biotite rimmed by opaque mineral (ilmenite) (Sample 4.48 X 80. Ordinary light).
Fig. 8.	Subhedral apatite inclusion (left centre) in potash feldspar (Sample 4.36. X 80. Ordinary light).
Fig. 9.	"Patch" perthite. Very little potash feldspar (dark, diffuse areas, remaining. (Sample 4.37. X 80. Crossed nicols).
Fig. 10.	Zircon (colourless), muscovite (lath-like, white) and ilmenite (opaque) inclusions in biotite. (Sample 4.48. X 80. Ordinary light).

PLATE 23

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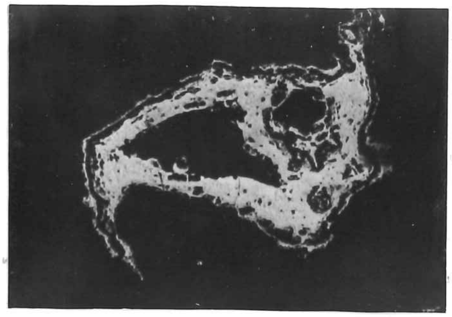

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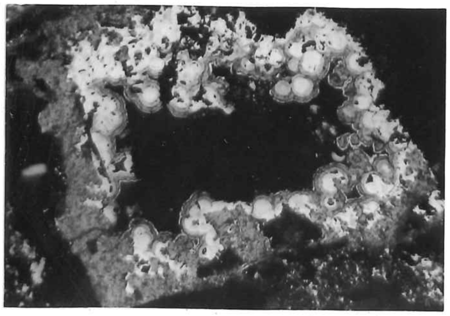

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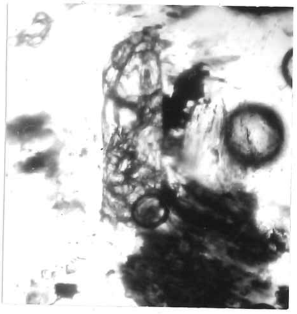

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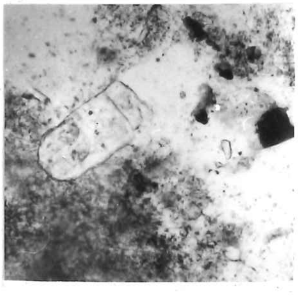

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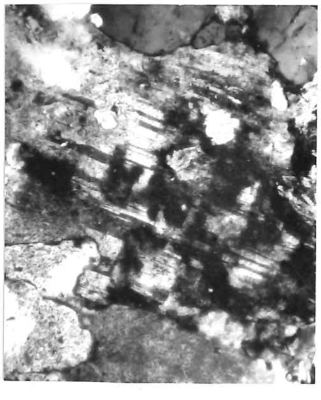

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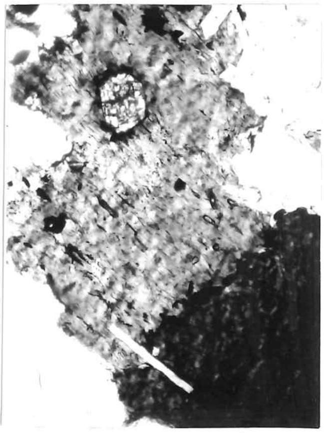

Plate 24.

Figs.1 & 2. Exsolution lamellae of rutile (R-dark grey) and haematite (pale grey to white - H) in ilmenite (I-medium grey). Darkest grey material is amphibole. (Sample 449 X 200. Reflected light).

Fig. 3. Haematite (white-pale grey) and ilmenite (darker grey) intergrowth. (Sample 4.49 X 200. Reflected light).

Fig. 4. Euhedral quartz grain (bottom) in contact with potash feldspar megacryst (top). (Sample 3.33 X 28. Crossed nicols).

Fig. 5. "String" quartz (colourless) developed in potash feldspar (clouded) in composition plane of simple twin. (Sample 3.33 X28. Crossed nicols).

