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Normanby Island T.P.N.G. Reconnaissance Petrography

by

H.L. Davies

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SUMMARY

Petrographic data on specimens collected during a helicopter reconnaissance of Normanby Island are presented, along with some data on Dobu, Fergusson and Goodenough Islands. The metamorphic grade of the Prevost Metamorphics is low greenschist facies, lower than was previously thought; glaucophane is present in one thin section. Granitic rocks which intrude the metamorphics may be predominantly granodiorite. The metamorphic grade of the Kurada Metavolcanics is greenschist and possibly lower; supposed hornblende andesite is in fact altered pyroxene basalt, and suspected ultramafic boulders are in fact lime-metasomatized basaltic? rocks. Typical rock-types of the ultramafic-mafic complexes are dunite, harzburgite, wehrlite, websterite, and finely granular gabbro and norite; prevalence of chromite in one thin section may be a pointer to economic chromite concentrations. Lower Miocene limestone and volcanogenic sediments include little or no terrigenous detritus; Lower Miocene vulcanism was probably dacitic-andesitic. Quaternary volcanics of central Normanby include pink blocky lavas which may be of syenitic composition. Further north on Dobu Island and south-eastern and south-western Fergusson Island alkaline rhyolite and rhyolite-obsidian are associated. Small fragments of xenolithic scoriaceous basalt are scattered on the rim of Diodio Maar on Goodenough Island.

INTRODUCTION

This report presents petrographic data on specimens collected during a helicopter reconnaissance of Normanby Island in 1967 (Davies, 1967). Miscellaneous new data on Dobu, Fergusson and Goodenough Islands is also included.

Specimen localities and field descriptions are recorded on a 1:63,360 data sheet filed at B.M.R., Canberra, and localities of many specimens are given in the text by latitude and longitude.

Brief details of each thin section will be recorded on punched cards at B.M.R. as follows:

Rock number	Rock type	Rock unit	Age	Locality (general)	1:250,000 sheet	lat/long	Fieldbook reference
(8)	(8)	(8)	(8)	(8)	(4)	(9)	(8)

e.g.

65521434 BASALT DYKEROCK - NORMANBY C565 09015053 HLD67114

65521410 VOLCGWKE (SEWA) LMIO NORMANBY C565 100015059 HLD67114

Latitude and longitude are based on Australian Army one mile maps. Fieldbook reference abbreviation stands for HLD(avies) (19)67 (book) 1 (page)15. Thin sections and rocks will be stored at B.M.R. Canberra. Chemical analyses are by A. Jorgensen of A.M.D.L.

PREVOST METAMORPHICS

Twelve specimens were examined in thin section, ten from eastern and south-eastern Normanby and two from near Esa'ala. These include basic schists (six) calcic schists (three) and QFB (quartz-feldspar-biotite) schists (three). Mineral content is summarized in Table 1.

Mineral assemblages in the basic schists are typical of the greenschist facies, quartz-albite-muscovite-chlorite subfacies, as defined by Turner and Verhoogen (1960, p. 534). This is the lowest grade of greenschist metamorphism. The presence of glaucophane in one sample (1351) might indicate that conditions were transitional from greenschist to glaucophane schist facies or that glaucophane schist conditions prevailed locally. The typical basic schist contains albite, clinozoisite, muscovite or stilpnomelane, chlorite, and tremolite or actinolite. The original rock type was probably basalt or dolerite.

TABLE 1: PREVOST METAMORPHICS MINERAL ASSEMBLAGES

	QUARTZ	CALCITE	ALBITE	C'ZOISITE	CHLORITE	STILPNOM.	MUSCOVITE	BIOTITE	TREMOLITE	ACTINOLITE	OTHER
BASIC SCHISTS											
65521351			X			X					epidote, glaucophane
65521387	X			X	X	X					
65521391		X	X	X	X		X				pyrite
65521392			X	X	X		X		X		sphene
65521394			X	X	X		X			X	pumpellyite?
65521395			X	X	X				X		
CALCIC SCHISTS											
65521353	X	X					X				
65521356	X	X									
65521458	X		X				X	X			diopside, wollastonite
QFB SCHISTS											
65521354	X	X	X				X	X			
65521390	X	X	X				X				plag. is oligoclase
65521453	X		X					X2			2 varieties of biotite

The calcic schists typically consist of quartz, calcite, and muscovite. One sample (1458, from near Esa'ala) is thermally metamorphosed to quartz-albite-muscovite-biotite-diopside-wollastonite gneiss. Sample 1391 is part calcic, part basic, and is listed with the basic schists.

