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The Geology of the Proserpine 1:250,000 Sheet Area, Queensland

by

D.E. CLARKE, A.G.L. PAINE, and A.R. JENSEN*

**Geological Survey of Queensland*

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Records 1968/22

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SUMMARY

The geology of the Proserpine Sheet area was mapped at 1:250,000 scale in 1962 and 1965-6 by the Commonwealth Bureau of Mineral Resources and the Geological Survey of Queensland.

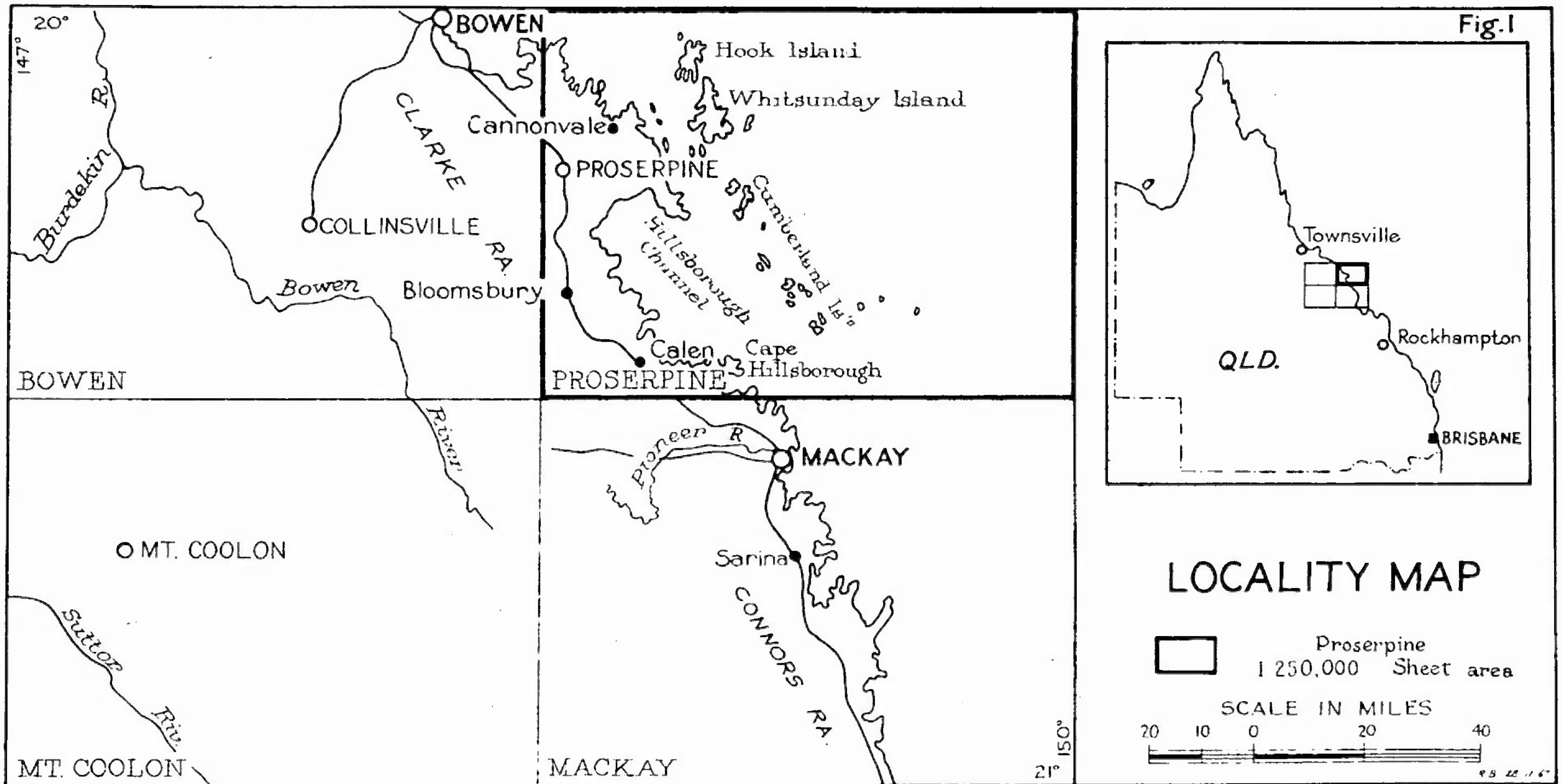
Proserpine (population about 2,500) is the only town in the area. It is 45 miles south-east of Bowen and 84 miles north-west of Mackay, and lies on the trunk railway and highway which traverse the Queensland coast. About one seventh of the Sheet area is occupied by the mainland; the remainder takes in the Cumberland Islands, the Coral Sea, and part of the Great Barrier Reef. The climate is tropical; the region has a relatively high rainfall (60 to 70 inches) and much of it is covered by rain forest. The mainland is hilly to mountainous, with peaks rising to over 3,000 feet in the Clarke Range, but a low-lying corridor, the Bowen-Proserpine Lowland, separates the mountains north and east of Proserpine from the mountains and hills in the south. Like the mainland, the islands are rugged, rising steeply from the sea to heights of 1200 to 1400 feet. The coastline of the islands and northern part of the mainland has been drowned by faulting.

