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IGNEOUS AND METAMORPHIC ROCKS OF CAPE YORK PENINSULA AND TORRES STRAIT

by

W.F. Willmott, W.G. Whitaker,
W.D. Palfreyman and D.S. Trail

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MAP

1:500,000 geological map of the igneous and metamorphic rocks of Cape York Peninsula and Torres Strait, Queensland and Papua. Preliminary edition.

SUMMARY

A broad ridge of Precambrian and Palaeozoic igneous and metamorphic rocks extends from the Mitchell River 450 km northwards to Temple Bay, on the east side of Cape York Peninsula. From Cape York a second submerged ridge of Palaeozoic igneous rocks extends across Torres Strait to Papua.

There are four geographically distinct groups of metamorphic rocks which probably belonged to the same Precambrian sedimentary sequence. They have been subjected to high-temperature/low-pressure regional metamorphism and increase in grade eastwards from phyllite of the greenschist facies to gneiss of the amphibolite facies. They consist mainly of mica schist and quartzite with local occurrences of greenstone, calc-silicate rocks, marble, and iron-rich rocks, and are intruded by dolerite in the south.

The Cape York Peninsula Batholith, which is composed predominantly of adamellite with subordinate granodiorite, is intrusive into the metamorphic rocks over a distance of at least 400 km. The age of the batholith is uncertain; it contains Precambrian rocks but also bears the imprint of an Upper Devonian event.

In Lower Carboniferous time coal-bearing sediments were deposited in small basins. In the Torres Strait area thick sheets of acid welded tuff and subordinate lavas were erupted, probably in the Carboniferous, and were then intruded by large bodies of granite and microgranite. Similar activity south of Temple Bay in Carboniferous or Permian times produced thick piles of acid pyroclastics and large bodies of high-level granite, which also intruded the older granitic and metamorphic rocks.

In the Mesozoic coarse sandstone and conglomerate followed by finer sediments were deposited on the flanks of the two basement ridges, which appear to be separated by a trough of these sediments. Tertiary uplift on faults along the east side of the peninsula resulted in the deposition of poorly consolidated sandstone and conglomerate. A plug of olivine nephelinite was emplaced near the faults, and in the Pleistocene olivine basalt lava and pyroclastics were erupted from small volcanoes in the north-eastern part of Torres Strait.

Most of the structures in the peninsula, such as the fold axes and foliation in the metamorphics, the faults, and the long axis of the batholith, have a northerly trend. The Palmerville Fault is a major structure which has been active from Silurian time onwards.

Alluvial and reef gold was mined extensively in Cape York Peninsula and in Torres Strait late in the 19th century; small quantities of wolfram and alluvial tin have also been won. Deposits of iron and manganese near Iron Range and of silica sand on Mesozoic sediments north of Temple Bay have not yet been exploited.

Traces of antimony, arsenic, copper, lead, zinc, and molybdenum have been reported and occurrences of bauxite, coal, mica, beach sands, and limestone are known.

INTRODUCTION

Cape York Peninsula is situated in far north Queensland between the Gulf of Carpentaria and the Coral Sea. It extends northwards for over 600 km from about the latitude of Cairns to Cape York, its northern extremity. It is separated from the Papuan mainland by Torres Strait, a stretch of shallow water, about 150 km wide, dotted with numerous islands and reefs (Fig. 1).

This Bulletin describes the Precambrian metamorphic and granitic rocks in the central and northern parts of the peninsula, and the Upper Palaeozoic igneous rocks which penetrate them. Some Cainozoic basic igneous rocks are also described. The Precambrian rocks in the Chillagoe area to the south were described by de Keyser & Lucas (1969), who also mapped the sediments of the Palaeozoic Hodgkinson Basin to the east; Upper Palaeozoic igneous rocks of the same region have been described by Branch (1966). In this Bulletin the Mesozoic and Cainozoic sediments overlying the older rocks are mentioned only briefly; those of the Laura and Papuan Basins have been described respectively by de Keyser & Lucas (1969) and the Australasian Petroleum Co. (1961). The sediments of the Carpentaria Basin are at present (1970) being mapped by the Bureau of Mineral Resources and the Geological Survey of Queensland.

The pre-Mesozoic basement rocks crop out between latitude $9^{o}00'S$ and $16^{o}30'S$, and longitude $142^{o}00'E$ and $144^{o}15'E$ in three separate inliers, named here the Yambo Inlier, the Peninsula Ridge, and the Cape York/ Oriomo Ridge (Fig. 4). The regional mapping was carried out by a combined party from the Bureau of Mineral Resources and the Geological Survey of Queensland between 1966 and 1968. Geologists who took part in the project, under the leadership of D.S. Trail, were the four authors of this Bulletin, and I.R. Pontifex and R.F. Spark, both of the Bureau of Mineral Resources. The preliminary results of each year's mapping have been described by Trail et al. (1968, 1969) and Willmott et al. (1969).

The rocks described crop out in parts of the Mossman, Cooktown, Walsh, Hann River, Ebagoola, Coen, Cape Weymouth, Oxford Bay, Torres Strait, Boigu, Daru, and Maer 1:250,000 Sheet areas. The topographic maps available were the standard 1:250,000 Sheets, which are distributed by the Division of National Mapping, the Queensland Four-Mile Series, published by the Queensland Lands Department, and a small number of war-time 1:63,360 Sheets of the southern part of Torres Strait and the northeastern part of Cape York Peninsula. Air-photographs at 1:50,000 or 1:80,000 scale are available for the whole of the area, except the far northeastern part of Torres Strait.

Geological maps produced during the survey are the accompanying 1:500,000 map of the region, and preliminary editions of the above Sheet areas, apart from Mossman and Cooktown, which were published earlier, and Boigu and Maer, parts of which were included with Torres Strait and Daru respectively. Coloured 1:250,000 geological Sheets with explanatory notes will be published later when mapping of the overlapping Mesozoic sediments of the Carpentaria Basin has been completed.

Nomenclature

The majority of the formal stratigraphic names have been defined by Whitaker & Willmott (1968, 1969a, b). The nomenclature used for igneous rocks is that followed by Joplin (1964).

The names used for islands in Torres Strait conform with those on the 1:250,000 topographic maps, except in a few cases where the indigenous equivalent is in more common use than the English name.

Relief and exposure

The south-central part of Cape York Peninsula is an area of low relief, except for some ridges of more resistant rocks. It is generally less than 300 m above sea level and slopes gently westward to the Gulf of Carpentaria; in the east it is bounded by rugged hilly country formed by the folded sediments of the Hodgkinson Basin. The rocks are poorly exposed, and outcrops can generally be found only in the beds of the larger streams.

Farther north, on the eastern side of the peninsula the basement rocks form a series of rugged plateaux and ranges up to 800 m high, which extend from south of Coen to north of Iron Range. Despite the thick cover of soil and dense vegetation, the rocks are moderately well exposed. The islands in the western part of Torres Strait rise to 400 m above sea level, and the numerous headlands along the coast provide excellent exposures. Most of the islands farther east are low and sand cays, but in the far north-east there are several hilly Cainozoic volcanic islands.

Climate and vegetation

The climate ranges from dry tropical in the south to humid tropical in the northeast. Rainfall is high, but is markedly seasonal with the bulk of the rain falling between November and April. In the north the rainfall is almost twice as great as in the south, and the ranges between Coen and Iron Range receive some rain throughout most of the year. During the long dry season the majority of streams are dry, and water is obtainable only in some of the larger rivers.

Most of the peninsula is covered by open tropical eucalypt forest which becomes progressively thicker towards the north. The eastern ranges between Coen and Iron Range support dense tropical rain forest, with open patches of eucalypt forest and blady grass. In the Janet Ranges near Iron Range low heath-type vegetation is developed on the barren hills of acid volcanic rocks. The western islands of Torres Strait support open eucalypt forest similar to that of the mainland; the higher peaks of Moa Island are covered with rain forest. The volcanic islands in the northeast are more fertile and support open grassland, coconut groves, and rain forest.

Population and industry

The population of Cape York Peninsula is thinly spread, and is almost entirely engaged in cattle raising; most of the cattle properties are in the south, with only a few north of Iron Range. The main town is Coen (pop. 175). The small settlement of Laura (pop. 30) lies a short distance to the southeast of the map area and Weipa (pop. 750), a bauxite-mining centre, on the west coast. In the Iron Range/Portland Roads

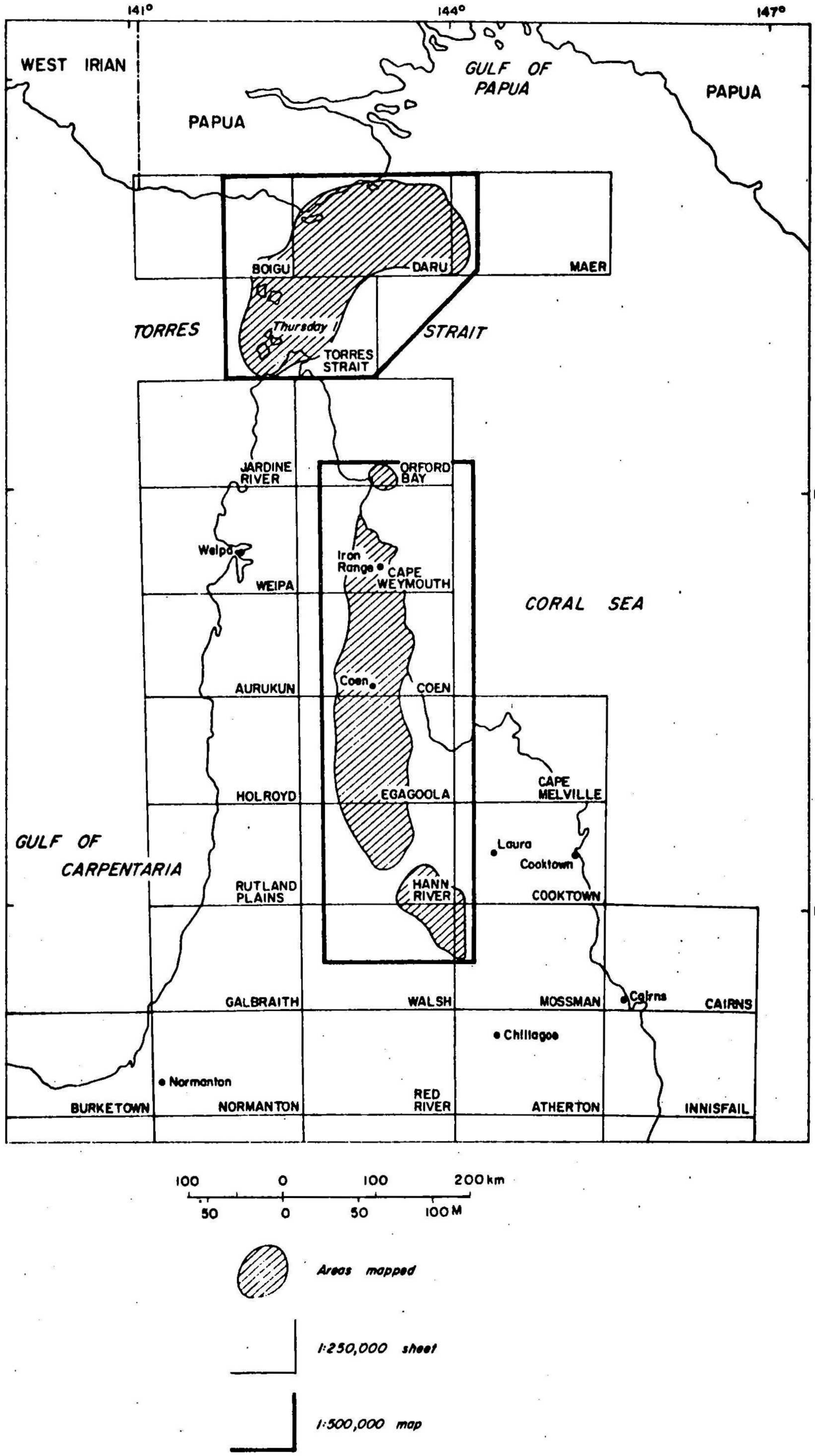


Fig 1 Locality map and sheet index.

district a number of people are settled on small holdings, and 200 to 300 Aborigines live in the nearby Lockhart River Community.

The islands of Torres Strait are inhabited by several thousand Torres Strait Islanders who live on Thursday Island (pop. 3000), the main centre of population, and in small villages on the outlying islands. At Bamaga, 25 km south of Cape York, a large Government community has been established to re-settle mainland Aborigines and Islanders from some of the less productive islands. Daru, an island off the southern coast of Papua, is the centre of administration for the Western District of Papua. The main industries in Torres Strait are pearl culture, and prawn fishing and processing.

Access and communications

In the past access to the peninsula has been particularly difficult, and even now few roads and tracks exist (Fig. 2). Most are suitable for four-wheel-drive vehicles only, and all are impassable during the wet season. The main access route is the Kennedy Road, or Peninsula Development Road, a partly formed and gravelled road connecting Coen and Laura with the unsealed Mulligan Highway between Cooktown and Cairns. The far southwest of the area west of Mount Mulgrave homestead is most conveniently approached by a well formed road from Chillagoe. North of Coen the Kennedy Road continues as a rough track to Portland Roads and Iron Range, but it is frequently washed out during the wet season. From the Kennedy Road north of the Archer River, a track branches off to Weipa on the west coast, and a very rough track continues northwards along the telegraph line as far as Cape York, although it is usually impassable at the ford on the Jardine River.

In the south, tracks to station homesteads branch east and west from the main road, but north of Coen few other tracks exist, particularly in the ranges between Coen and Iron Range. Two little-used and overgrown routes branch off the main road near Coen airport and lead eastwards into the ranges to the old mining areas at Leo Creek and at Buthen Buthen 75 km north-east of Coen; a very poorly defined route also connects Buthen Buthen with the track linking Iron Range and the old Lockhart River Community. A number of roads shown on the topographic map north of Iron Range were constructed by the Broken Hill Pty Co. Ltd in 1957-60, and are now largely overgrown.

A regular shipping service operates between Cairns, Portland Roads, and Thursday Island, and small government vessels service the outer islands of Torres Strait at irregular intervals. Scheduled air services call at Coen, Iron Range, Weipa, and Thursday Island, and smaller aircraft service a number of cattle stations. Daru is connected both by sea and air to Port Moresby. The telegraph line provides a reliable link between Thursday Island, Coen, and Cairns, but most of the other settlements and stations rely on radio networks based on Cairns or Thursday Island.

The majority of the Torres Strait Islands, a part of the mainland south of Cape York, and a large area in the Pascoe River/Lockhart River district are Aboriginal Reserves under the administration of the Queensland Department of Aboriginal and Island Affairs, locally based on Thursday Island.

To carry out this survey Land Rovers were used wherever possible, but even in the south the forest is dense enough to hinder overland travel considerably, and most streams are incised and difficult to negotiate. The ranges between Coen and Iron Range were mapped by 2-man parties working on foot or on horseback for 2 to 5 days, supported by Land Rover or by helicopter. An inflatable dinghy was used for a traverse down the Pascoe River. The Torres Strait islands and the coast of the Peninsula were mapped from a 13½-m launch, the M.V. Sapphire, on charter from Cairns.

Acknowledgements

We wish to acknowledge the great assistance provided by the Broken Hill Pty Co. Ltd and Australian Aquitaine Petroleum in freely supplying geological information on the Iron Range district. C.D. Branch formerly of the Bureau of Mineral Resources helped to elucidate the structure of the Janet Ranges Volcanics near Iron Range. Throughout the survey invaluable help was received from the inhabitants of Cape York Peninsula and Torres Strait and from the Department of Aboriginal and Island Affairs, Thursday Island. Mr A. La Cava of the M.V. Sapphire contributed greatly to the success of the mapping in Torres Strait.

History and previous investigations

European exploration of Cape York Peninsula began early in the 17th century with visits by Spanish and Dutch vessels to the west coast and Torres Strait. The first recorded passage of the Strait was made by Torres in 1606, but it was not until Cook's voyage of 1770 up the east coast of Australia that its existence was finally publicised.

In the period between 1790 and 1850 merchant ships began using Torres Strait and navigating the east coast of Cape York Peninsula; many vessels were wrecked on the treacherous reefs. Bligh (in 1789 and 1792) was one of the more famous early navigators. The first detailed survey of the shipping channels was made by Flinders in 1802; subsequent surveys were carried out by HMS Beagle (1839, 1841), HMS Fly (1843-5), and HMS Rattlesnake (1850-52).

Overland exploration began in 1848 with Kennedy's ill-fated expedition up the east coast of the peninsula (Jack, 1922). The western side was first traversed in 1864-5 by the Jardine brothers, who drove cattle to the newly established Queensland Government settlement of Somerset, which provided refuge for shipping passing through Torres Strait. This settlement was later moved to Thursday Island in 1877.

The subsequent history of settlement of the peninsula was closely linked with the discovery of a number of small goldfields, the development of the cattle industry and, in Torres Strait, with the rise of the pearl shell industry. The isolation of the region prohibited pastoral development and it has remained sparsely settled to the present day. A resurgence of gold mining in the 1930's at Wenlock and near Iron Range was terminated by the second World War and did not revive afterwards. The war itself saw much military activity at Iron Range and in Torres Strait, but a few airstrips are all that now remain. Since the war the pearl shell industry in Torres Strait has declined and many Islanders have moved south. The most significant developments of recent years are the construction of a gravel road as far north as Coen, the large scale re-development of cattle properties by southern and overseas capital, and the discovery and exploitation of the bauxite deposits at Weipa on the west coast.

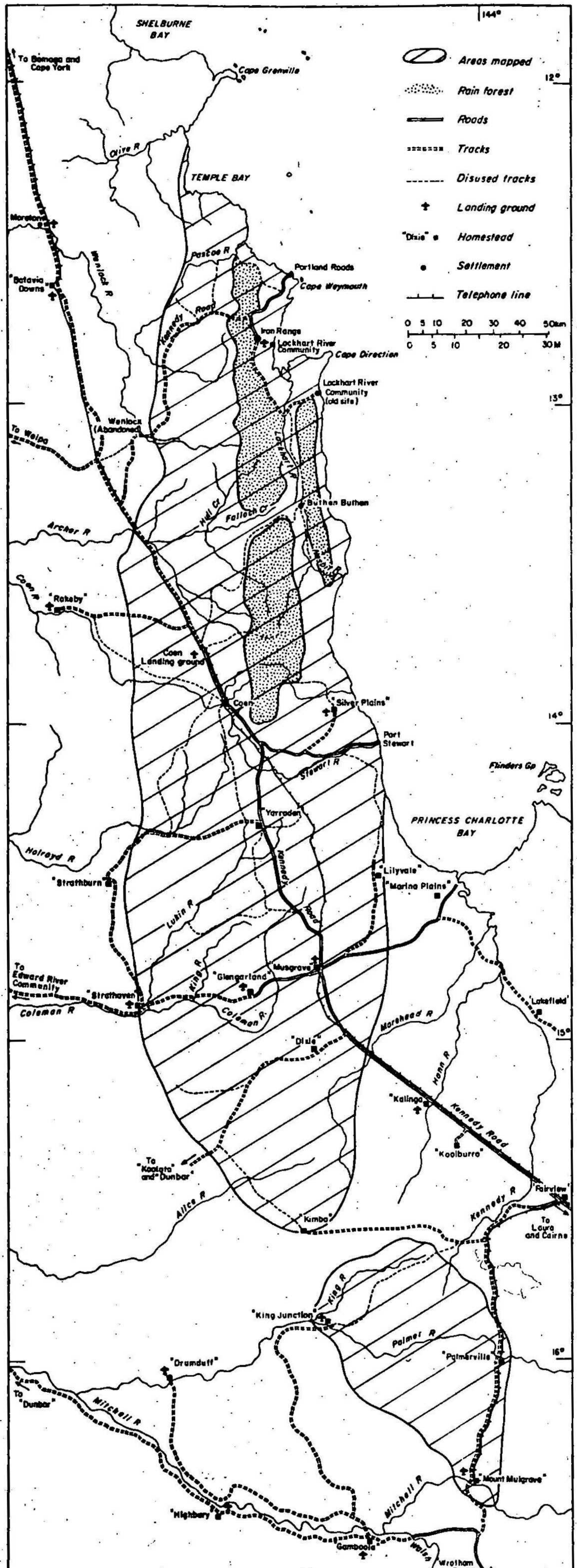


Fig.2. Access to areas mapped in Cape York Peninsula

The first geological observations in the area were made by Wickham, on board HMS Beagle (Stokes, 1846), and by Jukes (1847), on HMS Fly. Jukes noted the rocks of the coastline, and in Torres Strait he described the basic volcanics of Darnley Island and the Murray Islands in some detail, and mentioned the granitic rocks of the western islands. Further observations were made in Torres Strait by MacGillivray (1852) and Maitland (1892). A comprehensive report on the geology of Torres Strait by Haddon, Sollas, & Cole (1894) gives an excellent description of the volcanic rocks forming Stephens, Darnley, and the Murray Islands.

The first inland geological observations were made in the area to the south of Coen by Taylor, a member of Hann's 1872 expedition to northern Queensland (Hann, 1873a,b). This expedition was the first to record gold in the Palmer River, a few miles downstream from the present site of Palmerville homestead. Mulligan made similar observations of gold in 1873 (Jack, 1922), and the rush to the Palmer goldfield followed (Holthouse, 1967).

Alluvial gold was discovered at Coen in 1876, and in 1879-80 Jack (1881, 1922) visited the area for the Queensland Government. He made extensive geological observations in the course of two prospecting expeditions which covered the area from the head of the Kennedy River in the south to Somerset in the north. He noted and examined for gold many quartz reefs and patches of alluvial material. Jack also visited the Palmer River in 1887 (Jack, 1888). The history of European exploration of Cape York Peninsula, and of the early geological and mining activities in the area, are excellently summarized in Jack's 'Northmost Australia' (1922).

Most other early investigations were also concerned primarily with the search for gold. One of the most active prospectors in the region was John Dickie who discovered gold at Ebagoola (Hamilton goldfield) in 1900 (Dickie, 1900). Ball (1901) mapped the geology at Ebagoola and recognized two distinct phases of granite in the area. Dickie also reported gold in the upper Coleman River (Dickie, 1900), between the King and the Kennedy Rivers, northwest of Palmerville (Dickie, 1901), and on the Alice River (Dickie, 1909). Reef mining began at Coen in about 1892; the Great Northern mine was the largest producer and operated for several years.

Alluvial gold was discovered in the Rocky River, northeast of Coen in 1893 (Jack, 1922), and reef mining began there in 1896. Gold mining began to the north at Hayes Creek(Fig. 11) in 1909 (Shepherd, 1938) although gold was reported from this area as early as in 1880 (Jack, 1922). The alluvial gold of the Wenlock area was first worked in 1892 (Morton, 1930) and the field was rushed following larger discoveries in 1910; the Main Leader was not located until 1922 (Fisher, 1966). Also in 1892, wolfram was discovered northeast of Wenlock by Bowden, but mining did not begin until 1904 (Morton, 1924). A geological sketch map of the Cape York gold and mineral fields was published in 1911 (Greenfield, 1911). In Torres Strait gold was discovered on Horn Island in 1894, and on Possession Island in 1896 (Rands, 1896; Jackson, 1902, 1903).

Later, more general reports on the geology of the region were given by Jensen (1923) and Richards & Hedley (1925). Morton (1924) described the Pascoe River district near Iron Range, and Jardine (1928a,b) mapped the basic volcanics of Bramble Cay and Darnley Island in the northeast of Torres Strait. The discovery of gold in the Claudie River area near Iron Range in 1933 was reported by Shepherd (1939). Wolfram mines on Moa Island in Torres Strait, first worked by Islanders before and during the second World War, were described by Shepherd (1944), Andersen (1944) and Jones (1951a). The Aerial, Geological, and Geophysical Survey of Northern Australia (AGGSNA) investigated the gold of the Claudie River area and the Palmer River prior to the second World War (Broadhurst & Rayner, 1937; Rayner, 1937; Jensen, 1940 a,b).

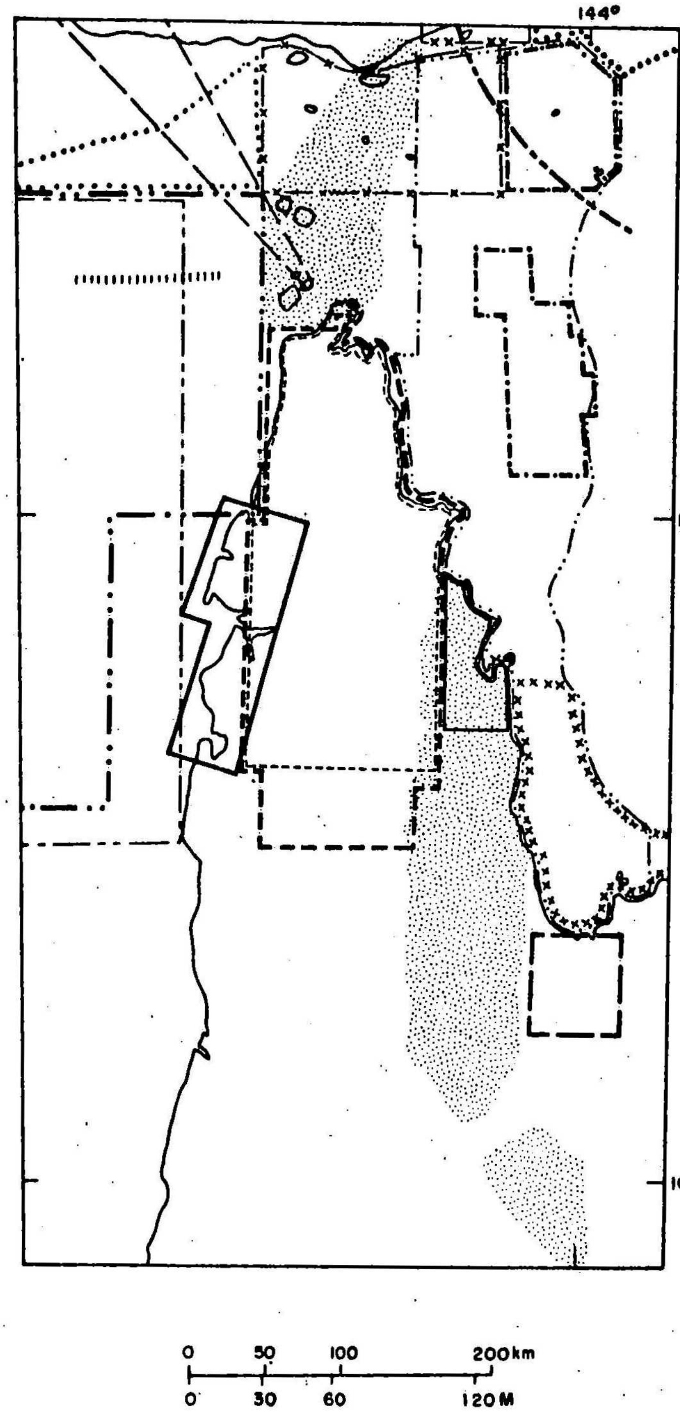
Since the war Jones & Jones (1956) have reported on the igneous rocks in the western part of Torres Strait, and summaries of the geology of the region have been given by Bryan & Jones (1946), David (1950), Hill (1956), Hill & Denmead (1960), and Jensen (1964). The Broken Hill Pty Co. investigated in detail iron ore deposits at Iron Range (BHP, 1962; Canavan, 1965 a,b), and Australian Aquitaine Petroleum mapped Upper Palaeozoic sediments between the Archer River and Cape York (AAP, 1965, 1967). Small alluvial and lode tin deposits discovered near Cape York in 1949 have been investigated by a number of mining companies. Many other reports and inspections of mineral prospects and mines were made by officers of the Geological Survey of Queensland, AGGSNA, and mining companies.

The three 1:250,000 Sheet areas southeast of the area described in this Bulletin were mapped between 1960 and 1963 (Amos & de Keyser, 1964; Lucas & de Keyser, 1965, a,b) by combined parties of the Bureau of Mineral Resources and the Geological Survey of Queensland. This work has been summarized in de Keyser & Lucas (1969) and Branch (1966). De Keyser (1963) described the Palmerville Fault and its possible extension to the north along the western shore of Princess Charlotte Bay. The isotopic age of a sample of granodiorite from near Musgrave homestead was published by Richards et al. (1966).

In recent years the surrounding Mesozoic sediments of the Laura, Carpentaria, and Papuan Basins have been investigated during the search for petroleum (Lucas & de Keyser, 1965b, Meyers, 1969, Australasian Petroleum Company Proprietary 1961, and Stach, 1964). Geophysical surveys carried out in the region are shown in Figure 3. In addition to these, the whole area shown in Figure 3 has been covered by a reconnaissance aeromagnetic survey carried out by Frome-Broken Hill (1955) and by reconnaissance gravity surveys directed by the Bureau of Mineral Resources (Shirley, in prep; Goodspeed & Williams, 1959). Two petroleum exploration wells have been drilled: Marina Plains No. 1, 15 km south of the mouth of the Kennedy River (Minad, 1965) and Anchor Cay No. 1, 30 km northeast of Darnley Island (Oppel, 1969); both were dry holes.

PHYSIOGRAPHY

The principal features of the physiography are named and illustrated in Figure 4. Cape York Peninsula consists of a north-trending axis of high ranges and plateaux, flanked on either side by plains developed on the flat-lying sediments of the Carpentaria and Laura Basins. The axis is situated towards the eastern side of the peninsula, and continues below the sea at Temple Bay. It is composed predominantly of pre-Mesozoic igneous and metamorphic rocks, although high plateaux of Mesozoic sediments form part of the axis in the north. The axis is relatively low in the south, but rises to a maximum height of 800 m east of Coen before sloping down to about 300 m north of Iron Range.



———	Reconnaisance gravity	F-BH (1957)		Aeromagnetic, seismic	Gulf (1962) (1965)
———	Aeromagnetic	Hopkins Reid (1957)	—·-·—	Magnetic and seismic	Tenneco (1967)
— —	Reconnaisance aeromagnetic	Delhi (1962)	—·—·—	Seismic	Tenneco (1968)
— —	Seismic	Marathon (1963)	......	Seismic	Phillips (1965, 1968)
-------	Aeromagnetic	A A P (1964)	—x—	Seismic	Amoseas (1968)
▪ — —	Seismic and gravity	C.G.G. (1965)	—xx—	Aeromagnetic	Amoseas (1969)
IIIIIIIII	Seismic	Marathon (1965 a)	xxxxx	Aeromagnetic	Corbett Reef (1969)
....	Seismic	Marathon (1965 b)	— - - —	Aeromagnetic	C.G.G (1969)
—·—	Aeromagnetic	Marathon (1965 c)			
- - - -	Seismic	Marathon (1966)	(stipple)	Mapped area	

Fig 3 Location of geophysical surveys

The islands in the western part of Torres Strait are the peaks of a drowned ridge, formed by pre-Mesozoic igneous rocks, extending from Cape York to the Papuan coastline. The ridge lies to the west of the northern continuation of the main axis of the peninsula, and is separated from it by Mesozoic sediments. Several of the islands in the northeastern part of Torres Strait have been built up by Quaternary volcanic activity.

The axis

The southernmost part of the main axis of the peninsula occupies the area between the Palmer and Mitchell Rivers, and is referred to here as the Yambo Inlier. It is formed by gently undulating hills of granitic and less resistant metamorphic rocks, with some rugged ridges of quartzite. This gently undulating country was termed the Mulgrave Plains (Fig. 4) by Amos & de Keyser (1964). On their eastern side the plains are separated abruptly by the Palmerville Fault from folded Palaeozoic sediments forming the rugged Palmer-Hodgkinson Uplands, named by Amos & de Keyser. The western and southern limits of the Mulgrave Plains are indistinct and merge into the plains of the Carpentaria Basin.

The Yambo Inlier is separated from the main belt of igneous and metamorphic rocks to the north, named here the Peninsula Ridge, by a remarkably flat plateau of Mesozoic sediments which form a connexion between the Laura and Carpentaria Basins. This plateau is referred to by de Keyser & Lucas (1969) as the western margin of the Deighton Tableland. On topographic maps the plateau is named The Desert, because it lacks surface water, although it is capped by rich red soil supporting a thick cover of tall trees. The plateau is dissected along its eastern and southern edges, but merges southwestwards with the plains of the Carpentaria Basin.

North of The Desert the Coleman Plateau, a very large sand-covered plateau developed mainly on granitic rocks, extends from the head-waters of the Morehead River 130 km northwards to the Stewart River. It is less than 120 m high in the south, but rises to about 220 m near Coen. De Keyser & Lucas include this plateau in the Coleman Peneplain and state that it extends westward to the Gulf of Carpentaria. However, west of the belt of basement rocks several erosion surfaces are developed at various heights on the Mesozoic and Cainozoic sediments, and until these are better known they should be referred to collectively as the Western Plains, or as the northern continuation of the Carpentaria Plains of Twidale (1966). We have therefore amended the name Coleman Peneplain to Coleman Plateau and we restrict it to the plateau formed on the basement rocks of the axis of the peninsula.

The eastern edge of the plateau is an abrupt scarp, rising steeply from the plains developed on the Laura Basin. The surface of the plateau falls gently southwestwards to low undulating country which merges into the Western Plains. De Keyser & Lucas state that the plateau merges in the south into the western part of the Deighton Tableland, or The Desert, but in fact it is distinctly lower than The Desert. A number of elongate ridges of resistant metamorphic rocks rise a few hundred metres above the plateau, and fringe it in places on its eastern margin.

East and north of the town of Coen, the McIlwraith Plateau, another very extensive plateau developed on granitic rocks, extends almost to the northern margin of the Coen Sheet area; it is generally over 300 m high. East of Coen it is stepped up to a surface generally between 450 and 550 m above sea level, and from this surface hills rise gently to a broad central summit about 700 m, on which the highest knoll reaches 800 m. South of Coen the McIlwraith Plateau is considerably higher than the Coleman Plateau and the junction between the two is abrupt and dissected. On the east the McIlwraith Plateau is bounded by a steep escarpment, which falls to the northern continuation of the plains of the Laura Basin, and to the broad valleys of Lockhart and Nesbit Rivers. Unlike the Coleman Plateau, it does not slope gradually westward, but is bounded on the west side also by a scarp which falls to the headwaters of the Archer River. Isolated flat-topped mountains such as Birthday Mountain and Bald Hill are probably remnants separated from the main plateau by erosion.

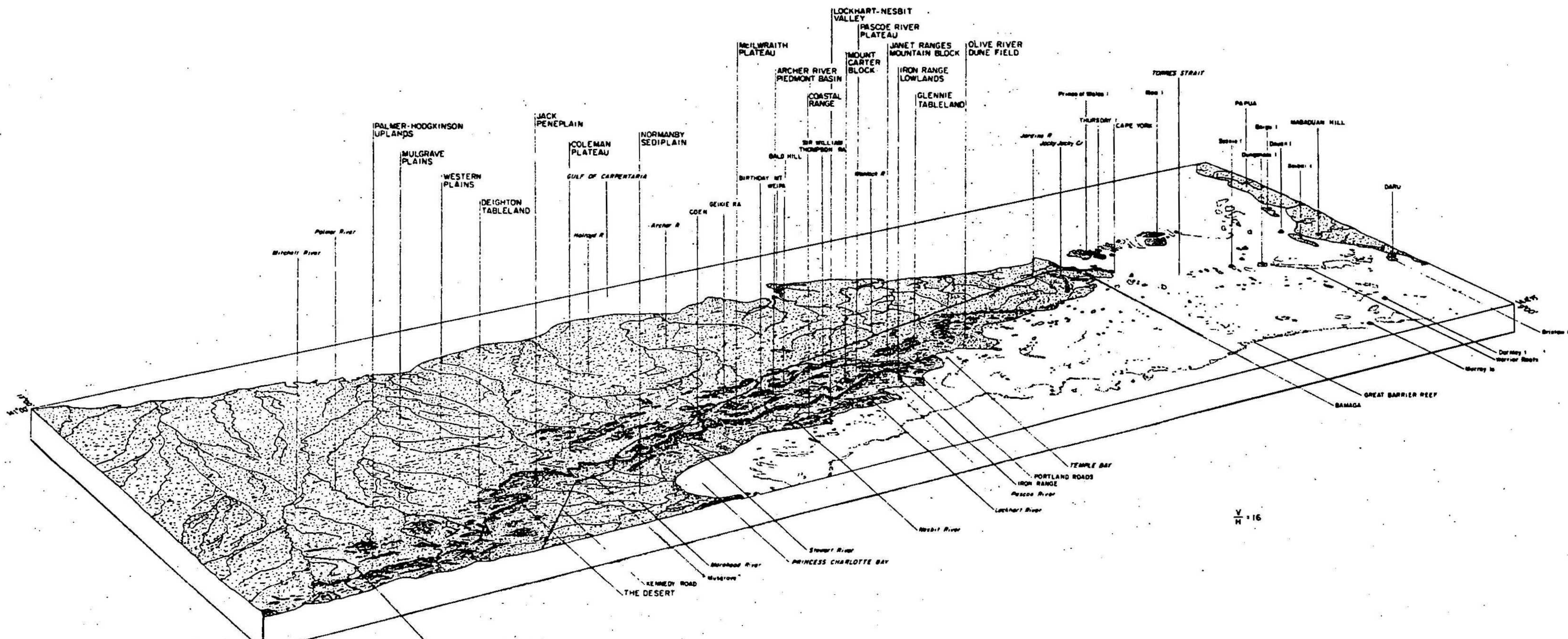
The McIlwraith Plateau is close to the coast and receives a high rainfall; in the south it is covered with rain forest but to the north this is interspersed with patches of open forest and grassland. The major creeks are perennial and have cut deep gorges into both the western and eastern escarpments.

North of Coen the headwaters of the Archer River have cut back into the McIlwraith Plateau to produce the Archer River Piedmont Basin. Material derived from the erosion of the plateau has been deposited over the floor of the basin as poorly consolidated sandstone and conglomerate. The northern part of the basin merges into low undulating country which rises gradually northwards to reach the level of the northern part of the McIlwraith Plateau.

The eastern escarpment of the McIlwraith Plateau falls to the Lockhart-Nesbit Valley, a well watered broad northerly trending corridor which has probably formed along a fault zone. The headwaters of the Lockhart and Nesbit Rivers are separated only by a low saddle. Thick deposits of poorly consolidated sandstone derived from the plateau to the west cover much of the valley, but in its northern half this is overlain by alluvium on which treeless grassy flats are developed. The northern end of the valley has been drowned and mangrove swamps extend several kilometres inland along it from the coast.

The Lockhart-Nesbit Valley separates the McIlwraith Plateau from the Coastal Range, which is in fact a number of high ranges linked by low saddles. They average 380 m in height and are clothed by thick rain forest with some grassy expanses. A narrow coastal plain runs from the ranges to the sea.

At the northern margin of the McIlwraith Plateau, resistant metamorphic rocks form the Mount Carter Block, which is over 600 m high, and rises well above the surface of the plateau. Creeks flowing off the block have cut deep gorges which are clothed by rain forest; the ridges between them are covered by thick heath-type vegetation. North of Mount Carter, a third large plateau developed on granitic rocks, the Pascoe River Plateau, extends as far north as Mount Tozer at approximately the same elevation as the northern end of the McIlwraith Plateau. The plateau is saucer-shaped, with a rim and escarpment around most of the margin and a flat sandy depression in the centre. The Pascoe River rises in the north-east and flows across to the western escarpment, which it has cut through.



To accompany Record 1971/94

Fig. 4. Physiographic diagram

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The eastern escarpment receives a high rainfall and is covered by thick rain forest; the western part of the plateau supports open eucalypt forest.

The Janet Ranges Mountain Block extends northwards from the northern margin of the Pascoe River Plateau to Temple Bay; it is formed by a jumbled mass of steep peaks up to 500 m high, separated by broad alluviated valleys. The poor soil developed on the acid volcanic rocks forming the mountains supports open heath-type vegetation known locally as turkey bush, which in many areas is only ankle high. West of the mountains the broad valley of the Pascoe River is largely floored by poorly consolidated Cainozoic sediments forming remarkably flat elevated plains covered by turkey bush. Where creeks have eroded the sediments, steep small escarpments or breakaways have developed.

On their eastern margin, the Pascoe River Plateau and the Janet Ranges Mountain Block are separated by a steep escarpment from the Iron Range Lowlands. The lowlands are largely covered by dense rain forest and extend northwards from the mount of the Lockhart River, where they are developed on Quaternary sediments, to Iron Range and Weymouth Bay where they are formed by strike ridges, up to 150 m high, of low-grade metamorphic rocks. Some hills of granite, such as the 400 m high Round Back Hills, and of iron-bearing schist rise above their general surface.

Northwards from Coen, the eastern edge of the Mesozoic sediments of the Carpentaria Basin is exposed as an escarpment which forms the Geikie Range, hills near Bald Hill, and part of the Sir William Thompson Range. Farther north, the eastern boundary of the sediments is more subdued but a high dissected tableland, the Glennie Tableland, about 200 m high, is developed in the north around Glennie Hill; it is covered by a hard lateritic surface supporting eucalypt forest and scrub. From this tableland and the escarpments of the Sir William Thompson and Geikie Ranges, the surface of the Mesozoic sediments slopes gently westward merging with the Western Plains.

The ranges and plateaux of the axis of Cape York Peninsula form the watershed of the Great Dividing Range. Streams on the east rise close behind the eastern escarpment and fall steeply to the coast. The western streams also rise near the eastern escarpment and fall gently to the west, except in the southern part of the McIlwraith Plateau where they have cut gorges into its western escarpment. On the Coleman Plateau the western streams follow the southward strike of the metamorphic rocks before coalescing into large rivers which cut across the strike to flow towards the Gulf of Carpentaria. The headwaters of some of the western rivers have been captured by more active easterly flowing streams; for example the Stewart River has captured the headwaters of the Holroyd River, and the headwaters of the Pascoe River may have originally continued westward to join the Wenlock River.

Plains of the Laura Basin

The plains on flat-lying Mesozoic and Cainozoic sediments of the Laura Basin have been divided into the Jack Peneplain and the Normanby Sediplain by de Keyser & Lucas (1969). The Normanby Sediplain is a floodplain which extends for up to 80 km inland from marine deposits bordering Princess Charlotte Bay, and for another 50 km as narrow strips along stream valleys. It extends north beyond the Chester River, where it merges into the southern part of the Lockhart-Nesbit Valley. The streams crossing the plain are braided for the greater part of their length, but change to a meandering form on reaching the strip of marine deposits flanking the coast. In this strip, beach ridges extend up to 15 km inland in some places, and indicate an emergence of about 3 m. Galloway et al. (1970) state that there is little evidence around the coastline that sea-level was ever more than about 5 m above its present height during the Pleistocene.

The Jack Peneplain consists of sand-covered and well vegetated interfluves separated by shallow stream valleys that broaden outwards onto the Normanby Sediplain. The interfluves are generally covered by loose residual sand which is probably derived from poorly consolidated Cainozoic sandstone and conglomerate. However, many low rises which trend northwards between the Morehead and Nesbit Rivers, and which are commonly covered by rich red soil carrying tall trees, are probably underlain at little depth by Mesozoic sediments or soft metamorphic rocks. The Jack Peneplain slopes up to the escarpment of the Deighton Tableland and the Coleman and McIlwraith Plateaux. The younger deposits of the Normanby Sediplain are probably encroaching on the Jack Peneplain. De Keyser & Lucas (1969) consider that the peneplain may have the same age as the surface of the Coleman Plateau; but we believe it to be considerably younger for reasons given below.

Plains of the Carpentaria Basin

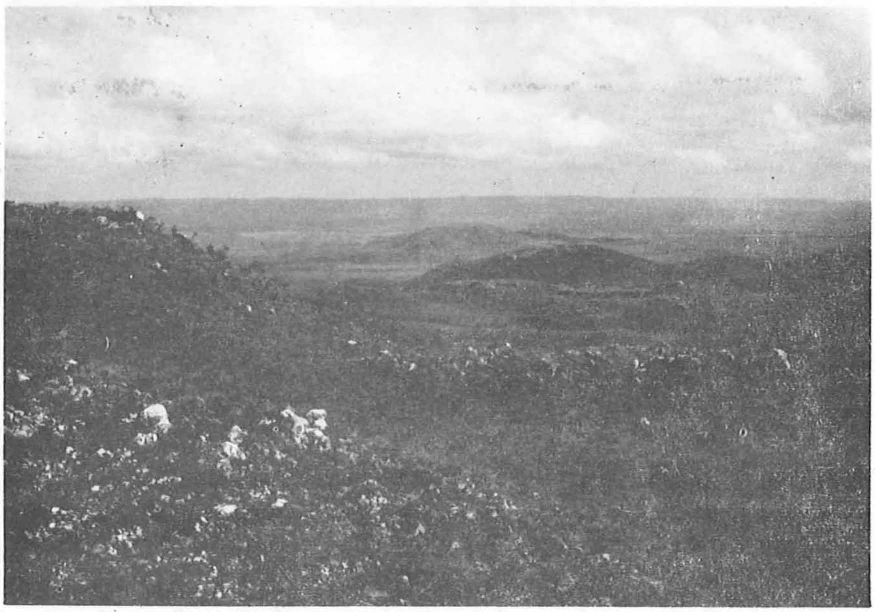
West of the axis of the peninsula the low plains on the Mesozoic and Cainozoic sediments extend westward to the Gulf of Carpentaria. To the south of the Mitchell River they have been named the Carpentaria Plains by Twidale (1966), but as they are little known farther north we do not extend the name and refer to them as the Western Plains, following Galloway et al. (1970). Near their eastern margin the plains are gently undulating and support relatively sparse open forest; some low mesas of sandstone rise from them. Between Coen and Temple Bay the plains are higher, sloping up to the escarpment of the Geikie and Sir William Thompson Ranges, and the Glennie Tableland.

The Olive River Dune Field north of Temple Bay has been developed on Mesozoic sandstones. The field consists of large longitudinal sand dunes trending northwest; they average 30 m in height but range up to 100 m. Many of the dunes are still advancing to the northwest under the influence of the prevailing southeasterly winds. Others have been stabilized by thick low bush. The dunes are composed of reworked sand derived from the underlying sandstones.

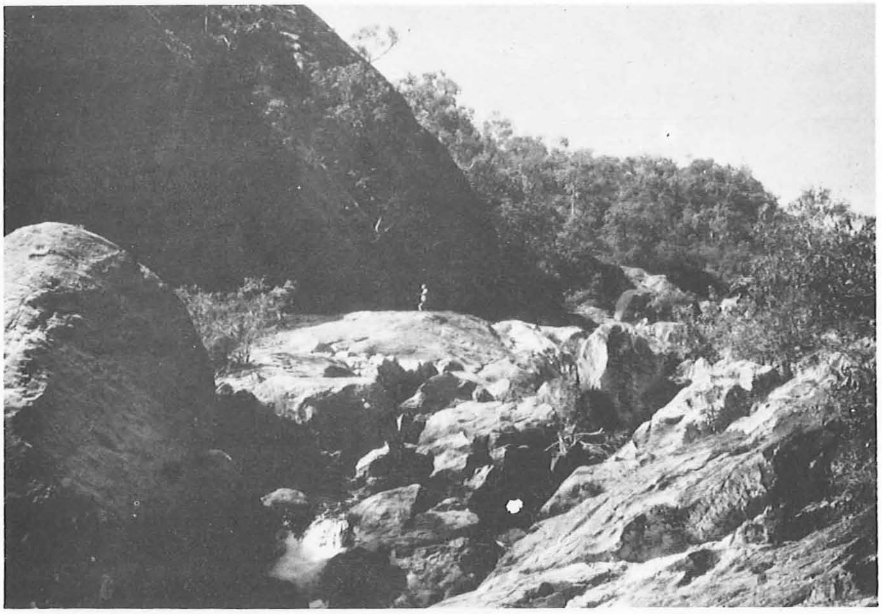
Torres Strait

The islands of Torres Strait have been divided into three physiographic types: the western rocky islands, the central and eastern sand cays, and the eastern volcanic islands. The western rocky islands are high rocky islands which extend in a north-trending belt from the coast of Cape York Peninsula to Dauan Island and Mabaduan Hill on the Papuan coast. They are generally over 100 m high and some have peaks which are much higher, such as Moa Island (400 m) Dauan Island (220 m) and Prince of Wales Island (250 m). In the interior, of the larger islands broad ranges are separated by sand-covered plains and valleys. The vegetation is generally open eucalypt forest but on the high peaks of Moa Island there are patches of rain forest. The depth of water between the islands is rarely greater than 10 m.

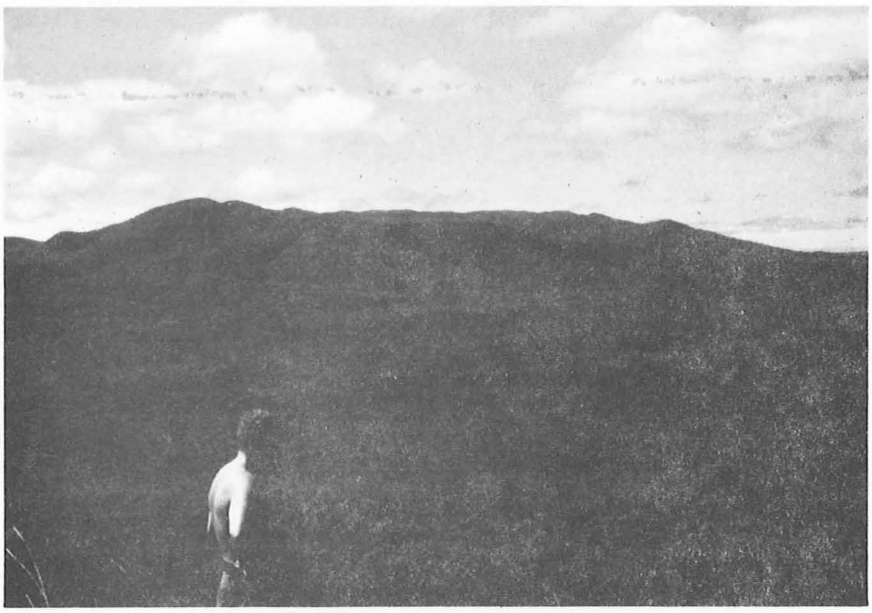
Pl. 1, fig. 1 Thursday Island



Pl. 1, fig. 2 Acid volcanics forming Janet Ranges



Pl. 2, fig. 1 Gorge in Kintore Adamellite forming McIlwraith Range.



Pl. 2, fig. 2 Sefton Metamorphics of Mount Carter Block rise above Pascoe River Plateau (Weymouth Granite)

The central and eastern sand cays between the western rocky islands and the Great Barrier Reef are composed of coral sand and debris which have accumulated on coral reefs of the platform type. The larger cays carry coarse grass, low thorn scrub, and groves of coconut palms. The central parts of Long and Dungeness Islands are low and swampy.

The eastern volcanic islands comprise five high islands in northeastern Torres Strait, near the northern end of the Great Barrier Reef. They are formed by Pleistocene basalt and tuff, and are the most fertile islands in Torres Strait, supporting thick grass, stunted tropical scrub, vegetable gardens, and many coconut groves. The Murray Islands consist of three well preserved volcanic cores.

The mainland of Cape York Peninsula immediately south of Torres Strait consists of undulating uplands on Mesozoic sediments. In the north the upland surface is about 100 m above sea level; it dips gently to the south and southeast, and is only about 30 m high near Bamaga. In the north and northwest the margin of the upland has been dissected, and gives way to rounded hills of acid volcanic rocks which underlie the sediments. South of Bamaga the country is very low; extensive freshwater swamps have developed near the mouth of the Jardine River, and mangrove swamps have formed in the estuaries on the south side of Newcastle Bay.

In southwest Papua immediately north of Torres Strait there is very little relief, and the coastal plains, swamps, and stream valleys extend for many kilometres inland to the Oriomo Plateau of Blake & Ollier (1970) which rarely exceeds 50 m in height. The swampy Boigu, Saibai, and Bristow Islands are similar to the coastal plain.

Development of physiography

Three large plateaux of granitic rocks extend northwards for 350 km from the headwaters of the Morehead River to Iron Range. We consider the plateau surfaces to be part of a modified peneplain on which the Mesozoic sediments of the Carpentaria Basin were also deposited. At the southern margin of the Coleman Plateau the peneplain is overlain by the Mesozoic sediments of The Desert; in the north of the Coen Sheet area at Bald Hill, Mesozoic sediments lie, at an elevation of about 350 m, on a surface that is probably a dissected remnant of the McIlwraith Plateau. Farther north several small outliers of Mesozoic sediments are perched on the western margin of the Pascoe River Plateau at an elevation of about 220 m, the average height of the plateau. The elevation of the base of the Mesozoic sediments in these three areas roughly corresponds with the elevation of the plateaux farther east. Twidale (1966) has pointed out that 'at the margins of the (Carpentaria) Plains there is evidence that the early Mesozoic erosion surface, upon which the basin sediments that underlie the plains were deposited, has been exhumed to form part of the present land surface'. The Mesozoic sediments did not necessarily cover the whole axis, although there was probably a wider connexion between the Laura Basin and the Carpentaria Basin than remains at present.

The present elevation of the plateaux is probably in part the result of Tertiary uplift of the eastern side of the peninsula along the northern continuation of the Palmerville Fault. In the south, de Keyser (1963) describes mid-Tertiary uplift or the eastern side of the Palmerville Fault between the Palmer and Mitchell Rivers. We believe that the movement was scissor-like, with the eastern block tilted down to the north and the western block tilted down to the south. The greatest uplift on the western side was near Coen; movement along subsidiary faults may have produced the difference in height between the McIlwraith and Coleman Plateaux, and faulting probably also took place along the Lockhart and Nesbit Valleys. Some direct evidence for post-Cretaceous uplift of the eastern part of Cape York Peninsula is provided in the north-central part of the Coen Sheet area, where the base of the Mesozoic sediments is over 350 m above sea level, and where a number of north-trending faults upthrown on the east cut the sediments; a fault also defines the western edge of the flat-topped Birthday Mountain.

Following the uplift, a prominent erosional escarpment was formed along the eastern margin of the plateaux. On the surface of the plateaux gentle westerly flowing streams stripped the Mesozoic covers from the peneplain on the basement rocks. On the southwestern side of the McIlwraith Plateau an escarpment was formed, possibly as a result of uplift along subsidiary faults. Poorly consolidated sediments derived from the erosion of the escarpments were laid down in the Archer River Piedmont Basin, the Lockhart-Nesbit Valley and the Laura Basin west and south of Princess Charlotte Bay. The level surface of the Jack Peneplain was formed on these deposits and on some older rocks, but it was subsequently dissected by streams and encroached upon by the Normanby Sediplain.

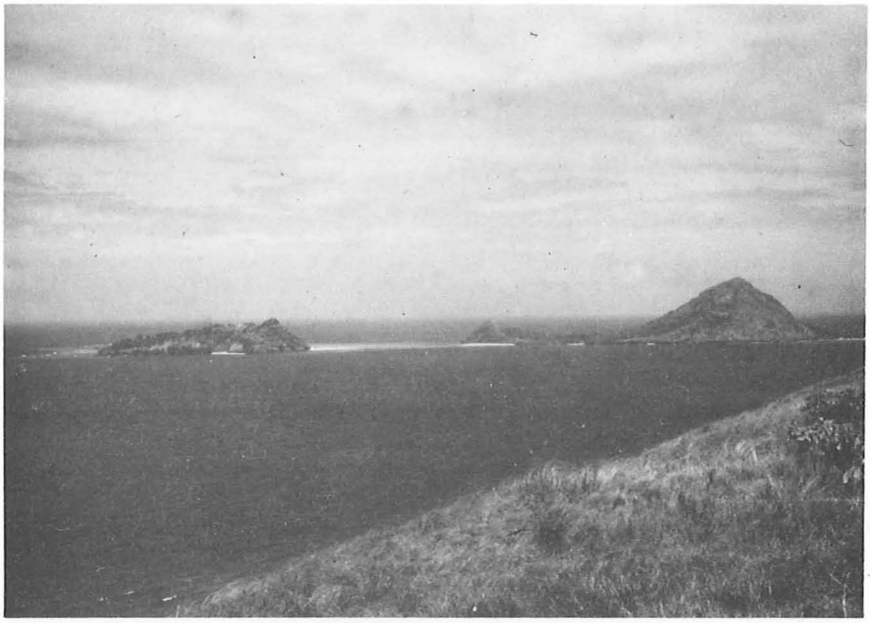
North of Iron Range, Cape York Peninsula appears to have been tilted down to the north, as the ranges forming the axis disappear beneath the sea, the base of the Mesozoic sediments is below sea level, and the mouths of streams such as the Lockhart and Kangaroo Rivers and Jacky Jacky Creek have been drowned. This northward tilting may have been initiated with the other Tertiary movements, but it has probably continued into the Quaternary and has resulted in the formation of the present sea-way of Torres Strait across the very shallow basement ridge.

OUTLINE OF GEOLOGY

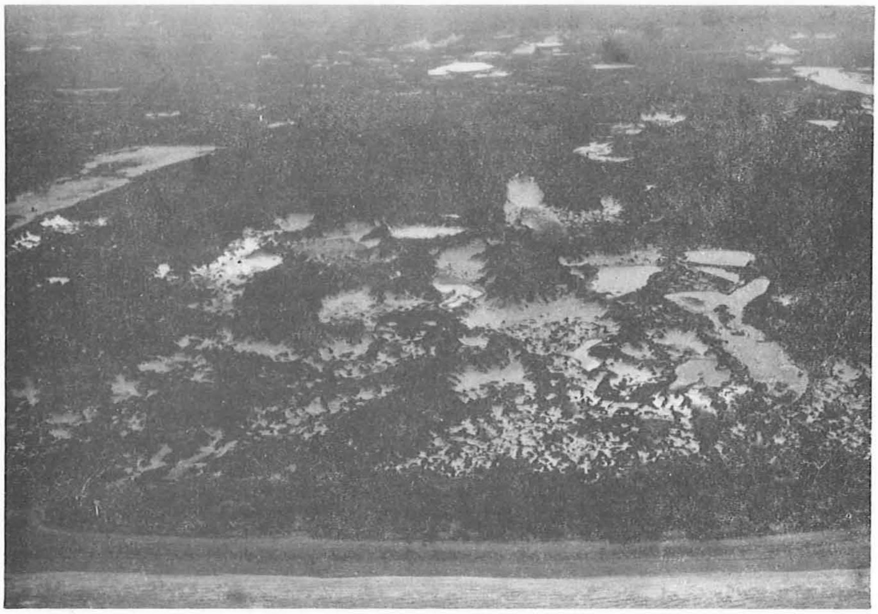
Introduction

Cape York Peninsula is formed of a stable shield of Precambrian metamorphic and granitic rocks, overlain by gently dipping Mesozoic and Cainozoic sediments of the Carpentaria, Laura, and Papuan Basins. The Precambrian rocks crop out in the east as the Peninsula Ridge and Yambo Inlier (Fig. 5) and continue south beneath the Mesozoic sediments to the Chillagoe area on the northern margin of the Georgetown Inlier (de Keyser & Lucas, 1969; White, 1965). In the southeast the Precambrian shield is separated from folded Palaeozoic sediments of the Hodgkinson Basin by the Palmerville Fault, a fundamental structure several hundred kilometres long. Both the Precambrian shield and the Hodgkinson Basin have been intruded by Upper Palaeozoic granitic rocks and associated acid volcanics, and similar rocks formed a pre-Mesozoic ridge across Torres Strait.

The Precambrian metamorphic rocks of the Yambo Inlier and Peninsula Ridge crop out discontinuously for over 450 km from the Mitchell River in the south to Temple Bay in the north. They appear to have originally formed a continuous sequence of regionally metamorphosed sediments, which have been intruded and disrupted by granitic rocks mainly of Precambrian(?) age. The different areas of metamorphics have been named the Dargalong Metamorphics, Coen Metamorphics, Holroyd Metamorphics, and Sefton Metamorphics, mainly on the basis of geographical location, and to a certain extent on lithology.



Pl. 3, fig. 1   Two eroded volcanic cones in Murray Islands



Pl. 3, fig. 2   Silica sand, Olive River dune field

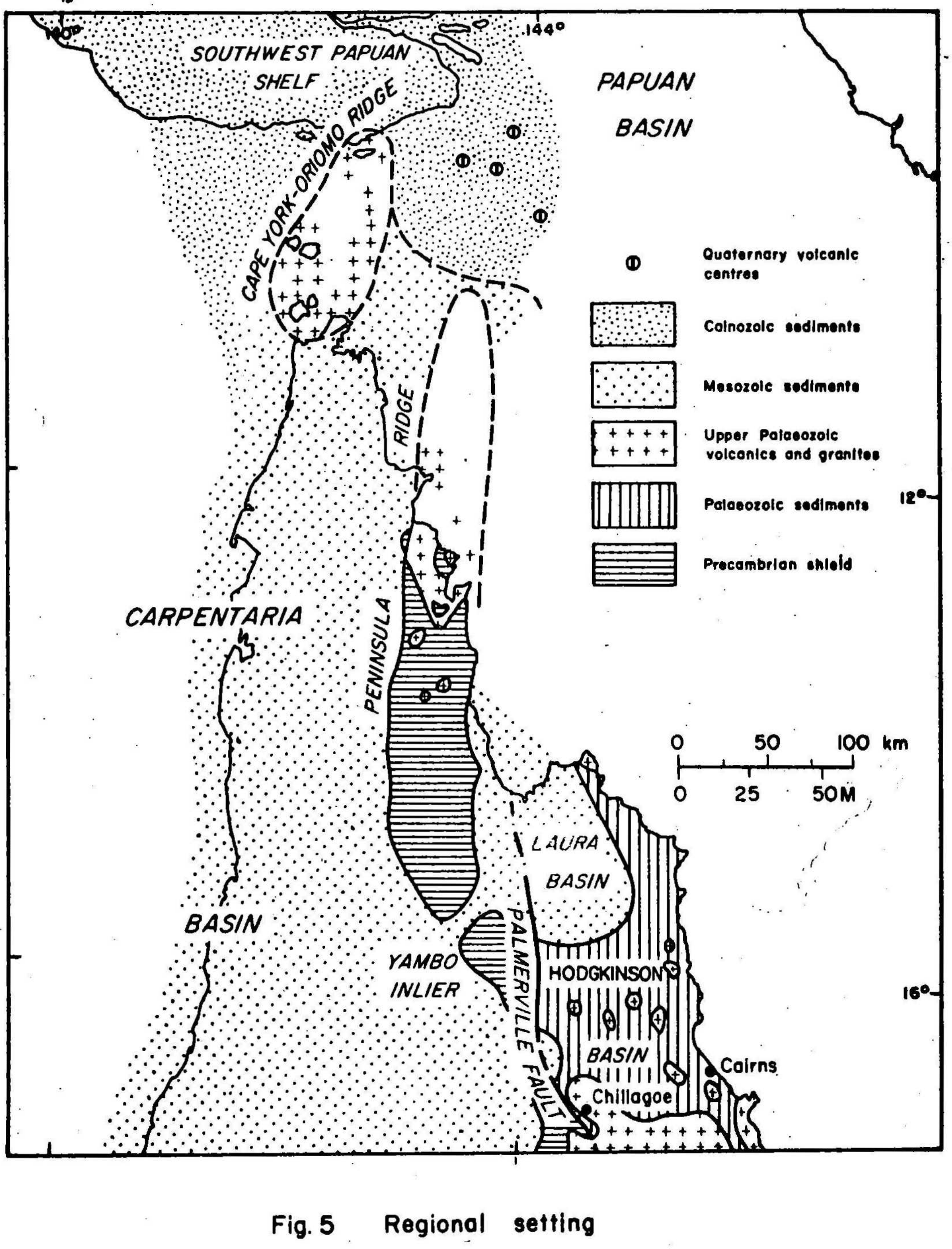


Fig. 5 Regional setting

The grade of metamorphism ranges from low in the greenschist facies in the north and west, to high in the amphibolite facies in the south and east; the metamorphism was of the low-pressure andalusite-sillimanite type. The rocks range from indurated sediments, slate, phyllite, quartzite, greenstone, fine-grained mica-quartz schist and schistose limestone, in the lower grade areas, to coarse-grained mica-quartz schist, quartzite, amphibolite, biotite-feldspar-quartz gneiss, calc-silicate rocks, and marble in the higher-grade regions. The metamorphics appear to have been derived mainly from mudstone and sandstone, with some greywacke, basic lavas, and limestone, and were possibly deposited in a relatively stable basin rather than a deep eugeosynclinal trough. In the north the sediments have undergone only one major episode of folding, with compression from the east-northeast resulting in a predominance of fold structures trending north-northwest. In the Yambo Inlier and in the Chillagoe area to the south, northeasterly trending structures are present and the folding appears to be more complicated. Isotopic dating of the metamorphics by the Rb/Sr method has so far been inconclusive, but suggests at least one period of metamorphism in the late Precambrian. Following this metamorphism, the sequence was intruded by dykes and irregular bodies of dolerite.

The Precambrian(?) granitic rocks form a large, generally concordant body, the Cape York Peninsula Batholith, which intrudes the entire metamorphic sequence over a distance of 420 km from the Yambo Inlier north to Weymouth Bay. The bulk of the batholith consists of biotite-muscovite adamellite, the <u>Kintore Adamellite</u>; other lithological units, some of which may be distinct phases, have been named the <u>Aralba Adamellite</u>, <u>Lankelly Adamellite</u>, <u>Morris Adamellite</u>, <u>Wigan Adamellite</u>, <u>Blue Mountains Adamellite</u>, and the <u>Flyspeck Granodiorite</u>. The Kintore Adamellite, and to a lesser extent the other units, are particularly variable in composition and texture, and commonly contain leucocratic varieties such as garnet-muscovite granite, pegmatite, and aplite, especially near contacts. Foliation and banding are also common near the margins. Close to the contact with the batholith the surrounding metamorphics have been thermally metamorphosed, and in places metasomatized and migmatized. The batholith was probably emplaced at a deep level in the earth's crust, but it is uncertain whether it is related to the late Precambrian period of metamorphism or to a younger event. The K/Ar ages of samples from the batholith indicate an Upper Devonian age, but Rb/Sr dating suggests the rocks are much older, possibly late Precambrian. The K/Ar results may represent an Upper Devonian event, which was possibly related to movements and metamorphism in the neighbouring Palaeozoic Hodgkinson Basin.

In the northern part of the Peninsula Ridge, in the Pascoe River area, a small Lower Carboniferous freshwater basin was developed on the metamorphic and granitic rocks. The <u>Pascoe River Beds</u> laid down in the basin consist of sandstone, arkose, greywacke, siltstone, shale, and minor coal, conglomerate, and chert. They were moderately strongly folded at some time between the Lower Carboniferous and Lower Permian.

During the late Palaeozoic, a considerable volume of acid volcanic rocks were erupted in the Iron Range district in the northern part of the Peninsula Ridge, and in Torres Strait. They probably form part of the extensive Middle Carboniferous to Lower Permian acid volcanic province much farther south in the Georgetown Inlier and along the Featherbed/Bulgonunna lineament of the Cairns hinterland (Branch, 1966, 1969; Paine, 1969). In the Iron Range district the <u>Janet Ranges Volcanics</u>, the <u>Kangaroo River Volcanics</u>, the <u>Cape Grenville Volcanics</u> and other unnamed volcanic rocks consist mainly of acid welded tuff, rhyolite, and pumice-flow breccia, with some rhyodacite(?) and dacite(?) welded tuff and andesite. The Janet Ranges Volcanics rest unconformably on the Lower Carboniferous Pascoe River Beds. In Torres Strait the Torres Strait Volcanics consist of acid welded tuffs and minor agglomerate, rhyolite, andesite, and interbedded sediments. In the southern part of the Strait four separate members have been recognized, each composed of several sheets of welded tuff all of which are similar in composition, and other minor rock types. In the southern part of the Yambo Inlier, the volcanic rocks form part of the Nychum Volcanics in the Georgetown Inlier. They have been described by Morgan (1961) and Branch (1966), and are mentioned only briefly in this Bulletin.

In both Torres Strait and the Iron Range district the volcanic rocks have been intruded by high-level Upper Palaeozoic granites, which are probably genetically related to the volcanics. In Torres Strait the Upper Carboniferous Badu Granite intrudes the Torres Strait Volcanics, and has produced patches of hornfels around its margins. It was followed by the intrusion of dykes and small bodies of porphyritic microgranite, and in the south by hydrothermal activity, which altered the volcanics in a discontinuous zone extending south from Hammond Island to Peak Point, on the mainland 10 km west of Cape York. In the Iron Range district the volcanics and older rocks were intruded and hornfelsed by the Lower Permian Weymouth Granite, which forms a large pluton 65 km long, and a number of smaller stocks and offshoots. Small bodies of diorite occur around and within the granite, and granophyric and hybrid rocks crop out in a belt along its western margin. Some small bodies of dolerite may also be associated with the granite. Farther south Upper Palaeozoic granitic rocks crop out near Bald Hill - the Wolverton Adamellite - and near Coen - the Twin Humps Adamellite. The Twin Humps Adamellite is the youngest of the Upper Palaeozoic rocks, and has an early Upper Permian age.

During late Permian and early Mesozoic times, the Precambrian and Upper Palaeozoic crystalline rocks were eroded to a peneplain. In the late Jurassic and Lower Cretaceous, sediments of the Carpentaria, Laura, and Papuan Basins were deposited in the west, southeast, and northeast. The sediments have been described by Meyers (1969) de Keyser & Lucas (1969) and the Australasian Petroleum Co. (1961) and are mentioned only briefly in this Bulletin.

During the Tertiary the Mesozoic sediments were partly stripped off and the old pre-Mesozoic peneplain was exhumed. Uplift in the east raised the basement rocks of the centre of the Peninsula Ridge to their present elevation, but farther north the basement may have been depressed. The Cainozoic sediments deposited after the uplift are mainly poorly consolidated sandstone and conglomerate, and younger residual sand, alluvium, and marine deposits.

Southeast of Coen a small body of olivine nephelinite, which is probably Cainozoic in age, forms a low hill a few kilometres inland from Princess Charlotte Bay. It is similar in composition to the Cainozoic ultra-alkaline lavas in the Cooktown district to the southeast (Morgan, 1968b).

