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Geology of New Ireland

by

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SUMMARY

New Ireland is a narrow northwesterly - trending island, 350 km long and up to 48 km wide. The highest peaks (2300 m) are in the broader southern part of the island. A low saddle near Namatanai separates the southern mountains from the Lelet Plateau and Schleinitz Range (maximum elevation 1450 m). The island consists of lower Oligocene andesitic pyroclastic rocks (Jaulu Volcanics) and related intrusives, which are partly concealed by lower Miocene and younger volcanogenic sediments and limestone. The Lelet Limestone (lower Miocene to Pliocene) forms a series of terraces northeast from the Lelet Plateau to sea-level. The oldest limestone forms the lowest terraces. This indicates that the limestone formed (as a fringing reef) during gradual subsidence of the island; subsidence was followed by rapid uplift to the present level. Similar limestone on southeastern New Ireland (Surker Limestone) may be equivalent to the Lelet Limestone. The Rataman Beds are a 500 m thick sequence of upper Miocene to Pliocene volcanic sediments which shows some evidence of turbidite deposition; the sediments possibly originated from a volcanic source on the Gazelle Peninsula of New Britain. Two major faults on southern New Ireland (Weitin and Sapom) strike northwest. These, and other parallel faults may have given rise to the present shape of the island by a combination of left-lateral transcurrent and vertical movements.

Seafloor volcanism in the lower Oligocene produced an island, possibly of equant dimensions. In the late middle Miocene or early upper Miocene this island was sheared northwestward on one or more subparallel faults; a graben, in which the Rataman Beds were deposited formed within the fault zone. From late lower Miocene until late Pliocene, the island subsided gradually and a succession of coral reef terraces was formed. Quaternary uplift was more rapid on the south-western side, and towards the southern end of the island.

The island is being actively prospected for porphyry copper deposits. Deposits of gold, bauxite, coal, limestone, and clays are present, and some may be economic.

INTRODUCTION

Location: New Ireland is the second largest island in the Bismarck Archipelago and lies within the Australian Trust Territory of New Guinea between latitude 2°30' and 4°55'S and longitude 150°40' and 153°10'E (Fig. 1).

The Australian Administration District Headquarters is at Kavieng, and the two sub-districts are administered from headquarters at Kavieng and Namatanai. There is also a patrol post at Konos, on the north coast about mid-way between the two sub-district headquarters.

Access: The coastal regiona of New Ireland are well served by roads, except in the south. An all-weather, coranus-surfaced road extends from Kavieng to Namatanai, a distance of about 270 km (Map 1). A 160 km section of this road was constructed before the First World War by the German Administration. Secondary roads extend as far south as Cape Mimias on the east coast. On the west coast there is a road of variable standard which, apart from two stretches of a few kilometres, extends from Wunik Plantation in the north to Dunup Plantation in the south. These secondary roads are largely suitable for use by four-wheel drive vehicles only, and the numerous creek and river crossings are subject to flash flooding. The two coastal roads are connected across the island by roads between Namatanai and Uluputur in central New Ireland, and Fangalawa and Lemusmus in the north. A third road between Karu and Konogo is rough and boggy and crosses rugged hogback topography; this road was closed to Administration vehicles in late 1969.

Copra boats provide access by sea to many plantations on both sides of the island.

There is a regular service to both Nematanai and Kavieng from Rabaul, New Britain. Short airstrips suitable for light aircraft are located at Kamiraba, about mid-way between Kavieng and Namatanai, and at Silur and Manga Mission stations in the southeast.

Natural helipads are found on the alluvial gravels near the mouths of major streams on the west and southeast coasts (Fig. 13). High altitude landings are possible only on the Lelet Plateau, where there is short bracken and grass in populated areas (Fig. 14). The paucity of helipads is due to the rugged topography and thick rainforest which characterize New Ireland. Many of the raised coral platforms, on the east coast of south-central New Ireland are covered by tall kunai and kangaroo grass and would only be suitable for helipads after having been burnt off (Fig. 11).

Topography and Vegetation: New Ireland is a narrow northwesterly-trending elongate island (335 km long) which broadens in the south to a maximum width of 48 km. From the northweet tip of the island, elevation increases gradually southeastwards to a maximum at the southern edge of the Lelet Plateau, mid-way along the island. The Lelet Plateau is up to 16 km wide.

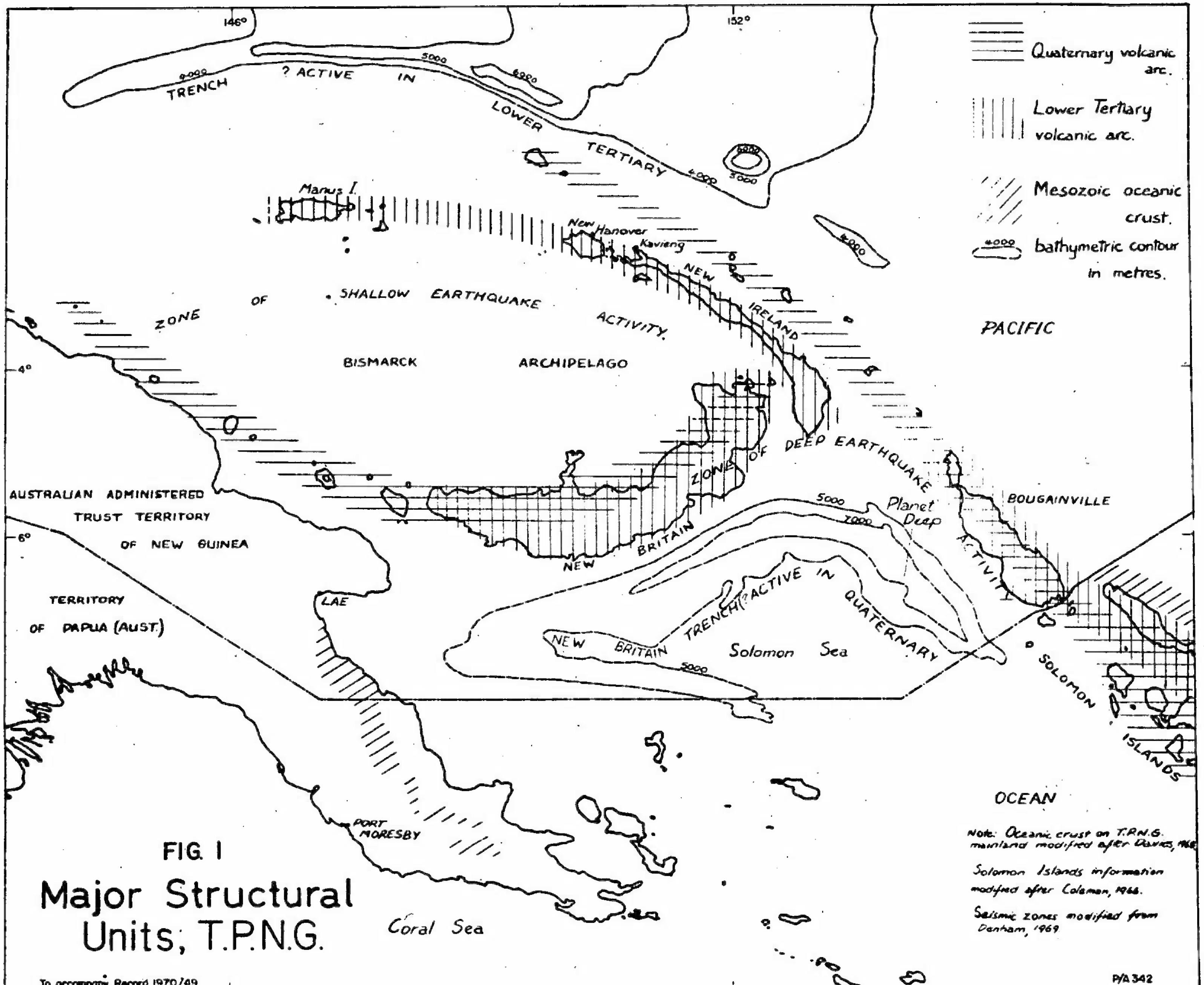

FIG. 1

Major Structural Units, T.P.N.G.

Southeast of the Lelet Plateau, there is a low, incipiently dissected saddle. Further southeast, the landmass rises abruptly to form a steeply dissected mountain block with maximum elevation 2,300 m, and relief of up to 2,000 m.

Most of New Ireland is covered by mature primary rainforest which is extremely dense in some areas. Along the coast there are many coconut (copra) plantations, and small areas of grassland are developed on some raised Recent coral reefs (Fig. 11). Small areas of secondary vegetation near villages are overgrown subsistence crop gardens.

Climate: Annual rainfall varies from about 3,000 mm to about 5,000 mm over the island. New Ireland does not have a strongly seasonal rainfall, though some months are statistically less wet than others. The northwest monsoon season corresponds to a rainfall minimum in the southern part of New Ireland and a rainfall maximum in the remainder of the island. The months May to November tend to have lower rainfall in the central region of New Ireland, but to the north the rainfall distribution is remarkably uniform throughout the year.

Population: The indigenous population is about 44,000, concentrated mainly along the coast.

Purpose of Survey and Method of Work: The aim of the study was to complete the geological mapping of New Ireland at 1:250,000 scale. Work was concentrated on the central to northwestern part of the island.

In January and February, 1969, the writer carried out a preliminary geological reconnaissance and logistics appraisal by Landrover. He was accompanied by R.P. Macnab for the first week of this reconnaissance, and by W. Manser, (University of Papua and New Guinea) towards the end of February.

The writer returned to New Ireland in September, 1969, and carried out five weeks fieldwork in southern, central and northern New Ireland. This work consisted of foot-traverses, with positioning by four-wheel-drive vehicle or coastal copra boat. In April, 1970, the writer, W. Manser, and, for part of the time, H.L. Davies, made a brief visit to collect samples of igneous rocks and limestone for radiometric and micropalaeontological age determination and chemical analysis.

Previous Work: The earliest published systematic fieldwork undertaken on New Ireland was that done by Karl Sapper in 1908, during German administration of the island (Sapper, 1910). Sapper, with some assistance from ethnologist Georg Friederici, geologically mapped a large part of New Ireland on a broad reconnaissance scale. Sapper's account of the geology of New Ireland is in the form of generalized traverse notes with a tentative stratigraphy and geological history.

After Sapper's visit, no regional geological mapping was carried out for 56 years, apart from a brief investigation of a coal occurrence near Matakan Plantation (Noakes, 1939).

In October 1964, D.J. French of the Geological Branch, Port Moresby, commenced a geological survey of southern New Ireland (French 1966). He followed Sapper's traverse routes and covered some new ground.

REGIONAL GEOLOGICAL SETTING

New Ireland, New Britain and the Solomon Islands were largely constructed by island arc volcanism in the Lower Tertiary (Fig. 1). New Ireland is approximately co-linear with the Solomons and may have been a part of the lower Tertiary Solomons Arc. However, the Solomons differ from New Ireland in having an Upper Cretaceous? 'basement' which has been slightly metamorphosed (Coleman, 1966). The stratigraphy of New Ireland is similar to that of New Britain except that the oldest rocks on New Britain are Eocene rather than Oligocene (R.J. Ryburn, pers. comm., 1970). Also New Britain is apparently not as strongly faulted, except on the Gazelle Peninsula.

The New Britain - Bougainville trench (Fig. 1) probably represents a zone of crustal shortening between the Pacific plate and Australian or Indian plate. A trench northeast of Manus Island, New Hanover, and New Ireland may also represent an Oligocene zone of crustal shortening. This trench (Fig. 1) has shown some recent seismic activity (Denham, 1969).

A zone of shallow earthquakes in the Bismarck Sea (Denham, 1969) has not been explained. The southern part of New Ireland is also seismically active and is near the intersection of the deep seismic zones which trend parallel to New Britain, the Solomon Islands, and the seismic zone in the Bismarck Sea.

OUTLINE OF GEOLOGY

The 'basement' rocks of New Ireland are Oligocene andesitic agglomerate, tuff, and lava intruded by presumably comagmatic gabbro, norite, diorite and tonalite. In the northwestern half and part of the southeastern half of the island, these rocks are overlain by up to 1400 m of shallow-dipping, lower Miocene to Plio-Pleistocene biogenic limestone. At least 500 m of upper Miocene to Pliocene reworked volcanic ash forms the isthmus of central New Ireland. Younger rocks include Quaternary foraminiferal chalk and raised coral terraces, fanglomerate, and raised beach gravels (Fig. 11).

Faulting has defined the southwest coast, and a fault valley diagonally transects southern New Ireland.

TABLE 1. STRATIGRAPHY

Epoch/Age	Hohnen, 1970	Sapper, 1910	French, 1966
Recent	alluvium	alluvium	alluvium
	raised coral reefs	raised coral	raised coral
Pleistocene	Maton Conglomerate		Maton Conglomerate
	Uluputur Beds	RELATIONSHIPS ? ? UNKNOWN	? / Tamul Layers (?)
	Punam Limestone	Punam Limestone	
Pliocene	Rataman Beds	Ratam Beds	
Upper Miocene	Lelet Limestone	Ramul Beds Umudu Beds ? ?	Punam Limestone (? ?) ? ?
Middle Miocene			
Late Lower Miocene	Surker Limestone	Surker Beds ? ?	Surker Beds
Basal Lower Miocene	Lossuk River Beds	? Younger Volcanics	Jaulu Volcanics
	Lemau Intrusives	? ?	
	Jaulu Volcanics	? Older Volcanics	
Lower Oligocene	Jau Limestone Member	Lagaiken Beds	Lagaiken Beds
		? Gneiss formation	? Basement ? Granodiorite and quartz diorite

The New Ireland landmass was constructed on probable oceanic crust by island arc volcanism in the Oligocene. It has since been subjected to faulting, vertical and horizontal movements, development of limestone reefs, and some further volcanism, which was probably remote from the present landmass and which ceased before the Quaternary.

STRATIGRAPHY

Stratigraphy is summarized in Table 1.

OLIGOCENE

Jaulu Volcanics

Definition

Derivation: Jaulu River, southern New Ireland, about 56MMV7585*.

Synonomy: Used as introduced by French (1966); referred to as "Younger Volcanics" by Sapper (1910).

Type Section: Jaulu River. The type section has not been measured.

Lithology: Dominantly coarse andesitic lapilli tuff and agglomerate. The clasts are largely sub-angular and some show chilled and/or altered margins (Fig. 4). Minor welded ash-flow tuff, lahar-type volcanic breccia, and lava are also present. Small lenses of tuffaceous limestone are locally common (Fig. 2).

Thickness: The maximum exposed thickness is about 2000 m. Thickness is variable because of erosion in late Oligocene and Recent time.

