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GEOLOGICAL RECONNAISSANCE OF GOODENOUGH, FERGUSSON, AND DOBU ISLANDS. PAPUA.

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by

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SUMMARY

Goodenough, Fergusson, and Dobu Islands are part of the D'Entrecasteaux Group which lies to the north of the eastern end of Papua.

The oldest rocks exposed are schists and gneisses which are lithologically similar to the metamorphic rocks of the Owen Stanley Range on the Papuan mainland. Pegmatites and basic and ultra-basic rocks intrude the metamorphic rocks, and Pleistocene and Recent basaltic and andesitic volcanics overly them unconformably. The youngest rocks are piedmont deposits and raised limestone reefs.

The topography is youthful, and bears a broad relationship to the geology. The islands are divisible into the following physiographic units:

1. rugged areas of crystalline rocks,
2. less rugged areas of dissected, flat-lying volcanics,
3. areas with slightly dissected lava flows and well preserved volcanoes,
4. fringing reefs.

Remnants of two erosion surfaces are preserved on Goodenough and Fergusson Islands.

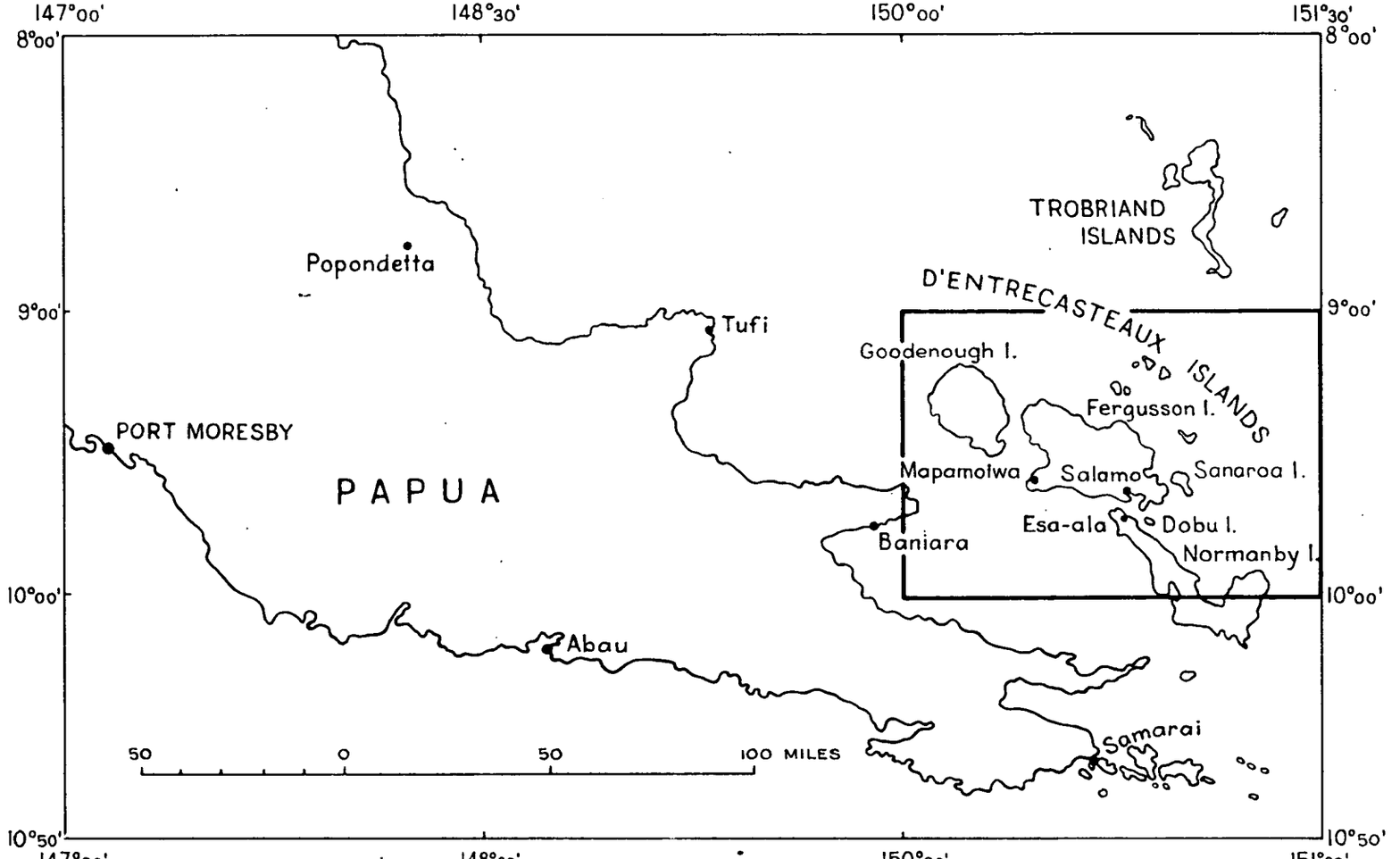
A small gold mine on Goodenough Island is the only mineral deposit to have been successfully worked on the islands. Economically, Fergusson Island is the most interesting as it contains pegmatites intruding the metamorphic rocks, and pumice deposits along the Numa Numa Peninsula. In addition sulphide mineralisation with a trace of gold is recorded from the Mebulibuli Peninsula, and sulphur is found at Iamalele. Small deposits of heavy mineral sands containing garnet and magnetite occur on the western and north-western coast of Fergusson Island, and on the south-western coast of Goodenough Island.