In the far northeast of Torres Strait basic tuff and basalt of Pleistocene age, named the Maer Volcanics, form several small islands, some of which can be recognized as extinct volcanic cones. They may form part of an extensive province of Pleistocene volcanic activity, which was developed mainly to the north in the Central Highlands of Papua and New Guinea.

Precambrian Metamorphic Rocks

The Precambrian metamorphic rocks of Cape York Peninsula (Table 1) are exposed discontinuously for over 500 km from around Chillagoe in the south to Temple Bay in the north. Originally they probably formed one continuous sequence of regionally metamorphosed rocks, which has been disrupted by the granitic rocks of the Cape York Peninsula Batholith; they are now mainly exposed along the western flank of the batholith or as remnants within it. The metamorphic grade ranges from low greenschist facies in the west and north, to high in the amphibolite facies in the east and south.

The metamorphics have been subdivided into four units, (Fig. 6) mainly on the basis of geographical location although lithology has also been taken into account. Near Chillagoe they have been termed the Dargalong Metamorphics (de Keyser & Wolff, 1964; de Keyser & Lucas, 1969) and this name has also been used for the rocks in the Yambo Inlier (Amos & de Keyser, 1964; Whitaker & Willmott, 1968).

North of the Yambo Inlier, in the Peninsula Ridge the metamorphic rocks are subdivided into the Coen Metamorphics, which lie within the eastern part of the Cape York Peninsula Batholith, the Holroyd Metamorphics, which crop out mainly to the west of the batholith, and the Sefton Metamorphics, which crop out in several bodies to the north of the other units. The Coen Metamorphics are defined in the Bulletin; they were previously included in the Dargalong Metamorphics by Whitaker & Willmott (1968). Detailed descriptions of each unit are given in the second part of the Bulletin.

Lithology

The metamorphics consist predominantly of high-grade mica-quartz schist, quartzite, and biotite-feldspar-quartz gneiss, but also include lower-grade rocks such as indurated sediments, slate, phyllite, quartzite, and fine-grained mica-quartz schist. Numerous bands of amphibolite, and its lowgrade equivalent, greenstone, occur in the sequence, which also contains small lenses of schistose limestone, marble, and calc-silicate rocks. In some areas near the granitic rocks the metamorphics have been recrystallized and metasomatized, and in places migmatite has been developed.

Each of the four metamorphic units has previously been subdivided into a number of lithological types, which were given formal names in the Sefton Metamorphics, and informal names in the other units (Whitaker & Willmott, 1968, 1969a). We now consider that these subdivisions are not sufficiently precise, as many contain similar rock types, and grade into each other. We have therefore abandoned the subdivisions and their names, and here describe the lithology of each metamorphic unit as a whole.

The Dargalong Metamorphics in the Yambo Inlier consist mainly of biotite-plagioclase-quartz gneiss, leucocratic gneiss, quartzite, and amphibolite in the eastern part of the inlier, and plagioclase-muscovite-biotite-quartz schist in the west. Sillimanite-bearing muscovite-quartz schist and quartzite form broad bands within the other rock types, mainly in the west. A few small lenses of amphibole and diopside-bearing gneiss are interbanded with the biotite-plagioclase-quartz gneiss.

The Holroyd Metamorphics consist of indurated sediments, phyllite, fine-grained schist, medium-grained schist and gneiss, quartzite, and some bands of greenstone and amphibolite. The indurated mudstone and sandstone crop out only in the west in a narrow north-northwesterly trending belt crossing the Lukin River near the Gorge. To the east and west they grade into (chlorite-)sericite-quartz phyllite, fine-grained (biotite-) muscovite-quartz schist and interbedded quartzite, which form about half of the unit. Graphite is present in much of the phyllite and schist. Medium to coarse-grained mica-quartz schist occurs mainly in the east; in places it contains garnet, andalusite, staurolite, cordierite, and feldspar. The feldspar-bearing rocks have a poorly developed gneissic texture. Sillimanite is a minor mineral in the schist along the eastern margin of the unit. Interbanded basic rocks occur mainly in the south, and grade from greenstone in the west to amphibolite in the east. Lime and magnesia-rich rocks occur in a few localities in thin bands associated with the greenstone.

The Coen Metamorphics consist of coarse-grained schist and gneiss similar to the eastern part of the Holroyd Metamorphics, with which they were continuous before the intrusion of the batholith. The main rock types are sillimanite-bearing biotite-muscovite-quartz schist, quartzite, biotite-quartz-feldspar gneiss, and amphibolite. Schist and quartzite are about three times as abundant as gneiss. Other rock types include garnet-amphibole-quartz feldspar gneiss, which occurs as scattered thin bands within the biotite gneiss, and various calc-silicate rocks, which form a few lenses within the other rock types.

The Sefton Metamorphics are composed mainly of fine-grained muscovite-quartz schist, phyllite, and quartzite, similar to the Holroyd Metamorphics to the southwest. In the Iron Range area the schist and quartzite are interbanded with hematite-quartz schist, magnetite quartzite, greenstone, marble, and calc-silicate rocks. In the Temple Bay region the muscovite-quartz schist grades into schistose limestone, and calc-silicate rocks are also present.

Composition of original sediments

The predominance of mica-quartz schist and phyllite, quartzite, and biotite-feldspar-quartz gneiss suggests that the metamorphics have been derived mainly from a sequence of mudstone and sandstone, with some more heterogeneous sediments such as greywacke and arkose. In the western part of the Holroyd Metamorphics, where the sediments have suffered only incipient metamorphism, the rocks are thinly-bedded mudstone, shale, and sandstone. Small slump structures are present in the pelitic rocks, and traces of cross-bedding have been recognized in some quartzite.

TABLE 1. PRECAMBRIAN METAMORPHIC ROCKS

Formation	Rock type	Relationships	Remarks
	Dolerite	Dykes and irregular bodies in Dargalong Metamorphics	Not metamorphosed, pre-dates batholith
Sefton Metamorphics	Mica schist and quartzite, greenstone, amphibolite, calc-silicate rocks, schistose limestone	Grade into Holroyd Metamorphics	Hematite and magnetite-bearing schist and quartzite at Iron Ra
Holroyd Metamorphics	Mica schist and quartzite, phyllite, slate, indurated sediments, greenstone, amphibolite, gneiss, migmatite	Grade into Coen Metamorphics	
Coen Metamorphics	Mica schist and quartzite, biotite gneiss, amphibolite; some garnet-amphibole gneiss and calc-silicate rocks		
Dargalong Metamorphics	Biotite gneiss, feldspar-mica schist, sillimanite-muscovite schist and quartzite, amphibolite, migmatite	Part of same sedimentary sequence as Coen, Holroyd, Sefton Metamorphics?	Confined to Yambo Inlier

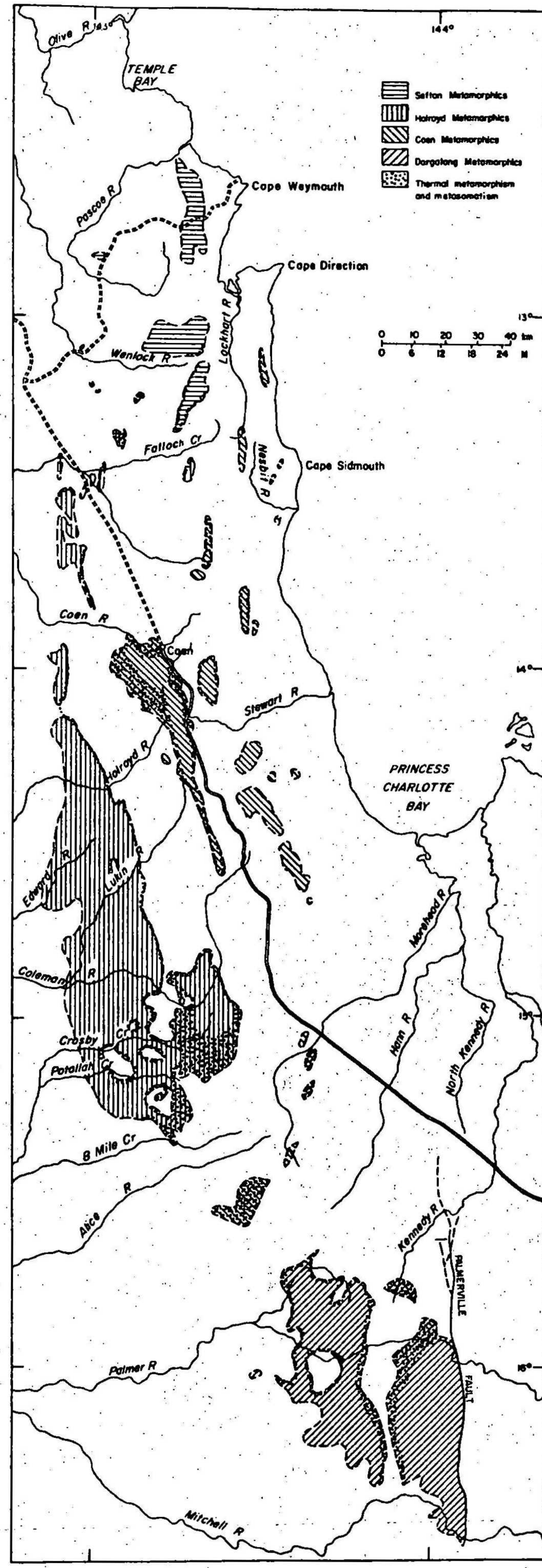


Fig. 6 Distribution of metamorphic rocks and thermal metamorphism.

Thin beds slightly richer in lime than the surrounding greywackes probably gave rise to the minor garnet-amphibole-bearing and diopsidic gneisses in the biotite gneiss of the Coen and Dargalong Metamorphics. The various calc-silicate rocks of the Coen and Sefton Metamorphics represent lenses of limestone, dolomite, and dolomitic detrital sediments, which graded into the surrounding rocks.

Bands of basic igneous rocks now represented by greenstone and amphibolite were included within the sedimentary pile, but were abundant only in the eastern part of the Yambo Inlier. The concordant relationship with the surrounding rocks and sharp contacts of the larger bands suggest that they are probably lavas. Near Iron Range and the Coleman River, amygdules have been recognized in the greenstone. However, one of the greenstones near Iron Range has a relict ophitic texture, which suggests that the rock was originally a dolerite sill or dyke. Many of the smaller bands of greenstone and amphibolite, although similar in composition to the larger bands, have a gradational contact with the surrounding rocks and probably represent lime-rich sediments. Some of the small lenses with talc-chlorite-tremolite assemblages may be metamorphosed ultrabasic rocks.

The iron-bearing schist and quartzite near Iron Range are considered to have been derived from ferruginous siltstone and sandstone by Canavan (1965b). Lee & Forsythe (1961) note that the magnetite quartzite changes along the strike into amphibole-quartz rocks, which are probably similar to the diopside-actinolite-quartz rocks forming thin bands in the Coen Metamorphics. They are probably derived from ferruginous and calcareous quartz-rich sediments, although Lee & Forsythe believe the amphibole-rich specimens may represent altered basic igneous rocks.

Environment of deposition

The predominance of rocks such as mudstone and sandstone associated with limestone, dolomite, and iron-rich sediments in the original sedimentary sequence suggests that it was deposited in a relatively shallow miogeosynclinal environment, rather than in a deep eugeosynclinal trough. The presence of relict detrital potash feldspar, plagioclase, and biotite in some of the less recrystallized rocks of the Holroyd Metamorphics, and the presence of pebbles of feldspathic quartzite and low-grade metamorphic rocks in a schistose conglomerate at Iron Range, suggest that the sediments were derived from a more ancient basement complex of metamorphic and plutonic rocks. The relict feldspar and biotite grains are relatively fresh and angular, and the sediments were probably transported only a short distance from their source.

Structure

On a regional scale the structure of the metamorphics is revealed by the presence of prominent trends on the air-photographs' which represent the original bedding of the sequence. In most areas the bedding dips steeply and strikes north to north-northwest. The sequence appears to have suffered only one major period of folding, in which the direction of maximum compression was east-northeast. The folding was isoclinal, and appears to have been tighter in the east than in the west. Between

Potallah Creek and the Lukin River, three large north-plunging folds, which repeat a band of quartzite and greenstone, are overturned from the east.

The schistosity and foliation in the rocks are broadly parallel with the regional strike of the bedding, although in the Holroyd Metamorphics in which bedding is still visable it is locally inclined to the schistosity. The schistosity generally dips steeply and is probably an axial-plane schistosity related to the isoclinal folds. The small crenulations in the schistosity in some specimens may reflect minor folding during the major period of deformation rather than a separate later deformation.

In the west the Holroyd Metamorphics have been cut by north-northwesterly trending faults. The largest, northwest of The Gorge on the Lukin River, appears to separate low-grade rocks to the west from high-grade rocks to the east. Large shear zones which cut the metamorphics between Coen and the Stewart River, and near the Archer River, probably formed during the intrusion of the batholith.

In the south, near the headwaters of the Morehead River, the trends in the metamorphics swing from north-northwest to northwest; farther south in the Yambo Inlier they swing from north to northeast. As the intersection of these trends is concealed by the Mesozoic sediments of The Desert, the structural relationship between the rocks of the two areas is unknown. Farther south in the metamorphics in the Chillagoe area the structure is more complicated, with both northeasterly and northwesterly trends. In the north between Falloch Creek and Mount Carter, the strike of the metamorphics swings to the north-northeast, but the cause of this is uncertain. Trends at Mount Carter itself outline a broad synform plunging northwards, in which broad bands of quartzite, clearly visible on the eastern limb, dip gently northwestwards. The schistosity is approximately parallel to the bedding as shown by the quartzite, but on the western limb both the schistosity and bedding are contorted. The synform appears to have developed after the formation of the schistosity and may have resulted from the intrusion of the Permian Weymouth Granite.

Metamorphism

The metamorphics are considered to have undergone only one major episode of regional metamorphism, apparently accompanying the orogeny which folded the original sedimentary sequence. The metamorphic grade of the rocks increases broadly in an easterly and southerly direction from low in the greenschist facies to high in the amphibolite facies. The metamorphism was of the low-pressure andalusite-sillimanite type, (see Miyashiro, 1961).

In the east the metamorphic sequence has been intruded by a deep-level granitic batholith; the accompanying thermal metamorphism, metasomatism, recrystallization and migmatization have affected the adjacent metamorphics, particularly the higher-grade rocks.

In the regional metamorphics the increase in grade is revealed by the mineral assemblages of both the psammo-pelitic rocks and the interbanded basic rocks (Fig. 7). The assemblages of the calcium-rich and magnesium-rich rocks are less useful. Recrystallization of the fabric is slight in the lowest-grade rocks, but is complete in the rocks low in the amphibolite facies.

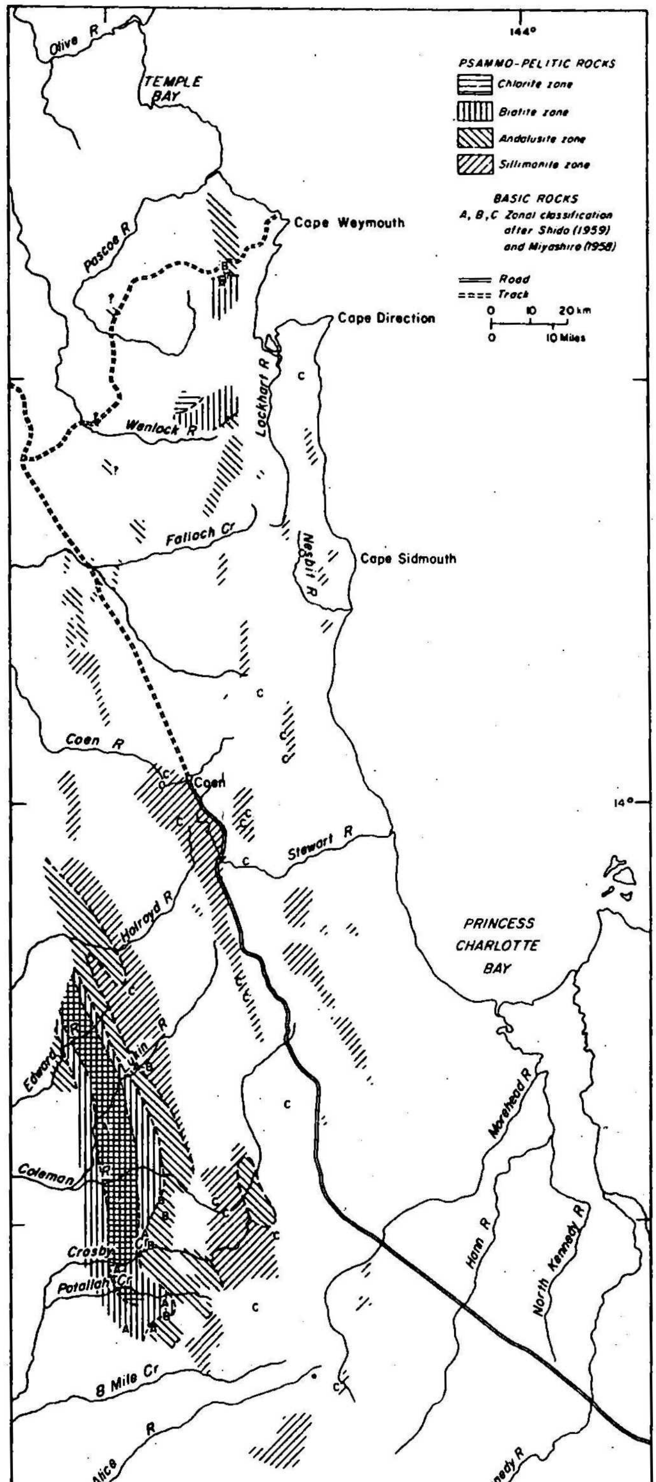


Fig.7 Regional metamorphic zones

In the psammo-pelitic rocks four metamorphic zones have been recognized: the chlorite and biotite zones in the greenschist facies, and the andalusite and sillimanite zones in the amphibolite facies. All four zones are represented in the Holroyd Metamorphics; the first three also occur in the Sefton Metamorphics, but only the sillimanite zone is represented in the Coen and Dargalong Metamorphics. The distribution of these zones is shown in Figure 7.

The rocks of the chlorite zone include the indurated sediments, phyllite, and slate in the central-western part of the Holroyd Metamorphics, and the phyllite and quartzite in the Sefton Metamorphics which form the northwestern part of the Mount Carter block. The common assemblage is (hematite-graphite-chlorite-) sericite-quartz; relict feldspar, and rarely biotite, may also be present.

The biotite zone comprises fine-grained or medium-grained schists, spotted in places with garnet and biotite. The general assemblage is (graphite-garnet-)biotite-muscovite-quartz, although the assemblages (graphite-)garnet-muscovite-quartz and (graphite-) muscovite-quartz also occur.

The medium-grained or coarse-grained schists of the andalusite zone are characterized by porphyroblasts of andalusite. In the lower-grade part of the zone schists spotted with garnet and biotite may also be present. Cordierite, staurolite, and potash feldspar occur in some of the rocks. The assemblages in this zone include: muscovite-quartz; biotite-muscovite-quartz; (andalusite-)garnet-biotite-muscovite-quartz; potash feldspar-muscovite-biotite-oligoclase-quartz; (tourmaline-graphite-)andalusite-muscovite-quartz; (hematite-graphite-) staurolite-muscovite-andalusite-biotite-quartz; cordierite-garnet-staurolite-biotite-muscovite-quartz; and cordierite-andalusite-muscovite-quartz.

The Sefton Metamorphics in the Iron Range area between the Kennedy Road and Temple Bay probably should be placed in this zone. However, although cordierite occurs in this area, neither andalusite nor staurolite have yet been identified in these rocks. The composition of the basic rocks from this area, discussed below, also indicates that these rocks should lie in the andalusite zone.

In the sillimanite zone in the eastern part of the Holroyd Metamorphics sillimanite first appears as fibrolite in quartz and muscovite. In the coarse-grained mica schists and gneisses of the Coen and Dargalong Metamorphics it forms medium-sized or large prisms, most of which have been replaced by muscovite. The most common assemblages are: (sillimanite-garnet-)potash feldspar-biotite-plagioclase-quartz; (sillimanite-garnet-)biotite-plagioclase; (biotite-) garnet-hornblende-quartz-plagioclase; (sillimanite-garnet-)plagioclase-biotite-muscovite-quartz; and (sillimanite-)muscovite-quartz.

In the western part of the zone in the Holroyd Metamorphics andalusite may coexist with the sillimanite in the last two assemblages, and in the (sillimanite-)andalusite-biotite-muscovite-quartz assemblage. Cordierite occurs sporadically throughout the zone.

The mineral assemblages in the metamorphosed basic igneous rocks fall into three zones which are termed A, B, and C, and conform essentially to those of Shido (1958), Shido & Miyashiro (1959), and Miyashiro (1958, 1968). The distribution of these zones is shown in Figure 7; the zones are delineated on the basis of the Z-axial colour of the calcic amphibole.

Zone A is characterized by green actinolite and is largely equivalent to the chlorite and biotite zones described above. Common assemblages in Zone A are: quartz-tremolite-actinolite; sphene-albite or oligoclase-quartz-actinolite; clinozoisite-muscovite-andesine*-tremolite or actinolite; sphene-quartz-clinozoisite-actinolite-albite or oligoclase; biotite-quartz-andesine*-actinolite; and labradorite*-oligoclase-actinolite.

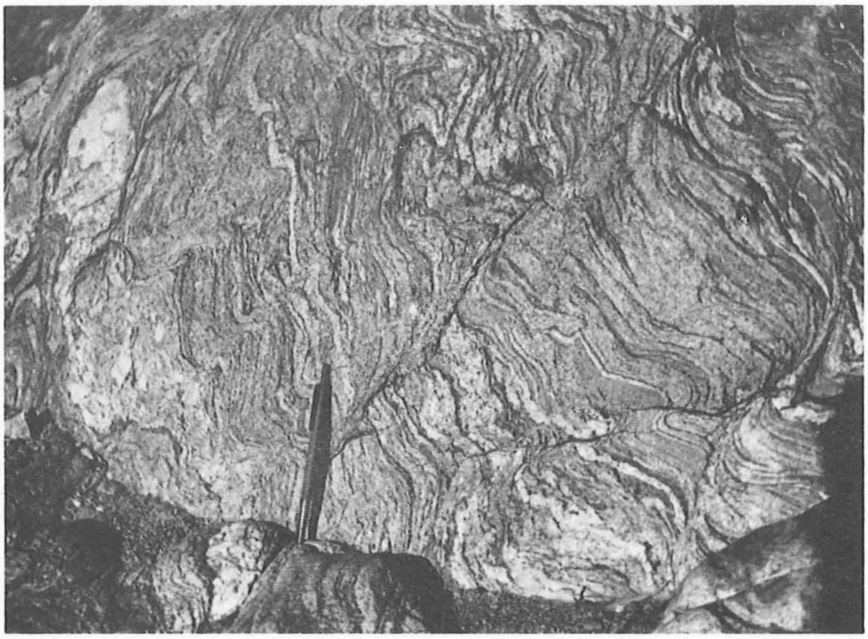
Zone B is characterized by blue-green hornblende and is equivalent to the andalusite zone of the psammo-pelitic rocks. Rocks in Zone B contain andesine and hornblende together with various amounts of quartz, sphene, clinozoisite or epidote, and rarely garnet or calcite. Rocks in this zone have only been positively identified in the south-central part of the Holroyd Metamorphics. In the Iron Range area basic rocks north of the Kennedy Road probably occur in Zone B, as they contain hornblende, unlike the rocks south of the road, which contain actinolite.

Zone C is characterized by green to greenish brown hornblende and is equivalent to the sillimanite zone of the psammo-pelitic rocks. The Zone C rocks are widespread and contain andesine or labradorite, of rarely bytownite, and hornblende together with minor amounts of quartz, sphene, apatite, and clinopyroxene.

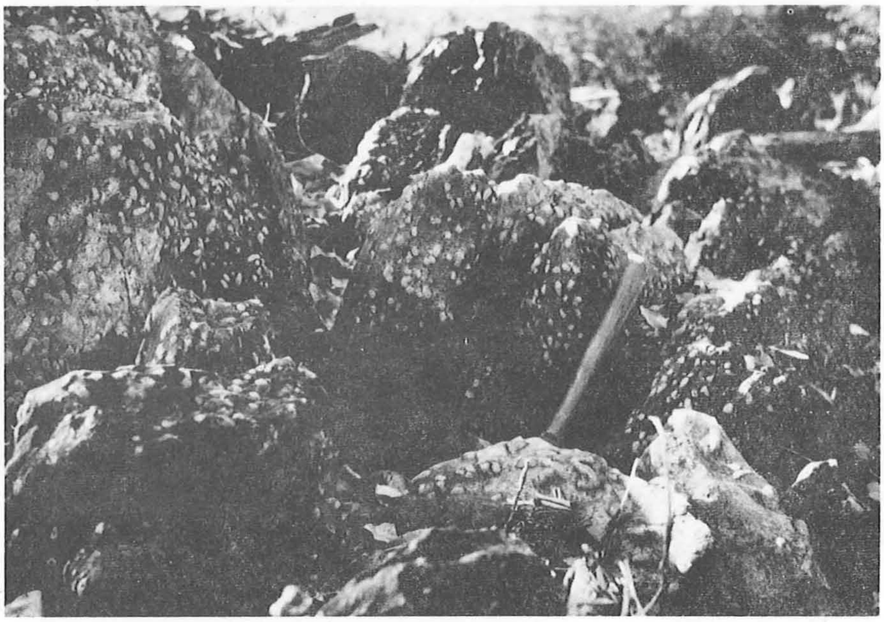
The mineral assemblages of both the psammo-pelitic and basic rocks indicate regional metamorphism of the low-pressure andalusite-sillimanite type. This, the Abakuma-type of metamorphism, is intermediate in pressure between contact or thermal metamorphism and the high-pressure kyanite-sillimanite or Dalradian type. Its characteristic mineralogy and geology is well documented by Shido (1958), Miyashiro (1958, 1961, 1968), Hietanen (1967), Winkler (1967), and Joplin (1968). In Cape York Peninsula as in the type area, andalusite is stable in the lower part of the amphibolite facies, and in places co-exists with sillimanite. Cordierite is also present in the amphibolite facies. Kyanite, typical of high-pressure terrains, appears to be absent. Garnet is absent from the basic igneous rocks, but occurs in some of the garnet-hornblende-bearing gneisses of the Coen Metamorphics.

Thermal metamorphism has been produced by the granitic batholith which intrudes the eastern part of the metamorphic sequence. The granite was emplaced at a deep level and is late syntectonic or post-tectonic. Although locally discordant, it is concordant with the surrounding rocks on a regional scale. The metamorphics along the margin

* Average composition; the crystals are zoned with sodic rims.

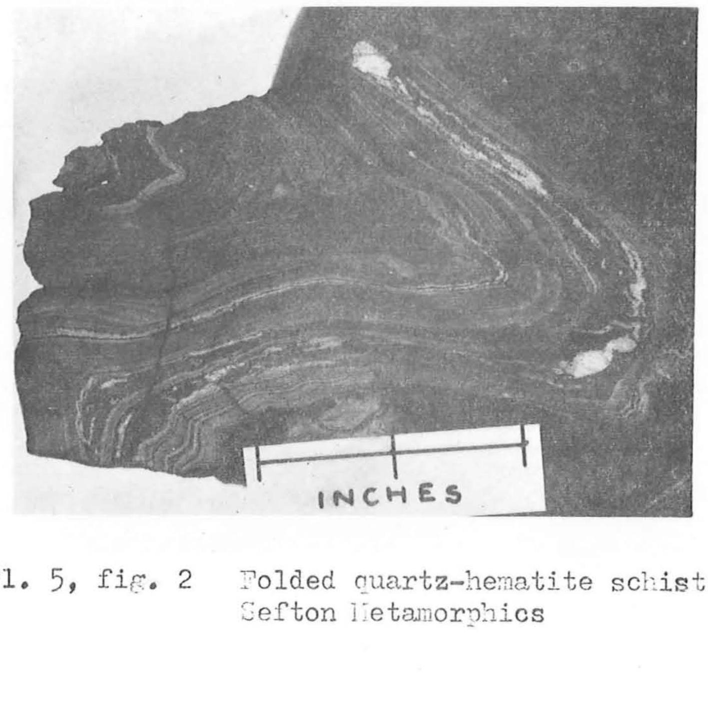


Pl. 4, fig. 1   Folding in gneiss, Dargalong Metamorphics



Pl. 4, fig. 2   Andalusite porphyroblasts in schist, Holroyd Metamorphics

Pl. 5, fig. 1   Cleaved siltstone, Holroyd Metamorphics



Pl. 5, fig. 2   Folded quartz-hematite schist from Iron Range, Sefton Metamorphics of the batholith have been affected by potash metasomatism, recrystallization, migmatization, and thermal metamorphism. The effects differ in intensity from place to place, but in general are best developed in the southern part of the Holroyd and Coen Metamorphics and in the Dargalong Metamorphics of the Yambo Inlier (Fig. 6).

Recrystallization to a granoblastic texture and accompanying potash metasomatism has produced massive microline-bearing gneiss and some augen gneiss in the northeastern part of the Yambo Inlier. Recrystallized schist and gneiss, some of which contains microcline, also occurs in the southeastern part of the Holroyd Metamorphics southeast of the Dixie Alice River road, as xenoliths in the batholith farther to the south, and in the small bodies of Coen Metamorphics along the western edge of The Desert. In various places all gradations exist between the recrystallized gneiss and the surrounding granitic rocks. Farther north these effects occur in relatively narrow marginal zones in bodies of Coen Metamorphics in the Ebagoola and Coen Sheet areas.

More intense recrystallization and metasomatism have produced migmatite, especially in the northeast part of the Yambo Inlier and in the southeast part of the Holroyd Metamorphics. The migmatite results from the penetration of the metamorphic rocks by generally concordant, thin veins of granitic material composed of quartz and microcline. The coarse crystals of muscovite, which are discordant to the schistosity in schists near the migmatite, and the tourmaline in some of the metamorphics are probably also of metasomatic origin.

Simple thermal metamorphic effects resulting from the intrusion of the granitic rocks are difficult to distinguish from the effects of the regional metamorphism. They have been recognized in the chlorite and biotite zones in the southern part of the Holroyd Metamorphics where the development of chiastolite porphyroblasts and fibrolite, together with the recrystallization of muscovite, has occurred along the margins of a number of small granitic plutons.

Retrogressive metamorphism is widespread throughout the amphibolite-facies rocks. The changes include the alteration of sillimanite and andalusite to sericite, cordierite to chlorite and sericite, plagioclase to sericite or clinozoisite, biotite to chlorite, garnet to chlorite, and hornblende to actinolite and chlorite. The retrogressive metamorphism may be related to the Upper Devonian event which was responsible for the K/Ar isotopic age of the batholith and metamorphics.

Age

Both near Chillagoe, to the south of the area mapped, and in the Yambo Inlier Dargalong Metamorphics are probably much older than the nearby Silurian to Devonian Chillagoe Formation which contains pebbles of gneiss and amphibolite (Amos & de Keyser, 1964; de Keyser & Lucas, 1969). The K/Ar age of 1044 m.y. of the muscovite granite intruding the metamorphics 11 km southwest of Chillagoe (Richards et al., 1966) indicates that the metamorphic rocks are Precambrian in age.

K/Ar ages obtained from the Coen and Holroyd Metamorphics indicate an event during the Upper Devonian, which was originally interpreted as the intrusion of the Cape York Peninsula Batholith, since this was also dated by the K/Ar method as Upper Devonian (Trail et al., 1969). Rb/Sr total-rock data from regional sampling of the Dargalong, Coen, and Holroyd Metamorphics, given in Appendix 1, suggest at least one metamorphic event in the late Precambrian, although no specific date could be fixed. Rb/Sr data from rocks of the batholith also suggest a late Precambrian age, although again no date could be determined. The K/Ar results could be interpreted as a re-setting of the micas for potassium and argon in the older granitic and metamorphic rocks during a major Upper Devonian event, at present of unknown origin.

The difference in direction and complexity of the structural trends in the Dargalong Metamorphics in the Yambo Inlier, and the Coen, Holroyd, and Sefton Metamorphics in the Peninsula Ridge, suggest there may be a difference in age between the metamorphics in the two areas. However, the Rb/Sr data show no significant variation, although the imprecise results obtained may conceal more than one age. Further detailed sampling for Rb/Sr dating carried out in 1970 may resolve the question.

Cape York Peninsula Batholith

The Precambrian metamorphic rocks have been extensively intruded by a concordant northerly trending belt of granitic rocks, which are probably Precambrian and which have been named collectively the Cape York Peninsula Batholith (Whitaker & Willmott, 1969a). The batholith (Table 2) is exposed over an area of at least 5500 sq km and probably underlies another 4000 sq km covered by Cainozoic sediments. It extends from the Mitchell River in the south to Weymouth Bay in the north, a distance of 400 km; its width ranges from 2 km in the Yambo Inlier to more than 60 km between Coen and Wenlock. The batholith crops out extensively in the broad Coleman and McIlwraith Plateaux between the Morehead River in the south and Mount Carter in the north. The batholith contains many small remnant bodies of metamorphics, and in the Coleman River area small granitic stocks or offshoots intrude the Holroyd Metamorphics several kilometres west of the main body. North of Mount Carter the batholith is overlain by Upper Palaeozoic sediments and volcanics and is penetrated by Lower Permian granite.

About 70 percent of the batholith consists of biotite-muscovite adamellite, named the Kintore Adamellite and Aralba Adamellite; the remainder is composed of biotite adamellite, (the Wigan Adamellite and Blue Mountains Adamellite), porphyritic biotite adamellite (the Lankelly Adamellite and Morris Adamellite) and hornblende-biotite granodiorite, tonalite, and diorite (the Flyspeck Granodiorite). Chemical analyses of the various rock types are given in Tables 9 and 10.

The named units are distinctive entities but are not necessarily separate phases of the batholith. Some, such as the Aralba Adamellite and Lankelly Adamellite, are possibly only variations of the Kintore Adamellite, as in places they grade into it. Other units, such as the Flyspeck Granodiorite and Blue Mountains Adamellite, have intrusive contacts with adjoining units and possibly represent separate

TABLE 2. PROTEROZOIC OR UPPER DEVONIAN CAPE YORK PENINSULA BATHOLITH

Formation	Rock types	Relationships	Remarks
Blue Mountains Adamellite	Biotite adamellite, hornblende-biotite adamellite	Intrusive contact with Kintore Adamellite	K/Ar ages U. Devonian; Rb/Sr ages late Precambrian?
Morris Adamellite	Porphyritic biotite adamellite	Intrudes sheared Kintore Adamellite	
Wigan Adamellite	Biotite adamellite and granite	Grades into Kintore Adamellite. Intrudes Flyspeck Granodiorite?	
Lankelly Adamellite	Porphyritic biotite adamellite; some leucocratic muscovite granite and banded pegmatitic granite	Grades into Kintore Adamellite	
Kintore Adamellite	Biotite-muscovite adamellite, leucocratic muscovite granite and banded pegmatitic granite	Grades into Lankelly, Aralba, and Wigan Adamellites, intrusive contacts with Blue Mountains and Morris Adamellites, and Flyspeck Granodiorite	Dominant rock type in batholith
Flyspeck Granodiorite	Biotite granodiorite, hornblende-biotite tonalite, biotite-hornblende diorite	Intrusive contacts with Wigan and Kintore Adamellites.	

intrusive phases. The Flyspeck Granodiorite forms many widely scattered bodies and may represent several phases. The distribution of rock units within the batholith is shown in the accompanying geological map. The dominant unit is the Kintore Adamellite which extends 400 km throughout the batholith from the Mitchell River in the south to Portland Roads in the north. The Aralba Adamellite forms large bodies in the northwestern part of the Yambo Inlier and appears to be a porphyritic variety of the Kintore Adamellite. The Lankelly Adamellite forms a single very large body east of Coen, and is probably also a variety of the Kintore Adamellite though it contains very little muscovite.

The Flyspeck Granodiorite forms several large bodies, most of which lie in the Kintore Adamellite between the Alice River and Wenlock, a distance of 230 km. It comprises rock types which are strikingly different from those of the Kintore Adamellite and the relationship between the two units is not evidently a close one. The Blue Mountains Adamellite, the Wigan Adamellite, and the Morris Adamellite are also distinctly different from the Kintore Adamellite and its varieties, and from each other; they form several large bodies exposed between Coen and Wenlock.

There is considerable variation in composition and texture within most of the units, and especially within the Kintore Adamellite. Leucocratic varieties such as garnet-muscovite granite, pegmatite, and aplite are most commonly found near the margins of bodies; biotite-rich and plagioclase-rich varieties occur in places. Variations in the abundance of phenocrysts are common and some units, such as the Kintore Adamellite, which are generally even-grained, are porphyritic in places.

All the granitic rocks are generally massive and lack foliation or banding, but near the margin of the batholith the Kintore Adamellite is foliated in places. Compositional banding is rare within the Kintore Adamellite; in places it appears to represent remnant xenolithic material and, locally, banded granite has a gradational contact with metamorphic rocks. Xenoliths of country rocks are fairly common, especially near the contacts of the batholith. Garnet-muscovite granite pegmatite and aplite dykes are abundant in some marginal areas of the batholith and penetrate the country rock up to several kilometres from the contact. Acid and intermediate dykes cut the Kintore Adamellite, and are particularly common in or near the Flyspeck Granodiorites. Near many contacts both granitic and metamorphic rocks are cut by quartz reefs, which carry traces of gold in places.

Minor shearing occurs throughout the batholith; but the more intense shearing is concentrated in a number of northwesterly or northerly trending zones up to 20 km in length.

The batholith has metamorphosed, metasomatized, and in places migmatized the surrounding metamorphics. These effects are most intense where the batholith cuts across the trend of the metamorphics; near the Morehead River and in the northeastern part of the Yambo Inlier extensive areas of migmatite and muscovite granite pegmatite and aplite adjoin the contact. Potash metasomatism which results in the growth of porphyroblastic potash feldspar in the neighbouring metamorphics, is also widespread in these areas. Elsewhere, the intrusion of the batholith has produced only a narrow band of hornfels immediately adjoining the contact.

Nature of the batholith

The generally concordant form of the batholith, the presence of foliation, pegmatite and aplite at its margins, and the occurrence of migmatite and metasomatized and partially granitized rocks in the surrounding metamorphics, suggest that it was emplaced at a considerable depth in the earth's crust, probably in the mesozone or upper catazone of Buddington's classification (1959).

Although it is a deep-level batholith emplaced in a metamorphic terrain, the batholith was not necessarily closely related to or generated by the metamorphic event, as it indiscriminately intrudes both low-grade and high-grade metamorphic rocks. Buddington states that most batholiths of the mesozone would be classed as post-tectonic, and those of the catazone as syntectonic. The position of this batholith is uncertain but future isotopic age determination may reveal more precisely the relationship between the metamorphism and the intrusion of the batholith.

Age

The K/Ar ages of micas from both the batholith and the surrounding metamorphics (Appendix 1) strongly suggest an event during the Upper Devonian, which was originally interpreted as the intrusion of the batholith (Trail et al., 1969; Appendix 1). The Rb/Sr total-rock data from regional sampling of the batholith suggest a late Precambrian rather than an Upper Devonian age, although no isochron could be drawn and no specific date could be fixed. However, the isotopic pattern could also be related to partial digestion of older material by younger granitic rocks, and the suggestion of a Precambrian age remains tentative only.

The K/Ar results are interpreted as the over-printing, on an older granitic and metamorphic terrain, of an Upper Devonian event, at present of unknown origin. The possibility remains however, that some of the granitic rocks of the batholith were in fact intruded, or re-mobilized, during the Upper Devonian.

Relationship with other granitic rocks

Muscovite granite pegmatite, and migmatite are associated with the Dargalong Metamorphics in their type area west of Chillagoe (Best, 1962; de Keyser & Wolff, 1964; de Keyser & Lucas, 1969); this area is separated from the Dargalong Metamorphics of the Yambo Inlier by only 50 km of Mesozoic sediments. Both sharp and gradational contacts with the metamorphics have been noted; the latter has been cited as evidence for granitization by de Keyser & Wolff, and de Keyser & Lucas. Where the granites have sharp contacts with the surrounding metamorphics they have been equated with the Precambrian Forsayth Granite; elsewhere they have been included with the metamorphics. Since a close similarity exists in composition, texture, and field relationships between the granitic rocks associated with the Dargalong Metamorphics in the Chillagoe area and in the Cape York Peninsula Batholith, they may have originated under similar conditions at approximately the same time. The relationship between the Cape York Peninsula Batholith and the Precambrian Forsayth Batholith, which intrudes metamorphics of the Georgetown Inlier, is uncertain. It may be clarified by future isotopic age determinations.

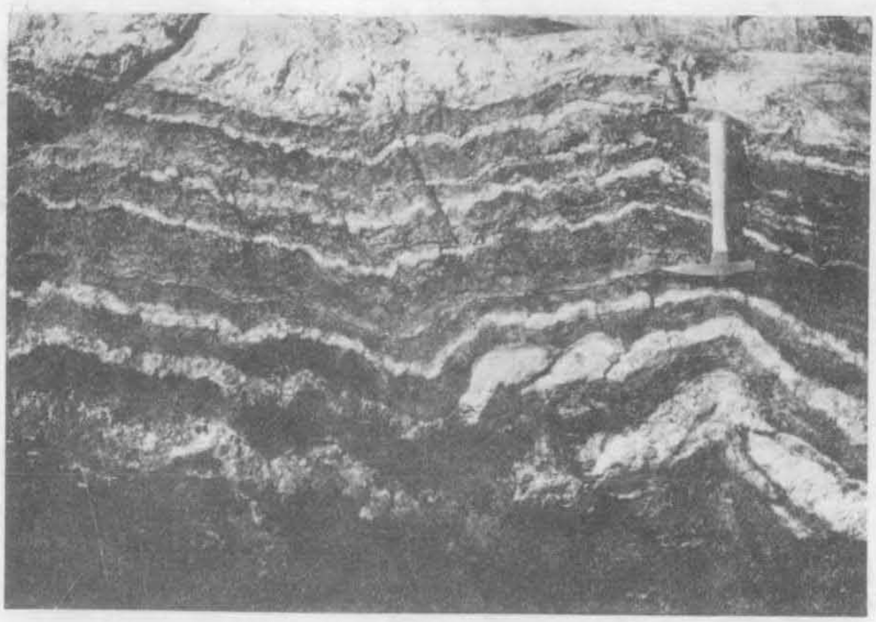
Pl. 6, fig. 1   Banding in Lankelly Adamellite

Pl. 6, fig. 2   Aligned phenocrysts near margin of Lankelly Adamellite

Pl. 7, fig. 1   Banding in Kintore Adamellite

Pl. 7, fig. 2   Aplite and pegmatite bands in Kintore Adamellite

Pl. 8, fig. 1 Foliated Kintore Adamellite in contact with amphibolite of Coen Metamorphics



Pl. 8, fig. 2 Hornfelsed Holroyd Metamorphics with pegmatite bands, near contact with Kintore Adamellite

Lower Carboniferous Sediments

In the Iron Range district small exposures of Lower Carboniferous sediments named the Pascoe River Beds (Whitaker & Willmott, 1969a), crop out in the valleys of the Pascoe River and its tributaries. They consist (Table 3) of sandstone, arkose, greywacke, siltstone, shale, and minor coal conglomerate and chert, which were probably deposited in a small freshwater basin on the metamorphic and granitic rocks. The sediments were moderately strongly folded and faulted before the overlying Janet Ranges Volcanics were extruded.

Provenance and depositional environment

The presence of abundant angular fragments of rhyolite and devitrified welded tuff in the lithic greywacke and tuffaceous sandstone indicates that the sediments were deposited close to a source of volcanic rocks, and suggests contemporaneous vulcanism. The feldspathic greywacke and arkose have probably been derived largely from a terrain of granitic or metamorphic rocks, as they contain grains of oligoclase and andesine, and less commonly of microcline. Flakes of muscovite, and more rarely biotite occur in the sediments.

The presence of thin coal seams and carbonaceous siltstone and shale suggests that the Pascoe River Beds are non-marine (AAP, 1965).

Structure

The Pascoe River Beds in the middle reaches of the Pascoe River have been folded into broad anticlines and tighter synclines, which have axes trending north-northwest. This folding has probably produced a repetition of some of the sequence in the Pascoe River. The sediments in Hamilton Creek and Garraway Creek have also been folded, but the directions of the fold axes there are irregular, possibly due to faulting. The folding took place before the deposition of the overlying Janet Ranges Volcanics, which are no younger than Lower Permian, and it probably occurred during the Middle or Upper Carboniferous.

Age

Although their base is not exposed, the Pascoe River Beds appear to overlie Precambrian Sefton Metamorphics in the Garraway Creek area. They contain a few fragments of schist and phyllite.

Plant fossils collected by Morton in Garraway Creek were identified by Dr A.B. Walkom as Lepidodendroids and *Cordaites*; they indicate a Carboniferous age (Morton, 1924). Plant remains collected by geologists of Australian Aquitaine Petroleum Ltd have been examined by Dr G. Playford (AAP 1965). From the sequence in the Pascoe River two shale horizons overlying thin coal seams yielded *Lepidodendron* and *Rhacopteris*. *Rhacopteris* was also identified in a thin siltstone band in Hamilton Creek. In Garraway Creek plant fossils in a thin siltstone band immediately under the Janet Ranges Volcanics were mainly *Lepidodendron*. These fossils suggest a Lower Carboniferous age for these beds. Evans

(1966) has examined spores in a carbonaceous siltstone from the Pascoe River and has concluded that this bed is no older than Devonian and no younger than Upper Carboniferous. Plant remains collected during this survey from Hamilton Creek have been identified by Mary E. White (1969; also Appendix 3) as Stigmaria ficoides Bgt., the root buttress of Lepidodendron, and a species of Cardiopteris. This flora indicates a Lower Carboniferous age.

Relationship with volcanic rocks

In the Hamilton Creek and Garraway Creek areas steeply dipping Pascoe River Beds are overlain by flat-lying Janet Ranges Volcanics, and the period of folding which separates the two units presumably marks a considerable time-break. However, the presence of abundant fragments of volcanic rocks in some of the sediments at these localities and rounded cobbles of welded tuff in sandstone in the Pascoe River indicates that volcanic activity either preceded or was contemporaneous with the deposition of the sediments. Dykes of quartz-feldspar porphyry which are reported (Morton, 1924; AAP, 1965) to have metamorphosed and partially digested sediments in the northern portion of the Pascoe River section, may be contemporaneous flows or thin welded tuff sheets, and the Janet Ranges Volcanics near Hamilton Creek contain a bed of tuffaceous sandstone.

Although the bulk of the volcanic rocks appear to be considerably younger than the Pascoe River Beds, some of the volcanics in places remote from the outcrop of the beds may be contemporaneous with them.

Upper Palaeozoic Volcanic Rocks

During the late Palaeozoic, a considerable thickness of acid volcanic rocks was erupted over about 200 sq km at sites near Iron Range and between Cape York and Papua in Torres Strait (Table 3). They probably form part of an extensive province of Middle Carboniferous to Lower Permian acid vulcanism, whose main development lies 400 km to the south in the Georgetown Inlier and along the Featherbed/Bulgonunna lineament of the Cairns hinterland (Branch 1966, 1969; Paine, 1969). The province of acid vulcanism may even have extended north of Torres Strait, as rhyodacite and dacite have been encountered in southwest Papua under Mesozoic and younger sediments in the Iamara and Wuroi petroleum exploration wells (Oil Search, 1963, 1965).

In both Cape York Peninsula and the Georgetown Inlier the volcanics were erupted through the Precambrian shield; in the Georgetown Inlier large cauldron subsidence areas developed, but such structures are not evident in the Peninsula; they may have been obscured by later granitic rocks or may be partly covered by the sea. As in the Georgetown Inlier, the volcanics consist predominantly of great thicknesses of acid welded tuff, with some flows of rhyolite and minor intermediate rocks.

TABLE 3. CARBONIFEROUS AND PERMIAN STRATIGRAPHY

Age	Formation	Thickness (m)	Rock Type	Relationship	Remarks
U. Permian	Twin Humps Adamellite		Hornblende-biotite adamellite	Intrudes rocks of batholith	Age 253 m.y. Broadly contemporaneous with Weymouth Granite
Permian?	Wolverton Adamellite		Leucocratic biotite adamellite and granite	Intrudes rocks of batholith; covered by Mesozoic sediments	Comtemporaneous? with Weymouth Granite
L. Permian	Weymouth Granite		Porphyritic biotite granite and adamellite; some microgranite	Intrudes Palaeozoic volcanics, rocks of batholith, and metamorphics	Age 262-273 m.y.
			Biotite-hornblende diorite and tonalite	Within Weymouth Granite	
L. Carboniferous to L. Permian			Granophyric and hybrid adamellite, granodiorite, and granite	Close association with both Weymouth Granite and Palaeozoic acid volcanics	Possibly co-magmatic with acid volcanics
			Dolerite	Intrudes? Palaeozoic volcanics	
	Cape Grenville Volcanics	300	Bedded breccia and tuff, welded tuff, rhyolite	Overlain by Mesozoic sediments	Contemporaneous? with Janet Ranges Volc
	Kangaroo River Volcanics	300	Acid welded tuff, intermediate lava, dacite and rhyodacite welded tuff	Intruded by Weymouth Granite	Contemporaneous? with Janet Ranges Volc
	Janet Ranges Volcanics	500	Rhyolite welded tuff, rhyolite, welded pumice-flow breccia, agglomerate	Unconformable on Pascoe R. Beds; intruded by Weymouth Granite	Extensively hornfelsed. Younger than L. Carboniferous, older than L. Permian
		100 ?	Acid welded tuff, agglomerate; some andesite and metabasalt	Doubtful	Similar to other Palaeozoic volcanics

Table 3 continued

Age	Formation	Thickness (m)	Rock Type	Relationship	Remarks
U. Carboniferous			Porphyritic microgranite	Intrudes Torres Strait Volc	Contemporaneous? with Badu Granite
	Badu Granite		Leucocratic biotite granite, porphyritic biotite granite and adamellite, hornblende-biotite adamellite and granodiorite	Intrudes Torres Strait Volc	Age 294 m.y.
	Nychum Volcanics	150	Rhyolite, welded tuff; subordinate andesite, basalt, and sediments	Unconformable on metamorphics; covered by Mesozoic sediments	U. Carboniferous Rb/Sr age and plants
Carboniferous	Torres Strait Volcanics	+300	Acid welded tuff, hornfels	Intruded by Badu Granite	Older than U. Carboniferous
	Muralug Ignimbrite	+150	Rhyolite welded tuff, rhyolite, breccia		
	Goods Island Ignimbrite	+80	Dacite, rhyodacite, and dellenite welded tuff; some sediments		
	Endeavour Straits Ignimbrite	+100	Rhyolite welded tuff; some agglomerate, breccia, rhyolite and andesite		Hornfelsed locally
	Eborac Ignimbrite	+100	Rhyolite welded tuff; some rhyolite and agglomerate		
L. Carboniferous	Pascoe River Beds	1000	Sandstone, arkose, greywacke, siltstone, shale; some chert, tuff, coal, and conglomerate	Covered unconformably by Janet Ranges Volc	Folded and faulted; base unseen

Pl. 9, fig. 1 Gently dipping carbonaceous siltstone, Pascoe River Beds

Pl. 9, fig. 2 Banded silicified siltstone, Pascoe River Beds

In the Georgetown Inlier the volcanics are intruded by Middle Carboniferous to Lower Permian high-level granitic rocks which Branch (1966) considers to be genetically related to the volcanics. The volcanics near Iron Range and in Torres Strait are also intruded by high-level granite and adamellite; the Upper Carboniferous Badu Granite in Torres Strait is probably related to the volcanics, but the relationship of the Lower Permian Weymouth Granite to the volcanics near Iron Range is uncertain. Recrystallization of the volcanics by the granitic rocks has occurred over considerable areas, and is more widespread and intense near Iron Range and in Torres Strait than in the Goergetown Inlier. In Torres Strait the volcanics have also been altered and mineralized, probably as a result of late-stage hydrothermal activity related to the intrusive rocks.

At the south end of the Yambo Inlier, volcanic rocks near Mount Mulgrave homestead on the Mitchell River have been included in the Nychum Volcanics, one of the volcanic units of the Georgetown Inlier described previously by Morgan (1961), Branch (1966), and de Keyser & Lucas (1969); only a brief description of them is given in this Bulletin. The volcanics in the Iron Range region crop out as three main sequences, each of which is geographically distinct and is probably composed of rocks erupted from a distinctive centre (Fig. 21). These three separate sequences have been named respectively the Janet Ranges Volcanics, the Kangaroo River Volcanics, and the Cape Grenville Volcanics (Whitaker & Willmott, 1969a). Other small outcrops of volcanic rocks east of Iron Range airport and at the 2nd Red Rocky Point have not been named. In Torres Strait the Torres Strait Volcanics (Whitaker & Willmott 1969b) crop out on numerous islands between the mainland of Cape York Peninsula and the coast of Papua at Mabaduan. Much of their original outcrop is now covered by the sea and by younger sedimentary rocks in Cape York Peninsula and in Papua. Their great extent suggests they were erupted from a number of centres, although none has been recognized. The welded tuffs in Torres Strait are distinctly different from those in the Iron Range district; the latter have far fewer phenocrysts and more pumice and rock fragments, and rhyolite lava is also more common near Iron Range. The two areas are thought to have formed discrete provinces during the same broad period of activity.

Age

No isotopic ages have been obtained from the volcanics. The Torres Strait Volcanics have been intruded by the Badu Granite, which has an upper Carboniferous age of 295$\pm$5 m.y. (Richards & Willmott, 1970). The high-level nature of this granite indicates that the volcanics may be comagmatic with it.

The Janet Ranges Volcanics are younger than the Lower Carboniferous Pascoe River Beds and older than the Lower Permian Weymouth Granite, and the other volcanic rocks in the Iron Range district probably have a similar age. If the Lower Permian Weymouth Granite is related to or even comagmatic with the volcanics, which is likely as it is a high-level granite closely associated with them, then they represent a period of vulcanism distinctly later than the vulcanism in Torres Strait. Alternatively the vulcanism may be contemporaneous in the two provinces, and the Weymouth Granite may not be genetically related to the volcanics.

Lower Carboniferous or earlier vulcanism occurred in the Iron Range district, as the Pascoe River Beds contain fragments of acid volcanic rocks; it is possible that some of the acid volcanics mapped as Lower Carboniferous to Lower Permian are products of earlier activity.

Petrography and chemistry

The volcanics consist mainly of rhyolite welded tuff and rhyolite flows with minor amounts of dellenite, rhyodacite and dacite welded tuffs, andesite, and basalt. The names of the rocks are based mainly on their chemical composition. Analyses of 23 volcanic rocks are given in Tables 4 and 5.

The rhyolite welded tuffs contain phenocrysts of quartz, alkali feldspar, plagioclase and, rarely, ferromagnesian minerals. The rocks from Torres Strait contain up to 60 percent phenocrysts compared with 20 percent in the Iron Range district. The alkali feldspar in the volcanics from the Iron Range district is untwinned; in the Torres Strait Volcanics it shows very fine cross-hatched twinning and maybe anorthoclase. Plagioclase phenocrysts are generally uncommon, except in the welded tuffs of the Endeavour Strait Ignimbrite, where they appear to be oligoclase. Fragments of altered hornblende and biotite are also scarce.

The fragments of pumice range from large blocks to microscopic shards. The lenticular fragments of collapsed pumice give the rock a eutaxitic texture. In some specimens from the Janet Ranges Volcanics the pumiceous lenses are extremely thin and elongate, and appear to have undergone extreme compaction before welding was completed. Except in one or two specimens, the pumice is completely devitrified to spherulitic and axiolitic intergrowths of quartz, feldspar, and green amphibole. Where the rock as a whole has been considerably devitrified, or even recrystallized by granitic rocks, the pumice fragments can still generally be recognized by their coarser devitrification or recrystallization products. The rock fragments generally consist of structureless devitrified acid rocks, welded tuff similar to the host rock, and intermediate rocks. Small aggregates of coarsely intergrown plagioclase and amphibole or chlorite, resembling partly digested fragments of coarse andesite, are present in the Endeavour Strait Ignimbrite.

Although the groundmass is almost invariably devitrified, glass shards are commonly still visible in many specimens, especially in those from Torres Strait. From the degree of compaction of the shards, most of the rocks appear to be moderately to densely welded. The devitrification has produced a microcrystalline intergrowth of quartz and feldspar, rarely with green amphibole or chlorite.

Dellenite, rhyodacite, and dacite welded tuffs form the bulk of the Good Island Ignimbrite, and the same rock types occur in the lower member of the Kangaroo River Volcanics. One or two similar bands also occur near the base of the Muralug Ignimbrite. In Torres Strait these rock types are closely similar in texture to nearby rhyolite welded tuff in the Endeavour Strait Ignimbrite. In the less acid rocks plagioclase phenocrysts predominate over quartz and alkali feldspar, and ferromagnesian

TABLE 4. CHEMICAL ANALYSES, VOLCANICS FROM IRON RANGE DISTRICT

	1	2	3	4	5	6	7	8	9	10	11
SiO_2	74.54	77.99	75.66	76.26	66.56	51.54	53.21	77.01	75.37	74.75	74.83
Al_2O_3	13.06	12.34	12.72	12.44	14.93	18.61	17.01	12.63	12.68	13.18	13.21
Fe_2O_3*	2.41	1.44	1.55	1.99	4.55	10.13	9.39	1.19	2.07	1.66	1.66
MgO	0.17	0.03	0.24	0.09	1.65	3.88	3.85	0.15	0.07	0.36	0.12
CaO	0.79	0.11	0.76	0.59	4.38	9.54	9.63	0.16	0.60	0.98	0.97
Na_2O	2.58	3.03	3.12	2.90	2.79	3.35	4.43	3.52	4.05	3.19	3.33
K_2O	5.55	5.20	5.24	4.99	3.21	0.94	0.76	4.97	4.40	5.32	5.35
TiO_2	0.20	0.10	0.10	0.13	0.89	1.56	1.49	0.16	0.17	0.16	0.15
P_2O_5	0.08	0.03	0.04	0.04	0.17	0.23	0.23	0.05	0.04	0.03	0.05
MnO	0.02	0.02	0.03	0.04	0.06	0.16	0.14	0.01	0.03	0.04	0.04
Loss on ignition	2.55	0.81	0.54	0.70	0.51	2.34	1.57	1.09	0.50	0.59	2.55
Total+	99.40	100.29	99.46	99.47	99.19	99.94	100.14	99.85	99.48	99.67	99.71

* Total iron as Fe_2O_3

\+ Does not include loss on ignition

Janet Ranges Volcanics

1. Recrystallized rhyolite welded tuff, Garraway Cr. 3 km upstream from junction with Brown Cr. (BMR 68480144).
2. Recrystallized rhyolite welded tuff, 5 km W of Garraway Hill. (BMR 68480146).
3. Rhyolite welded tuff, 6 km WNW of Garraway Hill. (BMR 68480145).
4. Rhyolite welded tuff, 5 km W of Garraway Hill. (BMR 68480147).
5. Dacite welded tuff, 11 km W of mouth of Pascoe R. (BMR 67480330).

Kangaroo River Volcanics

6. Altered andesite or basalt, 2 km SW of Baldy Hills. (BMR 67480266).
7. Altered andesite, 5 km WSW of Baldy Hills. (BMR 67480377).

Cape Grenville Volcanics

8. Rhyolite welded tuff, Indian Bay, C. Grenville. (BMR 68480149).
9. Rhyolite welded tuff, northern island of Sir Charles Hardy I. (BMR 67480315).

Undivided Volcanics

10. Rhyolite welded tuff, Lloyd I. (BMR 68480142).
11. Rhyolite welded tuff, Lloyd I. (BMR 68480143).

Analysed by G.H. Berryman (BMR) by x-ray fluorescence method.