Fig. 6. Myrmekite. Note vermicular quartz in plagioclase host. (Sample 3.26. X 80 Crossed nicols).

Fig. 7. Granulated quartz, interstitial between feldspar grains. (Sample 3.33 X 28. Crossed nicols).

Fig. 8. Complex oscillatory zoning in plagioclase. (Sample 3.26 X 28. Crossed nicols).

Fig. 9. Fine grained biotite laths developed in plagioclase cleavage. (Sample 3.33 X 28 Ordinary light).

Fig. 10. Myrmekitised border on plagioclase grain. (Sample 3.26 X 80. Crossed nicols).

PLATE 24

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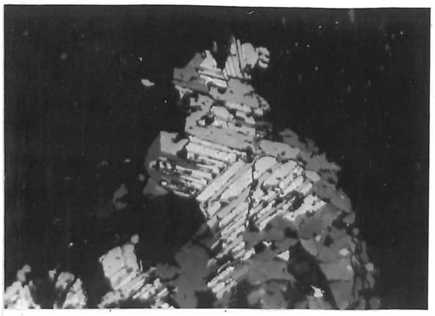

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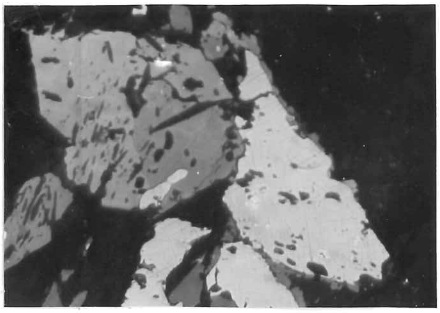

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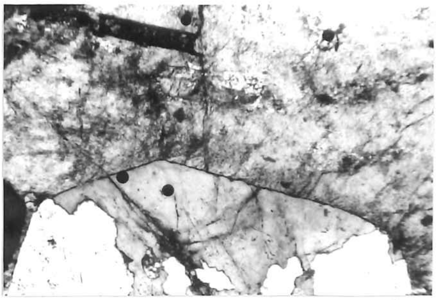

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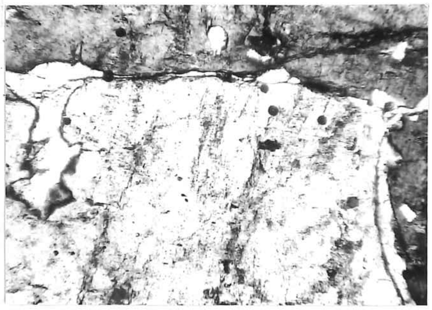

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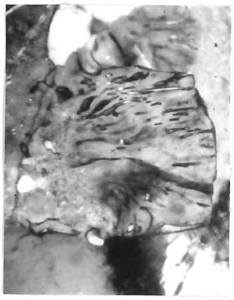

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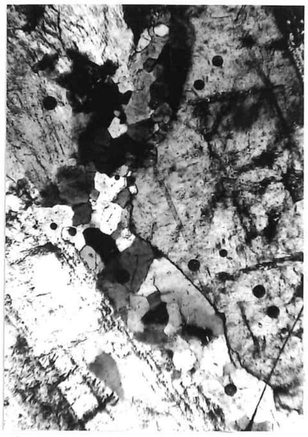

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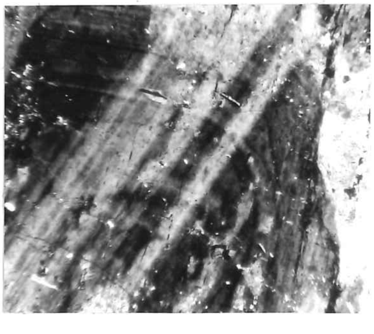

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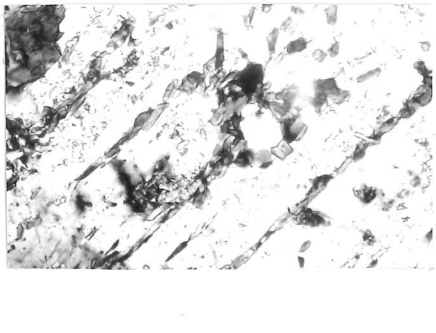

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Plate 25.

