DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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GEOLOGY OF ST. FRANCIS AND WEST ISLANDS, NUYTS ARCHIPELAGO.

GEOLOGICAL SURVEY

BY

R.B. FLINT AND A.F. CROOKS

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CONTENTS

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ABSTRACT

The major units present on St Francis and West Islands, South Australia, are Middle Proterozoic poorly foliated granite, a suite of acid volcanics and alkali granite. Dyke rocks include dolerite, leucogranite and acid porphyry. These are overlain by Pleistocene calcarenites of the Bridgewater Formation and calcretes.

INTRODUCTION

The Nuyts Archipelago, consisting of more than 20 islands, is located in the Great Australian Bight southwest of Ceduna. St Francis Island and West Island are two islands within the St Francis Isles - a group of islands within the Archipelago.

The islands were discovered in January 1627 by the Dutch. The captain of the vessel 'Gulden Zeepaert' was Francis Thijssen and aboard was Pieter Nuyts, then Councillor Extraordinary of the East India Government at Batavia. The two largest islands were named St Pieter and St Francis in honour of the patron saints of the captain and councillor, and all the islands southwest of Ceduna form the Nuyts Archipelago.

A geological plan (at 1:250 000 scale) was prepared by Walker and Botham (1968) and was based solely on aerial photo-interpretation. Kinsman in 1973 produced more-detailed plans, however the emphasis was on joints as once again the study was restricted to solely photo-interpretation.

During January 1973, R.B. Major (SADME) spent several weeks on board the Commonwealth lighthouse tender 'Cape Pillar' visiting numerous islands along the coast. St. Francis Island was visited and a few, very brief comments on the geology are in Major (1973).

On the 3rd-23rd February 1974, SADME conducted (by helicopter) a geological survey of all offshore islands in South Australia. Personnel involved were L.C. Barnes, A.H. Blissett, S.J. Daly, R.B. Major and V. Vitols and the survey included both St Francis and West Islands. Numerous samples were collected with follow-up work including petrology, geochemistry and geochronology. However, much of the data exists in field note books and various unpublished Amdel and SADME reports, and this report attempts to collate the geological information for these two islands. The geology of islands further south and southwest (Masillon, Fenelon and Hart Islands and Cannan Reefs) is summarised in Flint and Crooks (1981) while similar reports are presently in preparation for other islands in the Archipelago. The geochronological data is in Webb (1978) and is currently being re-assessed (Webb et al., in prep.).

GEOLOGY

Because of speed during the SADME 1974 survey, time on each island for geological investigations was short. Consequently critical boundary relationships were often not observed, and if observed, were interpreted differently from what the photographs and/or geochronology suggest. Hence there is considerable scope for more field work and refinement of concepts.

The major rock units present are Middle Proterozoic poorly foliated granites, alkali granites, acid volcanics and various granitic, doleritic and rhyolitic veins (all unnamed units).

These are unconformably ovelain by the Quaternary Bridgewater Formation. Table 1 documents the extent of petrological and analytical work undertaken on these rock types.

The oldest rocks are probably the granites on West Island. They are poorly foliated (foliation strikes 015^0) and are medium- to coarse-grained with large feldspar phenocrysts. The mafic content varies considerably from less than 1% to about 10%. There have been no age determinations, however the interpreted age range is 1650 - 1550 Ma, bracketing the late-Kimban Orogenic granites and early post-orogenic granites.

On southeastern St Francis Island are alkali granites as on Masillon and Fenelon Islands to the south. The granite is characteristically pale grey with a low mafic content, however the mafics present include aegerine-augite and riebeckite. Rb-Sr geochronology on 6 alkali granites from the Archipelago, including 2 samples from St Francis Island, gives an intrusive age of 1478 ± 15 Ma (I.R. 0.7114 ± 0.0032).

A similar age is obtained from acid volcanics on southeastern St Francis Island and a vein on West Island. Together with 7 samples from Hart Island their age is 1490 ± 12 Ma (I.R. 0.7056 ± 0.0005) (Webb, 1978) which is similar in age to the Gawler Range Volcanics. The volcanics include porphyritic dacites and rhyolites; the matrix is very fine-grained, varies in colour from reddish to dark grey-black and contains quartz, feldspar, mica, epidote and opaques. Phenocrysts (up to 3 mm) are common and include potassium and plagioclase feldspars and smaller phenocrysts of quartz and biotite.

There have been several generations of veining. A leucogranite vein (5532 RS 47) intrudes volcanics on northwestern St Francis Island. This sample has been erroneously grouped with

other leucogranites in the Achipelago which gives a Rb-Sr age (Webb, 1978) about 50 Ma older than the volcanics! It is probably equivalent to the porphyritic leuogranites of Goat, Lacy and Franklin Islands.

Dolerite veins intrude the granite on West Island, alkali granite on St Francis Island and acid volcanics on Hart Island (Flint and Crooks, 1981). It is not known how many generations of veining they represent. The dolerites often retain their texture but not original mineralogy. Albitic plagioclase, amphibole, epidote, chlorite and opaques are the dominant constituents.

Intruding a dolerite vein on West Island is a fine-grained ?rhyodacite vein; an intrusive rhyolite vein also occurs on south eastern St Francis Island. The rhyolite vein is up to 12 m wide and the rhyolite is highly porphyritic with up to 40% feldspar phenocrysts ranging in size below 15 mm. These veins may be contemporaneous with the main mass of volcanics or slightly younger. On northern Eyre Peninsula, extrusion of Gawler Range Volcanics and intrusion of younger acid-volcanic veins occured over a period of 65 Ma (Webb, 1978).

The unconformably overlying Quaternary Bridgewater Formation consists of fawn aeolian calcarenites (displaying very large foresets). Nodular calcretes are also present though these are not strictly part of the Bridgewater Formation. Elsewhere the formation has been subdivided into an upper and lower member with capping calcretes (Firman, 1975) and it appears that these units are also present on St Francis Island.