TABLE 5. CHEMICAL ANALYSES, TORRES STRAIT VOLCANICS

	1	2	3	4	5	6
SiO_2	74.45	75.74	76.89	76.33	75.55	61.50
Al_2O_3	15.43	12.38	11.95	12.92	13.02	16.50
Fe_2O_3*	0.59	1.86	1.96	1.54	1.86	7.72
FeO	0.38					
MgO	tr	0.46	0.04	0.50	0.12	1.82
CaO	0.44	0.45	0.93	1.16	1.15	4.30
Na_2O	0.97	3.18	2.94	2.83	3.34	3.56
K_2O	5.87	5.11	4.87	4.81	4.76	2.62
TiO_2	0.10	0.17	0.17	0.13	0.16	1.40
P_2O_5	-	0.06	0.05	0.05	0.05	0.29
MnO	-	0.02	0.02	0.05	0.03	0.07
Loss on ignition	2.47	0.71	0.99	0.44	1.39	1.98
Total+	98.23	99.43	99.82	100.32	100.04	99.78

* Total iron as Fe_2O_3 (excluding analysis 1)

\+ Does not include loss on ignition

Eborac Ignimbrite

1. 'Quartz porphyry', Eborac I. Analyst, S.A. Tout (Richards & Hedley, 1925; Jones & Jones, 1956)
2. Rhyolite welded tuff, summit Eborac I. (BMR 68480140)
3. Rhyolite welded tuff, Forbes Hd, Mt Adolphus I. (BMR 68480073)

Endeavour Strait Ignimbrite

4. Rhyolite welded tuff, E end Thursday I. (BMR 68480109)
5. Rhyolite welded tuff, Red I. (BMR 68480135)
6. Andesite, 1 km W of Cowal Cr. Settlement. (BMR 68480075)

Table 5 continued

	7	8	9	10	11	12	13
SiO_2	68.56	71.75	64.13	73.81	73.75	75.03	74.96
Al_2O_3	15.12	14.57	17.02	13.20	11.78	11.71	13.77
Fe_2O_3*	3.32	2.63	5.15	2.63	1.83	1.70	0.99
FeO							
MgO	0.74	0.57	1.79	0.24	0.11	0.03	0.13
CaO	3.11	2.79	5.09	0.87	0.49	0.60	0.39
Na_2O	3.39	2.68	3.14	2.90	3.05	3.38	4.39
K_2O	3.83	3.95	2.60	5.65	5.20	5.11	5.06
TiO_2	0.37	0.30	0.59	0.24	0.16	0.14	0.19
P_2O_5	0.11	0.09	0.17	0.05	0.04	0.03	0.04
MnO	0.05	0.05	0.08	0.04	0.02	0.02	0.07
Loss on ignition	0.75	0.70	0.78	1.52	0.85	0.48	0.65
Total+	98.60	99.38	99.76	99.63	96.43	97.75	99.99

Goods Island Ignimbrite

7. Rhyodacite welded tuff, 2½ km W of Heath Pt, Prince of Wales I. (BMR 68480137)
8. Dellenite welded tuff, SW corner Hammond I. (BMR 68480047)
9. Dacite welded tuff, SW corner Hammond I. (BMR 68480046)

Muralug Ignimbrite

10. Rhyolite or dellenite welded tuff, S coast Prince of Wales I. opposite Packe I. (BMR 68480013)
11. Rhyolite or dellenite welded tuff, Northwest Islet, Prince of Wales I. (BMR 68480015)
12. Rhyolite welded tuff, Hochepied Hd, Prince of Wales I. (BMR 68480136)

Undivided Volcanics

13. Rhyolite welded tuff, SW corner Gabba I. (BMR 68480180)

Analysed by G.H. Berryman (BMR) by X-ray fluorescence method (except analysis 1)

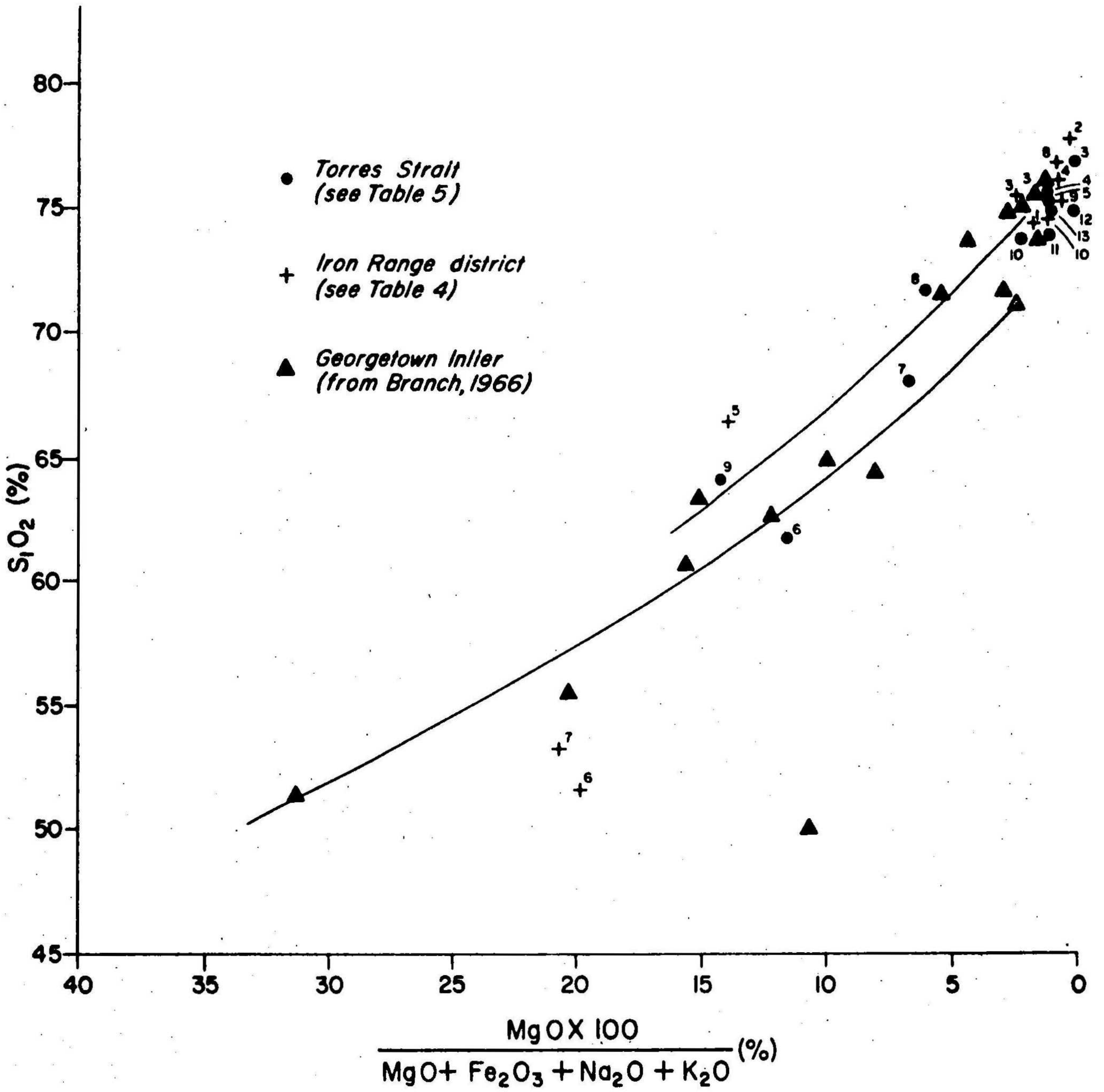


Fig. 8 Solidification index (Kuno, 1959), Palaeozoic acid volcanics

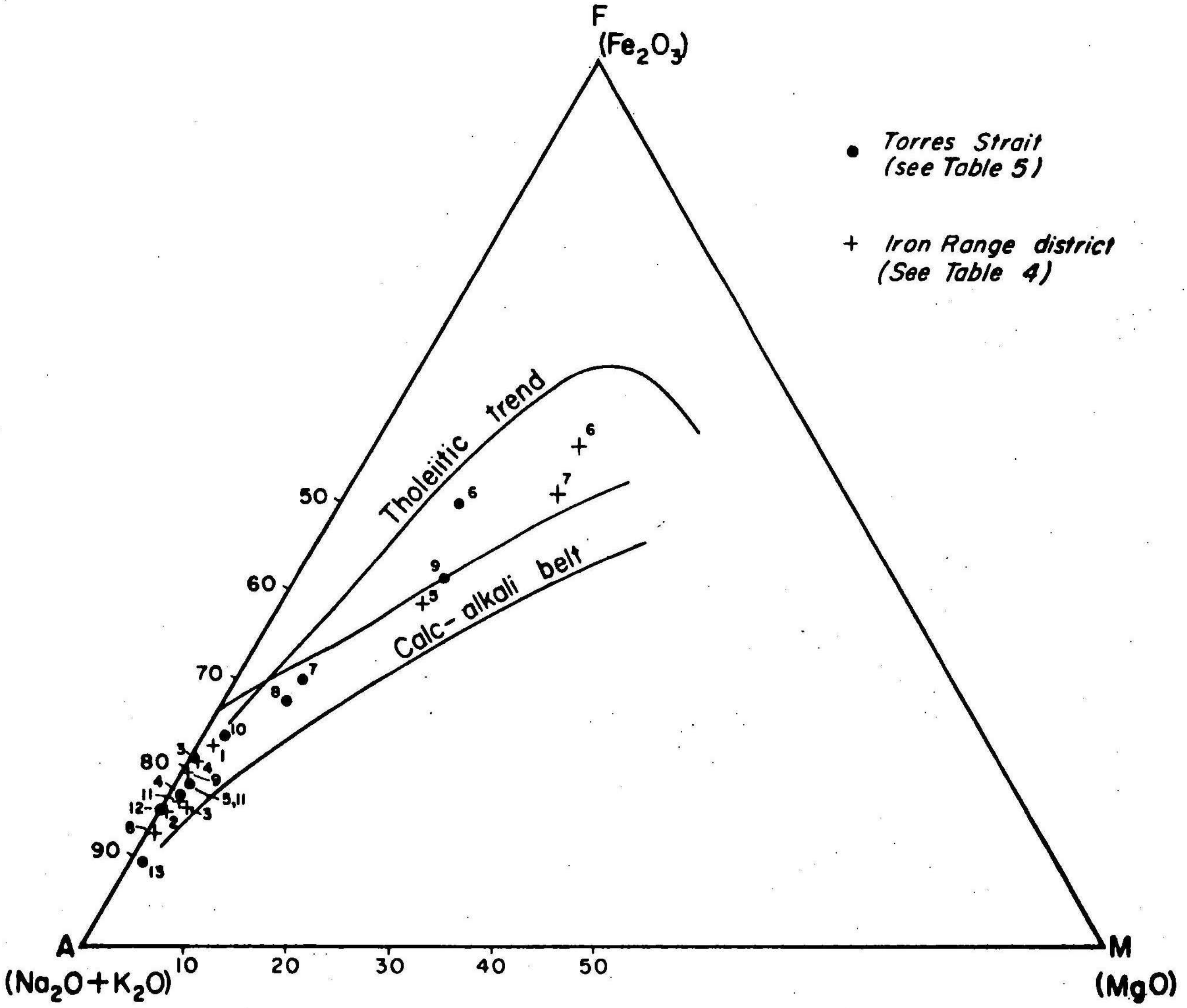
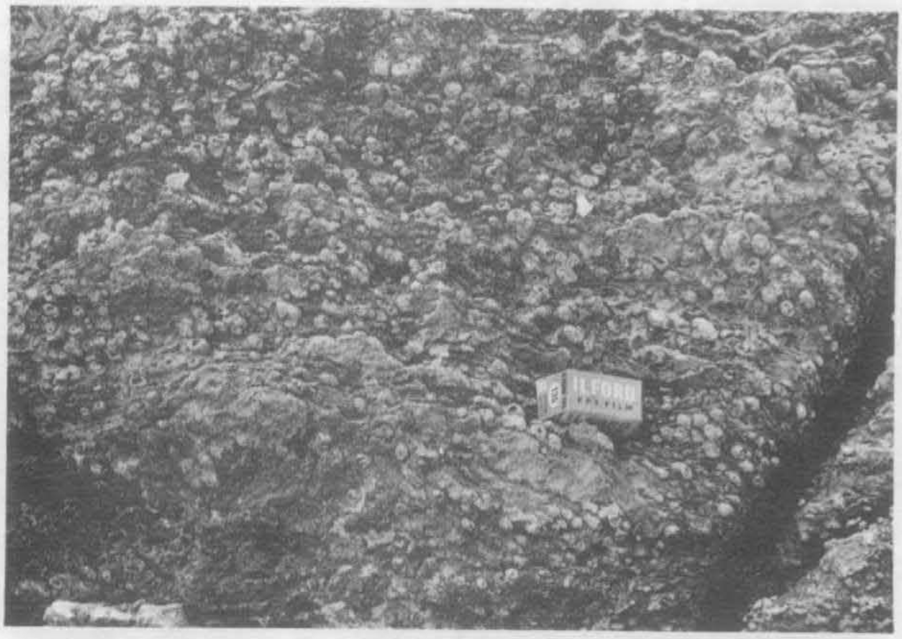
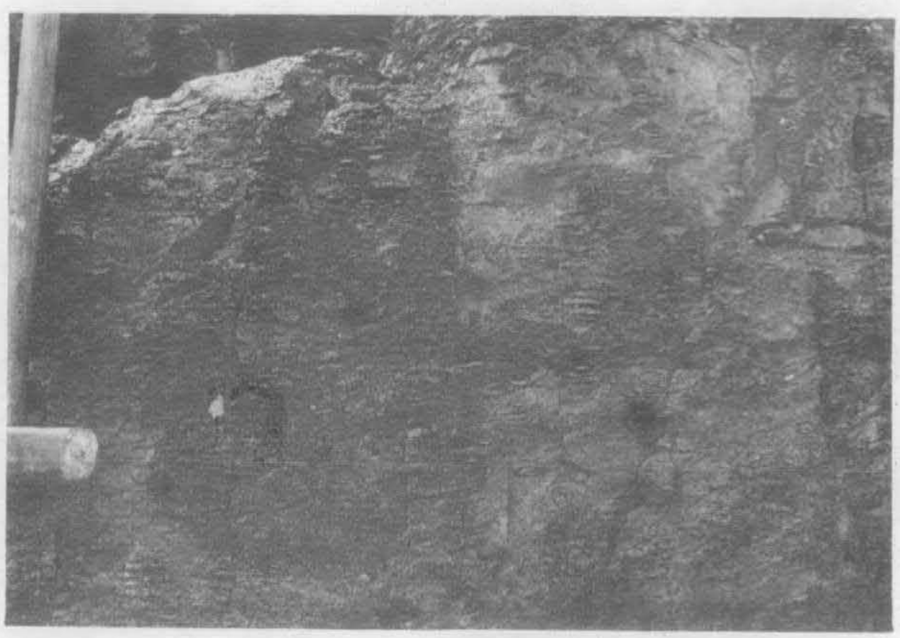


Fig. 9 FMA diagram, Palaeozoic acid volcanics

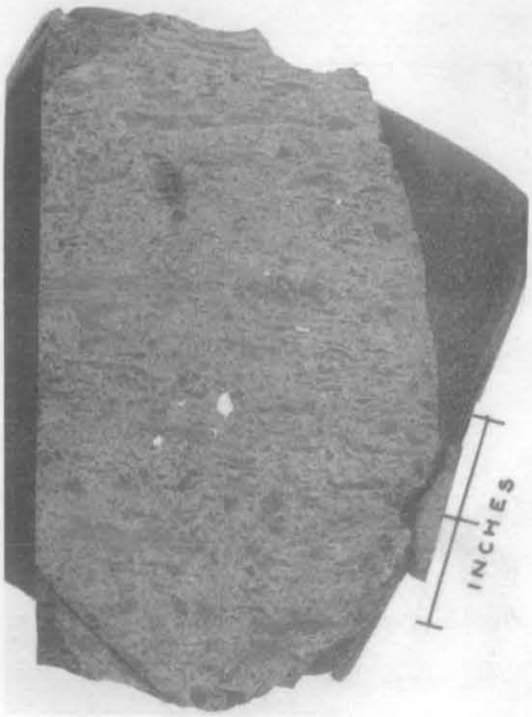


Pl. 10, fig. 1 Spherulites in rhyolite, Cape Grenville Volcanics

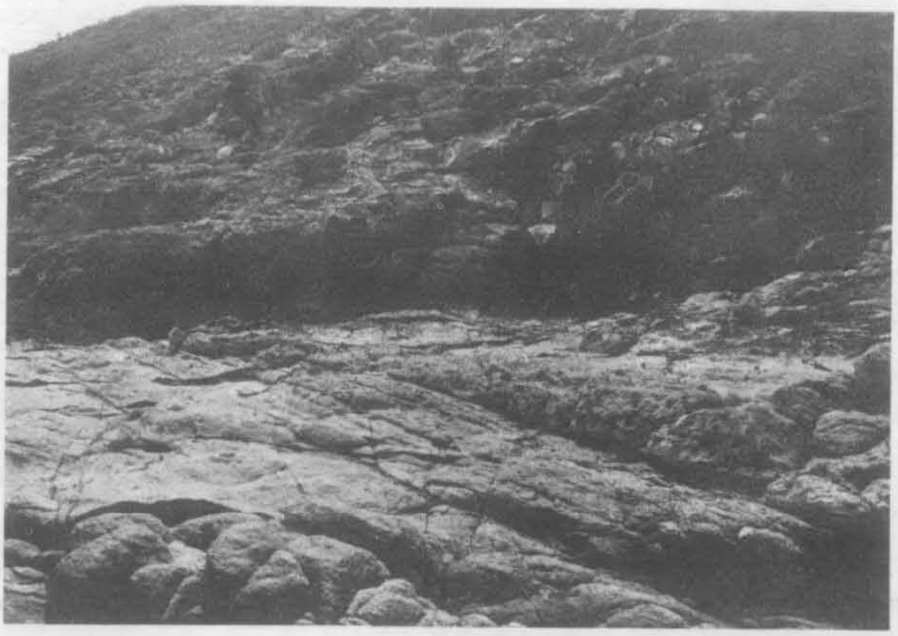


Pl. 10, fig. 2 Collapsed fragments of pumice in welded tuff, Cape Grenville Volcanics

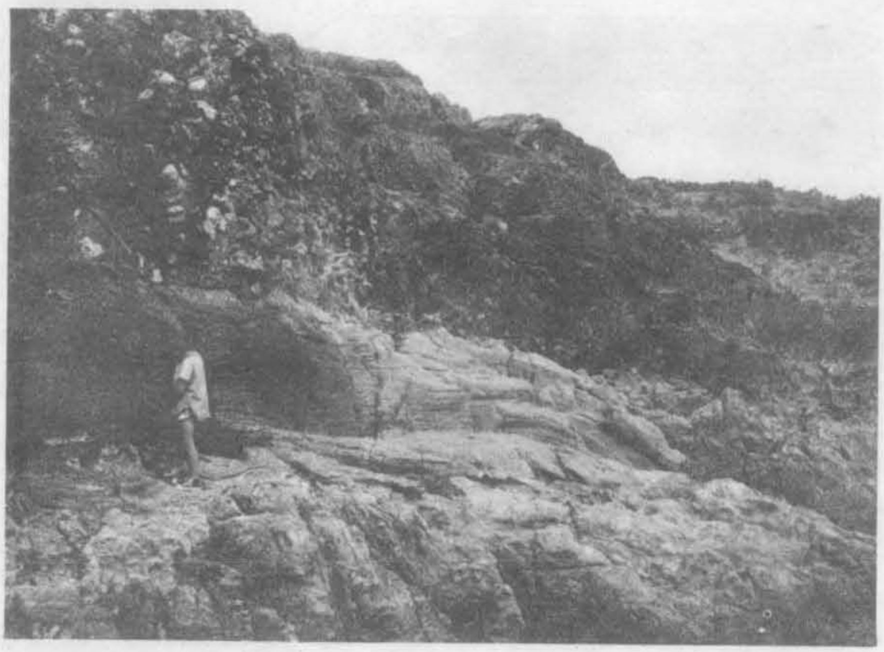
Pl. 11, fig. 1 Flow-banded rhyolite, Cape Grenville Volcanics



Pl. 11, fig. 2 Eutaxitic texture in welded tuff, Lloyd Islands. Note numerous lenses of devitrified pumice



Pl. 12, fig. 1 Bedded agglomerate overlain by massive welded tuff, Cape Grenville Volcanics



Pl. 12, fig. 2 Tongue of rhyolite penetrating agglomerate, Cape Grenville Volcanics minerals are more common; the proportion of phenocrysts present is as high, or higher than in the more acid rocks; pumice fragments are less common but rock fragments are more prevalent, and the groundmass has been devitrified to quartz, feldspar, and green amphibole. The dacite, and rhyodacite(?) welded tuffs of the Kangaroo River Volcanics contain far fewer phenocrysts than those in Torres Strait, and are more extensively devitrified. They also contain abundant rock fragments.

The petrography of the rhyolite and other welded tuffs of the four members of the Torres Strait Volcanics is summarized in Table 5. In general the welded tuffs from the Iron Range district contain far fewer phenocrysts (between 10 and 20%) and more pumice and rock fragments than the tuffs from Torres Strait. Glass shards are less commonly visible and the rocks appear to be more densely welded than those in Torres Strait. The petrography of the Iron Range rocks is not so easily made out as it is in the rocks from Torres Strait, since they have been considerably devitrified and incipient recrystallization caused by the granitic rocks is widespread.

Banded rhyolite flows occur mainly in the Janet Ranges Volcanics and the Cape Grenville Volcanics, but some rhyolite lava flows are present in Torres Strait. The abundant spherulites generally present probably result from the devitrification of the glassy lavas; in thin section the rocks are seen to be completely devitrified, with axiolitic texture developed along the flow bands.

Andesite is the most basic rock present in the volcanics, with the exception of specimen (Analysis 6, Table 4) from the Kangaroo River Volcanics; this is a high-alumina basalt similar to basalt from the Nychum Volcanics in the Georgetown Inlier, described by Morgan (1961). The andesite and the basalt are very fine-grained, non-porphyritic rocks, which consist mainly of a meshwork of plagioclase laths with minor interstitial green-brown hornblende. Some specimens are coarser, with plagioclase laths up to 5 mm long. Most of the andesite in the Kangaroo River Volcanics is slightly altered.

The chemical analyses have been used mainly to identify the rock series to which the volcanics belong, and to compare them with the similar volcanics from the Georgetown Inlier. Following Branch (1966) the solidification index (Kuno, 1959) has been plotted against silica (Fig. 8): on such a diagram calc-alkali rocks plot as a diagonal line, while tholeiitic and alkali rocks plot as a nearly horizontal line at almost constant silica as the solidification index decreases, until at low values of the index the silica increases rapidly. Although available analyses of basic and intermediate rocks are insufficient to show any definite trend, the volcanics from the Iron Range district and Torres Strait appear to fall on a diagonal line of the calc-alkali type, similar to the line for the volcanics of the Georgetown Inlier. When plotted on an FMA diagram (Fig. 9) the analyses fall between the typical tholeiite trend of Tilley (1950) and the calc-alkaline belt. Branch reports the same result for the Nychum Volcanics and for a volcanic sequence described by Oliver (1961).

Upper Palaeozoic Intrusive Rocks

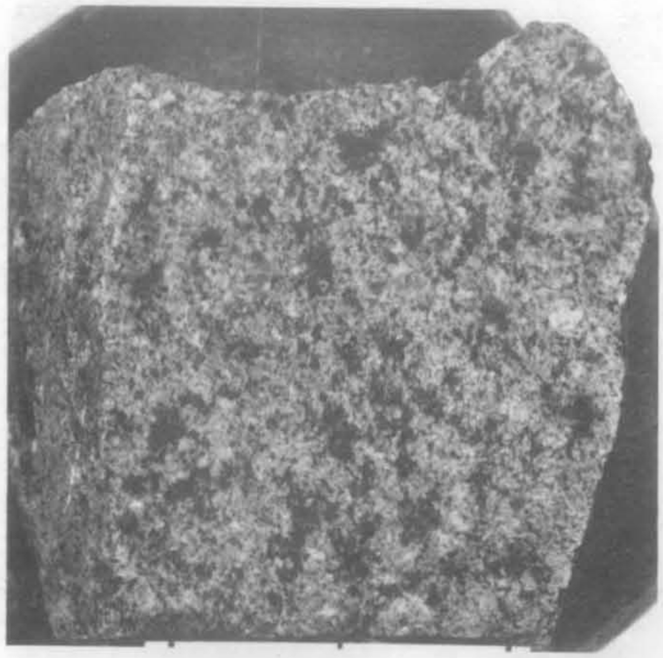
Upper Palaeozoic granitic rocks (Table 3) are exposed over more than 1700 sq km in the northern part of Cape York Peninsula; they crop out across Torres Strait, in the Iron Range district, and near Coen. They intrude the acid volcanics described in the previous section, and have been dated isotopically as Upper Carboniferous and Permian. In the Iron Range district the Weymouth Granite consists of a large pluton 65 km long, and a number of smaller stocks and offshoots. Small bodies of diorite occur on the margin of the granite and within the granite, and granophyric and hybrid rocks crop out as an elongate belt along its western margin. Some small bodies of dolerite may also be associated with the granite. Farther south Upper Palaeozoic granitic rocks also crop out near Bald Hill, the Wolverton Adamellite, and near Coen, the Twin Humps Adamellite. In Torres Strait several types of granite have been collectively named the Badu Granite. The associated small bodies of porphyritic microgranite and numerous acid and intermediate dykes cutting the granite are considered to belong to the same intrusive episode.

The Upper Palaeozoic granitic rocks are typical high-level granites associated with acid to intermediate volcanics (Joplin, 1964, p. 183). They form suboval plutons with sharp contacts, are commonly porphyritic, and in places contain many xenoliths. They generally contain orthoclase rather than microcline. Micrographic intergrowths are common, especially in the hybrid and granophyric rocks marginal to the Weymouth Granite and in the leucocratic biotite granite phase of the Badu Granite, where small miarolitic cavities are also present. Most intrusions are surrounded by an extensive aureole of recrystallized country rocks. In the Iron Range district the granitic rocks are accompanied by minor mineralization introducing tin, gold and wolfram, and in Torres Strait by mineralization introducing tin, wolfram, gold, copper, lead and pyrite.

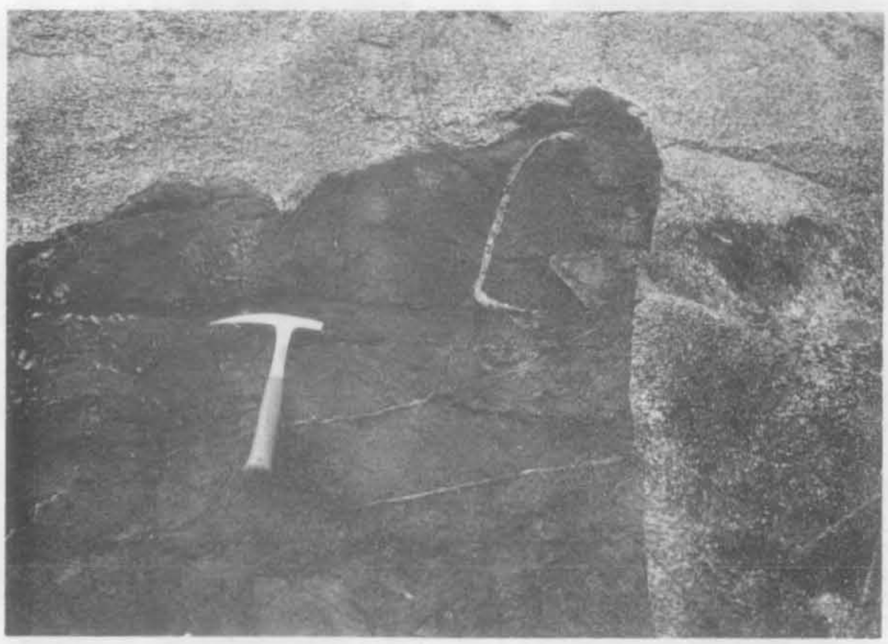
Age

K/Ar dating on biotite indicates an Upper Carboniferous age of 295 ∓ 5 m.y. for the Badu Granite (Richards & Willmott, 1970), Lower Permian ages of 262 and 273 m.y. for the Weymouth Granite, and an early Upper Permian age of 253 m.y. for the Twin Humps Adamellite (Appendix 1; Trail et al., 1969). These rocks are similar in age to high-level granites which are comagmatic with the Middle Carboniferous to Lower Permian volcanics of the Georgetown Inlier (Branch, 1966). The Upper Carboniferous Badu Granite may be comagmatic with the Torres Strait Volcanics, but the relation between the younger Weymouth Granite and the volcanics in the Iron Range district is less certain.

The Wolverton Adamellite has many features in common with the Weymouth Granite and is probably closely related to it in origin and age, but the early Upper Permian Twin Humps Adamellite apparently represents an event distinctly younger than the Lower Permian Weymouth Granite.



Pl. 13, fig. 1 Clots of ferromagnesian minerals in hybrid adamallite



Pl. 13, fig. 2 Contact between Weymouth Granite and hornfelsed Janet Ranges Volcanics

Mesozoic Sediments

The Precambrian and Palaeozoic basement rocks of Cape York Peninsula and Torres Strait are overlain and surrounded by gently dipping Mesozoic sediments of the Laura, Carpentaria, and Papuan Basins. These sediments (Table 4) were not examined in detail during this survey, and only a brief description is given here; they are shown on the map only as undivided Mesozoic sediments, though names applied by previous investigators are used in the discussion below. The sediments of the Laura Basin have been described by de Keyser & Lucas (1969), and those of the Papuan Basin by the Australasian Petroleum Co. Pty (APC, 1961). Parts of the Carpentaria Basin have been examined by Morton (1924), Woods (1961), AAP, (1965), and de Keyser & Lucas (1969); Meyers (1969) summarizes the available information. The Carpentaria Basin is at present being mapped by a combined party of the Bureau of Mineral Resources and Geological Survey of Queensland.

Laura Basin

Sediments on the western flank of the Laura Basin overlie the basement rocks on the eastern margin of the Yambo Inlier and the south-eastern margin of the Peninsula Ridge, between the Palmer and Morehead Rivers. They form part of the Lower Cretaceous Battle Camp Formation, named and described by de Keyser & Lucas (1969). The sediments consist of current-bedded pebbly sandstone, with a basal bed of conglomerate containing pebbles and cobbles of quartzite from the underlying metamorphic rocks. The sandstone is predominantly medium-grained and is very poorly sorted; it consists mainly of quartz with a little kaolinized feldspar and muscovite. Cross-beds are common, and graded beds up to 5 cm thick were noted in a few exposures. The sequence of sandstone and conglomerate appears to be thickest in depressions in the basement surface, which has a relief ranging up to 100 m .

The southern part of the plateau known as The Desert, consists of Mesozoic sediments connecting the Laura and Carpentaria Basins. The sequence comprises fine-grained sandstone, siltstone, and claystone overlying sandstone and conglomerate which probably represent the upper part of the formation; in this area the boundary between the Battle Camp Formation and the Wrotham Park Sandstone (Amos & de Keyser, 1964) of the Carpentaria Basin is indistinct and the two are in part lateral. equivalents.

On the coast at Princess Charlotte Bay cross-bedded quartz sandstone and conglomerate with pebbles of quartzite, schist, and ferricrete from a low ridge which ends in a headland near the mouth of Gorge Creek, 25 km south of the Stewart River. They are similar to the sediments on the nearby Cliff Islands which were considered by Lucas (1963) to be Cretaceous or Lower Tertiary. The poorly consolidated cross-stratified sandstone exposed in a low sand-covered ridge rising from the coastal plain north of Silver Plains homestead may be of the same age.

Carpentaria Basin

Sediments of the Carpentaria Basin overlie the basement rocks along the western margin of the Peninsula Ridge and the Yambo Inlier, and the southern margin of Torres Strait. Almost everywhere the basal part of the sequence consists of pebbly sandstone with conglomerate, overlain by fine-grained siltstone, mudstone, and shale; in a few places the siltstone sequence rests directly on the basement.

At the base of the sandstone sequence there is generally about 3 m of conglomerate containing pebbles, cobbles, and boulders of quartzite, schist, granite, and volcanic rocks. North of Bald Hill the conglomerate is up to 30 m thick. Between Wenlock and the Pascoe River some thin beds of shale and coal are present in the conglomerate (Morton, 1924; AAP, 1965). The sandstone, which forms the bulk of the sequence, is medium-grained to coarse-grained and poorly sorted; well developed current-bedding is usually present. The sandstone is generally leached, and most exposures are paved with ferricrete.

In the south between the Mitchell and Coleman Rivers, with the exception of The Desert region, the sandstone sequence is generally less than 30 m thick; in a few places the sandstone is absent and the overlying siltstone rests directly on the basement. North of the Coleman River the sandstone ranges up to 60 m thick and contains many beds of conglomerate, especially where it fills depressions in the basement. West of Coen the sequence thins to less than 30 m, but it thickens greatly farther north in the Geikie and Sir William Thompson Ranges, where Australian Aquitaine Petroleum (AAP, 1965) record 600 m of sandstone and conglomerate. Between Temple Bay and Cape York AAP estimate the sequence to be over 250 m thick.

In the south near the Mitchell River the sandstone sequence has been referred to as the Wrotham Park Sandstone by de Keyser & Lucas (1969). Woods (1961) considers it to be Neocomian, as it underlies the Aptian Blackdown Formation. Across The Desert the Wrotham Park Sandstone grades into the Battle Camp Formation of the Laura Basin.

In the north, between the Archer River and Cape York, Australian Aquitaine Petroleum (AAP, 1965) have informally named and subdivided the sandstone sequence into a number of formations or members. Fossil plants collected by Morton near the base of the sequence at Wenlock were determined as Lower Cretaceous by Walkom (1928). Whitehouse (1954) notes that Aptian fossils have been found a few miles south of Cape York, within the sandstone sequence.

The siltstone sequence crops out to the west of the underlying sandstone and conglomerate; it is composed of siltstone, mudstone, shale, and fine-grained silty sandstone. In the south near the Mitchell River the sequence has been referred to as the Blackdown Formation by de Keyser & Lucas (1969), and Woods (1961) considers it to be Aptian. North of the Archer River it has been termed the Mein Formation by Morton (1924); Australian Aquitaine Petroleum (AAP, 1965) estimate that it is over 60 m thick, and thickens westward. The abundant macrofossils and microfossils indicate a Neocomian to Albian age (Morton, 1924; Crespin, 1956; Cookson & Eisenack, 1958, 1960; Eisenack & Cookson, 1960; Fleming, 1965; Evans, 1966).

TABLE 6. MESOZOIC AND CAINOZOIC STRATIGRAPHY

Age	Formation	Thickness	Rock Type	Relationships	Remarks
Pleistocene?	Maer Volcanics	+ 250	Olivine basalt basaltic tuff	Contains fragments of Cainozoic limestone	Contemporaneous with basic volcanoes of Atherton Tableland and Highlands of New Guinea
Tertiary	Yam Creek Beds	1-60	Poorly consolidated sandstone; some conglomerate	Unconformable on Palaeozoic rocks	Possibly lake deposits along Pascoe R. and tributaries
	Lilyvale Beds	1-45	Poorly consolidated sandstone and conglomerate	Unconformable on rocks of batholith	River deposits following Tertiary uplift
			Olivine nephelinite	Plug in metamorphics	Probably contemperaneous with nephelinite at Cooktown
			Limestone; some mudstone, sandstone, and conglomerate	Unconformable on Palaeozoic volcanics	Only in SW Papua
Mesozoic		Up to 1500	Sandstone, siltstone, conglomerate	Unconformable on granitic, volcanic, and metamorphic rocks	Lateritized pyritic shale drilled in NE Torres Strait

Papuan Basin

The Mesozoic sediments of the Papuan Basin north of Torres Strait are not exposed and are only known from petroleum exploration wells. They consist of continental Jurassic arkosic sandstones with seams of coal and lignite, and marine Lower Cretaceous glauconitic quartz sandstone and silty mudstone (APC, 1961). They were deposited on a shelf formed by the slowly subsiding northern extension of the Australian continental platform. The sediments have an average thickness of about 1000 m, but thin to about 100 m over a basement ridge in the Oriomo area.

Seismic and magnetic surveys by Gulf Interstate Overseas Ltd (Gulf, 1962, 1965), Tenneco Australia Inc. (Tenneco, 1967, 1968), and Phillips Australian Oil (Phillips, 1965, 1968) suggest that Mesozoic sediments continue southwards into the northeastern part of Torres Strait where they drape irregularities in the basement and are faulted in a complex fashion. The Anchor Cay well passed through about 1500 m of Lower Cretaceous sandstone and siltstone, and Jurassic deep-water pyritic shale before approaching basement (Oppel, 1969); the pyritic shales are in marked contrast to the continental Jurassic sediments farther north. To the west and south the sediments apparently onlap basement rocks, but there may be a narrow northerly trending connexion between the Papuan Basin and the Carpentaria Basin between the southern end of the Warrior Reefs and Shelburne Bay.

Cainozoic Sediments

The basement rocks of the Peninsula Ridge are overlain in many places by thin deposits of poorly consolidated continental sandstone named the Lilyvale Beds and Yam Creek Beds, and by residual sand, alluvium, dune sand, and coastal marine sediments (Table 4). Both the basement rocks and the surrounding Mesozoic sediments are in places capped by a layer of ferricrete. North and northeast of Torres Strait the basement rocks and Mesozoic sediments of the Papuan Basin are overlain by a considerable thickness of Tertiary and Quaternary sediments. Coral reefs are abundant in Torres Strait, and form the Great Barrier Reef on the edge of the continental shelf.

The Cainozoic sediments were not examined in detail during this survey, and are only described briefly. The sediments of the Papuan Basin north and northeast of Torres Strait have been described in detail by the Australasian Petroleum Co. Pty, (APC, 1961); Stach, (1964); Gulf International Overseas Ltd (Gulf, 1965); Tenneco Australia Inc. (Tenneco, 1967); Thompson, (1967); Rickwood, (1968); Phillips Australian Oil (Phillips, 1968); and Oppel, (1969).

Cape York Peninsula

The Lilyvale Beds were named by Whitaker & Willmott (1968) from Lilyvale homestead in the eastern part of the Ebagoola 1:250,000 Sheet area. They form blanket deposits on the country below the eastern escarpments of the Coleman and McIlwraith Plateaux, and below the western escarpment of the McIlwraith Plateau in the Archer River Piedmont Basin.

They are generally covered by residual sand or alluvium, but are well exposed in the smaller streams, especially near the base of the escarpments. Scattered outcrops of similar rocks are common on the Holroyd Metamorphics and in the Yambo Inlier. Small exposures of unnamed but similar sediments occur in the central parts of Moa and Wednesday Islands in Torres Strait.

The beds are composed of poorly consolidated clayey sandstone and conglomerate. The rocks are friable, massive, and poorly sorted, and are characteristically developed where they overlie granitic rocks. The presence of angular quartz pebbles derived from quartz veins in the nearby granite indicates that the sediments have not been transported far from their source. The rocks weather to a characteristic honeycomb-pattern of small saucer-shaped depressions a few centimetres deep separated by sharp ridges.

The Lilyvale Beds are up to 10 m thick and generally appear to be horizontal. Lucas & de Keyser (1965b) have noted 45 m of clayey sandstone and grit, which may be Lilyvale Beds, in the Marina Plains 1 well, about 10 km south of Marina Plains homestead. Their thickness in the Archer River Piedmont Basin may also exceed 30 m.

The Yam Creek Beds were defined by Whitaker & Willmott (1969a) as poorly consolidated clayey sandstone and conglomerate which form elevated dissected plains around the Pascoe River and its tributaries, in the Cape Weymouth Sheet area. They were previously referred to informally as the Brown Creek Grit by the Broken Hill Pty Co. Ltd (BHP, 1962) and the Yam Creek Formation by Australian Aquitaine Petroleum (AAP, 1965).

The beds are generally more than 15 m thick but range up to 60 m in places; they are capped by up to 3 m of ferricrete. They contain less conglomerate and are generally finer grained than the Lilyvale Beds. They form elevated platforms which generally rise about 15 m above the level of the Pascoe River and its tributaries, and are covered by poor turkey-bush vegetation. The sediments may have been deposited in a lake formed by the damming of the ancestral Pascoe River following uplift near its mouth, or on an alluviated plain which has since been uplifted and dissected.

The term ferricrete is used for the massive cappings of concretionary ironstone. Ferricrete is almost invariably present on the Mesozoic sandstones overlying basement rocks. It also occurs on metamorphic rocks in the western part of the Holroyd Metamorphics, and is well developed on ridges of magnetite quartzite in the metamorphics at Black Hill in the Iron Range region, where it is rich in manganese as well as iron. Ferricrete also caps the Cainozoic Yam Creek Beds but is rare on the Lilyvale Beds. In Torres Strait it caps some ridges of acid volcanics on Moa Island and Mount Adolphus Island. On Turtle Head Island and on the nearby mainland bauxite or aluminous laterite appears to underlie the ferricrete, according to Connah & Hubble (in Hill & Denmead, 1960).

In many areas ferricrete is exposed in stream valleys at a lower elevation than the ferricrete capping the nearby ridges, as for example in the valley of Laradeenya Creek 12 km southwest of Cape York. Connah & Hubble suggest that these lower ferricretes may be younger, and may be related to present-day groundwater levels. For the older ferricrete they suggest a late Tertiary age.

Beds of white residual quartz sand up to a few metres thick are widespread over the granitic batholith in the Ebagoola and Hann River 1:250,000 Sheet areas, and thinner sheets extend over a large part of the remainder of the area mapped. Quartz sand is also abundant on the Mesozoic sandstones surrounding the igneous and metamorphic rocks. On the low plains of the Laura Basin quartz sand, probably residual, forms interfluvial areas which de Keyser & Lucas (1969) have grouped as the Jack Peneplain. The sand is probably derived from the underlying Lilyvale Beds. In the Ebagoola Sheet area east of Kintore Hill, the residual deposits of the interfluvial areas overlie metamorphic rocks, and the quartz sand lies on dark red micaceous silty soil.

Dune sand between Temple Bay and Shelburne Bay, in the Cape Weymouth and Orford Bay Sheet areas extends over an area of more than 380 sq km. These longitudinal dunes rise up to 100 m above sea level; they are aligned in a northwesterly direction and some that are still active are advancing towards Shelburne Bay. The dunes were probably formed by the prevailing southeasterly winds reworking thick residual quartz sand derived from the underlying Mesozoic sandstone. The dunes west of Newcastle Bay, south of Turtle Head Island, and along the coast of the mainland in the Orford Bay Sheet area, are all developed on Mesozoic sandstone. Patches of small dunes occur near Cape Griffith and south of Cape Direction.

Most of the alluvium ranges from silty clay to silty sand. It has been deposited in the lower reaches of some of the larger streams, such as the Lockhart, Claudie, and Jardine Rivers, and on the low plains of the Laura Basin and the low country east of the granitic escarpment farther north. The alluvium of the Laura Basin forms the Normanby Sediplain (de Keyser & Lucas, 1969) which is slightly lower in elevation than the interfluvial areas of residual sand forming the Jack Peneplain.

In other rivers the alluvium consists of silty sand, and in many areas there is no clear distinction between alluvial and residual sand.

Marine sediments fringe much of the coast of Cape York Peninsula, and many of the islands of Torres Strait. Sand cays have formed on coral reefs offshore.

There is a narrow ridge of quartz sand with subordinate shell debris at the top of most beaches; the sand generally slopes gently beneath the sea, but around Princess Charlotte Bay it is underlain by mud which extends seawards below low-tide level. Where a fringing reef is present, particularly in Torres Strait, the beach sand is mainly composed of fragments of shells and coral, with a thin layer of mud on the dead inshore part of the reef. In places the sand of the beach ridge has been cemented to form beach rock. The series of raised beach ridges which extends up to 15 km inland, around the southern shores of Princess Charlotte Bay indicates an emergence of 3 to 5 m.

In many places along the coast the beach ridge is backed by saline mud flats and mangrove swamps. The most extensive swamps are at the mouths of northerly flowing streams such as the Lockhart and Kangaroo Rivers. On many islands in Torres Strait there is no beach, and the reef flat extends seaward from a fringe of mangrove. The southern coast of Papua is also largely fringed by mangrove swamps.

Coral sand cays are present on the leeward ends of reefs of the platform type. They are formed by foraminiferal, shelly, and coral sand and shingle and are covered by coarse grass or stunted thorn scrub. Some cays, such as Sassie and Dungeness Islands are low and swampy.

Papuan Basin

Cainozoic sediments overlie basement and Mesozoic rocks immediately north of the southern coast of Papua; they extend south-eastwards into Torres Strait to about latitude 10°15'S, south of the Murray Islands. The oldest Cainozoic rocks in the Anchor Cay 1 well in the northeastern part of Torres Strait consist of more than 300 m of Eocene limestone resting unconformably on Mesozoic sediments (Oppel, 1969). Eocene rocks are not present to the northwest in Papua, but are well developed farther northeast in the Gulf of Papua. The top of the Eocene is bounded by an unconformity and no Oligocene strata are known.

During the Miocene an average of about 1000 m of shallow-water limestone was deposited over an extensive shelf covering much of southwest Papua and the northeast part of Torres Strait. The limestone is exposed over a broad area northwest of Daru, and over 1000 m of Miocene limestone was encountered in the Anchor Cay well. Thompson (1967) and Phillips Australian Oil (Phillips, 1968) consider that the eastern edge of the Miocene shelf is marked by a buried barrier reef chain, which extends in a northerly direction from the end of the present Great Barrier Reef to the head of the Gulf of Papua. In the deepening waters east of the shelf edge deepwater basinal limestone was deposited, except in areas of local uplift where platform reefs developed.

After the Miocene, only thin deposits of Pliocene and Pleistocene terrigenous sediments were laid down over most of the shelf of southwestern Papua (APC, 1961; McGregor, 1967; Blake & Ollier, 1970), but on its southeastern edge, in the Anchor Cay area, carbonate sedimentation has continued from the Pliocene to the present day, and more than 800 m of limestone was laid down; it is likely that a barrier reef complex has existed in this region from Miocene time. To the north the barrier reef was buried under a considerable thickness of Pliocene, Pleistocene, and Recent argillaceous sediments, probably following uplift of mountainous areas in Papua.

In southwestern Papua two levels of Recent(?) alluvium have been recognized in the coastal plain by photo-interpretation. This may indicate uplift of the area, and farther west in the Morehead area Blake & Ollier (1970) have recognized warping of Pleistocene sediments.

Coral Reefs

The Great Barrier Reef extends along the edge of the continental shelf from Princess Charlotte Bay as far north as Anchor and East Cays north of the Murray Islands. In the shallow water behind the barrier reefs many platform or patch reefs have grown. The Warrior Reefs in the northern part of Torres Strait are situated on the eastern edge of a shallow shelf, and are so extensive they could be regarded as a subsidiary barrier reef. Platform reefs between the western islands in Torres Strait are markedly elongate in an east-west direction, due to the swift currents that flow through the channels between the islands. Fringing reefs surround most of the islands in Torres Strait but are less common along the coast of Cape York Peninsula. They are poorly developed along the Papuan coast, probably as a result of the suspended sediment brought down by the Fly River and other Papuan streams.

Cainozoic Igneous Rocks

In the far northeast of Torres Strait basic tuff and basalt of Pleistocene age (Table 4) form several small islands, some of which can be recognized as volcanic cones. Although erupted from separate centres, the volcanics have been named collectively the Maer Volcanics (Whitaker & Willmott, 1969b).

To the south in Cape York Peninsula a single exposure of olivine nephelinite, which may be part of a small intrusive plug, occurs 50 km southeast of Coen, and 17 km inland from the western shore of Princess Charlotte Bay. It is similar in composition to the Cainozoic ultra-alkaline lavas near Cooktown (Morgan, 1968b) and has tentatively been given a Cainozoic age.

Maer Volcanics

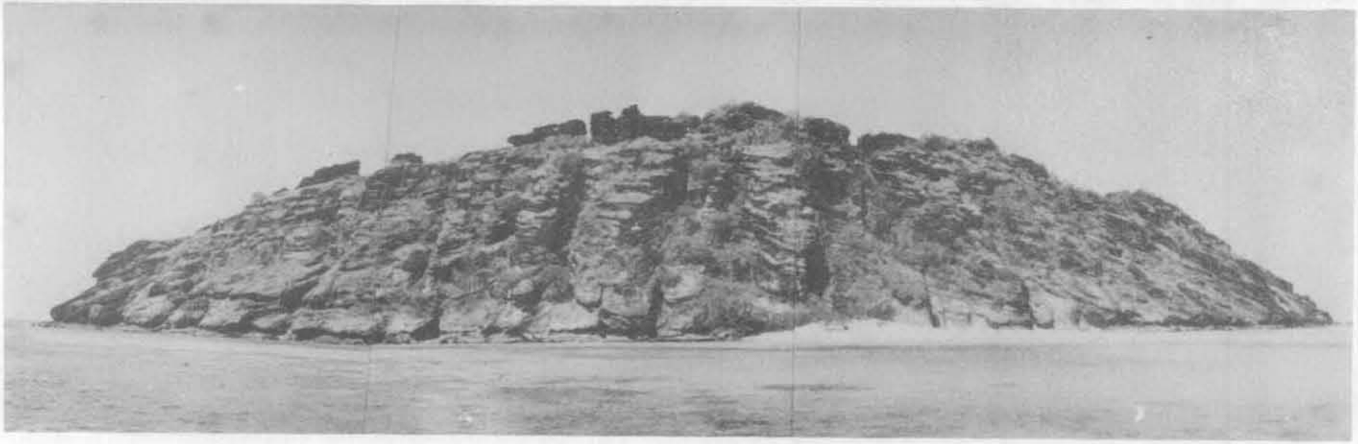
The Maer Volcanics comprise Cainozoic basic lava and tuff forming the Murray Islands, Darnley and Stephens Islands, the Black Rocks, and a small exposure at Bramble Cay, all in the northeastern part of Torres Strait. Calcareous tuff and tuffaceous sediment forming Daru Island in Papua are also included in the Maer Volcanics.

The volcanic activity in the northeastern part of Torres Strait was associated with a number of small volcanoes. The focus of activity appears to have changed with time, and some of the volcanoes, such as those on Darnley and Stephens Island, Bramble Cay, and the Black Rocks, have been eroded and destroyed, while the well preserved cones of the Murray Islands are probably considerably younger.

The eruptions at each centre appear to have started with the emission of volcanic ash, probably produced when a gas-rich basaltic magma, containing olivine and pyroxene crystals, came into contact with sea water. Basalt may have been erupted when the vents were closed off from the sea. Cross-beds and scours are common in the tuff at Darnley Island and their presence suggests it was deposited in the sea. If the tuff formed the southern half of an ash cone, as suggested by Jardine (1928b) and the basalt was extruded on its flanks, such a cone must have been approximately 8 km across and about 200 m high. The three ash cones of the Murray Islands were undoubtedly built up high above sea level and the scours and ill defined cross-beds in the tuff high on Gelam Hill on Maer Island may have formed by the scouring action of rain water and the deposition of ash in small ponds. The original form and size of the volcanoes on Stephens Island and Bramble Cay and the Black Rocks are unknown. Probably only a small cone was present at Bramble Cay, as the pillow structures in the basalt there suggest the lava either flowed into the sea or was extruded below sea level.

The age of the limestone fragments in tuff from the Murray Islands, Darnley Islands, and Daru has been determined by Dr D. Belford (pers. comm.) as Pleistocene or Recent. The tuffaceous sediments on Daru overlie sediments similar to Pliocene or Pleistocene sediments described by the Australasian Petroleum Co. (APC, 1961) from the Oriomo area of the Papuan mainland. The volcanoes have probably not been active in Recent time, as even in the relative young Murray Islands the cone of Maer has been dissected by three small creeks and a thin layer of soil has been formed over the tuff and the basalt flows; an extensive fringing coral reef has also grown since the formation of the island. The cones of Dauar and Waier Islands are less subdued than that of Maer Island and may represent the latest phase of activity, but they also are dissected, covered with vegetation and surrounded by fringing reefs. The volcanoes are therefore considered to be Pleistocene.

The Maer Volcanics may be broadly the same age as many large basic to intermediate volcanoes of Quaternary age which extend from the Central Highlands of New Guinea to the Biwau Hills, 200 km north of Daru (APC, 1961).



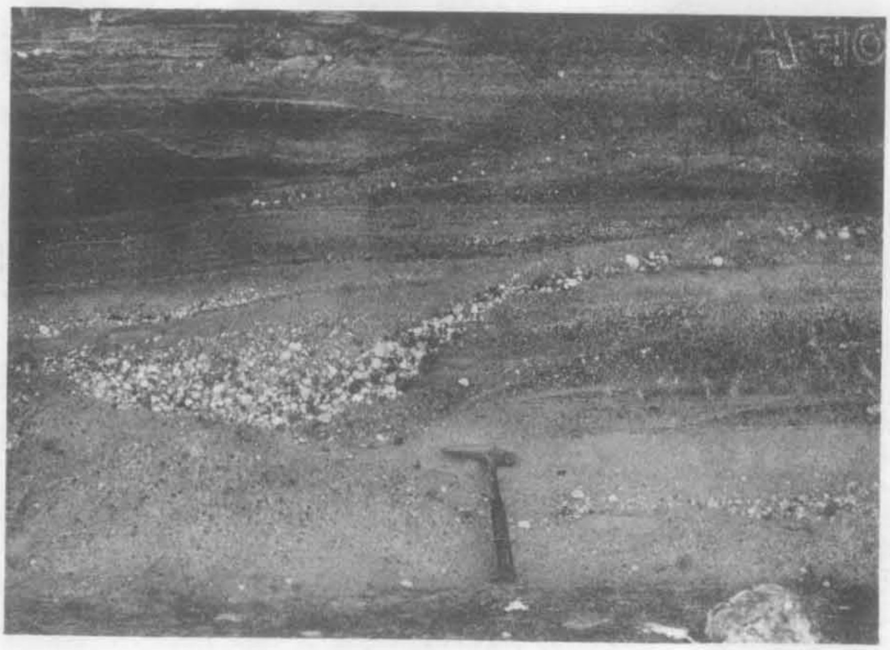
Pl. 14 Exterior of truncated ash cone forming Waier Island. Note radial dip

Pl. 15 Interior of truncated cone forming Waier Island. Note slumping of ash beds into extinct crater

Pl. 16, fig. 1 Bedded tuff exposed under basalt, Darnley Island

Pl. 16, fig. 2 Contact of basalt and tuff in Treacherous Bay, Darnley Island

Pl. 17, fig. 1 Bedded tuff deformed by bomb, Treacherous Bay, Darnley Island



Pl. 17, fig. 2 White limestone fragments in scour in bedded tuff, Treacherous Bay, Darnley Island

STRUCTURE

The igneous and metamorphic rocks of Cape York Peninsula and Torres Strait form two well defined northerly trending ridges, the Peninsula Ridge and its southern extension, the Yambo Inlier, which runs north from the Mitchell River to enter the sea at Temple Bay, and the Cape York/Oriomo Ridge, which extends across Torres Strait (Fig. 5). In the Peninsula Ridge and Yambo Inlier the major faults, the foliation and fold axes in the metamorphic rocks, and the contacts of the batholith all have a northerly trend (Fig. 10). The ridges are bounded to the east and west by sedimentary basins which are elongated in a northerly direction; one of them is partly the result of subsidence along the eastern side of the north-trending Palmerville Fault. The two ridges appear to be separated by a trough trending north-northeast through the northern part of Cape York Peninsula.

The dominant structure in the Precambrian metamorphic rocks is the steeply dipping northerly trending foliation which is probably the axial-plane foliation of tight isoclinal folds. The foliation is generally parallel to the banding in the metamorphics, which probably represent the original bedding. On both sides of the Coleman River, about 50 km west of Musgrave homestead, large isoclinal folds with north-trending axial planes are clearly visible on air-photographs, and are also shown on the accompanying 1:500,000 geological map. Three north-plunging folds, which appear to be overturned towards the west, are delineated by bands of quartzite and greenstone up to 1000 m across. The faults associated with these overturned folds may be east-dipping thrust faults. Folds of this type are also visible on the air-photographs of the area between the Lukin and Holroyd Rivers, about 40 km north of the Coleman River along the strike of the metamorphics, but they are not so well defined. Samll-scale isoclinal folds are common in the banded hematite-quartz schist in the vicinity of Iron Range, and traces of large-scale folds of this type are also evident on air-photographs of the area near Black Hill, about 20 km north of Iron Range airport.

In several places the trend of the foliation ranges from north to north-northwest, as in the Holroyd Metamorphics, or to north-northeast, as in the eastern part of the Yambo Inlier. In the northern part of the Yambo Inlier, the foliation outlines a large synform on the limbs of which it dips relatively gently at less than 40°, and strikes northeastwards. Similarly, the Mount Carter Block is a broad north-plunging synform outlined by foliation which swings from southeast through east to northeast. Both these structures appear to be complemented by upwarps occupied by granite, and it is likely that they were formed long after the rocks were foliated, possibly during the emplacement of the complementary granite intrusions.

The broad folds in the Holroyd Metamorphics southeast of the Potallah Creek goldmine, 60 km southwest of Musgrave homestead, appear to have been generated by the forcible intrusion of stocks of adamellite, and a sharp diversion in the trend of the foliation in the northern part of the Yambo Inlier may also be the result of the emplacement of granitic intrusions.

The tight minor folds with steeply plunging axes in the Dargalong Metamorphics adjacent to the Palmerville Fault are more clearly delineated in the Chillagoe Formation on the other side of the fault. W.B. Dallwitz (pers. comm.) has suggested that they indicate transcurrent movement on the fault.

The only other intense folding in the Peninsula Ridge is in the Carboniferous Pascoe River Beds, which are deformed into broad anticlines and tighter synclines with axes trending north-northwestwards.

The dolerite in the Yambo Inlier crops out mainly around the margins of the broad synform north of the Palmer River. The concordance of the dolerite with this structure and the lack of recrystallization and foliation within the dolerite, suggest that it may have been intruded after the development of the foliation but before the formation of the synform; this implies that it was also intruded before the emplacement of the granitic rocks in the complementary upwarps.

The foliation, shear zones, and contacts of the Cape York Peninsula Batholith are generally parallel with the predominant northerly strike of the foliation in the neighbouring metamorphic rocks. In places, principally in the Hann River and Ebagoola Sheet areas, the granitic rocks exhibit textural banding which is not necessarily concordant with the other structures. In many exposures the banding dips gently or is horizontal, in contrast to the foliation which almost everywhere has a steep dip.

Prominent shear zones appear to be almost entirely confined to the batholith. However, since they are generally parallel with the foliation in the metamorphic rocks it is likely that the effect of shearing on these less competent rocks is much less evident than it is in the massive granitic rocks, and the shear zones may well extend into them.

Shear zones within the granitic rocks extend across the Yambo Inlier, and extend in both granitic and gneissic rocks from Ebagoola to Coen; they are particularly abundant in the Lankelly Adamellite, and the preferred alignment of the phenocrysts in this adamellite may be a result of the shearing. The Coen Shear Zone separates the Lankelly Adamellite from the Coen Metamorphics and may continue northwards under alluvium to connect with the more diffuse Archer River Shear Zone.

Right-lateral transcurrent movement along the Archer River Shear Zone may be inferred from the relative positions of the Kintore Adamellite and the Holroyd Metamorphics near Geikie Creek, and a similar sense of movement along the Coen Shear Zone is apparent from the disposition of two bodies of schist on either side of the zone southeast of Coen.

All the shear zones trend northwards; their trends range between north-northeast and north-northwest. The gold mineralization at Coen appears to be located along the Coen Shear Zone. The parallel elongation of phenocrysts in the Lankelly Adamellite and the existence of foliation parallel to shearing in the Kintore Adamellite suggest that shearing may have begun before these rocks were completely crystallized. The presence of mylonite and granulated rocks in the shear zones, indicates that shearing also continued after the rocks were completely consolidated. In the Archer River Shear Zone underformed Morris Adamellite cuts sheared Kintore Adamellite, and both rock types are thought to be of roughly the same age.

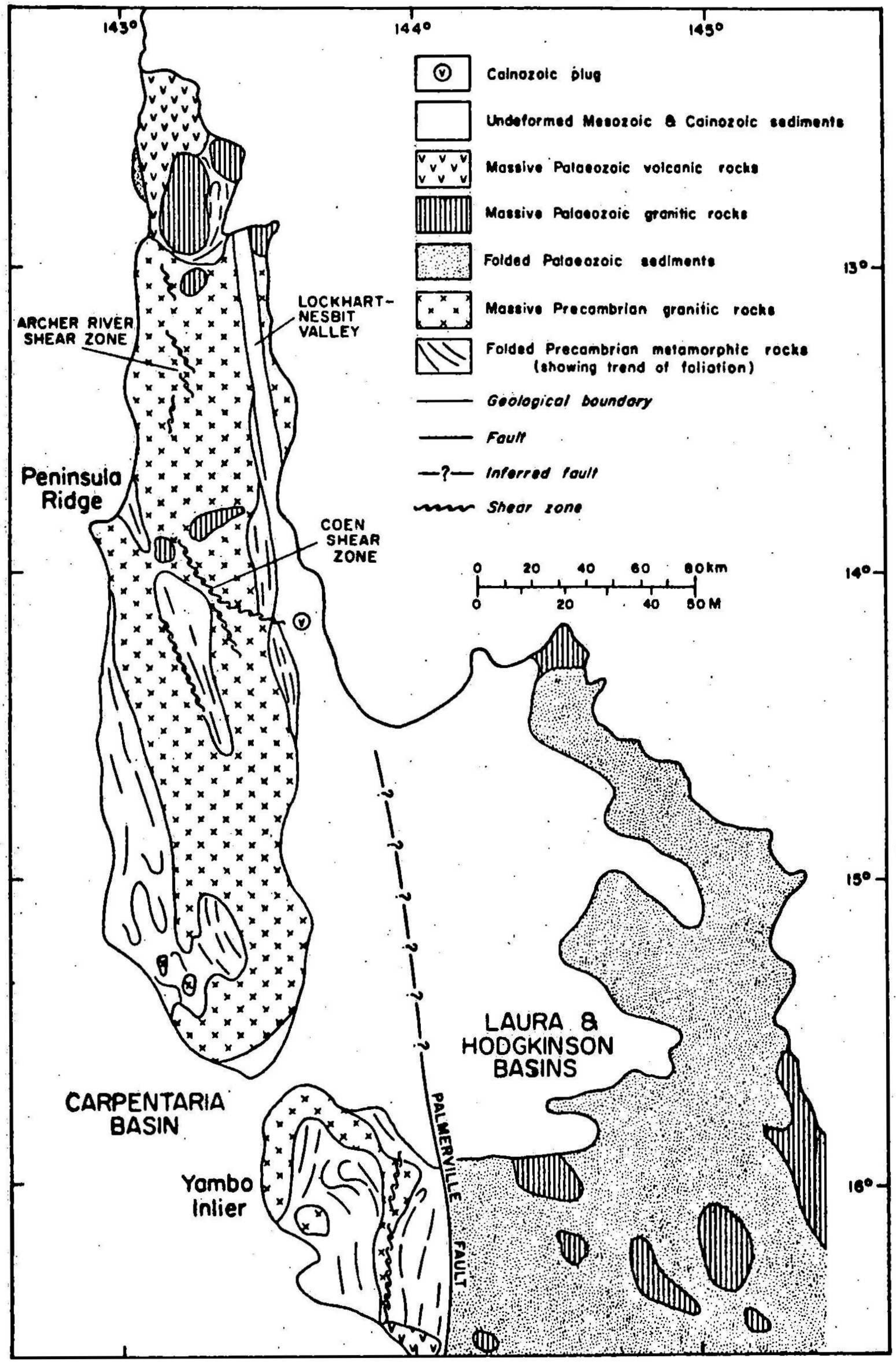


Fig.10 Structural elements of the Peninsula Ridge and Yambo Inlier.

Relatively few faults were mapped in Cape York Peninsula, probably because any known faults predominantly trend in the same direction as the foliation in the metamorphic rocks, and hence both in the metamorphic rocks and in the massive and uniform granitic and acid volcanic rocks faults cannot be readily discerned.

The Palmerville Fault was named and described by de Keyser (1963) as a fundamental structure of great significance. It separates the geosynclinal sediments of the Hodgkinson Basin entirely from the metamorphic rocks of the Yambo Inlier, and the presence of pebbles of metamorphic rocks in Silurian sediments of the Hodgkinson Basin suggests that the fault formed the limit of the basin at that early date. The existence of a small basin of Permian coal measures within the fault zone suggests that it was again active at that time, and activity on the fault continued at least into the Lower Cretaceous and probably into the Tertiary. The fault was one of the main structures controlling the development of the Laura Basin, which is strongly asymmetrical in cross-section and is deepest close to the fault (de Keyser & Lucas, 1969).

Cross-faults diverge from the Palmerville Fault at various angles and parallel faults are associated with it; Amos (1968) discusses this faulting in relation to the Palaeozoic sediments of the Hodgkinson Basin.

The northward extension of the Palmerville Fault is believed to follow approximately the east coast of the peninsula (de Keyser, 1963). The fault or faults which have formed the Lockhart/Nesbit Valley run parallel to the coast and are probably related to the Palmerville Fault. There are only a few faults which are not parallel to the Palmerville Fault; the most obvious of these are the fault along one side of the broad synform north of the Palmer River, in the Yambo Inlier, and another which cuts the synform of schist forming Mount Carter. Both these faults were probably formed during the intrusion of granitic rocks, at the same time as the folds with which they are associated.

The folds in the Carboniferous Pascoe River Beds do not appear to continue into the overlying massive acid volcanics. However, a broad syncline occurs in the Kangaroo River Volcanics south of Temple Bay with its axis trending north-northeast, and another broad fold may be present in the volcanics at Cape Grenville.

The high-level Weymouth Granite forms a large oval body with steeply dipping margins against which lie selvedges of hybrid rocks, volcanics, and older granitic rocks. Smaller masses of this granite and of the related dioritic rocks are subcircular and are presumably plug-like bodies. No ring fractures or cauldron subsidence have been found in the acid volcanics overlying the high-level granites.

Faults are the most prominent structural features in Torres Strait. Even zones of steep dips in the volcanic rocks are more likely to result from faulting than from folding. The faults which separate the Muralug Ignimbrite from the Endeavour Strait Ignimbrite may represent part of the outline of an area of cauldron subsidence mainly concealed by the sea. The few faults mapped in Torres Strait and the exposed contacts of volcanic and plutonic rocks have no evident preferred trend. The zone of alteration and mineralization which appears to trend northwestwards from the vicinity of Cape York to Horn Island is also largely concealed by the sea and its true form is unknown.

Faults are also the most prominent structures in the Mesozoic and younger rocks. The few faults mapped generally trend north; geologists of Australian Aquitaine Petroleum (AAP, 1965) consider that east-trending faults are important in the Cape Weymouth Sheet area, but none were observed during this survey.

The difference of a few hundred metres in the level of the base of the Mesozoic between Bald Hill and Temple Bay suggests that this part of the peninsula has been tilted down to the north, but the age of the basal Mesozoic sediments is not accurately known, and since the base of the Mesozoic dips southward in the vicinity of Cape York, and is demonstrably irregular around the Yambo Inlier and north of the Coleman River, these differences in level may reflect the relief of the floor of the sedimentary basin.

However, it is likely that the irregularities in the pre-Mesozoic surface described in the vicinity of the McIlwraith Range are the results of relatively late displacements on undetected faults. The existence of scarps along the western margin of the Laura Basin north of the Morehead River may also reflect relatively recent movement on northerly trending faults.

The location of the centres of Cainozoic vulcanism in Torres Strait close to a line joining Daru and the Murray Islands, together with the apparent increase in age, or at least in degradation of the volcanic landforms, northwestwards towards Daru suggests that a deep-seated linear feature is the source of this volcanic material. The existence of volcanic rocks at Bramble Cay does not fit this pattern, and the sea and the coral may conceal other degraded volcanic centres.

The coarseness of the Cainozoic sediments which carpet parts of the Laura and Carpentaria Basins and which probably fill the Archer River Piedmont Basin indicate that the existing highlands were elevated some time after the deposition and consolidation of the Cretaceous marine sediments and that this movement, as marked by gravel lying unconformably on marine Cretaceous of the Laura Basin (Lucas & de Keyser, 1965), was initially rapid. This has perhaps been continued intermittently to the present day, as unconsolidated sediments overlying the Lilyvale Beds commonly resemble them in texture.

ECONOMIC GEOLOGY

Gold has been the most important mineral produced in Cape York Peninsula and Torres Strait. It was discovered in the Palmer River in 1872, and later at Coen (1876), in Torres Strait (1894), near Wenlock (1892), at Ebagoola (1900), and finally at the Claudie River in 1933. Cassiterite and wolfram have also been mined, and traces of antimony, arsenic, lead, zinc, copper, and molybdenum have been recorded. Deposits of iron and manganese ore have been found at Iron Range. Minor occurrences of mica, coal, limestone, and heavy-mineral beach sands have been noted in the region, and silica sand occurs in coastal dunes. Exploration for petroleum in the sedimentary basins has so far been unsuccessful. The surface water and groundwater resources of the region have not yet been systematically explored.

Much of the information on the mines and prospects has been obtained from the Queensland Government Mining Journal and the Annual Reports of the Department of Mines. The production figures were also obtained from the Annual Reports of the Department of Mines.

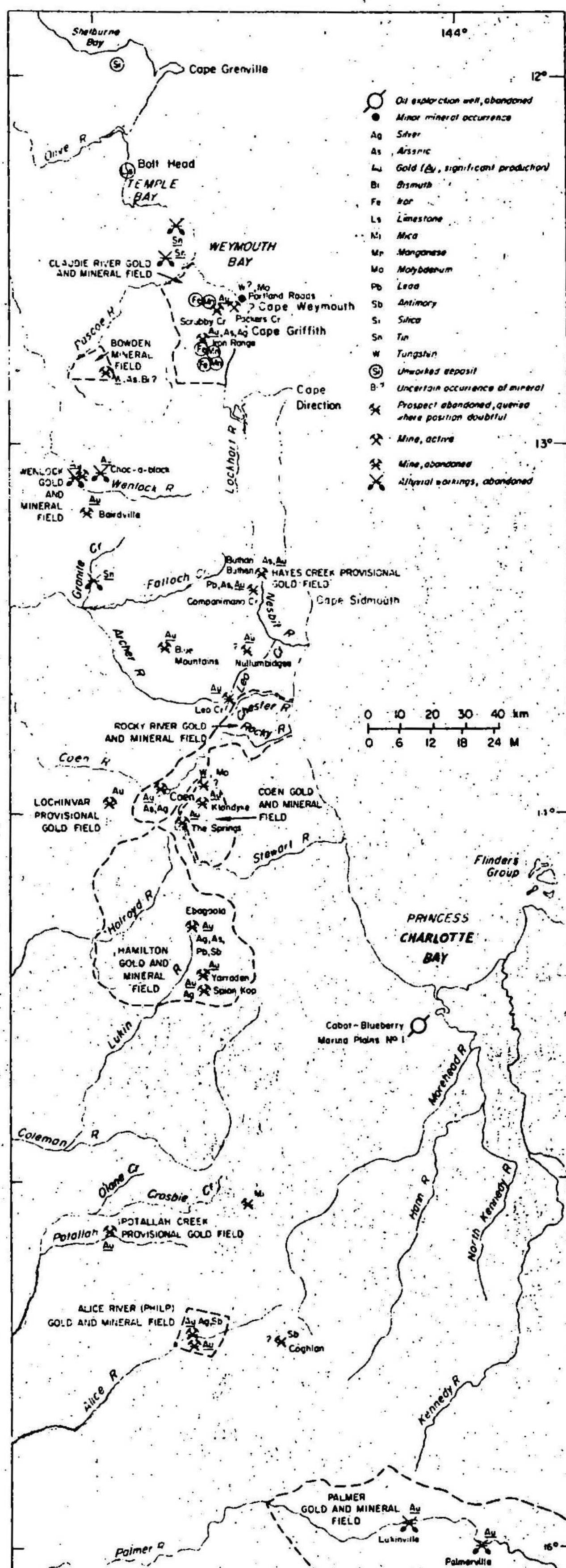


Fig.11 Mines, mineral fields, and occurrences of economic minerals in Cape York Peninsula.

Controls of Mineralization

The iron and manganese deposits of Iron Range are regionally metamorphosed iron-rich sediments, which form relatively thin bands in a steeply dipping sequence in the Sefton Metamorphics.

Most of the gold is associated with quartz lodes and acid dykes which are apparently related to the Cape York Peninsula Batholith (Fig.11). Apart from gold and traces of stibnite, arseno-pyrite, pyrite, and galena, there appears to be no other mineralization associated with these granites.

The Upper Palaeozoic plutonic rocks introduced small quantities of tin, tungsten, gold, molybdendum, lead, and copper. In the southern part of Torres Strait mineralization occurs in a discontinuous zone of altered volcanic and intrusive rocks, probably as a result of late-stage hydrothermal activity associated with the Upper Carboniferous Badu Granite and accompanying porphyritic microgranite. Within this zone cassiterite, pyrite, and chalcopyrite occur at Cape York, gold, galena, chalcopyrite, sphalerite, and pyrite at Horn and Possession Islands, and traces of copper minerals on other islands (Fig. 12).

Metals

Gold

Most of the gold was produced before the First World War. Both alluvial and lode gold have been mined. Although some of the reefs were rich, most were small and few sustained mining operations for long. Most of the reefs occur in the granitic rocks or in the adjacent country rock; a few are associated with major shear zones. Excluding the Palmer Gold and Mineral Field, the recorded production is about 220,000 oz of gold. The gold and mineral fields are described in order from south to north; the fields and main mining centres in Cape York Peninsula are shown in Figure 11, and the fields in Torres Strait in Figure 12.

In the Palmer Gold and Mineral Field alluvial gold was first reported from the Palmer River below Palmerville in 1872 (Hann, 1873a, b). The gold-bearing sands of the river and its tributaries were reported to be payable by Mulligan in 1873 and the rush to the field began soon afterwards (Jack, 1922; Holthouse, 1967). The alluvial gold was virtually exhausted by the end of the decade. A recorded production of 1,333,893 oz is given in Amos & de Keyser (1964), but the true figure was probably about twice as much. Some reef mining was carried out east of the Palmerville Fault (Amos & de Keyser, 1964; de Keyser & Lucas, 1969) but none is recorded to the west of the fault. Between 1926 and 1936 dredging at Strathleven, Glenroy, and Bonanza west of Palmerville (Jensen, 1940b; Amos & de Keyser, 1964) produced 3400 oz of gold, but operations ceased when the recovery grade fell to 4 dwt per cubic yard. The gold in the Palmer River was probably derived from reefs in the Palaeozoic Hodgkinson Formation, and not from the Cape York Peninsula Batholith.

Alice River (or Philp) Gold and Mineral Field. Gold was discovered in the upper reaches of the Alice River in 1903 by the prospector John Dickie (1903, 1905). In 1904 to 1909 mining was virtually confined to the Alice Queen and Peninsula King reefs. The field has received little attention since the First World War, and total recorded production from 1903 to 1917 is 3000 oz of gold from about 2800 tons of ore, plus about 450 oz of alluvial gold. Between 1904 and 1909 the Alice Queen reef produced about 1190 oz of gold from 1545 tons of ore, and the Peninsula King reef about 1002 oz of gold from 622 tons of ore.

The two reefs lie on the same north-northwesterly line, with a gap of about 1½ km between them. The Alice Queen in the north is a vertical quartz reef between 1 and 2 m wide and over 100 m long (Cameron, 1906). Of the two shafts, the southerly was 34 m deep in 1906. The quartz from the mullock dump contains small grains of pyrite and stibnite. Felsite dykes trending south-southeast cut the altered Kintore Adamellite to the west of the workings. The Peninsula King reef is 0.5 to 1 m wide. In 1906 several shallow shafts had been sunk along the line of the reef.

In the Potallah Creek Provisional Gold and Mineral Field only one reef, the Perserverence, has been recorded. It is situated in fine-grained schist of the Holroyd Metamorphics about 1 km west of a stock of Kintore Adamellite. According to Cameron (1906) the reef trends north and is 75 cm wide at a depth of 12 m. The only recorded production is 587 oz of gold from 584 tons of ore in 1903-04. A shaft was sunk at Potallah Creek in 1946; the reef at a depth of 33 m is reported to have been 2 m wide with a grade of 10 dwt of gold per ton.

Jensen (1964) records a small number of gold occurrences in the Potallah Creek area. Production of 5¼ oz of gold is recorded from Olain Creek in 1914 (probably O'Lane Creek, 13 km north-northwest of the Potallah Creek shaft).

Hamilton Gold and Mineral Field. A small rush followed the discovery of gold at Ebagoola early in 1900 by John Dickie (Dickie, 1900; Ball 1901). Gold was found farther south near the Lukin River in the following year. Peak production was reached in its first year when about 15,000 oz of gold, 11,000 oz from alluvials was recorded. Mining virtually ceased during the First World War and has been only sporadic since. Total production from 1900 to 1951 was 73,676 oz, made up of 44,099 oz of reef gold from 33,656 tons of ore, 21,940 oz of alluvial gold, and 7,637 oz from the treatment of 18,952 tons of tailings.

Mining at Ebagoola was centred about the old townsite. The Yarraden mining area, about 15 km south-southeast of Ebagoola, extends for about 8 km from the Lukin River southwards to Spion Kop; it does not include Yarraden homestead. Gold occurs principally in the numerous quartz reefs. Ball (1901) reported that the reefs in the Ebagoola area trend roughly north along the contact between the 'older' granite (Kintore Adamellite), which he considered to be metamorphosed, and the schist and gneiss to the east (Coen Metamorphics). He believed that the reefs were related to the 'newer' granite (Flyspeck Granodiorite); in the Yarraden area the reefs occur within the Flyspeck Granodiorite. In the Ebagoola area quartz occurs as leaders, veins, or compound reefs. The leaders are up to 15 cm wide and occur mainly in shrinkage cracks in granite. They are of limited length or depth and seldom rich in gold. Most of the alluvial gold is considered to have been derived from these veins. True fissure reefs, such as the Caledonia and All Nations reefs, occupy shears along the contact between the metamorphic and granitic rocks. The compound fissure veins are associated with acid dykes, or with beds of quartzite, such as the May Queen reef.

The water table is generally at less than 20 m in the dry season, and as a result sulphides such as pyrite and minor arsenopyrite, galena, or stibnite are found almost at the surface. Mining was generally not profitable at grades below 1½ oz of gold per ton.

TABLE 7. GOLD PRODUCTION AT EBAGOOLA, 1902-12*

Reef	Ore (tons)	Gold (oz)
Caledonia	3384	3292
*Hamilton King	2195	3662
May Queen	2022	2594
Hit or Miss	1072	2157
Hidden Treasure	1514	1534
All Nations	494	1222
Golden Treasure	984	1145
Violet	770	1596

From Annual Reports, Department of Mines, Queensland

*Minor production in 1930's included

Pl. 18 Abandoned battery at Ebagolla

The most productive workings in the Ebagoola area were the Caledonia, Hamilton King, May Queen, Hit or Miss, Violet, Hidden Treasure, All Nations, and Golden Treasure (Table 7).

In the Yarraden mining area the two most important reefs were the Golden King and the Savannah. According to Cameron (1906) the Golden King reef trends roughly north, dips vertically, and ranges from 15 to 40 cm wide; it was worked over a length in excess of 300 m to a maximum depth of 65 m. Mining was almost continuous between 1901 and 1915, and was resumed in 1917 and 1921. Recorded production is 7711 oz of gold from 7568 tons of ore. The Savannah reef lies about 500 m east of the Golden King and dips steeply west. It is more than 30 m long with a steep southerly plunge. Mining was carried out to a depth of at least 38 m. Between 1901 and 1907 and in 1912 a total of 2717 tons of ore yielded 5032 oz of gold. Attempts to reopen the mine in 1939-40 were unsuccessful.

Other reefs of importance in the Yarraden area were: the Lukin King with a total production from 1901 to 1926 of 2049 oz of gold from 1605 tons of ore, the Gold Mount which yielded 960 oz of gold from 769 tons of ore between 1901 and 1921, and the Hiaki (or Haikai) which produced 1261 oz of gold from 1596 tons of ore between 1909 and 1918.