Fig. 1.	Fine rutile needles in basal biotite plate. (Sample 3.1 X 80. Ordinary light).
Figs.2 & 3	Fine rutile needles, with associated fine biotite laths, and ilmenite grains, adjacent to biotite. (Sample 3.6 X 80. Ordinary light).
Fig. 4.	Extremely corroded quartz inclusion (centre) in chess-albite megacryst. (Sample 3.5 X 28. Crossed nicols).
Fig.5 & 6.	Fine subhedral rutile inclusions in biotite. (Sample 3.23 X 80. Ordinary light).
Fig. 7.	Fine rutile granules developed along biotite cleavages. Rutiles cross muscovite laths (colourless). (Sample 3.3 X 80. Ordinary light).
Fig. 8.	Kinked lamellar twinned plagioclase grain. (Sample 3.2 X 28 . Crossed nicols).
Fig. 9.	Biotite lath completely altered to rutile. (Sample 3.2 X 80. Ordinary light).

PLATE 25

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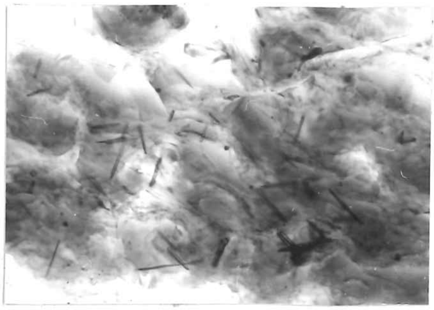

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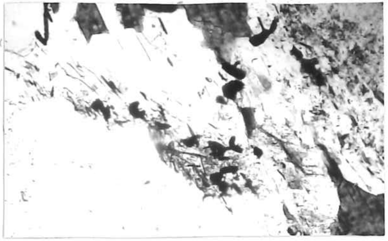

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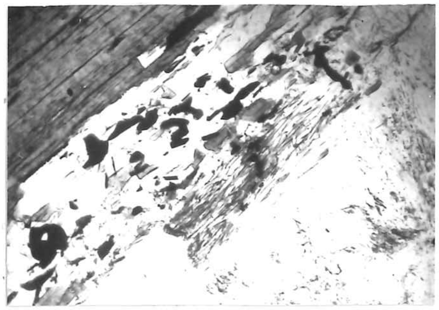

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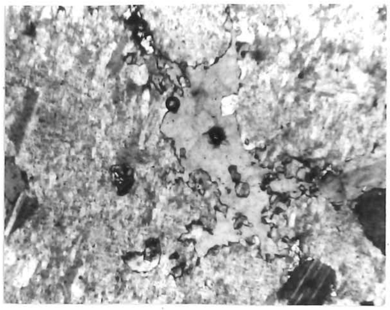

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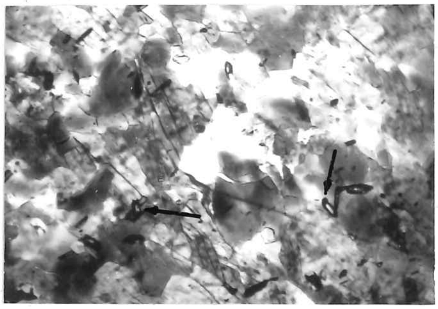

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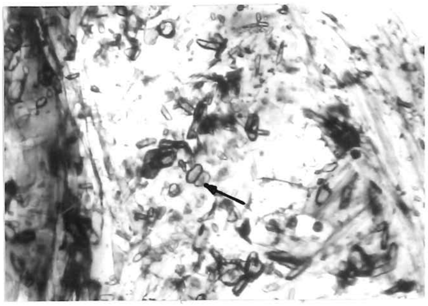