The Sheet area is underlain by volcanics and sediments which range in age from Upper Devonian to Tertiary, and by granite and other intrusions which were emplaced at several times from the Upper Carboniferous to the Cretaceous. The oldest rocks are the Campwyn Beds (Upper Devonian to Lower Carboniferous), a sequence of volcanics and sediments which form a strip of country along the coast west of Hillsborough Channel. The Edgecumbe Beds (Lower Carboniferous), which consist of sediments and volcanics partly equivalent to the Campwyn Beds, form small separate areas north and east of Proserpine. Upper Carboniferous to Lower Permian volcanics and sediments (Carmila Beds and Lizzie Creek Volcanics in the south, and Airlie Volcanics in the north) lie unconformably upon the older rocks. A Lower Permian coal-bearing sequence of restricted extent, the Calen Coal Measures, overlaps the Carmila Beds. Much of the Sheet area (including most of the islands) is formed from Cretaceous volcanics (Whitsunday Volcanics and Proserpine Volcanics), and thus represents the only extensive development of Cretaceous volcanics in Queensland outside the Maryborough Basin. A graben containing sediments of probably Tertiary age, the Hillsborough Basin, underlies Hillsborough Channel and the Bowen-Proserpine Lowland. These sediments

which may be up to 10,000 feet thick, are known only from the subsurface; however a veneer of sediments of similar age is exposed in the northern end of the Bowen-Proserpine Lowland, and Tertiary sediments and volcanics form a rugged headland at Cape Hillsborough. Pleistocene sand dunes occur on Whitsunday and Haslewood Islands. The granites and other intrusives (rhyolite, dolerite, diorite) range in age from Upper (or late Middle) Carboniferous to Cretaceous. Several rhyolite plugs of probably Tertiary age occur in the south. Dyke swarms are a prominent feature of the whole area.

Faulting has been active in the area, probably through to the Quaternary. The stratified rocks are moderately folded, with north-west-trending axes; steep dips, which occur in places, appear to be closely related to faulting.

No metalliferous deposits have been worked in the Sheet area. A small quantity of coal has been mined near Calen, and clay is quarried at Pindi Pindi for bricks. The sand dunes of Whitsunday and Haslewood Islands are a potential source of silica sand for use in glass-making. Part of the offshore area is held under an Authority to Prospect by Ampol Exploration (Qld) Pty Ltd, who are investigating the petroleum potential of the Hillsborough Basin.



To accompany BMR Record No 1968/22

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INTRODUCTION

The Proserpine Sheet area is located on the Queensland coast, roughly midway between Brisbane and Cape York. The geology of the Sheet area was mapped at 1:250,000 scale in 1962, 1965, and 1966 by the Bureau of Mineral Resources and the Geological Survey of Queensland. The earlier mapping was done by A.R. Jensen (B.M.R.) who, in 1963, produced a report and preliminary map of the southern half of the area. In 1965 D.E. Clarke (GSQ) and A.G.L. Paine (BMR) mapped the northern half and re-examined parts of the southern half. In 1966 they mapped the Cumberland Islands in the southern half of the Sheet (except Wigton Island and the islands south-east of Wigton), and spent several days with Jensen reappraising the mainland geology. This report and accompanying map incorporate and supersede those produced by Jensen in 1963. The Proserpine Sheet was the last area covered in a programme of regional mapping in the Townsville-Charters Towers-Bowen region.