Alluvial mining was mainly restricted to the Ebagoola area (Ball, 1901) and most of the production occurred before 1910. The gold was coarse, and was derived mainly from eluvial deposits shed from nearby reefs and leaders.

The Coen Gold and Mineral Field was proclaimed over an area of 95 sq km in 1892 and enlarged to 480 sq km in 1898 (Ball, 1901). Jack (1922) records the discovery of alluvial gold at Coen in 1876. In 1878 there was a small rush from the Palmer River to Coen, but few miners stayed more than two weeks and the workings were abandoned in the same year. Chinese miners attempted to work the alluvium in 1880 without success.

In 1885 land was taken up for mining silver, and machinery was erected in 1886, but productive reef mining did not start until 1892. Between 1893 and 1899, 16,425 tons of ore crushed at Coen yielded 28,553 oz of gold. Ball (1901) visited the field in 1900 and recorded mining activity at Coen town, at The Springs 15 km southeast of Coen, and at Klondyke 13 km northeast of The Springs. According to Ball the reefs range from several centimetres to 1.5 m in thickness, and generally trend between northwest and north, with a steep dip. Most of them are fissure veins composed of quartz; a few consist of siliceous slate; some of the poorer reefs contain pyrite or arsenopyrite.

The most successful mine was the Great Northern, about 1 km southeast of Coen township; it has produced about three-quarters of the gold won from the field. Other productive reefs in the vicinity of Coen, which were mined mainly before 1900, were the Daisy, Hanging Rock, Homeward Bound, Lankelly, Long Tunnel, Trafalgar, and Wilson reefs. Between 1894 and 1899 the Great Northern mine yielded 7422 oz of gold from 4325 tons of ore; Ball (1901) noted that the gold had a high silver content. In 1900 activity at Coen was almost at a standstill as a result of the opening of the Hamilton Goldfield nearby, but gold continued to be won at Coen for many years, mostly from the Great Northern and from the treatment of tailings with cyanide.

The total recorded production of reef gold at Coen from 1892 to 1916 was about 75,000 oz, of which 69,859 oz came from the Great Northern mine, including 13,259 oz from the treatment of 20,000 tons of tailings and mullock. The total amount of ore recorded between 1892 and 1916 was 28,537 tons, of which 25,820 tons came from the Great Northern mine. After 1910 production fell off rapidly, and in 1914 only 7 tons of ore were mined.

The Great Northern mine was reported to have been worked to a depth of 150 m, but little work was done at that depth. The north end of the number 4 level, somewhere below 54 m, was reported in 1909 to be 78 m from the shaft. The reef in the lower levels ranged in width from 75 to 120 cm. After 1909 production came from small rich leaders in the hangingwall and footwall above number 3 level, possibly at 54 m. Little is known of the mine after 1914, but attempts were made to re-open it as late as 1949 (Jones, 1949).

Mining was carried out at The Springs, 15 km southeast of Coen, from the early 1890's to about 1901. The main reefs were the Westralia, where 448 tons of ore were crushed for 629 oz of gold in 1901, the Goolha Goolha, the Rothwell, and the Sirdar, where 204 tons of ore produced 431 oz of gold between 1898 and 1901 (Ball, 1901). This part of the Coen field was abandoned during the rush to the Hamilton Goldfield in 1900-01.

At the Klondyke, 13 km northeast of The Springs, the Springfield reef yielded about 1300 oz of gold from 360 tons of ore between 1898 and 1902. The Klondyke lodes trend roughly north and occur in schist and gneiss of the Coen Metamorphics near their contact with the Lankelly Adamellite.

The workings at Coen and at The Springs occur within or adjacent to the Coen Shear Zone. This shear zone extends for about 27 km southeast of Coen and lies largely within the Lankelly Adamellite and along its southwest margin. In places the sheared adamellite resembles a schist; the sheared rocks contain a little pyrite and arsenopyrite. Quartz reefs are common along the shear zone, and at its southern end they range up to 5 km in length and 100 m in width. Most of the mullock dump at the Great Northern mine, which lies in the shear zone, consists of breccia composed of fragments of silicified granite in a matrix of white quartz; the country rock is sheared Lankelly Adamellite. The quartz and gold were probably deposited from hydrothermal fluids introduced after the rocks were sheared.

The Blue Mountains, 40 km north of Coen, are not included in the Coen Gold and Mineral Field, but gold mining was carried out there from some time before 1934 until 1951. The gold occurs in narrow quartz veins in granite (Banks, 1947). The total recorded production in 1935, 1938 to 1946, and 1948 to 1951 is 1078 oz of gold from 935 tons of ore; of this 561 oz from 584 tons came from mines operated by Blue Mountains Gold N.L., principally the Golden Ladder and the Convict. One of the other major producers was the Yarraman mine. Beck (1935) and Jolly (1946) have reported on the area. No mines were operating in 1967.

A small number of leases have been held in recent years in the Leo Creek area, 30 km northeast of Coen, but no production is recorded. In the Nullumbidgee area a few kilometres to the north $3\frac{1}{2}$ tons of ore yielded 12.7 oz of gold.

The small Lochinvar Provisional Goldfield on Tadpole Creek about 18 km southwest of Coen, is situated in Kintore Adamellite. The only recorded production is 70.7 oz of gold from 49 tons of ore in 1904.

Rocky River Gold and Mineral Field. Alluvial gold was discovered in the Rocky River, 32 km northeast of Coen, in 1893 by William Lakeland (Jack, 1922). Reef mining began on Neville Creek (location unknown) in 1896 and the gold and mineral field was proclaimed in 1897. Between 1896 and 1901, 936 tons of ore yielded 4586 oz of gold. Interest waned in 1901 following the discovery of the Hamilton Goldfield, but it revived for a short time in 1910 and 1911 when 56 tons of ore yielded 282 oz of gold. Jack (1922) notes that only four people lived on the field in 1914; and there were no returns that year. No mines were located during this survey in 1967.

The site of the Hayes Creek Provisional Gold and Mineral Field, 60 km northeast of Coen, was visited by Dickie and Campbell during a prospecting journey to Lloyd Bay in 1907, when parties were working alluvial gold there (Jack, 1922); Jack had found traces of gold in Hayes Creek during his 1880 expedition. Shepherd (1938) records that the Hayes Creek field was discovered in 1909; this no doubt refers to the start of reef mining on the Golden Gate claim by Messrs Preston and Dodd.

Production has been sporadic and small. In 1909 the Golden Gate claim produced 36½ tons of ore which yielded 219 oz of gold and a further 55 oz on cyanidation. In 1911 production for the field was 102¼ oz of gold from 20¾ tons of ore. The reefs yielded 36¾ oz of gold in 1914 and alluvial mining 12 oz. The field was deserted in 1915. Some prospecting continued until 1938, and between 1938 and 1942 about 150 tons of ore were crushed for a yield of about 195 oz of gold. In the early 1950's small parcels of ore are reported to have yielded between 2½ and 4 oz of gold to the ton (Jones, 1951b). One 4-ton crushing returned 6.55 oz of 850-fine gold.

Shepherd (1938) noted four sets of workings at the main centre at Buthen Buthen. At the Theodore lease a quartz reef between 30 and 35 cm wide was exposed for 65 m, striking 140° and dipping 47° southwest; the reef contained small amounts of pyrite and arsenopyrite. A reef on the Diana Lease was 20 cm wide and carried pyrite with a little free gold; on the Campbell and Buthen Buthen leases Shepherd saw only shallow trenches and small shafts. At Companimano Creek, 6 km south-southwest of Buthen Buthen, a quartz reef 90 to 120 cm wide contained free gold, galena, pyrite, and arsenopyrite. The reefs in the Hayes Creek field are situated in a major shear zone which trends north in Kintore Adamellite; the valleys of the Lockhart and Nesbit Rivers follow this zone.

In 1964 the valley of the Nesbit River between Buthen Buthen and Kampanjinbano (Companimano?) Creek was investigated as an alluvial gold prospect (Gibson, 1964). A basin almost enclosed by hills on Leo Creek, 8 km southwest of its junction with the Nesbit River was also tested. Very little gold was found.

Wenlock Gold and Mineral Field. Gold was discovered in 1892 at Retreat Creek, a tributary of the Batavia or Wenlock River and later the site of Bairdville (Morton, 1924, 1930). Further prospecting disclosed several small alluvial deposits at Downs Gully, Choc-a-block Creek, and other nearby sites, mainly between 1905 and 1911. The amount of gold produced up to 1910 has been estimated at 3000 oz.

In 1910 an aboriginal prospector named Pluto located a large lead at the base of the Mesozoic sediments overlying the Kintore Adamellite. This locality became known as Plutoville and was rushed by miners from Coen and Ebagoola (Jack, 1922; Morton, 1930). According to Fisher (1966) the early workings covered an area of about 350 sq m, and consisted of shallow alluvium and small reefs, which were worked to a maximum depth of 5 m. Morton (1930) mentions a shallow lead of cemented wash with rich gutters at these workings. Total recorded production from Plutoville is estimated at 6000 oz of gold (Fisher, 1966).

The Main Leader, a narrow quartz reef with payable gold for over 300 m along strike, was discovered in 1922 about 5 km northeast of Plutoville. The discovery became known as Lower Camp and later as Wenlock. Fisher (1966) describes the Main Leader as a northwesterly trending fissure reef, with a few cymoid loops, which dips at 60° to the south in the north and 35° in the south. At the south end it is cut by the Main Reef, a quartz reef over 6 m wide. The average width of the Main Leader is 20 cm, and its walls are slickensided. It contains free gold to a depth of at least 100 m, or about 30 m below the water table. Connah (1951) describes the Main Leader as quartz with distinctive white and blue banding, ranging in thickness from 2 to 45 cm. Short rich shoots with a northerly pitch are characteristic of the reef. Coarse particles of gold are evenly distributed in the reef, with a few rich local concentrations. Fisher (1966) estimates that the average grade was about 1½ oz of gold to the ton.

The Main Leader occurs in Kintore Adamellite and is overlain by Mesozoic sediments and alluvium. The deep leads at the base of the Mesozoic sediments on the west side of the Main Leader also contained gold. Connah (1951) found that the main deep lead was a narrow rich gutter which spread out into a wide drainage channel trending west-southwest. He suggested that the extension of the channel beyond the workings was downthrown by a fault trending southeast. This may be the continuation of a post-Cretaceous southeasterly trending fault, downthrown to the west, which was mapped in 1967, 13 km southeast of Wenlock. Total production from Lower Camp is estimated at 35,000 oz (Fisher, 1966). Morton (1924, 1930, 1932) and Shepherd (1941) have described the mining operations at Wenlock.

The Wenlock field was deserted during the Second World War. The claims along the Main Leader were amalgamated in 1946 but operations ceased again in 1952, partly as a result of flooding in 1950. Prospectors have continued to be active in and around the field, and in 1964-65 a party claimed to have obtained 2800 oz of gold from 2 tons of picked specimen stone.

According to Hadley (1943) and Beck (1935) gold was first produced from the <u>Claudie River Gold and Mineral Field</u> in 1933; the field was proclaimed in 1936. The gold was mined at Iron Range, Scrubby Creek, and Packers Creek. Shepherd (1939) records total production from 1935 to June 1938 as 5572 oz of gold from 6008 tons of ore and 1050 tons of tailings, and Packers Creek 175 oz from 370 tons. The largest producing reef was Gordons 'Iron Range' which yielded 3485 oz of gold from 2527 tons of ore. The average yield from the rest of the field was 10.4 dwt per ton. The field closed in 1942 for the duration of the war. A little mining was carried out after 1945, and between 1950 and 1953 the Cape York Development Co. attempted to develop a few of the mines at Iron Range without success. Total recorded production of the field from 1934 to 1942 is 10,710 oz of gold from 16,830 tons of ore and 3170 tons of tailings. Production since the war has been small, but a little gold is still obtained from a mine at Packers Creek.

There are two distinct environments of gold mineralization in the field. At Iron Range gold occurs in quartz veins and lodes in schist of the Sefton Metamorphics; at Scrubby Creek and Packers Creek the gold-bearing lodes and veins are in Weymouth Granite. The deposits have been described by Broadhurst & Rayner (1937) and Shepherd (1939). At Iron Range itself, the deposits are large and low-grade where associated with iron-bearing schist, but small and rich in the adjacent iron-free schist (e.g. the Iron Range reef), the reefs occur along fault lines in schist. Southeast of Iron Range some of the reefs are parallel with the schistosity and others have components both along and across the schistosity; where the components intersect, short ore shoots have formed. North of Iron Range the lodes are composed of crushed sericite schist with quartz stringers, such as the Peninsula Hope and Northern Queen lodes. Broadhurst & Rayner (1937) suggest that in the primary zone the ore shoots will prove to be lenses of silicified schist impregnated with sulphides, chiefly arsenopyrites.

Rayner (1937) notes that a wide body of sulphide ore had been discovered on the Peninsula Hope lease at Iron Range. A CSIRO (1953) report on the treatment of arsenical gold ore from the Peninsula Hope mine gives the head assay of the ore as 11.65 dwt of gold, 1.15 dwt of silver, 4.4 percent arsenic, 20.7 percent iron, 9.79 percent sulphur, and less than 0.05 percent copper. The sulphides are arsenopyrite and pyrite, with some altered pyrrhotite and traces of chalcopyrite, sphalerite, and gold.

The gold deposits at Packers Creek and Scrubby Creek are situated in the Weymouth Granite. The gold and sulphide deposits at Iron Range may have been introduced either by the Kintore Adamellite, the host of the gold and sulphide deposits elsewhere in Cape York Peninsula, or by the Weymouth Granite.

Gold was discovered in the Possession Island Provisional Gold and Mineral Field in Torres Strait in 1896, and production began in 1897; Jackson (1902) described the mines he visited in 1901. All the workings are located near the shore in the northwestern part of the island, east and northeast of the monument to Captain Cook. Mining was carried out until 1906 when the leases were abandoned. Some attempts were made to reopen the workings in 1919 and again in 1934-35 without success.

Recorded production between 1897 and 1905 is 4997 oz of gold from 7131 tons of ore. However, some returns for the Horn Island Gold and Mineral Field have been included in these figures. Four tons of ore yielded 2.8 oz of gold in 1919.

Jackson (1902) records that the main workings were located on two almost vertical reefs about 230 m apart, which trend south-southeast. Each reef is composed of quartz veins, up to several centimetres thick, in a matrix of fractured and altered welded tuff. The veins contain a small quantity of sulphide minerals. Jackson noted several shafts and small cuts. A sample of ore composed of vein quartz with galena and pyrite contained 1 oz 17 dwt 5 gr of gold and 1 oz 1 dwt 19 gr of silver to the ton.

Copper staining associated with limonite has been noted in outcrops of chloritized and silicified welded tuff northeast and southwest of the abandoned workings. Northeast of the workings some galena and pyrite have been observed in joints.

Alluvial gold was discovered in the eastern part of Horn Island in 1894 and the Horn Island Gold and Mineral Field was proclaimed the same year. Reef mining began in 1895 or 1896 in an area of about 0.5 sq km 1 km inland from the east coast.

The mines are situated in altered and silicified porphyritic microgranite, which forms a rise on the south side of a stretch of sandy alluvium. The mines and their history have been described by Rands (1896) and Jackson (1902). Recorded production is 999 oz of alluvial gold in 1894 to 1896, and 5680 oz of gold from 16,637 tons of ore in 1896 to 1900. The recovery of gold declined sharply in 1900 and by the next year the field was almost deserted.

Most of the reefs consist of closely spaced quartz veins in altered microgranite, and trend between east-southeast and southeast with steep dips. Sulphide minerals were found in many reefs only 3 m below the surface. Rands (1896) states that pyrite and galena are most common; some reefs also contain sphalerite and two contain chalcopyrite. The average yield decreased from 19.5 dwt per ton in 1896 to 12 or 13 dwt per ton in 1900. Sporadic production continued on a small scale until 1919, and prospecting went on at intervals until 1966.

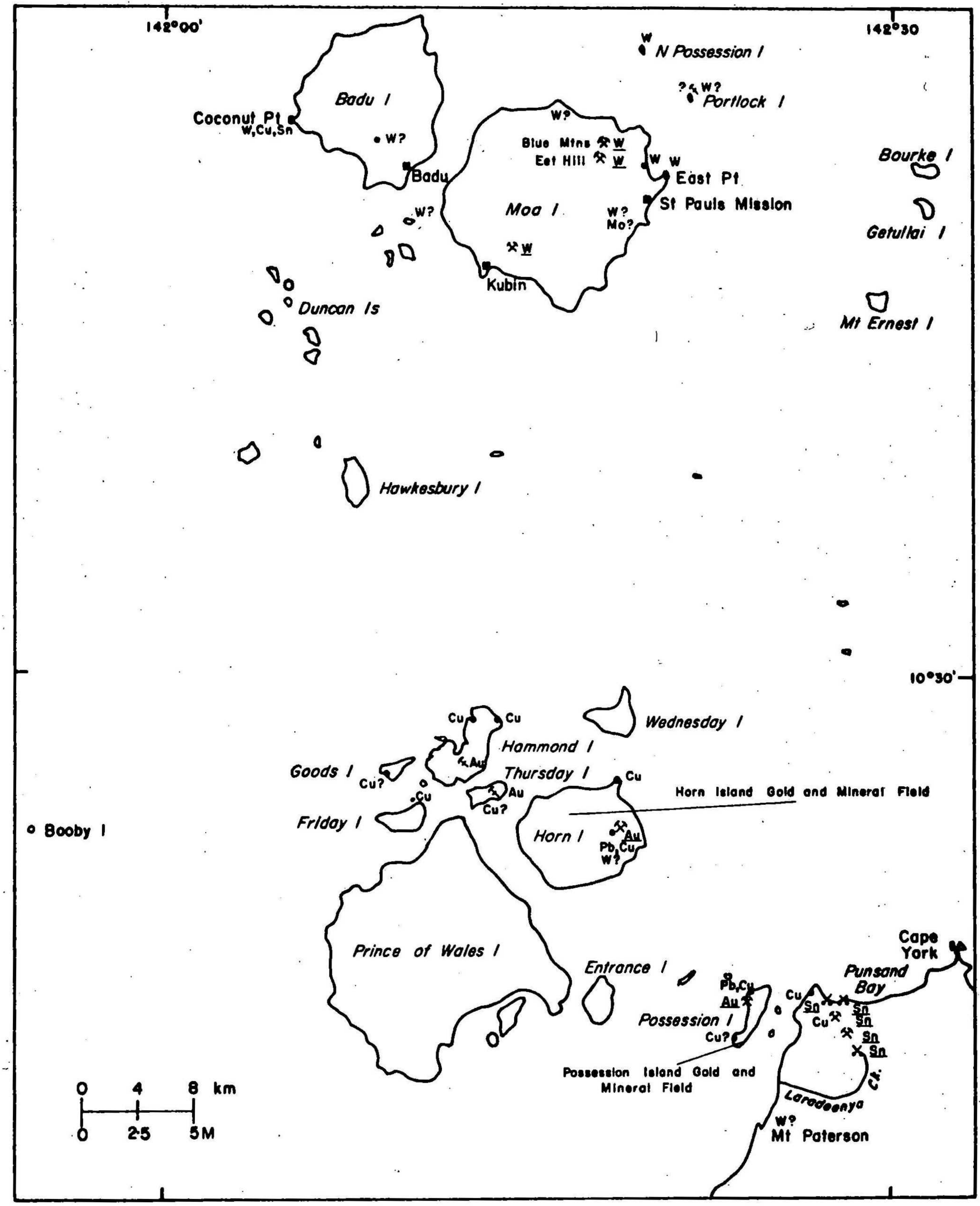
Australian Selection Pty Ltd drilled three holes to depths of about 75 m in 1963, but did not consider the prospect payable; an ore concentrate assayed at 24 oz 3 dwt 5 gr of gold, and 14 oz 4 dwt of silver to the ton in 1961. In 1965 overburden was removed and 120 cu m of alluvium was taken for sampling; the results are not known. A visit to the mines in 1968 revealed a large open cut probably on the Welcome reef, about 100 m long by 50 m across, and a smaller open cut, in the vicinity of the Dead Cat claim, with a timbered shaft in the bottom. In the smaller open-cut the porphyritic microgranite is yellowish green and intensely altered; it is cut and silicified by numerous quartz veins. The altered rock contains small patches of sulphide minerals. In the larger cut the microgranite is less altered and contains fewer quartz veins, and sulphide minerals form small veins within it. The most common sulphides are pyrite and galena; some chalcopyrite and a little wolfram (?) were also observed. A small 5-head battery was located near the smaller open-cut in 1968.

Elsewhere in Torres Strait minor amounts of gold are reported to have been produced from Hammond Island between 1907 and 1909, and possibly until 1919, and from Thursday Island in the 1930's.

Tin

Most of the cassiterite produced in the area has come from alluvial deposits in four localities. Total production is less than 200 tons of concentrate. All the deposits are probably related to the Upper Palaeozoic intrusive rocks.

Alluvial cassiterite has been mined in three localities between Coen and Temple Bay: Granite or Tin Creek at the Archer River, and Tin Creek and Stony Point, both north of the lower reaches of the Pascoe River. Alluvial cassiterite and cassiterite-bearing lodes occur about 8 km southwest of Cape York.



Mine abandoned
Prospect abandoned
Alluvial workings abandoned
Au Gold
Cu Copper
Mo Molybdenum
Pb Lead
Sn Tin
W Tungsten, significant production
• Mineral occurrence

Fig. 12 Mines, mineral fields, and occurrences of economic minerals in Torres Strait.

About 116 tons of tin concentrate were produced from the Granite Creek locality (Cherry, 1907b) between 1906 and 1931, together with a further 1½ tons between 1938 and 1940. The extent of the area mined is not known; the local people state that at least some of the cassiterite was won from the area indicated in Figure 11, from which small quantities may still be obtained after the wet season.

The small alluvial deposits at Tin Creek and Stony Point to the north of the Pascoe River were found to be uneconomic by the Broken Hill Pty Co. (BHP, 1962). About 12 tons of concentrate were produced between 1900 and 1928 with a further 2 tons in 1938-40. The tin is probably derived from the nearby Upper Palaeozoic granitic rocks. The Tin Creek deposits occur where the stream emerges from the granite hills, and a few shallow shafts have been sunk in the bouldery alluvium. BHP conducted shallow sampling of soil and alluvium around the entire block of granite north of the Pascoe River, but tin was found only near the known occurrences.

The occurrence of tin veins and alluvial cassiterite near Cape York was first noted in 1948. The tin mineralization occurs in the southeastern part of a zone of altered and mineralized welded tuff in the Torres Strait Volcanics, and appears to be confined to an area of about 10 sq km, which extends along the coast between the site of the old Cape York Post Office and Peak Point, and for about 3 km southwards into the hills behind the coast.

Tin has been worked in the alluvial sands and beach sands between these hills and Punsand Bay, and south of the hills in the upper reaches of Laradeenya Creek and its tributaries. Most of the 12 to 14 tons of tin concentrate produced between 1952 and 1962 came from small rich pockets in sand at the head of the beach in Punsand Bay. Some 10 to 12 tons of concentrate have been produced from a small number of lodes, principally in 1952-56 from Hollands Reef 3 km south of the beach.

According to Robertson (1959) Hollands Reef consists of 5 to 12 cm of silicified porphyry or welded tuff with visible tin, and 2 to 50 cm of mineralized quartz most of which contains no tin. The reef strikes about 10° and dips west at 10° to 45°. Fleischman (1953) states that the tin occurs in shoots. In 1968 we found that the silicified welded tuff at the workings is cut by many pyrite-bearing quartz veins about 2mm thick; pyrite also faces joints and forms thin rusty veins and lenses up to 30 mm by 10 mm. Some chalcopyrite (?) is also present in these lenses. Carpco Australia Pty Ltd (Carpco, 1958) investigated the ore from Hollands Reef and concluded that it was not difficult to treat. Other lode deposits - the Booty, Northern mine or Mulhollands, and Bluff Quarry - are described by Robertson (1959), Fleischman (1953), and Willmott et al. (1968).

Both the alluvial and lode deposits have been tested by various companies and individuals since 1949, and almost all have made discouraging reports. Surveys have been made of the Laradeenya Creek area by Mount Isa Mines Ltd (Carter & Porter, 1952), and by Mineral Deposits Pty Ltd (McKeague, 1957), and of the alluvial deposits bordering Punsand Bay by Mineral Deposits Pty Ltd, Cape York Tin Pty Ltd (Wilson, 1961), The Broken

Hill Proprietary Co. Ltd (Rowell, 1962), Tennent (1964), Webb & Fitzpatrick (1965), and by New Consolidated Goldfields (A/asia) Pty Ltd (Hughes, 1962). However, Consolidated Mining Industries Ltd were testing the alluvial deposits in 1969, with promising results.

No tin has previously been reported from any of the islands of Torres Strait, but a sample collected in 1968 from a mineralized porphyritic microgranite dyke at Coconut Point on Badu Island was found to contain over 1 percent metallic tin.

Tungsten

Wolfram occurs in two main areas: the Bowden Mineral Field 30 km west of Iron Range and Moa Island in Torres Strait. The former produced about 70 tons of concentrate and the latter about 84 tons, principally during the Second World War and the Korean War. Other minor occurrences of wolfram are known from the Coen/Iron Range region, and from Torres Strait.

Wolfram was discovered in the Bowden Mineral Field in 1892 (Cherry, 1907b; Morton, 1924) but claims were not taken up until 1904. The field was proclaimed in 1907 when there was an influx of miners following a rise in the price of wolfram. Production of wolfram concentrate is recorded as 69 tons 13 cwt for the period 1905 to 1916. Very little work has been done since the First World War, though 3½ cwt were produced in 1952.

Morton (1924) notes that the wolfram occurs in quartz lodes in a strip 2½ km long by 1½ km wide in disturbed mico schist (Sefton Metamorphics) close to the contact of an intrusive granite (Weymouth Granite). The lodes range up to about 2 m wide and are generally concordant with the strike and dip of the schistosity; a few lodes occupy almost vertical fissures cutting the schist. The wolfram is commonly concentrated in bunches in the quartz, and in places is accompanied by tourmaline, arsenopyrite, pyrite, and according to Cherry (1907b), bismuth. In one claim the wolfram is disseminated in the lode.

A small deposit of wolfram and molybdenite occurs about 10 km east of Coen. The wolfram occurs in a vein 22 cm thick, as bunches in quartz, and as layers with molybdenite on the sides (Ball, 1901). Recorded production is 2.5 tons in 1904, 2.6 tons between 1916 and 1918, and 0.7 tons in 1952. A small reef is reported to have been worked for wolfram on Rocky Island at Portland Roads (Cherry, 1907b); in 1967 quartz debris near the shaft was found to contain only small specks of molybdenite. Wolfram has also been reported north of the mouth of the Pascoe River (Cherry, 1907b; Dickie, 1909).

Except for the locality near Coen, the wolfram mineralization occurs within or close to the Permian Weymouth Granite. Although the occurrence near Coen apparently lies within the Lankelly Adamellite, it may be genetically related to the Permian Twin Humps Adamellite which is exposed to the west and north.

In Torres Strait wolfram has been mined since 1938 at three localities on Moa Island: the Blue Mountains, Eet Hill, and near Kubin Village (Shepherd, 1944). The wolfram occurs in quartz lodes intruding the Badu Granite or hornfelsed Torres Strait Volcanics.

At Eet Hill, about 8 km northwest of Saint Pauls Mission, Shepherd (1944) described the lode as white quartz striking 105°, with an average width of 2m and a maximum width of 3 m, exposed horizontally for 300 m along strike and vertically for 30 m in the side of the hill. Fleischman (1953) suggested that the reef consists of two or more quartz reefs within a 6 - 8-m dyke which cuts the granite, and that shoots of wolfram also occur in the dyke. Andersen (1944) observed that most of the lode was barren, with patches containing 6 to 20 percent wolfram. He estimated that the concentrates produced to the end of 1943 were 'of approximately 66 percent WO_3 grade', Jones (1951a) estimated that the content of picked ore mined from Eet Hill was about 1 percent wolfram concentrate, containing 70 percent WO_3. According to Andersen (1944) there is a second lode, the Gerheim, parallel to the Eet Hill lode and some distance to the south.

The workings at Blue Mountains are situated north of Eet Hill and about 2 km from the north coast of Moa Island. Shepherd (1944) described the lode as iron-stained white quartz cutting granite, and chloritized at its margins. It is 2 m thick at one cut, and is vertical with a strike of 70°. Shepherd reported only small isolated crystals of wolfram in the quartz; he was told that 900 lb of wolfram had been taken from a small cut 60 cm deep.

The workings near Kubin are about 2 km northeast of the village, and about 1 km from the shore. Shepherd (1944) described the workings located on a number of quartz lodes trending north and dipping at 20° to 30° east; they are generally 25 to 50 cm wide but one is 150 cm across. There may be four or five parallel lodes. Shepherd notes that the lodes occur in quartz porphyry (welded tuff) near its contact with fine-grained grey granite, and that hematite is abundant in the northeastern part of the workings. During Shepherd's visit rich bunches of wolfram were exposed in four pits. In 1968, during this survey, about ten shallow pits were observed extending for about 50 m along a line trending north, and sunk on one or two quartz reefs. The quartz veins are generally several centimetres thick and range up to 1 m in places; they cut sheared and recrystallized welded tuff. Wolfram was seen in a few pits, in lenses up to 5 cm by 1 cm.

Wolfram has been found at a few other localities on Moa Island and on adjacent islands: near Saint Pauls Mission (Shepherd, 1944; Jones, 1951a; Fleischman, 1953), near the north point of Moa Island (Jones, 1951a), in the southeastern part of Badu Island (Shepherd, 1944), on a small island 3 km south of Badu Island (Andersen 1944), at Coconut Point on Badu Island, where it occurs in quartz in a microgranite dyke together with tin (Willmott et al., 1969) and on North Possession Island, 12 km north of Saint Pauls Mission (Willmott et al., 1969). Sixty pounds of wolfram are reported to have been mined on Portlock Island, 8 km north-northeast of Saint Pauls Mission, in 1951, but no trace of mining or mineralization was seen in 1968. An occurrence of wolfram is also reported by Jones (1951a) from Mount Paterson, 20 km southeast of Cape York.

The wolfram mineralization in Torres Strait is a late-stage event related to the emplacement of the Badu Granite. At Eet Hill on Moa Island, Coconut Point on Badu Island, and North Possession Island, the wolfram-bearing quartz lodes appear to have been formed at the same time as dykes of porphyritic microgranite and other acid dykes. All who have inspected the wolfram deposits agree that Eet Hill is worthy of further investigation. As the lodes have been worked by handpicking and gouging there is very little wolfram to be seen.

Iron and Manganese

The deposits of iron ore at Iron Range were investigated in 1957 to 1962 by the Broken Hill Pty Co. Ltd (Canavan, 1965b). The deposits are formed by large steeply dipping lenses of schist and quartzite rich in magnetite and hematite in the Sefton Metamorphics (Fig. 13) and by their ferruginous weathering products. The iron-bearing rocks also contain substantial amounts of manganese.

Canavan (1965a) gives the indicated reserves at Iron Range as 1 million tons of ore containing between 54 and 62 percent iron (including manganese) and inferred reserves of 300,000 tons containing between 45 and 55 percent iron (including manganese). Some of the richest ore lies only 8 km from the sea and all the ore crops out between 15 and 30 km from Portland Roads, a protected deep-water anchorage.

Canavan (1965b) divides the iron-bearing rocks into the Black Hill or northern type, composed of magnetite quartzite with subordinate amounts of hematite, manganese oxides, rhodocrosite, calcite, pyrite, and pyrrhotite, and the Lamond Hill or southern type composed of hematite-quartz schist.

In the northern type, an important part of the total ore reserves consists of a highly oxidized residual capping, which usually has a high manganese content. The combined iron and manganese content of the capping is about 60 percent, and of this iron and manganese each form between 15 and 45 percent. This ore generally contains less than 2 percent silica; the less oxidized zone below ranges from 15 and 30 m thick and contains 20 to 30 percent silica; in the primary iron-bearing quartzite below the silica content is high. The manganiferous ore is composed mainly of pitted magnetite grains with interstitial fine-grained hematite; psilomelane and pyrolusite are confined to veinlets and microjoints (Canavan, 1965b). The southern or hematite-quartz type of deposit commonly lacks the residual capping found in the north and contains only a little manganiferous ore near the contacts of the ore lenses with the surrounding weathered schist.

Broadhurst & Rayner (1937) note that the iron-bearing schist at Iron Range or the associated quartz stringers, may contain a few pennyweights of gold per ton.

Antimony

Stibnite occurs with pyrite, arsenopyrite, and galena in the gold-bearing quartz reefs of the Alice River and Hamilton Gold and Mineral Fields (Ball, 1901; Cameron, 1906). An antimony deposit was reportedly discovered by Dickie in 1907, 30 km east of the Alice River Gold Mineral Field. Cherry (1907a) described three outcrops with 12 antimony occurrences within 3 km of the main Coghlan deposit. The Coghlan deposit produced ore assaying 58 percent antimony, but no production is recorded. In 1969-70 Consolidated Mining Industries Ltd were investigating the deposits.

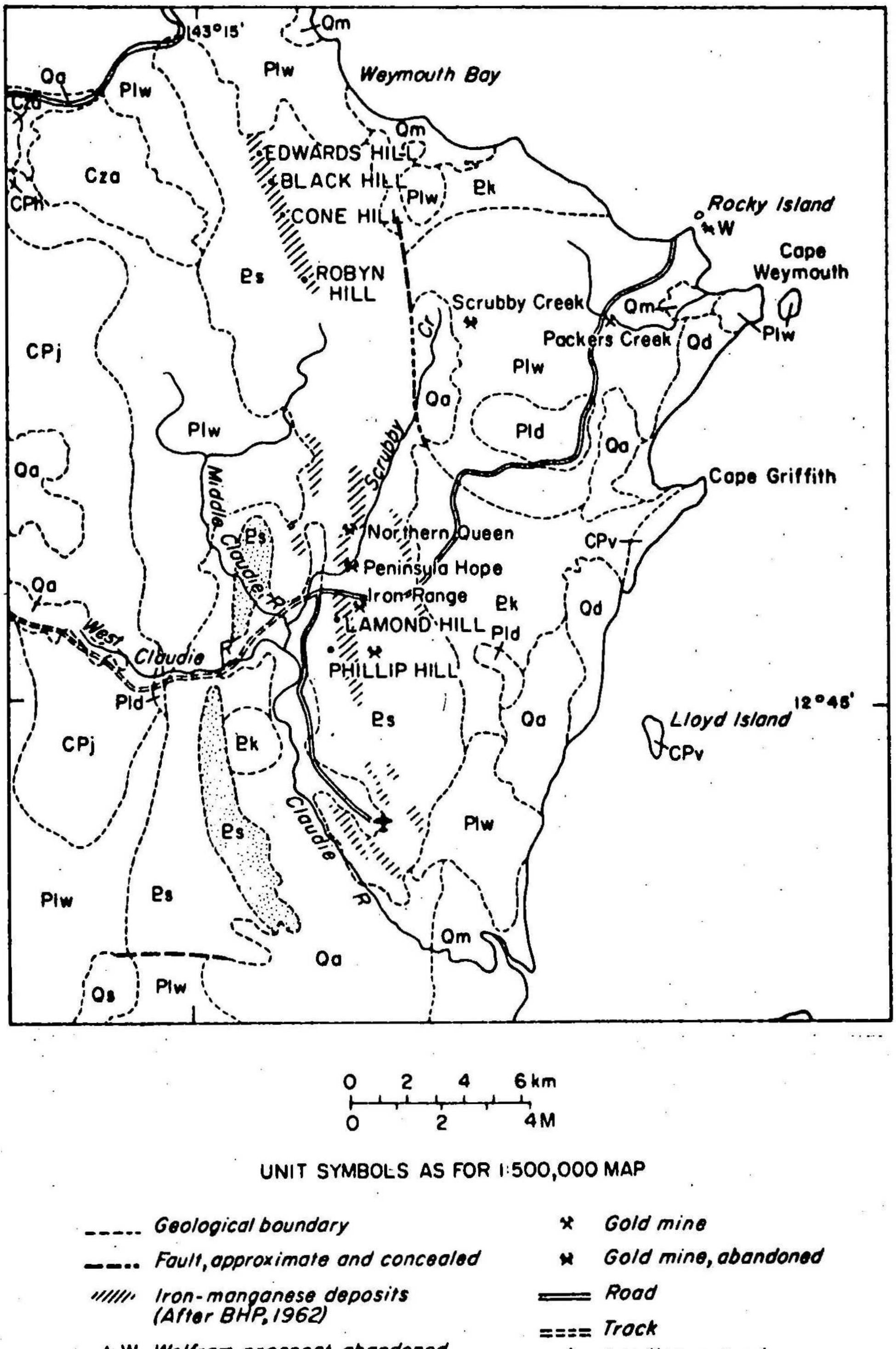


Fig 13 Iron-manganese deposits and gold mining centres in the Iron Range area.

Arsenic

Arsenopyrite is commonly associated with the gold mineralization throughout the region. It generally occurs with pyrite and galena and is most common between Coen and Iron Range. Its concentration is rarely recorded; Shepherd (1938) noted up to 1 percent of arsenic in gold-bearing samples from the Hayes Creek Provisional Gold Field, and ore from the Peninsula Hope mine at Iron Range contains 4.4 percent arsenic (CSIRO, 1953).

Lead

Galena, pyrite, and arsenopyrite are commonly associated with the gold mineralization. Galena is probably most abundant on Horn Island.

Copper

Surface evidence of copper mineralization is rare in Cape York Peninsula south of Temple Bay; minor malachite staining has been noted at a few exposures of greenstone in the Iron Range area, but minor copper mineralization is common in places in the southern part of Torres Strait (Fig. 19). It occurs mainly as chalcopyrite altering to malachite and azurite in quartz-veined and hydrothermally altered welded tuff or porphyritic microgranite. A regional geochemical survey (Whitcher, 1966) found only low background values between 5 and 15 ppm copper in Torres Strait; the highest values obtained were 40 ppm on Moa Island and 28 ppm in the central part of Hammond Island. Copper mineralization has also been noted by Spratt (1957), and Jackson (1902) reported chalcopyrite with the gold mineralization on Horn Island. On the northeast coast of Hammond Island Willmott et al. (1969) observed a zone of disseminated chalcopyrite measuring 50 m by 5 m in a body of tonalite near its contact with welded tuff.

Molybdenum

A minor occurrence of molybdenite associated with wolfram is reported by Ball (1901) about 10 km east of Coen; 2½ cwt of molybdenite were produced in 1915 and 1917. Traces of molybdenite are also recorded from the Bowden Mineral Field (Cherry, 1907b), on Rocky Island near Portland Roads, and southeast of Saint Pauls Mission on Moa Island (Jones, 1951a).

Aluminium

Bauxite is exposed beneath a cover of sand in coastal cliffs in the Turtle Head Island and Escape River area, 30 km south of Cape York. Connah & Hubble (in Hill & Denmead, 1960) note that bauxitization is prevalent east of the Great Divide; the bauxite ranges from 30 cm to 5 m in thickness and crops out at elevations between sea level and 50 m. They conclude that the bauxite is generally siliceous and of rather low average grade.

Heavy-mineral sands

The heavy-mineral beach sands between Princess Charlotte Bay and Cape Grenville appear to be of minor importance only. A number of thin discontinuous seams occur in the narrow beaches between Cape Sidmouth and Cape Direction, and near the mouths of the Nesbit and Pascoe Rivers (Zimmerman, 1969). The most common heavy mineral is ilmenite, which generally forms more than 90 percent of the heavy-mineral concentrate, with minor amounts of zircon, rutile, magnetite, and monazite; monazite forms 40 percent of the heavy-mineral concentrate in a sample collected between Cape Sidmouth and Cape Direction.

Patterson (1957) records the analysis of a sample from a small deposit in Shelburne Bay, northwest of Cape Grenville; it contained 65 percent heavy minerals, of which 30 percent was zircon, 53.5 percent rutile, and 2.06 percent ilmenite. Traces of cassiterite have been recorded in sand samples collected near the mouth of the Pascoe River (Zimmerman, 1969). Concentrations of garnet, monazite, ilmenite, and tantalite (?) have been reported from sands in the Palmer River. Ilmenite, monazite, zircon, and minor rutile occur in sands in the Lockhart River and in Geikie Creek.

Non-metals

Agate

Hann's expedition (Jack, 1922) reported the presence of agate in basalt for 12 km along the Mitchell River upstream from the site of Mount Mulgrave homestead. Agate is common in rubble on a hill composed of Nychum Volcanics a few kilometres south of Mount Mulgrave homestead.

Coal

In the Iron Range district thin seams of coal occur in the Lower Carboniferous Pascoe River Beds. Morton (1924) investigated the deposits on the Pascoe River and Hamilton Creek, 30 km northwest of Iron Range, and found that they consisted mainly of carbonaceous shale, with bands or streaks of coal up to several centimetres thick. A coal seam previously reported as 3 m thick is described by Morton as highly metamorphosed carbonaceous strata, 50 percent of which is formed by stony bands, in which the carbon is graphitic.

Spratt (1958) located two weathered coal seams $3\frac{1}{2}$ m and $2\frac{1}{2}$ m thick. He concluded they were not suitable for exploitation because of the intense folding and faulting in the nearby sediments. Miller (1957) found that coal pebbles in the Pascoe River were composed of material which was suitable as fuel, with a high calorific value and a low or moderate ash content. Morton (1924) reports that two coal pebbles from the Pascoe River contained 9.5 and 22.7 percent ash respectively, 51.3 and 42.6 percent fixed carbon, 37.9 and 34.1 percent volatile matter, and 1.3 and 0.6 percent moisture. Australian Aquitaine Petroleum (AAP, 1965) describes three thin seams of coal exposed in coaly shale in the Pascoe River and tributaries.

Coal also occurs in a thin bed of shale near the base of Mesozoic sandstones overlying the Pascoe River Beds near the confluence of Canoe Creek and the Pascoe River (Morton, 1924). The second analysis quoted by Morton refers to this locality.

Limestone and marble

Small pods of marble and calc-silicate rocks, rarely more than 30 m across, occur in the Kintore Adamellite on the east flank of the coastal range north of the Nesbit River, on the northwest side of the McIlwraith Range about 30 km northeast of Coen, and in the area to the southeast of Coen. Some of the marble is almost pure white and coarsely crystalline, but most of it contains scattered veins and clumps of silicate minerals.

Schistose limestone in the Sefton Metamorphics at Bolt Head, in Temple Bay was examined by The Broken Hill Proprietary Co. Ltd (BHP, 1962); they estimate that the deposit contains less than 1 million tons of limestone, of which about 25,000 tons is easily available; the quartz veins in the deposit would probably lower the grade to an undesirable level. Miller (1957) found the carbonate content of the limestone to be between 83.7 and 96.84 percent.

Mica

A small muscovite mine operated between 1941 and 1943 about 42 km south-southeast of Musgrave homestead (Ball, 1943). The mica books average 200 sq cm in area in places. They occur in quartz, pegmatite, and greisen bodies concordant with mica schist and quartz-feldspar gneiss of the Holroyd Metamorphics. The workings consist mainly of shallow shafts, small open cuts, and costeans. In 1942 a parcel of a few hundredweights was made up from 3½ tons of split mica and sent to Melbourne. The workings had been closed down by 1944.

Olivine

Olivine crystals derived from the weathering of basaltic tuff form a high proportion of the sand on small beaches on the south side of Maer Island; pyroxene and iron oxides are also present. The beaches themselves are too small to constitute useful deposits, and the presence of a broad fringing coral reef and its associated debris makes it unlikely that any sizeable deposit exists offshore.

Petroleum

Petroleum exploration has been confined mainly to geophysical surveys of the sediments in the Laura, Carpentaria, and Papuan Basins; these surveys are shown in Figure 3.

Exploration in the Laura Basin has been summarized by Lucas & de Keyser (1956b). One dry hole, the Cabot-Blueberry Marina Plains No. 1 was drilled. The Mesozoic sediments of the eastern edge of the Carpentaria Basin have been mapped by Australian Aquitaine Petroleum (AAP, 1965, 1967) who also examined the Carboniferous Pascoe River Beds for source rocks which might supply the overlying Mesozoic sandstone.

The northeastern part of Torres Strait is underlain by up to 3500 m of Mesozoic and Tertiary sediments similar to those of the Gulf of Papua, where gas flows have been obtained in a number of wells. Seismic and magnetic surveys indicate a number of positive structures developed by faulting in Mesozoic sediments, which were later draped by Miocene limestone. The Anchor-Cay No. 1 well was drilled on one of these structures but did not encounter hydrocarbons.

Phosphate

Very small deposits of guano are present on some of the smaller islands in Torres Strait; the largest is at Bramble Cay, 75 km east of Daru. They are of technical interest only. Ladd (1968) notes that several hundred tons were shipped from Bramble Cay in 1878 and it is possible that guano was removed from Booby Island, 35 km west of Thursday Island, at about the same time (Richards & Hedley, 1925).

Silica

Sand dunes cover an area of 400 sq km between the Olive River and Shelburne Bay, to the west of Cape Grenville. The dunes are largely vegetated and form hills up to 100 m above sea level; they extend up to 15 km inland. Samples of the dunes on the coast were found to be composed almost entirely of quartz with a few grains of limonite. Almost all the quartz grains are clear. White sand dunes cover large areas on the coast between Shelburne Bay and Newcastle Bay; they are not shown on the accompanying 1:500,000 scale map. Two smaller dune fields are located south of Bolt Head and Cape Griffith respectively. Many of the quartz grains are yellow and some contain clay in cracks. White sand dunes also occur along the coast between Cape Direction and the 2nd Red Rocky Point, and on the northern shore of Newcastle Bay.

The analyses of two samples from the beach dune in Margaret Bay and one from near Bolt Head are given below:

Percentage Composition of Silica Sands

	Shelburne Bay		Bolt Head
	BMR Sample No. 67480534	BMR Sample No. 67480535	BMR Sample No. 67480536
SiO_2	99.8	99.6	99.6
Fe_2O_3	0.015	0.015	0.030
Al_2O_3	0.10	0.08	0.11
CaO	0.01	0.04	0.01
Loss on ignition	0.11	0.10	0.12

In 1968 Metals Exploration N.L. at Shelburne Bay had proved over 6 million tons of sand, with a silica content in excess of 99 per cent, by hand-augering to depths of 12 m.

Stone

There is little demand for aggregate or other stone at present. Some patchy pisolitic ironstone deposits have been used to surface roads south of Coen and Higginsfield near Bamaga. The granite hill at Mabaduan in Papua may be used for aggregate and road metal as it is the only large exposure of hard rock within several hundred kilometres in Papua. A larger quantity of stone could be obtained from Dauan Island, only 25 km southwest of Mabaduan.

For building and ornamental stone Upper Palaeozoic granitic and volcanic rocks, and some white and green marbles found northeast of Coen could prove useful in the future. Dried coral blocks have been used for some buildings in Torres Strait.

Water

The average rainfall ranges from over 2000 mm in the coastal region near Iron Range to 1800 to 2000 mm in Torres Strait and less than 1000 mm in the southern part of Cape York Peninsula. The rainfall is seasonal, and most of it falls between December and March; in the coastal ranges light rain occasionally falls throughout the remainder of the year. The amount of surface water decreases throughout the year and by late winter is scarce in the south and west, and in the Torres Strait islands. Major rivers fed from the McIlwraith Range and ranges to the north, such as the Coen, Archer, Pascoe, and Claudie Rivers, generally flow throughout the year. In the south the perennial easterly flowing Hann River is fed from springs in the sandstone of The Desert. Permanent waterholes occur in or adjacent to many sizeable streams throughout the region. In the far south the large Mitchell River generally flows throughout the year.

Little is known of the groundwater. Some bores have been sunk for homesteads and cattle-watering points. They are sited in thin alluvial deposits along rivers and creeks, and are generally less than 10 m deep. The Cainozoic sands of the Lilyvale Beds in the Archer River Piedmont Basin and elsewhere may contain substantial groundwater supplies. Water is also obtainable in depressions in thick residual sands overlying the granitic rocks on the Coleman Plateau. Both surface and underground water supplies are likely to be greatest in the Mesozoic sediments flanking the igneous and metamorphic rocks; perennial lagoons are common on these sediments.

Hot springs with surface temperatures of about 65°C and 40°C respectively occur about 30 km north of New Bamboo homestead and at Musgrave homestead (Trail et al., 1968; Ball, 1901).

Ogilvie & Weller (1949) have previously reported on water supply in Torres Strait but their report has not been located. On Thursday Island in Torres Strait the only reservoir is inadequate. A little-used reservoir exists on nearby Horn Island, but an undersea pipeline would be difficult to construct and maintain, due to swift tidal currents. Sites for reservoirs are also available on Prince of Wales Island nearby.

Daru Island, in Papua, is also often short of water, although emergency poor-quality supplies are available in shallow bores. McGregor (1967) has suggested that increased tank storage of rain water may solve the problem for this island; this may also be the best solution for Thursday Island.

An irrigation scheme using water piped from the perennial Jardine River is planned for the Bamaga community, 30 km southwest of Cape York.

DESCRIPTION OF ROCK UNITS

Dargalong Metamorphics

(de Keyser, Bayly, & Wolff, 1960, amended)

Derivation of Name

The name Dargalong Beds was introduced by Skertchly (1899) after the abandoned mining camp of Dargalong near Chillagoe in the Atherton Sheet area. The name was changed to Dargalong Metamorphics by de Keyser, Bayly & Wolff (1960). Similar metamorphics in the Yambo Inlier, 50 km north of Chillagoe, were called the Frome Series by Jensen (1940), but were included in the Dargalong Metamorphics by Amos & de Keyser (1964). This nomenclature was followed by Whitaker & Willmott (1968) and is continued in this Bulletin, except that the gneiss and coarse schist north of the Yambo Inlier, which Whitaker & Willmott included in the Dargalong Metamorphics, are here renamed the Coen Metamorphics and are described separately.

Distribution

The Dargalong Metamorphics crop out over about 1100 sq km in the Chillagoe area, and over about 1500 sq km between the Mitchell and King Rivers in the Yambo Inlier. They are bounded in the east by the Palmerville Fault, which separates them from folded Palaeozoic sediments of the Hodgkinson Basin. Only the rocks in the Yambo Inlier are described here.

The metamorphics crop out in low undulating country with ridges of resistant quartzite or amphibolite up to 60 m high. The less resistant rocks are generally covered by sand and are well exposed only in the larger creeks and in the bed of the Palmer River.

Lithology

The Dargalong Metamorphics consist of biotite-plagioclase-quartz gneiss, plagioclase-muscovite-biotite-quartz schist, muscovite-quartz schist, quartzite, amphibolite, and rare bands of amphibole and diopside-bearing gneiss. Some migmatite is present near the contact with the Cape York Peninsula Batholith.

Biotite-plagioclase-quartz gneiss crops out mainly in the eastern part of the Yambo Inlier; it is greenish grey, medium-grained, and well foliated with light-coloured granular bands of quartz and feldspar up to 5 mm thick, alternating with thinner bands rich in biotite. The gneiss is also banded on a large scale, with all gradations between dark mica-rich gneiss and leucocratic gneiss. Small amounts of garnet are generally present, particularly in the biotite-rich gneiss which contains up to 20 percent garnet porphyroblasts up to 2.5 cm across. Some muscovite is generally present, particularly in the leucocratic gneiss, and sillimanite has been recorded in places.

Plagioclase-muscovite-biotite-quartz schist predominates in the west; it is brownish grey, medium-grained to fine-grained, and more finely foliated than the gneiss. It ranges from muscovite-quartz schist to plagioclase-biotite-quartz schist. A little garnet occurs in the biotite-rich schist, and accessory sillimanite in the muscovite-rich rocks. With an increase in the amount of plagioclase the schist grades into the gneiss of the eastern part of the Yambo Inlier.

In both schist and gneiss, the plagioclase ranges from calcic oligoclase to calcic andesine. It is commonly partly altered to sericite and clay, and in some specimens to epidote and clinozoisite. Large flakes of biotite are commonly concentrated in discontinuous bands which give the rock its foliation. The mica is strongly pleochroic from pale yellow-brown to dark red-brown, and contains inclusions of zircon, apatite, or monazite. Some of the biotite is altered to pale green chlorite. Most of the muscovite is associated with the biotite, but it also forms aggregates of small flakes derived from the alteration of sillimanite. In places the gneiss contains occasional large crystals of sillimanite; partly replaced by muscovite, or fine needles of sillimanite in mica or quartz. The accessories are zircon, apatite, monazite, sphene, and opaque minerals.

Muscovite-quartz schist and quartzite occur together as scattered bands and large bodies within the other rock types. Bands of schist from 1 m to a few hundred metres thick, commonly alternate with quartzite bands of similar thickness. The schist is light grey but weathers purple or red; it is fine to medium-grained and has a moderately well developed schistosity which is finely contorted in places. Most of the muscovite occurs as fine aggregates formed by the alteration of needles of sillimanite, but some larger flakes may also be present. The pseudomorphs range up to 8 mm in length, but some of the large porphyroblasts are up to 4 cm long. Small crystals of unaltered sillimanite are present in the centre of some of the pseudomorphs.

Sillimanite also forms very fine needles in muscovite and quartz grains, and in patches of chlorite which were probably formed by the alteration of cordierite. The schists are heavily stained by hematite, particularly along the planes of schistosity. Some of the hematite may have been produced by enrichment of iron at the weathered surface or by the breakdown of biotite or garnet, but the abundant small needles parallel to the schistosity may be a primary constituent. Pale pink porphyroblasts of garnet are common in some bands of quartz-rich schist.

The quartzite is medium-grained and generally has a sugary texture, but in some specimens the grains have a preferred orientation parallel to the schistosity. A little muscovite, pseudomorphs after sillimanite, garnet, and hematite are generally present. One specimen contains 60 percent garnet. Most of the garnet is altered to a boxwork of limonite. In the eastern part of the Yambo Inlier thick bands of quartzite and associated bands of amphibolite are present in the biotite-plagioclase-quartz gneiss.

Amphibolite occurs mainly in the eastern part of the Yambo Inlier interbanded with the biotite-plagioclase-quartz gneiss. It is a black or greenish black fine-grained rock composed of hornblende (50-70%), plagioclase (15-30%), and quartz (up to 15%). The lineation of the hornblende crystals is parallel to the direction of the foliation in the surrounding rocks. The long subhedral crystals of hornblende are commonly pleochroic from pale yellow to pale brown, although darker browns and greens occur in some specimens. The small interstitial subhedral grains of plagioclase commonly range from andesine to labradorite (An_{40} to An_{54}), but some are more calcic. Quartz occurs as small rounded interstitial grains.

The amphibolite bands range from 1 to 500 m wide and many of the larger bands are up to 5 km long. The contacts between the larger bands of amphibolite and the surrounding gneiss are generally sharp.

The small lenses of amphibole-bearing and diopside-bearing gneiss in the eastern part of the Yambo Inlier grade into the surrounding biotite-plagioclase-quartz gneiss. They probably represent carbonate-bearing sediments. The main assemblages are: (garnet-) quartz-diopside-hornblende-plagioclase, quartz-garnet-plagioclase-hornblende, (plagioclase-) quartz-biotite-hornblende, and quartz-diopside-plagioclase.

The irregular poikiloblastic laths of hornblende are pale brown in the diopside-free rocks, but green or greenish brown in the diopsidic rocks. The diopside forms small rounded grains and rare porphyroblasts up to 6 mm in length.

The migmatite in the metamorphics at the contact with granitic rocks, near the headwaters of the Kennedy River in the northeastern part of the Yambo Inlier, consists of biotite-feldspar-quartz gneiss intimately penetrated by concordant and discordant veins and dykes of garnet-muscovite pegmatite, aplite, and quartz. The gneiss has also been recrystallized and contains abundant small granoblastic crystals of microcline, and large porphyroblasts in places. Both were probably introduced as a result of potash metasomatism during the intrusion of the granitic rocks into which the recrystallized gneiss commonly grades.

The gneiss along the eastern boundary of the granitic rocks in the southern part of the Yambo Inlier has also been recrystallized and appears to grade into the granitic rocks, but no migmatite has been developed. Both the granite and gneiss near the contact have been affected by shearing and are difficult to distinguish.

Holroyd Metamorphics

(Whitaker & Willmott, 1968, 1969a)

Derivation of Name

The Holroyd Metamorphics were named after the Holroyd River in the northern part of the Ebagoola Sheet area. The definition was revised by Whitaker & Willmott (1969a) to include all metamorphic rocks along the western margin of the Cape York Peninsula Batholith as far north as Bald Hill and is here further revised to include small exposures as far north as Wenlock, which were previously referred to as the Sefton Metamorphics. The gneiss in the southeast, which was included in the Dargalong Metamorphics by Whitaker & Willmott (1968), has been transferred in the Holroyd Metamorphics in this Bulletin.

Distribution

The Holroyd Metamorphics crop out over about 3800 sq km in a northerly trending belt along the western margin of the batholith. They extend from 8 Mile Creek in the central part of the Hann River Sheet area 250 km northwards to Wenlock in the Coen Sheet area. In the south the belt is 55 km wide in the vicinity of the Coleman River, from where it is almost continually exposed northwards to near the Coen River. In the west the metamorphics are overlain by Mesozoic sediments.

The Holroyd Metamorphics form flat or undulating country with steep strike ridges where quartzite is predominant. These ridges rise up to 250 m above the surrounding country between the Lukin and Holroyd Rivers in the Ebagoola Sheet area. Exposures are generally restricted to creek banks. Quartzite, in places interbedded with schist, is well exposed in the strike ridges. The metamorphics are fairly well exposed in some dissected areas near the base of the Mesozoic sediments.

Lithology

The Holroyd Metamorphics comprise indurated sediments, slate, phyllite, fine to coarse mica-quartz schist, spotted and porphyroblastic schist, feldspathic schist, quartzite, gneiss, greenstone, and amphibolite. In general, the grainsize and metamorphic grade increase towards the east. The main lithological subdivisions in the south are shown in Figure 14.

A belt of indurated mudstone, fissile shale, and sandstone, up to 7 km wide, extends about 20 km north-northwest and 12 km south from The Gorge on the Lukin River. Small isolated outcrops also occur to the south near the Coleman River. With an increase in metamorphic grade the sediments grade to the east and west into the surrounding phyllite and schist.

The fine slaty cleavage in the sediments generally dips steeply. The cleavage planes commonly have a silky sheen and have a lineation along the intersection of the bedding and cleavage planes.

A sequence of mudstone and sandstone is well exposed in a gorge in the Edward River 12 km southeast of Strathburn homestead. The mudstone consists of irregular dark grey laminae interbedded with lighter bands; the irregularlity of the bedding suggests slumping or distortion by compaction. The rocks are composed of sericite and quartz with minor chlorite; the presence of relict grains of plagioclase and microcline, and rare biotite, suggest that they were derived, at least in part, from acid plutonic rocks. The interbedded sandstone is finely bedded and crude cross-bedding is present in places near the Lukin River.

Slate is not widespread in the Holroyd Metamorphics, but small outcrops occur mainly south of Potallah Creek. The slate is dark and graphitic, and is composed principally of sericite and quartz. It is interbanded with graphitic phyllite and indurated mudstone. The indurated sediments and the slate belong to the chlorite zone of metamorphism.

Phyllite and fine-grained schist are widespread throughout the western two-thirds of the Holroyd Metamorphics in the Hann River and Ebagoola Sheet areas, and in places in the Coen Sheet area.

The phyllite and fine-grained schist are composed mainly of sericite and quartz. They are grey, purplish red, or reddish brown, and are commonly ironstained. The sericite grades into muscovite in the coarser rocks. Other minerals present include a little graphite, chlorite, garnet, opaque minerals including hematite, relict feldspar, and detrital tourmaline and zircon.

Graphitic schist and phyllite are most widespread in the south between Potallah, O'Lane, and Ethel Creeks. They are characteristically dark grey and some of them weather to a greasy black dust. North of the Coleman River graphitic schist is abundant between The Gorge on the Lukin River and the King River, and also along the west side of the King River in an area up to 9 km wide. The rocks contain up to 20 percent graphite. The graphite flakes are oriented roughly parallel to the schistosity; they may be scattered or localized in bands and lenses. Some of the graphite occurs as very small disseminated particles.

Hematite is common in the south. It forms up to 5 percent of some of the ironstained rocks near the Potallah Creek mine in which it occurs as scattered stringers and rectangular pseudomorphs of sulphide minerals. The small quartz lenses in the graphite-sericite-quartz schist 6 km west of the mine, contain large grains of iron oxide.

In places spotted fine-grained schist crops out adjacent to the phyllite and schist. In the west it forms a belt up to several kilometres wide in the vicinity of the Edward River and in scattered localities as far south as Crosbie Creek. Similar rocks occur in a narrow zone extending for 20 km north of the Holroyd River; coarser schist farther east. Spotted phyllite and schist also crop out adjacent to the granitic rocks in the Potallah Creek area; they contain porphyroblasts of chiastolite and rare fibrolite in places.

The spotted rocks are composed mainly of sericite or muscovite, and quartz. They are generally homogeneous, but psammitic quartz-rich bands with gradational boundaries are not uncommon. This schist is light grey and in places ferruginous, but is generally not graphitic.

Most of the spots consist of biotite and garnet which are commonly altered to hydrous iron oxides. The spots, which form 2 to 15 percent of the rock, are almost invariably less than 1 mm in diameter, and have a random but fairly uniform distribution. Narrow bands of small porphyroblasts of andalusite are present in places. The spotted schist lies predominantly in the biotite zone of metamorphism, but in places they are close to the andalusite zone.

Medium-grained or coarse-grained schists predominate in the eastern part of the Holroyd Metamorphics in the Hann River and Ebagoola Sheet areas. They include muscovite-quartz and biotite-muscovite-quartz schists which are graphitic in places. In places muscovite predominates over quartz. These schists are commonly crenulated and exhibit a prominent lineation. They are grey to buff and are commonly ironstained.

Some of the schists contain subhedral to euhedral porphyroblasts of andalusite or chiastolite, which are generally partly altered to sericite. The non-porphyroblastic schists contain lenses or bands of andalusite-bearing schist from 10 to 100 m wide and up to 5 km long. The porphyroblasts are 2 to 3 cm long and are aligned parallel to the schistosity, which is warped around them.

Xenoblastic laths of staurolite and idioblastic garnet occur in some of the schists in the southeastern part of the Holroyd Metamorphics, but andalusite and staurolite or garnet are rarely present in the same exposure. Small grains of tourmaline are present in places.

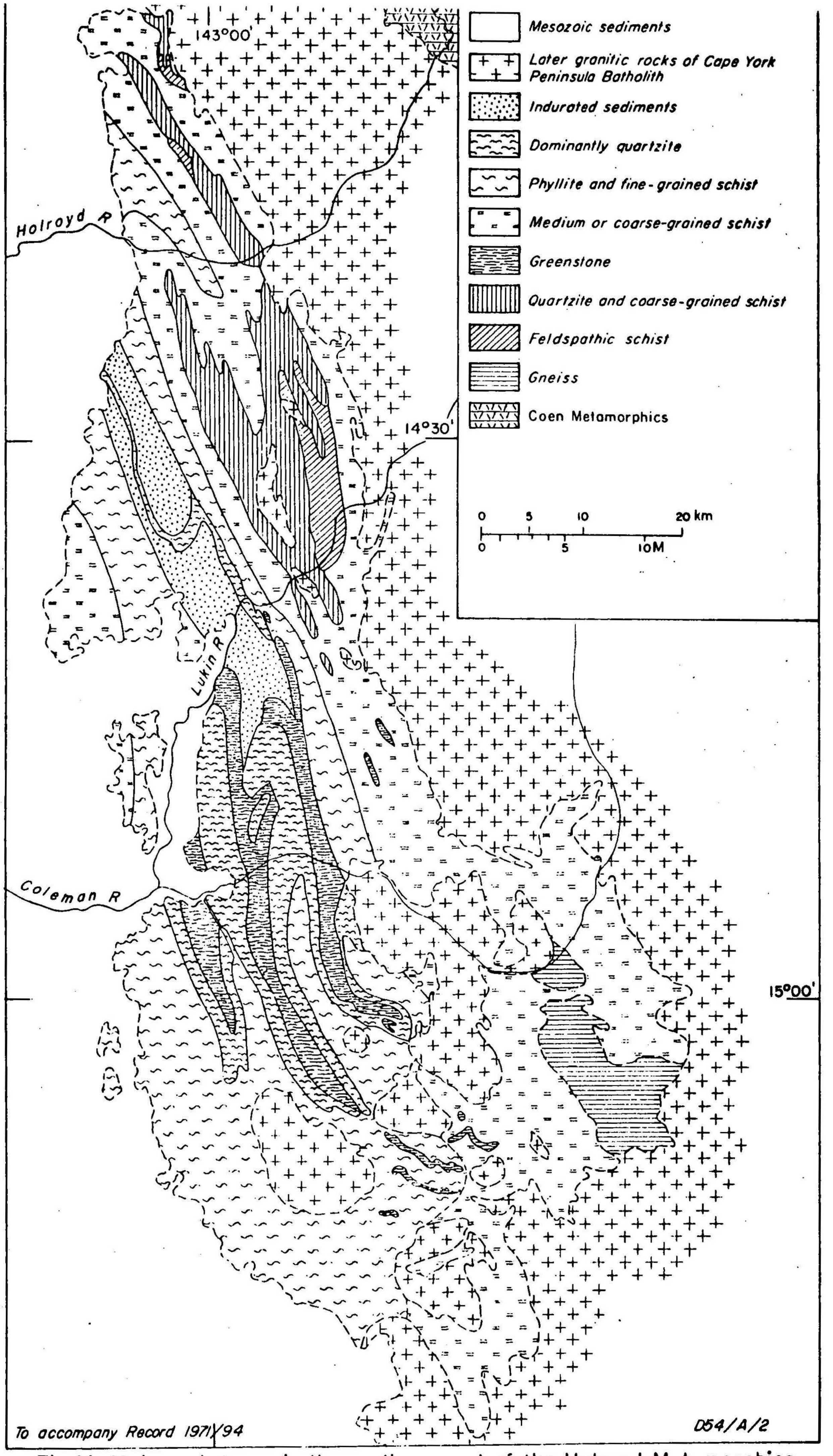


Fig.14 Main rock types in the southern part of the Holroyd Metamorphics.

Sillimanite, commonly as fibrolite, is widespread in the schist towards the eastern boundary of the metamorphics. Needles of fibrolite occur in quartz grains, in muscovite, and rarely in biotite flakes. The muscovite and fibrolite are generally altered to sericite. Some of the rocks contain masses of fibrolite parallel to the schistosity. Many of the small lenses of sericite may have been formed by the alteration of fibrolite, and some of the sillimanite may have been formed by the recrystallization of andalusite. Large prisms of sillimanite, similar to those in the Coen Metamorphics to the east, are rare.

The schist contains sporadic porphyroblasts of cordierite which have been largely altered to chlorite and sericite. Some of the schist along the margin of the batholith contains coarse flakes of muscovite inclined to the foliation. The recrystallization of the muscovite may be due to contact metamorphism, or to the later Upper Devonian event identified by K/Ar dating. The medium and coarse-grained schist belongs to the andalusite and sillimanite zones of metamorphism.

Feldspathic schist crops out in the eastern part of the Holroyd Metamorphics. The most common assemblage is oligoclase-biotite-muscovite-quartz, but sillimanite is also widespread. The feldspathic rocks are typically grey, or speckled light grey, dark grey, or green. They are poorly schistose or granofelsic, with incipient gneissic texture in places. The biotite generally contains inclusions of zircon and occasional monazite crystals with pleochroic haloes. Brookite or anatase, and more rarely sphene and cordierite may be associated with the biotite. Graphite or hematite may also be present.

The feldspathic rocks are best developed between the Holroyd and Lukin Rivers, and between the Coen River and Pretender Creek, 20 km to the south. South of the Lukin River oligoclase-bearing schist is rare, and where present contains minor microcline. The feldspathic schist of metasomatic origin is described separately.

Gneiss is relatively rare in the Holroyd Metamorphics. Apart from the feldspathic schist with an incipient gneissic texture, gneissic rocks occur only south of the Coleman River and in small areas north of the Archer River. The gneissic rocks formed during the emplacement of the Cape York Peninsula Batholith are described separately.

In the south the gneiss forms a belt up to 8 km wide within coarse mica-quartz schist, with which it probably has a gradational contact. The gneiss is composed of biotite, muscovite, feldspar, and quartz, and is fairly massive. The feldspar is usually andesine, but microcline is present in places. In the south the gneiss has been recrystallized and metasomatized by the batholith. The gneiss is similar to those in the Dargalong and Coen Metamorphics. Both the feldspathic schist and the gneiss belong to the sillimanite zone of metamorphism.

Beds or bands of quartzite, from 1 m to a few hundred metres thick, are widely distributed in the Holroyd Metamorphics, particularly in a folded belt extending for 15 km north and 20 km south of the Coleman River between the Lukin and King Rivers, and in a belt extending north and south from the Holroyd River near Pollappa. A few beds of quartzite are present elsewhere.

Near the Coleman River the quartzite bands are up to 2 km wide. They are clearly visible on the air-photographs and can be traced along stike for up to 30 km. They form prominent low hills, in places up to 75 m high, covered by blocky rubble. The quartzite is commonly white to gray, fine or medium-grained, and massive, but in places the rock is brown or pink. The quartzite commonly consists almost entirely of interlocking grains of strained quartz. The crude schistosity may be revealed in places by flakes of sericite. The rock is commonly ironstained and contains a little hematite, rare feldspar, and chlorite. The quartzites associated with graphitic phyllites may also contain graphite. Detrital grains of tourmaline and zircon may also be present.

Bedding can be recognized in places, and more rarely a crude cross-bedding.

In the western part of the Holroyd Metamorphics the bands of quartzite range from several centimetres to several metres in width, and in many places they have gradational contacts with the psammitic phyllite or schist.

The quartzite interbanded with the coarse-grained schist near the Holroyd River forms continuous bands up to 60 m thick which can be traced for up to 25 km. The interbanded belt of schist ranges up to 1 km in thickness. The quartzite is white or grey, medium or coarse-grained, and has a massive granulose texture. A little sericite and iron oxides may be present in the matrix. The subordinate bands of quartzite in the Holroyd Metamorphics in the Coen Sheet area are similar to those farther south.