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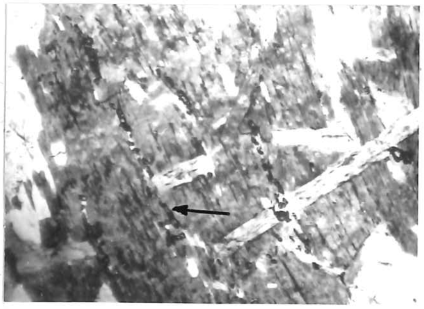

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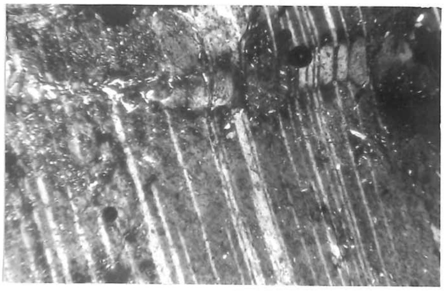

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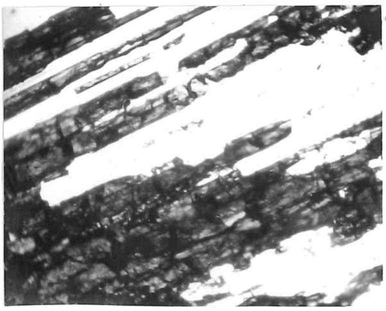

Plate 26.

Fig. 1.	Preferred orientation of rutile prisms in quartz (Sample 3.2 X 80. Crossed nicols).
Fig. 2.	Anhedral sphene, with associated opaque mineral, as inclusions in biotite. (Sample 3.15 X 28. Ordinary light).
Fig. 3.	Anhedral sphene, biotite (B) and hornblende (H). (Sample 3.8 X 80. Ordinary light).
Fig. 4.	Anhedral sphene inclusions in hornblende plates., (Sample 3.8 X 80. Ordinary light).
Fig. 5.	Abundant small box-shaped inclusions of potash feldspar in lamellar twinned plagioclase porphyroblast (Sample 3.8 X 28 Crossed nicols).
Fig. 6.	Anhedral quartz (white) rimming lamellar twinned plagioclase and clouded potash feldspar crystallites. On a larger scale this produces a "quilt-work" pattern. (Sample 3.29 X 28. Crossed nicols).
Fig. 7.	Quartz megacryst in fine grained groundmass. Note serrated borders of megacryst. (Sample 3.27 X 28 . Crossed nicols).
Figs. 8 & 9.	Complexly oscillatorily zoned plagioclase porphyroblasts. Note euhedral shape of individual zones. (Sample 3.7 X 28. Crossed nicols).
Fig. 10	Subhedral lamellar-twinned plagioclase inclusion in potash feldspar, rimmed by quartz. (Sample 3.9 X 80. Crossed nicols).

PLATE 26

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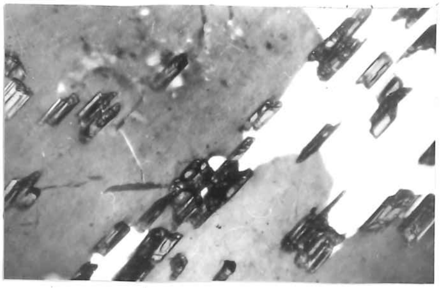

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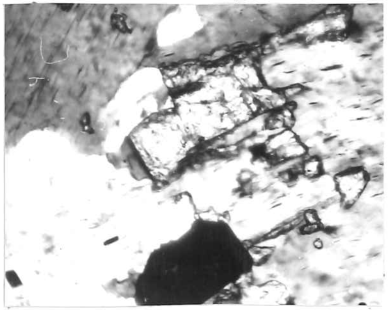

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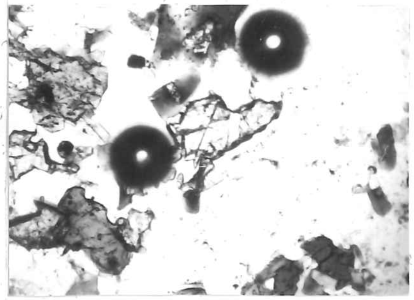