The Proserpine Sheet area is situated between latitudes 20 and 21 degrees south and longitudes 148½ and 150° east. Bushy, Tern and Redbill Islands, which lie just outside the Sheet area and are not covered by a designated sheet area, have been incorporated in the geological map which accompanies this Record.

The main industries are sugar production and tourism. Much of the southern half of the area is devoted to beef production. Timber is obtained in small quantities from the Clarke Range and trucked to Mackay for sawing.

Proserpine, with a population of about 2,500, is the only town in the area. It has a sugar mill and is the main point of entry for tourists bound for the island resorts, with which it is connected by regular air services and by bus and launch services through Shute Harbour. Tourist resorts are situated at Cannonvale and Airlie on the mainland, and on Hayman, South Molle, Brampton, Lindeman, and Long Islands. Except for single dwellings on Dent and Hamilton Islands, no other islands are inhabited.

The largest village not connected with the tourist industry is Calen (population about 300), which is a centre for the surrounding sugar and beef farms. Seaforth, Midgeton, and Ball Bay are small beach resorts serving Mackay and Proserpine. There are no deep water port facilities in the area, but Shute Harbour, which could probably be developed into a deep water port if the need arose, has been built as a small boats harbour to serve the tourist trade. The North Coast Railway and the Bruce Highway traverse the area from north to south. Many miles of subsidiary roads, both sealed and unsealed, serve the sugar cane growing areas and the mainland beach resorts.

Much of the area, particularly the Clarke and Conway Ranges, is rugged rain-forest country in which access is very poor. Elsewhere access is good, though mapping may be hindered by tall grass and sugar cane fields. Lack of access in rugged areas is partly counterbalanced by the splendid coastal outcrops in the islands and on the mainland north and east of Proserpine. Several weeks were spent examining these outcrops using a chartered 31-foot launch. Much of the coastline has deep water immediately offshore, and launch operations were very successful. In many areas geologists were set ashore directly from the launch, without the need for time-consuming landings by dinghy.

The climate of the Proserpine area is tropical, with mild dry winters and hot wet summers. The long term average annual rainfall (78 years) at Proserpine is 71.9 inches. Averaged over all years of record, approximately 70 per cent of the annual total falls in the summer months December-March, whilst only 16 per cent falls during the six month period May-October. The long term average at Bloomsbury is 60.5 inches, and is 71.6 at Calen in the southern part of the area. Detailed temperature information is not available for the Proserpine area, but that available for Mackay, just south of the Sheet area, is representative of the coastal plain which comprises the major part of the Proserpine Sheet area. Mean maxima of 86° F and mean minima near 73° F are recorded for the summer months December, January, and February. The average winter temperatures for June, July, and August are 72° F maximum and 54° F minimum. Frosts are very rare.

The Sheet area was mapped using aerial photographs of 1:85,000 scale flown by Adastra Airways in 1960. Coverage of the entire sheet area is available at that scale. 1:25,000 scale aerial photographs of the Proserpine 1-mile Sheet area were produced by Adastra Airways in 1961.

A 4 miles to one inch Military Sheet of the area (Proserpine, F55/4) was published in 1942. This sheet is largely out of date, and is unsuitable for use as a base map. The Division of National Mapping has compiled a planimetric map of the Sheet area at 1:250,000 scale, but it has not yet (1967) been printed. Copies of their 1:93,000 scale compilation sheets were made available to us for use as a base. Topographic sheets covering the Proserpine and Midge Point 1-mile Sheet areas, at a scale of 2 inches to 1 mile and with a contour interval of 25 feet, are being prepared by the Topographic Branch, Survey Office, Department of Public Lands, Brisbane. The Proserpine Sheet area lies within the 1:1,000,000 scale ICAO map Sheet no 3234 (Clermont).

The 1:250,000 scale geological map which accompanies this report consists of two plates, which were compiled in the following way:

<u>Planimetric Plate</u>

The planimetric plate on the accompanying map (Enclosure) is a simplified tracing of the 1:250,000 compilation supplied by the Division of National Mapping. Some additional information (e.g. tracks) was added to this tracing where appropriate, and spot heights were added from the Military Sheet and from the Lands Department topographic maps.

<u>Geological Plate</u>

Geological data were plotted on overlays of the air photographs. Simplified tracings, showing essential drainage and photo-centres only, were made from the 1:93,000 scale planimetric sheets. These tracings were photo-enlarged to photo-scale (1:85,000), and the geology was drawn from the photo overlays onto the tracings. The tracings, now bearing all geological information, were photo-reduced and re-drawn at 1:250,000 scale.