INTRODUCTION

About five weeks - 29th June to 2nd August, 1960 - were spent on a geological reconnaissance survey of Goodenough, Fergusson, and Dobu Islands to indicate areas of possible economic interest.

The three islands are part of the D'Entrecasteaux Islands which lie 20 to 40 miles north of the eastern end of Papua (see Fig.1). The D'Entrecasteaux Islands form the Esa'ala Subdistrict of the Milne Bay District which has its headquarters at Samarai. The subdistrict is administered from Esa'ala on Normanby Island, and there is a patrol post at

Locality map showing Fergusson Island 1:250,000 sheet area Fig.1



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Mapamoiwa on Fergusson Island. Hospitals exist at Mapamoiwa and at Salamo, both on Fergusson Island.

Coastal vessels which usually operate from Samarai visit the islands to deliver supplies and to pick up copra. Anchorages for these vessels exist at Mud Bay, Nuatutu, Malauna Bay, Wataluma Bay, Kwaiboga, Cape Rawlinson, and Taleba Bay on Goodenough Island; and at Kalo Kalo, Seymour Bay, Mapamoiwa, Salamo, Kedidia, Dawson Strait, and Hughes Bay on Fergusson Island. In the north-west season it is possible to anchor off the southern (Morima) coast of Fergusson Island between Kukuia and Salamo. There are small jetties at Nou Nou in Mud Bay on Goodenough Island; at Kalo Kalo, Mapamoiwa, Salamo, and Seblugomwa on Fergusson Island; and at Baruagura on Dobu Island. During the Second World War there were two wharves near Bolu Bolu on Goodenough Island.

Each fortnight Esa'ala is visited by the Otter amphibious aircraft which provides a bi-weekly service between Port Moresby and Samarai. A wartime airstrip at Vivigani on Goodenough Island is in reasonably good condition, and has been used in emergencies.

Motor vehicles are not used for transport on the islands although a network of wartime roads on the northern and eastern part of Goodenough Island is in fair repair except for stream crossings. The main government tracks give good access to the inhabited parts of the islands, and in most places provide easy walking. The less important tracks are in poor condition.

Government workboats are kept at Esa'ala and Mapamoiwa, and most Europeans have boats which may occassionally be hired.

During the survey carriers were obtained from rest house to rest house at the rate of one shilling an hour, and in places canoes were hired for a shilling an hour for each canoe and for each of the paddlers. Tobacco may be used instead of money, one stick being equivalent to one shilling. Because hourly labour was used work was restricted to the tracks, none of which provide good exposures of the geology.

Goodenough Island, which is about 24 miles long and 16 miles wide, is for its size one of the most mountainous areas in the world. It consists of an 8000 feet high mountain mass flanked on the northern and eastern sides by a grassy coastal plain up to five miles wide. Other smaller areas of grassy plain occur around Kilia, Diodio, and Aikauwa on the south-western side.

Fergusson Island, which is roughly 40 miles long and 16 miles wide has 6000-feet high mountain masses in the north-western and central parts and a 2000 feet high range of mountains on the south-eastern side along the Numa Numa Peninsula. The two large mountain masses are separated from each other by a belt of undulating lower country reaching from Seymour Bay on the west coast to Hughes Bay on the east coast, and containing Lake Rabua and several smaller lakes. Piedmont plains between Gomwa and Sebutuia Bays separate the small south-eastern range from the northern mountain masses.