Greenstone and amphibolite are not widespread in the Holroyd Metamorphics. The largest exposures are shown in Figure 8 and on the 1:500,000 map. In the southwest the greenstone belts range up to 30 km long and 3 km wide. North of the Lukin River and in the southeast, there are only a few narrow bands or small isolated bodies of greenstone and amphibolite. These rocks form distinctive dark bands on the air-photographs.

The greenstone in the large folds near the Coleman River is interbanded with pelitic and psammitic rocks, but is not so well exposed as the host rocks. The greenstone is a fine to coarse-grained dark green rock composed of fibres and prisms of amphibole or chlorite. The texture ranges from decussate to massive; some of the rocks have a relict igneous or epidioritic texture. One exposure consists of partly recrystallized basalt containing numerous amygdules.

The greenstone is composed mainly of colourless or pale green subhedral prisms of tremolite-actinolite, but some of them contain pale blue-green hornblende partly altered to chlorite. Tremolite, together with primary chlorite and talc, are characteristic of the magnesium-rich assemblages found as small lenses within the greenstones; they may represent metamorphosed ultramafic rocks. Similar lenses of tremolite-chlorite or tremolite-talc rock are also present farther east. The plagioclase in the greenstone ranges from partly recrystallized zoned grains with cores of andesine or labradorite rimmed by albite or oligoclase to unzoned grains of albite or oligoclase. The greenstone contains subordinate quartz, clinozoisite, sphene, biotite, sericite, and carbonate.

The amphibolites which occur mainly in the southeast, are composed mainly of blue-green or green and rarely brown hornblende, and andesine or labradorite. They are greenish black, and schistose to massive or granoblastic. They contain a little quartz, sphene, clinozoisite, calcite, and clinopyroxene. The amphibolites are the higher-grade equivalents of the greenstones.

Recrystallized and metasomatized rocks and migmatite were formed in the metamorphics during the intrusion of the Cape York Peninsula Batholith. In the east the contact with the batholith is poorly exposed, but along most of the contact there is a narrow zone in which the schist is penetrated by bands and dykes of leucocratic granite. The partial recrystallization of the schist was accompanied by minor potash metasomatism.

In the southeast around 8 Mile Creek there was extensive recrystallization and potash metasomatism. The biotite-muscovite-quartz schist grades into a coarser granoblastic rock towards the batholith. As the degree of contact metamorphism increases the spots of muscovite and microcline coalesce to form bands rich in mica or feldspar. Some of the banded rocks have been converted to migmatite by the injection of granitic material composed of quartz and microcline. The gneiss in the headwaters of Watch Branch Creek 15 km west of Dixie homestead has also been recrystallized and metasomatized, and is intimately interbanded with granitic material in places.

The granite plutons in the Potallah Creek area are surrounded by aureoles of contact metamorphism. Some spots of biotite and garnet have been developed in the low-grade phyllite and schist, and porphyroblasts of chiastolite and a little fibrolite (?) have been formed in places. The rare porphyroblasts of cordierite (?) in the phyllite near the Kennedy road south of the Archer River, and the recrystallization of muscovite obliquely to the foliation near the granite contact are also probably the result of contact metamorphism.

Coen Metamorphics

(New Name)

Derivation of Name

The name Coen Metamorphics is taken from the township of Coen (lat. 13°57'S, long. 143°11'E) in the Coen Sheet area. The formation consists of bodies of coarse schist and gneiss cropping out east of the Holroyd Metamorphics, most of which lie within the Cape York Peninsula Batholith. They were previously included in the Dargalong Metamorphics (Whitaker & Willmott, 1968, 1969; Trail et al., 1968, 1969), which are now restricted to the Yambo Inlier and Chillagoe area. The type area is the broad belt of metamorphics extending for about 20 km south from Coen.

Distribution

The Coen Metamorphics crop out over 1100 sq km as many isolated bodies separated by the later granitic rocks of the batholith. The largest belt, which extends southwards from Coen into the Ebagoola Sheet area, tapers in width from 15 km near Coen to 3 km between Ebagoola and the abandoned Bamboo homestead. A parallel belt to the east of the first belt runs southeastwards from Kintore Hill. North of Coen numerous small bodies of Coen Metamorphics crop out within the granitic rocks in the McIlwraith Range and coastal ranges; only the largest of them are shown on the map. In the Hann River Sheet area several small blocks of metamorphic rock crop out within the granitic rocks along the western edge of The Desert between Dixie and Kimba homesteads.

The metamorphics crop out in rough country with strike ridges of quartzite up to 150 m high. In spite of the relief, the less resistant rocks are poorly exposed and intensely weathered.

Lithology

The Coen Metamorphics consist mainly of biotite-muscovite-quartz schist, quartzite, and biotite-quartz-feldspar gneiss, with subordinate thin bands of garnet-amphibole-quartz-feldspar gneiss, amphibolite, and calc-silicate rocks. The schist, quartzite, and biotite gneiss grade into one another and are generally intimately interbanded, although large bodies of gneiss with little schist have been delineated near Coen and Ebagoola. Schist and quartzite are about three times as abundant as gneiss. Amphibolite is generally present as conformable bands, but the lenses of calc-silicate rock are less common.

Between Ebagoola and Coen the metamorphics have been intimately penetrated by adamellite, leucocratic granite, pegmatite, and aplite of the Cape York Peninsula Batholith. The small bodies of metamorphics within the batholith in the Coen Sheet area have also been invaded by similar granitic rocks.

The biotite-muscovite-quartz schist is fine to medium-grained, and has a moderately well developed fine schistosity that is crenulated in places. When fresh the rocks are silvery grey, but are stained purple where weathered, the mineralogical composition varies considerably but muscovite generally predominates over biotite, and with an increase in the amount of quartz the schist grades into quartzite. Many of the rocks contain sillimanite porphyroblasts, up to 8 cm long, which have been pseudomorphed by aggregates of muscovite. The schist also contains subordinate garnet, plagioclase, potash feldspar, and opaque minerals.

Most of the muscovite occurs as aggregates of minute flakes which were probably formed by the alteration of porphyroblasts of sillimanite, but some of the larger flakes may be primary. The biotite associated with the larger flakes of muscovite has been partly or completely replaced by colourless or pale green chlorite. Rare cores of sillimanite are present in the muscovite pseudomorphs. One specimen from the central part of the Coen Sheet area, contains minute needles of sillimanite formed by the recrystallization of cordierite (?), the remainder of which has been completely replaced by muscovite.

A little garnet (almandine?) is generally present, but in some specimens it forms up to 20 percent of the rock. The colourless or pale pink poikilitic porphyroblasts are altered to chlorite along fractures. A little plagioclase and potash feldspar is present in the transitional types between schist and biotite-quartz-feldspar gneiss. Some specimens contain up to 10 percent iron oxides and graphite as irregular or elongate flakes parallel with the schistosity. A little zircon, monazite, rutile, apatite, and tourmaline may be present, and one specimen contains spinel and corundum in what were probably alumina-rich bands.

The quartzite is grey or white, medium to coarse-grained, and generally has a sugary texture; in places the quartz grains have a weak preferred elongation parallel to the foliation in the neighbouring rocks. One specimen from 25 km northeast of Musgrave homestead contains garnet and sillimanite. Some of the euhedral needles of sillimanite are interstitial, others have grown with the quartz grains.

The biotite-quartz-feldspar gneiss is grey or white, medium to coarse-grained, banded, and poorly to moderately schistose. The banding is commonly irregular, especially where large feldspar porphyroblasts are present, and the leucocratic rocks have a massive granoblastic texture. The difference in texture between the finely schistose biotite-muscovite quartz schist and the gneiss is probably due to the high proportion of feldspar in the gneiss. Some of the gneiss interlayered with the schist and quartzite contains less feldspar and has a more pronounced schistosity than the large bodies of gneiss such as that near Coen. The gneiss contains from 20 to 40 percent calcic oligoclase to sodic andesine. Some specimens contain small subhedral grains of poorly twinned microcline, but except in the leucocratic gneiss, it forms less than 20 percent of the rock. The gneiss contains up to 25 percent biotite, which in places is replaced by colourless or light green chlorite. A little muscovite may be present, usually in the form of aggregates of small flakes, similar to those in the biotite-muscovite-quartz schist, which appear to be pseudomorphs after sillimanite (?). Colourless or pale pink garnet is relatively common; X-ray diffraction indicates that it is probably almandine. The accessories include zircon, monazite, apatite, sphene, and opaque minerals.

One specimen of gneiss from the Rocky River on the east side of the McIlwraith Range contains long streaks and thin folia of cordierite and sillimanite. The sillimanite forms myriads of fine needles within the cordierite, which is partly altered to muscovite.

Along the western edge of The Desert between Kimba homestead and the Kennedy Road crossing of the Morehead River, small bodies of muscovite-biotite-quartz-feldspar gneiss occur within the granitic rocks. The gneiss is medium to coarse-grained and leucocratic, and has a weak foliation defined by bands rich in biotite. The contacts with the granitic rocks are vague. Near the contact the gneiss is more leucrocratic and massive, and the granitic rocks contain streaky remnants of biotite-rich bands, which in places impart a weak foliation. The leucocratic gneiss is composed of a granoblastic mosaic of small equant grains of quartz, plagioclase, and microcline. The poorly developed preferred orientation, as defined by a few flakes of mica, suggests that the rocks have been recrystallized. The presence of up to 30 percent microcline and the abundance of muscovite in some specimens may be due to potash metasomatism.

The rare thin bands of garnet-amphibole-quartz-feldspar gneiss in the biotite gneiss have a similar texture to the host rock, although they are generally more mafic. The two types probably grade into each other through intermediate varieties such as amphibole-biotite-quartz-feldspar gneiss. The plagioclase is more basic than in the biotite gneiss and ranges from calcic andesine to calcic labradorite. The amphibole, which forms up to 40 percent of the rock, is generally yellow to pale greenish brown hornblende, but in places it consists of colourless to pale green tremolite-actinolite. Large poikilitic porphyroblasts of pale pink garnet (almandine?) form up to 25 percent of some specimens. The accessories include opaque minerals, sphene, apatite, and zircon.

The amphibolite is a fine-grained greenish black rock composed of hornblende and plagioclase. The amphibolite bands are up to 10 m thick and are conformable with the foliation in the surrounding metamorphic rocks; the lineation of the amphibole crystals is also parallel to the foliation. The bands of amphibolite within the Cape York Peninsula Batholith are probably large xenoliths that have resisted digestion.

The amphibolites are composed of hornblende (40-80%), plagioclase (15-35%), and quartz (up to 15%). The hornblende forms large poorly oriented subhedral pale yellow to greenish brown crystals. Near lenses of calc-silicate rock the hornblende has a bluish green tinge similar to that of the amphibole in the calc-silicate rocks. The plagioclase generally ranges from andesine to sodic labradorite. A little interstitial quartz is generally present, but some of the rocks contain up to 15 percent. Opaque minerals, sphene, and apatite are common.

Most of the calc-silicate rocks are light to dark green, fine-grained, banded and schistose, and are rich in calcic ferromagnesian minerals; they also include coarse-grained white marble. They crop out as small concordant lenses within the schist and gneiss, and as xenoliths within the granitic rocks. The largest outcrops occur just south of the Coen/Leo Creek track in the headwaters of Peach Creek, but they are very common in the coastal ranges, east of the Lockhart River valley. The calc-silicate rock occurrences are shown in Figure 15. Each outcrop includes irregular light and dark-coloured bands with different mineral assemblages which can generally be divided into three types as shown in Table 8.

I. The lime-magnesia-silica assemblages forming the light green and dark green bands are the most common. They are composed predominantly of tremolite and clinopyroxene in various proportions, with subordinate chlorite and altered plagioclase (?) in some specimens. A little quartz, sphene, and calcite may also be present. X-ray diffraction suggests that the colourless clinopyroxene ranges from diopside to hedenbergite. The large subhedral laths of tremolite are commonly poikilitic with inclusions of quartz and altered feldspar. X-ray diffraction on one specimen indicated about 10 percent of the actinolite molecule.

A calc-silicate band in gneiss on the coast 3 km north of the mouth of the Nesbit River contains aggregates of large subhedral crystals of vesuvianite in a rock composed predominantly of diopside and altered albite. At Whale Hill, 10 km southwest of Cape Sidmouth, a calc-silicate xenolith within granitic rocks is composed of epidote (60%), quartz (25%), and dark green hornblende (15%). Another rock from the west side of the McIlwraith Range between Wilson and Beetle Creeks, is deficient in silica; it is composed of calcite (15%), chondrodite (15%), spinel (20%), fine flakes of talc (?) (40%), and chlorite (5%). Some of the colourless to pale yellow euhedral chondrodite crystals are twinned and partly altered to serpentine. The large body of very dark calc-silicate rock south of the Coen/Leo Creek track is composed of bluish green hornblende (40%), plagioclase (30%), pale green clinopyroxene (25%), and quartz (5%). It may represent a transitional type between the more common calc-silicate rocks and the amphibolites.

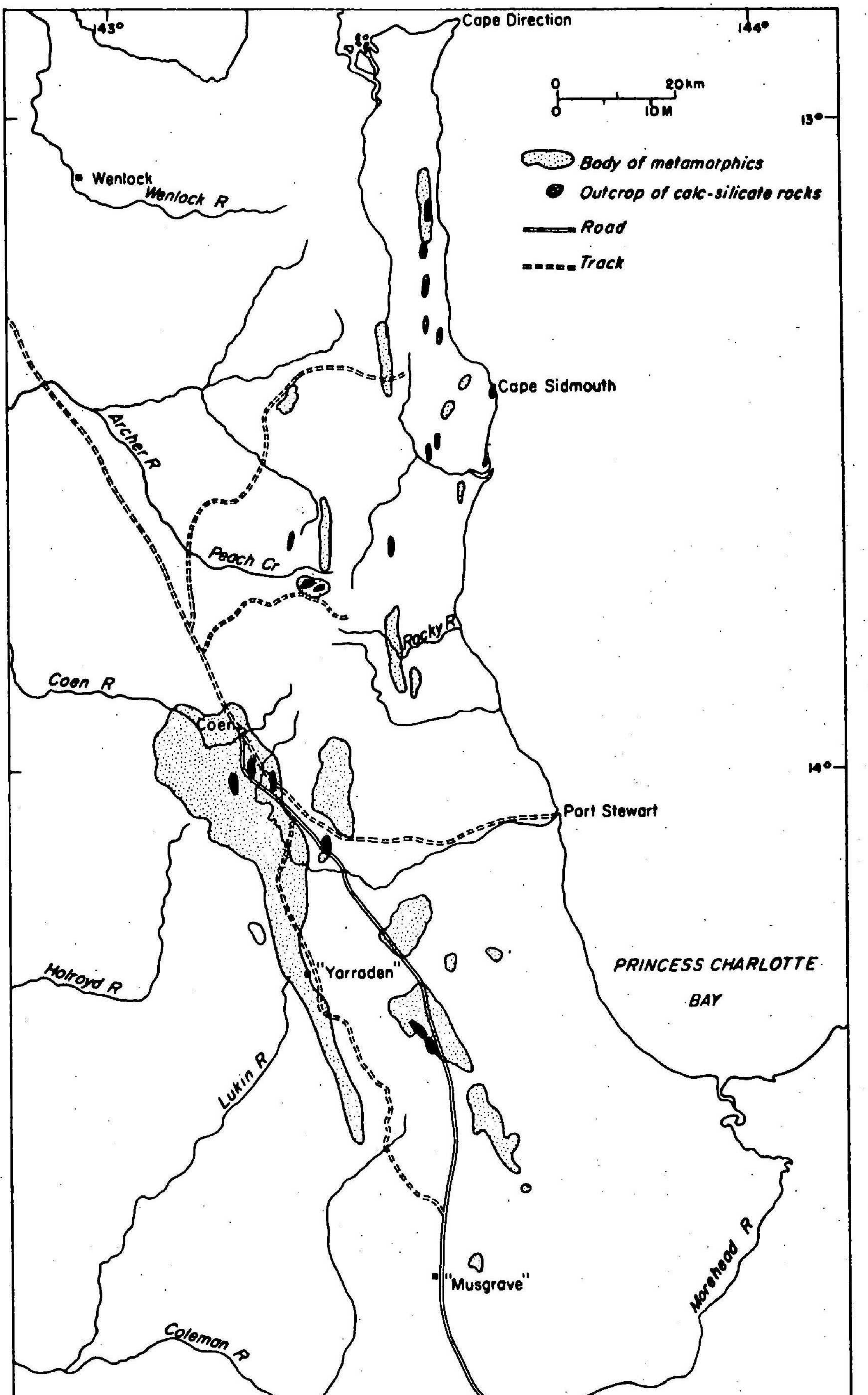


Fig. 15 Calc-silicate rocks in the Coen Metamorphics.

TABLE 8. MINERAL ASSEMBLAGES IN CALC-SILICATE ROCKS, COEN METAMORPHICS

I. Lime-magnesia-silica assemblages

tremolite
chlorite-tremolite
quartz-plagioclase-tremolite
plagioclase-diopside-tremolite
tremolite-diopside
plagioclase-termolite-diopside
quartz-plagioclase-diopside
vesuvianite-albite-diopside
calcite?-diopside
quartz-plagioclase-diopside-hornblende
quartz-clinozoisite-hornblende-diopside
hornblende-quartz-epidote
chlorite-chondrodite-calcite-spinel-talc?*

II. Carbonate-rich assemblages

olivine-calcite-dolomite*
olivine-diopside-calcite-dolomite*
diopside-calcite-dolomite

III. Silica-rich assemblages

diopside-actinolite-quartz
sphene-actinolite-diopside-quartz

*Silica deficient

II. The carbonate-rich assemblages forming the light-coloured bands are abundant in places. The body of impure white marble, several hundred metres long, south of the Coen/Leo Creek track is composed mainly of a mosaic of large irregular grains of dolomite and calcite. Small rounded grains of forsterite (?), partly replaced by serpentine, and bands of diopside (?) are also present.

III. The silica-rich assemblages were observed in a few places only. They contain up to 70 percent of quartz grains elongated parallel to the weak schistosity. The subordinate clinopyroxene and tremolite-actinolite (up to 35%) form small interstitial grains and large poikilitic laths. Some grains of altered feldspar and sphene may also be present.

Sefton Metamorphics

(Whitaker & Willmott, 1969a)

Derivation of Name

The Sefton Metamorphics were named after Sefton Creek in the northern part of the Coen Sheet area. The formation includes all the metamorphic rocks referred to informally by Broken Hill Pty Co. Ltd (BHP, 1962) as the Sefton Group, the Iron Range Group, the Bowden Group, and the Bolt Head Limestone.

Distribution

The Sefton Metamorphics are exposed over about 450 sq km in the Cape Weymouth Sheet area and northern part of the Coen Sheet area. They crop out in four main regions: the Mount Carter Block and a belt extending for 30 km south of Mount Carter almost as far as Falloch Creek, a northerly trending belt between the Iron Range airstrip and the Pascoe River, three small outcrops on headlands in Temple Bay, and several small bodies in the Bowden area. The rocks in the first three regions were named the Mount Carter Schist, the Iron Range Schist, and the Bolt Head Schist, by Whitaker & Willmott (1969a), but as similar rock types are present in all three areas, this terminology has been abandoned.

The Sefton Metamorphics are well exposed only in gorges cut into the Mount Carter Block, and on the headlands in Temple Bay where they form small wave-cut platforms beneath low cliffs of Mesozoic sandstone. In the rough country south of Mount Carter the metamorphics are poorly exposed except in the strike ridges of quartzite. In the relatively low country in the Iron Range area the metamorphics are generally concealed by deep soil and dense rain forest, although some prominent ridges of quartzite are present. In the Bowden area a few low ridges of quartzite rise above the poorly exposed less resistant metamorphics.

Lithology

The Sefton Metamorphics are composed predominantly of fine-grained muscovite-quartz schist and quartzite, with subordinate interbanded phyllite, muscovite-biotite-quartz-feldspar schist, hematite-quartz schist, magnetite quartzite, greenstone, amphibolite, calc-silicate rocks, and schistose limestone. The only rock type shown separately on the map is the belt of greenstone near Iron Range. The iron-bearing rocks near Iron Range were examined in detail by the Broken Hill Pty Co. Ltd between 1957 and 1962 (BHP, 1962; Canavan, 1965).

Muscovite-quartz schist and muscovite quartzite are interbanded; all gradations exist between schist with about 50 percent quartz and quartzite composed almost entirely of quartz and a little muscovite. In the western part of Mount Carter the fine-grained schist grades into phyllite; some of the fine-grained rocks probably contain a little graphite and hematite. The grainsize increases to the east and south in the Mount Carter Block, and along the belt extending beyond it to the south; some of the rocks at the southern end of the belt are gneissic.

The schist at Mount Carter contains up to 15 percent biotite in places. A little tourmaline is present in the biotite-bearing muscovite-quartz schist from the eastern and central parts of the block; one specimen contains 25 percent of small grains of tourmaline parallel to the schistosity. The biotite-bearing muscovite-quartz schist from the southern and eastern margins of Mount Carter contains scattered grains of andalusite; one specimen contains about 20 percent andalusite porphyroblasts, up to 1 cm long, which have been altered to aggregates of muscovite.

In the Iron Range the schist is well exposed only where it is interbanded with resistant quartzite. In Scrubby Creek 7 km west of Iron Range airstrip, bands of graphite-muscovite-quartz schist and muscovite-oligoclase-quartz schist are associated with muscovite quartzite and schistose conglomerate. The pebbles in the conglomerate consist mainly of feldspathic quartzite and some fine-grained graphitic rocks. Fine-grained graphitic phyllite crops out intermittently in this creek, and also 5 km farther south.

Reid (1959) notes that diamond drill cores of the mica schist at Lamond Hill, 7 km north of Iron Range airstrip, are composed of calcite (20%), quartz (20%), and muscovite with some biotite and chlorite (60%). The schist about 8 km north of Lamond Hill contains porphyroblasts of altered cordierite (?), abundant biotite and muscovite, and quartz.

Muscovite quartzite is common in the hills northeast of Iron Range airstrip and along the western margin of the metamorphics south of the Kennedy Road. It contains a little chlorite, graphite, or iron oxides. A few porphyroblasts of altered cordierite (?) occur in the quartzite exposed in the West Claudie River near the Kennedy Road.

In the Temple Bay region muscovite-quartz schist and quartzite crop out at Bolt Head. The schist is a dark grey fine-grained rock with a grey micaceous mineral (chlorite or stained muscovite?) oriented parallel to the muscovite. In places the schistosity is crenulated and strain-slip cleavage is developed. The schist is interbedded with impure schistose limestone.

In the Bowden region there are several small outcrops of muscovite-quartz schist and muscovite quartzite west of Kennedy Road, between the crossing on the Pascoe River and Garraway Creek. They range from phyllite to coarse schist. The large outcrop of metamorphics on Canoe Creek 5 km above its confluence with the Pascoe River, is composed of a core of quartzite in an envelope of muscovite-quartz phyllite; in the south the phyllite contains knots of altered andalusite (?). Another large outcrop, 8 km to the south, is composed of coarse muscovite-quartz schist, with books of mica up to 4 cm across, cut by irregular veins of quartz, quartz-tourmaline rock, and sheared granite.

The small bodies of muscovite-quartz schist in the Kintore Adamellite, along the southwest margin of the Weymouth Granite between the Pascoe River and Sefton Creek, contain graphite and small crystals of tourmaline in places. In some exposures the schistosity is crenulated.

Muscovite-biotite-quartz-feldspar schist is interbanded with muscovite-quartz schist and muscovite quartzite in the southern part of the belt south of Mount Carter, and in some isolated outcrops a few kilometres to the west. The schist is generally medium to coarse-grained, and in places it is gneissic and contains thin segregations of biotite-quartz rock. Varying amounts of microcline and cloudy sodic andesine are present. On the western side of the south end of the belt, and in an isolated outcrop 10 km to the north, the muscovite-quartz schist and muscovite-biotite-quartz-feldspar gneiss contain small irregular masses of migmatite.

The hematite-quartz schist forming the high ridge of Lamond Hill and several smaller ridges within a few kilometres of Iron Range Airport is composed of tightly folded bands of white quartz, between 1 mm and 10 cm thick, alternating with similar slightly thicker bands of red platy hematite with scattered crystals of magnetite. The hematite-quartz schist contains bands, several metres thick, of muscovite quartzite, muscovite-quartz schist, and calcite-quartz-mica schist.

The magnetite quartzite forming Black Hill, 23 km north of Iron Range airstrip, and other prominent hills nearby has been leached of silica at the surface to form a massive laterite rich in iron and manganese (BHP, 1962). Drilling by the Broken Hill Pty Co. Ltd at Black Hill (Sheppard & Jobling, 1960; Lee & Forsythe, 1961) has shown that the laterite has generally been derived from amphibole-bearing quartzite, although a little hematite quartzite is also present. Lee & Forsythe note that the magnetite quartzite changes along strike into amphibole-quartz rock. The amphiboles in the magnetite quartzite have been identified by BHP geologists as hornblende with subordinate tremolite, actinolite, cummingtonite, grunerite, and riebeckite; other minerals recorded are hypersthene, epidote, garnet, fayalite, calcite, rhodocrosite, and iron sulphides. The amphibole quartzites encountered in the drill holes are similar to the silica-rich calc-silicate rocks found farther south in the Coen Metamorphics. They were probably derived from iron-rich and calcium-rich quartzose sediments.

Greenstone or metamorphosed basic igneous rock forms a subdued ridge extending for 10 km northwards from Yarraman Creek, 5 km southwest of Iron Range airstrip, to the Kennedy Road. Greenstone is not exposed along the road or in the Claudie River nearby, but has been mapped for about 5 km to the north of the road by the Broken Hill Pty Co. Ltd.

At Yarraman Creek the greenstone is a dark blue-grey medium-grained metadolerite with a relict ophitic texture. It is composed of sericitized plagioclase, augite, chlorite, and a little quartz. The greenstone 1 km south of the Kennedy Road, however, which is probably a fine-grained altered lava, is composed of quartz, actinolite, epidote, and cloudy plagioclase. The rock contains up to 20 percent quartz which is commonly concentrated in small patches; epidote or plagioclase predominate over actinolite in the fine-grained groundmass. Amygdales filled with epidote, calcite, or quartz, can be seen in places. The greenstone north of the Kennedy Road is poorly exposed, but Reid (1959) has recorded the presence of magnetite-albite-quartz-epidote-hornblende schist.

Lee & Forsythe (1961) consider that the glaucophane amphibolite containing magnetite and the banded magnetite-quartz-hornblende rock found in the drill cores at Black Hill represent altered basic igneous rocks.

A few poorly exposed concordant bands of amphibolite crop out in the southern part of the belt of metamorphics south of Mount Carter. One of the bands is composed of green hornblende (60%), altered plagioclase (20%), quartz (10%), opaque minerals (10%), and a little biotite.

Schistose limestone crops out at Bolt Head and Limestone Point, 2 km to the south, on the coast of Temple Bay. The fine-grained limestone ranges from light to dark grey and is cut by thin veins of calcite. It consists of a mosaic of interlocking calcite crystals which, in places, have a strong preferred orientation. Locally the rock contains up to 30 percent quartz in thin bands of slightly elongated grains. The limestone grades into muscovite-quartz schist or quartzite with the increase in the proportion of muscovite-quartz bands. The dark grey variety contains small scattered grains of carbonaceous (?) material.

Calc-silicate rocks and marble are recorded by Lee & Forsythe from drill holes at Black Hill, north of Iron Range. They include impure marble, fine marble with tremolite, tremolite-quartz schist with some diopside, and quartz-chlorite and quartz-biotite rocks with minor tremolite, diopside, and ilmenite. Granular banded quartz-diopside-plagioclase rocks crop out in a few small exposures northeast of Black Hill; one contains a few porphyroblasts of garnet.

A calc-silicate rock is also exposed at Intruder Head 5 km north of Bolt Head in Temple Bay. It is composed of quartz (40%), green hornblende (30%), granules of diopside (30%), and a little plagioclase. The quartz is concentrated in bands with scattered crystals of plagioclase and the hornblende has a marked preferred orientation. A few small ill defined lenses of calcite are also present.

Precambrian (?) Dolerite

In the western part of the Yambo Inlier dykes and irregular masses of dolerite intrude the metamorphic rocks. The dykes which occur in small swarms, mainly south of the Palmer River, are up to 5 km long and trend in a northwesterly or northerly direction. Irregular bodies up to 5 km long and 2 km wide occur in the same region. In places they are elongated parallel to the foliation in the metamorphic rocks, but elsewhere they cut across it. A few dolerite dykes cut the Holroyd Metamorphics north of the Coleman River, and the Coen Metamorphics east of Yarraden homestead and north of Silver Plains homestead. The dolerite is generally more resistant than the metamorphic rocks, and forms slight rises or ridges covered with loose blocks and boulders set in a dark red-brown soil.

The dolerite consists of labradorite, or rarely bytownite, augite, poikilitic phenocrysts of a colourless orthopyroxene (probably enstatite), hornblende, and scattered grains of magnetite. The hornblende includes small brown subhedral, small lath-like phenocrysts and a red-brown type rimming and partly replacing clinopyroxene. The dolerite contains a little sphene, apatite, biotite, spinel, and olivine (?); secondary actinolite, chlorite, and calcite may also be present.

The dolerites were intruded after the regional metamorphism, but before the emplacement of the Cape York Peninsula Batholith, as altered dolerite is found as inclusions in the Kintore Adamellite of the Yambo Inlier. Farther north near Glengarland homestead a dolerite dyke has been thermally metamorphosed by the nearby Kintore Adamellite.

The metamorphics in the Chillagoe area and Georgetown Inlier were intruded by the Cobbold Dolerite before the intrusion of the Precambrian Forsayth Granite (White, 1965). Comparison of the rocks in the Cape York Peninsula with those in the Georgetown Inlier will not be possible until the age of the metamorphics and granites have been determined more precisely.

Flyspeck Granodiorite

(Whitaker & Willmott, 1968)

Derivation of Name

The Flyspeck Granodiorite was named after Flyspeck Creek at the headwaters of the Coleman River, about 25 km northwest of Musgrave homestead, in the Ebagoola Sheet area.

Distribution

The Flyspeck Granodiorite comprises several large elongate intrusions trending north-northwest in the central part of the Cape York Peninsula Batholith, between Dixie homestead in the Hann River Sheet area and Falloch Creek 190 km to the north. There are two other intrusions near the western margin of the batholith, one northwest of the Alice River Goldfield and the other north-northwest of Coen airstrip. Small bodies of granodiorite crop out north and northwest of Bald Hill in the Coen Sheet area, and also within the Kintore Adamellite along the east edge of the McIlwraith Range and in the centre of the range west of the Leo Creek Mine. There are a few small patches of granodiorite within the Lankelly Adamellite east of Coen. The small bodies of diorite and granodiorite east of the Geikie Range and south of the Archer River, which are included in the Flyspeck Granodiorite, are intruded by the Morris Adamellite.

The Flyspeck Granodiorite is moderately well exposed as boulders up to 5 m high, and in creeks. The soil on the granodiorite has a dark tone which is readily distinguished on air-photographs.

Lithology and Relationships

The Flyspeck Granodiorite consists mainly of biotite granodiorite and hornblende-biotite tonalite, and some biotite-hornblende diorite in the Coen Sheet area. Some of the rocks are adamellite according to the classification of Joplin (1964).

Most of the Flyspeck Granodiorite does not contain hornblende, but hornblende-bearing rocks predominate northwest of the Alice River Goldfield. The transitional zone between the biotite granodiorite and hornblende-biotite tonalite ranges in width from 1 m to $1\frac{1}{2}$ km. The granodiorite is generally massive, but in places ill defined biotite-rich bands alternate with bands rich in quartz and feldspar.

In the coarse-grained biotite-hornblende tonalite, northwest of the Alice River Goldfield crystals of hornblende and biotite are roughly aligned to produce a weak vertical foliation parallel to the contact. The northern and southern margins of the intrusion west of Coen Airport are gneissic and migmatitic, but towards the centre it becomes massive. The porphyritic gneissic granodiorite to the south contains large microcline phenocrysts. The foliation of the rock is due to the alignment of the hornblende and biotite crystals parallel to the schistosity in the surrounding metamorphic rocks. In the northern part of the body banded or migmatitic granodiorite alternates irregularly with the porphyritic type. Fine-grained biotite-rich xenoliths occur in several places. A small body of similar gneissic granodiorite is exposed at the base of the Mesozoic sandstone at the southern end of the Geikie Range.

Shear zones cut the Flyspeck Granodiorite northeast of Ebagoola, southeast of Coen, and at Coen. The sheared rock has a weak schistosity; the quartz grains are strained and in places broken, the plagioclase laths are bent or broken, and the biotite flakes are recrystallized, some with a preferred orientation.

The Flyspeck Granodiorite is cut by numerous small acid or intermediate dykes, with occasional larger dykes up to 10 m thick and several kilometres long. The dykes have no overall preferred direction, but several subparallel dykes are commonly present. They range from rhyodacite to andesite, and consist mainly of a fine mosaic of anhedral quartz and untwinned feldspar, with chlorite in places; some contain small euhedral phenocrysts of quartz, plagioclase, or untwinned feldspar. The granodiorite is also cut by a few pegmatite dykes.

The contact of the Flyspeck Granodiorite with the Kintore Adamellite is sharp. There is no marked change in the adamellite or granodiorite towards the contact, except for the concentration of muscovite granite towards the margin of the Kintore Adamellite. Dykes and veins of muscovite granite pegmatite belonging to the Kintore Adamellite cut the Flyspeck Granodiorite near the contact, yet the Flyspeck Granodiorite northwest of the Alice River Goldfield intrudes the migmatite formed along the contact of the Kintore Adamellite. West of the Leo Creek mine small bodies of biotite granodiorite appear to intrude the Kintore Adamellite.

East of the southern end of the Geikie Range, granodiorite and diorite are intruded by coarse porphyritic biotite adamellite of the Morris Adamellite, and the Wigan Adamellite intrudes fine-grained biotite-hornblende granodiorite east of Bald Hill.

Petrography

The Flyspeck Granodiorite contains between 20 and 40 percent of quartz. It forms equant or irregular grains with slightly sutured margins and undulose extinction; some grains may be recrystallized.

Potash feldspar forms between 0 and 40 percent of the total feldspar, which ranges up to 50 percent of the rock. It is generally microcline, but orthoclase has been recognized in a few specimens. The feldspar generally forms anhedral grains in the groundmass, but in some specimens it forms subhedral poikilitic phenocrysts, up to 1 cm across, containing inclusions of quartz, plagioclase, and biotite. The larger grains of potash feldspar are perthitic.

The granodiorite contains 30 to 50 percent of andesine (An_{32}-An_{42}). It forms well twinned subhedral or euhedral laths; some laths are zoned, and in some twin lamellae are bent or strained. The plagioclase is commonly altered to sericite and clinozoisite.

The subhedral laths of biotite (5-25%) are pleochroic from pinkish brown to pale yellow. In the biotite-rich rocks the aggregates of biotite are associated with accessory minerals. Some flakes contain small rounded zircon crystals with pleochroic haloes. The biotite is commonly partly altered to chlorite, epidote, or zoisite, and in places it is partly replaced by small grains of sphene.

Hornblende forms between 1 and 5 percent of the tonalite and some of the granodiorite, and from 30 to 40 percent of the diorite. It ranges from pale green to pale brown and forms anhedral grains which are generally associated with biotite. The accessories are allanite, zircon, sphene, and more rarely apatite and clinopyroxene.

Aralba Adamellite

(Whitaker & Willmott, 1968)

Derivation of Name

The name Aralba Adamellite is taken from Aralba Creek, a south-bank tributary which joins the Palmer River 52 km west of Palmerville.

Distribution

The Aralba Adamellite forms large irregular bodies with a total area of about 380 sq km in the northwest-central part of the Yambo Inlier. The adamellite is generally weathered, but is well exposed in the Palmer River and some large creeks. Two of the intrusions are largely concealed by residual sand and alluvium; two others are exposed as corestones in gently undulating country.

Lithology and Relationships

The Aralba Adamellite is a light grey medium to coarse-grained porphyritic biotite-muscovite adamellite containing large flakes of muscovite and abundant phenocrysts of microcline. It is similar to the Kintore Adamellite in mineralogical composition, but contains more muscovite.

In places the porphyritic adamellite grades, over a distance of a few metres, into an even-grained rock resembling the Kintore Adamellite; in one locality the porphyritic adamellite contains well defined xenoliths of even-grained adamellite up to 2½m across.

In the northern part of the Yambo Inlier the contact between the Aralba and Kintore Adamellites is obscured by the abundance of garnet-muscovite granite pegmatite and aplite; the texture of the Aralba Adamellite does not appear to change near the contact and it may grade into the Kintore Adamellite.

The contact between the Aralba Adamellite and the Dargalong Metamorphics commonly consists of a zone about 500 m wide in which bands of adamellite become increasingly common in the metamorphic rocks. In places the gneiss grades into adamellite through a granular zone enriched in quartz and feldspar.

Petrography

The Aralba Adamellite contains 30 to 45 percent quartz. It forms anhedral strained grains, some of which have sutured margins. The elongate grains are aligned parallel to the foliation. The anhedral or subhedral laths of microcline (15-40%) average 1.5 cm in length, but a few are up to 7 cm long. The larger laths are perthitic and enclose quartz and plagioclase crystals and, more rarely, flakes of muscovite and biotite. The subhedral twinned laths of plagioclase (20-30%) are commonly zoned from An_{28} to An_{24}. Many of the laths are partly altered to sericite and corroded against interstitial myrmekite. The subhedral flakes of muscovite (5-10%) are up to 1.5 cm across, and enclose small flakes of biotite. The biotite (2-5%) is generally associated with muscovite but also occurs independently as small subhedral flakes. It commonly contains small rounded inclusions of zircon. A little apatite is present, but garnet is rare.

Kintore Adamellite

(Whitaker & Willmott, 1968)

Derivation of Name

The Kintore Adamellite was named after Kintore, a prominent hill 42 km southeast of Coen.

Distribution

The Kintore Adamellite forms 65 percent of the Cape York Peninsula Batholith, and is exposed over an area of about 4500 sq km between the Mitchell River in the south and Weymouth Bay 420 km to the north. It forms the bulk of the Coleman and McIlwraith Plateaux, and is covered by thick sand or thick soil, and by rain forest in places north of the Stewart River. The adamellite is covered by a considerable thickness of sand, silt, and Tertiary sandstone in lowland areas. In places the adamellite is deeply weathered into sculptured rock forms; elsewhere unweathered tors and rounded ground-level platforms rise above the regolith.

Lithology and Relationships

The Kintore Adamellite consists mainly of biotite-muscovite adamellite grading into granite, and muscovite-biotite adamellite grading into granodiorite. A little muscovite granite and garnet-muscovite granite pegmatite and aplite occur near the margins of the batholith.

The adamellite is a light grey or grey fine or medium-grained rock composed of muscovite, biotite, plagioclase, microcline, and quartz with accessory garnet in places. It is generally even-grained though microcline phenocrysts up to several centimetres in length are present in small bodies throughout the adamellite.

In the Coen Sheet area biotite generally predominates over muscovite and the proportion of plagioclase is greater than elsewhere. In places very little muscovite is present and the rock grades into leucocratic biotite granodiorite. Leucocratic adamellite with a total mica content of less than 5 percent forms a few small discrete bodies in the Yambo Inlier.

Numerous small bodies of muscovite granite occur within the Kintore Adamellite; some of them contain numerous microcline phenocrysts up to 30 cm long. Diffuse bodies of fine-grained garnet-muscovite granite are commonly associated with the porphyritic muscovite granite near the margin of the batholith.

Irregular bodies, veins, and dykes of garnet-muscovite granite-pegmatite and banded aplite are associated with the garnet-muscovite granite. In some places they form well defined cross-cutting bodies, elsewhere they merge into the surrounding garnet-muscovite granite or biotite-muscovite adamellite. Barren reefs of massive white quartz occur near the margin of the batholith and in the surrounding metamorphics. They range from 0.5 to 20 m wide and from a few metres to 1 km long; one quartz dyke extends for 8 km. Rhyodacite, dacite, and andesite dykes cut the Kintore Adamellite in a number of places.

Satellite stocks of adamellite occur on the western flank of the batholith in the Hann River and Ebagoola Sheet areas. The stocks are subcircular or irregular in plan and range from 5 to over 120 sq km in area; they are composed of muscovite-biotite adamellite or muscovite granite. Porphyritic muscovite granite and associated garnet-muscovite granite, garnet-muscovite granite pegmatite and aplite are common near the margins of the stocks. Some of them are surrounded by discontinuous zones, up to 1 km wide, of massive white quartz reefs.

Faint compositional banding was noted in a number of places especially near the margin of the batholith where it grades into migmatite. The partial alignment of mica flakes commonly imparts a poorly defined foliation to the adamellite. The microcline phenocrysts in the marginal zone of the adamellite are aligned with the weak foliation parallel to the contact.

Bodies of schist, gneiss, amphibolite, and calc-silicate rocks, ranging from 1 m to several kilometres in length, occur within the Kintore Adamellite. They are intimately penetrated by Kintore Adamellite, and particularly by the garnet-muscovite granite.

Shearing and shear zones are common in the Kintore Adamellite for a distance of 350 km from the south end of the Yambo Inlier to the northern fall of the Archer River. Some of the shear zones are over 30 km long and range up to 100 m wide. The shearing has commonly produced elongation and strain in quartz grains, preferential alignment of mica flakes, and fracturing and granulation of feldspar crystals; biotite may be altered to chlorite in the sheared adamellite. The development of strong foliation in the adamellite adjacent to some of the shear zones suggests that movement may have begun before consolidation of the rock, but in other places the sheared rocks are mylonitized and recrystallized. In one exposure shearing appears to have preceded the emplacement of the pegmatite and aplite.

The direction of shearing generally lies between north and northwest, parallel to the regional trend of foliation and schistosity in the metamorphic rocks. A few shear zones trend north-northeast.

Acid dykes up to 30 m wide and a few kilometres long cut the Kintore Adamellite, particularly in the coastal ranges, the McIlwraith Range, and in the northern part of the Ebagoola Sheet area. They are generally composed of light pink fine-grained rhyolite or rhyodacite. A few are light green and contain chlorite. Some of the dykes are porphyritic. A few small andesite dykes cut the Kintore Adamellite in the same area, and a dyke of dacite(?) 400 m thick cuts the contact of the adamellite and metamorphic rocks about 10 km north of Yarraden.

Petrography

Some of the anhedral grains of quartz (20-50%) have undulose extinction and sutured margins. A few phenocrysts up to 5 mm across may be present. Microcline (1-40%) occurs as anhedral grains up to 1.6 cm across, and in the interstitial matrix. The larger grains are commonly perthitic and may contain flakes of mica, partly altered plagioclase crystals, and occasional rounded crystals of quartz.

The anhedral or subhedral laths of plagioclase (10-45%) average 4 mm long, with a few up to 1 cm. The composition ranges from calcic oligoclase to sodic andesine (An_{20} - An_{37}). Twinning is usually well developed; some crystals are strongly zoned, but the average difference in composition between core and margin is generally less than 5 percent. The laths are usually partly altered to sericite and clay minerals; some are partly replaced by clinozoisite and a carbonate mineral, and some are slightly corroded against interstitial myrmekite.

Muscovite and biotite together form up to 25 percent of the rock. Muscovite is generally more abundant than biotite, but in the even-grained massive adamellite they occur in equal proportions and in the Coen Sheet area biotite is predominant.

The biotite is pleochroic from light pinkish brown or light yellowish brown to dark reddish brown; it is commonly partly altered to chlorite, and occasionally to epidote. Some of the biotite flakes contain small round grains of zircon surrounded by pleochroic haloes. The adamellite contains a little garnet, zircon, and apatite, and occasional crystals of sphene, allanite, and tourmaline.

Lankelly Adamellite

(Whitaker & Willmott, 1968)

Derivation of Name

The Lankelly Adamellite was named after Lankelly Creek, a tributary of the Coen River northeast of Coen.

Distribution

The Lankelly Adamellite extends northwards for 30 km from Little Stewart Creek to Mount Croll, 10 km east of Coen airstrip, and forms the high plateau of the McIlwraith Range, east of Coen. The total area is about 500 sq km. The adamellite is well exposed right across the McIlwraith Range.

Lithology and Relationships

The Lankelly Adamellite is a grey porphyritic biotite adamellite, which commonly contains a little muscovite. It is characterized by the abundance of phenocrysts of pale pink microcline up to 4 cm long. In places the rock contains few phenocrysts and a high proportion of muscovite, and resembles the Kintore Adamellite. The zones of leucocratic muscovite adamellite up to 500 m across along the southern margin of the Lankelly Adamellite are associated with veins and dykes of muscovite granite pegmatite and aplite.

In places the microcline phenocrysts have a preferred orientation and are concentrated in bands elsewhere; bands and dykes of muscovite granite pegmatite and aplite alternate with bands of even-grained leucocratic adamellite. At the summit of the McIlwraith Range and at the mouth of Massey Creek gorge, bands of even-grained biotite adamellite alternate with bands of porphyritic adamellite, and near the second locality the porphyritic adamellite is cut by dykes of fine even-grained pink leucocratic biotite adamellite up to 200 m thick. Biotite-rich xenoliths from 0.5 to 3 m across are also common in this area. The zones of fine even-grained biotite granodiorite within the Lankelly Adamellite closely resemble a variety of the Flyspeck Granodiorite.

South of Coen the Lankelly Adamellite grades into the Kintore Adamellite with an increase in the proportion of muscovite and a decrease in the number of microcline phenocrysts. The presence of local zones of even-grained muscovite-biotite adamellite, leucocratic muscovite granite, and muscovite granite pegmatite and aplite within the Lankelly Adamellite suggests that it is closely related to the Kintore Adamellite.

Small bodies of metamorphic rock, ranging from a few metres to a kilometre across, are especially common in the adamellite near its southeast boundary. The Lankelly Adamellite is separated from the Dargalong Metamorphics to the west by a shear zone. As the shear zone is approached the microcline phenocrysts in the adamellite become aligned and then ruptured, quartz is recrystallized to a mosaic of small grains, and biotite and plagioclase are altered to chlorite and sericite respectively; the presence of thin bands of quartz-feldspar rock impart a foliation to the adamellite.

Petrography

The anhedral grains of quartz (25-45%) range up to 4 mm across. They have serrate margins and undulose extinction. The microcline (10-40%) is subhedral. The phenocrysts are up to 4 cm long. They are well twinned and the larger crystals are perthitic; they commonly contain small crystals of plagioclase, quartz, and mica. The subhedral laths of plagioclase (15-40%), up to 4 mm long, are well twinned and commonly zoned; they range from sodic to calcic andesine (An_{30} - An_{39}). Many of the laths are partly altered to sericite. The scattered anhedral or subhedral flakes of biotite are pleochroic from pale yellow to dark reddish brown. Muscovite (up to 5%) is generally associated with the biotite. Rounded grains of apatite up to 1.5 mm across are common, and small round grains of zircon, surrounded by dark pleochroic haloes, are present in the biotite.

Wigan Adamellite

(Whitaker & Willmott, 1969a)

Derivation of Name

The name Wigan Adamellite is taken from the Parish of Wigan, between Bald Hill and the Wenlock River.

Distribution

The Wigan Adamellite is an annular body with an area of about 120 sq km between Bald Hill and the southern flank of the Sir William Thompson Range in the northern part of the Coen Sheet area. The adamellite is well exposed as boulders on the flanks of low hills rising from a plain covered by sand and alluvium.

Lithology and Relationships

The Wigan Adamellite has a considerable range in composition and texture. The predominant leucocratic biotite adamellite or granite contains small feldspar phenocrysts in places and small clots or streaks of biotite. The leucocratic varieties generally contain numerous

TABLE 9. CHEMICAL ANALYSES, CAPE YORK PENINSULA BATHOLITH

	1	2	3	4	5	6	7	8	9	10	11
SiO_2	74.85	71.42	74.70	74.67	70.63	75.17	72.72	74.81	70.33	75.16	75.26
Al_2O_3	14.96	15.26	14.00	15.21	15.01	14.43	14.70	15.54	15.03	16.06	15.37
Fe_2O_3	0.70	2.51	0.13	1.07	2.29	1.34	2.13	1.17	2.80	1.43	0.57
FeO	*	*	1.20	*	*	*	*	*	*	*	*
MgO	0.22	0.80	0.22	0.40	0.77	0.51	0.65	0.37	0.72	0.76	0.34
CaO	0.36	1.60	1.84	0.74	1.99	0.93	1.80	1.48	2.18	2.20	1.09
Na_2O	4.45	2.58	3.85	3.71	2.72	3.14	3.00	3.85	2.53	3.22	4.17
K_2O	4.19	5.70	3.05	5.56	5.54	5.59	5.03	4.04	5.16	3.37	4.30
H_2O+			0.50								
H_2O-			0.14								
CO_2			0.08								
TiO_2	0.02	0.38	0.11	0.01	0.52	0.13	0.33	0.10	0.45	0.17	0.02
P_2O_5	0.24	0.09	0.07	0.08	0.15	0.09	0.14	0.11	0.17	0.10	0.05
MnO	0.16	0.03	0.04	0.15	0.02	0.03	0.05	0.03	0.04	0.03	0.03
Loss on ignition	0.73	0.70		0.36	0.79	0.67	0.70	0.64	0.96	0.71	0.62
Total+	100.15	100.37	99.93	101.60	99.64	101.36	100.55	101.50	99.41	102.50	101.20

* Total iron as Fe_2O_3

+ Does not include loss on ignition

Kintore Adamellite

1. Muscovite granite, 27 km SW of Dixie homestead. (BMR 67570026).
2. Porphyritic muscovite-biotite adamellite, 3 km SSW of Yarraden homestead. (BMR 67570013).
3. Biotite-muscovite granodiorite, on Kennedy Road 1.5 km NW of New Bamboo homestead. (BMR D54/12/1).
4. Aplite, at Coleman R. crossing of Musgrave-Glengarland road. (BMR 67570019).
5. Biotite-muscovite adamellite, Leo Cr. mine. (BMR 67570031).
6. Biotite-muscovite adamellite, 40 km N of Coen. (BMR 67570008).
7. Biotite adamellite, 20 km WSW of Buthen Buthen. (BMR 67570007).
8. Biotite muscovite adamellite, on Kennedy Road near Luttrell hill. (BMR 68480195)

Lankelly Adamellite

9. Porphyritic biotite adamellite, 6 km E of Coen airstrip. (BMR 68480237).

Aralba Adamellite

10. Biotite-muscovite granite, junction of Oswald Cr. with the King R. (BMR 68480222)
11. Garnet-muscovite-biotite adamellite, 37 km NE of King Junction homestead. (BMR 68480225).

Analysed by G.H. Berryman (BMR) by X-ray fluorescence method (except analysis 3) phenocrysts of feldspar and well defined clots of biotite, whereas the melanocratic adamellite and granodiorite are even-grained and contain scattered flakes of biotite.

Andalusite and cordierite are both present in a specimen from south of Sefton Creek, and separately in two other specimens, one from the same area and another from north of Bald Hill. No cordierite has been found in the neighbouring Sefton Metamorphics. The aggregates of andalusite and cordierite in the adamellite were probably formed as a result of the incorporation of aluminous metamorphic rocks. However, some of the discrete hexagonal crystals of cordierite may have crystallized from a granitic melt locally enriched in alumina (Joplin, 1964).

A few dykes and irregular patches of granite pegmatite and aplite occur in the Wigan Adamellite, mainly near the contacts. The patches generally grade into the adamellite.

There are two shear zones trending north and north-northwest in the Wigan Adamellite south of the Wenlock River. In the intensely sheared zone the quartz grains are crushed or strained and the rock has a mortar texture, with large rounded grains set in a mosaic of smaller grains. The feldspar crystals are deformed and altered and the streaky biotite is partly or wholly replaced by chlorite. In the less intensely sheared zone the adamellite is foliated parallel to the shear zones.

In Sefton Creek the contact between the Wigan Adamellite and the Lower Permian Weymouth Granite is sharp; the Wigan Adamellite nearby is cut by a dyke of pale pink aplite, which may be related to the Weymouth Granite. The pale pink aplite along the eastern margin of the Wigan Adamellite has been mapped as part of the Weymouth Granite. The contact of the Wigan Adamellite with the hybrid and dioritic rocks of the Weymouth Granite is also sharp. The contact of the Wigan Adamellite with the Kintore Adamellite 7 km northeast of Bald Hill appears to be gradational, though part of it may be faulted. The Wigan Adamellite is faulted against the Permian(?) Wolverton Adamellite 8 km north of Bald Hill, but the nature of this contact farther north is not known. The Wigan Adamellite intrudes and metamorphoses biotite-hornblende microgranodiorite 5 km northeast of Bald Hill, and in places they form an intrusion breccia. The microgranodiorite consists of intergrown crystals of hornblende and actinolite with a little plagioclase and quartz, set in a hornfelsed groundmass. The microgranodiorite has been mapped as Flyspeck Granodiorite, but its affinities are uncertain.

<u>Petrography</u>

Quartz (20-50%) forms equant or irregular slightly strained grains with irregular margins. Microcline perthite (15-50%) occurs as anhedral phenocrysts and interstitial grains. The phenocrysts commonly enclose grains of quartz or plagioclase, and are generally slightly altered to clay or sericite in places. The subhedral zoned crystals of plagioclase (10-40%) are generally partly or wholly altered to sericite, clay, or clinozoisite. The least altered laths range from sodic andesine to calcic oligoclase (An_{34} - An_{28}).

The ragged subhedral flakes of biotite (1-15%) are pleochroic from light yellow to dark brown; most of them are partly or wholly altered to chlorite. Some specimens contain ragged anhedral or subhedral flakes of muscovite (1-3%), commonly associated with biotite, and a few small flakes formed by the alteration of plagioclase. The accessories are rounded inclusions of zircon in biotite, apatite, and rare allanite and sphene.

Andalusite forms stubby pale pink prismatic crystals and a few laths. The irregular grains and subhedral or euhedral hexagonal crystals of cordierite are partly or wholly replaced by small crystals of a greenish yellow mineral, probably pinnite, which in turn is replaced by large flakes of muscovite.

Morris Adamellite

(Whitaker & Willmott, 1969a)

Derivation of Name

The Morris Adamellite was named after the Parish of Morris, where the adamellite crops out on the south side of the Archer River.

Distribution

The Morris Adamellite covers an area of about 150 sq km. It crops out as an elongate body, about 30 km long and up to 8 km wide, to the north and south of the Kennedy Road crossing of the Archer River. It is best exposed at the base of the escarpment formed by the Mesozoic sediments, and in the Archer River.

Lithology and Relationships

The Morris Adamellite is a light grey medium or coarse-grained biotite adamellite, containing regularly distributed subhedral phenocrysts of microcline microperthite up to 4 cm long. It probably grades into granite in places.

A leucocratic fine or medium-grained muscovite-biotite adamellite and a medium-grained even-grained biotite granite are exposed north of Geikie Creek. The leucocratic adamellite occurs as well jointed bodies up to 100 m across, which grade laterally into the biotite adamellite. A few veins of aplite and pegmatite penetrate the adjacent adamellite. The biotite granite is exposed over an area of a few hundred square metres near Geikie Creek.

Xenoliths are common throughout the Morris Adamellite. They are composed of fine-grained dark grey biotite adamellite and in places contain small phenocrysts of quartz and plagioclase. The xenoliths are round or elliptical and average about 30 cm in diameter, although they range up to 2 m across. They contain less quartz than the host rock and are richer in sphene, zircon, apatite, and allanite.

TABLE 10. CHEMICAL ANALYSES, CAPE YORK PENINSULA BATHOLITH

	1	2	3	4	5	6	7	8	9	10	11
SiO_2	61.80	69.17	66.74	68.02	67.05	56.24	64.98	71.99	71.71	74.20	72.16
Al_2O_3	16.55	16.45	16.19	17.28	16.63	17.09	16.06	14.11	14.14	14.21	15.79
Fe_2O_3*	5.47	2.65	4.86	3.44	4.42	7.55	5.29	2.35	3.87	1.41	1.58
MgO	4.14	1.55	2.13	1.21	1.57	4.18	1.76	0.73	0.98	0.66	0.70
CaO	6.19	2.72	4.30	4.65	3.92	6.97	3.88	2.01	2.24	1.36	2.28
Na_2O	2.51	2.94	2.47	2.99	3.04	1.92	2.59	2.63	2.78	3.14	4.00
K_2O	1.89	5.28	3.12	2.72	2.31	2.80	4.24	5.52	4.10	5.50	3.42
TiO_2	0.51	0.33	0.64	0.41	0.84	0.87	0.82	0.32	0.57	0.20	0.20
P_2O_5	0.12	0.32	0.14	0.10	0.15	0.23	0.23	0.08	0.19	0.08	0.10
MnO	0.09	0.07	0.08	0.06	0.04	0.13	0.09	0.05	0.07	0.52	0.03
Loss on ignition	0.75	0.85	0.59	0.75	0.46	0.49	0.56	0.57	0.57	0.52	0.48
Total+	99.27	101.48	100.67	100.88	99.97	97.98	99.94	99.79	100.65	100.81	100.26

* Total iron as Fe_2O_3

\+ Does not include loss on ignition

Flyspeck Granodiorite

1. Biotite-hornblende tonalite, 47 km NW of Kimba homestead. (BMR 68480229)
2. Biotite-granodiorite, 13 km NE of Dixie homestead. (BMR 67570021)
3. Hornblende-biotite granodiorite, Spion Kop. (BMR 67570017)
4. Porphyritic biotite granodiorite, 20 km SSW of Yarraden homestead. (BMR 67570015)
5. Hornblende-biotite granodiorite, 16 km SE of Coen. (BMR 67570001)
6. Biotite-hornblende tonalite, 20 km WNW of Coen Airstrip. (BMR 68480239)

Blue Mountains Adamellite

7. Coarse-grained biotite adamellite, 3 km E of Birthday Mountain trig. (BMR 67570032)
8. Fine-grained biotite adamellite, 5 km S of Birthday Mountain trig. (BMR 67570033)

Morris Adamellite

9. Porphyritic biotite adamellite, Kennedy Road crossing of Archer R. (BMR 67570006)

Wigan Adamellite

10. Leucocratic biotite adamellite, 22 km ESE of Wenlock. (BMR 68480201)
11. Biotite adamellite, 20 km ESE of Wenlock. BMR 68480200)

Analysed by G.H. Berryman (BMR) by X-ray fluorescence method

In the east the contact between the Morris Adamellite and the sheared Kintore Adamellite appears to be partly faulted and partly intrusive; in the south and west the Morris Adamellite intrudes schist and quartzite of the Holroyd Metamorphics. In the southwest pegmatite dykes, which are probably related to the Morris Adamellite, have intruded and recrystallized the adjacent metamorphics. The dykes are composed of albite, quartz, tourmaline, and minor muscovite; perthite occurs in dykes near the adamellite. Tourmaline crystals up to 15 cm across and 30 cm long are embedded in quartz, generally with their long axes at right angles to the walls of the dyke.

Petrography

The quartz (25-40%) in the porphyritic biotite adamellite forms unstrained anhedral grains and aggregates up to 1 cm across. The microperthitic microcline (20-40%) occurs mainly as anhedral phenocrysts up to 4 cm long, and as interstitial grains. The phenocrysts commonly contain inclusions of quartz and plagioclase. The zoned anhedral laths of plagioclase (25-45%) range from sodic andesine to sodic oligoclase, and commonly have a rim of albite; the cores are generally altered to sericite, and some to a carbonate mineral. The subhedral flakes of light brown to dark reddish brown biotite (1-15%) commonly contain inclusions of zircon. In places the flakes are partly replaced by chlorite or epidote. Apatite is common, but tourmaline and allanite are rare.

Blue Mountains Adamellite

(Whitaker & Willmott, 1969a)

Derivation of Name

The name Blue Mountains Adamellite is taken from the Blue Mountains, an isolated northwestern spur of the McIlwraith Range.

Distribution

The Blue Mountains Adamellite crops out west and northwest of the McIlwraith Range, in the centre of the Coen Sheet area. The largest exposures include Birthday Mountain and the western part of the Blue Mountains. Of the smaller bodies on the west flank of the McIlwraith Range, one lies between Beetle Creek and Wilson Creek, and the other on the eastern side of the Blue Mountains. The adamellite is also exposed at Ben Lomond, to the north, and in the headwaters of Falloch Creek and Hull Creek. The total area of outcrop is about 80 sq km. It is generally well exposed and commonly forms boulders up to 6 m in diameter.

Lithology

The Blue Mountains Adamellite consists mainly of massive pinkish grey fine even-grained biotite adamellite containing very little biotite, subordinate coarse hornblende-biotite adamellite or granite, and a little fine and coarse-grained leucocratic granite.

The coarse hornblende-biotite-bearing rock crops out at the western end of the Blue Mountains in the headwaters of Hull and Falloch Creeks, and as small patches elsewhere. In places the abundant phenocrysts of potash feldspar are bright pink. Along the west side of the Blue Mountains the adamellite grades into fine-grained leucocratic granite. At Ben Lomond a coarse leucocratic granite with very little biotite crops out.

In contrast to the Kintore Adamellite, the rocks of the Blue Mountains Adamellite are massive, non-foliated unbanded. They contain neither xenoliths nor roof pendants of metamorphic rock. Pegmatite and aplite, and muscovite are absent from the Blue Mountains Adamellite.

At the east end of the Blue Mountains, there is a sharp contact between the coarse hornblende-biotite adamellite and the Kintore Adamellite; the Blue Mountains Adamellite is cut by small veins of muscovite aplite.

Petrography

Quartz (23-43%) occurs as anhedral grains with subserrate margins and undulose extinction. In some specimens recrystallized grains rest against corroded feldspar laths. Orthoclase and microcline perthite (20-50%) from large anhedral grains which commonly enclose quartz and plagioclase crystals. Interstitial crystals of potash feldspar are also present. The zoned subhedral laths of plagioclase (8-38%) are partly altered to sericite and epidote; they range from calcic oligoclase to sodic andesine (An_{28} - An_{36}).

The small clusters and flakes of biotite (1-15%) are pleochroic from light yellow to dark brown. The mica contains many zircon inclusions and is generally partly altered to chlorite or epidote. In places the flakes are kinked, possibly as a result of shearing. The coarse hornblende-biotite adamellite contains between 1 and 6 percent hornblende, which occurs as scattered subhedral laths and in aggregates with biotite. Sphene (up to 1%) is present as subhedral crystals up to 2 mm across, and as smaller grains intergrown with biotite. Other accessories include allanite, zircon and apatite.

Pascoe River Beds

(Whitaker & Willmott, 1969a, amended)

Derivation of Name

Bryan (1927) first used the term Pascoe River Beds for the Carboniferous sediments in the Pascoe River area (Morton, 1924). The sediments were briefly investigated by the Broken Hill Pty Co. and were given the informal name Hamilton Group (BHP, 1962). Subsequently they were referred to informally as the Pascoe River Group by Australian Aquitaine Petroleum Ltd (AAP, 1965) who divided the group into a number of informally named formations. All these sediments were formally renamed the Pascoe River Beds by Whitaker & Willmott (1969a) because they were not well enough exposed to subdivide into formations, and because their base was not located.

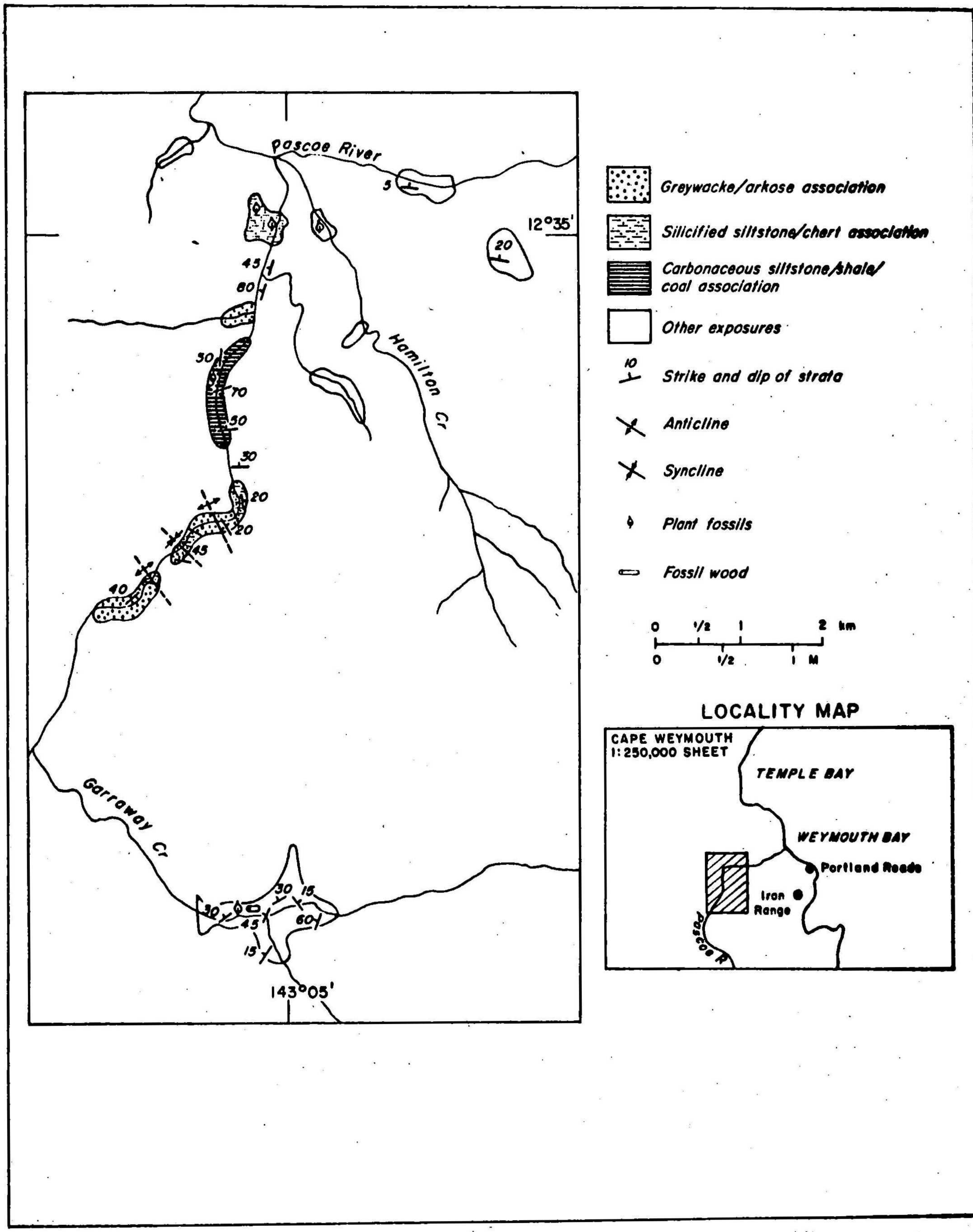


Fig. 16 Main exposures of the Pascoe River Beds

To accompany Record 1971/94

D54/A4/2

Distribution

The Pascoe River Beds crop out in the valley of the Pascoe River and in several of its small west-bank tributaries, in the valleys of Garraway, Brown, and Hamilton Creeks, and in an unnamed stream between Hamilton Creek and the Pascoe River (see Fig. 16). Haggerstone Island, 13 km southeast of Cape Grenville, on the northern margin of the Cape Weymouth Sheet area is composed of sediments which are correlated with the Pascoe River Beds. The most extensive and continuous exposures are found in the middle reaches of the Pascoe River from 3 km north of the Garraway Creek junction to 3 km east of the junction with Hamilton Creek. Elsewhere exposures are poor. The sediments only crop out where the overlying Janet Ranges Volcanics, Mesozoic sediments, and Yam Creek Beds have been stripped off. Most exposures are in the beds of streams and are underwater during the wet season; they are usually deeply weathered.

Lithology

The Pascoe River Beds were informally divided into seven formations by Australian Aquitaine Petroleum Ltd (AAP, 1965), but no attempt was made during this survey to define these formations because the outcrops are not sufficiently continuous, and because the beds may be repeated by faulting and folding. However, the sequence in the Pascoe River and its west-bank tributaries has been divided into three lithological associations (Fig. 16), which broadly correspond with three of the formations proposed by Australian Aquitaine Petroleum; these are a carbonaceous shale/coal association, an arkose/greywacke association and a siliceous siltstone/chert/greywacke association. These associations have not been recognized elsewhere.

Carbonaceous shale and siltstone, grading in places into fine carbonaceous sandstone, predominate in the first association; some poorly sorted lithic greywacke and thin bands of coal grading into carbonaceous shale are present in places. The arkose/greywacke association is characterized by the abundance of medium or coarse-grained arkose or feldspathic sandstone; feldspathic greywacke, tuffaceous sandstone, and tuff are less common. All the sediments are massive and thickly bedded. The siltstone/chert/greywacke association comprises siliceous carbonaceous siltstone and shale, chert, lithic greywacke, and subordinate subgreywacke, tuffaceous sandstone and volcanic(?) breccia.

About 1000 m of the Pascoe River Beds are exposed in the Pascoe River (AAP, 1965). Away from the main area of outcrop in the Pascoe River, the sequence in Garraway Creek consists of sandstone, lithic greywacke, tuffaceous sandstone, tuff, conglomerate, siltstone, and shale. The coarser sediments are more abundant, and in places they contain a considerable proportion of rock fragments. The siltstone and shale near the junction of Brown and Garraway Creeks are well bedded, massive, and in part carbonaceous. In places they have been partly silicified and slightly recrystallized. The sandstone, conglomerate, siltstone, and shale in Brown Creek contain a little interbedded chert.

Isolated outcrops of fine-grained lithic greywacke, feldspathic greywacke, siltstone, and shale are exposed in a small east-bank tributary of the Pascoe River. The lithic greywacke is massive and well bedded and grades into feldspathic greywacke. The thinly bedded fissile siltstone and shale range from green or purple to dark grey. In Hamilton Creek siltstone, fine-grained sandstone, and lithic greywacke crop out between 3 and 7 km upstream from the Pascoe River junction. About 13 km from the junction there is a small exposure of argillaceous siltstone below the Janet Ranges Volcanics. Carbonaceous shale and a little feldspathic sandstone crop out south of the Pascoe River midway between Hamilton Creek and the north end of the Jacky Jacky Range. The sequence on Haggerstone Island 13 km southeast of Cape Grenville, consists of 30 to 38 m of interbedded quartz sandstone, conglomerate, feldspathic sandstone, greywacke, and tuffaceous sandstone, which dip gently northwest.