TABLE 1: Summary information table for St Francis and West Islands of the Nuyts Archipelago.

	PETROLOGY	ANALYSES	GEOCHRONOLOGY	ROCK NAME
ST FRANCIS ISIAND				
5532 RS 28	P	As Ag	Rb-Sr	Granite
" 29	P	-	-	Amphibolite
" 30	P	-	Rb-Sr	Rhyolite
" 31	P	As Ag	Rb-Sr	Granite
" 32	P	-	-	Granite
" 33	P	As Ag	Rb-Sr	Rhyolite
" 34	P	-	Rb-Sr	Rhyolite
" 35	P	-	Rb-Sr	Rhyolite
" 36	P	-	Rb-Sr	Dacite
5533 RS 43	P	-	-	Rhyolite
" 44	P	-	-	Rhyolite/dacite contact
" 45	P	-	-	Rhyolite
" 47	P	As Ag	Rb-Sr	Granite
WEST ISIAND				
5532 RS 16	P	-	-	Dolerite
" 17	P	-	-	Amphibolite
" 18	P	As Ag	Rb-Sr	Rhyodacite
" 19	P	Ag	-	Granite
" 21	P	-	-	Granite
" 22	P	-	-	Granite/ amphibolite contact

As Silicate analyses Ag Geochemical analyses

GEOCHEMISTRY

Six samples from the two islands have been analysed for trace elements (Table 2) and for all but one of these there are also silicate analyses (Table 3). Specimens analysed vary from alkali granites (5532 RS 28 & 31) to volcanic dykes (5532 RS 18 & 33) to granitic dykes (5533 RS 47). There are no analyses for the volcanics on northwestern St. Francis Island and no silicate analyses for the granites on West Island.

In comparison to other data in Table 2, some of the trace element contents for specimen 5532 RS 33 are anomalous. This is particularly so for Ba, and to a lesser extent Pb, Rb and Sr. These trends, in this porphyritic rhyolite, are also evident in the analyses on volcanics on Hart Island (Flint and Crooks, 1981).

Silicate analyses in the alkali granite reveal a considerable enrichment in SiO_2 at the expense of most other oxides except Na_2O and K_2O (as compared with world-average oxide weight per centages for granite from Le Maitre, 1976). Both the granitic vein intruding volcanics (5533RS47) and the granite on West Island (5532 RS 18) also show similar trends.

TABLE 2: Trace element analyses

SAMPLE	Ag	Au	Ba	Be	Bi	Co	Cr	Cu	Li	Mo	Pb	Rb	Sb	Sn	Sr	Th	U	V	W	Zn	Zr
5532 RS 18	-	-	50	-	-	<2	<5	4	10	-	40	165	-	-	26	12	4	<10	-	97	410
"	<1	<0.5	-	3	<10	-	-	25	-	4	60	-	<30	2	-	20	4	10	<50	90	-
5532 RS 19	<1	<0.5	-	5	<10	-	-	32	-	4	15	-	<30	1	-	12	6	20	<50	40	-
5532 RS 28	-	-	20	-	-	<2	<5	2	15	-	28	210	-	-	4	10	<4	<10	-	51	360
5532 RS 31	-	-	<10	-	-	<2	<5	6	52	-	20	260	-	-	32	22	8	<10	-	220	580
5532 RS 33	-	-	1900	-	-	2	<5	10	14	-	80	95	-	-	250	6	4	<10	-	90	260
5533 RS 47	-	-	360	-	-	<2	<5	6	3	-	16	150	-	-	70	30	4	<10	-	15	110

Table 3: Silicate analyses

	WEST IS 5532 RS 18	ST. FRANCIS IS 5532 RS 33	Rhyolite*	ST. FRANCIS IS. 5532 RS 28	ST. FRANCIS IS. 5532 RS 31	ST. FRANCIS IS. 5533 RS 47	Granite+
SiO_2	77.50	69.24	72.82	78.18	77.42	77.68	71.30
TiO_2	.19	.50	.28	.15	.16	.10	.31
Al_2O_3	11.33	14.41	13.27	11.07	11.11	12.50	14.32
Fe_2O_3	1.08	1.41	1.48	1.20	1.37	.22	1.21
FeO	.50	1.35	1.11	.20	.30	.15	1.64
MnO	.06	.15	.06	.02	.17	.01	.05
MgO	.10	.66	.39	.03	.08	.09	.71
CaO	.14	1.41	1.14	.03	.18	.19	1.84
Na_2O	3.56	4.45	3.55	4.05	4.16	3.70	3.68
K_2O	4.66	4.33	4.30	4.32	4.38	4.72	4.07
P_2O_5	.02	.16	.07	.01	.01	.01	.12
H_2O^+	.21	.59	1.10	.14	.35	.36	.64
H_2O^-	.03	.01	.31	.02	.01	.03	.13
TOTAL	99.38	98.67	99.88	99.42	99.70	99.76	100.02

Average of 116 rhyolites* and 2236 granites+ from Le Maitre (1976).

PHOTOGRAPHY

Colour photographs were taken by R.B. Major (SADME) during both his visits in January 1973 and February 1974. Tabulated below is a selection of the better-quality slides. Not all of the photographs are illustrated; several slides have been chosen(*) as being representative of either the aerial view or ground scenic view of the rock types present.

ST. FRANCIS ISLAND

Photo No.

22510 Aerial view west towards St. Francis and West Islands (RBM-1974).

22511 Aerial view northwards towards St. Francis Island with Egg, Smooth, Dog and Lacy Islands in the background (RMB-1974).

22512 Aerial view northwestwards over the bay on northern side of the island (RBM-1974).

22513* Aerial view northwestwards of small bay north of the lighthouse (RBM-1973).

22514 Contact between intrusive dyke of porphyritic rhyolite (5532 RS 33) and grey granite. The rhyolite has a chilled margin 3-5 cm wide (RBM-1974).