Dobu is a roughly oval volcanic island, about 3 miles long and 2 miles wide, rising nearly 1000 feet above sea level.

The climate is tropical. The lowlands are hot and humid throughout the year, whereas the highlands can be cool, especially at night. Two seasons are recognisable; one from December to April with north-west winds, and one from June to October with south-east winds. The wind is strongest and most persistent in July and August, and it is light and variable between the seasons. The D'Entrecasteaux Islands lie within the 100 to 150 inches a year rainfall belt. The rainfall is uniformly distributed throughout the year except for the southern end of Normanby Island, where the maximum monthly rainfall is in the south-east season, and for the northern end of Goodenough Island where the maximum monthly rainfall is in the north-west season. In the areas without marked seasonal rainfall variation, rainy periods of four to ten days followed by dry periods of similar length are common. There is a slight variation in temperature and humidity during the year, the warmest and most humid period being in the north-west season.

About twenty Europeans live on the three islands. They are settled at Nuamata Plantation, Wataluma Mission, Nuatutu Plantation, Wadlagi Mission, and Nou Nou on Goodenough Island; at Kalo Kalo Mission, Mapamoiwa, Salamo Mission, Kedidia Plantation and Seblugomwa Plantation on Fergusson Island; and at Baruagura Mission on Dobu Island. The native population of the three islands is about 20,000. On Goodenough Island the population is restricted to the coastal lowlands; on Fergusson Island the villages are distributed over the coastal areas and in the inland valleys. On Dobu Island the population is close to the coast.

MAPS AND AERIAL PHOTOGRAPHS

During the survey the following maps and aerial photographs were used:

Maps

Type of Map	Date	Name	Number	Scale
Australian Army Map	1943	Goodenough Island	2064	1 in : 1 mile (1 : 63,360)
Australian Army Map	1943	Fergusson Island West	1298	"
Australian Army Map	1943	Fergusson Island East	1297	"
Australian Army Map	1943	Dawson Strait	1299	"
Australian Army Map	1944	Fergusson Island	1578	1 in : 4 miles (1 : 253,440)
Admiralty Chart	1955	Kegawam Island to Cape Nelson and Kiriwina Island.	Aus. 038	1 in : 4.73 miles (1 : 300,000)

Aerial Photographs:

MISSION	PHOTOS	TYPE	HEIGHT	FOCAL LENGTH	SCALE
36X Goodenough and Fergusson Islands, 8th Photo Squadron; 6/2/1943.	Run 1. 1-32 Run 2.33-64 Run 3.65-94	Vertical and Oblique	26,600'	153.3 mm.	1:52,900
338 RS-M-MM183 13AF ; 25/10/1947	49VV-82VV 96VV-98VV	Vertical	26,000'	153,6 mm.	1:51,600
338 RS-M-MM182 13 AF; 20/10/1947	22VT-48VT	Vertical and Oblique	26,000'	152.7 mm.	1:50,800

MISSION	PHOTOS.	TYPE	HEIGHT	FOCAL LENGTH	SCALE
338 RS-M-MM-164 134F; 21/10/1947	39VV-43VV 44VV-59VV 70VV-83VV 89VV-100VV	Vertical	20,000'	154.9 mm.	1:39,400
338 RS-M-MM157 134F; 9/10/1947	IVT-31VT	Vertical and Oblique	20,000'	152.4 mm.	1:40,000
338 RS-M-MM153 134F; 9/10/1947	46VV-55VV 56VV-75VV 76VV-85VV 86VV-95VV	Vertical	20,000'	154.9 mm.	1:39,400
338 RS-M-MM113 204F; 7/6/1947	IVT-15VT	Vertical and Oblique	26,000'	154.9 mm.	1:52,400
338 RS-M-MM112 204F; 1/6/1947	131VV-153VV	Vertical	20,000'	152.2 mm.	1:40,000

The aerial photographs were taken by the United States Army Air Force. The 36X and 338 RS missions each gives almost complete coverage of the three islands, and both are of fair quality, although the 338 RS group is the better. Sets of the photographs are held in the aerial photograph library of the Department of Forests, Port Moresby.