Torres Strait Volcanics

(Whitaker & Willmott, 1969b, amended)

Derivation of Name

The Torres Strait Volcanics are named after Torres Strait, between Cape York and Papua. The name Torres Strait Ignimbrite was introduced by Jones & Jones (1956), but as there are a number of separate units of welded tuff and other rock types the name was amended to Torres Strait Volcanics by Whitaker & Willmott (1969b).

Distribution

The most extensive area of outcrop covers 400 sq km in the southern part of Torres Strait; it includes the western and northern coast of Cape York Peninsula from Mutee Head to Albany Island, Mount Adolphus Island and adjacent islands, the islands of Endeavour Strait, and the Prince of Wales, Horn, Wednesday, Thursday, Friday, Hammond, and Goods Islands. About 100 sq km of volcanics are also exposed on the islands to the north as far as the Papuan coast.

The volcanics form relatively infertile islands, up to 250 m high, consisting of broad rugged hills separated by sand-covered plains and valleys. The rocks are well exposed in many headlands around the islands.

Lithology

The Torres Strait Volcanics consist mainly of crystal-rich rhyolite welded tuff, with subordinate rhyolite lava flows, agglomerate, volcanic breccia, andesite, and interbedded sediments. In many areas they have been recrystallized and hornfelsed by granitic rocks, and in the southern part of Torres Strait they have been hydrothermally altered and mineralized.

In the southern part of Torres Strait, four members have been recognized, each of which is composed mainly of acid crystal-rich welded tuff with a distinctive composition (Table 11). They have been named the Eborac Ignimbrite, Endeavour Strait Ignimbrite, Goods Island Ignimbrite, and the Muralug Ignimbrite; each member comprises a number of sheets of welded ash-flow tuff of similar composition, and other minor volcanics. The term 'ignimbrite' has been adopted on the advice of the Queensland Sub-committee for Stratigraphic Nomenclature.

TABLE 11: DISTINGUISHING CHARACTERISTICS OF WELDED TUFF MEMBERS OF THE TORRES STRAIT VOLCANICS

Member	Thickness (m)	Colour and Composition	Phenocrysts: Abundance (% total rock)	Size (mm)	Composition (% total rock): Qtz	AlF	Plag	Fm	Acc	Pumice Fragments	Rock Fragments	Groundmass	Minor Rock Types: Composition	Location and Description
Muralug Ignimbrite	+ 150	Grey; weathers light brown to fawn. Rhyolitic	10 - 20 Av 15	4	10	10	1	1	-	Abundant to rare. Generally 5 cm to 30 cm; devitrified	Rare; devitrified structureless acid rocks, some intermediate	Devitrified but glass shards common	Volcanic breccia Rhyolite lava	Interbedded with tuff in SE part Prince of Wales and Entrance Is. Boulders of tuff and rhyolite breccia, av 50 cm, range to 2 m.
													Dacite(?) welded tuff	Thin sheet under main mass at NE margin. Dark grey, 70% is fragmented crystals of plagioclase K-feldspar and ferromagnesians. Also on Woody Wallis Is.
Goods Island Ignimbrite	+ 80	Dark grey to black; weathers grey, Dellenitic to dacitic	Av 45	4	10	10 Av	20	5	All	Seen only in thin section; devitrified	Common, up to several cm long, black tuff similar to host. Up to 70% of rock in places. Some are andesite; some are microscopic aggregates of plagioclase and amphibole	Devitrified to quartz, feldspar, and amphibole or chlorite	Carbonaceous and tuffaceous siltstone and sandstone	Interbedded tuff on Hammond, Goods, and Friday Is. Grey with fragments of quartz and feldspar crystals up to 3 mm. Poor plant remains

Abbreviations: Qtz, quartz; Fm, ferromagnesian minerals, mainly hornblende and biotite; All, allanite; Al/F, alkali feldspar, probably anorthoclase; Acc, accessories; Av, average; An, anorthoclase; Pl, plagioclase; Mz, monzonite

Table 11 continued

Member	Thickness (m)	Colour and Composition	Phenocrysts: Abundance (% total rock)	Size (mm)	Composition (% total rock): Qtz	AlF	Plag	Fm	Acc	Pumice Fragments	Rock Fragments	Groundmass	Minor Rock Types: Composition	Location a[nd] Descripti[on]
Endeavour Strait Ignimbrite	+ 100	Greenish grey or pinkish grey; weathers brown. Rhyolitic	Av 45	6	15	20 Av	10	2	All	Seen only in thin section; devitrified	Abundant and small; larger pebbles and blocks in places. Structureless acid rocks, acid tuff, and intermediate rocks. Also microscopic aggregates of plagioclase and amphibole	Devitrified to quartz, feldspar, and chlorite; structureless	Agglomerate, volcanic breccia	Mutee Hd to Red Is and Dayman I. Angul fragments of welde tuff, rhyolite, an andesite
													Andesite	S of Cowal Cr., Dum I. Labradorite and blende laths in gr of chlorite and op minerals
													Rhyolite	Interbedded with t above agglomerate, on Mona Rock and M I., where strongly spherulitic
													Recrystallized welded tuff, hornfels	On S and E coasts NE part Prince of
													Rhyolite	On Little Adolphus S end of Mt Adolph
Eborac Ignimbrite	+ 100	Light grey; weathers purple. Rhyolitic	25 - 60 Av 30	5	15	15	3	-	Mz?	Generally rare; abundant and up to 1 m on Albany. Adolphus and Lacey I devitrified	Rare, small. Devitrified structureless acid rocks. Tuff band with rhyolite fragments on Mt Adolphus I	Devitrified to quartz and feldspar; glass shards in places	Agglomerate	At Osnaburg Pt con boulders of welded

The Eborac Ignimbrite appears to be the lowest in the sequence, and is probably overlain by the Endeavour Strait Ignimbrite. There is a gradual change in the composition of the welded tuff sheets from the Endeavour Strait Ignimbrite into the overlying Goods Island Ignimbrite. The Muralug Ignimbrite is faulted against the Endeavour Strait Ignimbrite, but its position relative to the other members of the sequence is unknown. The lithology and petrography of each member are summarized in Table 11. The small patches of volcanics on the islands in the northern part of Torres Strait have been mapped as undivided Torres Strait Volcanics.

The Eborac Ignimbrite crops out over about 28 sq km along the northern coast of Cape York Peninsula, from the bay west of Cape York to Albany Island, and on Mount Adolphus and adjacent islands. It is composed mainly of light grey rhyolite welded tuff containing abundant small phenocrysts of quartz and white or pale pink feldspar. Pumice and rock fragments are generally not common. In places the tuff is vaguely banded due to local variations in the proportion of phenocrysts; the alternating crystal-rich and crystal-poor bands are about 15 cm thick. Some rhyolite and agglomerate crop out on Mount Adolphus and Little Adolphus Islands, and at Osnaburg Point on Albany Island. Near Cape York the member is at least 100 m thick; its base is not exposed. The name is taken from Eborac Island a few hundred metres from Cape York (Whitaker & Willmott, 1969b).

The Endeavour Strait Ignimbrite crops out over about 45 sq km along the west coast of Cape York Peninsula from Mutee Head to Peak Point, 10 km west of Cape York, on many small islands in Endeavour Strait, and on Horn, Prince of Wales, Thursday, and Wednesday Islands. It is composed mainly of light greenish grey or pinkish grey rhyolite welded tuff containing phenocrysts of quartz and pale pink feldspar up to 1 cm long. The welded tuff contains numerous small fragments of structureless fine-grained acid rocks, acid welded tuff, and dark intermediate rocks; larger blocks are present in places. Pumice fragments are generally seen only in thin section.

The subordinate agglomerate, volcanic breccia, rhyolite, and andesite, which crop out along the west coast of the peninsula between Red Island Point, 7 km northeast of Cowal Creek, and Mutee Head, (Fig. 17), and rhyolite on Mona Rock and Murangi Island, 6 km west of Cape York, probably represent the basal part of the unit which marks the break between the welded tuff sheets of the Endeavour Strait Ignimbrite and those of the underlying Eborac Ignimbrite. The rhyolite on Murangi Island is markedly spherulitic.

On the south and east coasts of Horn Island the welded tuff has been hornfelsed by an intrusion of porphyritic microgranite. The recrystallization decreases from east to west, where the hornfels appears to pass into unmetamorphosed welded tuff. In the west the hornfels is pink and medium-grained, and still contains recognizable quartz and feldspar phenocrysts; in the southeast it is fine-grained and granoblastic, and consists of quartz (40%), andalusite (40%), and a little microcline, biotite, muscovite, and hercynite spinel. The welded tuff in the north-eastern part of Prince of Wales Island is also mildly recrystallized.

The Endeavour Strait Ignimbrite is probably over 100 m thick, but as little structure is visible, its thickness cannot be accurately estimated. The name is taken from Endeavour Strait, between the mainland and Prince of Wales Island.

The Goods Island Ignimbrite is exposed over about 27 sq km on Goods, Prince of Wales, Friday, Hammond, and Thursday Islands. It consists of dark grey to black dacite or dellenite welded tuff, containing small white feldspar phenocryst and rare phenocrysts of quartz and hornblende. Fragments of andesite and welded tuff, similar to the host rock, are common. Pumice fragments are seen only in thin section. The welded tuff is similar in texture to the Endeavour Strait Ignimbrite, but is not as acid. On Thursday Island the boundary between the two units appears to be gradational.

Carbonaceous and tuffaceous siltstone and sandstone are interbedded with the welded tuff on Hammond, Goods, and Thursday Islands. The grey or dark grey carbonaceous siltstone contains interbeds from 0.5 to 15 cm thick of black poorly sorted tuffaceous sandstone. Poorly preserved plant remains have been found in the finer beds (Jones & Jones, 1956). A bed of limestone has been reported from the west end of Goods Island (Mr P. O'Rourke, pers. comm.).

In the northeastern part of Hammond Island the welded tuff and interbedded siltstone have been recrystallized, probably by nearby granitic rocks. The welded tuff has been only slightly affected, but the matrix of the siltstone is recrystallized and speckled with small aggregates of muscovite. The Goods Island Ignimbrite is at least 80 m thick and is probably much thicker. The maximum thickness of the interbedded sediments is about 10 m on Thursday Island.

The Muralug Ignimbrite crops out about 130 sq km on Prince of Wales Island, Entrance Island, and the Wallis Islands. It is composed predominantly of light grey rhyolite welded tuff containing small phenocrysts of quartz and pink feldspar. Compressed pumice fragments up to 5 cm long are abundant in some outcrops, but absent in others; rock fragments are rare, except in the Wallis Islands.

Over much of Prince of Wales Island the Muralug Ignimbrite probably consists of a single massive horizontal sheet at least 150 m thick, but in the southeast corner of the island and on Entrance Island the sequence consists of two sheets of similar welded tuff separated by up to 50 m of flow-banded rhyolite and volcanic breccia. A thin bed of agglomerate or autobrecciated rhyolite is also present on Woody Wallis Island. Along the northeastern margin of the unit the main massive welded tuff is underlain by a number of thin sheets of welded tuff of similar composition, except for one sheet of dark grey welded tuff which is probably dacitic in composition. A thin band of similar tuff is also exposed on Woody Wallis Island. The name of the member is taken from Muralug, the indigenous name for Prince of Wales Island (Whitaker & Willmott, 1969b).

Undivided Torres Strait Volcanics form several islands and parts of islands in the northwestern part of Torres Strait. West Island is composed of several sheets of dark grey to black welded tuff similar to the Goods Island Ignimbrite. Fragments of devitrified pumice and massive acid rocks are present in places, and on the northwest side of the island a bed of volcanic breccia, composed of angular fragments of welded tuff set in a tuffaceous matrix, is interbedded with the welded tuff. At the southern end of the island, the volcanics are intruded by granite, but are not visibly recrystallized.

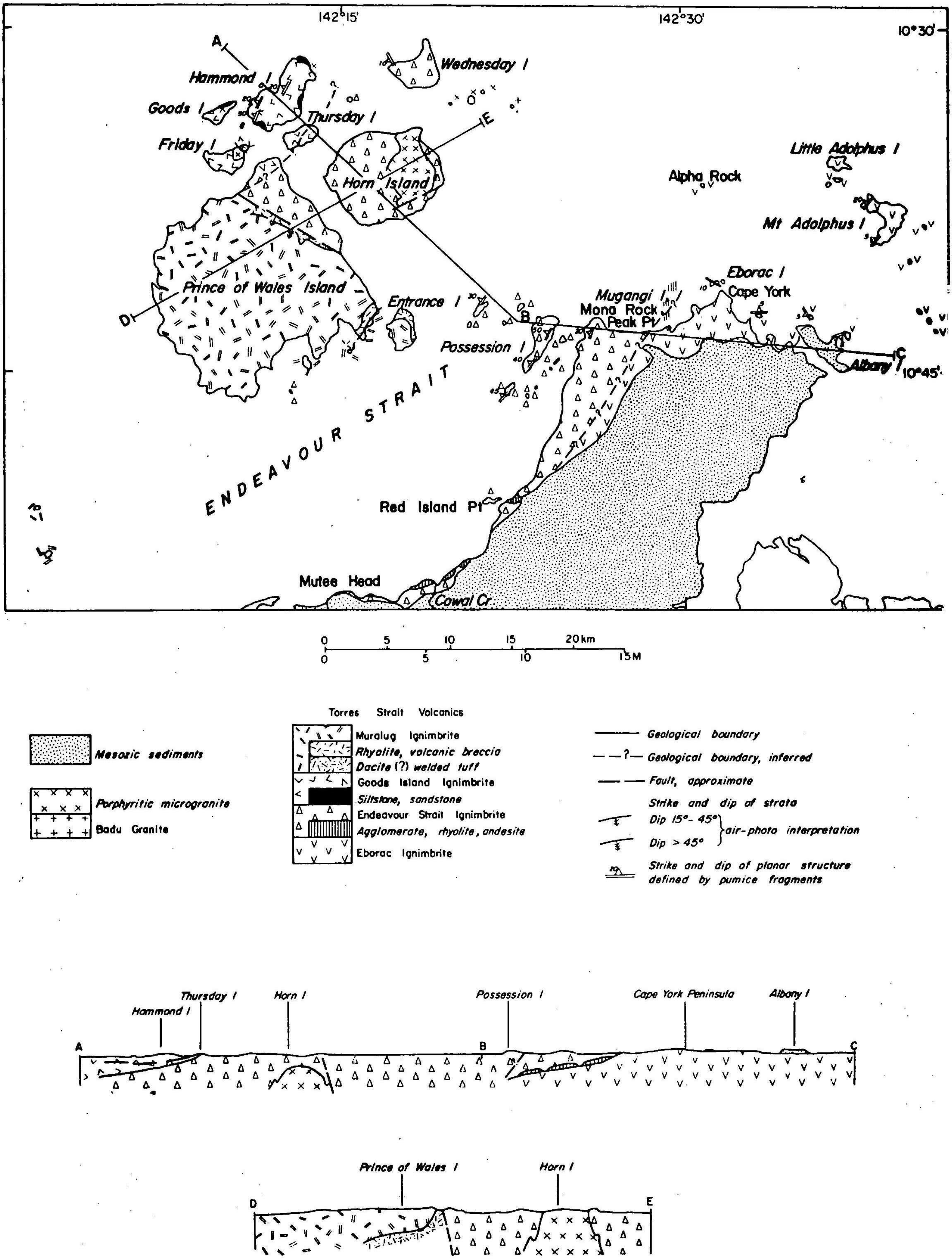


Fig 17 Subdivision of the Torres Strait Volcanics in the southern part of Torres Strait.

To accompany Record 1971/94

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Two small outcrops of volcanic rocks surrounded by granite are exposed in the Duncan Islands. The altered volcanics are light grey, recrystallized, and structureless, although quartz and feldspar phenocrysts can still be recognized. Hornfelsed volcanics also crop out 7 km south of Badu, on Barney, Brown, and Clarke Islands (Fig. 18). The hornfels is faintly foliated, and consists of thin bands of muscovite and biotite between folia of quartz and feldspar. On Clarke Island the rock has a gneissic texture, and small crystals of garnet are present in the biotite-rich bands. In the northern part of Barney Island recrystallized fragments of pumice up to 15 cm long are aligned parallel to the streaky structure. They are undistorted and clearly indicate the pyroclastic origin of the rocks. Rounded aggregates of tourmaline up to 2 mm across occur in the hornfels on Brown Island. The hornfels has been intruded by granite on all three islands.

On the northeast side of Badu Island, brown welded tuff with abundant fragments of pumice and black welded volcanic breccia or acid lava are exposed in a small body within granite. The volcanic breccia or lava contains abundant angular fragments of welded tuff up to 8 cm long; the glass shards in the fragments are moderately to densely welded, but the matrix is faintly flow-banded. The volcanics have been recrystallized for a short distance from the contact with the surrounding granitic rocks.

The southwestern half of Moa Island consists of recrystallized and hornfelsed volcanic rocks. Most of them are composed of corroded quartz and feldspar phenocrysts set in a recrystallized groundmass, but the more intense recrystallized rocks near granite contact contain porphyroblasts of andalusite, muscovite, biotite, and garnet set in a groundmass of cordierite, quartz, and feldspar. The ovoid andalusite porphyroblasts range up to 5 cm long, and are concentrated in bands up to 1 m thick. The aggregates of mica impart a weak foliation to the rock.

The southern end of Mabuiag Island is composed of massive pinkish grey welded tuff containing numerous quartz and feldspar phenocrysts, but virtually no pumice or rock fragments. The leucocratic bands, 2 m long and 5 cm wide, noted in one outcrop may represent large compacted pumice blocks. The welded tuff has been intruded by granite and porphyritic microgranite, but there is little evidence of recrystallization even at the contacts.

The southwestern part of Gabba Island is composed of dark grey rhyolite welded tuff which contains small white feldspar phenocrysts and occasional crystals of quartz, fragments of pumice, and abundant rock fragments. The rock fragments are devitrified welded tuff, rhyolite, and some intermediate rocks. They average 1.5 cm across and form up to 30 percent of the tuff. The groundmass is only slightly devitrified, and incipiently welded or moderately welded glass shards are clearly visible in thin section. The welded tuff is intruded by granite in the northern part of the island, and is recrystallized within about 5 m of the contact.

A small outcrop of recrystallized welded tuff occurs on the west coast of Dauan Island, which is predominantly composed of granite. The groundmass has been recrystallized but the original porphyritic texture has generally been preserved and rock fragments can be recognized in places. Small aggregates of biotite are common. Towards the granite contact the rock becomes progressively finer and more even-grained, and passes into dark green hornfels composed of quartz (60%) and cordierite (40%) with a little biotite and muscovite.

Small patches of hornfelsed volcanics crop out near Mabaduan on the southern coast of Papua. The altered volcanics are grey, medium-grained, granoblastic or weakly foliated, and are composed of quartz, feldspar, biotite, and numerous garnet porphyroblasts up to 5 mm across. The foliation is defined by elongate aggregates of fine-grained biotite.

Saddle Island is composed of two types of welded tuff. The non-porphyritic light grey fine-grained incipiently welded tuff forming the westernmost hill is composed of small angular fragments of quartz and feldspar (up to 40%) set in a devitrified matrix of very fine quartz and feldspar. The matrix was probably mainly composed of glass shards some of which are still visible in thin section. The tuff contains small fragments of other pyroclastic rocks in places, and a few large blocks, up to 50 cm across, of black bedded mudstone were noted in some outcrops.

The eastern half of the island is composed of greenish grey welded tuff, similar to the Endeavour Strait Ignimbrite. It overlies the welded tuff described above, and dips gently southeast. The tuff contains blocks of bedded siltstone, and in places numerous fragments of pumice. The Harvey Rocks midway between Saddle Island and the main area of outcrop of the Endeavour Strait Ignimbrite are also composed of welded tuff similar to the Endeavour Strait Ignimbrite.

Booby Island, Black Rock, 8 km north of Moa Island, and Nine-pin Rock, 7 km south of Saddle Island are composed of hydrothermally altered pyroclastic rocks.

Thickness and Structure

The thickness of the Torres Strait Volcanics is difficult to estimate as the base is not exposed and much of the area of outcrop is covered by the sea. In the south the four members do not form a simple succession, but in many areas they are probably over 300 m thick.

Bedding is seldom visible in the massive welded tuffs, and the attitude of the sheets had been deduced from the orientation of the compressed pumice fragments, which are generally assumed to be parallel to the surface on which the tuff sheets were deposited. The Eborac Ignimbrite is relatively flat or dips gently southwest. The Endeavour Strait Ignimbrite dips gently northwest and presumably overlies the Eborac Ignimbrite. The steep northwesterly dips on some of the islands of Endeavour Strait may be due to faulting. The Goods Island Ignimbrite, which also dips gently northwest, except where disturbed by faulting, probably overlies the Endeavour Strait Ignimbrite.

On the air-photographs the main massive welded tuff of the Muralug Ignimbrite appears to be horizontal, but along their northeast margin the underlying vertical thin sheets of welded tuff form a prominent linear feature which separates the Muralug Ignimbrite from the Endeavour Strait Ignimbrite. The steep dip of the tuff sheets suggests that the feature is the boundary fault of a cauldron subsidence area which was formed slightly later than the Endeavour Strait Ignimbrite (cf. Branch, 1966, p.19).

On the northwest coast of Prince of Wales Island the pumice fragments dip steeply and their orientation is irregular over short distances. The steep dips may be due to folding, but it is more likely that they represent irregularities in the flow or compaction of the welded tuff. The dip and strike of the interbedded sediments in the Goods Island Ignimbrite vary considerably, and the tight small scale folds were probably developed in the sediments as a result of slight flexuring of the massive welded tuffs.

Thermal Recrystallization

The main areas in which the volcanics have been recrystallized by granitic rocks are shown in Figure 16; small areas of recrystallized volcanics also occur on the west coast of Dauan Island, and at Augaramuba Point and Marakara Island about 5 km east of Mabaduan in Papua.

The recrystallization is most extensive and intense near the Badu Granite. The volcanics are slightly recrystallized for about a metre from the contact with the porphyritic biotite granite. In the south, the hornfels on Horn Island has been developed around the contact of a porphyritic microgranite, and a similar rock may be present at depth beneath recrystallized welded tuff on Prince of Wales Island.

Rocks only slightly affected by the recrystallization have their pyroclastic textures preserved, and show only a general coarsening of the groundmass, with some corrosion of the phenocrysts. The more intensely recrystallized rocks have a fine to medium-grained hornfelsic texture, although corroded quartz phenocrysts can still be recognized. The hornfels commonly has a weak foliation defined by thin layers of biotite. On Barney Island the foliation has been emphasized by the recrystallization of pumice fragments. The most common mineral assemblage is biotite-muscovite-feldspar-quartz, which indicates the albite-epidote hornfels facies or lower hornblende-hornfels facies of metamorphism (Turner & Verhoogen, 1960). The highest grade of metamorphism occurs near contacts with granitic rocks on Horn, Moa, and Dauan Islands, and has produced assemblages containing andalusite, cordierite, or garnet, which belong to the hornblende-hornfels facies.

Alteration and Mineralization

In many places in the southern part of Torres Strait the volcanics have been altered to pale green, purple, or white rocks in which the original textures have been destroyed. Most of the alteration occurred in irregular patches along a zone extending from Goods and Hammond Islands through Horn Island and Endeavour Strait to near Peak Point on the mainland (Fig. 19); there are also small areas of alteration on Booby Island, West Island, Black Rock (north of Moa Island), Mabuiag Island, and Ninepin Rock.

In places there is a gradation between the unaltered and altered rocks, but in others the contact is sharp. Where the alteration is only slight, quartz and feldspar phenocrysts and fragments of rock and pumice are still visible, but in the intensely altered rocks only the quartz phenocrysts are preserved.

The alteration consists mainly of the replacement of feldspar in both phenocrysts and groundmass by a clay mineral. The more intense alteration is accompanied by fracturing, silicification, and the introduction of closely spaced intersecting quartz veins, up to 5 cm wide, which form irregular boxworks. Large lodes of quartz have also been formed in the altered rocks; some consist of zones of closely spaced small quartz veins, but others such as that forming the hill behind Horned Point on Horn Island, consist of large single veins.

In many places the alteration is accompanied by the introduction of a little gold, cassiterite, pyrite, chalcopyrite, or galena. The ore minerals are generally scattered in the quartz veins, but in places they form thin stringers cutting the altered country rock.

As the alteration has affected the acid dyke rocks, the intrusive porphyritic microgranite, and the surrounding volcanics on Horn Island the mineralization was probably due to late-stage hydrothermal activity associated with the intrusion of the Badu Granite and porphyritic microgranite.

Nychum Volcanics

(Morgan, 1961)

Derivation of Name

The Nychum Volcanics were named after Nychum homestead, 48 km north-northwest of Chillagoe, in the Atherton Sheet area.

Distribution

The volcanics crop out over an area of 600 sq km between the Walsh and Mitchell Rivers between Chillagoe and Mount Mulgrave homestead; they may extend westwards beneath the Mesozoic sediments. Only the northernmost outcrops, on the Mitchell River, are shown on the accompanying map.

Lithology

The formation consists of acid lavas, tuff, and welded tuff, with subordinate andesite, basalt, and some interbedded sediments. Lateral variations in the succession are common, but basalt, andesite, and sediments are generally present near the base of the sequence. About a dozen andesite vents and two or three rhyolite vents have been recognized by Morgan (1961). In the type area around Nychum homestead the total thickness is about 150 m.

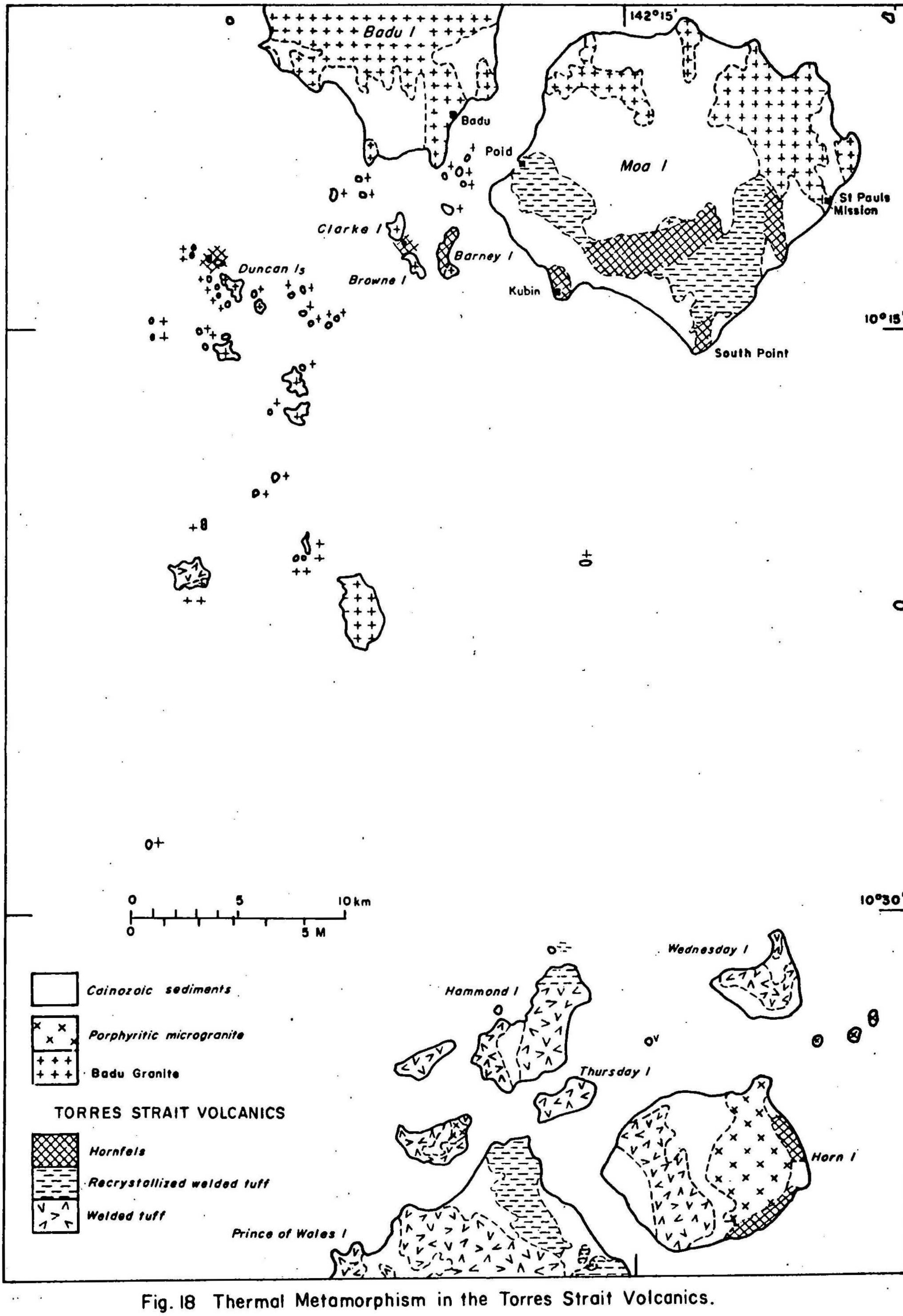

Fig. 18 Thermal Metamorphism in the Torres Strait Volcanics.

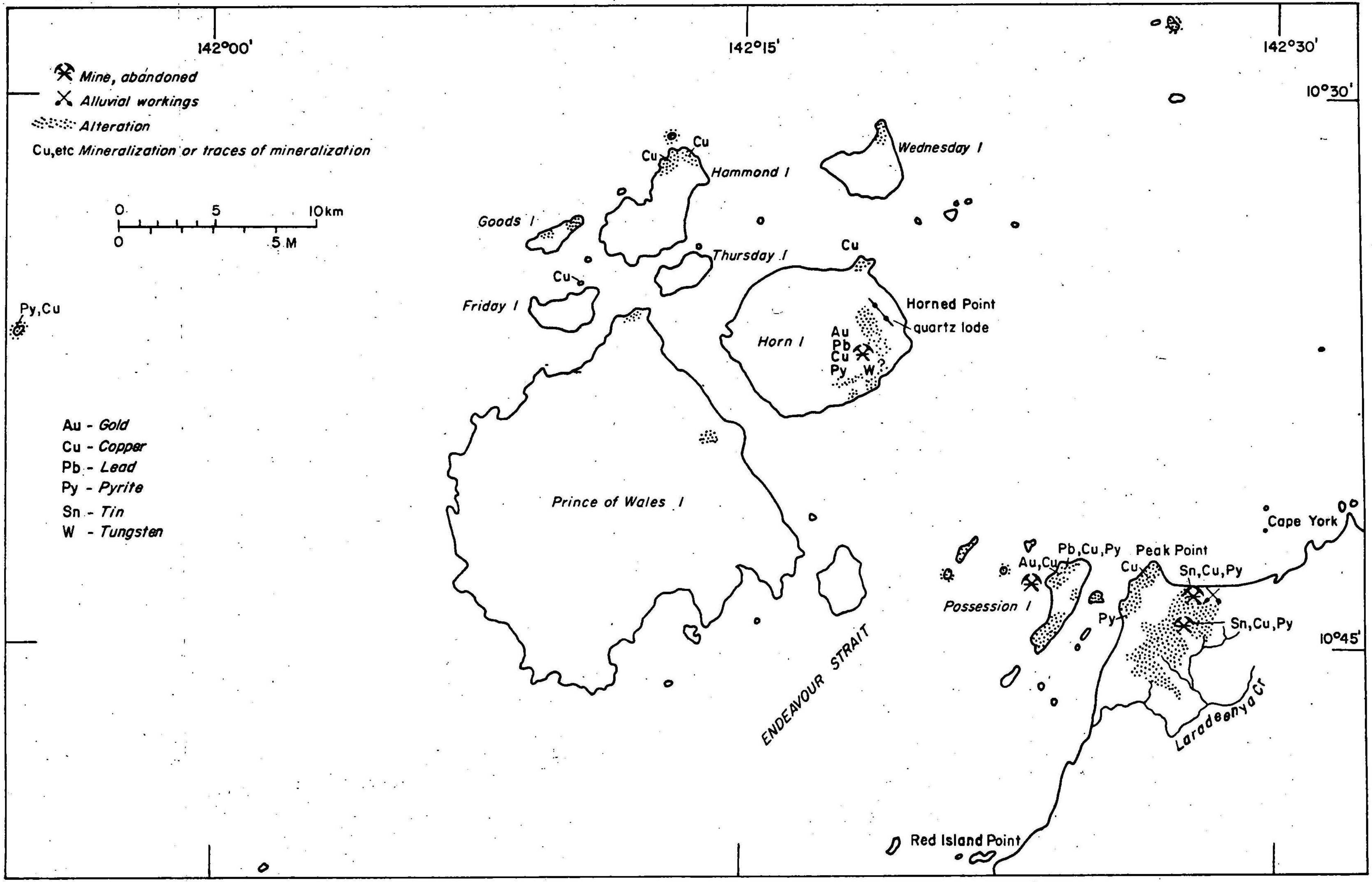

Fig. 19 Alteration and accompanying mineralization in the southern part of Torres Strait.

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On the Mitchell River the lowest exposed rocks are coarse current-bedded arkose or tuffaceous sandstone and grey siltstone, and a coal seam 1.5 m thick. The sediments are overlain by cream amygdaloidal and porphyritic acid lavas, hypersthene basalt, dacite, welded tuff, and andesite. Near Mount Mulgrave homestead agate concretions are present in vesicles in the acid lavas just south of the river. In the bed of the Mitchell River 11 km to the west there is a porphyritic acid dyke or fissure vent, 100 m wide, in the sheared Precambrian granitic basement. Similar acid dykes, up to 15 m wide, crop out in the gneiss 1 km to the east. The dykes are probably related to the volcanics, although they are similar to the acid dykes intruded shortly after the granitic rocks.

Age

On the basis of fossil plants found along the Mitchell River, the Nychum Volcanics were originally assigned to the Upper Permian or Lower Triassic by Amos & de Keyser (1964), and in 1965 Morgan (pers. comm.) found plant fossils near Nychum homestead similar to those at the Mitchell River. However, in 1968, Rb/Sr dating of the volcanics near Nychum homestead suggested an Upper Carboniferous age and re-examination of the plant specimens from near Nychum homestead indicated that they could be as old as uppermost Carboniferous (Black, 1969). The volcanics exposed on the Mitchell River are probably of the same age.

Badu Granite

(Whitaker & Willmott, 1969b)

Derivation of Name

The Badu Granite was named after Badu Island, the third largest island in Torres Strait, about 80 km northwest of Cape York.

Distribution

The Badu Granite forms the majority of the rocky islands in Torres Strait north of 10°30'S latitude and crops out at Mabaduan on the Papuan coast. The distribution of the main rock types is shown in Figure 20. It intrudes the Torres Strait Volcanics, and remnants of the volcanics or roof pendants are found within the granite on a number of islands. North of the area mapped the Badu Granite is overlain by the Mesozoic and Tertiary sediments of western Papua.

The granite is generally well exposed, especially along the coasts of Badu and Moa Islands and on the many smaller islands. On Moa and Dauan Islands it forms peaks up to 400 and 220 m high; Dauan Island is mantled by a jumbled mass of large boulders. The wave-eroded pavements and piles of boulders on the coast are generally fresh, although the leucocratic granites, as for example on Badu Island, are weathered.

Lithology

The Badu Granite includes many rock types. Where it is fairly homogeneous it consists of leucocratic biotite granite, porphyritic biotite granite and adamellite, and hornblende-biotite adamellite and granodiorite (Figure 21). Chemical analyses of the granite are given in Table 12.

The greater part of Badu Island and the small islands nearby to the southwest, west, and north, and the small islands near Mabuiag Island, are composed of leucocratic biotite granite which contains a little hornblende in places. The colour ranges from cream to pink and red. The granite ranges from fine to coarse-grained, and generally contains phenocrysts of quartz and some potash feldspar. In places the fine-grained granite contains miarolitic cavities partly filled with quartz and potash feldspar, and patches of aplite. Quartz veins up to a few centimetres thick are common and, in places the granite contains narrow zones of mylonite. A little pyrite is present in some exposures.

The anhedral quartz (30-40%) commonly forms micropegmatitic intergrowths with potash feldspar. Orthoclase microperthite (40-45%) forms relatively large anhedral grains and subhedral phenocrysts. The oligoclase (20-25%) is surrounded by narrow sodic rims, especially where the percentage of plagioclase is higher than average. Where plagioclase forms only 10 to 15 percent of the rock the perthite contains numerous patches of albite. The small crystals of biotite (1-5%) and hornblende (up to 2%) are variously altered to chlorite and leucoxene, and rarely, epidote. A similar leucocratic biotite granite crops out on the north coast of Moa Island, and on Tobin, Possession, Gabba, Cap, and Yama Islands. A number of pink leucocratic microgranite dykes are also present there, and in places, especially on Yama Island, rounded fine-grained biotite-hornblende granodiorite or tonalite xenoliths are common.

The porphyritic biotite granite between Clarke and Hawkesbury Islands (Fig. 20) is a grey medium or coarse-grained rock with subhedral to euhedral phenocrysts of pink feldspar up to 1.5 cm long. The granite is coarser and less susceptible to weathering than the leucocratic granite on Badu Island. The quartz and orthoclase microperthite are coarsely intergrown. In the porphyritic granite on Stonehenge, Tuft Rock, and Hawkesbury Island (Fig. 20) the feldspar is microcline. The granite contains roof pendants of recrystallized Torres Strait Volcanics on Clarke and Barney Islands, on two of the Duncan Islands, and on West Island. Small bodies and dykes of aplite, intrude the granite in places; they contain miarolitic cavities up to 4 cm across, partly filled with quartz.

On the west side of Hawkesbury Island the porphyritic granite is intruded by an even-grained biotite granite. Near the contact the even-grained granite is finer in grain, and the porphyritic biotite granite is intruded by sheets of biotite granite pegmatite up to 1 m thick.

On Moa Island two types of porphyritic biotite granite are present (Fig. 20). The granite near Mount Augustus is similar to the porphyritic biotite granite between Clarke and Hawkesbury Islands, but the granite in the Saint Pauls Mission area on the east coast and on Portlock Island (Fig. 20) contains microcline but lacks intergrowths of quartz and potash feldspar. The microcline phenocrysts average 1.5 cm by 1 cm, and the rock grades into adamellite in places. The granite shows faint compositional banding in some exposures. Several kilometres northwest of Saint Pauls Mission a belt of pink leucocratic microgranite or adamellite is exposed. On the western slopes of Mount Augustus small bodies of fine-grained biotite granite or hornblende-biotite granite appear to intrude the porphyritic granite. Porphyritic biotite granite similar to that near Saint Pauls Mission also crops out at Mabaduan on the Papuan coast and on nearby Dauan Island. It is variable in grainsize, and on Dauan Island it contains hornblende.

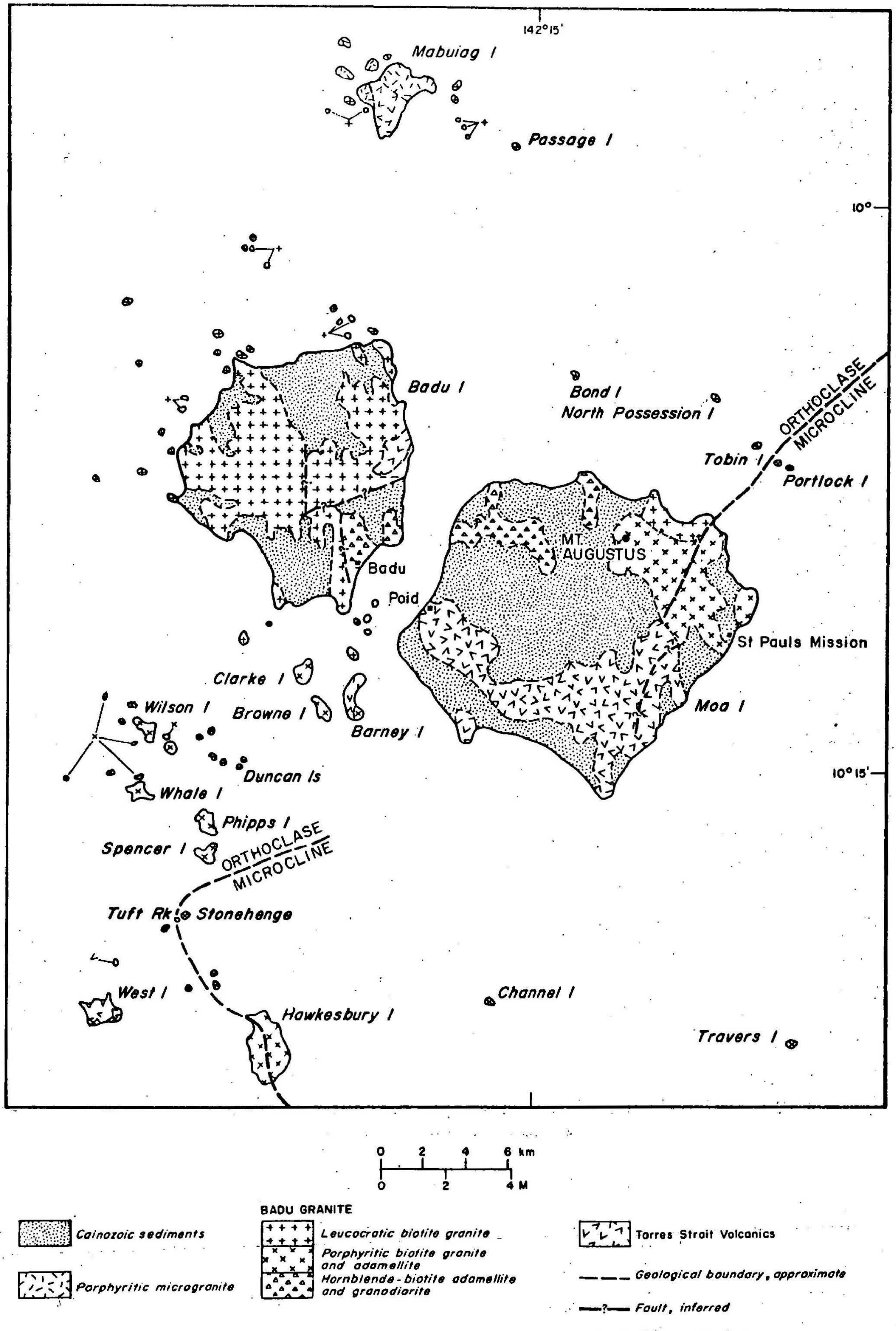


Fig. 20 Main rock types in the Badu Granite.

TABLE 12. CHEMICAL ANALYSES, UPPER PALAEOZOIC INTRUSIVE ROCKS FROM TORRES STRAIT

	1	2	3	4	5	6
SiO_2	70.67	72.75	74.45	71.12	77.53	66.71
Al_2O_3	14.86	13.97	14.23	14.50	11.67	16.63
Fe_2O_3*	1.91	2.10	0.75	2.46	2.44	3.24
MgO	0.74	0.00	0.20	0.46	0.46	0.44
CaO	2.23	1.48	1.46	2.22	0.14	1.95
Na_2O	3.63	3.46	3.85	3.00	2.48	3.90
K_2O	3.84	5.19	4.54	4.89	5.21	6.11
TiO_2	0.23	0.21	0.10	0.27	0.18	0.40
P_2O_5	0.09	0.08	0.05	0.09	0.03	0.13
MnO	0.05	0.04	0.02	0.05	0.17	0.07
Loss on ignition	0.43	0.39	0.39	0.80	0.87	0.64
Total+	98.25	99.28	99.65	99.06	100.31	99.68

*Total iron as Fe_2O_3

+Does not include loss on ignition

Badu Granite

1. Porphyritic biotite granite, N end Hawkesbury I. (BMR 68480132)
2. Porphyritic biotite granite, Clarke I. (BMR 68480134)
3. Porphyritic biotite adamellite, Mabaduan village, Papua. (BMR 68480177)

Porphyritic Microgranite

4. Coarsely porphyritic microgranite, NE coast of Horn I. (BMR 68480138)
5. Porphyritic microgranite dyke, S coast Badu I. (BMR 68480062)
6. Porphyritic microgranite dyke, West I. (BMR 68480050)

Analysed by G.H. Berryman (BMR) by X-ray fluorescence method

Hornblende-biotite adamellite and granodiorite are exposed in the western half of Moa Island and in a small area opposite on Badu Island. The rocks are grey to pinkish grey and medium-grained, and contain a few pink orthoclase phenocrysts in places. The irregular laths of hornblende, up to 5 mm long, are less common than biotite. Some intergrowths of quartz and orthoclase microperthite are present in the more acid varieties. In places the granodiorite has a speckled appearance due to the presence of small clots, up to 1.5 cm in diameter, composed of small laths of hornblende and plagioclase. The granodiorite also contains dark grey fine to medium-grained xenoliths up to 30 cm across. The hornblende-bearing rocks appear to have been faulted against the leucocratic biotite granite west of Badu village.

Other varieties of granite crop out on small isolated islands. Burke, Getullai, and Mount Ernest Islands, east of Moa Island, are composed of pink fine to coarse leucocratic biotite granite with some patches and dykes of aplite, and rare pegmatite. The biotite generally forms small clumps, and on Burke Island streaks and patches of biotite-rich material are present. The microcline is strongly poikilitic and slightly microperthitic.

The west end of Travers Island is composed of a massive dark grey fine equigranular muscovite-biotite granodiorite, which is intruded by light grey medium-grained porphyritic muscovite-biotite adamellite or granodiorite. The microcline phenocrysts range up to 3 cm in length. They are common in some areas but are virtually lacking at the east end of the island. Near the vertical contact with the fine-grained granodiorite the medium-grained rock is banded and slightly foliated. The bands consist of alternating layers of biotite-rich and biotite-poor material, up to 30 cm wide, parallel to the contact. The medium-grained rock near the contact is cut by irregular dykes and patches of aplite and muscovite granite pegmatite. Both rock types are similar in composition, and are moderately recrystallized, sheared, and microfractured.

Channel Island, 5 km east of Mabuiag, is composed of pink leucocratic medium-grained biotite-muscovite granite, which is aplitic or pegmatitic in places. Muscovite forms large crystals and biotite small clots; the quartz is strained and recrystallized. Twin Island is composed of grey medium-grained massive biotite granite, with pink potash feldspar phenocrysts up to 2 cm long, which grades into muscovite-biotite or muscovite granite. The muscovite-bearing phases are cut by or intimately banded with pegmatite composed of large clumps or bands of pink potash feldspar crystals set in a granitic matrix; some large crystals of muscovite are also present. In places granite is sheared and altered, and is intruded by quartz veins up to 50 cm thick.

On East Strait Island 3 km to the south, the biotite granite is medium or coarse-grained, leucocratic and pink or red. The granite is composed of quartz, microcline microperthite, and scattered clumps of biotite up to 5 mm across. An extensive horizontal sheet of pegmatite 30 cm thick is composed of intergrown crystals of quartz and potash feldspar up to 10 cm long. Similar rocks are exposed on Strait Rock near the Tuesday Islets.

On Hammond Island, a small body of grey medium-grained muscovite-biotite tonalite or granodiorite intrudes altered and recrystallized welded tuff of the Goods Island Ignimbrite. The rock contains a few patches of muscovite-rich pegmatite. Near the sharp and almost vertical contact with the volcanics the tonalite contains small grains of chalcopyrite in a mineralized zone up to 6 m wide.

Contact Metamorphism

The intrusion of the granites into the Torres Strait Volcanics was accompanied by extensive thermal metamorphism. Recrystallization of the volcanics is most intense near the porphyritic biotite adamellite, particularly on Dauan, Moa, Barney, and Clarke Islands. The least altered rocks are slightly coarser in grain and retain their original texture, but near the granite contacts they have been converted to biotite-quartz-feldspar hornfels containing garnet, cordierite, and andalusite. This assemblage indicates metamorphic conditions of the hornblende hornfels facies. The leucocratic biotite granite on Badu Island appears to have been intruded at a lower temperature, as the surrounding volcanics have been only slightly recrystallized for about a metre from the contact.

Dyke Rocks

Apart from the aplite, pegmatite, and microgranite dykes closely associated with the Badu Granite, the granite and volcanics are cut by dykes of intermediate composition, porphyritic microgranite, and felsite.

Intermediate dykes are most common in the southwest part of Badu Island and in the eastern part of Moa Island. They range up to 15 m wide, but are generally much narrower. The dykes are greenish black and generally contain a few small plagioclase phenocrysts up to 3 mm long. They range from dacite(?), through hornblende andesite and hornblende-augite andesite, to augite andesite. The andesine or sodic labradorite is altered to sericite and a little epidote and the hornblende to actinolite, chlorite, or tremolite. The augite is titaniferous. The dykes contain a little iron oxide, apatite, sphene and calcite.

Numerous flow-banded felsite dykes up to 10 m wide, but generally much narrower, intrude the Torres Strait Volcanics on the small islands in Endeavour Strait. The dykes are generally vertical and trend between 20° and 60°, approximately parallel to the strike of the volcanics. They consist of small cream, pink, or green embayed quartz phenocrysts up to 1.5 mm across, and subordinate sericitized potash feldspar phenocrysts set in a microcrystalline quartzofeldspathic groundmass. The flow banding is commonly very contorted, especially along the margins of the dykes. The largest dykes become massive towards their centres. Narrow quartz veins are common in and near many of the dykes.

The felsite dykes intruding the Badu Granite to the north are generally banded in narrow marginal zones only, and some are massive throughout. The massive dykes generally have a coarser groundmass. Plagioclase, quartz, and potash feldspar phenocrysts, up to 2 mm long, are common. Many of the quartz phenocrysts have slightly corroded margins. The dykes contain a few small chloritized flakes of biotite.

The porphyritic microgranite dykes are similar to the large bodies of porphyritic microgranite described below.

Where the dykes are numerous the sequence of intrusion appears to be consistent. In the southwest part of Badu Island the order is: intermediate dykes, porphyritic microgranite dykes, and at least two groups of felsite. A few narrow younger intermediate dykes intrude the microgranite dykes. Near Saint Pauls Mission, on the east coast of Moa Island, there are no porphyritic microgranite dykes, but the sequence is otherwise the same as on Badu Island. The dykes generally have no preferred directions, but in places groups of dykes are roughly parallel, as for example in the southwest part of Badu Island. The volcanics in the southern part of the strait, which are remote from the main granitic rocks, are only intruded by felsite dykes.

Alteration and Mineralization

In the southern part of Torres Strait the volcanics, acid dykes, and porphyritic microgranite described below, have been hydrothermally altered, fractured, and penetrated by quartz veins. The alteration was accompanied by the introduction of a little gold, cassiterite, galena, chalcopyrite, and pyrite. The alteration probably represents the final phase of intrusion of the Badu Granite, and the associated dykes and porphyritic microgranite.

The wolfram-bearing quartz veins on a near Badu and Moa Islands are also related to the Badu Granite and the associated felsite and porphyritic microgranite. Finely disseminated chalcopyrite occurs in the small body of tonalite at the northeast end of Hammond Island.

Age

The Badu Granite has been dated as Upper Carboniferous 294 m.y. by the K/Ar method on four samples of biotite (Richards & Willmott, 1970). The high-level character of the granite suggests that is co-magmatic with the Torres Strait Volcanics. The porphyritic microgranite described below is probably only slightly later than the granite, and almost certainly belong to the same intrusive event.

Granite basement has been encountered to the north in southwest Papua in a number of petroleum exploration wells (APC, 1961; Oil Search, 1964), but it appears to be considerably younger than the Badu Granite. Harding (1966) reports an Upper Permian K/Ar age of 236 m.y. for basement granite in the Aramia 1 Well, 165 km north-northwest of Mabaduan.

Porphyritic Microgranite

Distribution

On Mabuiag Island a small body of porphyritic microgranite intrudes the Torres Strait Volcanics, and between Mabuiag Island and Hawkesbury Island many dykes of microgranite invade the Badu Granite. Other porphyritic microgranites intrude the volcanics on Horn Island and the Tuesday Islets, Friday Island, and Mount Adolphus Island.

Lithology

At Mabuiag Island the porphyritic microgranite is a massive poorly jointed red-brown rock containing phenocrysts of altered orthoclase, up to about 1 cm long, and smaller phenocrysts of embayed quartz and some plagioclase set in a finely crystalline groundmass with small clots of dark green mafic mineral. The contact between the microgranite and the welded tuff to the south and west was not seen. The tuff is not visibly altered by the intrusion.

The dykes of microgranite between Mabuiag and Hawkesbury Islands are up to a few hundred metres wide and 3 km long. Most of the larger dykes are brown with a finely crystalline groundmass similar to the microgranite on Mabuiag Island, but the narrower dykes are dark grey and aphanitic. Chemical analyses of dyke rocks are given in Table 12.

Some of the altered subhedral or euhedral orthoclase grains are poikilitic, and others have recrystallized margins. The subhedral phenocrysts of oligoclase, or more rarely albite, have sodic rims or potash feldspar overgrowths. The groundmass consists of microcrystalline intergrowths of quartz and feldspar, microgranophyric intergrowths of quartz and potash feldspar with a few plagioclase grains, or a microgranitic rock composed of quartz and poikilitic grains of potash feldspar. The mafic minerals include small grains and clots of chlorite, biotite, and hornblende. The clinopyroxene in one of the larger dykes is partly altered to hornblende and actinolite.

Coarse porphyritic microgranite has intruded and thermally metamorphosed the Endeavour Strait Ignimbrite in the eastern part of Horn Island, and is also exposed in the Tuesday Islets to the northeast. A small body of similar microgranite intrudes the volcanics near the northeast coast of Prince of Wales Island, opposite Horn Island. A specimen of similar porphyritic microgranite was obtained from the Herald Patches, 4 km north of the Tuesday Islets, by Captain MacRobert, of the Department of Shipping and Transport in 1970. The microgranite is grey and has a fairly uniform texture. It contains phenocrysts of cream to pale green plagioclase (up to 2 cm), cream to pale pink alkali feldspar (up to 2.5 cm), clear quartz (up to 1 cm), and dark green to black clots of mafic minerals (up to 1 cm). The subhedral oligoclase which forms between 3 and 50 percent of the phenocrysts, are partly altered to sericite and calcite. The alkali feldspar phenocrysts include subhedral crystals of microcline or anorthoclase (10-30%) with poorly developed cross-hatch twinning, and subhedral well twinned crystals of albite (0-25%) with quartz inclusions. The quartz phenocrysts (15-40%) are euhedral and embayed. The microcline or anorthoclase phenocrysts are marginally intergrown with the groundmass, and in some specimens, are surrounded by overgrowths which include a rim of fine-grained quartz. The mafic minerals generally occur in patches composed of small ragged crystals of hornblende altered to actinolite and epidote. The accessories are zircon, apatite, opaque minerals, and allanite. The very fine-grained groundmass is composed of intergrown quartz, microcline, and some oligoclase. A chemical analysis is given in Table 12.

In the east-central part of Horn Island the microgranite is hydrothermally altered and veined by quartz; the altered rocks contain lead, copper, and iron sulphides.

One or two small intrusions of quartz-alkali feldspar microgranite crop out on Mount Adolphus Island, 15 km northeast of Cape York; they probably intrude the Eborac Ignimbrite which forms the bulk of the island.

The microgranites are massive and grey, and contain white to greenish white subhedral phenocrysts of sanidine or anorthoclase (?) and some small rounded crystals of quartz. Some of the feldspar phenocrysts are granophyrically intergrown with quartz, and some are partly altered to calcite. The quartz phenocrysts have corroded margins and are optically continuous with the adjacent groundmass. The groundmass consists of finely crystalline quartz and feldspar, with dusty opaque minerals, and a little calcite, chlorite, and sphene.

The full extent and relationships of the microgranites are unknown. They crop out on a small headland in Blackwood Bay and near the summit of Mount Adolphus; they probably caused the recrystallization of the groundmass in the nearby Eborac Ignimbrite.

A small body of porphyritic biotite microgranite intrudes the Goods Island Ignimbrite in the eastern part of Friday Island. The microgranite is massive and pale pink, and is composed of quartz and alkali feldspar phenocrysts set in a microcrystalline groundmass.

The quartz phenocrysts, which range from 2 to 4 mm across, are rounded and fractured, and have corroded margins. The alkali feldspar phenocrysts include subhedral zoned crystals of albite up to 7 mm long, which are partly altered to clay and sericite, and anhedral grains of orthoclase with a poorly developed microperthitic texture. The ragged flakes of biotite are largely altered to chlorite and epidote. The groundmass consists of microcrystalline quartz and alkali feldspar, and a little sphene.

There are several breccia zones or minor fault zones in the microgranite near the contact with the volcanics, and several large xenoliths, of recrystallized welded tuff, up to 6 m across, were noted in the microgranite. Small dykes and veins of pink aplite penetrate the volcanics near the contact.

The porphyritic microgranites are probably genetically related to the Badu Granite, and some of them may be slightly younger than the granite.

Unnamed Volcanic Rocks

Distribution

Small masses of volcanic rocks, which have not been formally named, crop out at Cape Griffith, Lloyd Island and Sunter Islet, east of the Iron Range airstrip, and at the 2nd Red Rocky Point, south of Cape Direction. They are assumed to be between Lower Carboniferous and Lower Permian, like the nearby Janet Ranges Volcanics.

Lithology

The grey acid welded tuff at Cape Griffith is composed of phenocrysts of quartz and feldspar and numerous rock fragments set in a devitrified matrix, and a few ill defined interbeds of brownish grey massive agglomerate containing pebble-size fragments of intermediate volcanic rocks. The beds strike between northeast and southeast and generally dip steeply eastwards. Sunter Islet consists of fine-grained massive andesite with phenocrysts of greenish feldspar. The andesite may be a dyke rather than a flow. The acid pyroclastics of Lloyd Island range from fine-grained welded tuff to pebble agglomerate. Small pumice fragments are particularly common in the welded tuff.

The basalt at 2nd Red Rocky Point has been hornfelsed by the nearby Permian granitic rocks, and is cut by dykes of leucocratic microgranite. The basalt is dark grey to black, fine-grained, and partly foliated or banded. It contains a few phenocrysts of feldspar, and veins of quartz and epidote between 5 mm and 1 cm thick. The altered rock has a fine-grained hornfelsic texture, and is composed of biotite, actinolite, and plagioclase.

Fine-grained altered acid rocks crop out on a number of headlands in Temple Bay; they have intrusive contacts and are either related to the acid volcanics or the nearby Weymouth Granite.

Janet Ranges Volcanics

(Whitaker & Willmott, 1969a)

Derivation of Name

The Janet Ranges Volcanics were named after the Janet Ranges, 20 km northwest of the Iron Range airstrip.

Distribution

The main outcrops (Fig. 21) cover an area of 350 sq km inland from Portland Roads and Iron Range; they extend from the Goddard Hills 30 km southwards to Bowden Hill and Mount Tozer. They also crop out over an area of 25 sq km in a narrow northerly trending belt farther south near Luttrel Hill. In the main area of outcrop the volcanics are moderately well exposed, and form rounded rubble-covered mountains supporting low heath-type vegetation.

Lithology

The volcanics have been subdivided informally into three members composed of acid welded tuff, acid lava, and welded pumice-flow breccia. The sequence has been established in the broad arc extending from the Middle reaches of Garraway Creek to Hamilton Creek and Mount Nelson. The distribution of the members is shown in Figure 21.

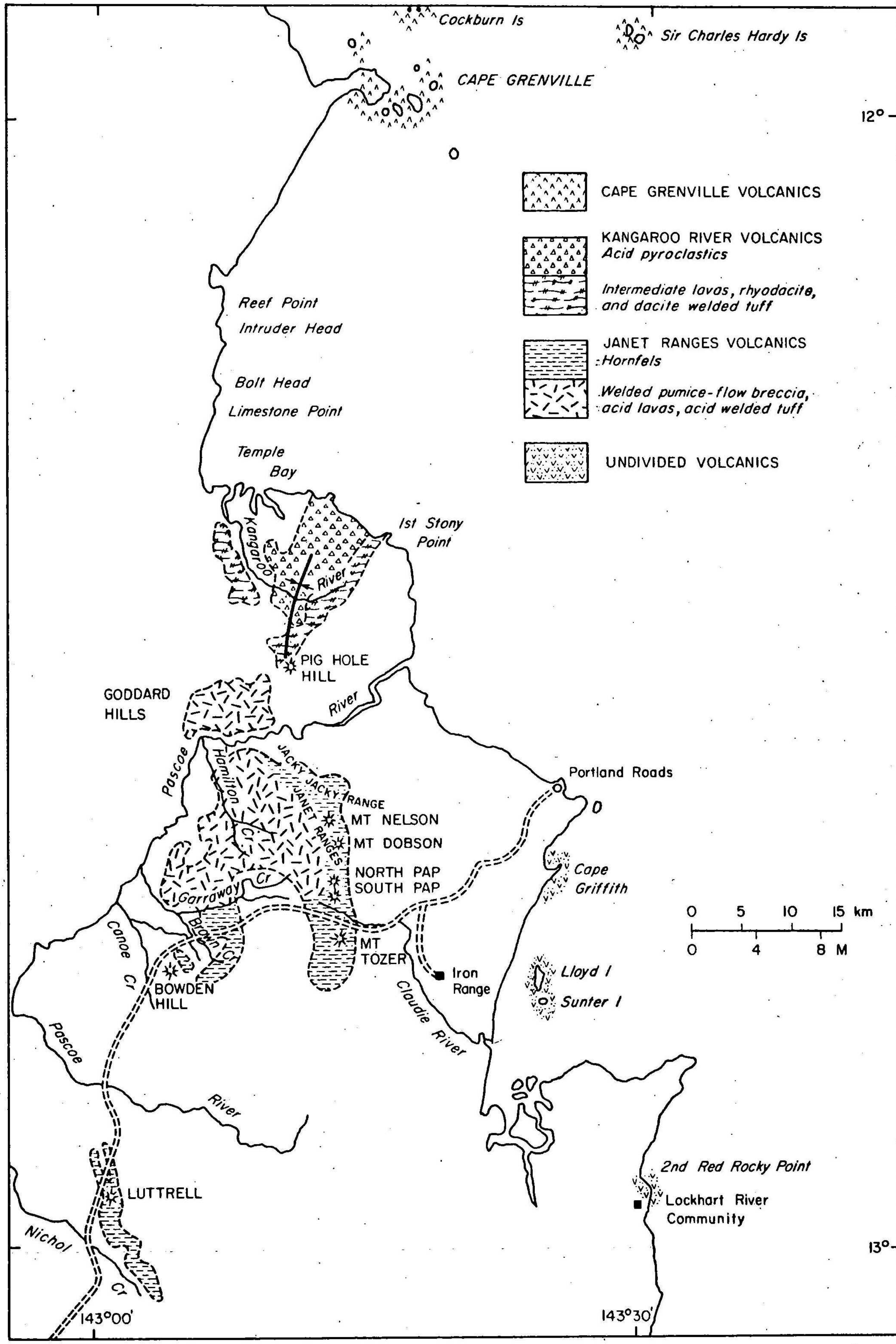


Fig.21 Carboniferous-Permian volcanic rocks in the Iron Range district.

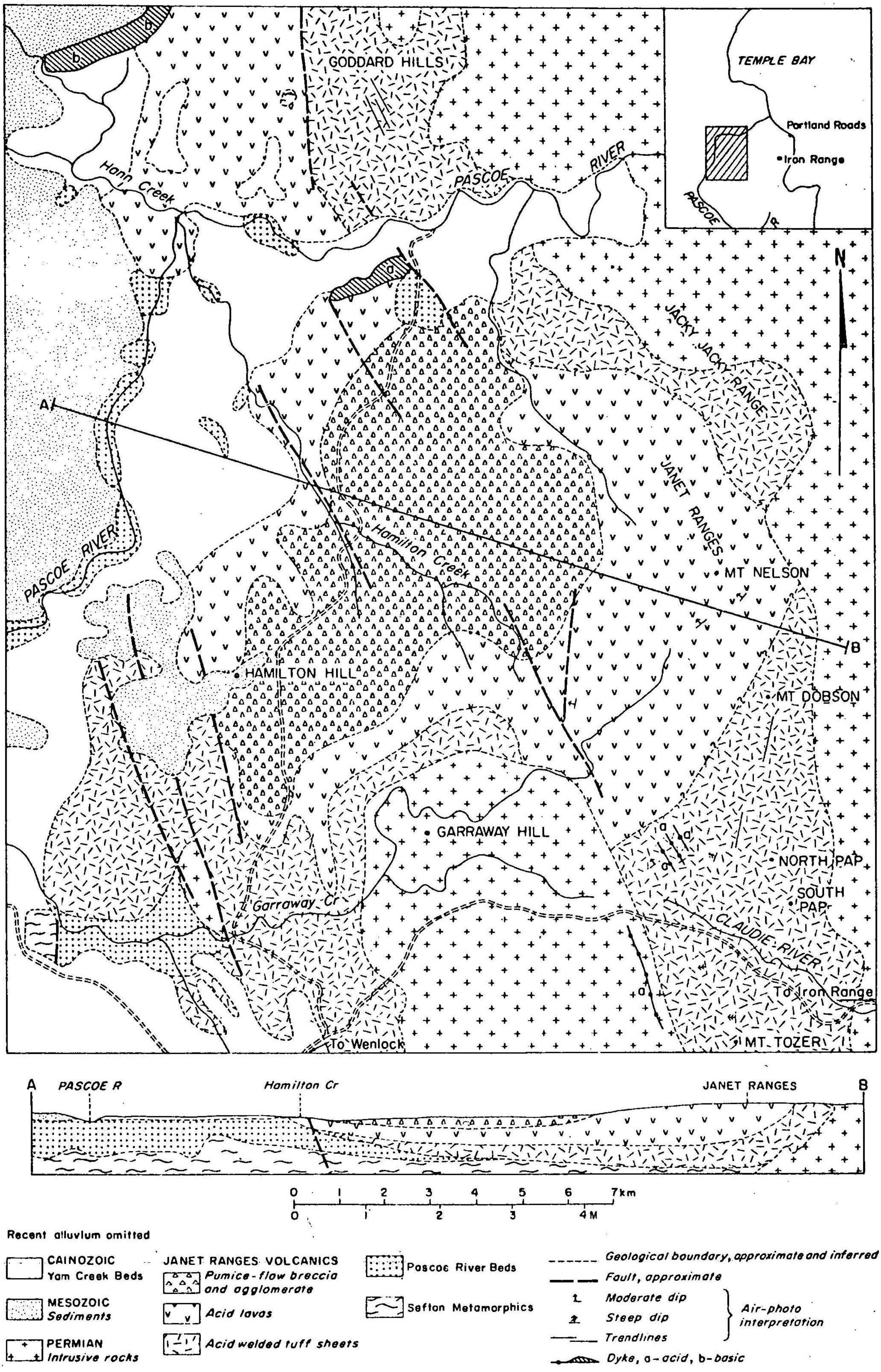


Fig. 22 Distribution of rock types within the Janet Ranges Volcanics.

The lowest member consists of a sequence of rhyolite welded tuff sheets, which range up to about 50 m thick. The individual sheets have been welded together into compound cooling units. The lower part of the member is composed of light brown massive welded tuff containing euhedral crystals of quartz, potash feldspar, and plagioclase. The upper part consists of massive black welded tuff, which in places contains numerous compressed fragments of pink pumice. The welded tuff sheets are best exposed in the middle reaches of Garraway Creek where they rest unconformably on the Pascoe River Beds.

The middle member consists mainly of a sequence of rhyolite lava flows. It is best developed in the Janet Ranges near Mount Nelson where it is probably over 150 m thick. The individual flows, which can be traced for hundreds of metres, are strongly flow-banded and spherulitic. The spherulites generally range from 5 mm to 8 cm in diameter, and appear to be constant in size within any one flow. They were probably formed during devitrification of the original glassy lavas. Between Garraway Creek and Hamilton Hill the sequence is much thinner and consists of autobrecciated flow-banded lavas; similar lavas crop out in the lower reaches of Hamilton Creek and in the western half of the Goddard Hills. Towards the top of the sequence a few thin bands of pumice-flow breccia are interbedded with the lavas.

The uppermost member consists of at least 60 m of welded pumice-flow breccia, which is exposed mainly in the headwaters of Hamilton Creek. The breccias contain numerous large uncompressed fragments of pumice and fragments of acid lava set in a fine fragmental matrix. In the lower reaches of Hamilton Creek the boundary with the underlying autobrecciated acid lavas is indistinct.

Away from the Garraway Creek/Hamilton Creek/ Mount Nelson region the three members are not easily distinguished on the air-photographs, and the succession has been disrupted by faulting and by the intrusion of Permian granitic rocks. Near Mount Tozer, North and South Pap, and Mount Dobson, the lowest member may be represented by the hornfelsed rocks underlying the acid lavas southwest of Mount Nelson. Similar hornfels crop out in the Jacky Jacky Range, and the welded tuff exposed in the Goddard Hills may also belong to the same sequence though some of the welded tuff in the Goddard Hills is dacitic. In the lower reaches of Hamilton Creek the lowest member is represented by a few welded-tuff sheets interlayered with acid lavas.

The belt of volcanics northeast of Luttrel Hill (Fig. 12) consists of a narrow band of recrystallized acid flows followed by recrystallized volcanic breccia, agglomerate, and welded tuff to the west. Still farther west the rocks are intensely recrystallized and the nature of the original sequence is uncertain.

<u>Thickness and Structure</u>

In the east the volcanic rocks are at least 500 m thick, but to the west they thin considerably against a ridge of Pascoe River Beds and Sefton Metamorphics, although they may extend northwestwards under the Mesozoic sediments.

The volcanics are generally flat or gently dipping, except where intruded by granitic rocks. Along the eastern margin the volcanics have been tilted to the west by the intrusion of the Weymouth Granite, and near Mount Tozer the dip is 50° to 60°. In the west a number of short northwesterly trending faults cut the volcanics. The volcanics near Luttrel Hill form a thin steeply dipping sliver between the western contact of the Weymouth Granite and an elongate intrusion of hybrid adamellite.