The Q-F-B (quartz-feldspar-biotite) schists are made up of quartz, albite, biotite and/or muscovite, and calcite. The plagioclase in one specimen (1390) is oligoclase.

Discussion

In the reconnaissance report (Davies, 1967) it was suggested that the Prevost Metamorphics can be correlated with the high-grade (amphibolite facies) metamorphics of Fergusson and Goodenough Islands. Examination of thin sections shows that the metamorphic grade of the Prevost Metamorphics is much lower than was at first thought (lowest greenschist bordering glaucophane schist facies). Despite this difference in metamorphic grade the various groups of metamorphics are probably correlatable for they share certain broad chemical characteristics (much quartzo-feldspathic material, considerable calcic and basic material, little or no aluminous schist) and all have been folded into broad domes and anticlines.

GRANODIORITE

Two samples of rocks described in the field as granite (Davies, 1967) are in fact granodiorite. One is from Ubuia Island (9 48'S, 150 47'E) and the other from the western flank of the Gidogidora Granite (9 51'S, 150 51'E). The Ubuia granodiorite (1406) consists of quartz, strongly zoned oligoclase, microcline, biotite and sphene; plagioclase is about 80 percent of total feldspar. The Gidogidora granodiorite (1401) consists of quartz, strongly zoned plagioclase with labradorite core, brown biotite, and amphibole clots; no potash feldspar was identified but it may be present in fine graphic intergrowth with quartz on the outermost rim of the plagioclase grains.

Granodiorite (Stanley, 1916) or diorite (J.E. Thompson, personal communication, 1967) also crops out north-east of Sewa Bay at about 9 58'S, 150 58'E. Stanley (ibid.) also records "hornblende-biotite granite" at the summit of the Solomonai Range near Esa'ala, and pegmatite veins nearby. He investigated reports of tin mineralization in this area and found none.

DYKE ROCKS

Porphyritic basalt dykes intrude the Gidogidora Granite in Gidogidora Creek (9 50'S, 150 53') and the quartzo-feldspathic metamorphics on the eastern flank of Mount Solomonai at 9 44'S, 150 48'E. The basaltic composition trends towards microdiorite in some of the northern samples, with the appearance of primary hornblende and biotite, and in two the matrix includes albite. Mineral compositions are tabulated below:

1434 (Gidogidora):	lab. - cpx (titanaugite) phenocrysts: matrix same
1449 (Solomonai):	lab. - cpx - lamprob. phenocrysts; lamprob. - plag. matrix
1454 "	biot. - hbe - cpx - lab. phenocrysts; biot. also in matrix, matrix permeated by albite.
1455 "	apat. - biot. - hbe - lab.
1457 "	biot. - hbe - lab; ab and lab. in matrix
1459 "	lab. predominates, also lamprob., chlor., sphene.

KURADA METAVOLCANICS

The typical rock type of the Kurada Metavolcanics is chloritic and epidotic basic schist with relict igneous textures (Davies, 1967); it was not examined in thin section. Rock types which were examined include "porphyritic hornblende andesite", two samples of suspected ultramafics, and silicified basalt breccia from the supposed thrust zone immediately south of Mount Bwebweso.

The "porphyritic hornblende basalt" (1342) is in fact an altered porphyritic basalt, now entirely altered to actinolite, epidote, and albite; basaltic texture is preserved.

The suspected ultramafics (1343, 1345), which were also described in the field as "ferruginous green limestone" are in fact composed of diopside, epidote, and quartz in the one case, and epidote, hydrogrossular, quartz, and pyrite in the other. Both are thought to be <u>basaltic volcanics</u> which have been subjected to lime metasomatism. 1343 is made up of fragments of coarser diopside-epidote-quartz rock (grain-size up to 0.6 mm.) in a matrix of very fine diopside-epidote-quartz (0.03 mm.); matrix minerals were verified by X-ray diffraction. Perhaps the original rock was a hyaloclastite (palagonite tuff) of basaltic fragments in basaltic glass. 1345 is mostly epidote with brown irregular "veins" of hydrogrossular which are possibly localized along former cracks; fine veinlets of pyrite are developed normal to a quartz vein.

The silicified basalt breccia (1382, 1383) consists of basalt fragments in a matrix of finely granular quartz; the basalt is completely altered to chlorite but the original texture is preserved.