22515* Close-up of porphyritic rhyolitic dyke (5532 RS 33) showing zoned feldspar phenocrysts and elliptical xenoliths (RBM-1974).

22516* View south across the beach to 30 m high cliffs of Bridgewater Formation (RBM-1973).

22517 Calcified roots in calcarenites and calcrete clasts in calcrete, Bridgewater Formation (RBM-1973).

22518	Contact between nodular calcretes of the Bridgewater Formation and grey granite (RBM-1973).
22519	Panoramic view northeast to Egg Island (RBM-1973).
22520	Panoramic view east-southeat (RBM-1973).
22521	Panoramic view northwards (RBM-1973).
22522	Panoramic view northwards (RMB-1973).
22620*	Close-up of typical alkali granite specimens (RBF-1981).
22621*	Close-up of typical acid volcanics (RBF-1981).
22622*	Typical intrusive dyke specimens; 5532 RS 29 - dolerite, 5533 RS 47 - leucogranite, 5532 RS 33 - porphyritic rhyolite (RBF-1981).

WEST ISLAND

Photo No.	
22523	Aerial view southwest towards West Island (RBM-1974).
22524	Aerial view southwestwards of West Island (RBM-1974).
22525	Vertical, aerial view of a dolerite dyke (5532 RS 16 & 17) (RBM-1974).
22526	View southeastwards (from the cliff top) of an amphibolite dyke (as per Photo No. 22525) which intrudes poorly-foliated granite (5532 RS 19) (RBM-1974).
22527	Close-up of rhyodacite vein (5532 RS 18) cross-cutting the dolerite (5532 RS 16 & 17) (RBM-1974.
22528	Close-up of stained rhyodacite vein cross-cutting the porphyritic dolerite (RBM-1974).

22529 Contact between poorly foliated granite (biro parallels foliation) and ?xenolith of amphibolite (RBM-1974).

R.B. Flint

RBF,AFC:AF

R.B. FLINT

A.F. CROOKS

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APPENDIX

PETROGRAPHIC DESCRIPTIONS

Modified extracts from unpublished Amdel reports:-
Lowder (1973a & b) and Steveson (1974a, b, c).

Samples 5533 RS 43-44 and 5532 RS 28-31 & 34-36 were collected by R.B. Major (SADME) during a visit (by boat) to St. Francis Island in January 1973.

Samples 5533 RS 45 & 47 and 5532 RS 16-19, 21-22 & 32-33 were collected by A.H. Blissett during the SADME 1974 island survey.

ST. FRANCIS ISLAND

Sample 5532 RS 28 Specimen P41/73 in Lowder 1973a

Rock name: Granite
Field observations: Leucocratic, massive, fine to medium-grained granite with minor mafics (up to 5 mm).

Thin Section:

Potassium feldspar 60%	Aegirine-augite 1-2
Quartz 30	Sphene & opaques trace
Plagioclase 5-10	

The rock consists mainly of large (up to 6 mm) potassium feldspar and quartz crystals, often with graphic intergrowths. Potassium feldspar is perthitic and lightly clouded, and is cut by vein quartz. Plagioclase is a minor interstitial phase. Quartz grains are anhedral and show undulose extinction.

Dark yellowish-green crystals, showing weak pleochroism and near parallel extinction are aegirine-augite. There are traces of sphene and opaques often associated with and probably replacing pyroxene.

Sample 5532 RS 29 Specimen P47/73 in Lowder 1973b

Rock name: Amphibolite
Field observations: Green to grey, fine-grained amphibolitic dyke (Striking 055^0, dipping 80^0SE) which is up to 0.4 m wide. Surrounding rocks are granite (5532 RS 28).

Thin Section:

Feldspar 40%	Chlorite 5
Epidote 20-30	Quartz 5
Amphibole 10-15	Opaques 2-3
Biotite 10	

Primary ferromagnesian minerals have been replaced by epidote, amphibole, biotite and chlorite; average size of which is 0.1 mm. Most of these grains are intimately intergrown, although some epidote has psuedomorphed larger grains. Small opaque grains are widely distributed.

Between the ferromagnesian minerals there is a feldspar (and minor quartz) matrix. The feldspar is probably all albite, and there are some albitised relic phenocrysts. However most of the feldspar is fine-grained and interstitial.

Sample 5532 RS 30 Specimen P52/73 in Lowder 1973b

Rock name: Rhyolite
Field observations: Dull pinkish-brown porphyritic rhyolite with pink feldspar phenocrysts up to 2 mm. Float.

Thin Section: The rock contains a few percent of clouded feldspar phenocrysts, with rare phenocrysts of quartz and sphene. There are also some patches of opaques and of degraded biotite. Phenocrysts range up to 3 mm. The remainder is a fine-grained, quartzo-feldspathic groundmass. Minute opaques or semi-opaques (some in elongate aggregates) are scattered through the rock. Much of the groundmass has a spherulitic texture.

Sample 5532 RS 31 Specimen P56/73 in Lowder 1973b

Rock name: Alkali granite

Field observations: Light grey (weathers dark-grey) equigranular, medium-grained granite with feldspar+quartz+biotite+?hornblende+opaques.

Thin Section:

Feldspar 70%	Riebeckite 1
Quartz 20-30	Sphene 1
Aegirine-augite 3-5	Opaques trace

Potash feldspar and quartz (graphically intergrown) are the dominant constituents. Grain size is highly variable, ranging up to 5 mm but with most grains between 0.3 - 1 mm. Plagioclase is only a minor constituent. Feldspar grains are very lightly clouded, and there is concentration of opaques along grain boundaries and fractures. Quartz grains show moderate to strong undulose extinction.