Distribution and Relationships: The Jaulu Volcanics form the 'basement' of New Ireland. They are exposed along the entire length of the island in places where younger sediments have been removed by erosion; some of the Jaulu Volcanics were perhaps never buried. The base of the Jaulu Volcanics is below present sea-level. The irregular top of the unit is overlain by lower Miocene and younger biogenic limestone and some clastic sedimentary rocks.

Fauna and Age: The volcanics are probably of lower to upper Oligocene age. Limestone lenses in volcanics in the Kaluan River near 56MLB7627 include a genus known to range from Eocene to upper Oligocene (lower Te stage), (D.J. Belford, pers. comm., 1970). The Jau Limestone Member, which appears to be contemporaneous with the lower parts of the Jaulu Volcanics in southeastern New Ireland, contains Oligocene

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* 10,000 metre grid co-ordinates - International Spheroid.

foraminifera (Appendix 2). Schubert (1911) assigned a lower Oligocene age to a foraminiferal fauna in tuffaceous limestone float from the Kait River (about 56MMA7006). The float had probably shed from a lens of the Jau Limestone Member. A basal Miocene age has been obtained from the Lossuk River Beds, which apparently overlie the Jaulu Volcanics with low angular unconformity in northwestern New Ireland.

Description

The Jaulu Volcanics hava a uniform lithology wherever observed. They are generally massive, and it is only the finer-grained rock types that show bedding (Fig. 3). The predominant rock type is agglomerate which contains sub-angular blocks and lapilli 4 mm to about 50 cm across, with a grain-size mode in the range 10-15 cm (Fig. 6). The blocks are generally in contact with one another or very nearly so, and matrix is usually subordinate (Figs. 5 & 6). Some clasts or blocks are themselves agglomerate, and consist of fragments of lava embedded in a tuffaceous matrix. Most clasts making up the framework of the agglomerate are a mela-andesite lava with euhedral plagioclase phenocrysts up to 4 mm long set in an almost aphanitic, dark grey groundmass. Mafic phenocrysts are also commonly present, but are difficult to distinguish from the dark groundmass in handspecimen. In some examples, angular clasts have chilled margins about 1 cm wide (Fig. 4).

The finer phases of the Jaulu Volcanics are well represented on the southern fall of the Lelet Plateau, where they are interbedded with agglomerate (Fig. 5). Only in this region have bedding attitudes been measured. In the Kaluan River, the dip of the pyroclastics and interbedded tuffaceous limestone varies from 10° south to 15° north, with a fairly consistent strike of 090°. A few kilometres to the northwest, the Jaulu Volcanics in Kassa Creek have steeper dips, ranging from about 30° to 70° north. The finely bedded rocks in this area include highly indurated welded ash-flow tuff, cemented ash-fall tuff, coarse lapilli tuff and some weathered lava(?). Ash-fall tuff appears to be the most common pyroclastic and generally shows some grading. Other tuffs exhibit a eutaxitic texture with flow swirls, indicating partial welding of ash-flow fragments. These tuffs are interbedded with coarse lapilli tuff, agglomerate and lenses of tuffaceous limestone.

Lava flows appear to be rare and have been observed only in weathered outcrop in Kaluan River and near the Huru River in southwestern New Ireland. They are more densely jointed and more commonly sheared than the agglomerate and might thus weather more readily. This may explain the paucity of lavas in outcrop. The agglomerate and tuff, on the other hand, are extremely resistant to weathering and erosion. The pyroclastics generally weather to grey, red, or mottled grey and red. Extensively weathered examples of the agglomerate are usually brown and have a pitted surface due to etching out of plagioclase phenocrysts.

The Jaulu Volcanics are commonly intruded by dykes and stocks of the Lemau Intrustives. Contact metamorphism and metasomatism are described in more detail below (p.).

Figure 2. Tuffaceous limestone and fine, water-laid tuff of the Jaulu Volcanics, Kaluan River. GA/4996.

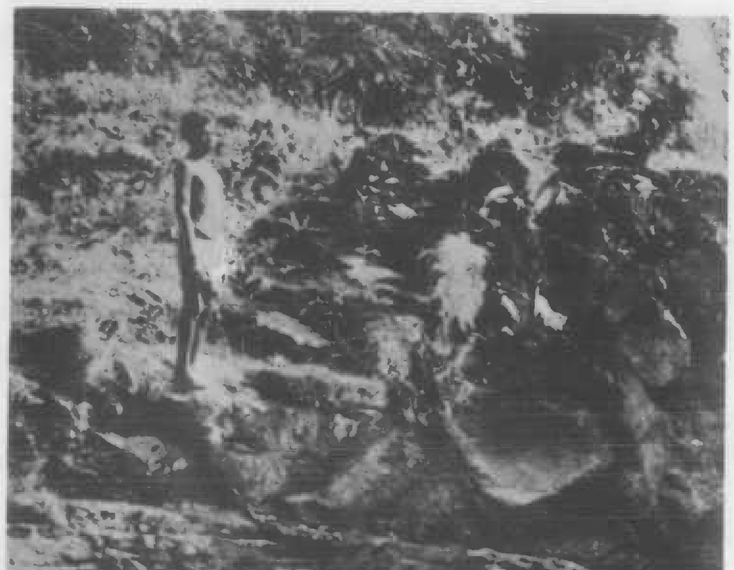

Figure 3. Thinly bedded tuff overlain by massive lapilli tuff and agglomerate; Jaulu Volcanics, Kaluan River. GA/5000.

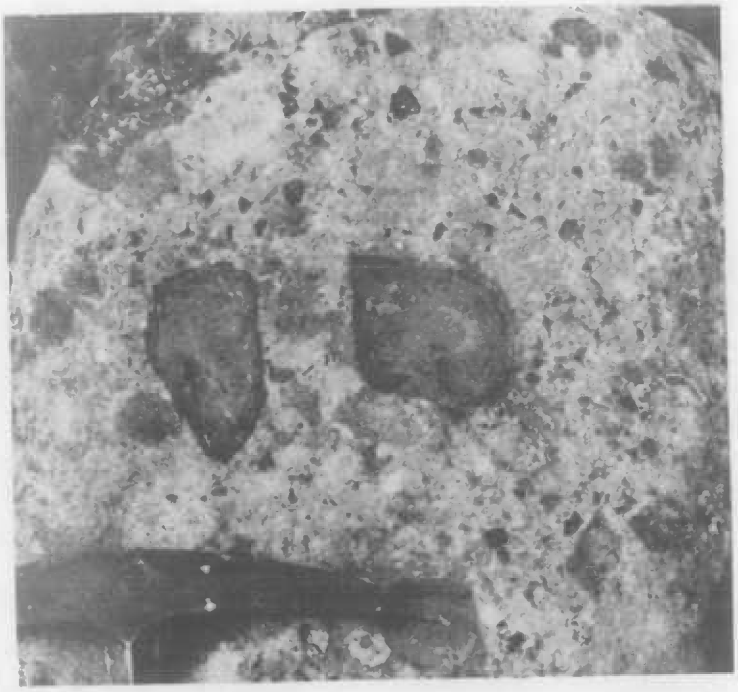

Figure 4. Poorly sorted lapilli tuff from the Jaulu Volcanics. The large dark clasts (centre) have chilled margins. GA/5999

Figure 5. Moderately well sorted lapilli tuff, Jaulu Volcanics. GA/4994.

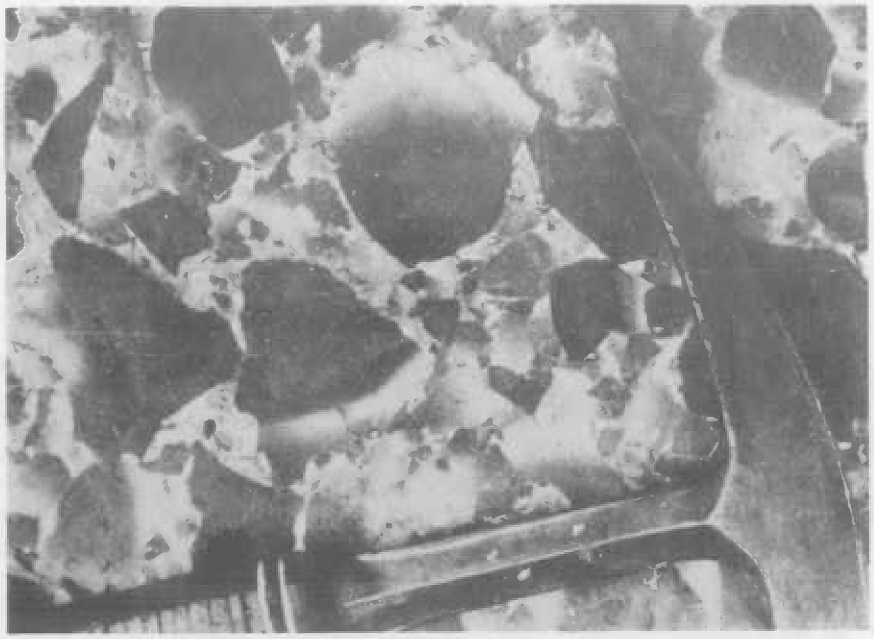

Figure 6. Andesitic agglomerate, Jaulu Volcanics.
GA/4998

Figure 7. Zeolitic agglomerate, Jaulu Volcanics.
M/1045

Petrography: The blocks of lava which make up the framework of the agglomerate are invariably porphyritic with a microcrystalline groundmass. The phenocrysts in order of relative abundance are: polysynthetically twinned plagioclase and/or oscillatory zoned plagioclase, pale green diopsidic augite, lamprobolite, slightly pleochroic hypersthene or bronzite, green hornblende, and opaques. The relative proportions of augite, orthopyroxene, and lamprobolite are variable. Rocks that contain abundant augite and hypersthene contain little or no lamprobolite and vice versa.

Green hornblende and quartz are not common in the Jaulu Volcanics, and might be restricted to those rocks that have been affected by the Lemau Intrusives. In such rocks, the phenocrystic clinopyroxene is generally corroded and partly altered to opaques, chlorite and actinolite, and the groundmass consists of a mosaic of granoblastic quartz and albite with abundant, very finely disseminated opaques.

In agglomerate clasts which have not been affected by the Lemau Intrusives, the groundmass generally consists of a mesh of randomly oriented labradorite microlites with interstitial opaques and pale brown glass. In other samples the texture is trachytic, but plagioclase is the dominant feldspar.

The phenocrysts are generally euhedral in unaltered rocks; in some specimens, augite and lamprobolite are subhedral. Plagioclase phenocrysts generally show polysynthetic twinning and have compositions in the range An 55-65. Many plagioclase phenocrysts also exhibit normal or oscillatory zoning with bytownite cores and labradorite or andesine rims. The more calcic plagioclase is generally etched and altered. Grains with normal zoning commonly have corroded and kaolinized cores surrounded by unaltered narrow rims with euhedral crystal faces. In the case of oscillatory zoned plagioclase, the core and second outermost zones are usually fresh and the remainder of the crystal altered.

Metasomatized or metamorphosed Jaulu Volcanics: Where the Jaulu Volcanics have been affected by later intrusions, the following mineral assemblages have developed.

1. albite-epodite-chlorite-quartz.
2. chlorite-albite-carbonate-epidote-sphene.
3. quartz-sericite-chlorite.
4. actinolite-quartz-plagioclase.
5. quartz-actinolite-tremolite-chlorite.
6. hornblende-plagioclase-quartz-biotite.
7. hedenbergite-plagioclase-andradite(?).

These assemblages indicate metamorphism to the albite-epidote hornfels facies (Turner & Verhoogen, 1960) in assemblages 1-5, hornblende hornfels facies (6) and pyroxene hornfels facies(7). Textures are granoblastic or hornfelsic with various amounts of relict primary texture and primary minerals.

Pre-metamorphic lithology of most of these rocks was porphyritic andesite. Assemblage 7 probably represents an impure limestone.

Probably the metamorphism was not isochemical. There is some evidence of alkali and silica metasomatism, particularly in the more silicic intrusives. Mafic phenocrysts of the andesite lava fragments are altered in various degrees to actinolite, chlorite and opaques. Plagioclase phenocrysts are generally less extensively altered, but in some cases show sodic reaction rims.

Depositional environment of Jaulu Volcanics: The Jaulu Volcanics form the "basement" of an oceanic island; it is assumed that the volcanics built up from the sea floor and that some were erupted in a subaqueous environment.

The welded agglomerate and welded ash-flow tuff that are exposed on New Ireland might have formed subaerially as muee ardente deposits. Most of the volcanic clasts are angular to sub-angular and the finer-grained material shows no evidence of reworking by turbidity currents of of settling through a deep column of water. None of the rare lavas shows any evidence of pillow structures.

Clay lenses containing reef limestone fragments and tuffaceous limestone interbeds indicate that the volcanics were in part deposited in shallow water.

Some blocks in the agglomerate have angular shapes and planar boundaries, yet have chilled margins about 1 cm wide (Fig. 4). These blocks may have been erupted as partly solidified lava and the molten or partially molten rims were chilled during subaerial or submarine passage. The two volcanic plugs that have been located (Djual Island - 56MKB6276, and northwestern New Ireland - 56MKB6194) are of welded blocks with little interstitial fine-grained material. Agglomerate immediately adjacent to these centres consists of blocks which do not have chilled or altered margins.

Jau Limestone Member

Definition

Derivation: Jau River, southern New Ireland (56MNV8985).

Synonomy: Probably includes part of the Lagaiken Beds and all of the Kait Beds (Sapper, 1910). On re-examination of Schubert's (1911) fauna lists, J.G. Binnekamp noted that a species of foraminifera from the type locality of the Lagaiken Beds and assigned by Schubert to the Oligocene is now known to range from middle Miocene to Recent

(Appendix 1). This area of limestone is now tentatively assigned to the Surker Limestone. Other occurrences of Lagaiken Beds limestone occur as lenses within the Jaulu Volcanics and are here included in the Jau Limestone Member. The Kait Beds is a hypothetical formation proposed by Sapper to explain the source of lower Oligocene limestone float in the Kait River. This float was probably derived from the Jau Limestones Member.

Representative Sections: Olisigo and Jau Rivers (56MMA6924 and 56MMV8985).

Lithology: Sheared, recrystallized, locally hornfelsed limestone and tuffaceous limestone.

Thickness: Variable, generally less than 100 m.

Distribution and Relationships: The Jau Limestone Member occurs as small lenses in the Jaulu Volcanics, near the base of the succession.

Fauna and Age: Boulders in the Kait River have yielded a lower Oligocene fauna (Schubert, 1911), and fauna in the Jau River occurrence has been given an Oligocene age (Terpstra, 1966).

BASAL LOWER MIOCENE

Lossuk River Beds

Definition

Derivation: Lossuk River, northwestern New Ireland (56MKB8490).

Synonomy: Includes the sedimentary rocks of the Lossuk River Beds, Kalasi Creek Beds and Lumis River Beds (Ripper & Grund, 1969).

Type Section: Headwaters of the easternmost tributary of the Lossuk River (56MKB8490).