Petrography

All mineral percentages quoted are based on visual estimates of the thin sections.

ACKNOWLEDGMENTS

All isotopic dates for rocks from this area were determined by A.W. Webb (BMR) at the Department of Geophysics and Geochemistry, Australian National University, Canberra.

Two of the authors (A.G.L.P. and D.E.C.) gratefully acknowledge the seamanship, hard work, and stimulating company of Mr Ivan Ross, owner-skipper of the launch "Ebb Tide", without which their survey of the coast and islands would have been neither so comprehensive nor so buoyantly performed.

The permission of Ampol Exploration (Queensland) Pty Ltd, to incorporate results of geological mapping, geophysical surveys, and drilling for oil in the area is acknowledged.

PREVIOUS INVESTIGATIONS

The first recorded geological observations in the area are those of Jack (1887), who referred to the sandstone, coaly shale and coal between Constant Creek and St Helens Creek. Maitland (1889a) noted volcanics in the sequence recorded by Jack, and on lithological grounds he correlated the sequence with the 'Bowen River Beds', assigning a Permo-Carboniferous age to it. He also noted an interbedded sandstone and trachyte sequence at Cape Hillsborough (now known to be Tertiary), which he called the Desert Sandstone (Cretaceous).

While investigating the occurrence of coal in the district, Cameron (1903) recognized a sequence of tuff and volcanic conglomerate underlying the interbedded sandstone and volcanics mapped by Maitland as Permo-carboniferous. Cameron regarded the tuff and conglomerate as 'equivalent to the lowest division of the Bowen River Beds, on the Bowen River Coal Fields, as described by Jack in 1879'. Ball (1910) reported that the geology of the area was more complicated than Maitland's or Cameron's maps would suggest, but he did not revise their maps. He offered the opinion in passing that 'Mounts Blackwood, Jukes, Ossa, and Pelion all belong to the same trachytic series'.

The investigation of the occurrence of coal was again the cause for the visit of a geologist to the area, this time in 1924. On this occasion it was J.H. Reid who wrote in his report (1924b) 'while no detailed geological work has been done in the district between Mackay and Proserpine, sufficient information is available to leave little doubt that the coal measures here belong to the Middle Bowen Formation of Permo-Carboniferous age, and are regarded as equivalents of the Collinsville coal measures'. Later (1929a) he recorded that the basis of this correlation was the thickness of coal and the lithological similarity of the associated sandstones and conglomerate beds. Reid, in agreement with Cameron, thought the freshwater sequence with interbedded volcanics, underlying the coal measures, was equivalent to the Lower Bowen Volcanics. However, he suggested that the basal part of the sequence could be of 'Gympie' age, (Upper Carboniferous), because it appeared to be conformable with the underlying Rockhampton Series (now mapped as Campwyn Beds) and because of the absence of Glossopteris.

G.A.V. Stanley (1927), in discussing the physiography of the Bowen District and of the northern islands of the Cumberland Group (Whitsunday Passage), recorded numerous geological observations and published the first large-scale geological map of the northern half of the Sheet area. He mapped all the volcanics to the north and east of Proserpine as 'Lower Bowen' i.e. Permian age, but suggested that the geology of the area was complex.

Between 1955 and 1957, five scout bores were drilled in the search for oil by the Mackay Oil Prospecting Syndicate (MOPS), at Cape Hillsborough. MOPS No. 4 was drilled to 303 feet and MOPS No. 5 to 2,405 feet. The geology of the district was discussed in an unpublished report by the consultant geologist to the company (Lawrence, 1956).

Fossils were collected in the Cape Hillsborough-Seaforth area by students of the University of Queensland in 1957, and localities and identifications are given in Appendix A.

N.H. Simmonds and R.M. Tucker (1960) surveyed the limestone resources of the Repulse Islands and inspected a few of the Cumberland Islands. The geology of these islands was discussed by Simmonds (1961).

In 1962 W.C. White and G.A. Brown (1963) completed a geological reconnaissance survey for Ampol Exploration (Qld) Pty Ltd, in the Northumberland and Cumberland Islands and the coastal belt between Broad Sound and Proserpine. G.A. Brown (1963) subsequently compiled a report on the geology of the district around Proserpine.