The most unusual feature is the presence of the sodic pyroxene aerigine-augite and the sodic amphibole riebeckite. Pyroxene forms irregular, yellowish-green, weakly pleochroic grains up to about 1.5 mm. Pyroxene cleavages are evident and the mineral has near-parallel extinction. Amphibole crystals are smaller, rarely over 0.5 mm long, and are strongly pleochroic from dark blue to yellowish-green (and has a small extinction angle). Sphene is a common accessory mineral.

Sample 5532 RS 32 Specimen P1062/74 in Steveson 1974a

Rock name: Porphyritic microgranite.

Field observations: Medium-grained leucogranite similar to 5532 RS 28.

Thin Section: The rock contains about 50-60% potassium feldspar and about 40% quartz. Often the minerals have a granophyric-like texture, but otherwise the crystals are large and separated into monomineralic clusters in a more normal allotriomorphic granular texture. The potassium feldspar is a twinned orthoclase perthite, occurring as bladed to anhedral crystals up to 2 mm. Exsolved plagioclase, marginal reaction with quartz and quartz in ?tension cracks are common phenomena. Quartz appears to have extensively replaced potassium feldspar, 'islands' of potassium feldspar remain in optical continuity.

Overall the rock has a porphyritic subgranophyric texture which has been modified by deformation, remobilisation of quartz and grain boundary reactions.

The principal mafic mineral is epidote which occurs as crystals and oriented groups of crystals up to 2 mm. The epidote is generally turbid and associated with limonitic material in fractures.

Sample 5532 RS 33 Specimen P1091/74 in Steveson 1974a

Rock name: Porphyritic rhyolite

Field observations: Pink porphyritic rhyolite; very fine-gained reddish-brown matrix with feldspar phenocrysts to 10 mm. Occurs as a dyke 12 m wide, striking 040^0; chilled margins 3-5 cm wide. Elongate pebble to cobble size xenoliths of granite.

Thin section: About 30-35% of the rock are phenocrysts of plagioclase and potassium feldspar. Feldspars form subhedral and equant to tabular crystals which have patchy perthitic and antiperthitic textures. The largest crystal (in the section) is 15 mm long and contains exsolved quartz. There are only a few small quartz phenocrysts. Mafic phenocrysts are probably represented by elongate aggregates of epidote, chlorite and opaques.

The groundmass is extremely fine-grained, grain size varying from 0.005 to 0.05 mm. The groundmass is siliceous with abundant potassium feldspar. Most of the groundmass has a random granular texture but there are also granoblastic areas which consist almost exclusively of quartz and small patches of granophyric intergrowths of quartz and potassium feldspar. The groundmass appears to have a banding. Occasionally elongate quartz and plagioclase (in the groundmass) have a decussate arrangement.

Biotite is a common accessory, and occurs in small flakes associated with epidote, chlorite and semi-opaques. Some radiating patches of epidote up to 0.4 mm across may be amygdales.

Sample 5532 RS 34 Specimen P53/73 in Lowder 1973b

Rock name: Rhyolite

Field observation: Dark, porphyritic acidic volcanic with cream feldspar phenocrysts.

Thin Section: Groundmass 70%

Phenocrysts:
Feldspars 20%
Quartz 5
Mafics 2
Opaques 1

This is a porphyritic rock with numerous feldspar phenocrysts up to 5 mm. Both potassium feldspar and plagioclase are recognisable; the former are clouded and the latter are heavily sericitised. Quartz phenocrysts are common and generally smaller than the feldspars.

Mafic phenocrysts originally consisted of biotite and possibly hornblende; they are now biotite, opaques, chlorite and epidote. Epitode patches also occur within feldspar phenocrysts. Quartz+epidote+chlorite veins cut across the rock.

The groundmass is very fine-grained and consists of granular quartz, feldspar and mica. There are also patches and discontinuous veins of quartz.

Sample 5532 RS 35 Specimen P54/73 in Lowder 1973b

Rock name: Rhyolite

Field observation: Similar to 5532 RS 34 but red in colour.

Thin section: The rock is virtually identical to 5532 RS 34, the only difference being that the groundmass has a darker appearance. This is probably due to disseminated hematite which gives the rock a red colour.

Sample 5532 RS 36 Specimen P55/73 in Lowder 1973b

Rock name: Dacite

Field observations: Dark, fine to medium-grained porphyritic volcanic. Greenish feldspar phenocrysts up to 2 mm.

Thin section: This is a porphyritic volcanic with the phenocrysts being mostly plagioclase. These range in size from 15 mm (in hand specimen) to groundmass grains. The plagioclase is spotted with epidote and sericite alteration. Some mafic phenocrysts were originally present but these have now been replaced by epidote, chlorite and secondary biotite. Minor primary biotite also remains.

The groundmass is holocrystalline and is mostly feldspar and quartz (staining indicates mostly potassium feldspar). The felsic minerals generally form granular intergrowths; lath-shaped plagioclase are probbly micro-phenocrysts. The groundmass also contains epidote, biotite and opaques.

Sample 5533 RS 43 Specimen P42/73 in Lowder 1973a

Rock name: Rhyolite

Field observations: Grey to dark-grey, massive, porphyritic volcanic. White feldspar phenocrysts to 3 mm and some grey quartz phenocrysts.

Thin section: Groundmass 80%

Phenocrysts:
Feldspar 10-15%
Mafics 1-2
Opaques trace
?Allanite trace

The rock is porphyritic with individual phenocrysts up to 3 mm (with larger aggregates of phenocrysts). Both plagioclase and potassium feldspar are present in about equal proportions. Alteration of feldspar (particularly plagioclase) varies from a light cloudiness to extensive replacement by sericite and epidote. Both feldspars

show some rounding and embayment due to resorption. Quartz phenocrysts are highly embayed and rounded by resorption. They also display strong undulose extinction.

Original mafic phenocrysts consisted of biotite and possibly hornblende. Some greenish-brown biotite remains, but most has been replaced by chlorite and epidote. Opaque phenocrysts are generally surrounded by a thin chloritic rim. There are a few, small (0.1 - 0.3 mm), brown isotropic grains (microphenocrysts) which may be allanite.