Lithology: Finely laminated siltstone, well cemented, angular calcirudite, pebbly feldspatho-lithic labile sandstone and conglomerate.

Thickness: About 150 m in the type section.

Distribution and Relationships: Unconformably overlie the Jaulu Volcanics from which they are largely derived. Overlain with apparent conformity by late lower Miocene parts of the Lelet Limestone.

Best exposures are in the northwestern extremity of New Ireland where the Lelet Limestone has been largely eroded off. The Beds may be developed elsewhere on the Jaulu Volcanics, for example in the Andalom River (56MLB72235), where Ripper and Grund (1969) named calcareous mudstone the "Andalom Marl".

Fauna and Age: A well preserved fauna of pelagic foraminifera indicates a basal Miocene age (Keston, 1969). A finely comminuted coral, algal, and pelecypod fauna occurs locally.

Description

The Lossuk River Beds have been derived largely from the Oligocene Jaulu Volcanics. They include pale grey feldspatho-lithic labile sandstones flecked with white kaolinized feldspars. Well rounded pebbles (2-6 cm) of andesite porphyry form up to 30 percent of the sediment and in places form pebble or boulder conglomerate lenses.

The interbedded fine calcirudite consists of angular algal and coral clasts, and a fragmental pelecypod fauna, in a calcite cement; they are probably fore-reef deposits.

LOWER MIOCENE (Tertiary "e" Stage)

Surker Limestone

Definition

Derivation: A tributary of the Hiruan River known during the German administration as Surker Creek (56MMA7458).

Synonomy: The Surker Beds are named by Sapper (1910), and as adopted by French (1966).

Type Section: Hiruan River (56MMA7458 to MA8559). Surker Creek no longer appears on maps of the area and its precise locality is not known. The Hiruan River cuts through the Surker Limestone along 16 km of its course.

Lithology: Lepidocycline chalk, clayey calcarenite and calcirudite*; minor arenaceous limestone containing pelecypods and rare calcareous, tuffaceous sandstone.

Thickness: About 500 m in the type section; probably up to 1300 m maximum thickness in the south.

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* Limestone terminology in this report after Folk (1965).

Distribution and Relationships: Unconformably overlies the Jaulu Volcanics and Lemau Intrusives in the northeastern part of southern New Ireland. The Rataman Beds of upper Miocene to Pliocene age abut against the Surker Limestone in the northwest, while to the southeast the Limestone abuts against the Pliocene or younger Panam Limestone.

Fauna and Age: The Surker Beds characteristically contain a Lepidocycline fauna which indicates a lower Miocene, Te stage age (Appendix III).

Description

The Surker Limestone forms a curviplanar sheet with irregular undulations which appear to reflect the relief on the underlying Jaulu Volcanics. The gentle warping of the Limestone thus appears to be a primary feature resulting from deposition of coral on an igneous basement of moderate relief.

The Limestone is characteristically white and massive and forms vertical cliffs. Clay is common, the Limestone includes locally common pelagic foraminifera and much coral debris; the depositional environment may have been an intra- or back-reef lagoon into which foraminifera were washed from the open sea.

LATE LOWER MIOCENE TO PLIOCENE(?)

Lelet Limestone

Derivation: Lelet Plateau, central New Ireland.

Synonymy: The Schleinitz Range - Lelet Plateau Limestone (Ripper & Grund, 1969) has been re-named to include limestone on the southern slopes of the Lelet Plateau. These limestones were not named by Sapper.

Type Section: Along the foot track from Kantembu Village (56MLB8542) to Limbin village (56MLB8233).

Lithology: Coral and algal biostromal calcarenite, calcirudite and minor foraminiferal biomicrite. The limestones are pure, white to cream, and range from completely recrystallized at the base of the succession to only slightly recrystallized at the top.

Thickness: Up to 1400 m. The Lelet Limestone is made up of a series of on-lapping limestone platforms which were deposited on a basement of high relief; the thickness of the unit probably varies considerably.

<u>Distribution</u>: The limestone caps the Lelet Plateau and Schleinitz Range in the northern half of New Ireland and mantles the northeastern fall of these ranges. The distribution of deep karst topography (Figs 12 & 14) approximately coincides with the areal extent of the Limestone. Karst Topography is not as well developed on any other limestone on the island.

<u>Relationships to contiguous units</u>: The Lelet Limestone unconformably overlies the Oligocene Jaulu Volcanics and Lemau Intrusives and conformably overlies the basal Miocene Lossuk River Beds. The lower to middle Miocene parts of the Limestone appear to abut against the upper Miocene to Pliocene Rataman Beds. Younger Pliocene or Pleistocene beds of the Lelet Limestone overlie the Rataman Beds in the centre of New Ireland, for example, on the Karu-Konogogo road (56MMB1015). The uppermost beds of the Lelet Limestone, though of similar age to the Punam Limestone, are characterized by karst topography and consist of coral and algal material, whereas these features are absent in the latter.

<u>Relationships to non-contiguous units</u>: The lower Miocene beds of the Lelet Limestone can probably be correlated with the Surker Limestone, which appears to be exclusively lower Miocene. Because the Lelet Limestone is much longer-ranging than the Surker, and as the two limestone formations are geographically distinct, it was thought worthwhile to distinguish between them.

<u>Fauna and Age</u>: The Lelet Limestone appears to range in age from late lower Miocene to Pliocene or possibly Pleistocene (see Description below). This determination is based on a sparse foraminiferal fauna (Appendix 2, this report: Ripper & Grund, 1969). The Limestone is characterized by abundant coral and algal remains.

Description

The greatest development of the Lelet Limestone is in the region of the Lelet Plateau. The thickness of the unit gradually decreases to the northwest, where only the lower part of the succession is represented. Outliers of late lower Miocene limestone in northwesternmost New Ireland (56MKB6795) overlie Jaulu Volcanics and the Lossuk River Beds.

On the northeast fall of the Lelet Plateau, a group of about fourteen terraces extends from sea-level to an elevation of about 1400 m. The terraces have a vertical spacing of about 100 m, are about 100 m wide, and are generally several kilometres long. They appear to converge slightly towards the northwest. Samples taken from the edges of the terraces have yielded a late lower Miocene age near sea-level and middle or upper Miocene ages at higher levels. A sample from about 300 m stratigraphically below the top of the formation yielded a Pliocene or younger foraminiferal fauna.

With detailed micropalaeontological studies it might be possible to re-define the Lelet Limestone as several shorter-ranging formations or members and these might or might not coincide with the subdivisions defined by the terraces.

The uppermost beds of the Limestone dip at up to 5°, northeast while the older parts of the formation probably dip at about 10-15° northeast. The youngest limestone (Pliocene or younger) occurs only in the southern part of the Lelet Plateau. Slightly older (probably Pliocene) limestone caps the remainder of the Plateau and the Schleinitz Range.

The lithology of the Limestone is quite uniform. At the base of the sequence, the Limestone consists of extensively recrystallized coral and algal reef material and biodismicrite or biosparite. In all but the uppermost beds, diagenetic modifications have resulted in a massive, structureless, white limestone. The biodismicrite contains scattered smaller foraminifera and are cloudy in thin section, suggesting the presence of clay.

Near the Lossuk River, in the extreme northwest of New Ireland, a log of calcified wood about 1 m in diameter and 4 m long was found. The cellular structure of the wood has been retained as a network of dark organic stains in the carbonate, and the calcite crystals have grown parallel to the length of the pre-existing fibres of the wood. The calcified wood was found in a largely coralline, late lower Miocene part of the Lelet Limestone.

<u>Depositional environment and history</u>: The Lelet Limestone was probably deposited on the igneous 'basement' when the latter formed an elongate volcanic island of considerable relief. This is indicated by the present difference in elevation along the strike of about 500 m between the lowermost exposed limestone and the highest exposure of the volcanic 'basement'. This difference is far greater than the depth tolerance of living corals (about 100 m).

The Limestone appears to have formed a series of biostromal platforms which grew outwards from a lower Miocene island shelf or slope. Each limestone platform probably formed by upward growth of the reef complex keeping pace with gradual subsidence of the island. The whole sequence of limestone platforms which makes up the Lelet Limestone indicates conditions of gradual subsidence from the late lower Miocene at least, to the Pliocene with periods of stability, and non-deposition and erosion probably occurring throughout this time.

Following deposition of the Pliocene or younger platforms which completely capped the volcanic island as atolls, the whole of the island must have been rapidly uplifted. If it is assumed that the uppermost limestone beds are early Pliocene (see Appendix 2) then the <u>minimum average</u> rate of uplift was at least 0.28 mm/yr. If we assume that the uppermost limestone is basal Pleistocene, then the minimum average rate of uplift was about 1.4 mm/yr.

The flight of about 14 terraces, each about 100 m wide and with a vertical spacing of about 100 m, which extends from sea-level to an elevation of about 1400 m on the Lelet Plateau, might have been formed by wave erosion during uplift of the island. If this was so, the regular spacing of these terraces would indicate that uplift was of a regular pulsatory nature with intermittent periods of stability. Alternatively, the terraces may represent original fringing reef platforms (see Geomorphology, p. 35). No off-lapping fringing coral reefs have been deposited on the terraced northern fall of the Lelet Plateau, with the possible exception of the section from sea-level to an elevation of about 50 m.

UPPER MIOCENE TO PLIOCENE

Rataman Beds

Definition

Derivation: Rataman District of New Ireland (during German administration only), or Rataman village (56MMA5275), which has long been abandoned.

Synonomy: The Rataman Beds as re-defined here include the Rataman Beds and Tamul Beds as named by Sapper (Sapper, 1910; French, 1966).

Type Section: Along the foot track from Komalu Plantation (Map 1) to the top of the divide at 520 m (56MMB216035 to MB225050).

Lithology: Poorly lithified, water-laid, ash-fall andesitic and dacitic(?) tuff, volcanolithic lutite and minor clayey limestone. Small lenses of coal and conglomerate occur locally.

Thickness: About 500 m in the type section. This probably represents the maximum thickness of the unit. In other areas the Rataman Beds cover 'basement' with substantial relief, and their thickness is variable.

Distribution and Relationships: The Rataman Beds form much of New Ireland from the narrow isthmus near Karu (56MMB1019) to near Palabong (56MMA5363). They overlie the Jaulu Volcanics in the south with high-angle unconformity. Their base is generally below sea level, and the underlying rocks are largely concealed. Locally, the Rataman Beds are overlain unconformably by poorly indurated calcarenite to calcirudite of the Punam Limestone. In more restricted areas, they are overlain by coarse sedimentary breccia and conglomerate of the Uluputur Beds.

Fauna and Age: Contains an abundant fauna of foraminifera, coral and mollusca which indicates a basal upper Miocene to Pliocene age (Appendix 2).

Description

In the narrow isthmus which extends from Nabuto Bay to Karu Bay, the Rataman Beds form a planar dip-slope which strikes parallel to the long axis of the island and which is truncated along the southwest coast by a fault.

Figure 8. Thinly interbedded volcanolithic arenite and lutite of the Rataman Beds. M/1043

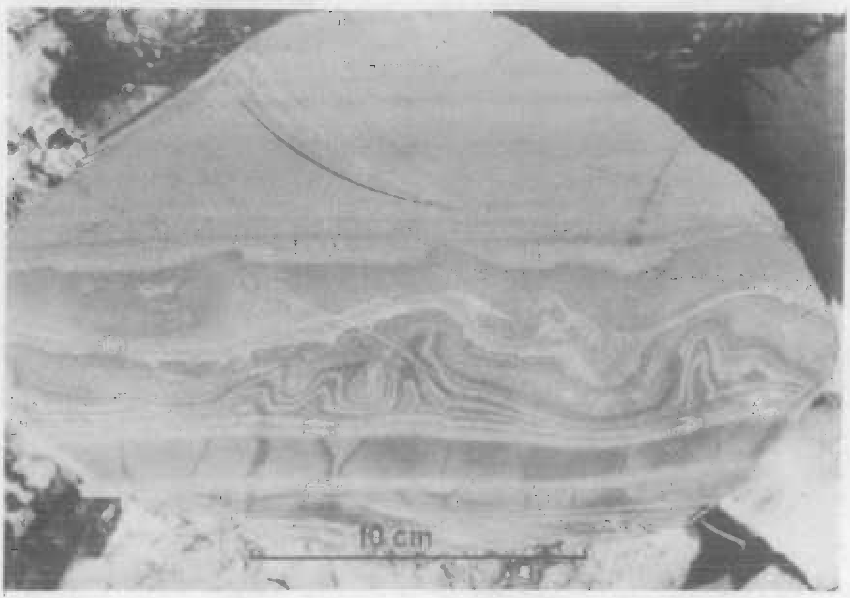

Figure 9. Convolute laminations, caused by penecontemporaneous slumping, in a boulder from the Rataman Beds. GA/4995

In this region, a maximum thickness of 500 m of fine tuffaceous calcilutite and arenite is exposed. Strata dip at angles between 5° and 20°NE with strike between 280° and 310°. Immediately below the fault scarp on the western side of the isthmus, the attitude of the strata abruptly changes to a southwesterly dip of up to 20°.

In the southeast, bedding attitude is more variable, possibly because of post-depositional compaction of originally sub-horizontal sediments. Compaction appears to have increased low initial dips to about 25-30° where sediments lapped against, or completely covered, basement highs.

The top of the Rataman Beds is marked in places by a 13 m thick unit of massive, dark grey-brown, rather friable lithic arenite. The lower part of the arenite unit is current-laminated and contains rounded and orthogonal clasts from 2 mm to 1 mm in diameter, of buff-coloured tuffaceous calcilutite from the underlying bed. The calcilutite bed is 15 to 30 m thick. Below the arenite and calcilutite, the succession consists of about 500 m of alternating finely-bedded tuff grading to volcanic lithic arenite and volcanolithic lutite which grade in turn into foraminiferal calcilutite (Fig. 8). Individual beds generally range from 15 to 45 cm thick. The lithic arenites are derived from ash-fall vitric-crystal tuff and are often finely current-bedded. The calcilutites are generally buff coloured and are quite soft and semi-plastic; the volcaniclastic lutites are orange or blue, and are brittle with a conchoidal fracture. The Rataman Beds contain lenses of pebble conglomerate near the base of the succession. The pebbles are predominantly prophyritic andesite. At a few localities, low-grade lignitic brown coal seams up to 1 m thick are interbedded with the volcanolithic sedimentary rocks (see Economic Geology, p. 45).

The sedimentary and fine pyroclastic rocks are generally well bedded and are well mass sorted, if not size sorted; graded bedding is present in some outcrops. The grading appears to be a gravity sorting of water-laid ash-fall detritus. In many cases, the bottom of the graded bed is marked by a 1.5 cm thick layer of coarse 'tubular' pumice ash and fine pumice lapilli. The coarse interval grades upward into medium to fine ash with increasing crystal content in the finer grades. Each graded bed is between 10 and 30 cm thick.