GEOMORPHOLOGY

The physiography of the three islands is youthful, and there is a broad relationship between the geology and the topography.

The following geomorphological units are recognisable on Goodenough and Fergusson Islands.

1. Mountainous areas of crystalline rocks, one on Goodenough Island and two on Fergusson Island. The northern and north-eastern side of the mass on Goodenough Island and the north-eastern side of the northerly mass on Fergusson Island are bounded by fault scarps, and in the Gunwala Creek area on Goodenough Island there is markedhog-back topography. Of the lineations visible in the photographs of areas of crystalline rocks, the strongest set is that trending north-east.
2. Less rugged areas of dissected and weathered lava fields.
3. Areas of well-preserved Recent volcanic craters and slightly dissected lava fields.
4. Piedmont plains and dissected alluvial fans.
5. Fringing reefs and low terraces of uplifted reef.

Remnants of at least one and possibly two old erosion surfaces are present on the two islands. The older surface occurs on the top of the mountain masses and is visible on the aerial photographs of the area around the highest peaks of Goodenough Island. What may be the remnants of a second surface can be seen in the lowland between Seymour and Hughes Bays on Fergusson Island, where there is a bench on the northern side of the valley. This surface may also be represented by the weathered surface on the dissected volcanics of unit 2 above.

Well-preserved volcanoes occur on the three islands. Dobu Island, a strato volcano probably in the dying solfataric stage (Fisher, 1957, p. 62,) has two principal craters. The main crater Bulebulu, contains three craterlets, and is breached on the eastern side. The lesser double crater, called the Eastern Craters, contains feebly active solfataric areas. Two well-preserved craters, Lamonai and Oiau, exist on Fergusson Island opposite Dobu. Oiau is an almost circular crater breached on its eastern side, and partly filled by a plug of obsidian. Lamonai is a sheer-sided crater within a symmetrical cone. Stanley (1920,p. 11,) reported a large lava breach on its southern slopes; this can be faintly made out on the aerial photographs. The alignment of Dobu, Oiau, and Lamonai cones suggests a linear crustal weakness along the Numa Numa Peninsula. Other well preserved volcanoes exist on Goodenough Island on the Bwaido Peninsula and at Diodio, and on Wagipa Island.

Topography suggests the presence of two crater lakes in the Iamalele area on Fergusson Island. On Goodenough Island there appear to be two small craters at Wataluma Hill, and a single crater two miles south of Nuatutu where a hummocky lava flow extends down to the sea from a vent, about three quarters of a mile inland. Baker and Coulson (1948 p.661) consider that Oiava-ai is a volcano also.

GEOLOGY

The oldest rocks exposed on the islands are schists and gneisses. These contain metamorphosed acidic and basic igneous rocks and are intruded by pegmatites and by basic and ultrabasic rocks. They are overlain unconformably by Pleistocene and Recent basaltic and andesitic volcanics, and by Recent piedmont deposits and raised limestone reefs.

Metamorphic Rocks.

Metamorphic rocks form most of the high mountain masses on Goodenough and Fergusson Islands. No evidence was seen to support the report by Stanley (1920, p. 15.) that slightly altered phyllite and quartz schist rest unconformably on a higher-grade metamorphic series of granite gneiss. The metamorphic rocks seen included :

i. granite gneiss in the Kukuia - Morima - Tutubeia area.

ii. mica schist west of Si-iluga Bay on the southern coast, and near Fegani Bay on the north-western coast of Fergusson Island.

iii. an intimate mixture of granite gneiss, garnet gneiss, and amphibolite on the other parts of Fergusson Island and on Goodenough Island.

Stanley (1920, p. 14) reported marble in the Galea District, and Baker and Coulson (1948,p. 657) described the following rock types from scattered localities on the two islands: hornblende-biotite-schist, granite gneiss, muscovite gneiss, biotite gneiss, hornblende-biotite-diopside-gneiss, garnetiferous-hornblende-gneiss, biotite-amphibolite, epidote-amphibolite,

hornblende-epidote-schist, garnetiferous-muscovite-gneiss, zoisite-amphibolite, epidote-albite-amphibolite, and hornblende-epidote-zoisite-schist. The age of the metamorphic rocks is not known. They are lithologically similar to the older metamorphic rocks of the Owen Stanley Ranges which are regarded as Palaeozoic.