The groundmass is fine to very fine-grained. It is quartzo-feldspathic but includes numerous small mica flakes, some epidote and opaques and traces of zircon and apatite. The groundmass could be devitrified volcanic glass.

Sample 5532 RS 44 Specimen P48/73 in Lowder 1973b

Rock name: Rhyolite/dacite contact

Field observations: Contct between grey to dark-grey rhyolite (5532 RS 43) and a reddish-brown dacite. Relationship between the two types is not known.

Thin section: The red volcanic is probably a dacite as it contains numerous feldspar and a few mafic phenocrysts in a granular quartzo-feldspathic groundmass. The grey volcanic is a rhyolite, containing phenocrysts of quartz, feldspar and biotite in a very fine, somewhat banded, groundmass.

In the dacite, feldspar phenocrysts are heavily clouded and range in size up to 2 mm. The mafics are mostly altered to chlorite and epidote (originally biotite). Some of the opaque phenocrysts may be primary (though oxidised). The groundmass is equigranular (0.03 m) and includes quartz, feldspar and opaques.

In contrast, the groundmass of the rhyolite is not equigranular but most of it has a grain size below 0.01 mm. Quartz and feldspar are the dominant constituents, but there are also minute mica flakes and a little epidote and opaques.

The phenocrysts include plagioclase and potassium feldspar up to 3 mm. Quartz and feldspar phenocrysts show resorption. Most of the biotite has been chloritised.

The contact between the two rock types is sharp, and is cut by veins of epidote. It appears that the rhyolite has invaded the dacite.

Sample 5533 RS 45 Specimen P1089/74 in Steveson 1974a

Rock name: Rhyolite

Field observations: Mottled pale grey and dark-grey porphyritic rhyolite. Intruded by amphibolite vein at least 0.6 m wide.

Thin section: 25-30% of the thin section consists of phenocrysts. The most conspicuous mineral is quartz which forms rounded and embayed crystals (up to 1.5 mm). Undulose extinction is characteristic for all quartz phenocrysts, some of which have been fractured and filled with sericite and groundmass material. Feldspar phenocrysts (up to 3 mm) are equant and anhedral. Potassium feldspar phenocrysts are more abundant than plagioclase and are generally a turbid, untwinned orthoclase. Feldspar phenocrysts have sharp but irregular boundaries against the groundmass. Occasionally, sericitisation of the feldspars has been extensive and the sericitic veining in the groundmass extends to include the sericite in the phenocrysts. Aggregates of relatively coarse-grained epidote and quartz appear to pseudomorph original phenocrysts (?calcic plagioclase).

The groundmass is extremely fine-grained with an average grain size down to 10 microns. The exact mineralogy of the groundmass is not apparent, but is appears likely there is considerable quartz. The texture is granular, crystals are uniformly equant and anhedral and closely interlocked.

Apart from the epidote, mafics are rare; there are a few chlorite flakes and some widely dispersed ferruginous material.

The rock has been extensively veined with irregular veins of semi-opaque material.

Sample 5533 RS 47 Specimen P1090/74 in Steveson 1974a

Rock name: Sheared granite

Field observations: Cream to pink micro-granite vein (up to 0.5 m wide) intruding rhyolites.* Veins irregular, but generally striking 190^0 and dipping 35^0E.

*Note: In Webb (1978) this specimen is grouped with others that are 50 Ma older than the volcanics.

Thin section: The thin section contains shear zones as well as quartz showing extreme undulose extinction.

Potassium feldspar (about 30% rock) is an orthoclase perthite showing a patchy exsolution structure. Often quartz appears to have replaced potassium feldspar. Plagioclase is not as common as potassium feldspar. Zoned crystals and polysynthetic twinning are common. Twin planes show some kinking.

Quartz is abundant and forms irregularly shaped crystals (up to 1 mm). Much of the quartz shows extreme undulose extinction. Shear planes are defined by the concentration of very fine-grained minerals (grain size less than 0.1 mm).

Accessory minerals are rare, the most abundant are opaques but there are also some semi-opaques and translucent material. There is no biotite or chlorite.

WEST ISLAND

Sample 5532 RS 16 Specimen P1252/74 in Steveson 1974b

Rock name: Dolerite

Field observations: Dark, fine-grained dyke rock. Phenocrysts in zone in the middle of the dyke (2.5 m wide dyke). 1 m wide fine-grained margins.

Thin section: The sample consits of about 40% hornblende which occurs as subhedral to anhedral grains up to 0.15 mm. Plagioclase and quartz have an average grain size of 0.15 mm also and form equant andedra in a random granular texture. Some plagioclase present forms lath-shaped crystals to 0.25 mm and have a decussate texture. There is also some opaques, epidote, chlorite and a little sphene.

The white crystals (up to 2 mm) recognisable in hand specimen are feldspar and quartz. These crystals are commonly surrounded by epidote.

Sample 5532 RS 17 Specimen P1253/74 in Steveson 1974b

Rock name: Porphyritic amphibolite

Field observations: As for sample 5532 RS 16.

Thin section: Hornblende and chlorite are about equally abundant (each 10-15%). Hornblende and groups of chlorite flakes are commonly closely intergrown. Original igneous plagioclase are now represented by epidote, sericite and clay - with some plagioclase still remaining. Quartz is not common, about 5% of the rock. Epidote is a pale variety and has a grain size of 0.5 mm. Opaques and sphene are widely distributed.

Sample 5532 RS 18 Specimen P1064/74 in Steveson 1974a

Rock name: Recrystallised ?rhyodacite

Field observations: Red, fine-grained acid rock in bands up to 10 m wide which intrude granite (5532 RS 19).

Thin section: The rock has an even-grained granular texture and consists of quartz, with minor opaques, potassium feldspar and plagioclase. The grain size is 0.05 - 0.15 mm and the crystals occur as equant anhedra.