Convolute lamination and flame structures are common in the finely laminated volcanic lutites. The amplitude of the convolutions is generally of the order of 2 cm and the peaks of the folds generally have a preferred inclination (Fig. 9). This suggests that the convolutions may be slump or current rather than load structures (Bouma, 1962). Current lamination is common in arenite beds and corresponds to Walker's (1963) "type-2 ripple-drift cross-lamination". The latter two sedimentary structures are often spatially related, but as most of the structures were seen in small float boulders, their precise relationships could not be determined.

<u>Petrography</u>: The clastic sedimentary rocks hava a small proportion of matrix and a continuous, or almost continuous framework. The framework generally consists of labile mineral grains which are angular to sub-rounded and predominantly of low to moderate sphericity; opaque grains are commonly of high sphericity. The clasts of the tuffs and labile arenites include diopsidic augite, oscillatory and normally zoned plagioclase, pumice, glass shards, green and brown hornblende, opaques, and lesser biotite, lamprobolite, hypersthene or bronzite, actinolite, apatite and quartz. The matrix is made up of palagonite or allophane, kaolin, zeolites, chalcedony(?) and other alteration or replacement products of volcanic rock fragments. Micrite makes most of the matrix of the calcilutites. The bulk of the sedimentary rocks are thus texturally and mineralogically immature.

<u>Diagenesis of Rataman Beds</u>: Zeolites are the principle diagenetic minerals of the Rataman Beds, though in some samples calcite, which may be of remobilized primary origin, is common. Very fine-grained zeolites are common in most of the volcanolithic sediments, though grainsize is generally too small to allow microscopic identification. Where identification was possible, the minerals chabazite, analcime and heulandite(?) were found in that order of abundance. These are early diagenetic minerals (Packham and Crook, 1960) and indicate diagenetic conditions of the uppermost zones of the zeolite facies (Coombs, et al., 1959). The zeolites appear to replace very fine volcanic glass shards and to fill tubules in pumice clasts.

Coombs et al. (1959) listed chabazite as stable under surface or near-surface conditions in an environment that is oversaturated with respect to silica. This fact precludes burial of the Rataman Beds to depths greater than about 500 m, or the present greatest observed depth of burial. Analcime, on the other hand, is not a good depth indicator and may persist to depths of 5,000 m or more.

Not all of the volcanic glass is replaced by zeolites. Some is fresh and some has altered to a honey-coloured isotropic substance which may be palagonite or allophane. Calcite fills the tests of foraminifera, and in many examples it partially replaces etched plagioclase along cleavages and forms grain coatings.

Near Matakan Plantation, on the southwest coast of New Ireland (56MMA3878), the Rataman Beds are locally siliceous and are much distrubed by localized faulting and folding. The fine-grained siliceous beds are interbedded with coarse dacite or rhyodacite crystal-lithic tuff which contains quartz phenocrysts. Because the siliceous beds are so fine-grained (microcrystalline to cryptocrystalline) it is not known whether the silica they contain is primary or authigenic.

<u>Depositional environment and history</u>: The thick succession of alternating graded and current bedded lithic labile arenites and clay-rich globigerinal ooze limestones, both of which occur as beds 15-50 cm thick, suggests an alternation of contrasting bottom conditions. The current and convolute lamination which are characteristic of sediments of

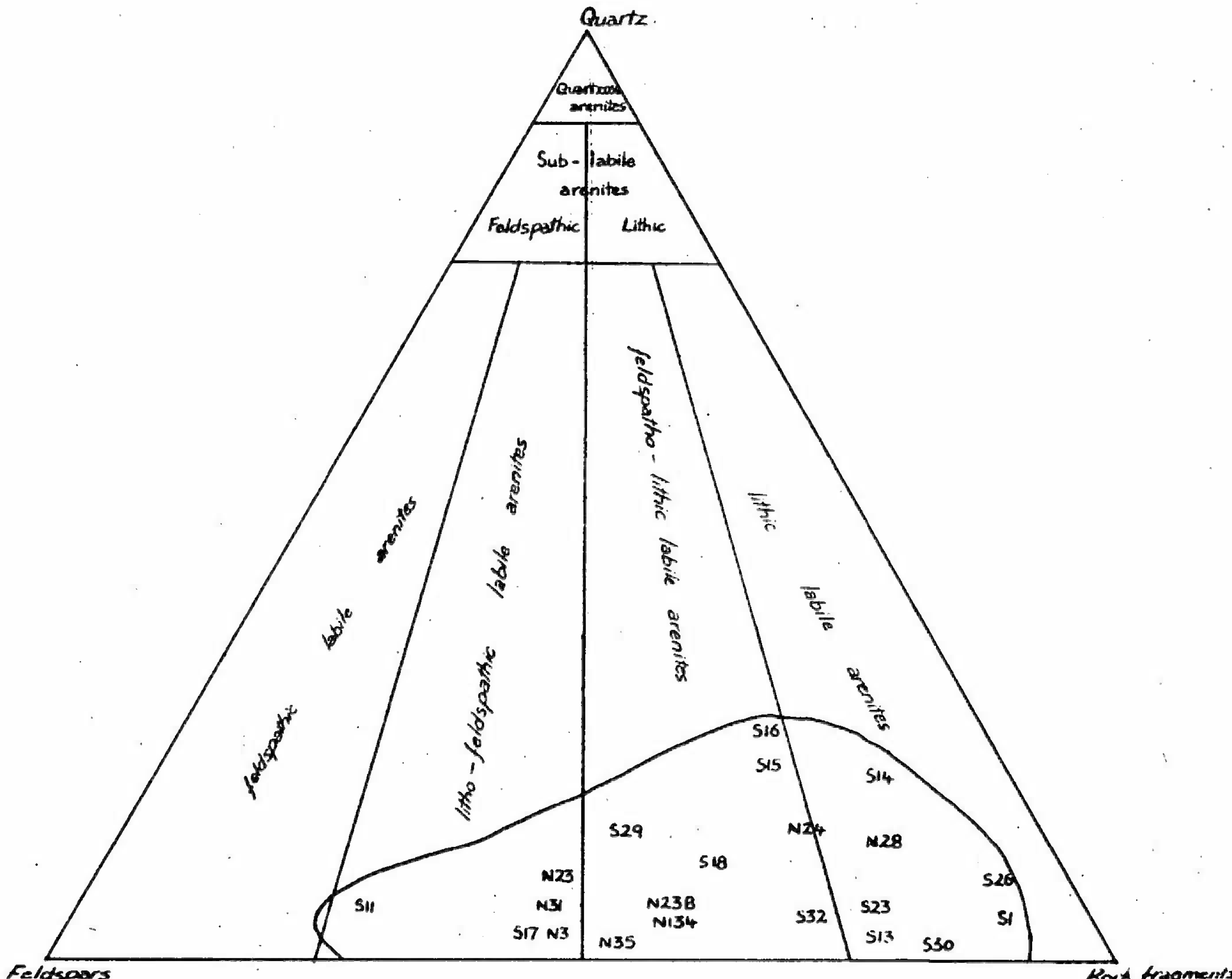

FIG. 10

QFR Diagram for Arenites of the Rataman Beds (Crook's 1960 classification).

To accompany Record 1970/49

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arenite and coarse lutite grain size, indicate quite strong bottom currents. The globigerinal ooze limestones and marls, on the other hand, indicate extremely quiet bottom conditions. It appears that a quiet depositional environment was interrupted at regular intervals by density currents bearing detritus of volcanic origin. Schubert (Sapper, 1910) believed that the globigerinal oozes of the Rataman Beds were deposited at depths of 1000 m or more. Schubert reached this conclusion after comparing the Rataman fauna with that collected during the "Challenger" voyage. This estimation of depth agrees with that obtained by subtracting the elevation of the observed base of the Rataman Beds from the elevation of the base of penecontemporaneous coralline limestones in the Lelet Plateau region.

The basence of any 'basement' rocks in the isthmus from Nabuto Bay to Karu Bay, as well as the absence of any reef limestones equivalent to the Lelet Limestone, can be explained by postulating that the Pataman Beds were deposited in a braben or dilated shear zone. If a west-northwest-trending fault displaced the inferred pre-upper Miocene island and if the fault zone was dilated by tensional stresses, a trough would have formed in the area now occupied by the Rataman Beds (Fig. 18).

PLIOCENE TO PLEISTOCENE(?)

Punam Limestone

Definition

Derivation: Punam village, southeastern New Ireland (56MMA4882).

Synonomy: The Punam Limestone of French (1966) and the Punam Beds of Sapper (1910) have been re-defined to include only limestone and to exclude volcaniclastic sediments which are now included in the Rataman Beds or the Uluputur Beds.

Type Section: Along the northern tributary of the Puk River (56MMA4583 - MA4882).

Lithology: Finely bedded, friable, moderately recrystallized chalky limestone and foraminiferal calcarenite. A coral-rich facies occurs in the southeastern part of New Ireland (56MMA9849).

Thickness: About 200 m in the type section. The shallow water facies to the south which has also been mapped as Punam Limestone, is up to 1000 m thick.

Distribution and Relationships: Unconformably overlies the Rataman Beds along a narrow strip on the northeast coast of south-central New Ireland. The Punam Limestone also unconformably overlies the Jaulu Volcanics along the west coast of southernmost New Ireland, and fills embayments in the Surker Limestone (56MMA9743).

Fauna and Age: The abundant Globigerina and Pulvinulina fauna compares closely with Recent forms (Schubert, 1911). Stratigraphic relationships indicate a Pliocene or younger age.

Description

Composed of white vuggy limestone which ranges from massive, friable, and chalky through calcarenite to fine calcirudite, Bedding is sub-horizontal with individual beds ranging from 15 cm to 1 m thick. The Limestone is generally only slightly recrystallized and is distinguished from older limestones by its easily recognized fine bedding.

PLEISTOCENE

Uluputur Beds

Definition

Derivation: Uluputur village, southwest coast of New Ireland (56MMA3289).

Synonomy: That part of the Punam Beds of Sapper (1910) and that part of the Punam Limestone of French (1966) which consist of coarse lithic labile rudite and arenite derived from the Rataman Beds.

Type Section: Northwest tributary of the Sae River, Namatanai - Uluputur Road (56MMA319920).

Lithology: Finely bedded, volcanically derived, calcareous cobble to boulder conglomerate with clasts of tuff, volcanolithic arenite and lutite, overlain by coquinoid lithic sandstone, which passes upward into alternating blue-grey siltstone and pale brown lithic coquinoid sandstone.

Thickness: About 100 m in the type section and near Punam Village.

Distribution and Relationships: Abuts against, and forms restricted embayments in the Punam Limestone; the two may be contemporaneous in part. Unconformably overlies the Rataman Beds in the type section.

Fauna and Age: Contains an abundant molluscan fauna, the few well preserved examples of which range up to Recent time. Probably of late Pleistocene age.

Description

The attitude of the Uluputur Beds varies from horizontal to a northwesterly dip of about 5^{o}. The base of the succession consists of approximately 15 m of finely bedded buff-coloured arenaceous siltstone and mudstone. These sediments pass upwards into a poorly sorted, intraformational pebble to boulder conglomerate with a calcite matrix. Clasts vary from about 9 cm to 3 m in diameter with a mode at about 30 cm. The smaller clasts are angular but roundness increases with diameter. They consist almost entirely of augite crystal tuff, volcanically derived sandstone and lutite and appear to be derived from the basal upper Miocene to Pliocene Rataman Beds.

The upper surface of the conglomerate is extremely irregular and is overlain by approximately 4 m of massive, poorly sorted lithic sandstones. The top of the Uluputur Beds consists of about 6 m of alternating, 10 to 20 cm thick beds of blue-grey tuffaceous siltstone and buff-coloured lithic coquinoid sandstone. Sole marks and horizontal worm burrow casts are common at the base of the sandstone beds; flute casts are common, but groove casts are rare. Shell fragments in the sandstone beds include abundant gastropods as well as pelecypod fragments. The writer tentatively identified Dentalium sp. in this fauna.

Depositional environment: The Uluputur Beds appear to represent an inner neritic facies which was deposited on Rataman Beds in small, shallow embayments in the coastline.

PLEISTOCENE TO RECENT

Maton Conglomerate

Definition

Derivation: Maton River (56MMA6828), southwestern New Ireland.

Synonomy: Maton Conglomerate as named by French (1966).

Type Section: Maton River, near Mala Plantation.

Lithology: Coarse, current-bedded, cobble to boulder conglomerate and interbedded pebbly sandstone. The framework consists predominantly of well sorted fragments of Jaulu Volcanics and is generally continuous; the matrix is sand.

Thickness: 200-300 m.

Distribution and Relationships: Unconformably overlies the Jaulu Volcanics, Rataman Beds and Punam and Surker Limestones on different parts of the coastal area of southern New Ireland. Unconformably overlain along the coast by Pleistocene to Recent coral terraces.

Age: Probably Pleistocene to Recent.

Description

The Maton Conglomerate consists of conglomerate with some very friable sandstone, siltstone and mudstone. The sediments are generally unconsolidated or poorly cemented, except in examples which contain much finely comminuted coral debris. Cross-bedding and scour and fill structures are common. The cobble to boulder conglomerate contains well rounded fragments of andesite porphyry, gabbro, diorite, and granodiorite. In some places (for example 56MNA1223), the unit consists of well cemented sandy beach-rock (which is predominantly sandstone), with lenses of cobble conglomerate.

In the region of the Daulum River (56MMA8658) an isolated tongue of conglomerate occurs in an embayment in the Surker Limestone. At this locality, the conglomerate shows evidence of cyclic deposition: units commence with basal boulder layers and grade upwards to cobble then pebble conglomerate over a thickness of about 2 m. These graded units form a sequence about 60 m thick.

Depositional environment: The Maton Conglomerate probably represents a coalesced series of fanglomerate deposits which have been reworked locally by wave action. The conglomerate dips at 15-20° towards the coast on both sides of southern New Ireland; this is probably a primary depositional dip. Beach deposits forming at the present time in southern New Ireland are indistinguishable from parts of the Maton Conglomerate. The cyclic nature of the unit reflects the pulsatory nature of the uplift of the island during the Pleistocene or Recent.

Raised Fringing Coral Reefs

Broad, unrecrystallized off-lapping coral terraces occur on the northeastern fall of southern New Ireland at elevations of about 300-400 m, 80-85 m and at close intervals from 65 m to sea-level. At the lower levels, i.e., up to 30-40 m above sea level, the raised fringing reefs form an almost continuous strip along the northeast coast of New Ireland. At many places along the coast, the raised reefs form low headlands some of which extend out to sea for up to 6 km (Fig. 11). Raised coral is also patchily developed along the southwest coast of the island.

The margins of the raised terraces consist of in situ colonial corals. The back-reef facies is made up of coarse to finely comminuted coral material, Tridacna clam shells, foraminiferal tests and, locally, oolites.