Pegmatites

The metamorphic rocks on Fergusson Island are intruded by quartz-mica pegmatites. In the northern mass of metamorphics a small pegmatite occurs about a mile north of Sibutu, and float material was seen between Sibutu and Didiau on the north coast, and is reported from Waibewo Creek. Float material was seen near Matala Point on the north-eastern side of the southern massof metamorphics.

Basic and ultrabasic intrusive rocks

Boulders of gabbro and dolerite were seen in the Salakahadi, and Wadelei Districts on Fergusson Island. On Goodenough Island similar rocks crop out between Bolu Bolu and Nuatutu, and boulders were seen in the streams on the western side of the island.

Strongly weathered ultrabasic rocks crop out on the eastern side of Fergusson Island between Boa Creek and Sebutuia Bay, Dallwitz and Roberts (appendix I) have described a specimen from Mebulibuli Creek in this area as "sulphide bearing serpentinised dunite". Boulders of dunite were seen near the head of the Salamo River west of the main area of outcrop.

Volcanic rocks.

Two periods of vulcanism can be distinguished. They are represented by older dissected volcanics which are deeply weathered and by younger volcanics associated with well preserved volcanoes. The older group consists of basaltic and andesitic lavas and tuffs, and the younger group consists of vesicular trachyte, pumice, basalt, and volcanic glass. Stanley (1919) gives the following sequence in the younger volcanics exposed on Oiau on Fergusson Island:

Top

Obsidian (porphyritic pitchstone with large sanidine crystals.)

Pumice and obsidian.

Trachytic flow.

Pumice.

The volcanics are unconformable on the metamorphics. Their age has not been established, but their disposition suggests that they are probably not older than Quaternary or very young Tertiary.

Piedmont and limestone deposits

The most recent deposits are the piedmont fans which spread out from the mountains towards the sea, and the slightly raised reef limestone adjoining the coastline.

At the base of the mountains the piedmont deposits consist of angular metamorphic components, including blocks up to fifteen feet across. Seawards the boulders are smaller and less angular, and the deposits are better sorted, and finally grade into sand and mud.

A fringing reef bounds most of the coastlines of the three islands. Raised Recent limestone occurrs in Mud Bay on Goodenough Island, and on the coastline of Fergusson Island from just north of Mapomoiwa to the western edge of Si-ilugu Bay. Generally the top of this limestone is about ten feet above sea level, but at Mapamoiwa it is up to fifty feet above sea level.

STRUCTURE

Although the detailed structure of the metamorphic rocks appears to be complex, the topography of the metamorphic areas suggests that they are broadly folded along north-north-west axes. Two fault scarps are obvious, one along the northern and eastern side of the metamorphic mass on Goodenough Island, and the other on the northern side of the north-eastern mass of metamorphics on Fergusson Island. Within the metamorphic areas several minor sets of lineations and a well-marked set of north-east trending lineations is visible on the aerial photographs.

The older volcanics show north-east lineations similar to those in the metamorphic areas.

SEISMIC AND VOLCANIC ACTIVITY

In 1955 Taylor (p.5) recorded that there had been very limited volcanic activity in the area over the preceding forty years. Tectonic earthquakes are reported from the Ward Hunt Strait in October, 1956 (Reynolds, 1957,p.3.). Numerous small tremors and swarms of tremors are felt at Salamo and at Esa'ala, and shocks are occasionally felt at Nou Nou and at Nuatutu on Goodenough Island. Taylor (1956, p.8) considers that the tremors felt at Salamo and at Esa'ala have the characteristics of local shocks originating from foci around the south-eastern end of Fergusson Island rather than deep-seated tectonic shocks.

In commenting on the Lamonai - Dobu volcanic area Taylor (1955, p.1.) stated that although "there are no reports of volcanic eruption in the region, nor is there any evidence of such events in the legends of the local natives", "the volcanic cones are in such well preserved physiographic condition that it seems unwise to consider them extinct". The same conclusion might be drawn for the volcanoes on the Bwaido Peninsula on Goodenough Island and on Wagipa Island.

Solfataric areas occur on Fergusson Island at Deidei and at Iamalele, and on Dobu Island in the Eastern Craters. At Deidei and at Iamalele there are boiling springs, small geysers, hot pools, mud pots, and white siliceous sinter terraces, and at Iamalele there are also small steam vents surrounded by mounds of sinter and sulphur.