Plagioclase has well-developed polysynthetic twinning while potassium feldspar is generally untwinned except for occasional grid iron twinning. The feldspars are about equally abundant.

In one or two cases there may be relics of an original spherulitic texture. Generally, igneous textures have been completely removed by pervasive quartz recrystallisation and probably some solution of feldspar.

Other minerals are present in only trace amounts, the most common is dusty red hematite. Other minerals include opaques, chlorite, zircon, sericite and possible epidote.

Sample 5532 RS 19 Specimen P1065/74 in Steveson 1974a

Rock name: Deformed granite

Field observations: Pale, medium to coarse-grained, poorly foliated granite. Large potassium feldspar phenocrysts (up to 10 mm) occur in medium to coarse-grained matrix. Foliation strikes approximately 015^0.

Thin section: The thin section contains one large phenocryst of perthitic orthoclase almost 10 mm across. This crystal is equant and has irregular boundaries against crystals in the groundmass. Other potassium crystals are equant to elongate perthitic orthoclase with a pervasive turbidity. Plagioclase is less abundant and is normally confined to crystals less than 1 mm. Zonation is common and is indicated by sericitic cores and clearer rims. The two feldspars constitute about 60% of the rock. There is also some microcline.

The rock has been extensively recrystallised. Quartz occurs as extremely strained crystals which have sutured quartz/quartz margins. Bulbous and lobate quartz crystals penetrate into adjacent feldspars. Narrow zones of granulation are marked by thin strings of very fine-grained granoblastic quartz. No original igneous quartz remains and the microcline may be also be secondary.

The most abundant mafic mineral is brown pleochroic biotite, which has associated exsolved opaques. Other mafics include chlorite, and small amounts of sericite, apatite and zircon.

Sample 5532 RS 21 Specimen P1092/74 in Steveson 1974c

Rock name: Deformed granite

Field observations: Leucocratic, medium-grained, biotite-poor, poorly foliated (015^0) granite. Considered to be a possible variant of 5532 RS 19 and ?equivalent to 5532 RS 31 on St. Francis Island. Main rock type for the island.

Thin section: The rock consists almost entirely of felsic minerals and has a texture indicative of intense shearing and deformation. Some potassium feldspar retain its perthitic texture and is present as equant anhedra up to 2 mm. The remainder of the rock consists of recrystallised material, notably quartz which occurs as granoblastic and mortared textures with a curved foliation. Quartz/quartz crystal margins are extremely irregular. Thin seams of quartz occur in fissures

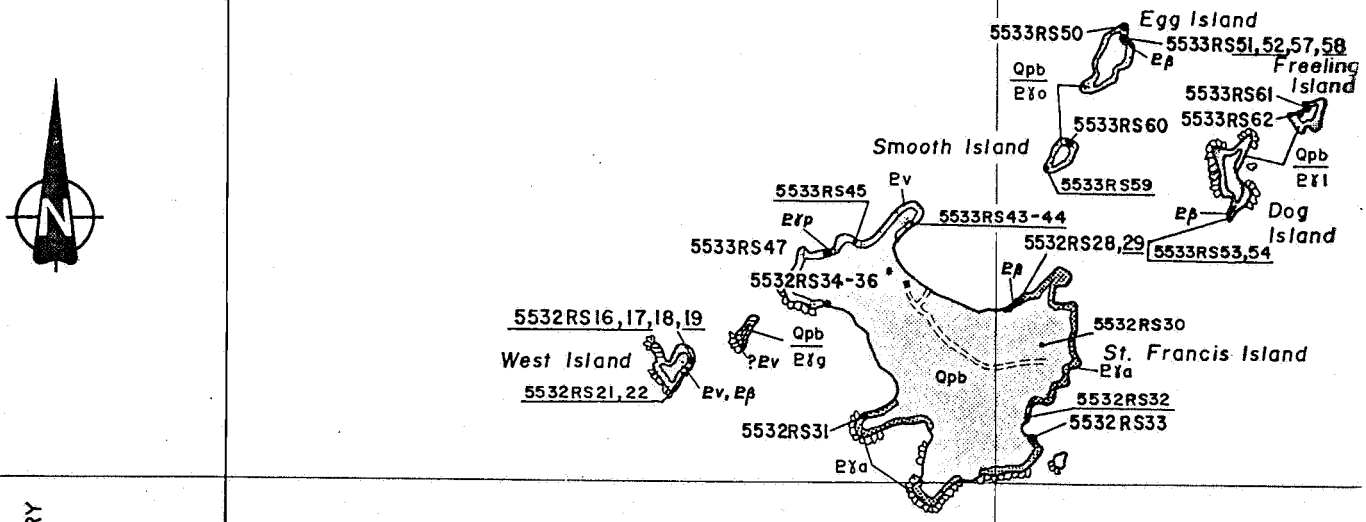
within feldspars and also around some of the larger feldspars. Evidence of the rock's original granitic textures has been almost completely removed.

Sample 5532 RS 22 Specimen P1093/74 in Steveson 1974c

Rock name: Granite/amphibolite contact.

Field observations: Granite (5532 RS 21) is intruded by dark green to black amphibolite dyke (striking SE). Near the contact, the granite is pinkish-red.

Thin section: The ganitic rock has suffered considerable deformation and recrystallisation and now has a granular to granoblastic texture. Quartz is abundant and often occurs as large irregular and strained crystals, and has probably been introduced. Large relic crystals of plagioclase and potassium feldspar remain. The crystal grain size decreases towards the contact zone with there being an indefinite contact. The dyke rock consists of bands rich in hornblende and alternately epidote. A turbid felsic mineral, probably plagioclase, is also present. The averge grain size of these minerals is 0.02 mm. These alternating bands occur throughout the area sectioned and may or may not be representative of the dykes.