Discussion

The metamorphic grade of the Kurada Metavolcanics remains unknown because no thin sections of the typical chloritic and epidotic basic schist have been prepared. Field observation has the Kurada Metavolcanics as lower grade than the Prevost Metamorphics because, in particular, schistosity is not as strong and "biotite" (in fact stilpnomelane) is not developed. The Prevost Metamorphics are lowest greenschist facies so we might expect to find prehnite, pumpellyite, and zeolites in the typical Kurada Metavolcanics.

It is possible that the Kurada Metavolcanics and the Prevost Metamorphics represent parts of the one sequence of volcanics and sediments. Tentative correlation with mainland rock units (metabasalt and marble schist at Mt. Suckling, Owen Stanley Metamorphics) suggests that both are Cretaceous. If this is so we might guess, from their relative positions on Normanby Island, that the basaltic metavolcanics overlie the more sialic metamorphics.

ULTRAMAFIC - MAFIC COMPLEXES

The ultramafic - mafic complexes are made up of dunite, harzburgite (olivine, enstatite), wehrlite (olivine, diopside), some enstatite pyroxenite veinlets, and various finely granular gabbros and norites, some olivine bearing, some silicified and uralitized. Table 2 shows mineral assemblages.

TABLE 2: ULTRAMAFIC-MAFIC COMPLEX MINERAL ASSEMBLAGES

	OLIVINE	SERPENTINE	ENSTATITE	HYPERSTHENE	DIOPSIDE	BYTOWNITE	HORNBLENDE	CHROMITE	CARBONATE	QUARTZ	REMARKS
ULTRAMAFIC			(numbers indicate approximate percentage by volume)								
6552 1381				75	15	10					
6552 1384	85		15								
6552 1385	90				5			3			
6552 1404		50						40	10		
6552 1405	75				25			5			
6552 1408	40	30	10					5	15		
6552 1409	60	20	10								
6552 1424	50				50			0			suit. analysis
6552 1427				X	X						
6552 1429	80		15					3			
6552 1430	40	40			10						
MAFIC											
6552 1422				X	X	X	X				
6552 1423				X	X	X	X			X	
6552 1425				X	X	X					
6552 1431	X			X	X	X					suit. analysis
6552 1432				X	X	X	X			X	

The suite of rocks is similar to that which occurs near gabbro - peridotite contacts in the Papuan Ultramafic Belt. Unusual features include:

1404: large (7 mm.) chromite grains occur in a poorly defined layer in a coarse-grained antigorite matrix

1385: diopside appears to form a discontinuous vein in olivine groundmass

1408: chromite and enstatite veinlet in olivine groundmass; carbonate alteration of serpentine

1424: wehrlite of olivine (50) and diopside (50), suitable for chemical analysis; note absence of chromite.

The coarse antigorite in 1404 may indicate heating after serpentinization, perhaps by granite intrusions. The concentration of chromite in this hand specimen may be a pointer to economic concentrations of chromite in this area. The apparent veining of olivine rocks by diopside and chromite-enstatite in 1385 and 1408 may help us to decipher the petrogenesis of the olivine-pyroxene rocks.

The mafic rock types are also like those of the Papuan Ultramafic Belt. They are remarkable for fine granular texture (1 - 2 mm in most, and 0.5 mm in 1423), for their generally uniform mineralogy (hypersthene - diopside - bytownite) and for local silicification and uralitization. The latter two features probably indicate acid intrusives nearby.

The reconnaissance geological map of Normanby (Davies, 1967) shows mafic rocks on the north side of Ubuia Island (9 48'S, 150 47'E). This is an error; the rock type is in fact granodiorite (see under "Granodiorite").

LOWER MIOCENE SEDIMENTS

A dense grey limestone boulder (1412), collected from a small stream which drains into eastern Sewa Bay at 10°01'S, 150°59'E, contains Eulepidina which is a Lower Miocene (Tertiary e stage) foraminifera (D.J. Belford, personal communication, 5 June 1967). Other boulders in the same stream are volcanogenic sediments of varying grain-size and these too are presumably Lower Miocene. Altered andesite which crops out nearby may be part of the same rock unit. I suggest that the Lower Miocene rocks might be known as the Sewa Beds as they crop out on the eastern side of Sewa Bay. B.M.R. stratigraphic nomenclature records show that Sewa was previously used by E.R. Stanley but this may not be true for he does not use it in his report on Normanby Island (Stanley, 1916).