Hot springs occur on the eastern coast of Dobu Island; about a mile north of Nou Nou on Goodenough Island; and one mile south-east of Matala Point on Fergusson Island. A hot spring is reported (Taylor 1955, p.4.) near Nade on Fergusson Island, and one is shown on the army map of Goodenough Island on the coast two miles north of Bolu Bolu.

MINERAL POTENTIAL

A small goldmine is the only mineral deposit which has been successfully worked on the three islands. The pegmatites and the pumice deposits on Fergusson Island have the best prospects.

Pegmatites

Pegmatites occur in both masses of metamorphics on Fergusson Island. Fragments of clear coarsely crystalline quartz, possibly of piezo-electric quality, were seen on the track between Didiau and Sibutu, and are reported from Waibewo Creek. Mica specimens up to six inches across, but too stained and soft to be saleable, have been found in the area north of Sibutu, and small specimens of tantalite and amblygonite received at the Geological Office in Port Moresby are reported to have come from the same area. Edwards (1950, p.2).reports kyanite from the streams in the Iamalele area.

Pumice

A large quantity of pumice is available in the Salamo - Mt.Lamonai - Mt. Oiau area on Fergusson Island, and pumice forms the bulk of Dobu Island. The cleanest and most accessible deposit is at Mt. Oiau , where cliffs of pumice up to 200 feet high are exposed within the crater. This deposit which is at least three quarters of a mile long and up to half a mile wide probably contains more than 10,000,000 cubic yards of pumice. The size of the pumice fragments ranges from dust to six inch blocks, and it was estimated that more than 50% by volume are fragments larger than one quarter of an inch across. The following analyses of pumice are available:

	Mt.Oiau (Stanley,1919)	Dobu Island (Ann.Rept.Brit. New Guinea 1896-97 p.50.)
SiO_2	71.27%	69.62%
Al_2O_3	9.10%	15.26%
FeO, Fe_2O_3	10.13%	3.05%
MnO_2	trace	trace
CaO	0.89%	0.94%
K_2O	3.14%	5.20%
Na_2O	5.18%	3.69%

Sulphur

Deposits of sulphur exist in the Iamalele solfataric area where Edwards (1950, p.5.) estimated that 1000 tons of clean sulphur and 3000 tons of sulphur contaminated with quartz sand, mica and clay are available. Edwards states that the sulphur is deposited in mud pools and around scattered groups of fumaroles which form domes and elongated mounds, and that similar mounds with no fumarolic activity have an irregular core of clean sulphur surrounded by a halo of a mixture of sulphur and sand. He adds that the sulphur extends no more than five feet below the ground surface, and that the sulphur appears to be rapidly removed after deposition and replaced by silica. The following analyses quoted by Stanley (1919, p. 12.) show this relationship:

	Surface Samples.	Subsurface Samples.	Siliceous beds Below sulphur crusts.	
S	86.2%	46.5%	Nil	1.3%
SiO_2	12.0%	16.1%	80.0%	53.2%
Al_2O_3	-		7.3%	17.8%
FeO, Fe_2O_3	-		0.5%	0.6%
MgO	-		1.8%	0.4%
K_2O	-		5.5%	3.9%
Ignition loss	-		-	21.0%

The small amount of sulphur available is spread over too large an area to be a workable deposit.

Heavy mineral sands

Beaches with thin seams of heavy mineral sand containing magnetite and garnet occur on the south-western coast of Goodenough Island between Kilia and Waibula. Between Nuatutu and Nou Nou on the eastern coast the beaches are narrow and cobbly, and the rest of the Goodenough Island coast was not seen.

On Fergusson Island beaches with deposits of heavy mineral sands occur on the western and northern coasts between Seymour Bay and Gwabe Gwabe. There may be similar deposits in Hughes Bay, in Sebutuia Bay and in Si-ilugu Bay. Narrow, cobbly beaches occur on the southern coast of Fergusson Island between Cape Mourilyan and Seliselina Point, and on the north-eastern coast between Matala Point and Sebutuia Point.

Other mineral occurrences

In Mebulibuli Creek on Fergusson Island there is a small outcrop of sulphide bearing, opalised, serpentinised dunite (see appendix 1). Specimens of the material have been analysed by S. Baker.

	P. 396 (Collected by J.E. Thompson)	P. 398 (Collected by J.E. Thompson)	P. 191 (Collected by L. Wilkinson)
Fe	14.74%	22.80%	Not determined
Cr	0.48%	1.51%	" "
Ni	0.20%	0.25%	0.32%
Cu	trace	trace	Not determined.