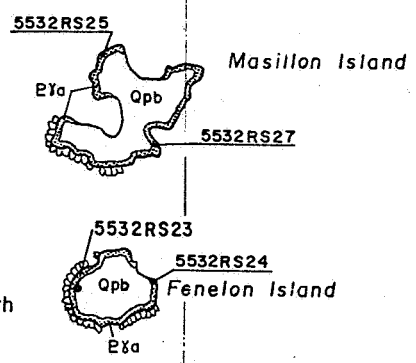


QUATERNARY

MIDDLE PROTEROZOIC

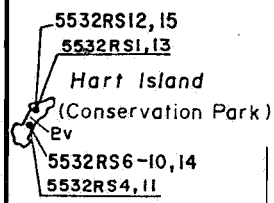
- Qpb — Bridgewater Formation : aeolian calcarenites and calcretes.
- Eβ — Dolerite dykes : ophitic textures, chilled margins, variously altered.
- Eγp — Leucocratic granite vein, intrudes volcanics.
- Eγa — Alkali granites : massive, grey, medium grained, sodic amphibole and pyroxene-bearing. Age 1478 ± 15 Ma.
- Eγo — Porphyries : dark grey, abundant quartz and potassium feldspar phenocrysts to 8mm.
- Ev + Ev — Volcanics : flow-banded porphyritic dacites to rhyolites with quartz, feldspar and mafic phenocrysts. Matrix is fine grained and reddish to grey-black. Age 1490 ± 17 Ma.
- Eγl — Leucogranites : pale pink, medium-grained and porphyritic varieties. Age 1547 ± 17 Ma.
- Eγg — Granites : medium to coarse grained, poorly foliated.

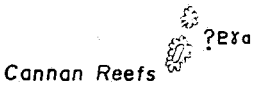
ST. FRANCIS ISLES
(Conservation Park)



• 5532RS23 Geochronology sample

5532RS27 Rock sample number, prefixed by 1:100000 map sheet number





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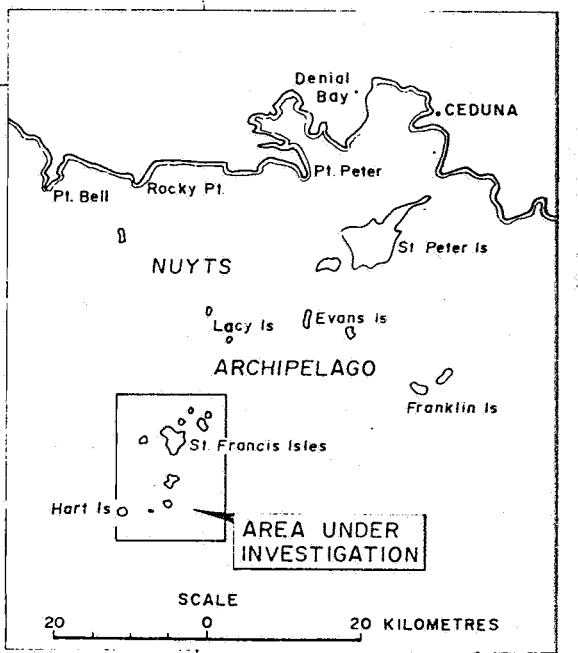

Fig. 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

NUYTS ARCHIPELAGO
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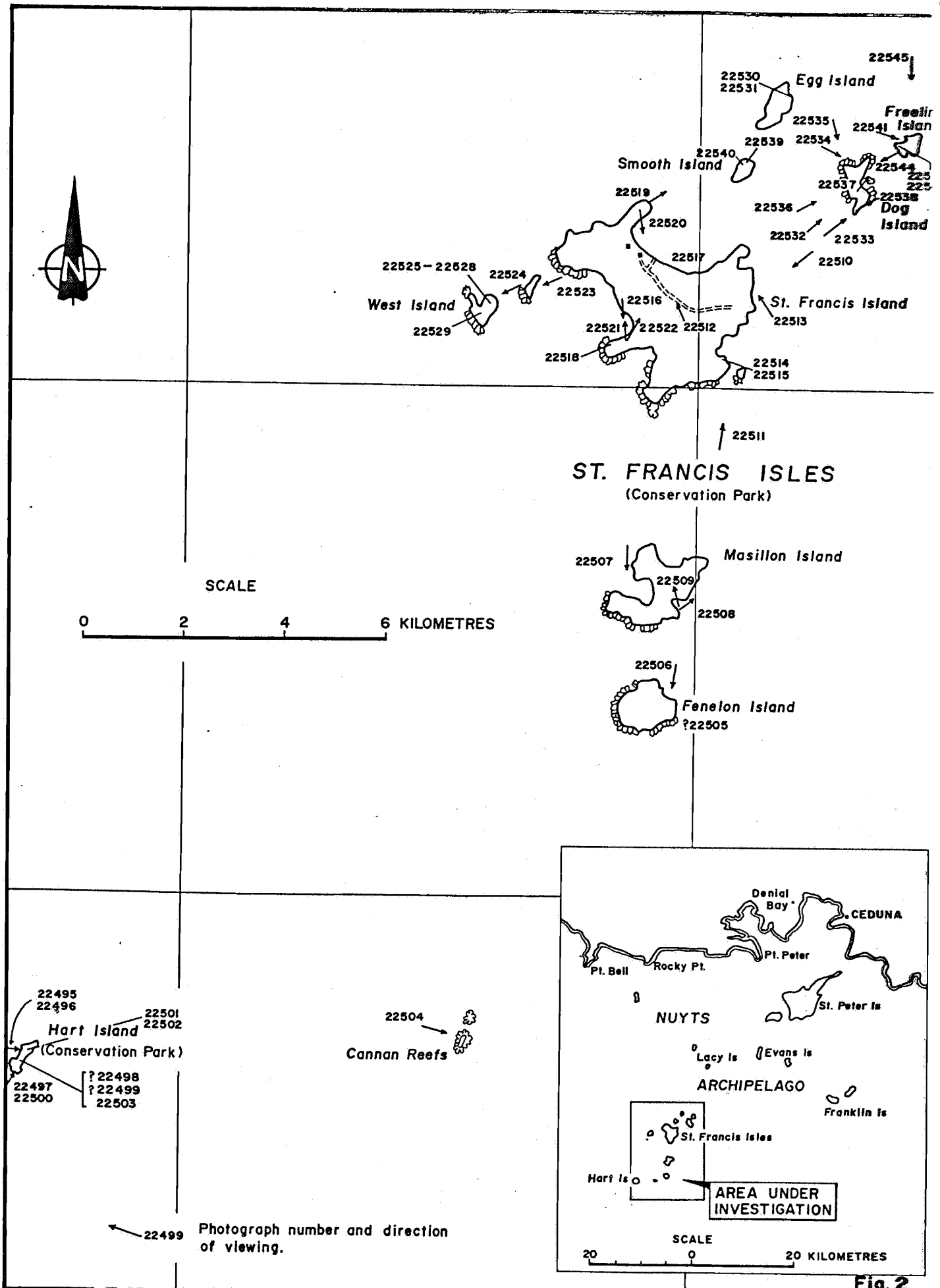