INTRUSIVE ROCKS

Lemau Intrusives

Definition

Derivation: Lemau Village (56MLB4848)

Synonomy: That part of the "Older Volcanics" of Sapper (1910) that comprises holocrystalline, medium to fine grained intrusive rocks. Includes the part of the Jaulu Volcanics of French (1966) that consists of gabbro and diorite intrusives. Also includes the Lemau Igneous Belt of Ripper and Grund (1969).

Type Section: The larger creeks that drain into Katherine Harbour (56MLB4951 to LB5248).

Lithology: Gabbro and norite which is commonly uralitized, Diorite, tonalite, and granodiorite, and leucocratic dyke rocks. Gabbro and norite are in places alkali metasomatised and in places exhibit igneous flow foliation. Most of the plutonic rocks contain abundant, finely disseminated and vein-forming pyrite.

Extent and Relationships: Discontinuously exposed in areas up to 32 km long and 6 km wide in a belt about 200 km long which lies along the southwestern side of the island. The Lemau Intrusives occur as dykes and stocks in the Oligocene Jaulu Volcanics and contain abundant volcanic xenoliths. The intrusives are overlain by the lower Miocene part of the Lelet Limestone, and are younger than the Jaulu Volcanics which are overlain by the basal Miocene Lossuk River Beds.

Age: Older than basal Miocene and younger than lower Oligocene.

Description

The Intrusives are exposed as bodies of dyke and stock-like dimensions which intrude the Jaulu Volcanics. They include a wide variety of rock types. They are generally medium to fine-grained and more or less equigranular. Most have ophitic to sub-ophitic texture, are leucocratic and have a gabbroic composition. The gabbro and norite are at various stages of modification to subidiomorphic granular textures and granodiorite composition.

Unaltered gabbro and norite consist of diopsidic augite and hypersthene or bronzite (moderately pleochroic from pale pink to pale green, 2V 50-70) in variable proportions, with plagioclase which shows polysynthetic twinning and some oscillatory zoning. Unzoned plagioclase in about 20 thin-sections has compositions within the range labradorite to bytownite (An_{55}-An_{85}), as determined by Michel-Levy's method. Plagioclase with oscillatory zoning has an overall composition of labradorite to bytownite with cores of bytownite to anorthite. The colour index of rocks of intermediate to acid composition is generally less than 30, but the basic plutonics range from leucocratic to very melanocratic.

Many of the rocks are characterized by what appears to be normal gabbroic mineral composition modified by late crystallization of silica and alkali-rich mineral phases. The later minerals include biotite, albite, actinolite, quartz and, rarely, potash feldspar. These are commonly peripheral to earlier formed minerals such as pyroxene and calcic plagioclase. In the extreme case, modification of this type has resulted in basic rocks being made over to rocks of granodiorite composition and subidiomorphic to allotriomorphic granular texture. Such rocks contain relict grains of diopsidic augite, orthopyroxene, and bytownite. Corroded pyroxene crystals occur at the centres of actinolite aggregates, and, less commonly, in the cores of green hornblende crystals. In addition, calcic plagioclase is in many cases rimmed and partly replaced by more sodic plagioclase (albite to andesine). Biotite forms up to 15% of some of the modified basic plutonics, and is generally associated with potash feldspar, fibrous actinolite, chlorite, and opaques. Magnetite is minor in most of the plutonic rock types, but pyrite is very common and forms up to 30% by volume of some rocks. Apatite forms quite large grains in most specimens.

The examples cited above indicate alteration of early-formed crystals by late stage fluids, presumably before the magma had completely solidified. Other types of alteration indicate alkali metasomatism, i.e., the alteration of completely recrystallized rocks by highly mobile aqueous fluids rich in alkalis and silica. This has caused replacement of quartz and labradorite in intermediate rocks by a fine-grained mosaic of quartz and albite, as well as the alteration of pyroxene to actinolite.

The more acid plutonics in the type area commonly contain fine-grained melanocratic xenoliths 10-15 cm in diameter and with ill-defined boundaries. In hand specimen, the xenoliths resemble lava fragments from the Jaulu Volcanics. In one thin section (N57), a small melanocratic xenolith from granodiorite consists of small clusters of fine-grained orthopyroxene, clinopyroxene, and opaques; these clusters are rimmed by fibrous actinolite, chlorite and biotite. The remainder of the xenolith has been made over to granodiorite similar to the host rock. This alteration is not confined to the margins of the xenolith, but pervades it, leaving only scattered, minute patches unaltered. These patches or clusters of mafic minerals may represent relict fragments of Jaulu Volcanics.

Norite (N11) from the headwaters of the Hiruan River has a weak foliation formed by ill defined alternating felsic and mafic rich bands in which the minerals have sub-parallel long axes. This is probably an igneous flow foliation developed during intrusion of the norite as a largely crystalline mush.

Discussion

The apparent late-stage enrichment of the gabbro and norite in silica and alkalis might be explained by partial melting and assimilation of abundant intermediate xenoliths in a partly crystallized magma. Alternatively, reaction between early-formed crystals and accumulated late-stage alkalic and silicic fluids from the same melt may have produced a rock of acid composition, with some relict basic minerals.

The Lemau Intrusives probably represent the slowly crystallized portion of the magma that gave rise to the Jaulu Volcanics. They probably intruded the volcanics during or immediately after the final stages of volcanism, and probably crystallised at less than 3 km below the surface.

The Intrusives are finely jointed parallel to their linear northwesterly trending distribution. They may therefore be early syntectonic, that is, they might have been emplaced along a crustal weakness parallel to the southwest coast of the island and have been jointed during later fault movement (see Structure).

GEOMORPHOLOGY

Lelet Plateau and Schleinitz Range

The Lelet Plateau provides one of the most spectacular examples of deep karst topography in the Territory of Papua and New Guinea. The plateau is the expression of a thick wedge-shaped sequence of biostromal, and less common biohermal limestones. The top of the plateau is roughly planar and dips about 5° northeast. The northeastern fall of the plateau is made up of a series of fourteen narrow, regularly spaced, sub-horizontal terraces, many of which persist for the length of the plateau. The southwestern edge of the plateau is marked by steep limestone cliffs up to 530 m high (Fig. 12).

In detail, the planar upper surface of the plateau is completely covered by closely-spaced, low, rounded conical hills, which rise 30 to 100 m above the interspersed sink-holes or dolines (Fig. 14). Sub-parallel, sinuous hogback ridges up to several tens of kilometres long and 100 m high, are also common on the plateau surface of the Schleinitz Range and parts of the Lelet Plateau. These ridges are probably biohermal structures and might represent former growing edges at the windward side of atolls.

Little well-defined surface drainage is developed on the plateau, except on the flanks. Runoff from the plateau is fed by the dolines or sink holes into large caverns and thence into underground streams. These exit from the base of the plateau limestones just above sea-level on the northeast coast of the island and discharge into the sea as strongly flowing rivers. Most of the runoff from the flanks of the plateau is distributed in a sub-parallel, anastomosing network of stream channels and in single consequent or joint-controlled rectilinear rills.

The stepped coral terraces flanking the Schleinitz Range and the Lelet Plateau generally have outer margins that are slightly raised above the inner level of the terraces. In situ biohermal or growing coral and algal reef structures have been found on some of these elevated margins. This suggests that the terraces are growth structures rather than wave-cut benches formed during uplift.

The margins of the terraces on the northeast fall of the plateau are dissected transversely by closely spaced consequent stream channels which are narrow and steep-sided. As a result, the terraces have a serrated appearance and spires similar to karst fluting have formed. Such spires have not developed on narrower terraces on the southwestern fall of the Schleinitz Range and Lelet Plateau, and this led some previous workers to regard the southwestern limestones as a distinct stratigraphic unit (Ripper & Grund, 1969). It seems likely that the lack of spires is due to the lack of runoff on the southwestern side of the plateau.

Southern New Ireland Limestones

In the northeastern part of the southern New Ireland block, the Surker Limestone forms a thin veneer, probably less than 500 m thick, over an igneous basement. The Limestone forms a gently undulating sheet which appears to reflect the relief on the underlyinb basement, and dips at low

Figure 11. Open grassland with raised Quaternary coral terraces, Cape Sena. GA/3137

Figure 12. Steep fault scarp bounding densely forested karst developed on Lelet Limestone, southeast edge of Lelet Plateau. GA/3150.

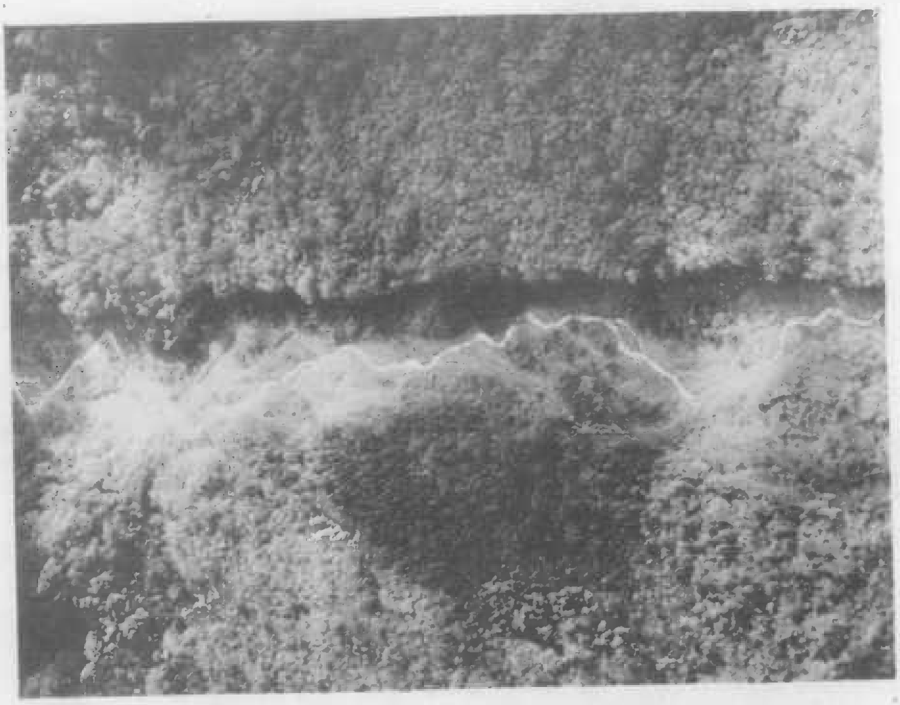


Figure 13. Dense rain forest flanking the broad gravelly bed of the Kamdaru River. The valley is flat-floored. GA/3148.

Figure 14. Partly cleared, thinly populated karst country on the Lelet Plateau. This type of clearing, and that in Fig. 13 (above) afford some of the few natural helicopter landing sites in the interior of New Ireland. M/1044.

angles to the northeast. Rare dolines occur, probably in the thicker parts of the limestone, but surprisingly no karst topography is developed. The lack of karst may be due to the high clay content of the limestone, which would make it relatively resistant to solution effects. An irregular dendritic drainage system has developed on the otherwise smooth, curviplanar surface of the limestone. Most stream channels are extremely narrow and steep-sided and are generally not deeply incised, except in the cases of the larger Hiruan and Daulum Rivers which are deeply entrenched in narrow V-shaped valleys up to 300 m deep.

Basement Volcanics

The landforms developed on the Jaulu Volcanics also show a strong response to lithology. In the volcanic terrain, the predominant form of erosion is parallel slope retreat of the deep, narrow, V-shaped valleys. Where the rivers are cutting down through fresh rock, the gorges generally have vertical walls, due to the breaking off of large blocks of agglomerate along sub-vertical, widely spaced joints. Valleys are joint-controlled, or, less frequently, fault-controlled. Good examples of the latter are the colinear Kamdaru and Weitin Rivers which cut diagonally across southern New Ireland (Fig. 13). The valleys of these two rivers are colinear and form a single, broad, V-shaped valley that is remarkably straight throughout its length of 62 km, and marks the trace of the Weitin Fault.

Up to three small volcanic cones or plugs of probable Oligocene age have been recognized in the northwestern extremity of New Ireland. These were probably exhumed in the Quaternary by erosion of Miocene limestone cover (see Jaulu Volcanics).

Raised Quaternary Coral Terraces

These flank most of the northeast coast and parts of the southwest coast of the island. Those that occur on the present coastline commonly show solution effects caused by wave action. Examples of these effects are blow holes such as occur near Kaf Kaf, and double and single wave-cut notches.

Wave-cut notches in raised coral are common around much of the coastline of New Ireland. In many examples there is a pair of notches separated by a narrow cusp; the lower notch is in the zone of wave action at high water. In some cases, however, such as at Kolonoboi and at Ramat on the central northeast coast, both notches have been raised above sea level, and in these cases, the raised reef-flat below the lower notch is about 3-4 metres above the present day reef-flat.

Christiansen (1963) concluded that the uppermost notch of a pair is probably the older and was formed at a time of higher sea level. The evidence is that in some cases the uppermost notch has stalactites developed on it while the lower notch has not. The alternative explanation is that the notches were formed at high and low water, but if this was the case, the separating cusp would not be formed, as there must be all gradations between these two levels.

Well developed single notches occur along the northeast coast near Kaf Kaf, and on the opposite side of the island in the same region. In these cases, the notch lies within the zone of wave action at high water or perhaps 0.5 m above.

The elevation of raised wave-cut notches appears to increase south-eastward, but the regularity is disturbed by Recent faulting. The double notches probably occur only on the southwest coast and the southeast part of the northeast coast. The evidence suggests that tectonism rather than eustasy has been the main factor in the development of the raised notches.