The nickel content of these specimens is normal for dunite.

Stanley (1919,p.1) reports a gossanous outcrop which assayed 0.03 ozs. of gold per ton from the Mebulibuli Peninsula between Wailala Creek and the coast, and mentions traces of copper in this area.

Gold

A small goldmine located about a mile west of Beli Beli was worked immediately after the Second World War.

Mrs. A. Gribben, of Nou Nou, reported that a prospector obtained gold from the south-western part of Goodenough Island. In 1951-52 Bulolo Gold Dredging Company held and percussion-drilled three Extended Prospecting Areas on Goodenough Island; these were probably situated on the northern and north-eastern coastal plains.

CONCLUSION

Economically, Fergusson Island is the most interesting of the three islands. Both masses of metamorphics on this island may repay prospecting for pegmatite minerals such as mica, tantalite, amblygonite, kyanite, and beryl, and the sulphide shows on the Mebulibuli Peninsula warrant more detailed examination. Large deposits of clean pumice close to sheltered anchorages may provide a source of light-weight aggregate for construction projects in Papua and New Guinea as well as a source of pumice for the abrasive and cosmetic industries in Australia.

The gold mine on Goodenough Island was not visited.

The sulphur deposits at Iamalele on Fergusson Island and the heavy mineral sands on both Fergusson and Goodenough Islands appear to be of academic interest only.

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APPENDIX 1.

PETROGRAPHIC AND MINERAGRAPHIC EXAMINATION OF NICKELIFEROUS ROCKS FROM MEBULIBULI CREEK, FERGUSSON ISLAND

by

W.B. Dallwitz and W.M.B. Roberts.

Specimen P190 resembles closely a dark grey volcanic glass (pitchstone), and has a conchoidal fracture. It contains a spongy meshwork of fine-grained sulphide.

In thin section the rock is found to consist mainly of opal and sulphide. Structures remaining in the opal clearly show that the rock was formerly a serpentine, and that this serpentine was probably derived from olivine. In other words, the rock can be genetically referred to as an opalized, sulphide-bearing serpentinized dunite.

Books of talc and a few grains of red-brown chromite are scattered through the slide. Fine-grained doubly-refracting material, possibly talc, forms abundant inclusions in the opal in places. The structures referred to in the previous paragraph pseudomorph those of a serpentine which consisted of antigorite veined by chrysotile. The veinlets of chrysotile have been replaced by more or less clear opal, whereas the antigorite has been made over to murky brownish opal. Black iron ore, probably magnetite (which is a common by-product of serpentinization), is associated with the clear opal replacing former chrysotile veins.

The polished section showed that marcasite, pyrite, and chromite are present. In crushed rock magnetite can be detected with a magnet, but is invisible under the microscope because of its extremely fine grainsize.

Chromite form euhedral and subhedral crystals, ranging up to 2 mm. in length, which have been fractured and later recemented by marcasite. The crystals are almost invariably surrounded by a "halo" of marcasite, which, although obviously later in origin, is not replacing the earlier chromite.

The marcasite itself is present mainly as spongy masses through which irregular veins of coarser-grained marcasite are emplaced. These veins are clearly controlled by well-developed jointing in two directions about 60° to each other. The spongy masses themselves represent a diffusion outwards from these mineralizing channels.

Pyrite occurs in the same manner as marcasite, although much less abundantly, forming spongy masses as well as diffusion textures resembling liesegang rings. This mineral appears to be moulding irregular granular areas of marcasite, but the evidence is not sufficient to state that it is of later origin.

Specimen P191 is a dark grey, chalcedonic rock containing sulphide. Marginally the rock has been stained brown and red through weathering of iron sulphide.

In thin section the rock is found to consist of chalcedony, sulphide, and fine-grained black, opaque material (magnetite - see below). Veinlets of coarser chalcedony traverse the slide; these may contain brown chalcedony showing distinct spherulitic structure. Brown chalcedony in small clots is also scattered through the main body of the rock.

This specimen is similar to P190 but more highly altered

and silicified; none of the talc remains and all reliable signs of former serpentinous structure have been obliterated. The presence of chromite in the polished section accords with the idea that the rock is derived from dunite.

The opaque minerals are the same as for section P190, although far less sulphide is present.