Fig. 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

NUYTS ARCHIPELAGO PHOTOGRAPHY COVERAGE

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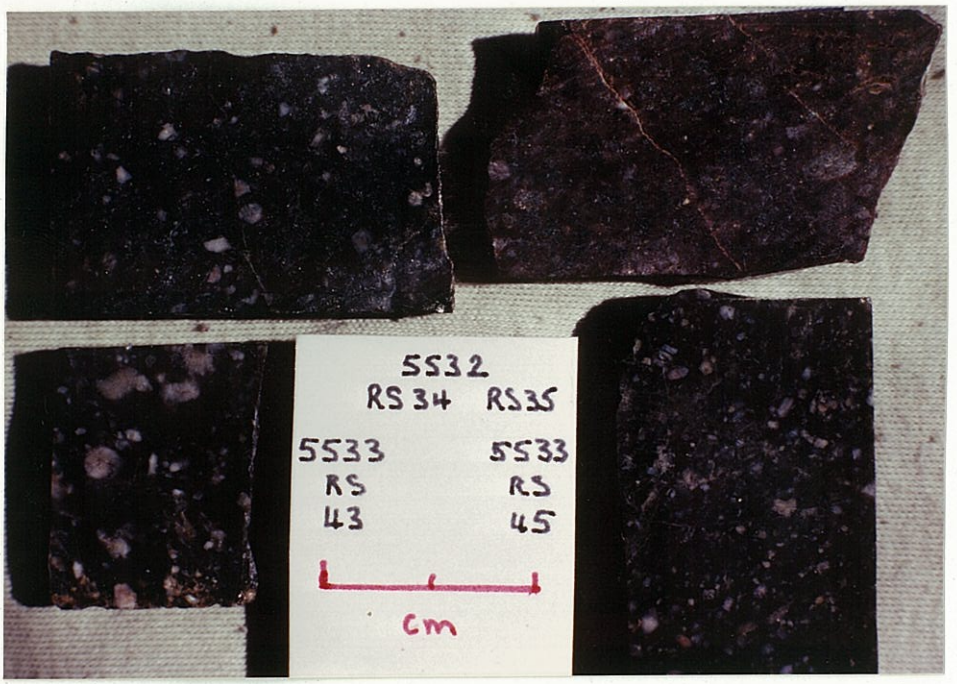
ST. FRANCIS ISLAND

PLATE 1: Aerial view northeastwards of small bay north of the lighthouse
Photo No. 22513

PLATE 2: View southwards, showing ~30 m high cliffs of calcrete and calcarenites of the Bridgewater Formation
Photo No. 22516

PLATE 3:
Close-up of typical alkali granite specimens.
Photo No. 22620



ST FRANCIS ISLAND

PLATE 4: Close-up of typical acid volcanics
Photo No. 22621

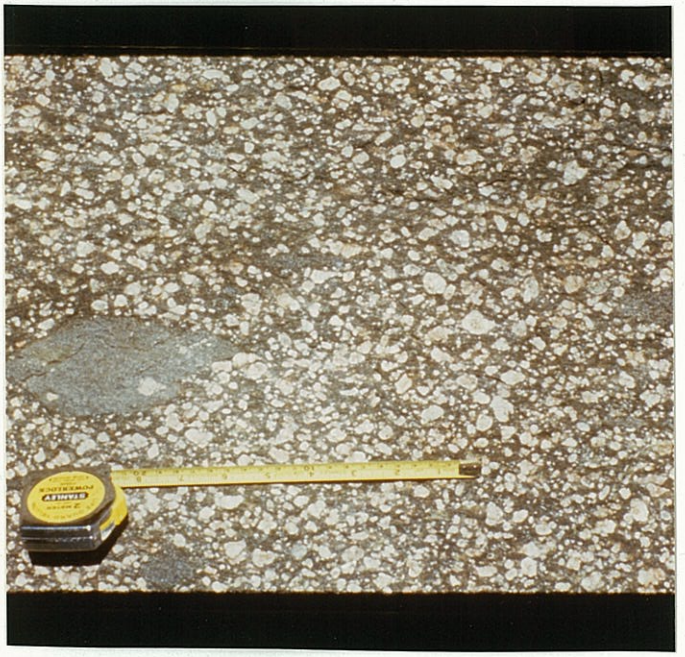


PLATE 5: Porphyritic rhyolite dyke (5532 RS 33) which intrudes alkali granite
Photo No. 22515

PLATE 6:
Typical intrusive dyke specimens;
5532 RS29- dolerite
5533 RS47-leucograni
5532 RS33-porphyriti
rhyolite(see above
Photo No. 22622