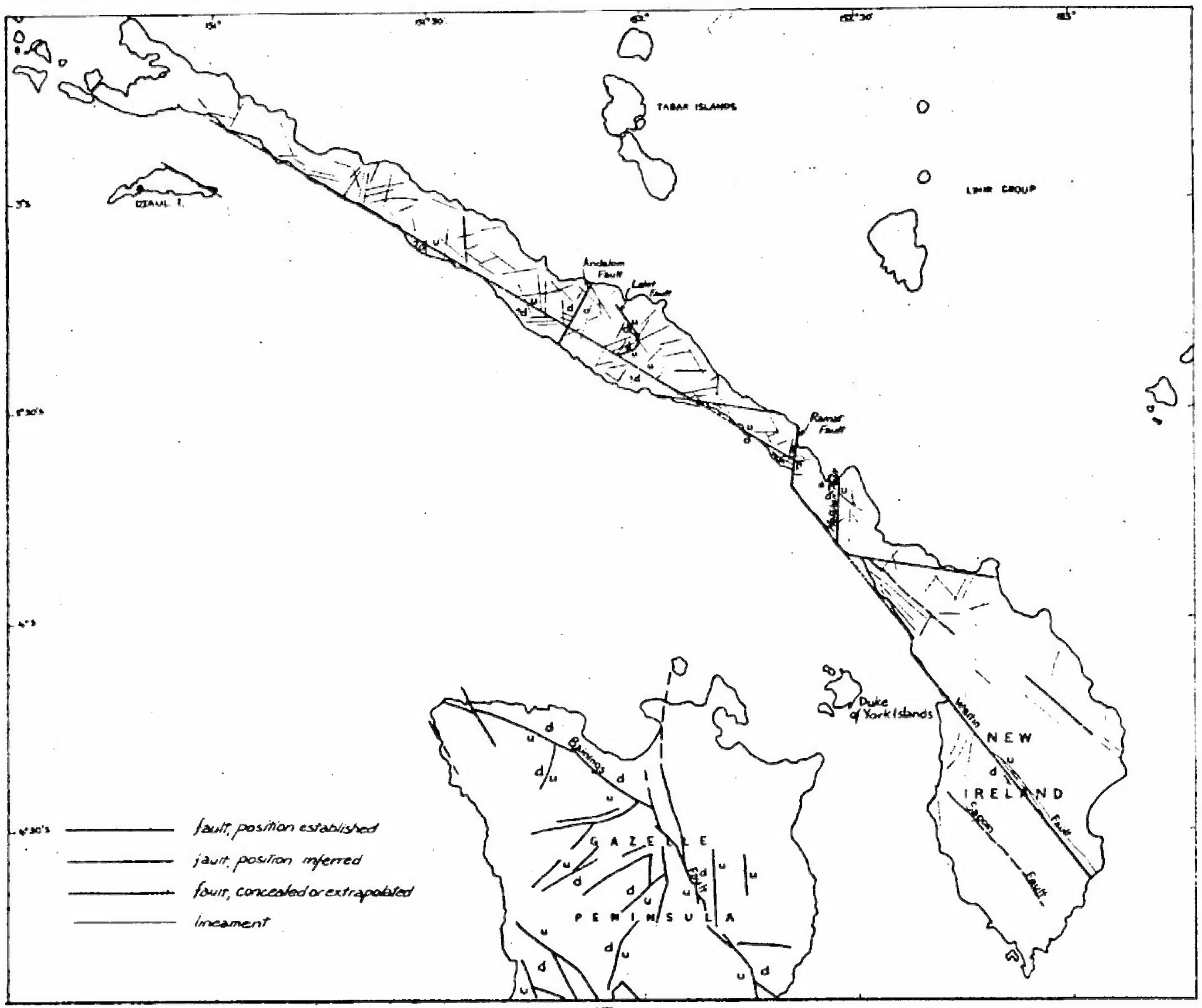


FIG. 15

Structural Map of New Ireland showing relationship to Gazelle Peninsula.

To accompany Record 1970/49

Note: Structure of Gazelle Peninsula is after R.P. Macnab (Record 1970/63)

File No. P/A 281.

STRUCTURE

Four common orientations of steeply dipping faults, large-scale joints and lineaments are found on New Ireland. The most common faults and joints have northwest and northeast trends; those which trend north are less common, and easterly trending lineaments are uncommon. Of these faults and joints, those with a northwest trend appear to have the most significant displacements, for example, the Sapom Fault and the Weitin Fault and its probable continuation to the northwest along the coast of the island (Fig. 15). Small movements have taken place on faults which trend north (for example, the Matakan and Ramat Faults) and displacement has been demonstrated on only one northeast-trending fault (the Andalom Fault).

Fault displacements are difficult to determine because of the homogeneous nature of the rocks they transect. Vertical displacements have been determined for a few faults: the Matakan Fault appears to be a normal fault with a scissor-like displacement of about 150 m (maximum), the northwestern continuation of the Weitin Fault near Komalu Bay has a measured vertical displacement of 500 m, and the Lelet Fault appears to be an arcuate normal fault with a vertical displacement of about 250-300 m.

The Sapom Fault is parallel to but younger than the Weitin Fault; unlike the Weitin Fault, it does not appear to have controlled sedimentation since the upper Miocene. Strongly sheared, coal-bearing strata were reported by French (1966) from the northwestern part of the Sapom Fault, but he did not determine sense of movement.

The Ramat Fault is a Recent structure and has displaced the coastline on both sides of New Ireland by about 6 km. The sence of movement on this fault is dextral transcurrent.

The Andalom Fault, a high angle reverse fault, appears to have been active since the lower Miocene. The volcanic 'basement' is strongly sheared in a broad fault zone, about 0.5 km wide, which dips about 50° east. The Lelet Limestone has also been sheared, though not as strongly, indicating renewed movement subsequent to deposition of the limestone. The boundary between the limestone and the volcanics has been displaced vertically by a maximum of about 150 m at the northern end of the fault. The amount of displacement that has taken place diminishes southward and indicates scissor-like movement along the fault.

The escarpments of most of the other faults are too extensively eroded to determine the attitude of the fault plane.

Transcurrent displacements along the northwesterly trending faults have not been proven, but the remarkably straight traces of the faults indicates that they are of the wrench type. French (1966) demonstrated that Recent sinistral transcurrent movements on the Weitin Fault had displaced the courses of small tributary streams of the Kamdaru River. The writer is not convinced that this is conclusive evidence of left-lateral transcurrent movement, though this seems most

(Fig. 16). The surface expression of the fault is in unconsolidated alluvium, so small displacements of the courses of streams would be quickly smoothed out by flood waters. The floor of the Weitin-Kamdaru Valley is quite flat (Fig. 13) and is largely bounded by parallel fault traces, up to 1 km apart, which have rectilinear sections up to 10 km long.

Local folding and tilting of blocks has been observed in the Andalom and Matakan Faults. Near the Andalom Fault, the Jaulu Volcanics dip 45° to 70° north, whereas to the south, in the Kaluan River, dips are generally less than 30°. This indicates that there has been tilting of small blocks in the fault zone. In the Matakan River, on the other hand, the less competent sedimentary rocks have responded to movement on the Matakan Fault by localized folding as well as tilting. In the lower reaches of the Matakan River, the Punam limestone on either side of the river dips away from the fault. Upstream, where the fault displaces Rataman Beds, the rocks are gently folded along the fault zone.

French (1966) reported small-scale, tight folding in tuffaceous siltstone containing coal seams. He attributed most of the small-scale folding in unconsolidated or poorly cemented sediments to compaction and slumping. This certainly appears to be the case for the Rataman Beds, where the folding is non-cylindrical about randomly orientated fold axes.

The narrow elongate shape of New Ireland is probably structurally controlled (Fig. 17). The island could have formed as a continuous chain of volcanoes, but more likely formed as a volcanic island of undefined but possibly equant dimensions which was sheared and drawn out by a series of west-northwesterly trending transcurrent faults. There is evidence for at least one such fault (Fig. 15). Subsequent to the shearing-out of the island into an elongate shape, it was probably further extended by movements along two parallel northwesterly trending faults which bounded a horst-like structure. Erosion and sedimentation have largely obscured the faults which bound the horst, but good evidence of faulting is found on the southwest sides of the Lelet Plateau and the isthmus of Rataman Beds, in central New Ireland (Fig. 13). The thick sequence of sub-horizontal limestone beds which forms the northeast fall of the Lelet Plateau thicken towards the northeast but are abruptly truncated, indicating that New Ireland has been uplifted as a horst with a few degrees of tilt to the northeast.

Large thicknesses of uncemented or poorly cemented conglomerate beds (probably uplifted beach gravels), unrecrystallized raised coral, and numerous waterfalls testify to continued uplift of New Ireland. This uplift may still be taking place along the faults which bounded the horst and which controlled sedimentation throughout the Miocene and Pliocene.

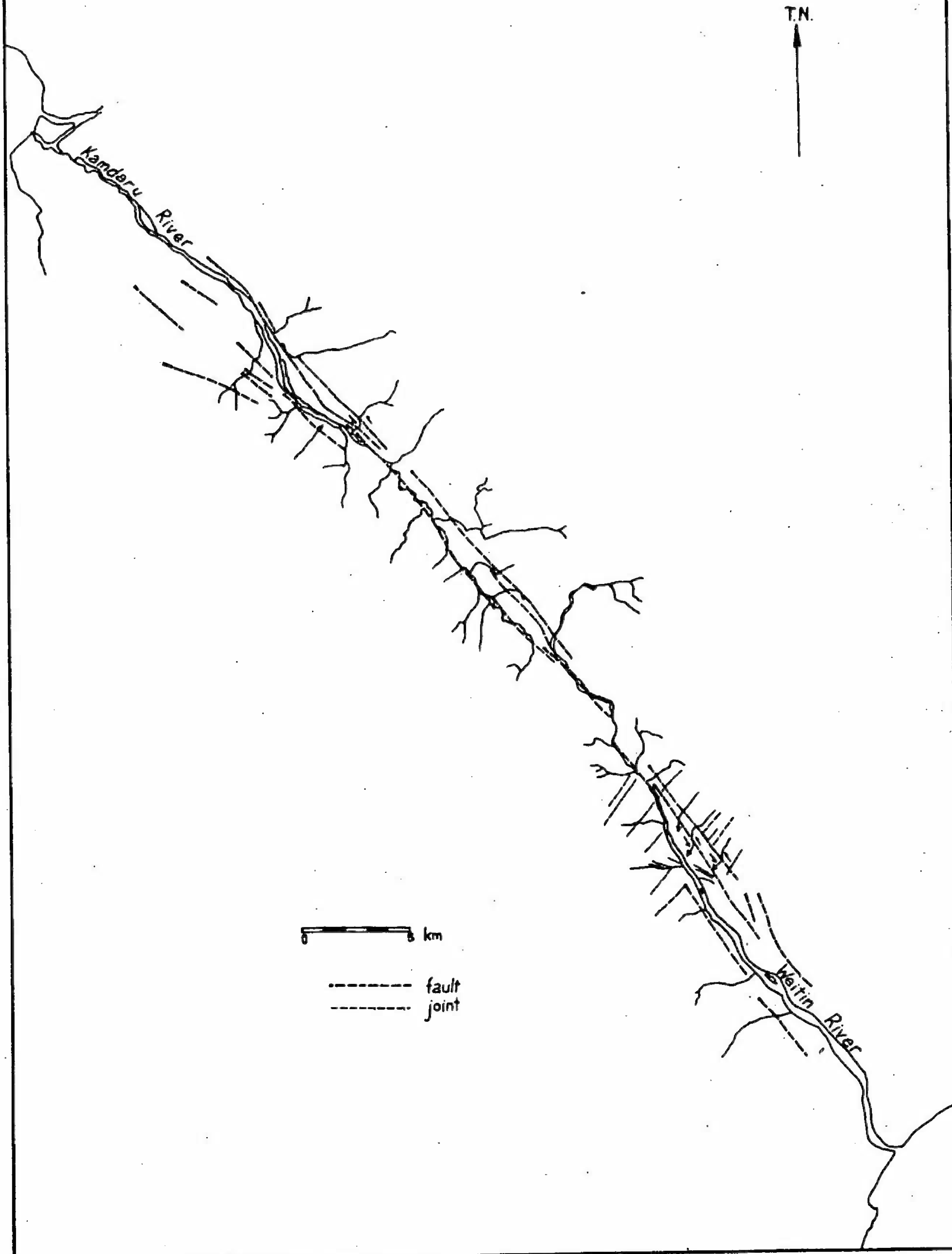
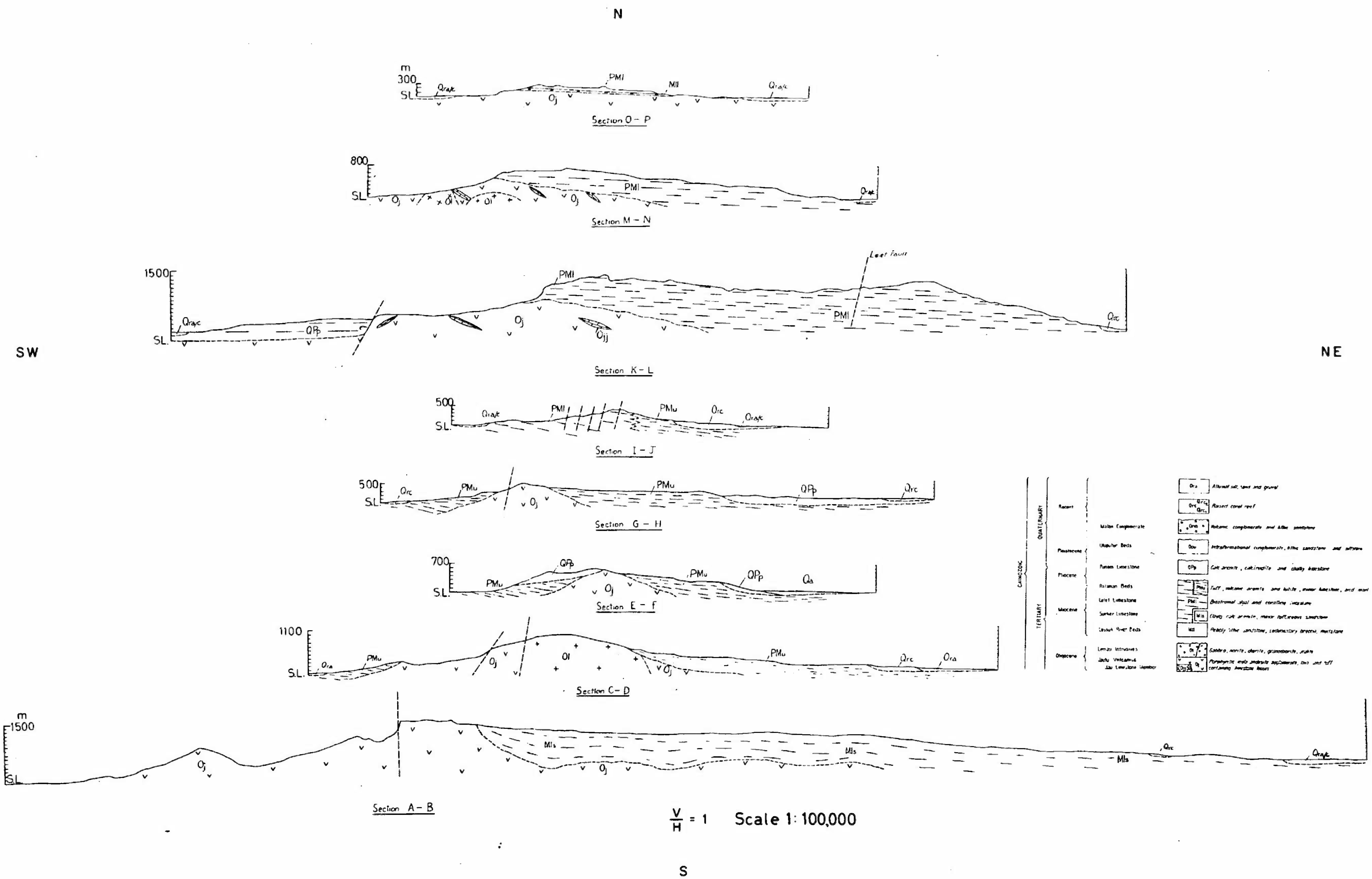


FIG. 16

Detailed Structural Map of Weitin Fault showing probable displacements of drainage caused by Recent movement on faults.