The clastic sediments associated with the Lower Miocene limestone have been examined carefully as cut slabs to establish whether terrigenous material and, in particular, ultramafic detritus are present. They appear to be entirely volcanogenic; the typical lava fragment is a white andesite or dacite consisting of green (celadonite?) pseudomorphs after amphibole phenocrysts, some chlorite and magnetite after pyroxene? phenocrysts, and altered oligoclase or andesine phenocrysts in a matrix of feldspar and quartz (1411, thin section). Other fragments include intermediate? lava, microdiorite or microgranodiorite, feldspar crystals, and grey and green chert. Another sample of the clastic sediments (1419) is a conglomerate which includes a six-inch boulder of red-brown andesite; this is flowbanded, xenolithic, and consists of hornblende and andesine phenocrysts in a haematitic and calcified matrix.

The andesite in the conglomerate is similar to andesite which crops out nearby on the shores of Sewa Bay. One outcrop (1416) includes phenocrysts of clinopyroxene, hornblende and altered plagioclase; the other outcrop is more altered, porphyritic, vesicular, haematitic and calcified.

Discussion

The absence of terrigenous detritus in the Lower Miocene sediments suggests that, except for the volcanic pile, Normanby Island was not a land area at this time and that uplift did not begin until Mid-Miocene or later. The scanty evidence suggests that Lower Miocene vulcanism was andesitic and subaerial, rather than basaltic and submarine as is the case on the nearby Papuan mainland.

QUATERNARY VOLCANICS

A sample of pink blocky lava (1399) from the hills west of Sewataitai Plantation was selected as representative of the pink lavas which were found at most of the heli-landings between the Gidogidora Granite and Sewa Bay. Thin section shows it to be a breccia of lava fragments in a carbonate matrix. Chemical analysis indicates that the lava fragments are of alkali syenite composition, if we assume that all of the carbonate is $CaCO_3$ and that all was introduced from outside the lava (see Table 3). The syenitic composition is interesting in view of the proximity of syenitic intrusives on the eastern Papuan mainland. However it needs to be verified by analysis of unaltered lava samples.

TABLE 3

Chemical analysis of syenitic? lava (1399)

	A	B
SiO_2	51.3	63.2
Al_2O_3	13.3	16.4
Fe_2O_3	4.85	5.97
FeO	1.48	1.83
MgO	2.85	3.52
CaO	8.45	1.83
Na_2O	1.81	2.24
K_2O	2.75	3.40
H_2O^-	3.40	-
H_2O^+	3.10	-
CO_2	5.25	-
TiO_2	0.96	1.18
P_2O_5	0.35	0.43
MnO	0.11	0.14
Total	99.96	100.14

Column B shows analysis recalculated to 100 after removal of H_2O^+, H_2O^-, CO_2, and sufficient CaO to account for all CO_2 as introduced $CaCO_3$. The calculation will be in error if some of the $CaCO_3$ formed by reaction of CO_2 solutions with CaO in the lava, or if all of the carbonate is not $CaCO_3$, or if other elements have been removed in solution during carbonatization.

Phenocrysts in the thin section would suggest andesitic rather than syenitic lava composition; they are andesine-labradorite and altered basaltic hornblende. The supposed andesine-labradorite has unusual optics (2V = 70 to 75 (+)) perhaps due to high temperature crystallization; polysynthetic twins extinguish at around 20°. The lava groundmass includes microliths of feldspar and some devitrified glass.

The lava may be a submarine flow breccia which collected carbonate from sea floor sediments.

DOBU AND FERGUSSON ISLAND RHYOLITE

Dobu Island is constructed of unconsolidated rhyolitic volcanic ash on a basement of flow-banded rhyolite and obsidian; the basement is exposed at the south-eastern point of the island. Vertical flow banding in the obsidian may indicate Quaternary folding or may be a primary flow attitude. Two specimens of flow banded rhyolite were examined in thin section. One (1448) consists of anorthoclase and colourless augite phenocrysts in a cryptocrystalline groundmass with veinlets of quartz, basaltic hornblende and blue-green pyroxene (or amphibole). The other (1461) consists of anorthoclase and aegirine-augite phenocrysts in a groundmass of the same minerals and basaltic hornblende. These samples are petrographically similar to those from Lamonai and Oiau craters on Fergusson Island and the small east crater of Dobu which Morgan (1966) has described. The chemical composition of these is peralkaline rhyolite (Morgan, ibid.).