The presence of the thick sequence of acid lavas along the eastern margin suggests that the main centres of eruption were in this area.

Thermal Recrystallization

The volcanics have been recrystallized and hornfelsed for some distance from the contact of the Permian granitic intrusions. Recrystallization is common along the eastern margin of the volcanics, but also occurs near Bowden and Luttrel (Fig. 12). Close to the contact the groundmass has a hornfelsic texture, the phenocrysts are deeply embayed, and most of the original texture has been destroyed; farther away the recrystallization has caused only a general coarsening of the groundmass.

Near Luttrel Hill the degree of recrystallization of the volcanics is greater in the west near the contact with a hybrid adamellite than in the east near the Weymouth Granite.

Age

The volcanics are no younger than Lower Permian, as they are intruded by the Lower Permian Weymouth Granite; they may be comagmatic with the granite and only slightly older than it. Massive subhorizontal welded tuff rests on folded Lower Carboniferous Pascoe River Beds near the junction of Garraway Creek and Brown Creek. As the volcanics are not affected by the folding, they are probably younger than Lower Carboniferous. However, the presence of volcanic material in the Pascoe River Beds indicates that some of the volcanics belong to an earlier period of vulcanism. The Kangaroo River Volcanics and the Cape Grenville Volcanics are probably similar in age to the Janet Ranges Volcanics.

Kangaroo River Volcanics

(Whitaker & Willmott, 1969a)

Derivation of Name

The Kangaroo River Volcanics were named after the Kangaroo River, which flows across the volcanics into Temple Bay.

Distribution

The volcanics are exposed in a triangular area of 130 sq km north of the mouth of the Pascoe River and south of Temple Bay. They crop out mainly as rough rubble-covered mountains north of the Kangaroo River; the intermediate and basic rocks in the lower part of the formation occupy lower more fertile country.

Lithology

The formation has been divided informally into two members: the lower consists mainly of intermediate lavas, dacite and rhyodacite welded tuff, and the upper is mainly acid welded tuff and breccia (Fig. 12).

The lower member is about 75 m thick. It consists of intermediate lavas, dacite and rhyodacite welded tuffs, and subordinate rhyolite welded tuff and rhyolite. The intermediate and basic lavas are fine to medium-grained, and range from light grey through creamy brown to dark greyish black. Some of the lavas towards the top of the sequence contain vesicles filled with calcite. The dark grey dacite and rhyodacite welded tuff contain phenocrysts of plagioclase, pink alkali feldspar, hornblende, and numerous dark grey rock fragments.

The lithology of the upper member is not known in detail, but it includes about 150 m of acid welded tuff, volcanic breccia, and some flow-banded rhyolite. The welded tuff ranges from buff to cream, and contains small uncompressed fragments of pumice. The volcanic breccia contains numerous fragments of flow-banded acid lavas and phenocrysts of quartz and feldspar in a light-coloured matrix.

Thickness and Structure

The Kangaroo River Volcanics are at least 220 m thick, and may range up to 300 m. On the air-photographs the upper member appears to be a single massive sheet which has a sharp contact with the underlying intermediate and dacitic rocks, but the presence of bands of rhyolite within the tuff suggests that it consists of several sheets of welded tuff separated by lava flows.

The volcanics form a gentle syncline with the axis plunging gently north-northeast. The dip on the flanks ranges from 5^{o} to 10^{o}, but near Pig Hole Hill at the nose of the syncline, steep dips, probably due to faulting, are common. The age of the folding is uncertain, but it may be related to the intrusion of the Permian granitic rocks.

Age

Near Pig Hole Hill the volcanics appear to overlie a small inlier of Precambrian Sefton Metamorphics, and a few kilometres to the northeast they are intruded and tilted by a body of granophyric adamellite probably related to the Lower Permian Weymouth Granite. The relationship of the Kangaroo River Volcanics to the Janet Ranges Volcanics a few kilometres to the south is unknown, but they are probably also Lower Carboniferous to Lower Permian.

Cape Grenville Volcanics

(Whitaker & Willmott, 1969a)

Derivation of Name

The Cape Grenville Volcanics were named after Cape Grenville, a large headland on the southern margin of the Orford Bay Sheet area, 70 km north-northwest of Portland Roads. On one island near Cape Grenville welded tuff now included in these volcanics, was named the Clerke Island Ignimbrite by Jones & Jones (1956).

Distribution

The volcanics crop out in the southern part of the Orford Bay Sheet area, and are exposed over about 15 sq km on Cape Grenville, the adjacent Home Islands, Sunday Island, the Cockburn Islands, and the Sir Charles Hardy Islands. They form rounded hills covered with poor vegetation, and are well exposed in many rocky headlands.

Lithology

In the Cape Grenville area the volcanics may be divided into three or possibly four members consisting of well bedded volcanic breccia, welded tuff, and acid lavas (Fig. 23).

In Indian and Margaret Bays the lowest member is composed of thinly bedded volcanic breccia and coarse tuff. The pyroclastic rocks contain fragments of acid welded tuff and intermediate to basic volcanic rocks, up to 45 cm across, set in a coarse pink matrix; in places the blocks form thin layers which extend for many metres.

The second member consists of 15 to 20 m of welded tuff composed of numerous lenses of pink pumice up to 8 cm long, set in a greyish purple aphanitic groundmass. The lenticules form a planar structure roughly parallel to the bedding surface. In the cliffs along Indian Bay the base of the member lies disconformably on the bedded volcanic breccia. On the east side of Waterhole Bay the top of the member consists of a number of thin sheets of pumice-rich welded tuff which have apparently cooled as one unit; welded tuff is also exposed on Orton and Gore Islands (Fig. 23).

The third member consists mainly of strongly flow-banded and spherulitic acid lavas, which crop out in the northeastern half of Cape Grenville, on Sunday Island, and on part of Gore Island. On the east side of Waterhole Bay the base of the sequence consists of a layer of agglomerate, 10 m thick, composed of blocks of flow-banded acid lava averaging 60 cm across. The agglomerate contains tongues of lava up to 10 m long.

The welded tuff with abundant pumice fragments on Hicks, Clerke, Perry, and Nob Islands (Fig. 23) is similar to the welded tuff in the member underlying the acid lavas. It may be part of that welded tuff member, or it may constitute a fourth member which overlies the acid lavas.

Buchan Rock the southernmost island of the Cockburn Islands is composed of welded tuff which contains abundant elongate pumice fragments; it is similar to the welded tuff in the second member at Cape Grenville. Pig, Manley, and Bootie Islands the other islands of the Cockburn Islands are composed of dark welded tuff containing only a few pumice fragments set in a groundmass of strongly welded devitrified glass shards.

The welded tuff forming the Sir Charles Hardy Islands is similar to that of the second member at Cape Grenville. The rock generally contains fragments of pink and green pumice up to 8 cm long, but where the fragments are less common the rock becomes massive.

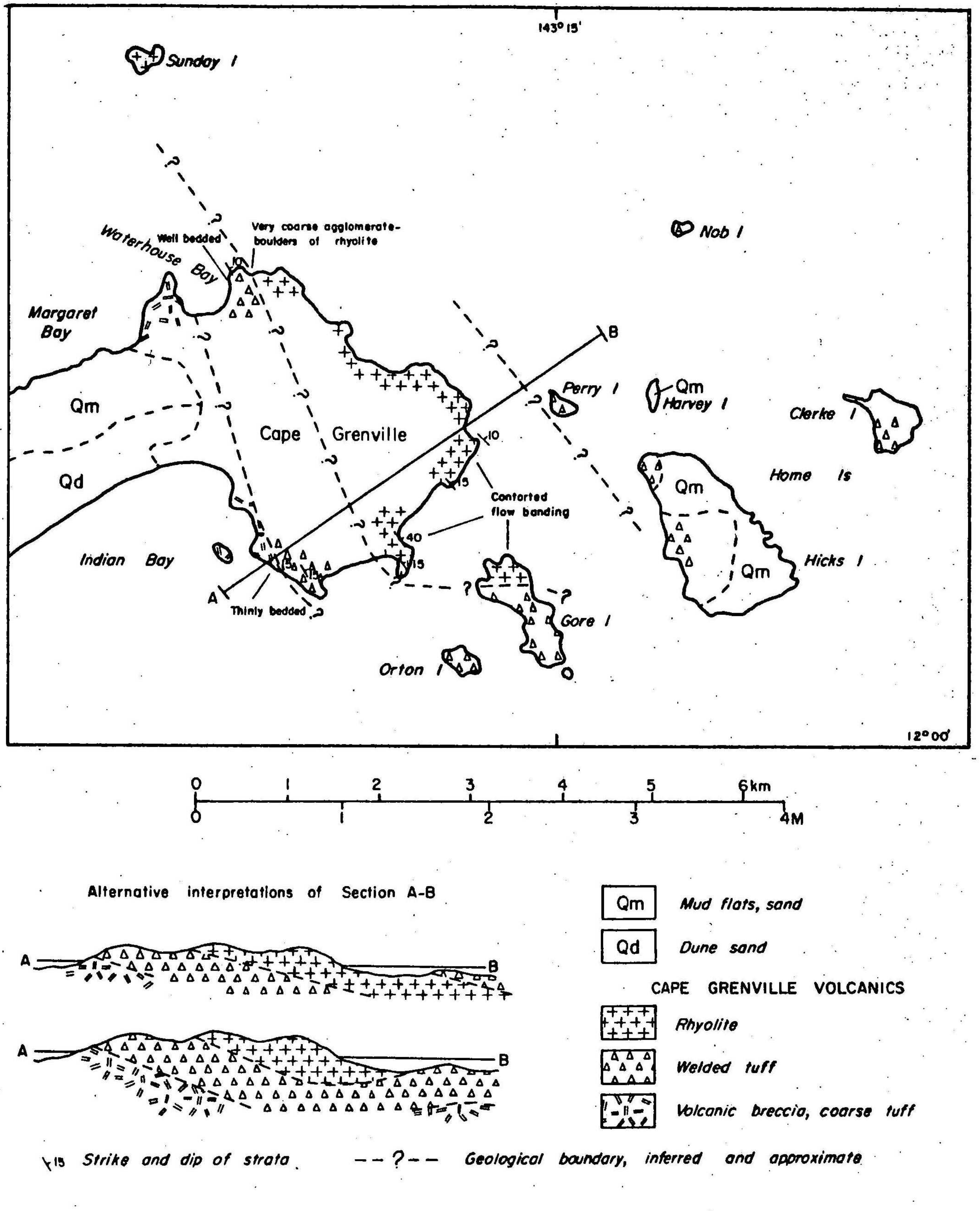


Fig. 23 Volcanic rocks of the Cape Grenville area.

Thickness and Structure

The total thickness of the volcanics is unknown as the base is not exposed; their lateral extent is obscured by Mesozoic sediments and by the sea. At Cape Grenville they appear to be between 200 and 300 m thick.

At Cape Grenville the volcanics strike roughly northwest and dip at 10^{o} to 15^{o} to the northeast. If the welded tuff on Hob, Clerke, and Hicks Islands is the same as the welded tuff member exposed in Indian and Waterhole Bays, the member is folded into a gentle syncline with the axis plunging to the northwest. The direction of dip of the welded tuff on these islands, however, is unknown.

Weymouth Granite

(Whitaker & Willmott, 1969a)

Derivation of Name

The Weymouth Granite was named after the County of Weymouth. The granite is also well exposed at Cape Weymouth.

Distribution

The Weymouth Granite is exposed over a total of 1100 sq km in the Cape Weymouth and Coen Sheet areas, mainly in a large suboval pluton 65 km long between Garraway Creek in the north and the head-waters of Hull Creek in the south. Smaller plutons crop out near Cape Direction, and between Iron Range airstrip, the Goddard Hills, and the northern coast of Weymouth Bay. The granite also forms the Forbes Islands, Quoin Island, and small exposures along the coast of Temple Bay.

The granite is generally well exposed, particularly around the edge of the Pascoe River Plateau, where it weathers to rounded boulders up to 15 m across. It also crops out as a pavement in the bed of the Pascoe River and in several of its larger tributaries. Some ridges in the granite are mantled by large boulders blackened by lichen, and resemble the black granite hills in the Trevethan Granite near Cooktown (de Keyser & Lucas, 1969).

Lithology

The Weymouth Granite is a pink and grey, medium or coarse-grained hornblende-bearing biotite granite or adamellite containing phenocrysts of pale pink or salmon-pink potash feldspar up to 2.5 cm long. Small rounded xenoliths of fine-grained granodiorite are common. Subordinate coarse leucocratic granite or alaskite and irregular patches and dykes of microgranite and aplite are present. The micro-granite is also pink or grey and crops out mainly near Sefton Creek on the western margin of the Mount Carter Block; dykes of microgranite and felsite invade the country rocks near the granite contact. The small masses of altered fine-grained porphyritic acid rocks intruding the Sefton Metamorphics in Temple Bay may be related to the earlier acid volcanics or may be associated with the granite.

The granite generally contains between 30 and 40 percent of anhedral quartz, but it ranges from 15 to 55 percent. The subhedral phenocrysts of microcline or orthoclase (13-53%) are weakly microperthitic in places. The microcline is mostly confined to the eastern part of the granite. The subhedral laths of oligoclase or sodic andesine (10-52%) are commonly rimmed with albite and partly altered to sericite and clay. The ratio of potash feldspar to plagioclase ranges from 2:1 to 1:1, and even the rocks which are classified as granite generally contain 20 to 30 percent plagioclase. The biotite (2-10%) is yellow-brown to dark brown, and in places is altered to chlorite and (rarely) epidote. Some specimens contain up to 3 percent of small subhedral dark green grains of hornblende, which in places forms aggregates with biotite. The accessories include small inclusions of zircon in biotite, and apatite, and a little allanite, sphene, and monazite. The monazite appears to be restricted to the granite in the Cape Direction area. Chemical analyses are given in Table 13.

Contact Effects

The Carboniferous or Permian acid volcanics have been thermally metamorphosed by the granite for a distance of several kilometres from the contact. In the least altered rocks there is a slight increase in the grainsize of the groundmass, due to recrystallization, but closer to the contact the volcanics have been converted into massive biotite-quartz-feldspar hornfels.

Between the Pascoe River and Bowden Hill the granite intrudes a belt of hybrid and granophyric rocks. The contact is complicated by the presence of numerous apophyses of granite in the older rocks, and by the presence of many large xenoliths of recrystallized volcanics and hybrid rocks within the granite. At the contact with the Kintore Adamellite in the Round Back Hills 10 km west of Portland Roads large lenses of biotite gneiss or foliated Kintore Adamellite occur within the Weymouth Granite. Similar lenses are present in the Weymouth Granite near Portland Roads.

Age

Lower Permian isotopic ages of 262 and 273 m.y. have been obtained on biotite from the Weymouth Granite near Portland Roads by the K/Ar method (Appendix 1: also Trail et al., 1969).

The close association between the Weymouth Granite and the Carboniferous or Permian acid volcanics and the associated high-level granophyric and hybrid rocks in the Iron Range district suggest that the granite may be co-magmatic with the volcanic rocks. If, however, the volcanics are similar in age to the Torres Strait Volcanics, that is, no younger than Upper Carboniferous, the Weymouth Granite is distinctly younger than the volcanic rocks.

Diorite

Distribution

Several plutons of diorite occur within or near the margin of the Weymouth Granite. The largest, at Ogilvie Hill 9 km southwest of Portland Roads, is 8 sq km in area. Other intrusions crop out near Ham Hill, 9 km northeast of Iron Range airstrip, on the Kennedy Road 3 km east of Mount Tozer, and near Sefton Creek, 18 km and 22 km east of Wenlock. The Diorite crops out as small rounded boulders and weathers to a darker soil than the adjacent granite.

Lithology and Relationships

The diorite is dark grey or bluish black, and generally medium-grained. It ranges from quartz-biotite-hornblende diorite to hornblende-biotite tonalite.

The laths of sodic andesine (40-60%) are partly altered to sericite. The larger grains may be zoned, and ophitic intergrowths with hornbelnde are common. Hornblende forms 30 to 40 percent of the diorite and 5 to 15 percent of the tonalite; the pale brownish green subhedral grains are poikilitic in places. Biotite forms 5 to 10 percent of the quartz diorite and 10 to 15 percent of the tonalite. The mica is generally intimately associated with hornblende; it is pleochroic from red-brown to dark brown and is partly altered to chlorite and occasionally to zoisite or clinozoisite. Interstitial quartz forms up to 10 percent of the diorite and 10 to 15 percent of the tonalite. The rock contains small grains of opaque minerals, and a little potash feldspar is also probably present. Chemical analyses are given in Table 13.

The relationship of the diorite to the Weymouth Granite has not been established. The presence of many large xenoliths of diorite in the granite near Portland Roads and Cape Weymouth suggests that the diorite is older than the Weymouth Granite, though a product of the same intrusive episode.

Granophyric and Hybrid Intrusives

Distribution

Two belts of granophyric and hybrid intrusive rocks are exposed along the western margin of the main body of the Weymouth Granite. The southern belt extends from near Sefton Creek to Bowden Hill and is from 2 to 5 km wide and 65 sq km in area (Fig. 20). The rocks intrude the Proterozoic or Devonian Kintore Adamellite and the Carboniferous or Permian Janet Ranges Volcanics, and are intruded in the east by the Permain Weymouth Granite. Three small hybrid intrusions occur in the Janet Ranges Volcanics northeast of Bowden Hill near Garraway Creek; another crops out near the northern end of the Jacky Jacky Range. The northern belt has an area of about 60 sq km; it extends for about 22 km north of the Pascoe River, from the Goddard Hills to Fair Cape. In the west the hybrid rocks intrude the Kangaroo River Volcanics and Janet Ranges Volcanics, and in the east they appear to be intruded by the Weymouth Granite.

Lithology

The fine-grained granodiorite or adamellite in the southern belt contains small clots of ferromagnesian minerals, which suggests a hybrid origin. The hybrid character of the rocks becomes progressively less evident to the north as the texture becomes more granophyric. From the headwaters of Nichol Creek north to the Pascoe River the hybrid rocks consist predominantly of grey biotite-hornblende microadamellite or microgranodiorite which are slightly coarser in places. North of the headwaters of One Mile Creek the hybrid rocks consist of pink and grey granophyric hornblende-biotite microadamellite.

The grey biotite-hornblende rock is massive and fine to medium-grained; it contains rare phenocrysts of plagioclase, and has a characteristic clotted texture. In some exposures it is difficult to distinguish from the recrystallized Janet Ranges Volcanics, which it intrudes. The pink and grey hornblende-biotite microadamellite generally contains small white feldspar phenocrysts, and is mottled with greenish black clots of dark minerals up to 1 cm across. The relationship between the two types is not known. Throughout the belt, especially near Bowden Hill, both types contain numerous small partly assimilated xenoliths of recrystallized volcanics.

Between the Goddard Hills and Fair Cape the northern belt consists entirely of granophyric alkali granite. The rock is greenish grey and weathers pink or red, and is sparsely mottled with light green mafic minerals. The granite is massive, even-grained, and medium or coarse-grained. The granite is well jointed and commonly contains numerous quartz veins from 1 to 5 cm wide. The most prominent joints strike 160°, and between 60° and 80°. The contact between the alkali granite and the Kangaroo River Volcanics is sharp. In the contact zone, which ranges in width from 5 to 15 m, the thermally metamorphosed volcanics are intruded by veins of pink microgranite and tourmaline-quartz-feldspar pegmatite. The tourmaline-bearing pegmatite may be the source of the small amounts of cassiterite found in the alluvium near the contact. A little pyrite (?) is present in the joints in the granite near the contact. In the east the Weymouth Granite probably intrudes the granophyric alkali granite, but the contact was not examined.

The hybrid rocks range in texture from granitic or microgranitic to granophyric or micrographic. Laths of oligoclase occurs as small phenocrysts and as grains in the matrix. They are subhedral to euhedral, well zoned and twinned; some of the crystals have cores of andesine and many have irregular overgrowths of alkali feldspar. The plagioclase is probably a high-temperature form. A few anhedral albite phenocrysts were seen in one specimen. The matrix is generally composed of quartz and potash feldspar, probably orthoclase, and commonly has a micropegmatitic, granophyric, or micrographic texture. Where the matrix is coarser in grain intergrowths are not so common, and the quartz tends to be subhedral and bipyramidal.

Green hornblende and dark brown biotite (10-15%) form diffuse aggregates or small clots up to 5 mm across. In the more sharply defined clots quartz and potash feldspar are generally absent. Hornblende is commonly partly altered to actinolite and dusty opaque minerals, and biotite to chlorite and epidote. Apatite is common in the mafic clots, and a few grains of clinopyroxene were noted in a specimen from near Garraway Creek. A little zircon, monazite, opaque minerals, and rare allanite are also present.

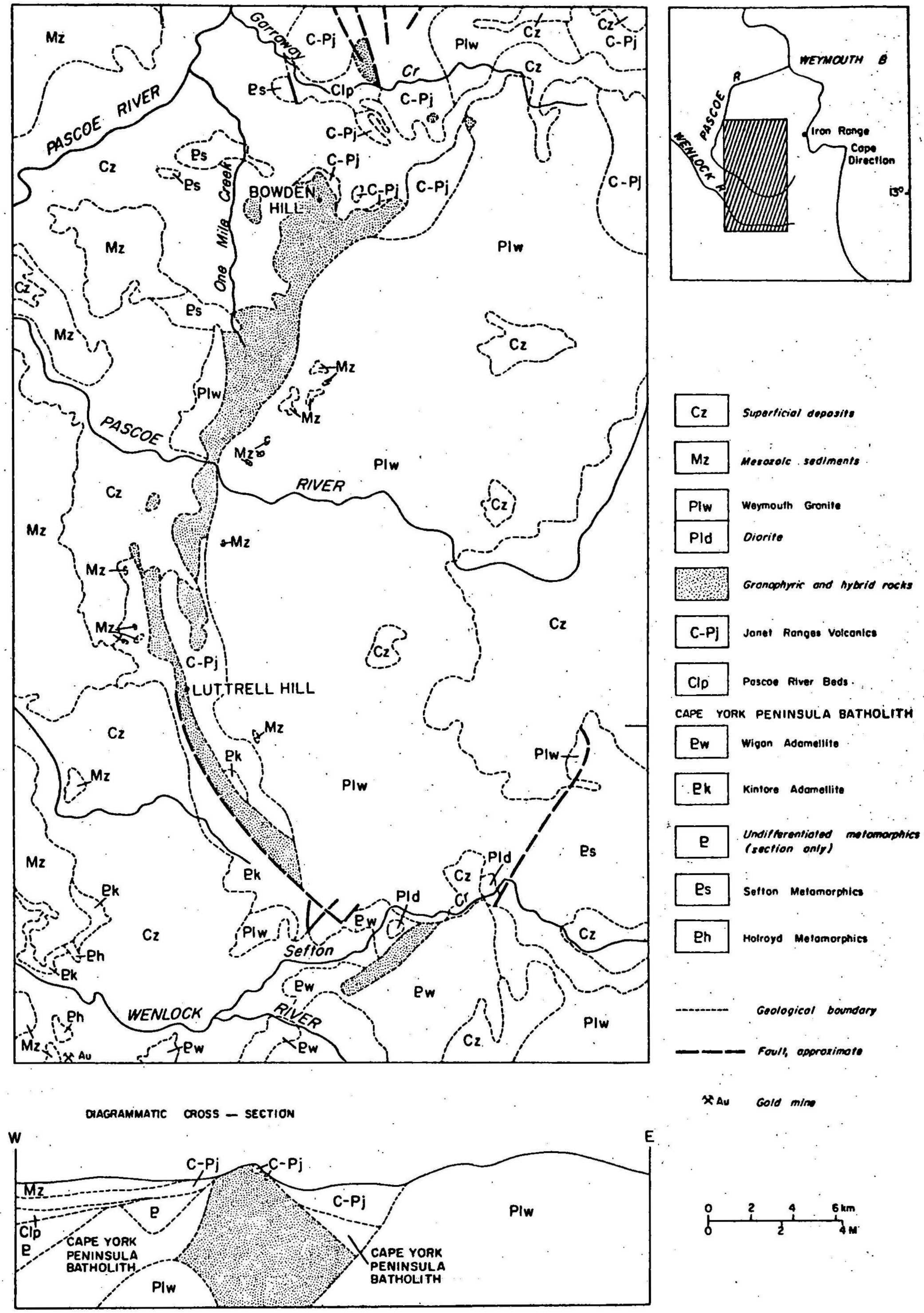


Fig. 24 Granophyric and hybrid rocks west of Iron Range.

The composition of the hybrid rocks changes from south to north: the quartz/potash feldspar matrix becomes more finely intergrown, the ratio of hornblende to biotite decreases from about 5:1 to 1:5, the mafic clots become smaller and more diffuse, and the degree of alteration of the mafic minerals and feldspar increases.

The alkali granite in the northern belt consists of a micrographic intergrowth of quartz and altered potash feldspar (probably orthoclase), and scattered crystals of oligoclase, commonly enclosed in potash feldspar. The small grains of biotite are largely altered to chlorite; a few flakes of muscovite are present. The euhedral grains are commonly embayed. Zircon, apatite, and opaque minerals are accessory. Chemical analyses are given in Table 13.

Genesis and Age

The granophyric and hybrid high-level intrusions are probably co-magmatic with the Carboniferous or Permian volcanics of the Iron Range district (Joplin, 1964, p. 183). In the south the texture is probably due to the assimilation of dioritic or more basic material. The juxtaposition of the granophyric and hybrid rocks and the Weymouth Granite, and the fact that the granite intrudes dioritic rocks in the east, suggest a close relationship between the hybrid rocks and the granite, and both may be related to the volcanics. However, the exact age of the volcanics is not known, and it is possible that the Weymouth Granite represents a later intrusive event.

Dolerite

An oval body of dolerite, about 2 sq km in area, intrudes the Kangaroo River Volcanics about 13 km south of Temple Bay, near the Kangaroo River. Similar dolerite or basalt crops out 8 km to the southwest, where it apparently intrudes the volcanics in a poorly defined ring structure.

The dolerite is a massive dark grey fine or medium-grained rock. It is cut by occasional thin veins of dark green fibrous chlorite, and in places the joints are coated with small crystals of pyrite(?). The dolerite is composed of euhedral laths of labradorite (55%), subophitic hypersthene (15%), clinopyroxene (10%), pale green-brown hornblende (10%), formed mainly by the alteration of pyroxene, and interstitial opaque minerals and quartz (5%). The dolerite may be related to the Carboniferous or Permian vulcanism, or to the Weymouth Granite, diorite, and hybrid and granophyric rocks.

An altered basic rock with a doleritic texture crops out on Pigeon Island and on a nearby headland on the mainland near the mouth of the Pascoe River. Two dolerite dykes intrude the Cape York Peninsula Batholith south of the Weymouth Granite and north of Geikie Creek, in the Coen Sheet area.

Wolverton Adamellite

(Whitaker & Willmott, 1969a)

Derivation of Name

The Wolverton Adamellite was named after the Parish of Wolverton.

Distribution

The adamellite crops out north and west of Bald Hill in the northern part of the Coen Sheet area. It is exposed over about 80 sq km but extends northwest under Mesozoic sandstones. The adamellite is fairly well exposed as small boulders and blocks, especially at the base of the Mesozoic cover rocks.

Lithology

The Wolverton Adamellite is a grey to pink fine to medium-grained massive well jointed leucocratic biotite adamellite or granite; some aplite or microgranite, which is granophyric in part, occurs towards its eastern margin. The medium-grained adamellite contains a few phenocrysts of potash feldspar up to 7 mm long. The main joints trend 140° to 150° and dip vertically, and the minor joints strike from 80° to 100°.

The leucocratic adamellite and granite are composed of quartz (30-35%), untwinned orthoclase(?) microperthite (35-43%), plagioclase (19-30%), and a little dark brown biotite, largely altered to chlorite. The leucocratic granophyric microgranite on the southeast margin consists of orthoclase(?) microperthite (50%), quartz (35%), and oligoclase (15%). A chemical analysis is given in Table 13.

The adamellite is cut by two or three large systems of quartz reefs trending between 140° and 150°. In the south the reefs swing round to between 170° and 180° and cut across the eastern margin of the adamellite where it is faulted against older rocks. The numerous small veins of transluscent quartz, which probably occupy tension cracks in the adamellite, constitute a second generation of quartz.

Age

The Wolverton Adamellite has not yet been dated isotopically, but several features suggest that it is related to the Lower Permian Weymouth Granite, which crops out 13 to 20 km to the northeast. Similar pink orthoclase-bearing granitic rocks are otherwise restricted to parts of the Weymouth Granite and the Twin Humps Adamellite, both of which are Permian. The microgranite within the Weymouth Granite near Sefton Creek is finer in grain but otherwise similar to the Wolverton Adamellite. The small body of pink porphyritic biotite granite near the northern margin of the Wolverton Adamellite is also similar to the Weymouth Granite.

Twin Humps Adamellite

(Whitaker & Willmott, 1969a)

Derivation of Name

The Twin Humps Adamellite was named after the Twin Humps, an isolated range 6 km northwest of Coen.

TABLE 13. CHEMICAL ANALYSES, UPPER PALAEOZOIC INTRUSIVE ROCKS FROM COEN/IRON RANGE DISTRICT

	1	2	3	4	5	6	7	8	9
SiO_2	73.83	71.87	74.40	59.79	47.54	70.57	76.21	76.83	70.90
Al_2O_3	14.00	14.76	13.45	16.67	17.81	14.15	12.63	12.78	13.87
Fe_2O_3*	2.13	2.41	2.18	7.75	10.93	4.09	1.19	1.28	3.18
MgO	0.51	0.76	0.31	4.73	7.69	0.75	0.20	0.34	1.19
CaO	1.81	2.00	0.86	7.36	11.43	2.26	0.44	0.83	2.49
Na_2O	3.89	3.23	4.03	2.21	1.48	3.69	4.21	3.60	3.15
K_2O	3.86	4.88	4.67	2.06	0.46	3.92	5.01	4.61	3.62
TiO_2	0.21	0.33	0.16	1.15	0.94	0.46	0.11	0.12	0.50
P_2O_5	0.07	0.12	0.02	0.16	0.10	0.13	0.02	0.05	0.13
MnO	0.05	0.05	0.06	0.13	0.16	0.07	0.02	0.05	0.05
Loss on ignition	0.41	0.59	0.56	1.13	0.45	0.21	00.28	0.38	0.53
Total+	100.36	100.41	100.14	102.01	98.54	100.09	100.04	100.49	99.08

* Total iron as Fe_2O_3

\+ Does not include loss on ignition

Weymouth Granite

1. Biotite granite, Restoration I. (BMR 67570042)
2. Biotite granite, 3 km SW of Portland Roads. (BMR 67570035)
3. Hornblende-biotite granite, Heming Ra. (BMR 67570036)

Diorite

4. Biotite-hornblende tonalite, on Kennedy Rd 5 km ENE of Mt Tozer. (BMR 68480199).
5. Hornblende diorite, 5 km SE of Ogilvie Hill. (BMR 68480198)

Granophyric and Hybrid Rocks

6. Hornblende-biotite granodiorite, on Kennedy Rd near crossing of Pascoe R. (BMR 68480196).
7. Leucocratic biotite granite, Stony Pt. (BMR 67570040).

Wolverton Adamellite

8. Biotite granite, 8 km WSW of Bald Hill. (BMR 68480194).

Twin Humps Adamellite

9. Hornblende-biotite granite or adamellite, 11 km NNW of Coen. (BMR 68480238).

Analysed by G.H. Berryman (BMR) by X-ray fluorescence method.

Distribution

The adamellite is exposed over about 130 sq km in the Twin Humps Range north of Coen, and as an easterly trending body in the McIlwraith Range east of Coen airstrip. It intrudes the Kintore Adamellite and Lankelly Adamellite of the Cape York Peninsula Batholith and the Coen Metamorphics. In the eastern extremity in the McIlwraith Range, where the adamellite is covered by rain forest, the boundary has been located by photo-interpretation. The Twin Humps Adamellite is well exposed as large rounded boulders and spalls. It is well jointed and has a distinctive pattern on the air-photographs, especially east of Coen airstrip.

Lithology

The typical medium or coarse-grained grey hornblende-biotite adamellite in the Twin Humps Range is generally even-grained, but in places contains phenocrysts of potash feldspar up to 1.5 cm long, set in a fine-grained biotite-rich groundmass. A chemical analysis is given in Table 13.

The subordinate pink variety is generally more variable in grain-size and composition than the grey adamellite, and contains more patches and cross-cutting bodies of quartz-feldspar pegmatite and aplite. The contact between the two types is gradational except on the west side of the range where the contact is sharp, but the relative age of the two types is not clear. The fine-grained pink leucocratic granite on the west and southwest flank of the range has a sharp contact with the grey adamellite, but it probably grades into the pink adamellite.

East of Coen airstrip pale pink leucocratic biotite adamellite or granite predominate. They are generally coarse-grained and even-grained, although small patches of quartz-feldspar pegmatite and cross-cutting pegmatite and aplite are common, especially in the north. The adamellite becomes progressively finer towards its southwestern contact with the Lankelly Adamellite, where it is cut by numerous veins of biotite-quartz-feldspar pegmatite.

In the Twin Humps Range the pink or grey hornblende-biotite adamellite is composed of anhedral phenocrysts of microcline microperthite, quartz, subhedral laths of oligoclase, slightly altered to sericite and clay, and up to 5 percent biotite and hornblende. Although the ratio of potash feldspar to plagioclase varies considerably the total feldspar content is constant at about 60 percent. A little allanite and zircon are also present. The marginal pink leucocratic granite in the Twin Humps Range contains a little biotite, but no hornblende or allanite.

The Twin Humps Adamellite east of Coen airstrip has a composition close to the adamellite-granite boundary. The rock contains orthoclase rather than microcline, and hornblende and allanite are absent. Two specimens have the following range in composition: quartz 35 to 38 percent, orthoclase 24 to 37 percent, plagioclase 22 to 36 percent, and biotite 3 to 5 percent.

The Lankelly Adamellite between the two bodies of Twin Humps Adamellite is intruded by a number of acid dykes, the largest of which forms the summit of Mount Croll a prominent hill east of Coen airstrip. The dykes are composed of light cream aphanitic rhyodacite(?) containing up to 20 percent small phenocrysts of quartz and potash feldspar, and a few crystals of plagioclase. The dykes are probably related to the Twin Humps Adamellite.

Age

The pink hornblende-biotite adamellite in The Twin Humps has been dated isotopically as early Upper Permian at 253 m.y. (Appendix 1; also Trail et al., 1969). The relationship between the Twin Humps Adamellite and the Permian intrusives farther north is uncertain. The adamellite may belong to the same intrusive episode as the Weymouth Granite, but its slightly younger isotopic age and the absence of volcanics may indicate that it belongs to a separate period of intrusion.

Olivine Nephelinite

A plug of olivine nephelinite about 2.5 km in diameter crops out near Balclutha Creek, 50 km southeast of Coen. The plug forms a hill about 15 m high surrounded by white residual sand which was probably derived from the underlying Coen Metamorphics. The nephelinite crops out as boulders up to 1.5 m across, but the contacts of the plug are not exposed. The BMR gravity map (Shirley in prep.) shows a prominent gravity high of + 45 mgal, between the Stewart River and Massey Creek, which may indicate the presence of other plugs. Dr D.O. Zimmerman (pers. comm.) has recorded an olivine nephelinite in the same region about 7 km west of Silver Plains homestead.

The nephelinite is a dark massive fine-grained rock composed of subidiomorphic scattered olivine phenocrysts (12%) between 0.1 and 5 mm across, set in a fine-grained groundmass of light green clinopyroxene laths (50%) up to 0.1 mm long, anhedral nepheline grains (10%), and small grains of opaque minerals (28%). The rock is generally very fresh, but some of the olivine may be altered to serpentine. A silicate analysis and CIPW norm are given in Table 14.

The nephelinite is possibly related to the ultra-alkaline lavas of the Cooktown district (Morgan, 1968b), and has been assigned a similar Cainozoic age.

Maer Volcanics

(Whitaker & Willmott, 1969b)

Derivation of Name

The name Maer Volcanics is taken from Maer Island, the largest of the Murray Islands 200 km northeast of Cape York. The volcanics were described previously but not named by Haddon, Sollas & Cole (1894) and Jardine (1928a, b).

TABLE 14. CHEMICAL ANALYSIS AND CIPW NORMS OF OLIVINE NEPHELINITE

				CIPW Norm
SiO_2	39.30	an		1.25
Al_2O_3	12.00	ne		27.00
Fe_2O_3	6.25	lc		1.60
FeO	7.50	kp		8.70
MgO	11.30	di	wo	18.90
CaO	11.30		en	16.30
Na_2O	5.10		fs	2.60
K_2O	2.80	ol	fo	10.40
H_2O^+	0.92		fa	1.65
H_2O^-	0.39	mt		6.30
CO_2	0.20	il		3.00
TiO_2	2.20	ap		1.60
P_2O_5	0.83	cc		0.60
MnO	0.15	H_2O		1.31
Total	100.24			

Analyst: A. Jorgensen, Australian Mineral Development Laboratories, Adelaide.

Distribution

The volcanics from the Murray Islands (Maer, Dauar, and Waier), Darnley Island, Stephens Island, the Black Rocks, and a small exposure at Bramble Cay, all in the northeastern part of Torres Strait. The calcareous tuff and tuffaceous sediments forming Daru Island in Papua were probably deposited at the same time as the Maer Volcanics, and have been included in them.

Physiography and Structure

The three Murray Islands (Fig. 25) consist of volcanic cones composed of tuff. Maer Island is an ash cone with an elliptical crater about 2.5 km long by 1 km wide. At the west end of the island the rim of the crater rises to a peak about 200 m high, known locally as Gelam. In the east, the rim of the crater is less than 60 m high and has been breached by basalt flows with an aggregate thickness of over 30 m. The basalt flows support dense tropical forest in contrast to the tuff of the crater which is covered with long grass. The dip of the tuffs increases outwards from 10° on the crest of the rim of the crater to about 30° around the coast of the island. Local dips up to 60° due to slumping have been recorded. About 1 km east of Gelam, a small central cone rises over 30 m from the floor of the crater. The cone is mainly covered by friable red soil which contains blocks of highly vesicular basalt, but horizontal coarse tuff or agglomerate crops out in the south. It lies near the apex of the triangular outcrop of basalt forming the eastern end of the island, and is possibly the vent from which the basalt was erupted.

Dauar Island is an ash cone about 1 km long and 180 m high. In the north and south the crater has been breached by the sea, and the island consists of a high western hill and a much lower eastern hill, separated by the thickly vegetated floor of the crater. The radial dips on Dauar Island range from 10° on the crest of the western hill to over 30° on the dip slopes in the western part of the island.

Waier Island represents the semicircular western half of an ash cone with a diameter of about 1 km. The eastern half of the cone was probably much lower in height because of the strong prevailing south-easterly winds, and has since been destroyed by the sea. In the preserved part of the cone the radial dips range from horizontal around the summit of the crater rim, to 30° or 40° on the outward flanks. On the steep slopes inside the rim, slumped blocks of tuff up to 50 m across dip inwards at up to 50°. On all three islands the highest parts of the crater rims are in the west, probably due to the prevailing south-easterly winds.

Darnley Island is a broad dome-shaped hill composed predominantly of basalt; it is about 5 km across and rises about 180 m above sea level. The island has been largely cleared of scrub and is now covered by grass up to 1 m high. In the south and southwest the dip slopes formed by the basalt flows slope gently to the south. On a ridge running south from the summit of the island two prominent steps, each between 10 and 15 m high may outline lava flows. The north side of the island is much steeper and has been dissected by two streams running down into the semicircular Treacherous Bay. In the small cliffs around the shores of the bay the basalt is underlain by bedded tuff dipping outwards at 10° to 20° from a point in the sea north of Treacherous Bay. This led Jardine (1928b) to believe the tuff formed the southern part of an ash cone.

Stephens Island is a small plateau of basalt about 2.5 km long and 30 m high covered by stunted tropical forest. The source of the basalt is unknown.

The Black Rocks protruding above a small reef flat about 8 km southwest of Bramble Cay are composed of coarse bedded tuff (Jardine, 1928a). The rocks are about 250 sq m in area and rise about 3 m above low tide level; they could not be visited during this survey because of the high seas breaking over them. Bramble Cay is a sand clay with two small exposures of basalt at the east end of the coral reef flat. The largest is crescentic and about 400 sq m in area. The rocks are about 3 m high and at high tide are almost submerged.

Daru Island is generally low and swampy, but has a central rise between 15 and 30 m high, formed by tuffaceous sediments, on which the town of Daru is situated. Best (1954) suggested that the tuffaceous material may have been ejected from a vent situated on the highest part of the rise near the north end of the island, but we feel that this hill is only a slightly higher prominence formed by the sediments.

Lithology

All three cones of the Murray Islands are composed of weathered yellow-brown bedded tuff, in which lapilli and small bombs of basalt, crystals of olivine and pyroxene, and round fragments of white limestone are set in a matrix of small fragments of altered brown basaltic glass. Beds of coarse tuff up to 60 cm thick alternate with and grade sharply into beds of medium-grained or fine-grained tuff which are generally several centimetres thick. Fine-grained beds up to 2 m thick generally predominate; lenses of coarse material to a few metres long, occur within the fine tuff. Cross-beds and scours were noted in places.

The bombs are composed of blocks of vesicular basalt up to 1 m across, but most of them are only a few centimetres across. Bombs are most abundant in the coarse-grained beds and some of them have distorted the beds for a few centimetres beneath them. The rounded fragments of limestone range up to several centimetres across. They are generally more abundant in the coarser beds, but on Maer Island at least they appear to be concentrated in particular beds which contain relatively few basalt fragments. The limestone is light grey with white patches of recrystallized material, and contains fragments of coral and molluscs.

There are a few thin beds of tuff on Maer Island which are almost entirely composed of weathered and well rounded brown lapilli. At Dauar Island the subhorizontal tuff cropping out within the crater is relatively rich in olivine and pyroxene crystals. In the tuff forming Waier Island some of the beds contain up to 30 percent of basaltic bombs. Limestone fragments are also more common on Waier Island.

The basalt which breaches the cone of Maer Island is a dark vesicular aphanitic rock with numerous olivine and pyroxene phenocrysts. The variation in the number of the phenocrysts in the coastal exposures suggests that several flows may be present.

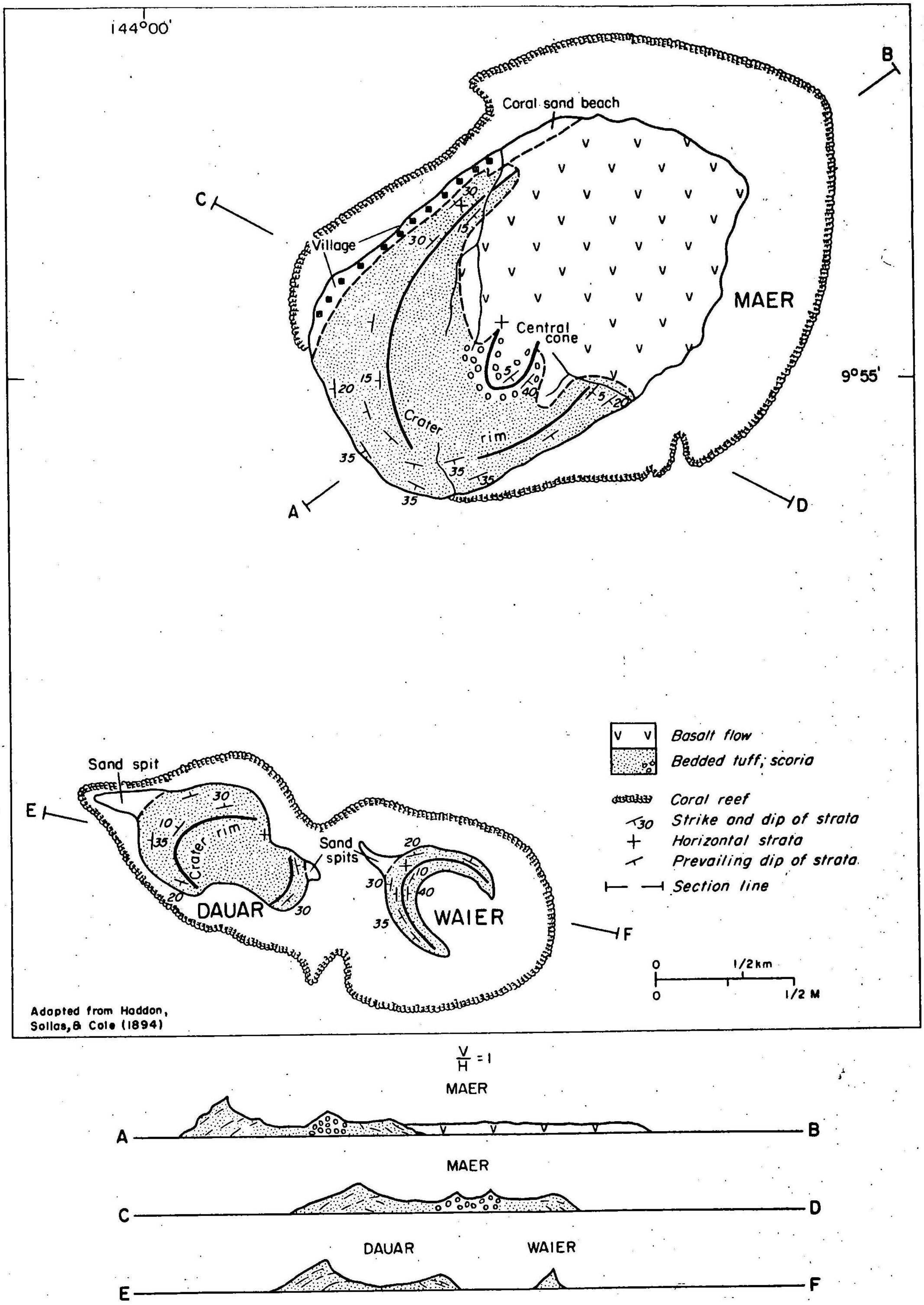


Fig. 25 Volcanic cones of the Murray Islands.

On Darnley Island at least 30 m of bedded tuff are exposed beneath the basalt in Treacherous Bay; the base is not exposed. The tuff is similar to the tuff of the Murray Islands, but limestone fragments and cross-beds and scours are more common. Some of the larger basalt bombs have deformed the underlying tuff beds for a few centimetres. The strike of the bedding is roughly parallel to the curved shore of Treacherous Bay.

The contact between the basalt and underlying tuff is well exposed around the shore of Treacherous Bay; in places the basalt rests directly on fresh tuff, in others they are separated by a layer about 30 cm thick of rounded cobbles and small boulders of basalt set in a sparse matrix of red clay. In one place a thin tongue of basalt has penetrated the tuff along a bedding plane.

The basalt contains abundant phenocrysts of olivine and pyroxene and some laths of plagioclase; nodules of olivine are present in places. The rocks are generally not as vesicular as those on Maer Island. The basalts are about 150 m thick. Few of the flows can be distinguished, although on the northern slopes of the island, the tops of two flows may be represented by glassy basalt containing large blocks of vesicular basalt and by a horizon of red earth. Towards the northeast the ridge of blue clay, which trends southeast across the island, may represent the weathered outcrop of a less resistant flow.

The basalt at Stephens Island is highly vesicular; the vesicles are up to 8 cm long, and of them many are partly filled by zeolites. The basalt contains more phenocrysts of plagioclase, in addition to olivine and augite, than those from basalt at Darnley and Maer Islands.

Jardine (1928a) describes the Black Rocks as coarse ash and tuff with a well developed banded structure. They are composed of fragments of decomposed olivine basalt set in a fine-grained matrix of olivine and augite crystals and calcareous material. The beds strike at 110° and dip southwest at 15°.

The larger of the two exposures at Bramble Cay consists of vesicular basalt resting on non-vesicular basalt containing pillow structures. A few of the pillows have concentric banding. The breccia described by Jardine consists of ferruginized and cemented blocks of basalt. The smaller exposure at Bramble Cay is a compact aggregate of rounded fragments of vesicular basalt.

The fine-grained tuffaceous sediments on Daru Island contain small rounded fragments of basalt and limestone set in a matrix of lapilli, smaller fragments of altered glass, and abundant calcite cement. The matrix also contains scattered grains of olivine, pyroxene, and iron oxide. McGregor (1967), when reporting on water wells and bores at Daru, notes that the tuffaceous sandstone is almost horizontal and ranges from 3 to 15 m thickness; the bottom of the sandstone was found up to 4 m below sea level and it is underlain by a thick layer of yellow or blue clay. The sediments encountered in the bores beneath the tuff are similar to Pliocene-Pleistocene sediments described by the Australasian Petroleum Co. (APC, 1961) from the Oriomo area in Papua.

Petrography

All the basalts contain abundant phenocrysts of olivine and augite; most are holocrystalline but some from the Murray Islands contain appreciable amounts of glass.

The basalts on Darnley Island contain about 10 percent euhedral or subhedral olivine phenocrysts about 2 mm across. The crystals are commonly partly or almost completely altered to deep red iddingsite, or rarely to serpentine. Pale brown augite (9%) forms large euhedral or subhedral crystals or clusters of crystals up to 4 mm across. Many of the crystals are twinned and some are faintly zoned. A few small phenocrysts of labradorite (3%) are present. The groundmass consists of small subparallel laths of sodic labradorite and granules of augite, olivine, and opaque minerals set in a matrix of plagioclase and alkali(?) feldspar. Some specimens contain small interstitial isotropic grains of analcite. Spherical vesicles are common; most of them are empty, but some are filled with calcite, while others have a narrow shell of green zeolite.

The basalt on Stephens Island contains up to 18 percent labradorite phenocrysts up to 3 mm long. The olivine and augite phenocrysts are smaller (2 mm) and slightly less abundant than in the basalt from Darnley Island. The groundmass is similar, but analcite is absent.

The basalt on Bramble Cay is similar to the basalt on Darnley Island, but broken fragments of olivine and augite crystals are present in addition to the large phenocrysts; granules of opaque minerals are also much more abundant in the groundmass at Bramble Cay.

The basalts on Maer Island contain fewer and smaller phenocrysts than those on Darnley Island. Augite is not nearly so common (3-4%), but olivine is more abundant (over 11%). The olivine is only rarely altered to iddingsite, and the augite is much paler in colour than at Darnley Island. The groundmass contains a little interstitial analcite. Spherical vesicles are particularly common, and in the more vesicular rocks the groundmass contains considerable amounts of reddish brown glass.

The basalt bombs in the tuff on Waier Island are similar in composition to the holocrystalline tuffs on Maer Island.

The tuffs from the Murray Islands and Darnley Island are composed mainly of fragments of highly vesicular glass altered to yellow palagonite. The fragments contain large phenocrysts of olivine and augite and some microlites of plagioclase. A few small crystals of brown hornblende are present in the glass fragments in the tuff from Dauar Island. Small rounded vesicles are common even in the smallest fragments, and many are filled with a colourless isotropic mineral, perhaps analcite. Fragments of highly vesicular basalt with a hypocrystalline groundmass are also common, and a few fragments of limestone are generally present. In the tuffs from the Murray Islands the limestone fragments contain shell debris and their margins only are recrystallized; the limestone fragments from Darnley Island are completely recrystallized.

TABLE 15. CHEMICAL ANALYSES OF MAER VOLCANICS

	1	2	3	4	5	6	7	8	9
SiO_2	50.70	51.50	50.00	50.5	49.80	50.40	50.70	50.10	49.40
Al_2O_3	15.50	15.60	14.30	14.6	14.10	14.80	14.70	14.50	14.80
Fe_2O_3	4.75	2.50	1.82	3.75	2.65	4.20	3.40	4.85	3.75
FeO	4.60	6.75	6.90	5.50	6.40	4.95	5.75	4.20	5.70
MgO	6.05	6.45	7.45	7.45	7.50	7.00	7.65	6.95	7.65
CaO	7.45	7.75	7.20	6.75	7.40	6.75	6.95	7.10	6.70
Na_2O	4.05	4.15	3.95	4.30	3.55	4.25	4.50	3.50	3.65
K_2O	1.67	1.64	2.85	3.35	2.55	2.70	2.80	3.00	2.60
$H_2O(+)$	1.08	0.38	0.83	0.39	1.13	0.93	0.31	1.40	1.58
$H_2O(-)$	0.82	0.28	1.07	0.35	1.52	0.75	0.35	1.27	0.98
CO_2	0.05	<0.05	0.35	<0.05	0.36	<0.05	<0.05	0.21	0.15
SO_3	0.54	-	0.10	-	-	-	-	-	-
TiO_2	2.10	2.15	2.25	2.30	2.20	2.25	2.20	2.20	2.15
P_2O_5	0.43	0.46	0.63	0.66	0.58	0.67	0.66	0.65	0.70
MnO	0.13	0.15	0.13	0.14	0.14	0.14	0.14	0.12	0.13
Total	99.92	99.82	99.83	100.09	99.87	99.84	100.16	100.05	99.94

CIPW Norms

		1	3	5	8	9
	or	9.87	16.84	15.07	17.72	15.36
	ab	34.25	29.00	30.02	29.60	30.87
	an	19.19	12.88	15.01	15.50	16.33
	ne	-	2.39	-	-	-
di	wo	6.11	6.89	6.53	6.12	4.76
	en	5.02	4.56	4.54	5.27	3.57
	fs	0.35	1.83	1.44	0.02	0.71
hy	en	9.50	-	2.49	6.20	2.69
	fs	0.67	-	0.79	0.03	0.54
ol	fo	0.39	9.80	8.16	4.09	8.96
	fa	0.03	4.34	2.85	0.02	1.98
	mt	6.89	2.64	3.84	7.03	5.44
	il	3.99	4.27	4.18	4.18	4.08
	ap	1.02	1.49	1.38	1.54	1.66
	cc	0.11	0.80	0.82	0.48	0.34
	H_2O	1.90	1.90	2.64	2.67	2.56
	Total	99.27	99.64	99.76	99.97	99.85

Table 15 continued

1. Stephens I. (BMR 68480169)
2. Stephens I. (BMR 68480176)
3. Darnley I., SW coast.(BMR 68480263)
4. Darnley I., SW corner. (BMR 68480175)
5. Darnley I., S coast. (BMR 68480173)
6. Darnley I., W coast. (BMR 68480260)
7. Darnley I., W coast. (BMR 68480261)
8. Darnley I., ridge E of summit. (BMR 68480259)
9. Darnley I., ridge E of summit. (BMR 68480299)

Analysts: C. Holland, A. Jorgenson, AMDL, Adelaide.

TABLE 16. CHEMICAL ANALYSES OF MAER VOLCANICS

	10	11	12	13	14	15	16	17	18	19
SiO_2	50.20	49.80	49.00	48.40	47.7	48.90	48.5	49.20	48.00	47.60
Al_2O_3	15.30	15.40	15.30	16.80	15.7	16.50	14.5	16.80	15.10	14.80
Fe_2O_3	2.20	2.70	2.25	3.05	2.20	1.84	1.80	2.20	2.00	2.35
FeO	6.90	6.65	7.05	5.60	6.35	6.60	7.95	6.35	8.00	7.55
MgO	7.40	7.10	8.35	6.70	8.20	6.80	9.65	6.70	8.55	8.80
CaO	7.20	7.20	7.35	6.35	6.95	6.35	7.65	6.40	7.85	8.15
Na_2O	4.65	4.70	4.05	4.15	3.95	4.45	3.95	5.10	4.05	4.30
K_2O	2.45	2.50	2.45	3.25	3.10	3.40	2.15	1.93	2.25	2.20
$H_2O(+)$	0.39	0.56	0.56	2.00	1.95	1.59	0.72	1.52	0.39	0.61
$H_2O(-)$	0.30	0.42	0.62	0.72	0.81	0.49	0.30	0.78	0.65	0.56
CO_2	0.06	0.05	0.10	0.01	<0.05	0.16	<0.05	0.09	0.13	0.03
SO_3	-	-	-	-	-	-	-	-	-	-
TiO_2	2.30	2.35	1.95	2.00	1.93	1.96	1.90	2.00	2.05	1.97
P_2O_5	0.64	0.71	0.71	0.77	0.74	0.75	0.67	0.79	0.74	0.68
MnO	0.13	0.13	0.15	0.14	0.15	0.14	0.16	0.14	0.16	0.16
Total	100.12	99.87	99.89	99.93	99.78	99.93	99.95	100.00	99.92	99.76

CIPW Norms

		10	11	12	13	15	17	18	19
	or	14.48	14.77	14.48	19.20	20.09	11.40	13.29	13.00
	ab	28.66	28.26	25.98	25.02	23.17	33.09	22.76	19.98
	an	13.65	13.55	16.34	17.62	15.01	17.26	16.38	14.59
	ne	5.78	6.23	4.43	5.46	7.84	5.44	6.23	8.88
di	wo	7.31	7.19	6.20	3.67	4.42	3.66	7.06	8.85
di	en	4.89	4.87	4.16	2.63	2.87	2.44	4.53	5.88
di	fs	1.87	1.77	1.57	0.70	1.25	0.95	2.06	2.33
hy	en	-	-	-	-	-	-	-	-
hy	fs	-	-	-	-	-	-	-	-
ol	fo	9.48	8.98	11.65	9.84	9.85	9.98	11.74	11.23
ol	fa	4.00	3.60	4.86	2.90	4.72	4.31	5.87	4.90
	mt	3.19	3.33	3.26	4.42	2.67	3.19	2.90	3.41
	il	4.37	4.46	3.70	3.80	3.72	3.80	3.89	3.74
	ap	1.52	1.68	1.68	1.83	1.78	1.87	1.75	1.61
	cc	0.14	0.11	0.23	0.02	0.36	0.20	0.30	0.07
	H_2O	0.69	0.98	1.18	2.72	2.08	2.30	1.04	1.17
Total		100.03	99.78	99.78	99.84	99.83	99.90	99.80	99.64

Table 16 continued

10. Bramble Cay. (BMR 68480168)
11. Bramble Cay. (BMR 68480293)
12. Maer I. SE coast. (BMR 68480286)
13. Maer I. NE coast. (BMR 68480253)
14. Maer I. NE coast. (BMR 68480329)
15. Maer I. NE coast. (BMR 68480254)
16. Maer I. N coast. (BMR 68480264)
17. Maer I. N coast. (BMR 68480255)
18. N. side of Waier I. Lava bombs in tuff. (BMR 68480247)
19. N, side of Waier I. Lava bombs in tuff. (BMR 68480291)

Analysts: C. Holland, A. Jorgenson, AMDL, Adelaide

LEGEND FOR FIGURES 26, 27, and 28.

- • Basaltic rocks of Maer Volcanics (numbers refer to analyses in Tables 15 and 16)
- o Basaltic rocks from Cooktown district (Morgan, 1968b)
- O Average of olivine basalts from Cairns hinterland (Morgan, 1968a)
- + Shoshonitic rocks from Central Highlands of Papua-New Guinea (Jakes and White, 1970)
- ⊡ Average olivine basalt (Nockolds, 1954)
- H Hawaiian alkali basalt trend: ob, olivine basalt; h, hawaiite; m, mugearite (Macdonald, 1949, Muir and Tilley, 1961).
- G Gough Island alkali basalt trend (Le Maitre, 1962)
- SH Shoshonite trend (from absarokite-shoshonite-banakite-quartz banakite series of Yellowstone Park, U.S.A., from Joplin, 1968b)
- S Skaergaard tholeiitic liquid series (Wager, 1960)
- K Kilauea tholeiitic rocks (Muir and Tilley, 1963)
- T Tasmanian tholeiitic trend (from Joplin, 1968b)
- CA Calc alkaline association (from Joplin, 1968b)
- M Boundary between alkali and tholeiitic fields (Macdonald and Katsura, 1964)
- N Boundary between mildly and strongly alkaline rocks (Saggerson and Williams, 1964)

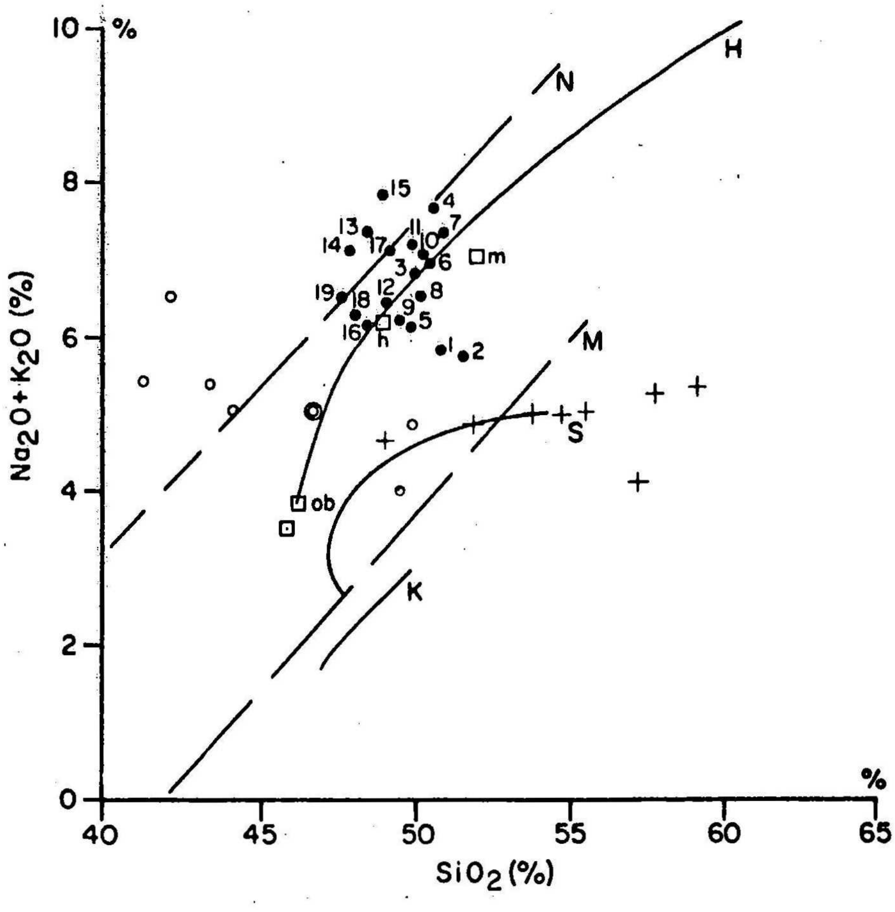


Fig. 26 $SiO_2 : Na_2O + K_2O$ for Maer Volcanics and other basalts.

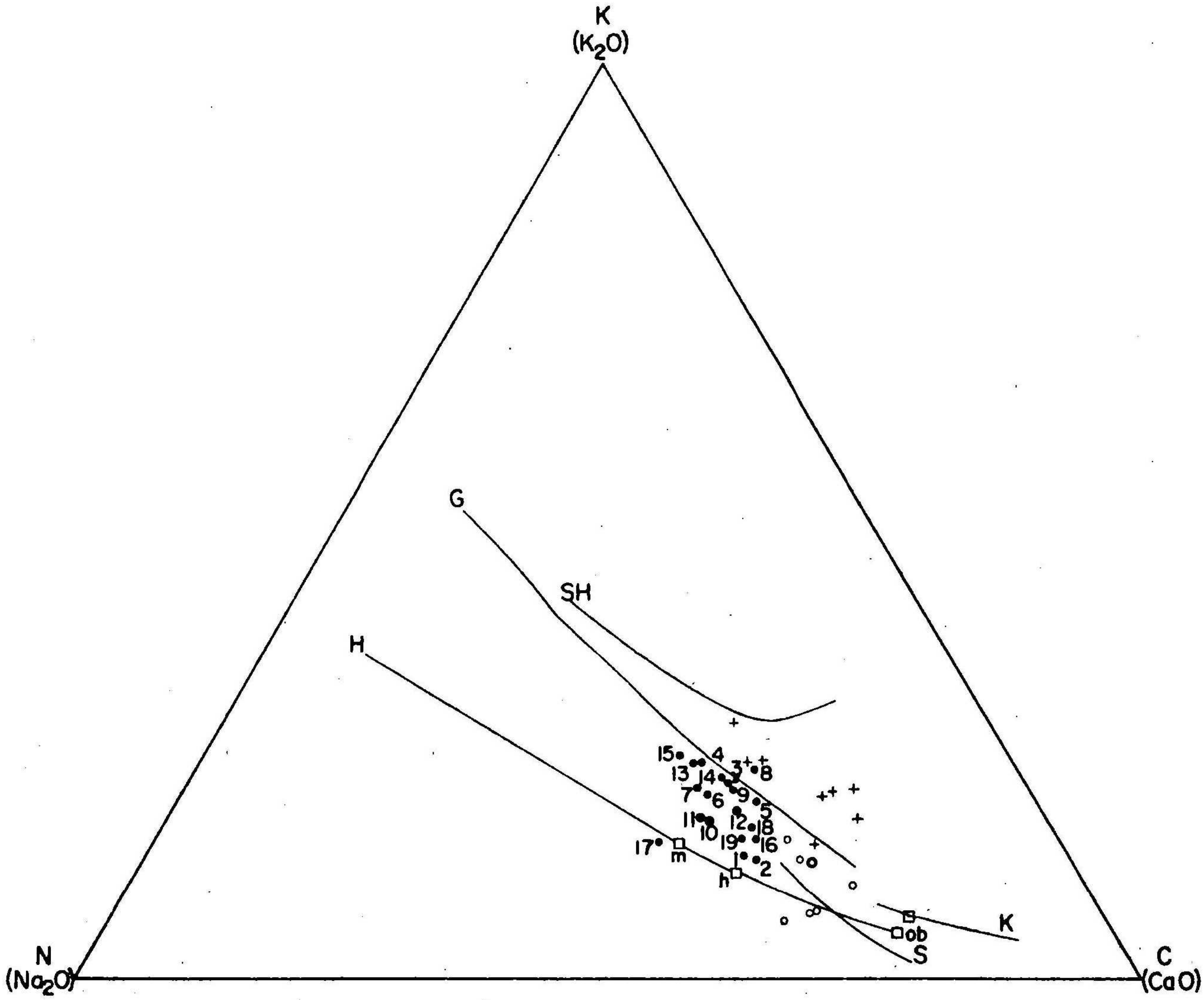


Fig. 27 KCN diagram, Maer Volcanics and other basalts.

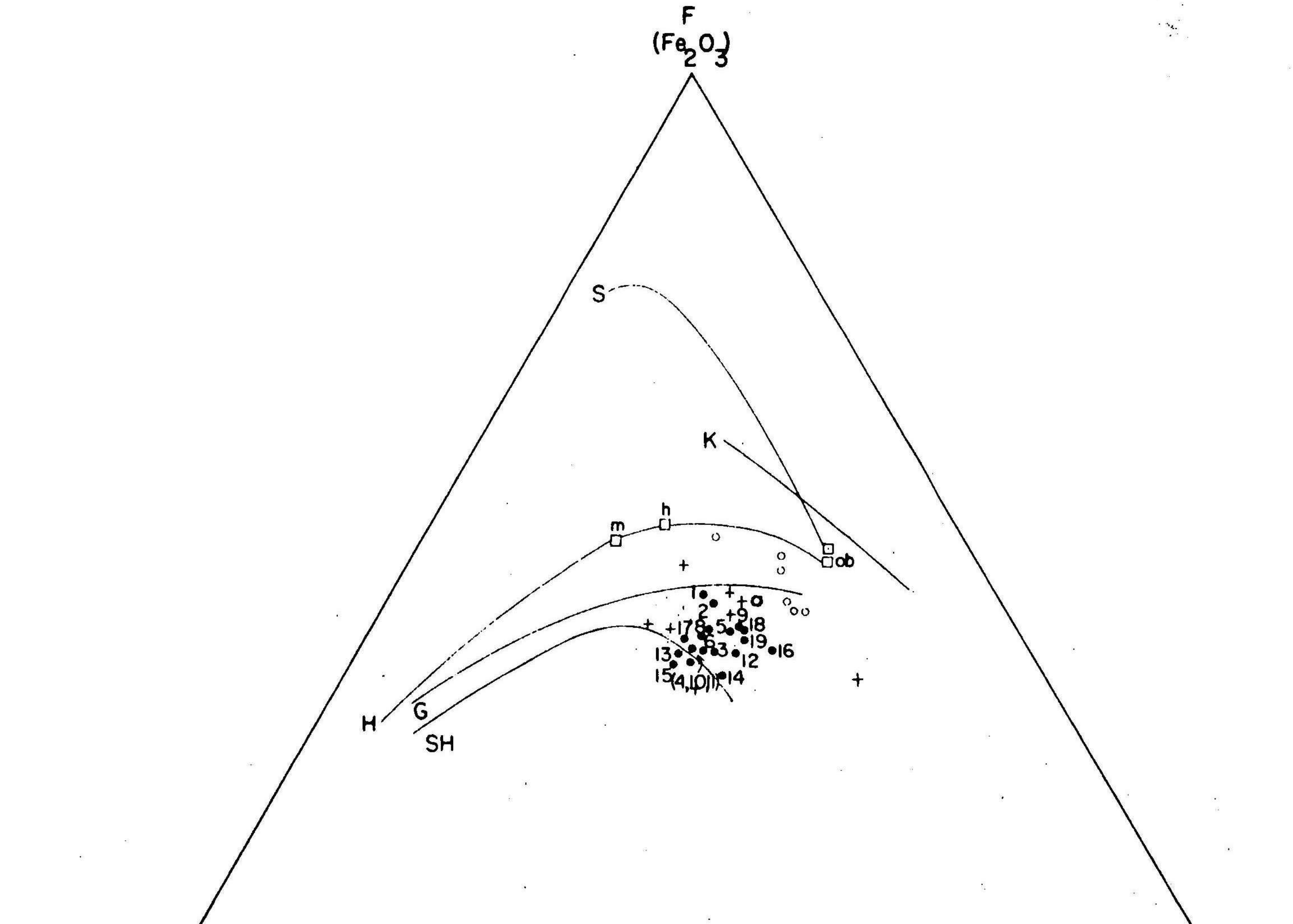


Fig. 28 FMA diagram, Maer Volcanics and other basalts.