FIG. 17

SECTIONS ACROSS NEW IRELAND



To accompany Record 1970/49

GEOLOGICAL HISTORY

In the lower Oligocene, explosive volcanism formed a large volcanic island of agglomerate and tuff of intermediate composition. Volcanism waned in the upper Oligocene, when the volcanic pile was intruded by the parental, or subvolcanic magma.

After cessation of igneous activity, there was some tectonism with local steepening of dips in stratiform volcanics along faults. The island was then eroded to a youthful topography of considerable relief and there was some contemporaneous deposition of pebbly sandstones and conglomerates derived from the volcanics. Fringing reefs developed along what is now the northeast side of the island in the late lower Miocene.

Subsidence continued throughout the late lower and middle Miocene and large thickness of on-lapping fringing coral and algal reef limestones developed on the northeast side of the island.

At about the end of the middle Miocene, the island was probably divided into two by a west-northwest trending sinistral transcurrent fault or series of faults. The two halves of the island were then probably separated by a trough, or graben(?). Ash-fall andesitic to dacitic tuff from the Blanche Bay area or from nearby volcanic centres that are now submerged, contributed detritus to this trough, which continued to fill with ash and foraminiferal tests throughout the upper Miocene and Pliocene. This volcanolithic sedimentation took place along the eastern side of the southern half of the island, as well as on the western side, indicating that this part of the island was largely submerged. Subsidence of the two halves of the island continued throughout this time with fringing reef limestones continuing to build up along the northeast coast of the northern half and along the southwest coast of the southern half of the island.

By the Pliocene, the two halves of the original volcanic island were fused by the thick accumulation of clastic sediments and foraminiferal oozes. The island was by this time almost entirely submerged; only the central part of the southern block of Oligocene volcanics remained emergent. At the same time, the northwestern half of the island was completely covered by carbonate reefs, probably in the form of an atoll, or atolls.

Probably in late Pliocene time, faulting was renewed along the west-northwesterly trending system which controlled distribution of sediment in the southern part of the island during the upper Miocene and Pliocene. Two major parallel west-northwest-trending faults formed on either side of the thick pile of volcanics and bioclastic limestone and these were uplifted to form an elongate horst. This horst consisted of a southern part of Oligocene volcanics and intrusives with some lower Miocene and Pliocene limestone, joined to a northern part of similar lithology but with predominant limestone, by a narrow strip of volcaniclastic sediments. Some tilting of the horst to the northeast (5-10°) was associated with the uplift.

Rapid pulsatory uplift continued from late Pliocene(?) to Recent time with the development of an off-lapping series of fringing coral reefs along the northeast coast of the island. There was local reworking of the clastic sediments in the central part of the island, and extensive deposition of fanglomerates and beach gravels in the south. Uplift was greatest in the southeast and least in the northwest. Probably a further 5-10° of tilting to the northeast took place in the Pleistocene. Some high-angle, northwest-trending normal and transcurrant faulting took place, with associated sub-vertical, northeast and northwesterly striking joints.

Uplift continued in late Pleistocene to Recent time with the exposure above sea-level of wave-cut notches of Pleistocene to Recent age. The youngest raised coral terraces are horizontal, indicating that the latest pulse of uplift is not associated with tilting.

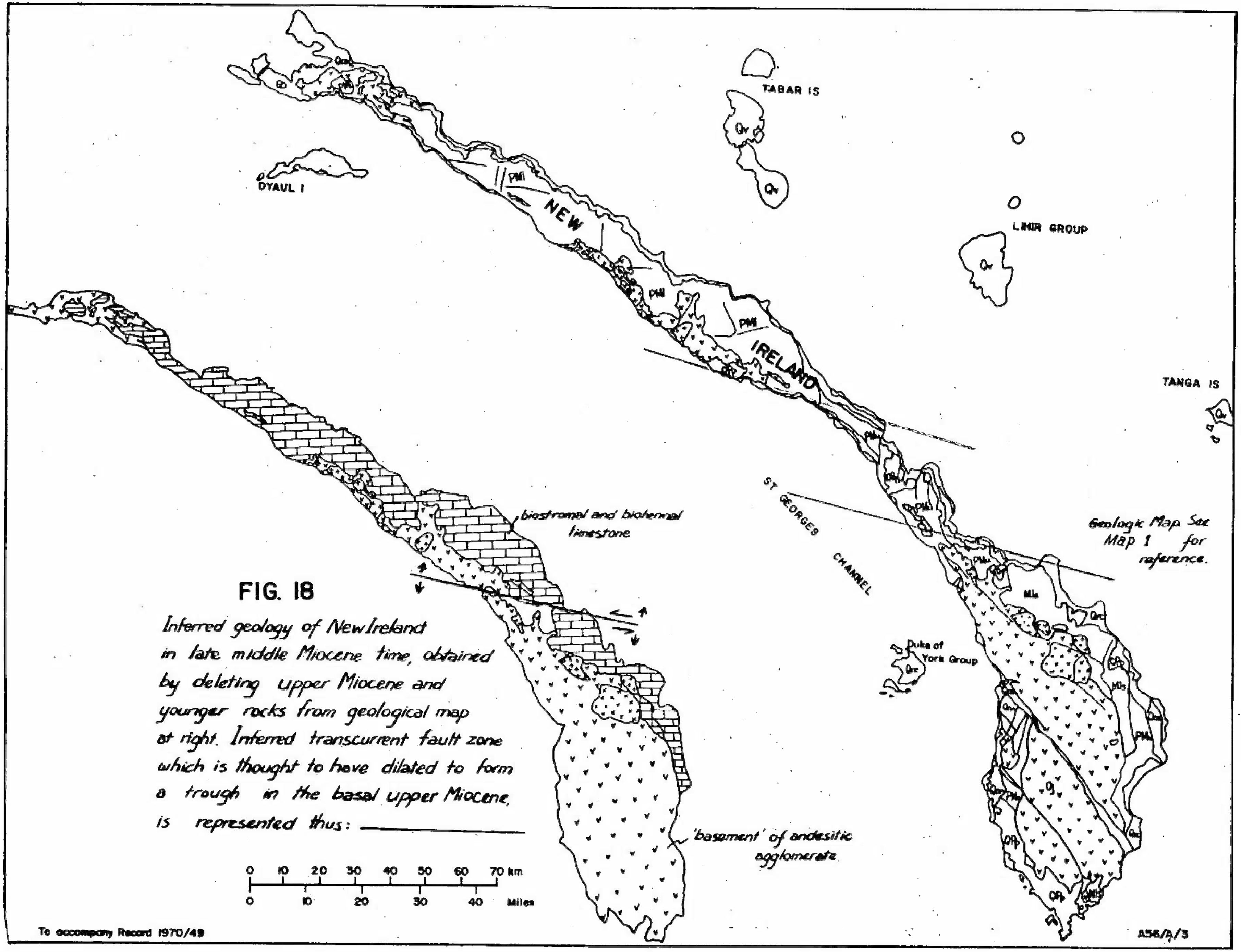


FIG. 18

Inferred geology of New Ireland in late middle Miocene time, obtained by deleting upper Miocene and younger rocks from geological map at right. Inferred transcurrent fault zone which is thought to have dilated to form a trough in the basal upper Miocene, is represented thus: ———

To accompany Record 1970/49

A56/A/3

ECONOMIC GEOLOGY

At the time of wirting, the companies Placer Prospecting, Conzinc Riotinto of Australia Exploration, and Swiss Aluminium Mining (Australia) had carried out geochemical sampling programs in New Ireland. The results obtained by the first two companies did not reveal any significant anomalies; the results of Swiss Aluminium's program are at present confidential. French (1966) also carried out some geochemical sampling of stream sediment in southern New Ireland. Two of French's samples, which were from the headwaters of the Weitin River, yielded copper values of 200 ppm; background values for the volcanics in this area average 35-40 ppm.

Gold is believed to have been obtained by the Germans from the Tomadin River (56MMA6445), and according to natives from Palabong village, a native has recently extracted small quantities of gold from a creek north of Palabong (56MMA53607). Gold is also rumored to have been worked in the Tabar Islands (152°00'E, 2°45'S), but details of this occurrence are not known.

The common occurrence of propylitized andesite, diorite, and gabbro in the mountains above Palabong (56MMA5561), together with the occurrence of malachite-stained rocks on the beach near Palabong (Sapper, 1910), and the possible occurrence of gold, indicates an area that warrants detailed prospecting. The wirter panned a few kilograms of stream sediment in each of the creeks near Palabong, but could not distinguish any gold amongst the concentrates of abundant heavy minerals. The writer did not find any evidence of copper minerals in the Palabong area, but the igneous rocks in this area appear to be hydrothermally altered. Some copper minerals were found farther south in float from the Danlilian River (56MMA6541).

Pyrite is ubiquitous in the volcanic, plutonic and hypabyssal rocks which form the 'basement' of New Ireland. Eight analyses of pyritic rock chips have been carried out in addition to hundreds of stream sediment analyses (French, 1966; Placer Prospecting, 1966; C.R.A., 1968), but to date no gold, copper, or other base metals have been detected in economically significant quantities in these rocks.

Moderately thick soils of the terra rossa type are developed to different degrees on the limestone of the Lelet Plateau and Schleinitz Range. Only a few samples of these soils were collected by the writer and analysed, and, though none of these was of economic grade, they were sufficiently rich in alumina to warrant further sampling.

Coal has been reported from three localities on New Ireland; near Metakan Plantation (56MMA398790), in the Topaio River (56MMA7010) and in the Tamul and adjacent Tamai River (56MMA0109). However, these deposits are too small, and the coal is too difficult to extract and of insufficiently high quality, for them to be considered economic at present. The coal is largely of lignite grade, and analyses show high sulphur content (Sapper, 1910; Noakes, 1939).

The beaches of New Ireland are largely of coarse gravel in the south and of coral wave-cut platforms in the north. Small patches of sand occur along a small stretch of coastline from Rukalik to Purabunbun (56MMA8958 to MA8758), but only very small quantities of titaniferous magnetite occur in this sand. Two panned concentrates assayed at 5% TiO_2.

Abundant raised Recent coralline limestone occurs along the northeast coast of New Ireland at numerous readily accessible localities. This material, which is largely clayey calcirudite and sometimes referred to as coranus, is used for surfacing roads and airstrips.

Large amounts of high purity limestone are available in the Schleinitz Range and Lelet Plateau for the manufacture of cement. The limestone could be quarried close to the all-weather road between Kavieng and Namatanai.

High purity blue-grey clay occurs in large quantities in the lower reaches of the Matakan River (56MMA388906) about 3 km from the town of Namatanai. This clay may be suitable for use in a local pottery industry, or if it occurs in sufficient quantity and has the required physical and chemical properties, it may prove useful for a clay brick industry.

ACKNOWLEDGEMENTS

The writer gratefully acknowledges the valuable assistance, both in the field and in writing this report, of W. Manser (University of Papua and New Guinea), and H.L. Davies. The writer also wishes to acknowledge the co-operation and assistance of the following people: the District Commissioner, New Ireland District; the Assistant District Commissioner, Namatanai Sub-district; D.E. Cately and G. Cifali of Swiss Aluminium Mining (Australia) Pty Ltd; Fr A. Gendusa, planters R. Lanzarote, M. Griffiths, P. Bull, and other hospitable planters; local government councillors whose assistance is gratefully remembered.

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APPENDIX 1

COPY OF PART OF SCHUBERT'S (1911) MICROPALAEONTOLOGICAL REPORT WITH COMMENTS BY J.G. BINNEKAMP

All Schubert's determinations are based on random sections which do not permit classification beyond the generic level. The comments below are based on re-interpretation of Schubert's fauna lists combined with inspection of plates where possible.

329. Alveolinella is now known to range from middle Miocene to Recent.

330. Cycloclypeus communis (as discussed on p.97 of Schubert's paper) is tentatively included in the references of C. cf. carpenteri Bradley by Tan (1932). Schubert's illustrations do not allow identification beyond the generic level. An association of C. carpenteri and Miogypsina (mentioned by Schubert as possibly present) would indicate Tf stage, middle Miocene.

From Tangula Lambel (Southern New Ireland). This fauna could indicate Te stage. No illustration is given with the description (p. 116) and verification of the identification, apparently based on a random section, is not possible.

345. Tc stage, lower Oligocene.

361. See remarks for 330.

373. " "

373a " " and 329.

373c " "

380. An association of Lepidocyclina, Miogypsina, Myogypsinoides and Cycloclypeus could indicate Te or Tf stage, upper Oligocene to middle Miocene.

Timaifluss. An association of Alveolinella, Cycloclypeus and Lepidocyclina is now known to indicate Tf Stage, middle Miocene.

Umudu. See remarks 329 and 330.

APPENDIX 2

FORAMINIFERA AND AGE OF SAMPLES COLLECTED BY P.D. HOHNEN FROM CAPE LEMERIS 1:50,000 SHEET, NEW IRELAND

by

D.J. BELFORD

Twenty seven samples collected over two profiles, and three samples from separate localities have been examined. Most of the samples lack a diagnostic foraminiferal fauna, and it has not been possible in most cases to make a precise age determination. Coral, algal and bryozoan fragments occur commonly.

Lelet Limestone: Of samples N. 41 to N. 54 inclusive, collected over one profile, only three, N. 42, N. 43 and N. 44 contain a fauna which permits any attempt at a definite age determination.

N. 42 contains:

Lepidocyclina sp (no subgenetic determination possible)
Gypsina sp.
Amphistegina sp.
Planorbulina sp.
Cycloclypeus sp.
Carpenteria sp.

N. 43 contains:

Lepidocyclina sp. (possibly *Nephrolepidina*)
Cycloclypeus sp.
Amphistegina sp.

N. 44 contains:

Lepidocyclina? sp. fragments
Cycloclypeus sp.
Amphistegina sp.
Planorbulina sp.

These three samples are lower to middle Miocene in age, but no more definite age determination can be made.

The remaining samples in this profile consist largely of coral and algal limestone, with the foraminifera including *Amphistegina*, *Planorbulina*, *Cycloclypeus*, *Carpenteria*, an indeterminable rotaline genus, and miliolids. These samples are considered to be most probably from a raised Quaternary limestone, but the fauna is insufficiently diagnostic for a definite age determination.

Samples from the second measured profile, N. 111 to N. 127 inclusive, give a similar result. Only two samples N. 120 and N. 120A, give any indication of a Miocene age.