Marcasite is the principal sulphide, forming irregular thread-like veinlets having a random arrangement and distribution; sponge-like areas which are common in section P190, are not present in this specimen.

Pyrite forms irregular masses composed of euhedral crystals 0.001 mm. across, which are only visible at extreme magnification. Chromite occurs as in section P190, but is slightly less plentiful; the largest crystal measures 0.15 mm. across.

Magnetite, although quite abundant, could not be identified in polished section because of its extremely finely divided state.

The source of nickel

The sulphides of both rocks were tested microchemically for nickel, and all gave a negative result.

The polished sections were analysed in the X-ray fluorescent spectrograph, and the presence of nickel was verified.

The finely-divided magnetite was not apparent as such under the microscope, and was only identified by its behaviour when the finely crushed rock from specimen P191 was probed with a magnet. Sufficient magnetite was separated to test microchemically with dimethyl glyoxime; a strong reaction for nickel was obtained.

These rocks have been formed by serpentinisation and subsequent silicification of dunite, and it is fairly certain that the dusty magnetite is a by-product of the serpentinisation (see above). The magnetite has picked up nickel present in the original olivine during its alteration to serpentine.

Nickelian magnetite has been recorded in the literature.

FERGUSSON ISLAND
NEW GUINEA

SCALE 4 MILES TO 1 INCH

4 3 2 1 0 4 8 MILES

150°00' 9°00' 151°30' 9°00' 10°00' 150°00' 151°30' 10°00'

PACIFIC OCEAN

GOODENOUGH ISLAND

FERGUSSON ISLAND

NORMANBY ISLAND

Cape Rawlinson
Cape Mouritvan
Cape Vogel
LUAMATA I.
LUPOSA BAY
WATALUMA BAY
MALAUNA BAY
IYOWU R.
BODA-BODA BAY
VIVIGANI
GUMADAWA-A
MT. NIMADAU
VIMEUO
QUALTUBEKEA
Auguna
Aikauwa
TAWANAQUA BAY
MORATAU COAST
TALEBA BAY
Wanatalweka C.
Diodio
MODAUWEA DISTRICT
Nou Nou
Faiava
MUD BAY
Wailagi Mission
BWAIDO DISTRICT
Killa
WAGIPA I.
GALAIWA BAY
BWAIDO PENINSULA
BARRIER ISLANDS
NIUATUTU BAY
Kalo Kalo
Cape Labillardiere
SUNDAY I.
WAGABU I.
Didiau Bks
Gwabe Gwabe
Mailolo
Waikawa C.
HUGHES BAY
FEGANY BAY
Sibutu Bks
IAMALELE DISTRICT
Lake Alaua
Faguilu
SEYMOUR BAY
SALAKAHADI DISTRICT
GAMABILA DISTRICT
KUKUIA DISTRICT
Mapamoiwa
Kukuia
MORIMA DISTRICT
Nade
SI-ILUGU BAY
Matala Pt.
C. Vinall
Wadelei
WADELEI DISTRICT
BASIMA DISTRICT
Mebulibuli C.
MEBULIBULI PENINSULA
GALEA DISTRICT
Sebutuia Point
SEBUTUIA DISTRICT
SEBUTUIA BAY
Laloma
CRATER
Dadei
KEDIDIA BAY
KURANUMA BAY
DAWSON STRAIT
Sebugoma
Esa'ala
Buruaguta
DOBU I.
DOAIBOE I.
NEUMARA I.
SOLOMONAI
SALAMO
URASI I.
NABWAGETA I.
KALAIO I.
NOAPOI I.
TATANA I.
WAMEA I.
WAWIWA I.
AMPHLETT GROUP
WATOTA I.
VABWAIA I.
UAMA I.
TEWARA I.
SANAROA ISLAND

Reference

QUATERNARY

- Qa — *Limestone, mud, sand, conglomerate*
- Qv — *Basaltic and andesitic lava, tuff and pumice*

TERTIARY

- Tb — *Gabbro, dolerite, dunite*
- Tv — *Basaltic and andesitic lava*

PALAEOZOIC

- Pm — *Schist, gneiss, amphibolite*

- 70 — *Attitude of metamorphic foliation*
- ---?--- *Inferred fault*
- V — *Volcanic vent*
- Sp — *Hot spring*
- Au — *Gold mine*
- *Reef*

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