The matrix of the tuffs (about 20%) is composed of very small fragments of glass, fragments of olivine and pyroxene crystals, granules of opaque minerals, and interstitial calcite and analcite.

The tuffaceous sediments at Daru are broadly similar to the tuffs described above, but glass and other fragments are less abundant. The groundmass, which forms 45 percent of the rock, is composed predominantly of calcite and analcite(?).

Chemistry

Chemical analyses of 19 samples of basalt from the various islands and CIPW norms of some are given in Tables 15 and 16; plots of the analyses are compared in Figures 26, 27, and 28.

The chemical composition of the basalts is somewhat unusual, and they do not compare closely with any of the well known basaltic magma types. On the SiO_2:Na_2O + K_2O diagram (Fig. 26) they plot between hawaiite and mugearite of the alkali-basalt association, but are richer in potash and magnesia and poorer in total iron (Figs. 27, 28). These features are characteristic of the potash-rich shoshonite association proposed by Joplin (1968), although in the Maer Volcanics they are less pronounced. Compared with volcanics of similar age to the north and south the Maer Volcanics are transitional between slightly potash-rich alkali basalts of the Cairns and Cooktown regions to the south (Morgan, 1968 a, b) and potash-rich basic and intermediate lavas of the Central Highlands of Papua-New Guinea, which Jakes & White (1970) have referred to the shoshonite association. The progressive increase in the potash content to the north may be related to changes in the tectonic environment towards the northern margin of the Australian craton.

REFERENCES

AAP (Australian Aquitaine Petroleum Pty Ltd), 1964 - An airborne magnetometer survey of Wenlock River (Cape York Peninsula) (unpubl.).

AAP, 1965 - Pascoe "B" - William Thompson. Field Rep. 12 (unpubl.).

AAP, 1967 - Final report on surrendering the permit, Authority to Prospect 95P (unpubl.).

AMOSEAS (American Overseas Petroleum Ltd), 1968 - Final report Warrior Reef seismic survey, AP 133P (unpubl.).

AMOSEAS, 1969 - Interpretation of airborne magnetometer Survey, Fly River, Papua (unpubl.).

AMOS, B.J., 1968 - The structure of the Palaeozoic sediments of the Mossman and Cooktown areas, north Queensland. J. geol. Soc. Aust., 15, 195-208.

AMOS, B.J., and de KEYSER, F., 1964 - Mossman, Qld - 1:250,000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes SE/55-1.

ANDERSEN, O., 1944 - Banks I. wolfram deposits. Qld Govt Min. J., 45, 215.

APC (Australasian Petroleum Co. Pty Ltd), 1961 - The geological results of petroleum exploration in western Papua. J. geol. Soc. Aust., 8 (1).

BALL, L.C., 1901 - Hamilton and Coen Goldfields. Qld Govt Min. J., 2, 358-64, 415-20. Also in Geol. Surv. Qld, Publ. 163.

BALL, C.W., 1943 - Morehead mica occurrence. Qld Govt Min. J., 44, 64-7.

BANKS, J.G., 1947 - Mining in Cape York Peninsula. Qld Govt Min. J., 48, 319-20.

BECK, J.G., 1935 - Cape York Peninsula fields. Qld Govt Min. J., 36, 379.

BEST, J.G., 1962 - Atherton, Qld - 1:250,000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes SE/55-5.

BEST, J.G., 1954 - Water investigation, Daru - Western District, Papua. Bur. Miner. Resour. Aust. tech. File PNG/SC 54-8 (unpubl.).

BHP (Broken Hill Pty Co. Ltd), 1962 - Final report on authority to prospect No. 86M, Cape York, Queensland. (unpubl.).

BLACK, L.P., 1969 - Isotopic relationships in the Chillagoe-Herberton area, north Queensland. Ph.D. thesis, Aust. Nat. Univ. (unpubl.).

BLAKE, D.H., and OLLIER, C.D., 1970 - Geomorphic evidence for Quaternary tectonics in southwestern Papua. Rev. Geomorph. dynam., 19, 28-32.

BRANCH, C.D., 1966 - Volcanic cauldrons, ring complexes, and associated granites of the Georgetown Inlier, Queensland. Bur. Miner. Resour. Aust. Bull. 76.

BRANCH, C.D., 1969 - Phanerozoic volcanic history of northern Queensland. Geol. Soc. Aust. spec. Publ., 2, 177-82.

BROADHURST, E., and RAYNER, E.O., 1937 - Claudie River gold and mineral field. Aer. Surv. N. Aust., Qld Rep. 12.

BRYAN, W.H., 1927 - Earlier palaeogeography of Queensland. Proc. Roy. Soc. Qld, 38, 79-102.

BRYAN, W.H., and JONES, O.A., 1946 - The geological history of Queensland, a stratigraphic outline. Univ. Qld Dep. Geol. Pap., 2(12).

BUDDINGTON, A.F., 1959 - Granite emplacement with special reference to North America. Bull. geol. Soc. Amer., 70, 671-747.

CAMERON, W.E., 1906 - Some goldfields of the Cape York Peninsula. II. The Alice River (Philp) Goldfield. III. The Hamilton Goldfield. Qld Govt Min. J., 7, 643-7. Also Geol. Surv. Qld Publ. 209a.

CANAVAN, F., 1965a - Iron ore deposits of Australia; in GEOLOGY OF AUSTRALIA ORE DEPOSITS. 8th Gwealth Min. metall. Cong., 1, 13-23.

CANAVAN, F., 1965b - Iron and manganese ore deposits of Iron Range. Ibid., 391-3.

CARPCO (Australasia Pty. Ltd), 1958 - Investigation of crude ore samples from the mining leases Barbaras Bar and Hollands Reef, Cape York (unpubl.).

CARTER, S.R., and PORTER, W.V., 1952 - Final report on Lockerbie tin prospecting area. Mt Isa Mines Ltd (unpubl.).

CHERRY, F.J., 1907a - Report on Cape York Peninsula goldfields. Qld Govt Min. J., 8, 430-1.

CHERRY, F.J., 1907b - Mining on the Archer and Pascoe Rivers, Cape York Peninsula. Ibid., 8, 431-3.

CGG (Compagnie Generale de Geophysique), 1965 - Archer River seismic and gravity survey. Aust. Aquitaine Petrol Pty Ltd, (unpubl.).

CGG, 1969 - Papuan Basin and basic belt aeromagnetic survey, Territory of Papua and New Guinea, 1967. Bur. Miner. Resour. Aust. Rec. 1969/58 (unpubl.).

CONNAH, T.H., 1951 - Wenlock Goldfield. Qld Govt Min. J., 52, 301.

COOKSON, I.C., and EISENACK, A., 1958 - Microplankton from Australian and New Guinea Upper Mesozoic sediments. Proc. Roy. Soc. Vic., 70(1), 19-78.

COOKSON, I.C., and EISENACK, A., 1960 - Upper Mesozoic microplankton from Australia and New Guinea. Palaeontology, 2(2), 243-61.

CORBETT REEF LTD, 1969 - Report on aeromagnetic survey, Corbett Reef, AP 127P (unpubl.).

CRESPIN, I., 1956 - Micropalaeontological examination of samples from Cape York Peninsula. Bur. Miner. Resour. Aust. Rec. 1956/1 (unpubl.).

CSIRO 1953 - Treatment of arsenical gold ore from the Peninsula Hope mine. Sci. ind. Res. Org. Melb., Ore Dress. Invest. 453.

DAVID, T.W.E., ed. BROWNE, W.R., 1950 - THE GEOLOGY OF THE COMMONWEALTH OF AUSTRALIA. 3 vols, London, Arnold.

DE KEYSER, F., 1963 - The Palmerville Fault - a fundamental structure in north Queensland. J. geol. Soc. Aust., 10, 273-8.

DE KEYSER, F., 1965 - The Barnard Metamorphics and their relation to the Barron River Metamorphics and the Hodgkinson Formation, north Queensland. Ibid., 12(1).

DE KEYSER, F., BAYLEY, M.B., and WOLFF, K.W., 1960 - The Chillagoe area; in THE GEOLOGY OF QUEENSLAND. Ibid., 7, 116-23.

DE KEYSER, F., and LUCAS, K.G., 1969 - Geology of the Hodgkinson Basin. Bur. Miner. Resour. Aust. Bull. 84.

DE KEYSER, F., and WOLFF, K.W., 1964 - The geology and mineral resources of the Chillagoe area. Bur. Miner. Resour. Aust. Bull. 70. Also Geol. Surv. Qld Publ. 317.

DELHI (Australian Petroleum Ltd), 1962 - Geophysical report of reconnaissance airborne magnetometer survey over Gulf of Carpentaria (unpubl.).

DICKIE, J., 1900 - Prospecting in the Gulf country. Qld Govt Min. J., 1, 165.

DICKIE, J., 1901 - Prospecting in the Gulf country. Ibid., 2, 384.

DICKIE, J., 1903 - Recent gold discovery in the north. Ibid, 4, 428.

DICKIE, J., 1905 - Prospecting in the Gulf country. Ibid., 6, 542.

DICKIE, J., 1909 - Prospecting in the Gulf country. Ibid., 10, 145.

EISENACK, A., and COOKSON, I.C., 1960 - Microplankton from Australian Lower Cretaceous sediments. Proc. Roy. Soc. Vic., 72(1), 1-11.

EVANS, P.R., 1966 - Contribution to the palynology of northern Queensland and Papua. Bur. Miner. Resour. Aust. Rec. 1966/198 (unpubl.).

FISHER, W.J., 1966 - The Wenlock Goldfield. Bull. Aust. Inst. Min. Metall., July 1966, 12-13.

FLEISCHMAN, K.R., 1953 - Inspection of the Lockerbie (Cape York) area and wolfram workings on Moa, Torres Strait. Qld Govt Min. J., 54, 933-7.

FLEMING, P.J.G., 1965 - Lower Cretaceous marine fossils from the Coen and Cape Weymouth 1:250,000 Sheet areas. Geol Surv. Qld file Rep. (unpubl.).

F-BH (Frome-Broken Hill Co. Pty Ltd), 1955 - Report on a reconnaissance aeromagnetic survey of the Gulf of Carpentaria area, Australia (unpubl.).

F-BH, 1957 - Reconnaissance gravity surveys in the Gulf of Carpentaria (unpubl.).

GALLOWAY, R.W., GUNN, R.H., and STOREY, R., 1970 - Lands of the Mitchell-Normanby area, Queensland. Sci. ind. Res. Org., Melb., Land Res. Ser., 26.

GIBSON, C.R., 1964 - Report on Nesbit River alluvial gold, N. Queensland, Clutha Development Co. (unpubl.).

GOODSPEED, M.J., and WILLIAMS, L.W., 1959 - Preliminary report on underwater gravity survey Great Barrier Reef area, Thursday Island to Rockhampton. Bur. Miner. Resour. Aust. Rec. 1959/70 (unpubl.).

GREEN, D.H., and RINGWOOD, A.E., 1967 - The genesis of basaltic magmas. Contr. Miner. Petrol., 15, 103-90.

GREENFIELD, W.H., 1911 - Sketch map of Cape York Peninsula gold and mineral fields. Geol. Surv. Qld Publ. 233.

GULF (Interstate Overseas Ltd), 1962 - Aerial magnetic report, authority to Prospect 88P (unpubl.).

GULF, 1965 - Final report seismic survey AP 88P Torres Strait, Princess Charlotte Bay, Queensland, Australia (unpubl.).

HADDON, A.C., SOLIAS, W.J., and COLE, G.A.J., 1894 - The geology of Torres Strait. Trans. Roy. Irish Acad., 30, 419-76.

HADLEY, B.A., 1934 - Report on inspection of Peninsula division. Qld Govt Min. J., 35, 389.

HANN, W., 1873a - Report from Mr W. Hann, leader of the northern expedition party. Votes Proc. Legis. Assem. Qld 1031-43.

HANN, W., 1873b - Copy of the diary of the northern expedition under the leadership of W. Hann. Ibid., 1045-70.

HARDING, R.R., 1969 - Catalogue of age determinations on Australian rocks, 1962-1965. Bur. Miner. Resour. Aust. Rep. 117.

HIETANEN, A., 1967 - On the facies series in various types of metamorphism. J. Geol., 75(2), 187-214.

HILL, D., 1956 - The geology of the Great Barrier Reef in relation to oil potential. Geol. Surv. Qld file Rep. (unpubl.).

HILL, D., and DENMEAD, A.K., eds, 1960 - THE GEOLOGY OF QUEENSLAND. J. geol. Soc. Aust., 7.

HOLTHOUSE, H., 1967 - RIVER OF GOLD. Sydney, Angus & Robertson.

HOPKINS, B., and REID, I.W., 1957 - Report of the prospecting party, Cape York Peninsula, 1957. Broken Hill Pty Co. Ltd (unpubl.).

HUGHES, K.K., 1962 - Report on Authority to Prospect 184M, Cape York area. New Consolidated Goldfields (A/sia) Pty Ltd (unpubl.).

JACK, R.L., 1881 - On exploration in Cape York Peninsula, 1879-1880. Geol. Surv. Qld Publ. 8.

JACK, R.L., 1888 - Annual progress report of the Government Geologist for 1887. Geol. Surv. Qld Publ. 41. Also in Ann. Rep. Dep. Min. Qld, 1887.

JACK, R.L., 1922 - NORTHMOST AUSTRALIA. Melbourne, Robertson.

JACKSON, C.F.V., 1902 - Report on a visit to the west coast of Cape York Peninsula and some islands of the Gulf of Carpentaria. Geol. Surv. Qld Publ. 180.

JACKSON, C.F.V., 1903 - West coast of Cape York Peninsula, and Horn Island and Possession Islands goldfields. Qld Govt Min. J., 4, 10-20.

JAKES, P., and WHITE, A.J.R., 1970 - Structure of the Melanesian arcs and correlation with distribution of magma types. Tectonophysics, 8, 223-36.

JARDINE, F., 1928a - Bramble Cay, Torres Strait - geological notes. Rep. Gt Barrier Reef Comm., 2, 93-100.

JARDINE, F., 1928b - Darnley Island - geological and topographical notes, Ibid., 2, 101-109.

JENSEN, H.I., 1923 - The geology of the Cairns hinterland and other parts of north Queensland. Geol. Surv. Qld Publ. 274.

JENSEN, H.I., 1940a - The Palmer River district. Aer. Surv. N. Aust. Qld Rep. 45.

JENSEN, H.I., 1940b - The Palmer River field. Ann. Rep. Aer. Surv. N. Aust. for 1939, 20-2.

JENSEN, H.I., 1964 - Sketch of the geology and physiography of Cape York. Qld geogr. J., 62, 12-60.

JOLLY, J.L., 1946 - Mining in Cape York Peninsula goldfields. Qld Govt Min. J., 47, 327-8.

JONES, L.S., 1949 - Peninsula inspection. Qld Govt Min. J., 50, 730.

JONES, L.S., 1951a - Banks Island and mainland, Cape York inspections, July, 1951, Ibid., 52, 722-6.

JONES, L.S., 1951b - Peninsula inspections, August, 1951. Ibid., 52, 980-7.

JONES, O.A., and JONES, J.B., 1956 - Notes on the geology of some north Queensland islands. Rep. Gt Barrier Reef Comm., 6, 31-54.

JOPLIN, G.A., 1964 - A PETROGRAPHY OF AUSTRALIAN IGNEOUS ROCKS. Sydney, Angus and Robertson.

JOPLIN, G.A., 1968a - A PETROGRAPHY OF AUSTRALIAN METAMORPHIC ROCKS. Sydney, Angus and Robertson.

JOPLIN, G.A., 1968b - The shoshonite association: a review. J. geol. Soc. Aust., 15, 275-94.

JUKES, J.B., 1847 - NARRATIVE OF THE SURVEYING VOYAGE OF H.M.S. FLY. London, Boone. Also Libraries Board of S. Aust. Facsimile Edn (in prep.).

KUNO, H., 1959 - Origin of Cenozoic petrographic provinces of Japan and surrounding areas. Bull. volc., 20, 37-76.

LADD, H.S., 1968 - Preliminary report on conservation and controlled exploitation of the Great Barrier Reef. Qld Dep. Min. file Rep. (unpubl.).

LEE, F., and FORSYTHE, D., 1961 - Report of the prospecting party, Cape York Peninsula, 1960. Broken Hill Pty Co. Ltd (unpubl.).

LE MAITRE, R.W., 1962 - Petrology of volcanic rocks, Gough Island, South Atlantic. Bull. geol. Soc. Amer., 73, 1309-40.

LUCAS, K.G., 1963 - Report of Laura Basin Party; in geological branch summary of activities - metalliferous section. Bur. Miner. Resour. Aust. Rec. 1963/146 (unpubl.).

LUCAS, K.G., and de KEYSER, F., 1965a - Cooktown, Qld - 1:250,000 Geological series. Bur. Miner. Resour. Aust. explan. Notes SD/55-13.

LUCAS, K.G., and de KEYSER, F., 1965b - Cape Melville, Qld - 1:250,000 Geological series. Ibid., SD/55-9.

MACDONALD, G.A., 1949 - Hawaiian petrographic province. Bull. geol. Soc. Amer., 60, 1541-96.

MACDONALD, G.A., and KATSURA, T., 1964 - Chemical composition of Hawaiian lavas. J. Petrol., 5, 82-133.

MACGILLIVRAY, J., 1852 - NARRATIVE OF THE VOYAGE OF H.M.S. RATTLESNAKE. London, Boone. Also Libraries Board of S. Aust. Facsimile Edn, 1967.

MACGREGOR, J.P., 1967 - Investigation for the town water supply for Daru, Western District, Papua. Bur. Miner. Resour. Aust. Rec. 1967/21 (unpubl.).

McKEAGUE, E.J., 1957 - Report on Lockerbie tin area, Cape York. Mineral Deposits Pty Ltd (unpubl.).

MAITLAND, A.G., 1892 - Geological observations in British New Guinea in 1891. Geol. Surv. Qld Publ. 85.

MARATHON (Petroleum Australia Ltd), 1963 - Marina Plains reflection seismograph survey (unpubl.).

MARATHON, 1965a - Sparkaray seismic survey, Gulf of Carpentaria (unpubl.).

MARATHON, 1965b - Final report, marine seismic survey, A to P 104P (unpubl.).

MARATHON, 1965c - Completion report, northeast Gulf of Carpentaria aeromagnetic survey, 1964-65 (unpubl.).

MARATHON, 1966 - Final report R-1 seismic survey AP 58P - Queensland (unpubl.).

MAXWELL, W.G.H., 1968 - ATLAS OF THE GREAT BARRIER REEF. Amsterdam, Elsevier.

MEYERS, N.A., 1969 - Carpentaria Basin. Geol. Surv. Qld Rep. 34.

MILLER, P.G., 1957 - Reports on authorities to prospect 63M and 116M. Comm. Alum. Co. Pty Ltd (unpubl.).

MINAD (Mines Administration Pty Ltd), 1965 - Final report, authority to prospect 61 (unpubl.).

MIYASHIRO, A., 1958 - Regional metamorphism of the Gosaisyo-Takanuki district in the central Abakuma Plateau. J. Fac. Sci. Univ. Tokyo, Sec. 2, 11, 219-72.

MIYASHIRO, A., 1961 - The evolution of metamorphic belts. J. Petrol., 2, 277-311.

MIYASHIRO, A., 1968 - Metamorphism of mafic rocks; in BASALTS, vol. 2, 799-834. N.Y., Interscience.

MORGAN, W.R., 1961 - The Carboniferous and Permo-Carboniferous igneous rocks of the Mossman 4-mile Sheet area, north Queensland. Bur. Miner. Resour. Aust. Rec. 1961/125 (unpubl.).

MORGAN, W.R., 1968a - The petrology of some Cainozoic basaltic rocks from the Atherton Tableland and Einasleigh-Mount Garnet areas, north Queensland. Proc. Roy. Soc. Qld, 80, 1-12.

MORGAN, W.R., 1968b - The geology and petrology of Cainozoic basaltic rocks in the Cooktown area, north Queensland. J. geol. Soc. Aust., 15, 65-78.

MORTON, C.C., 1924 - Geology and mineral occurrences, Pascoe River district. Qld Govt Min. J., 25, 78-83, 129-34.

MORTON, C.C., 1930 - Batavia River gold diggings. Ibid., 31, 452-5, 492-8.

MORTON, C.C., 1932 - Batavia River diggings. Ibid., 33, 257.

MUIR, I.D., and TILLEY, C.E., 1961 - Mugearites and their place in alkali igneous rock series. J. Geol., 69, 186-203.

MUIR, I.D., and TILLEY, C.E., 1963 - Contributions to the petrology of the Hawaiian basalts: II. The tholeiitic basalts of Mauna Loa and Kilauea. Amer. J. Sci., 261, 111-28.

NOCKOLDS, S.R., 1954 - Average chemical compositions of some igneous rocks. Bull. geol. Soc. Amer., 65, 1007-32.

OGILVIE, C., and WELLER, N.H.E., 1949 - Report on utilization of the water resources of the Torres Strait Islands. Qld Irrig. Water Supply Comm. Rep. (unpubl.).

OIL SEARCH (Ltd and Island Exploration Co. Pty Ltd), 1963 - Well completion report, Iamara No. 1. (unpubl.).

OIL SEARCH, 1964 - Well completion report, Mutare No. 1 (unpubl.).

OIL SEARCH, 1965 - Well completion report, Wuroi No. 1 (unpubl.).

OLIVER, R.L., 1961 - The Borrowdale Volcanics and associated rocks of the Scafell area, Lake District. Quart. J. geol. Soc. Long., 117, 377-418.

OPPEL, T.W., 1969 - Tenneco-Signal Anchor Cay Number 1, offshore Queensland. Well completion report. Tenneco Oil Co. (unpubl.).

PAINE, A.G.L., 1969 - Palaeovolcanology of central eastern Queensland. Geol. Soc. Aust. spec. Publ., 2, 183-92.

PATTERSON, O.D., 1957 - Report on authority to prospect 25M, Cape York, Olive River to Fly Point. Mineral Deposits Pty Ltd. (unpubl.).

PHILLIPS (Petroleum Co.), 1965 - Complete interpretation report, marine seismic reconnaissance survey, Gulf of Papua (Unpubl.).

PHILLIPS (Australian Oil Co.), 1968 - Final report marine seismic survey Gulf of Papua (Permit 42R-1) (unpubl.).

RANDS, W.A., 1896 - Report on the Horn Island goldfield. Geol. Surv. Qld Publ. 112.

RAYNER, E.O., 1937 - The Claudie River Gold and Mineral Field. Aer. Surv. N. Aust., Qld Rep. 30.

REID, I.W., 1959 - Report of the prospecting party, Cape York Peninsula, 1958. Broken Hill Pty Co. Ltd (unpubl.).

RICHARDS, H.C., and HEDLEY, C., 1925 - A geological reconnaissance in north Queensland. Trans. Roy. geogr. Soc. Aust., Qld Branch, 1, 1-28.

RICHARDS, J.R., WHITE, D.A., WEBB, A.W., and BRANCH, C.D., 1966 - Isotopic ages of acid igneous rock in the Cairns hinterland, north Queensland. Bur. Miner. Resour. Aust. Bull. 88.

RICHARDS, J.R., and WILLMOTT, W.F., 1970 - K/Ar age of biotites from Torres Strait. Aust. J. Sci. 32, 369-70.

RICKWOOD, F.K., 1968 - The geology of western Papua. APEA J., 1968, 51-61.

ROBERTON, G.S.T., 1959 - Cape York Peninsula, Inspector's Report, 1958. Qld Govt Min. J., 60, 136-8.

ROWELL, K.A., 1962 - Final report on authority to prospect 190M, Queensland. Broken Hill Pty Co. Ltd (unpubl.).

SAGGERSON, E.P., and WILLIAMS, L.A.J., 1964 - Ngurumanite from southern Kenya and its bearing on the origin of rocks on the northern Tanganyika alkaline district. J. Petrol., 5, 40-81.

SHEPHERD, S.R.L., 1938 - Hayes Creek Goldfield. Qld Govt. Min. J., 39, 336-8.

SHEPHERD, S.R.L., 1939 - Claudie River Goldfield. Ibid., 40, 6-13.

SHEPHERD, S.R.L., 1941 - Wenlock Goldfield. Ibid., 42, 259.

SHEPHERD, S.R.L., 1944 - Wolfram on Banks Island. Ibid., 45, 209-14.

SHEPPARD, R.T., and JOBLING, W.J., 1960 - Report of the prospecting party, Cape York Peninsula, 1959. Broken Hill Pty Co. Ltd (unpubl.).

SHIDO, F., 1958 - Plutonic and metamorphic rocks of the Nakoso and Iritono districts in the central Abakuma Plateau. J. Fac. Sci. Univ. Tokyo, Sec. 2, 11, 131-217.

SHIDO, F., and MIYASHIRO, A., 1959 - Hornblende of basic metamorphic rocks. Ibid., Sec. 2, 12, 85-102.

SHIRLEY, J.E., in prep. - Reconnaissance gravity survey, north Queensland, 1966. Bur. Miner. Resour. Aust. Rec.

SPRATT, R.N., 1958 - Pascoe River coal, Queensland. Consolidated Zinc Pty Ltd (unpubl.).

SPRATT, R.N., 1957 - Reconnaissance investigation of islands in Torres Strait, Queensland. Enterprise Exploration Co. Pty Ltd (unpubl.).

STACH, L.W., 1964 - Petroleum potentialities of the continental shelf between Cape York and southwestern Papua. APEA J., 1964, 68-73.

STOKES, J.L., 1846 - DISCOVERIES IN AUSTRALIA WITH AN ACCOUNT OF THE COASTS AND RIVERS EXPLORED AND SURVEYED DURING THE VOYAGE OF H.M.S. BEAGLE IN THE YEARS 1837-43. 2 vols. London, Boone.

TENNECO (Australia Inc.), 1967 - Final report, seismic and magnetic survey, northern Great Barrier Reef area AP 88P and 111P (unpubl.).

TENNECO, 1968 - Final report, northern Great Barrier Reef (AP 88P) detail, Triangle Reef (AP 134P) marine seismic survey (unpubl.).

TENNENT, D.C., 1964 - Report on authority to prospect 256M, Cape York Peninsula. Rep. for P.E. Gault Esq (unpubl.).

THOMPSON, J.E., 1967 - A geological history of eastern New Guinea. APEA J., 1967, 83-93.

TILLEY, C.E., 1950 - Some aspects of magmatic evolution. Quart. J. geol. Soc. Lond., 106, 37-61.

TRAIL, D.S., PONTIFEX, I.R., PALFREYMAN, W.D., WILLMOTT, W.F., and WHITAKER, W.G., 1968 - The igneous and metamorphic rocks of the southern part of Cape York Peninsula, Queensland. Bur. Miner. Resour. Aust. Rec. 1968/26 (unpubl.).

TRAIL, D.S. WILLMOTT, W.F., PALFREYMAN, W.D., SPARK, R.F., and WHITAKER, W.G., 1969 - The igneous and metamorphic rocks of the Coen and Cape Weymouth 1:250,000 Sheet area, Cape York Peninsula, Queensland. Ibid., 1969/64 (unpubl.).

TURNER, F.J., and VERHOOGEN, J., 1960 - IGNEOUS AND METAMORPHIC PETROLOGY. N.Y., McGraw-Hill.

TWIDALE, C.R., 1966 - Geomorphology of the Leichardt-Gilbert area, north-west Queensland. Sci. ind. Res. Org., Melb., Land Res. Ser. 16.

VIND, E.W., and HARWOOD, C.R., 1965 - Geophysical exploration in Torres Strait, APEA. J., 1965, 188-90.

WAGER, L.R., 1960 - The major element variation of the layered series of the Skaergaard intrusion and a re-estimation of the average composition of the hidden layered series and of the successive residual magmas. J. Petrol., 1, 364-498.

WALKOM, A.B., 1928 - Fossil plants from Plutoville, Cape York Peninsula. Proc. Linn. Soc. N.S.W., 53(2), 145-50.

WEBB, E.A., and FITZPATRICK, B.F., 1965 - Preliminary geological report on Cape York tin deposit. AP256M. Rep. for P.E. Gault Esq. (unpubl.).

WHITAKER, W.G., and WILLMOTT, W.F., 1968 - The nomenclature of the igneous and metamorphic rocks of Cape York Peninsula, Queensland. Pt 1 - the southern area. Qld Govt Min. J., 69, 345-55.

WHITAKER, W.G., and WILLMOTT, W.F., 1969a - The nomenclature of the igneous and metamorphic rocks of Cape York Peninsula, Queensland. Pt II - the Coen-Iron Range area. Ibid., 70, 130-42.

WHITAKER, W.G., and WILLMOTT, W.F., 1969b - The nomenclature of the igneous rocks of Torres Strait, Queensland. Ibid., 70, 530-6.

WHITCHER, I.G., 1966 - Drainage reconnaissance, Torres Strait Islands. C.R.A. Exploration Pty Ltd (unpubl.).

WHITE, D.A., 1965 - The geology of the Georgetown/Clarke River area, Queensland. Bur. Miner. Resour. Aust. Bull. 71.

WHITE, M.E., 1969 - Report on the 1967 collection of plant fossils from Cape York Peninsula. Bur. Miner. Resour. Aust. Rec. 1969/53 (unpubl.).

WHITEHOUSE, F.W., 1954 - The geology of the Queensland portion of the Great Australian Artesian Basin. Appendix G in ARTESIAN WATER SUPPLIES IN QUEENSLAND. Qld Dep. Co-ord. Gen. Public Works. Also in Qld parl. Pap. 1955, 2, 653-718.

WILLMOTT, W.F., PALFREYMAN, W.D., TRAIL, D.S., and WHITAKER, W.G., 1969 - The igneous rocks of Torres Strait, Queensland and Papua. Bur. Miner. Resour. Aust. Rec. 1969/119 (unpubl.).

WILSON, L.T., 1961 - Final report authority to prospect 157M. Cape York Tin Pty Ltd (unpubl.).

WINKLER, H.G.F., 1967 - PETROGENESIS OF METAMORPHIC ROCKS. 2nd Edn. Berlin, Springer-Verlag.

WOODS, J.T., 1961 - Mesozoic and Cainozoic sediments of the Wrotham Park area. Qld Govt Min. J., 62, 228-33.

ZIMMERMAN, D.O., 1969 - Final report on authority to prospect 519M, east coast, Cape York Queensland. Mid.East Minerals N.L. (unpubl.).

APPENDIX 1

ISOTOPIC AGE DETERMINATIONS, CAPE YORK PENINSULA

by

R. Bennett

Granitic and metamorphic rocks from Cape York Peninsula have been dated isotopically by both the K/Ar and Rb/Sr methods. The two sets of determinations were carried out at the Australian National University during 1968 and 1969 by A.W. Webb and Miss R. Bennett, of the Bureau of Mineral Resources. The majority of K/Ar results were given previously by Trail et al. (1969); they are repeated in Table A of this appendix. Additional K/Ar determinations carried out by J.R. Richards of the Australian National University are given in Table B. The Rb/Sr results are presented in Table C. The determinations of Rb and Sr values and Sr isotopic ratios were carried out by the isotopic dilution method described by Compston, Lovering, & Vernon (1965).

The K/Ar ages of micas from both the granitic rocks of the Cape York Peninsula Batholith and the surrounding metamorphic rocks strongly suggest an event during the Upper Devonian, which was originally interpreted as the intrusion of the batholith (Trail et al., 1969, appendix 1). The Devonian ages of the metamorphics were assumed to be minimum ages reflecting the approximate time of the intrusion of the adjacent igneous rocks.

The Rb/Sr total-rock data from regional sampling of the batholith produced a complex pattern on the isochron diagram, almost certainly due to initial Sr^{87}/Sr^{86} variation between samples (Fig. A). No definite isochron or isochrons can be recognized in the distribution of points, although the general trend suggests a late Precambrian rather than Devonian distribution. In addition a Devonian slope for any isochron would require an unusually high initial Sr^{87}/Sr^{86} ratio, especially for those samples enriched in radiogenic Sr, and this is considered unlikely. However, this isotopic pattern could also be related to partial digestion of older material by younger granitic rocks, and the suggestion of a Precambrian age remains tentative only.

The Rb/Sr total-rock data from regional sampling of the metamorphic rocks more strongly suggests at least one metamorphic event in the late Precambrian, although it is similarly inconclusive and no isochron can be drawn (Fig. B). To obtain more reliable Rb/Sr age determinations it will be necessary to re-sample the region on a more detailed basis, to restrict the variation of the initial Sr^{87}/Sr^{86} ratio for each proposed isochron. Several samples of chemically dissimilar specimens from a single outcrop will be needed to enforce this condition.

The K/Ar results could be interpreted as a resetting of the micas for K/Ar in older granitic and metamorphic rocks during a major Upper Devonian event of unknown origin, although this suggestion remains to be proved.

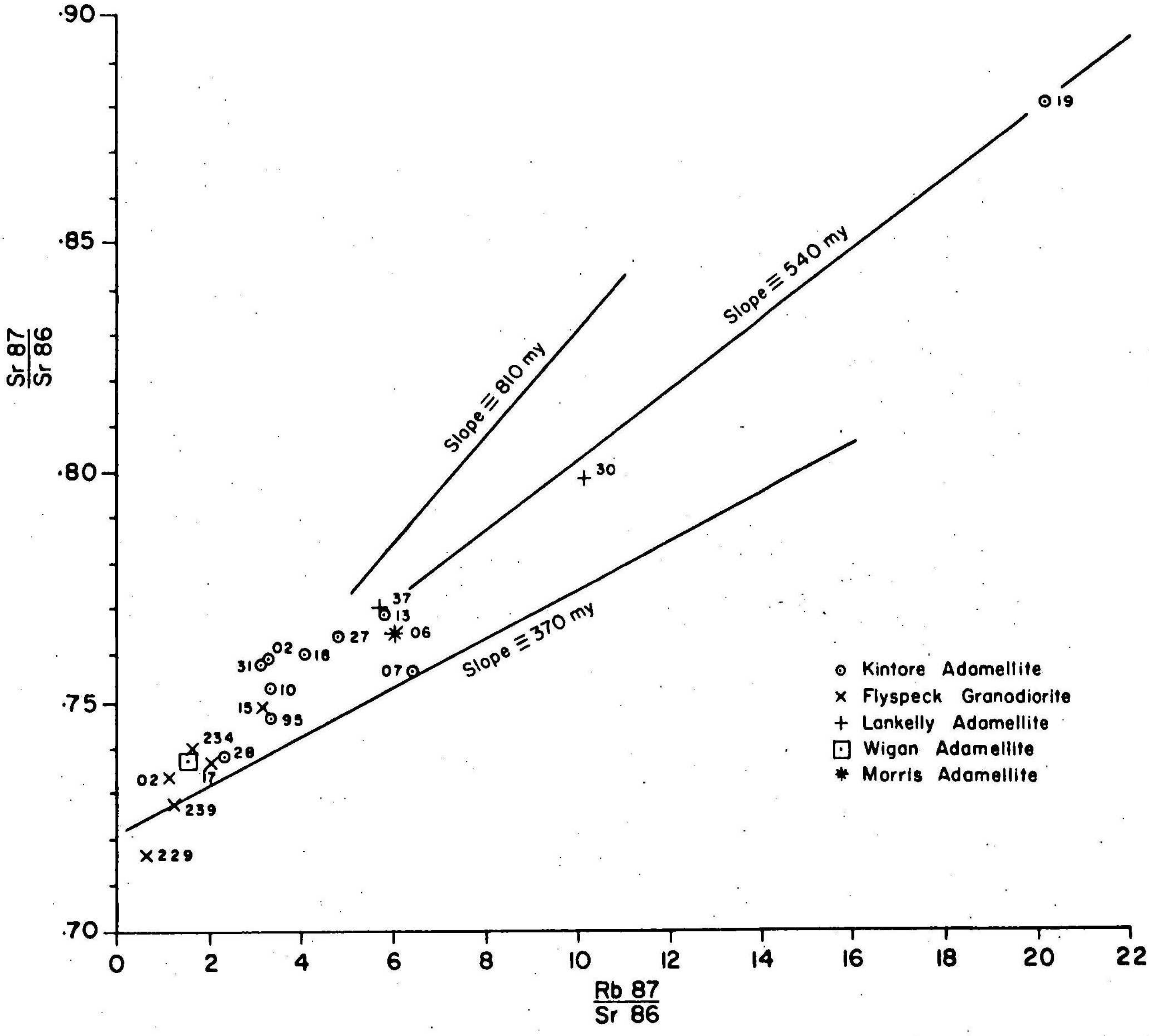
In addition to the Precambrian and Devonian ages determined above, Lower Permian ages between 262 and 273 m.y. have been obtained by the K/Ar method for the Weymouth Granite, near portland Roads, and an early Upper Permian age of 253 m.y. for the Twin Humps Adamellite, north of Coen. These are probably true ages, as the intrusions represent the last major igneous activity in the region, and the Weymouth Granite penetrates volcanic rocks that lie on Lower Carboniferous sediments.

References

COMPSTON, W., LOVERING, J.F., and VERNON, M.J., 1965 - The rubidium-strontium age of the Bishopville Aubrite and its component enstatite and feldspar. Geochim. Cosmochim. Acta, 29, 1085-99.

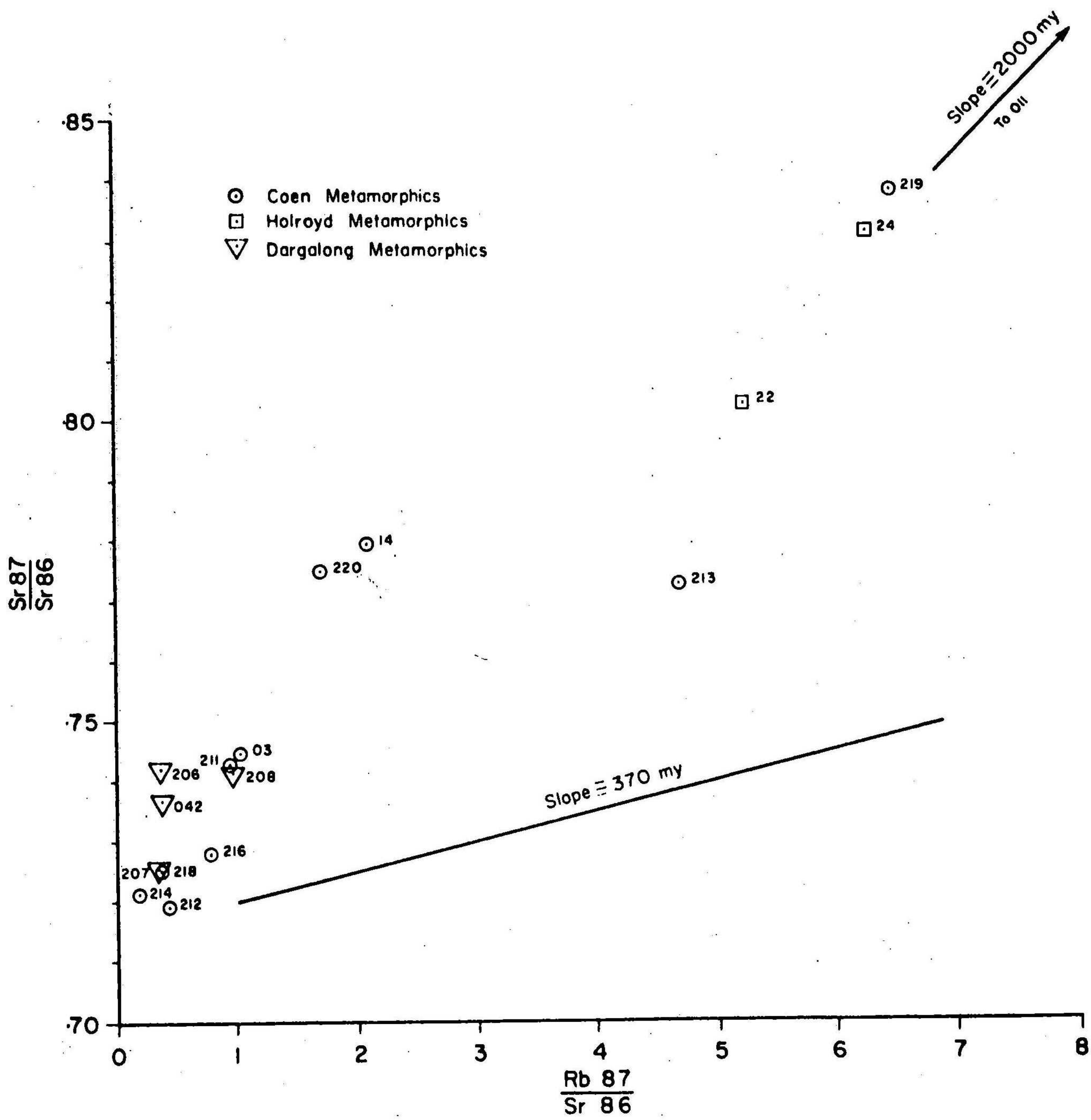
RICHARDS, J.R., WHITE, D.A., WEBB, A.W., and BRANCH, C.D., 1966 - Isotopic ages of acid igneous rocks in the Cairns hinterland, north Queensland. Bur. Miner. Resour. Aust. Bull. 88.

TRAIL, D.S., WILLMOTT, W.F., PALFREYMAN, W.D., SPARK, R.F., and WHITAKER, W.G., 1969 - The igneous and metamorphic rocks of the Coen and Cape Weymouth 1:250,000 Sheet areas, Cape York Peninsula, Queensland. Bur. Miner. Resour. Aust. Rec. 1969/64 (unpubl.).



Appendix I Fig. A $\frac{Rb}{Sr}$ isochrons for granitic rocks.

To accompany Record 1971/94 *M(Pt)91*



Appendix I Fig. B $\frac{Rb}{Sr}$ isochrons for metamorphic rocks.

TABLE A : K/Ar ANALYSES

ANU No.	BMR No.	Mineral	K (%)		$^{40}Ar^{*}/^{40}K$	^{40}Ar atm. (%)	Age (m.y.)
Cape York Peninsula Batholith							
Kintore Adamellite							
GA5723	66480463	Muscovite	8.869) 8.872)	8.87	0.02410	1.8	373
		Biotite	7.218) 7.212)	7.22	0.02385	12.0	370
GA5724	66480464	Muscovite	8.759) 8.719)	8.74	0.02423	0.8	375
		Biotite	6.385) 6.416)	6.40	0.02370	1.1	367
GA5745	67570010	Muscovite	8.746) 8.803)	8.77	0.02349	2.4	365
		Biotite	6.658) 6.695)	6.68	0.02297	1.3	357
GA5738	67570007	Muscovite	8.819) 8.797)	8.81	0.02481	13.9	383
		Biotite	6.967) 6.933)	6.95	0.02429	0.8	376
GA5739	67570008	Muscovite	8.925) 8.930)	8,93	0.02354	11.9	365
		Biotite	4.941) 4.978)	4.96	0.02236	3.0	348
Flyspeck Granodiorite							
GA5742	67570001	Biotite	7,748) 7.748)	7.75	0.02216	1.3	346
Lankelly Adamellite							
GA5744	67570009	Biotite	7.350) 7.310)	7.33	0.02204	2.8	344
Morris Adamellite							
GA5737	67570006	Biotite	7.174) 7.158)	7.17	0.02407	3.1	373
Metamorphic rocks							
GA5743	67570003	Biotite	7.698) 7.674)	7.69	0.02220	2.3	346
GA5746	67570014	Biotite	7.865) 7.819)	7,84	0.02312	1.1	359
GA5747	67570022	Biotite	7.721) 7.734)	7.73	0.02408	1.3	372

ANU No.	BMR No.	Mineral	K (%)		$^{40}Ar^{*}/^{40}K$	^{40}Ar atm. (%)	Age (m.y.)
Permian Intrusives							
Twin Humps Adamellite							
GA5736	67570005	Biotite	4.684) 4.710)	4.70	0.01580	2.4	253
Weymouth Granite							
GA5767	67570035	Biotite	7.143) 7.084)	7.11	0.01713	2.8	273
GA5768	67570042	Biotite	6.298) 6.290)	6.29	0.01641	5.8	262

TABLE B : K/Ar ANALYSES BY J.R. RICHARDS

ANU No.	BMR No.	Mineral	K (%)	Radiogenic ^{40}Ar (standard a.g. x 10^{-5})	Atm. Ar (%)	Age (m.y.)
Cape York Peninsula Batholith						
Aralba Adamellite						
69-773 (69-5941)	68480225	Biotite	7.59 ± .01	12.31	3.0	368 ± 4
69-774	68480228	(Biotite	7.66 ± .01	12.25	12.1	364 ± 4
		(Muscovite	9.34 ± .05	14.66	1.7	358 ± 8
				$^{40}Ar^{*}/^{40}K$		
Kintore Adamellite						
*GA 529	D 54121	(Biotite	6.65	(.02256 (.02317	2.1 1.4	351 360
		(Muscovite	8.84	.02401	6.3	372

* In Richards et al. (1966).

APPENDIX 2

ISOTOPIC AGE DETERMINATIONS, TORRES STRAIT

by

J.R. Richards

Isotopic ages obtained by the K/Ar method on biotites from four samples of the Badu Granite in Torres Strait were presented in Richards & Willmott (1970). The results are repeated in Table A below:

TABLE A

ANU No.	BMR No.	K (%)	Radiogenic ^{40}Ar (standard cc/g x 10^{-5})	Air Correction (%)	Age (m.y.)
69-770	68480132	$7.07_5 \pm 00_2$	8.95	4.2	294 ± 4
69-771	68480134	$6.66_6 \pm 03_5$	8.41	2.5	293 ± 5
69-772	68480177	$6.63_9 \pm 02_6$	8.68	1.8	302 ± 5
69-957	68480133	$7.05_5 \pm .02_7$	8.69	2.6	286 ± 3

The best estimate of the age of these granites is thus 294 ± 5 m.y., which falls in the Upper Carboniferous according to the Geological Society of London (1964).

References

GEOLOGICAL SOCIETY OF LONDON, 1964 - Phanerozoic time-scale, *Quart. J. geol. Soc. London*, 120S, 260.

RICHARDS, J.R., and WILLMOTT, W.F., 1970 - K-Ar age of biotites from Torres Strait. *Aust. J. Sci.*, 32, 369-70.

TABLE B: Rb/Sr ANALYSES

ANU No.	BMR No.	Rb (ppm)	Sr (ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}
Cape York Peninsula Batholith					
Kintore Adamellite					
GA5745	67570010	179	155	3.3621	0.7527
GA5778	67570013	261	130	5.8142	0.7681
GA5779	67570018	208	150	4.0407	0.7602
GA5780	67570019	236	34	20.2989	0.8810
GA5781	67570027	222	134	4.8188	0.7638
GA5782	67570028	160	200	2.3300	0.7380
69-5928	67570031	227	209	3.1568	0.7580
69-5932	67570007	320	145	6.430	0.7562
69-5942	68480202	225	199	3.2822	0.7589
69-5944	68480195	222	193	3.3429	0.7460
Flyspeck Granodiorite					
69-5930	67570017	161	232	2.004	0.7361
69-5931	67570015	191	174	3.1881	0.7483
69-5934	67570002	116	302	1.1139	0.7335
69-5937	68480239	161	384	1.2157	0.7278
69-5938	68480234	116	203	1.6625	0.7395
69-5939	68480229	78	340	0.6651	0.7166
Lankelly Adamellite					
69-5929	67570030	311	89	10.1485	0.7981
69-5936	68480237	262	132	5.746	0.7701
Wigan Adamellite					
69-5943	68480200	188	351	1.5451	0.7370
Morris Adamellite					
69-5933	67570006	308	147	6.0783	0.7643

TABLE B, Rb/Sr ANALYSES (cont.)

ANU No.	BMR No.	Rb (ppm)	Sr (ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}
Metamorphic Rocks					
Coen Metamorphics					
GA5743	67570003	105	300	1.0199	0.7441
GA5746	67570014	183	130	2.0779	0.7793
GA5949	68480211	70	212	0.9506	0.7427
GA5950	68480212	43	305	0.4090	0.7191
GA5951	68480213	146	91	4.6691	0.7724
GA5952	68480214	10	156	0.1942	0.7215
GA5953	68480216	30	116	0.7584	0.7279
GA5954	68480218	19	141	0.3828	0.7252
GA5955	68480219	170	78	6.4218	0.8382
GA5956	68480220	124	212	1.6975	0.7749
Holroyd Metamorphics					
GA5747	67570022	162	90	5.2141	0.8028
GA5791	67570024	197	93	6.2110	0.8314
GA5792	67570011	664	29	77.6754	2.3745
Dargalong Metamorphics					
69-5945	66480042	38	281	0.3894	0.7368
69-5946	68480206	44	356	0.3586	0.7421
69-5947	68480207	13	115	0.3383	0.7257
69-5948	68480208	76	226	0.9733	0.7419

APPENDIX 3

PLANT FOSSILS FROM THE PASCOE RIVER BEDS

by

Mary E. White*

Plant fossils were collected from two localities in the Pascoe River Beds by W.D. Palfreyman in 1967. At both localities elements of the same flora are present; Stigmaria ficoides Bgt., the root buttress of Lepidodendron, is associated with a species of Cardiopteris which shows diversity of pinnule form. A Lower Carboniferous age is suggested by the flora.

Locality 1: In Hamilton Creek; 6 km above its confluence with the Pascoe River and 35 km west of Portland Roads. Grid reference E6492 N33912 on the Cape Weymouth Sheet, SD54/4.

Fossil specimen numbers F22963-F22984; field numbers 67480476-67480495.

Two plant species are identified at locality 1. Stigmaria ficoides Bgt., the root buttress of Lepidodendron, is present in a number of specimens; specimen F22966 is illustrated in Figure B. The circular markings are attachment points for stigmarian roots which had a central vascular strand. This appears as a spot in the centre of the rootlet scar in many specimens. Among the stem-like impressions in the specimens are some smooth ribbon-like impressions which may have a median sulcus. These are impressions of stigmarian rootlets.

The other plant present in a species of Cardiopteris. The material consists of a great quantity of dissected leaf tissue impressions. Some specimens are almost a solid mass of plant impressions. Much of the leaf material is broken up into fragments of single pinnules and on first inspection the fragments appear to be referable to Rhacopteris. However there is diversity of pinnule type depending on the position of the pinnule on the pinna; furthermore the frond is a bipinnate one. This feature precludes it from Rhacopteris which is by definition once-pinnate with alternate, commonly overlapping flabelli-form pinnules which range from entire to deeply dissected.

Examples of pinnule type are illustrated in Figures A, C, D, and E. In Figure A is an example of a Cardiopteris type pinna. In Figure C are pinnules of Rhacopteris type. Figure D shows the bipinnate nature of the frond, and Figure E shows one Cardiopteris type frond and many pinnule fragments which look like Rhacopteris.

* 34 Beatty Street, Balgowlah, N.S.W.

There are many stem impressions in the material. Some of these show regular pitting of the surface with a pattern of horizontally elongated depressions. Others have fine vertical striation. Some, for example the forking stem in Figure A, show both pitting and striation, having different decortication levels. The ornamentation of the fork has a strongly psilophyte appearance. The stems are presumably referable to Cardiopteris sp.

Diversity of pinnule form is a well known phenomenon in Carboniferous plants of Cardiopteris type and it is difficult to classify plant fragments from the Carboniferous fern-like genera. A large collection showing the full range of variation of pinnule form as in the present case, is necessary before safe determination can be made; even then the choice of a generic name remains somewhat arbitrary. It has been suggested that the genus Ultopteris should be used for plants bearing both Rhacopteris and Cardiopteris pinnules. Positive identification to either of the other genera would take into account the bipinnate nature of the frond in Cardiopteris.

Cardiopteris in the form of examples of the most variable species Cardiopteris polymorpha Goeppert occurs in the Lower Carboniferous in Australia in abundance. C. Polymorpha is a much larger and more robust plant than the species under investigation. All pinnules and pinnae of the species are delicate and fern-like and the plant must have been very different in gross form from the substantial Cardiopteris polymorpha.

The range of Cardiopteris covers the Carboniferous period; it may be present in passage beds to Permian associated with Glossopteris. In view of evidence on a Glossopteris-Cardiopteris assemblage in Middle Carboniferous rocks (Richards, Morgan, & White, in press) there is reason to doubt its extension into Permian.

Locality 2: In Pascoe River, 2 km above its confluence with Hamilton Creek and 40 km west of Portland Roads. Grid reference E6473N33931, on the Cape Weymouth Sheet, SD54/4.

Fossil specimen numbers F22985-F22996; field numbers 67480496-67480507.

The specimens from locality 2 are poorly preserved. Most contain indeterminate plant remains in the form of stem impressions, minute branching filaments, and some macerated plant material. In specimens F22990 and F22992 are fragments of Cardiopteris sp. the same as at locality 1. Some of the stem-like impressions are probably Stigmarian roots. The specimens are of the same age as those at Locality 1.

Age: Plant evidence indicates a Carboniferous age for the fossil horizon.

Fig. A. Cardiopteris sp. Stems and pinnules. Specimen F22963

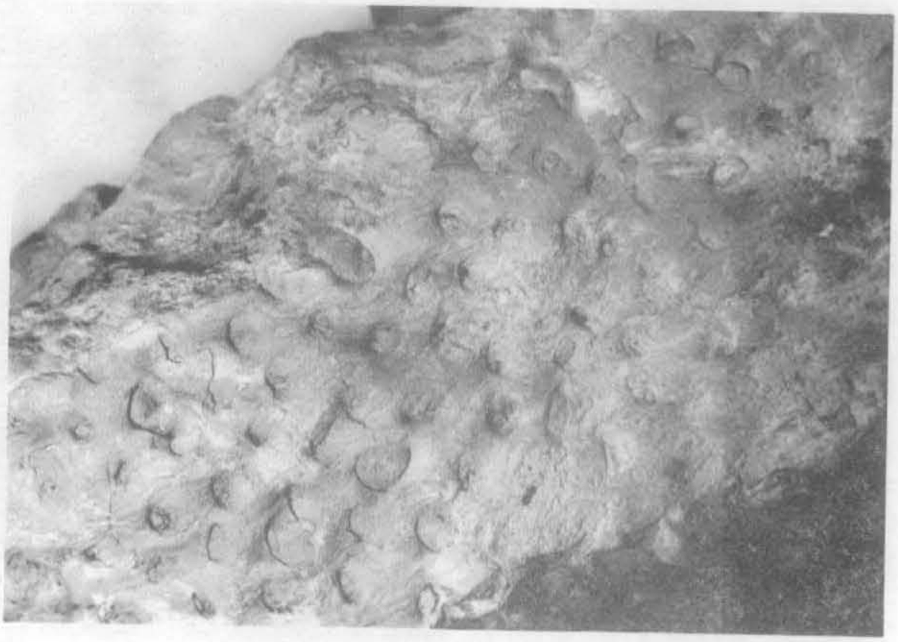


Fig. B. Stigmaria ficoides Bgt. Specimen F22966

Fig. C. Cardiopteris sp. Specimen F22969

Fig. D. Cardiopteris sp. Specimen F22970. Showing bipinnate nature of the frond. X2.

Fig. E. Cardiopteris sp. Specimen F22976

PRELIMINARY EDITION, 1970
SUBJECT TO AMENDMENT

IGNEOUS AND METAMORPHIC ROCKS

CAPE YORK PENINSULA AND TORRES STRAIT

QUEENSLAND AND PAPUA

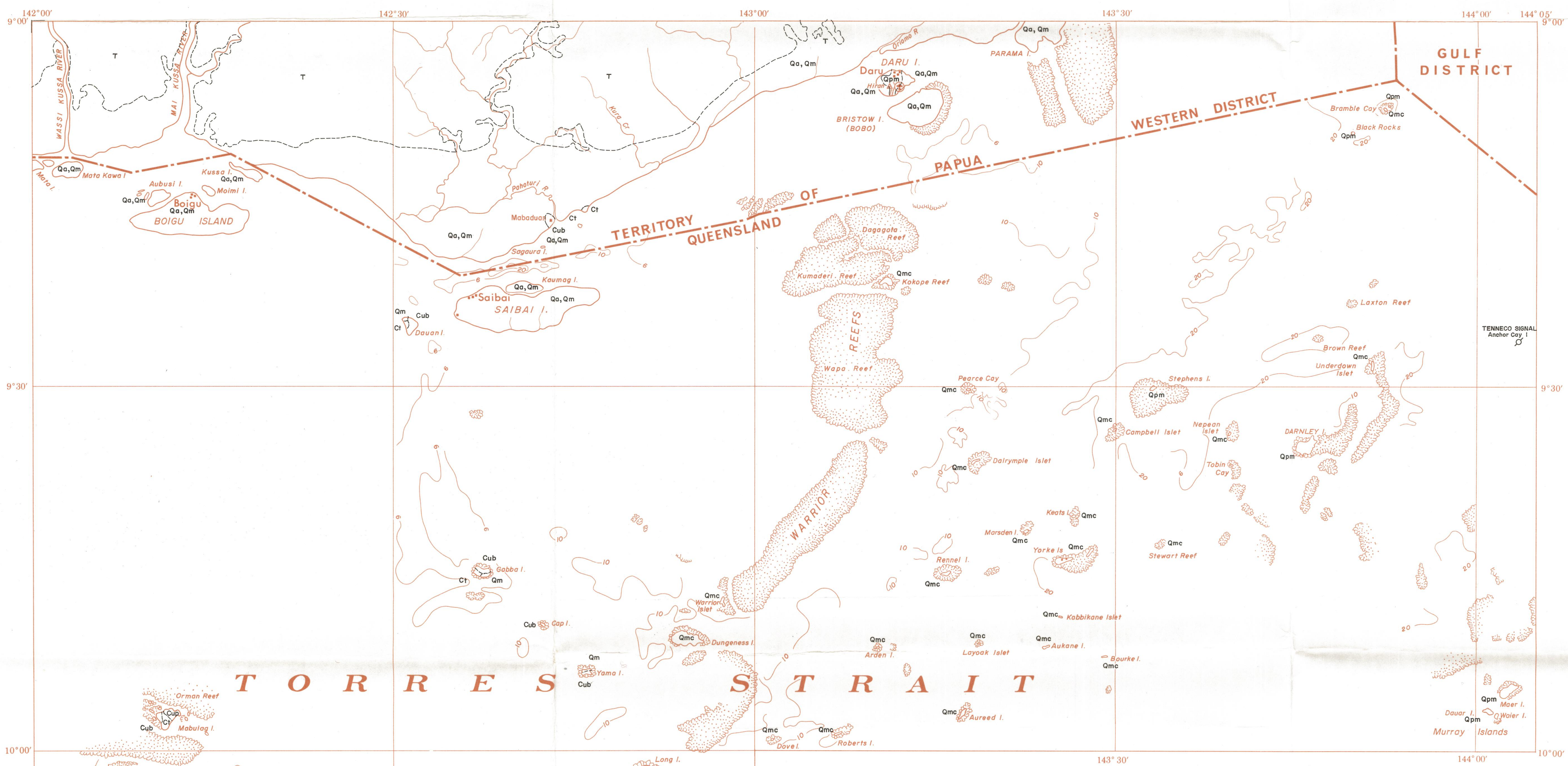
Scale 1:500,000

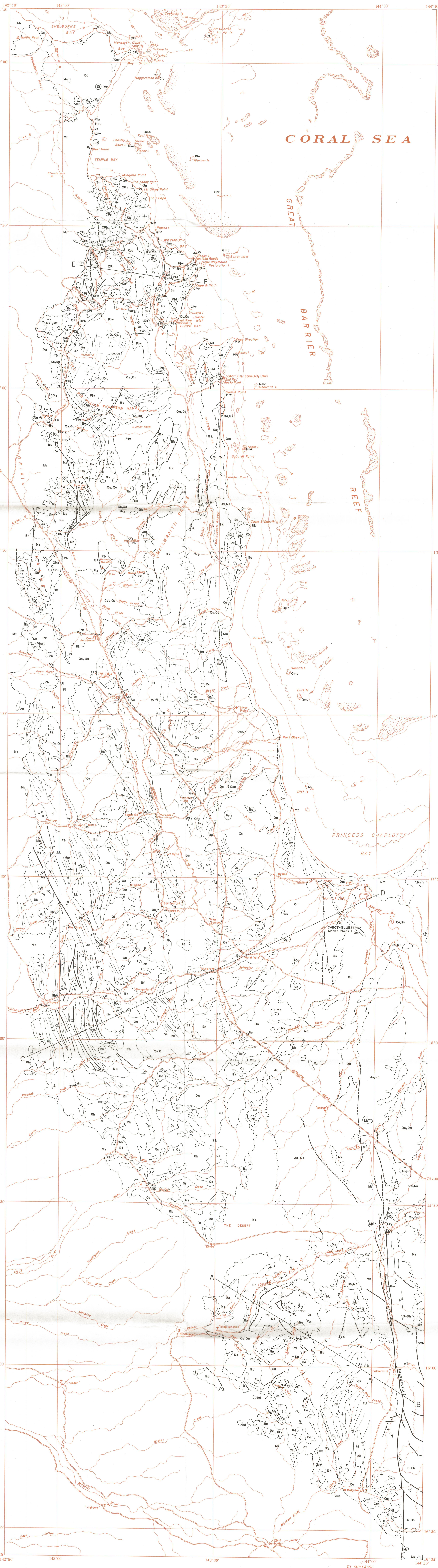
10 5 0 10 20 30 40 50 Kilometres

10 5 0 10 20 Miles

Compiled and published by the Bureau of Mineral Resources, Geology and Geophysics, in conjunction with the Geological Survey of Queensland. Issued under the authority of the Hon. R.W. Swartz, Minister for National Development

Geology, 1966–68 by D.S. Trail, W.F. Willmott, W.D. Palfreyman, I.R. Pontifex, R.F. Spark (B.M.R.)
W.G. Whitaker (G.S.Q.)
Compiled, 1969–70 by W.F. Willmott and I. Chertok
Cartography by Geological Branch, B.M.R.
Drawn, 1970 by I. Chertok





Reference

CAINOZOIC	QUATERNARY		Qm	Estuarine and coastal mud, beach sand; beach rock
			Qmc	Coral sand, shingle and beach rock
			Qd	Dune sand
			Qa	Alluvium, mainly silt
			Qs	Residual sand
	PLEISTOCENE	Maer Volcanics	Qpm	Basalt lava and tuff
	TERTIARY TO QUATERNARY	Yam Creek Beds	Cza	Poorly consolidated sandstone, some conglomerate
		Lilyvale Beds	Czy	Poorly consolidated sandstone and conglomerate
			Czn	Olivine nephelinite
	TERTIARY		T	Limestone, some mudstone, sandstone, conglomerate
MESOZOIC			Mz	Sandstone, conglomerate, siltstone
PALAEOZOIC	UPPER PERMIAN	Little River Coal Measures	Pur	Sandstone, shale, impure coal, limestone
		Twin Humps Adamellite	Put	Hornblende-biotite adamellite
	PERMIAN ?	Wolverton Adamellite	Pw	Leucocratic biotite adamellite and granite
	LOWER PERMIAN	Weymouth Granite	Plw	Biotite granite and adamellite, commonly porphyritic; some microgranite
			Pld	Biotite-hornblende diorite and tonalite
	LOWER CARBONIFEROUS TO LOWER PERMIAN		CPh	Granophyric and hybrid adamellite, granodiorite and granite
			CPo	Dolerite
		Cape Grenville Volcanics	CPc	Bedded volcanic breccia and tuff, welded tuff, rhyolite
		Kangaroo River Volcanics	CPk	Acid welded tuff, rhyolite, andesite; dacite ? and rhyodacite ? welded tuff
		Janet Ranges Volcanics	CPj	Rhyolite welded tuff, rhyolite, welded pumice-flow breccia; volcanic breccia, agglomerate; some hornfels
			CPv	Acid welded tuff, agglomerate; some andesite and meta-basalt
	UPPER CARBONIFEROUS		Cup	Porphyritic microgranite
		Badu Granite	Cub	Leucocratic biotite granite, porphyritic biotite granite and adamellite, hornblende-biotite adamellite and granodiorite
		Nychum Volcanics	Cun	Rhyolite welded tuff, andesite, basalt tuff, arkose, shale, coaly shale
	CARBONIFEROUS ?	Torres Strait Volcanics	Ct	Acid welded tuff, hornfels
		Muralug Ignimbrite	Cm	Grey rhyolite welded tuff; some rhyolite, volcanic breccia, and dacite ? welded tuff
		Goods Island Ignimbrite	Cg	Dark grey dacite, rhyodacite and dellenite welded tuff; some siltstone and sandstone
		Endeavour Strait Ignimbrite	Cn	Greenish grey rhyolite welded tuff, some agglomerate, volcanic breccia, rhyolite and andesite; local hornfels
		Eborac Ignimbrite	Ce	Light grey rhyolite welded tuff, some rhyolite and agglomerate
	LOWER CARBONIFEROUS	Pascoe River Beds	Clp	Sandstone, arkose, greywacke, siltstone, shale; some chert, tuff, coal and conglomerate
	MIDDLE DEVONIAN TO LOWER CARBONIFEROUS	Hodgkinson Formation	DCh	Greywacke, siltstone, slate; some chert, andesite, spilite and conglomerate
	LOWER SILURIAN TO LOWER DEVONIAN	Chillagoe Formation	SDh	Limestone, chert, quartz greywacke, siltstone, sandstone, conglomerate, basalt
?	PROTEROZOIC OR UPPER DEVONIAN	Cape York Peninsula Batholith: Blue Mountains Adamellite	Ᵽb	Biotite adamellite, hornblende-biotite adamellite
		Morris Adamellite	Ᵽm	Porphyritic biotite adamellite
		Wigan Adamellite	Ᵽw	Biotite adamellite and granite
		Lankelly Adamellite	Ᵽl	Porphyritic biotite adamellite; some leucocratic muscovite granite and banded pegmatitic granite
		Kintore Adamellite	Ᵽk	Biotite-muscovite adamellite, leucocratic muscovite granite and banded pegmatitic granite
		Aralba Adamellite	Ᵽa	Porphyritic biotite-muscovite adamellite
		Flyspeck Granodiorite	Ᵽf	Biotite granodiorite, hornblende-biotite tonalite, biotite-hornblende diorite
PRECAMBRIAN	PROTEROZOIC ?		Ᵽo	Dolerite
		Sefton Metamorphics	Ᵽs	Muscovite schist, quartzite, mica-feldspar schist, hematite and magnetite-bearing schist and quartzite, greenstone amphibolite, calc-silicate rocks, limestone
				Mainly greenstone
		Holroyd Metamorphics	Ᵽh	Fine to coarse mica schist, phyllite, slate, indurated sediments, quartzite, greenstone, amphibolite; some feldspathic schist, gneiss and migmatite
				Mainly quartzite
				Greenstone
		Coen Metamorphics	Ᵽc	Mica schist, quartzite, biotite gneiss, amphibolite; some garnet-amphibole gneiss and calc-silicate rocks
				Mainly biotite gneiss and amphibolite
		Dargalong Metamorphics	Ᵽd	Biotite gneiss, feldspar-mica schist, quartzite, amphibolite and migmatite
				Mainly sillimanite-muscovite schist and quartzite

Geological boundary
Anticline
Overturned anticline, showing direction of plunge
Syncline
Overturned syncline, showing direction of plunge
Fault
Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes
Shear zone
Strike and dip of strata
Vertical strata
Dip < 15° } air-photo interpretation
Dip 15°–45°
Dip > 45°
Trend lines
Joint pattern

Strike and dip of foliation
Vertical foliation
Plant fossil locality
Dyke: a – acid, i – intermediate, b – basic, q-quartz, p – porphyry
Oil exploration well, abandoned
Mine, abandoned
Alluvial working, abandoned
Unworked deposit
Au Gold
Mi Mica
W Wolfram
Fe Iron
Mn Manganese

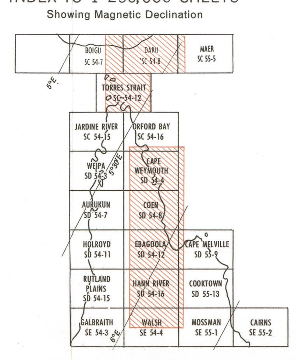
Sn Tin
Si Silica
Ls Limestone

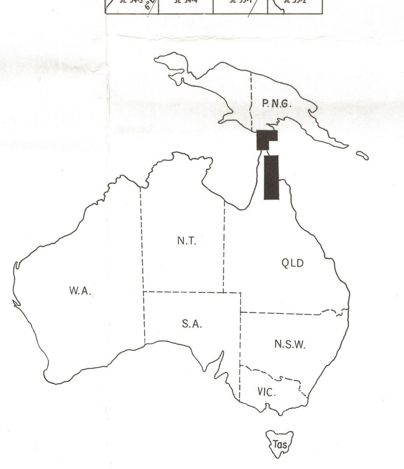
Road
Vehicle track
Telephone line
"Kimba" Homestead
Airport
Landing ground
Trigonometrical station
Coral reef
Fathom line
Building
Built up area

GEOLOGICAL RELIABILITY DIAGRAM

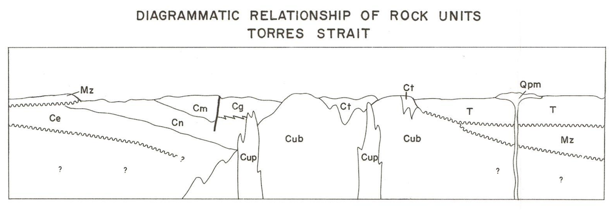
B1 Detailed reconnaissance and air-photo interpretation
B2 General reconnaissance and air-photo interpretation
C Air-photo interpretation

INDEX TO 1:250,000 SHEETS
Showing Magnetic Declination

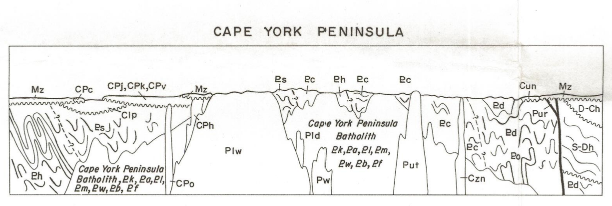




DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS
TORRES STRAIT



CAPE YORK PENINSULA



Unconformity
Geographical boundary

Sections
Cainozoic sediments omitted
Folding schematic
Scale: $\frac{V}{H} = 4$