N. 120 contains:

Lepidocyclina sp. (very small specimens)
Amphistegina sp.
Carpenteria sp.
Planorbulina sp.

No. 120A contains:

Miogypsina? sp.
Marginopora sp. or Sorites sp. (fragments)
Planorbulina sp.
Amphistegina sp.
Indeterminable rotaline genus.

The recorded fauna indicates that a middle Miocene age is most probable for these samples.

The foraminiferal fauna of the remaining samples in this profile includes:

Amphistegina, Cellanthus, Operculina, Marginopora (fragments), Planorbulina, Sphaerogypsina, Cycloclypeus, Carpenteria, Calcarina?, Planorbulina, an indeterminable rotaline genus

and miliolids; coral and algal fragments and echinoid spines occur commonly. These samples are not older than Pliocene, but are considered to be most probably from a raised Quaternary limestone.

Rataman Beds. Sample N. 24, inland from the south coast near Nakudukudu Bay, contains abundant planktonic foraminifera, (Globigerinidae and Globorotaliidae) including Globorotalia sp. cf. G. tumida, and is uppermost Miocene or lower Pliocene in age.

Jaulu Volcanics: Sample N. 221, on the Kaluan River, contains Halkyardia sp., an indeterminable rotaline genus and rare miliolids. The specimen of Halkyardia observed is very small and not specifically determinable; the genus ranges from Eocene to the lower Te stage (upper Oligocene), but it is not possible to fix a precise age within this range.

Rataman Beds: Sample S. 10 a float from near the north coast, east of Dalomakas Bay, contains planktonic foraminifera (Globigerinidae and Globorotaliidae) including Sphaeroidinellopsis-Sphaeroidinella, and is also given on upper Miocene to lower Pliocene age.

APPENDIX 3

MICROPALAEONTOLOGICAL REPORT

by

G.R.J. Terpstra
(6 Feb., 1970)

Samples collected by P.D. Hohnen from limestone outcrops of New Ireland have been examined and the following results obtained.

60NG.0008 Hiruan River, Southern New Ireland. Surker Limestone
Amphistegina sp. Cycloclypeus sp., Planerbulinella sp.
Planktonics and undeterminable smaller foraminifera.

No age determination.

60NG.0011 Huru River, Southern New Ireland. Surker Limestone Amphistegina sp. Operculina sp. Planktonics, Globorotalia cf. sultrata.

Not older than mid middle Miocene.

60NG.0014 Huru River, Southern New Ireland. Surker Limestone.
Amphistegina sp., Carpentaria sp. Operculina sp.
Rare Planktonics and indeterminable smaller foraminifera.

No age determination.

60NG.0018 2 miles North of Palabong, Southern New Ireland. Surker Limestone. Lepidocyclina (Eulepidina) sp.

Age: lower Miocene, Te stage.

58NG.0057 (Matakan River)
Amphistegina sp. Operculina sp.
Algae

No age determination

58NG.0058 Kulot, Central New Ireland.
Algae.

No age determination.

56NG.0031 Near Cicacui Plantation.
Amphistegina sp. Carpenteria sp. Lepidostegina sp.
Miogypsina sp.
Coral limestone. Algae.

Age: middle Miocene to ?lower Miocene.

Bureau of Mineral Resources,
6th February, 1970

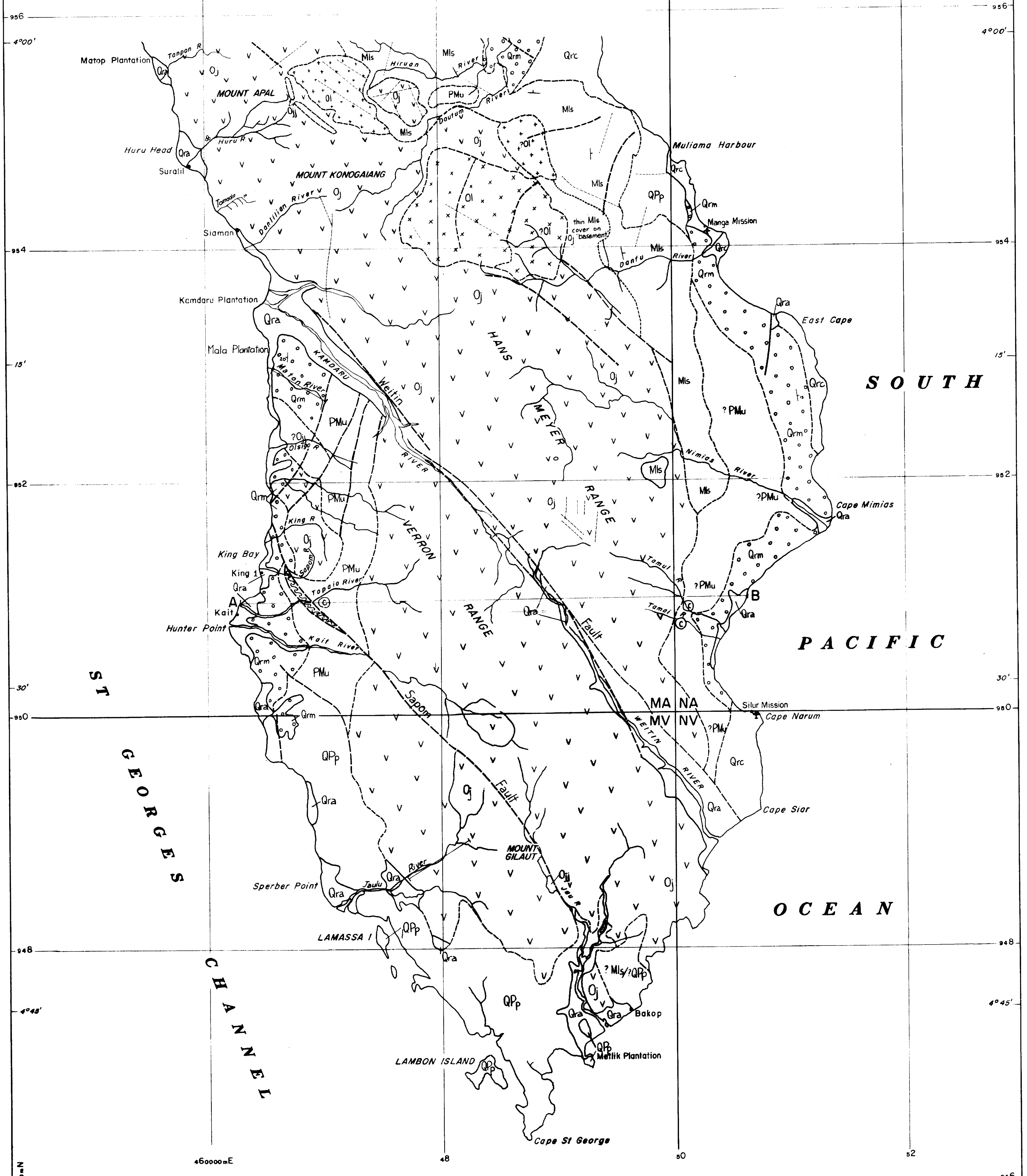

SOUTH PACIFIC OCEAN
BISMARCK SEA
MAP 1
SHEET 1
GEOLOGICAL MAP OF NEW IRELAND
1:250,000
Kilometres
SCHLEINITZ RANGE
LELET PLATEAU
Kavieng
Kapsu Bay
Fangalawa Bay
Logagon Bay
Cape Lessu
Cape Panakondo
Cape Lemeris
Katherine Harbour
Cape Narago
Lemusmus I.
Balgai Bay
Kalili Bay
Komalu Bay
Lahur Bay
Ramat Bay
Namatanai
Elizabeth Bay
CAPE MATANATAMBERAN
Cape Sena
Malakan Plantation
Donup Plantation
Palabong
KC LC
KB LB
LB MB
LA MA
Recent
Pleistocene
Pliocene
Miocene
Oligocene
QUATERNARY
TERTIARY
CAINOZOIC
Maton Conglomerate
Uluputur Beds
Punam Limestone
Rataman Beds
Lelet Limestone
Surker Limestone
Lossuk River Beds
Lemau Intrusives
Jaulu Volcanics
Jau Limestone Member
Qra Alluvial silt, sand and gravel, Qra/c alluvium and soil over raised coral
Qrc Qrc2 Qrc1 Raised coral reef younger older
Qrm Volcanic conglomerate and lithic sandstone
Qpu Intraformational conglomerate, lithic sandstone and siltstone
QPp Calc arenite calcirudite and chalky limestone
PMu Tuff volcanic arenite and lutite minor limestone, and marl
PMl Biostromal, algal, and coralline limestone
Mls Clayey calc arenite, minor tuffaceous sandstone
Mll Pebbly lithic sandstone, sedimentary breccia, mudstone
Oi Granodiorite, diorite; gabbro, norite
Oj Ojj Porphyritic mela-andesite agglomerate, lava and tuff, containing limestone lenses
Geological boundary
Fault
Where location of boundaries and faults is approximate, line is broken; where inferred, queried; where concealed, faults are shown by short dashes
Strike and dip of strata
Prevailing strike and dip of strata
Dip < 5°
Dip 5-15°
Dip 15-45°
Trend lines
Joint pattern
Air-photo interpretation
Strike and dip of joint
Horizontal joint
Vertical joint
Extinct Volcanic vent-intermediate composition
Microfossil locality
Type section locality
Measured section
Unworked coal deposit
Coal
Airstrip
Airport
Escarpment
Village
LOCATION DIAGRAM
WEST IRIAN
NEW GUINEA
PAPUA
NEW IRELAND
NEW BRITAIN
Port Moresby
AUSTRALIA
Geology, 1969, from general reconnaissance and air photo interpretation by P.D. Hohnen. Compiled and drawn, 1970, by P.D. Hohnen
To accompany Record 1970/49

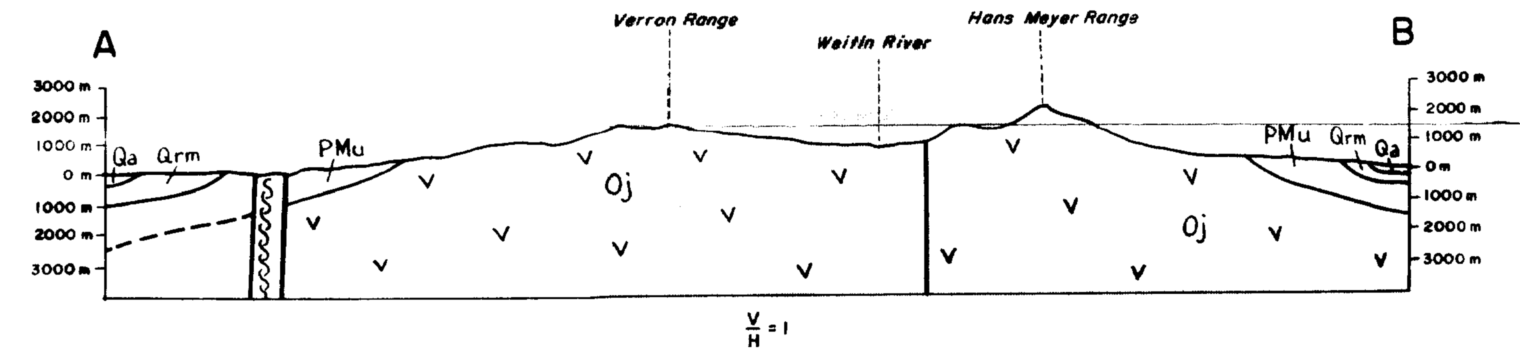
SHEET 2

GEOLOGICAL MAP OF NEW IRELAND

1:250,000

5 0 5 10 15 20 Kilometres





CAINOZOIC

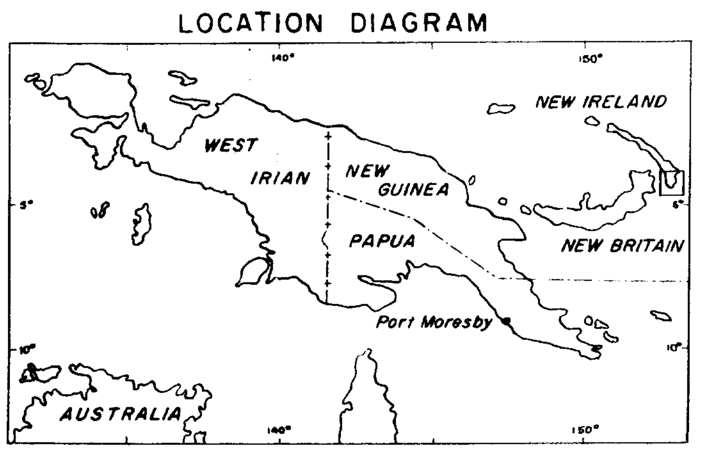
QUATERNARY	Recent		Qra	*Alluvial silt, sand, and gravel*
			Qrc	*Raised coral reef*
		Maton Conglomerate	Qrm	*Volcanic conglomerate and lithic sandstone*
	Pleistocene	Uluputur Beds	Qpu	*Intraformational conglomerate, lithic sandstone, and siltstone*
		Punam Limestone	QPp	*Calc arenite, calcirudite, and chalky limestone*
TERTIARY	Pliocene	Rataman Beds	PMu	*Tuff, volcanic arenite and lutite, minor limestone, and marl*
	Miocene	Lelet Limestone	PMl	*Biostromal, algal, and coralline limestone*
		Surker Limestone	Mls	*Clayey calc-arenite, minor tuffaceous sandstone*
		Lossuk River Beds	Mll	*Pebbly lithic sandstone, sedimentary breccia, mudstone*
	Oligocene	Lemau Intrusives	Ol	*Granodiorite, diorite, gabbro, norite*
		Jaulu Volcanics	Oj	*Porphyritic mela-andesite agglomerate, lava and tuff containing limestone lenses*
		Jau Limestone Member	Ojj	

- *Geological boundary*
- *Fault*

Where location of boundaries and faults is approximate, line is broken; where inferred, queried; where concealed, faults are shown by short dashes

- *Strike and dip of strata*
- *Prevailing strike and dip of strata*
- *Dip < 5°* (Air-photo interpretation)
- *Dip 5-15°* (Air-photo interpretation)
- *Dip 15-45°* (Air-photo interpretation)
- *Trend lines* (Air-photo interpretation)
- *Joint pattern* (Air-photo interpretation)
- *Strike and dip of joint*
- *Vertical joint*
- *Extinct volcanic vent-intermediate composition*
- *Microfossil locality*
- *Type section locality*
- *Measured section*
- *Unworked coal deposit*
- *Coal*
- *Airstrip*
- *Airport*
- *Escarpment*
- *Village*

LOCATION DIAGRAM



Geology, 1966, 1969, from general reconnaissance and air photo interpretation by P.D. Hohnen and D.J. French. Compiled and drawn, 1970, by P.D. Hohnen.

MAP 2

A56/A 2

To accompany Record 1970/49