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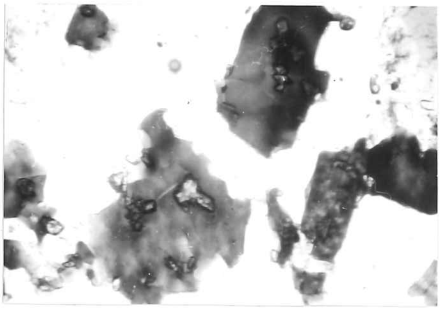

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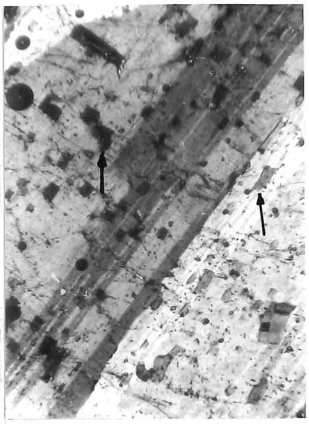

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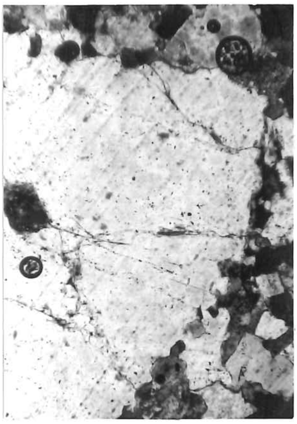

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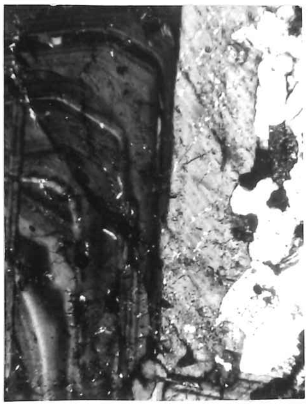

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Plate 27.

Fig. 1.	Progressively zoned plagioclase grain containing an inner zone of inclusions. (Sample 3.7 X 28. Crossed nicols).
Fig.2.	Myrmekite at grain boundary between groundmass plagioclase and potash feldspar . (Sample 3.7 X 80. Crossed nicols).
Fig.3.	"Film" perthite potash feldspar megacryst, with an outer graphic zone. The border of the outer graphic zone with the inner part of the megacryst is very sharp. (Sample 7.9 X 28. Crossed nicols).
Fig. 4.	Portion of a graphic outer zone rimming potash feldspar. Quartz is black, potash feldspar clouded. (Sample 7.9 X 80. Crossed nicols).
Fig. 5.	Graphic quartz-feldspar intergrowth in potash feldspar grain. (Sample 7.9 X 28 Crossed nicols).
Fig. 6.	"String" quartz developed along composition plane perthitic potash feldspar simple twin. (Sample 7.9. X 28. Crossed nicols).
Fig.7.	Euhedral quartz grains surrounded by perthitic potash feldspar. (Sample 7.9 X 80. Crossed nicols).
Fig.8.	Oscillatorily zoned plagioclase grain with sericitised core (Sample 7.9 X 80. Crossed nicols).
Fig.9 & 10.	Myrmekite "cauliflowering" from plagioclase into potash feldspar (Sample 7.9 X 80 . Crossed nicols).

PLATE 27

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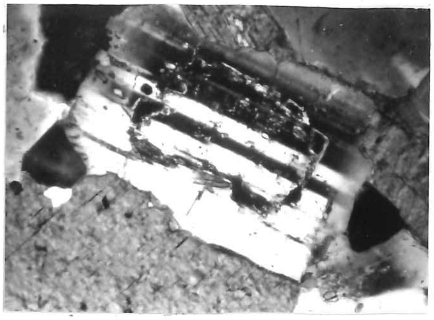