Flow-banded rhyolite and obsidian are also associated in south-western Fergusson Island where they are thought to cap the plateau south-east of Seymour Bay at 9°35'S, 150°32'E (Davies and Ives, 1965, p.41). Samples of these have been analyzed by A. Jorgensen of A.M.D.L., and the flow-banded rhyolite has been examined in thin section. The flow-banded rhyolite has been described as a biotite dacite (Davies and Ives, 1965, p. 42, sp. R11357) because its high alkali and low lime content is not obvious in thin section. In another sample of the same rock (1357) I found phenocrysts of oligoclase, biotite and basaltic hornblende, and a cryptocrystalline matrix. The plagioclase has anomalous optics (2V = 70 (-), polysynthetic twins extinguish at 20°, relief higher than balsam) probably owing to high temperature crystallization. Some crystals show zoning from low to high to low relief but all zones have 2V = 70 (-).

The chemical analyses in Table 4 show that the south-western rhyolite (1357) and obsidian (1358) differ from those of south-eastern Fergusson Island and Dobu in having more silica, less iron, and less soda. Composition approximates Nockolds' (1954) average alkali rhyolite and rhyolite-obsidian; alumina is a little higher and iron a little lower.

TABLE 4

Chemical analyses of rhyolite and rhyolite-obsidian

	1357	1358	M	N
SiO_2	72.9	74.3	70.1	74.57
TiO_2	0.27	0.20	0.29	0.17
Al_2O_3	14.5	13.5	14.70	12.58
Fe_2O_3	0.92	0.40	1.14	1.30
FeO	0.23	0.87	1.68	1.02
MnO	0.02	0.03	0.09	0.05
MgO	0.19	0.18	0.20	0.11
CaO	0.58	0.72	0.52	0.61
Na_2O	5.05	4.35	6.04	4.13
K_2O	4.45	4.70	4.55	4.73
H_2O+	0.38	0.42	0.26	0.66
P_2O_5	0.02	0.02	0.03	0.07
Total	99.51	99.69	99.59	100.00

1357: Flow-banded rhyolite ("biotite dacite") south-western Fergusson Island

1358: Obsidian, south-western Fergusson Island.

M: Average of four samples of obsidian and rhyolite from south-eastern Fergusson Island (calculated from data in Morgan, 1966).

N: Average alkali rhyolite + (rhyolite-obsidian) (Nockolds, 1954)

GOODENOUGH AND FERGUSSON ISLAND BASALTS

Boulders of basalt lava were collected from the mouth of Afuana Creek on Goodenough Island (9 26'S, 150 22'E) and from Dudunaia Creek on Fergusson Island (9 39'S, 150 27'E). These yielded little new information. The Dudunaia Creek sample (1442) is a porphyritic olivine-clinopyroxene-labradorite basalt. The Afuana Creek samples (1368, 1371) probably represent the red-black vesicular basalt which underlies the fan of lava south-west of Nuatutu (Davies and Ives, 1965, p. 43). They are xenolithic and contain phenocrysts of olivine, enstatite, bytownite/labradorite, and, in the case of 1371, probably some clinopyroxene.

Diodio Maar

The Diodio Maar is an explosion vent in the alluvial plains of south-eastern Goodenough Island. It is marked by circular depression partly occupied by a lake and enclosed by a low ridge of predominantly alluvial material. Amongst the alluvial material on the surface there are small pebbles (half inch to two inches) of superficially weathered scoriaceous xenolithic basalt; this is predominantly labradorite laths in a devitrified glass matrix. Xenoliths in one thin section (1444) include broken olivine euhedra, a little orthopyroxene, albite/oligoclase, sanidine (2V from 10 to 20° (-)), quartz-albite-orthoclase-magnetite rock, and quartz-orthoclase rock. The purplish trachyte recorded previously (Davies and Ives, 1965, p.44) was not seen.

FERGUSSON ISLAND METAMORPHICS

Samples of metamorphic rock were collected from the northern front of the Mailolo Block (Davies and Ives, 1965, p.8) where garnet amphibolites and aluminous schists are being eroded. Mineral assemblages in these samples are similar to those previously described (Davies and Ives, 1965, pp. 18-22). Specimens 1372, 1374 and 1375 are typical hornblende amphibolites with various combinations of hornblende, oligoclase, quartz, garnet, zoisite, potash feldspar, apatite and epidote, and with sphene, rutile, magnetite, and pyrite as accessories. 1380 is an intermediate schist: epidote-quartz-garnet-biotite-hornblende-plagioclase. 1377 and 1378 represent the aluminous schists which are particularly rare in the D'Entrecasteaux Islands; 1377 is garnet-quartz-muscovite, 1378 is staurolite-kyanite-garnet-muscovite-quartz.

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