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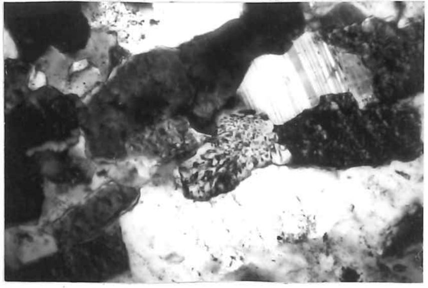

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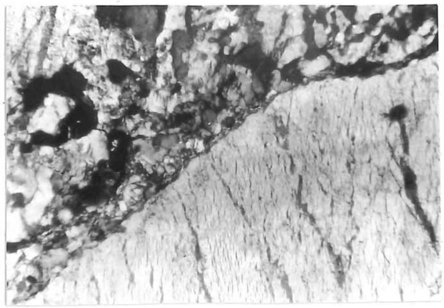

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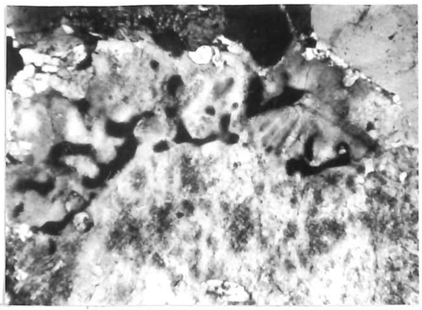

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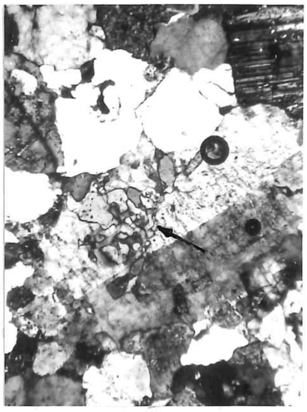

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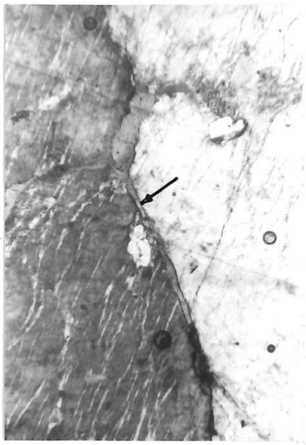

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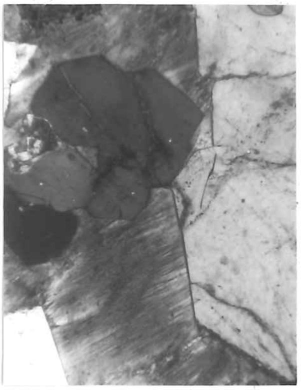

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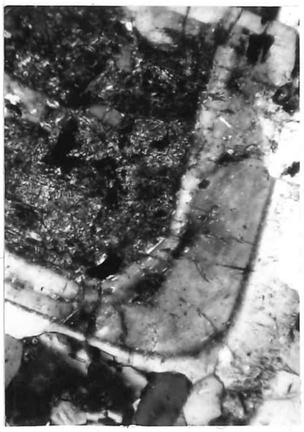

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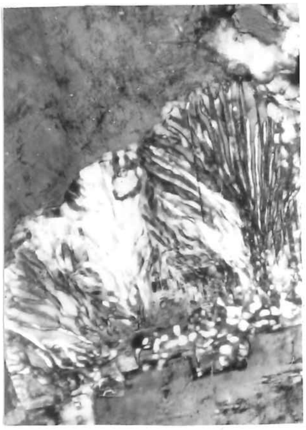

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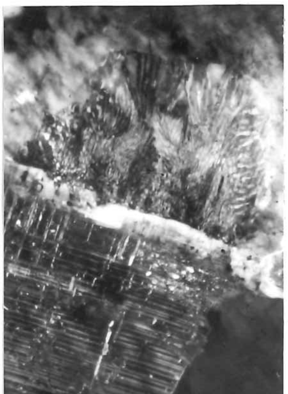


Plate 28

Fig. 1. Phlogopite littered with fine rutile granules. (Sample 7.1 X 80. Ordinary light).

Fig. 2. Phlogopite with muscovite (colourless) and zircon inclusions. Fine rutile granules developed in phlogopite cleavages, also cross muscovite lath. (Sample 7.1 X 200. Ordinary light).

Fig. 3. Fractured and kinked lamellar twinned albite grain (Sample. 7.7 X 28. Crossed nicols).

Fig. 4. Phlogopite (grey) with chlorite (colourless) and fine rutile inclusions. (Sample 7.17 X 80. Ordinary light).

Fig. 5. Large prism-shaped apatite grain, small rutile subhedral grains, and chlorite flakes in Albitised Schist, (Sample 7.8 X 80. Ordinary light).

Fig. 6. Rutile needles in quartz. Quartz vein. (Sample 7.2 X 80. Crossed nicols).

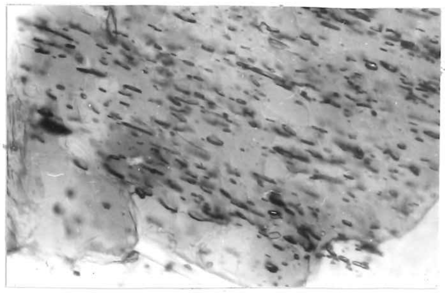
Fig. 7. Euhedral brown tourmaline grain in Albitised Andalusite Schist (Sample 7.18 X 80. Ordinary light).

Fig. 8. Euhedral brown tourmaline grain around which chlorite laths tend to wrap. Albitised Andalusite Schist. (Sample 7.18 X 80 Ordinary light).

Fig. 9. Ilmenite anhedra in Amphibolite groundmass. (Sample 7.14 X 200. Reflected light).

PLATE 28

1



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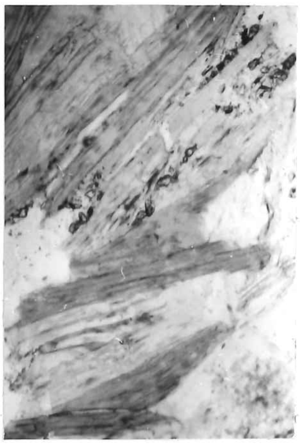

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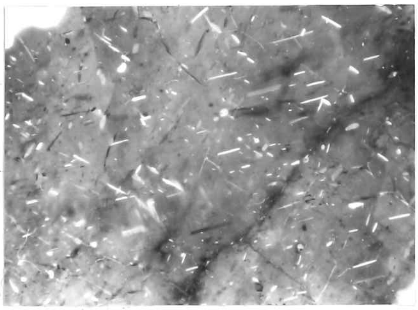

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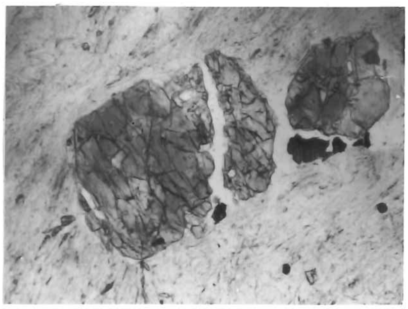

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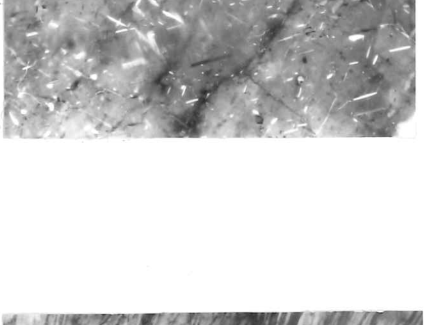

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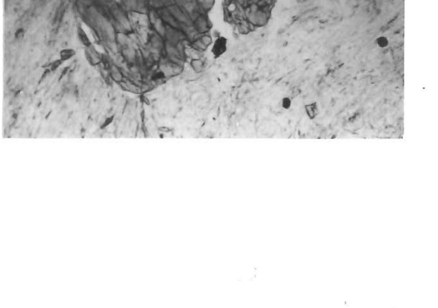


Comparison of Potash Feldspar Megacrysts from Different Localities.

Plate 29

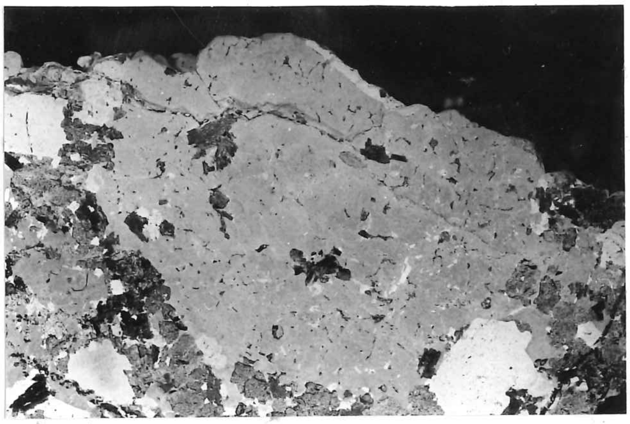
Fig. 1. Ovoid-shaped potash feldspar megacryst, containing zones of fine plagioclase inclusions and randomly distributed quartz and biotite inclusions. Porphyritic Granite, Port Elliot. Stained slab. (length of megacryst approximately 2").

Fig. 2. Ovoid-shaped potash feldspar megacryst containing zones of biotite quartz and plagioclase inclusions. Porphyritic Adamellite, Granite Island. Stained slab. (Diameter of megacryst approximately 1").

Fig. 3 Ovoid-shaped potash feldspar megacryst containing abundant quartz inclusions, and some plagioclase and biotite inclusions. (shown by discontinuous lines). Porphyritic Adamellite, Rosetta Head. Stained slab. (Length of megacryst approximately 1").

1

2



3

Modified Hornfelses.

Plate 30.

Fig. 1. Porphyroblast Hornfels. Sample 3.15. note plagioclase-mantled potash feldspar porphyroblast (top left), plagioclase porphyroblasts (white) and quartz porphyroblasts (dark grey) in fine groundmass (Width of stained slab approximately 2").

Fig. 2. Inclusion-filled plagioclase-mantled potash feldspar porphyroblast in fine grained groundmass. Porphyroblastic Hornfels. Sample 3.29 (diameter of porphyroblast approximately $\frac{5}{4}$"). Stained slab.

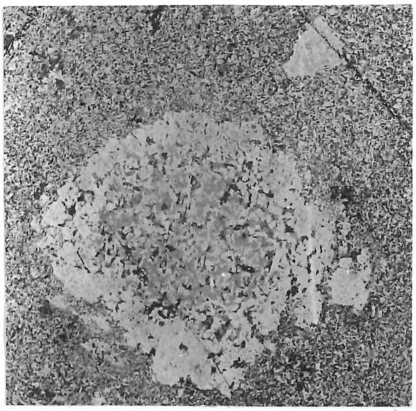
Fig. 3. Granitised Hornfels. Sample 3.27. Note abundance of porphyroblasts relative grain size of groundmass compared with Porphyroblastic Hornfels. (Width of stained slab approximately 2".)

Fig. 4. Granitised Hornfels. Sample 3.27 (Width of stained slab approximately 2").

PLATE 30

1

2



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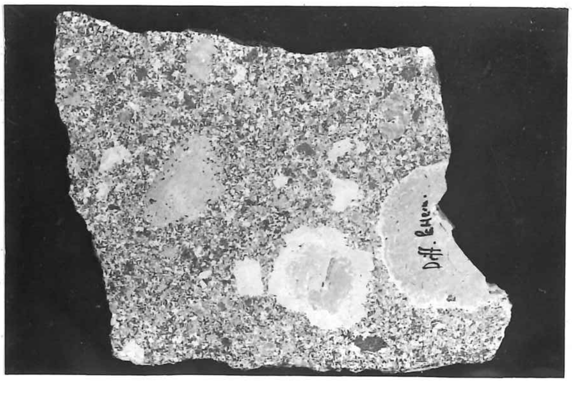

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