In June 1963, Aero Services Ltd, (for Ampol) flew aeromagnetic traverses with a one-mile separation, across a belt 20 to 30 miles wide extending south-east from Edgecumbe Bay to Cape Hillsborough (Hartman, 1963). Traverses further to the south were flown in bands, each consisting of three lines separated by one mile. The bands were separated by random intervals of about four to eight miles. The southern limit of the survey was about latitude 22°.

In October 1963, Namco International Inc. (for Ampol) conducted a seismic refraction and reflection programme in the lowland area between Proserpine and New Beach along the north-western side of Repulse Bay. Western Geophysical Company of America (for Ampol) in February 1964 carried out a marine seismic survey in an area bounded on the north by Repulse Bay, in the south by latitude 21°, and extending approximately 25 miles offshore.

In 1965, Ampol Exploration (Qld) Pty Ltd, drilled an onshore well, Proserpine No. 1, 7½ miles south-east of Proserpine, as a stratigraphic test to determine the age, depositional environment and physical characteristics of the sediments of the Hillsborough Basin (referred to by Ampol as the Mackay Basin).

PHYSIOGRAPHY

An impression of the physiography of the area is given in Figures 2 and 3.

The area may be divided into six physiographic units: the Clarke Range; the Coastal hills and plains; the Bowen-Proserpine Lowland; the Coastal Range and continental islands; Hillsborough Channel; and the Coral Sea and Great Barrier Reef. Physiographic boundaries coincide with some of the major geological boundaries, indicating that geological structure and differential weathering have been the dominant influences in the development of the present physiography.

The Clarke Range, in the south-west of the area, varies between 2,000 feet and more than 3,000 feet above sea level, and slopes regionally to the south-west. It is a rugged deeply dissected mountainous area, with a complex physiography. Headward erosion by torrential coastal streams is active along the eastern face of the range. North from Kanaka Creek the eastern face consists of a regular escarpment about 2,000 feet high, but in the south it takes the form of steep spurs and deep re-entrants. In the north, the major watershed between eastward and westward drainage coincides with the top of the escarpment, but in the south the watershed lies several miles west of the foot of the range. This topographic contrast has resulted from a considerable westward migration of the divide north of Kanaka Creek, whereas in the south the divide lies in a position similar to that which it occupied at the beginning of the present erosion cycle. Remnants of former base levels of erosion, the Kangaroo Creek Tableland and Dicks Tableland, can be recognized west of the divide. The Kangaroo Creek Tableland is bounded in the east by the escarpment, but peaks rise 1,000 feet above it to the west. The Dick Tableland, an area of gentle relief and rejuvenated drainage, is breached by Massey Gorge, which is about 1,000 feet deep in the Sheet area, deepening to the west.

The Coastal hills and plains form a strip 12 to 15 miles wide between the Clarke Range and the coast. Near the Clarke Range relief may amount to 1,600 feet or more, but the relief falls off towards the sea. Examples of high hills near the coast are Mt Jukes (1,850 ft. Photo Plate 13), the Conder Hills (1,180 ft), and the Cape Hillsborough range (966 ft). The boundary between this unit and the Clarke Range is gradational, and the morphology of the unit, like that of the Clarke Range, is very varied. The unit merges with the Bowen-Proserpine Lowland, and with Hillsborough Channel. Fringing mangrove swamps and saltwater creeks occur at the estuaries of the larger coastal streams. Drainage is mainly to the north-east, normal to the coast. However, the O'Connell River flows north-south before turning north-east to enter Repulse Bay. Its north-south course is influenced by the O'Connell Fault, and recent movements on the fault may have facilitated entrenchment of the river.

The Bowen-Proserpine Lowland is the name which was given by G.A.V. Stanley (1927) to the lowland extending south-east from Edgecumbe Bay, in the Bowen 1:250,000 Sheet area, to Repulse Bay. The Lowland corresponds broadly with a Tertiary graben, the Hillsborough Basin. Regional slope of the unit is gentle to the east and south-east. In the lower reaches of the Proserpine River the area is swampy and subject to flooding. The surface here consists chiefly of mud with some ridges of unconsolidated sand. Along the coast behind New Beach are a series of vegetated sand dunes, testifying to slight recent emergence. A coquina of coarse pelecypod and gastropod shell fragments within the first 22 feet of Proserpine No. 1 well also suggests slight recent emergence.

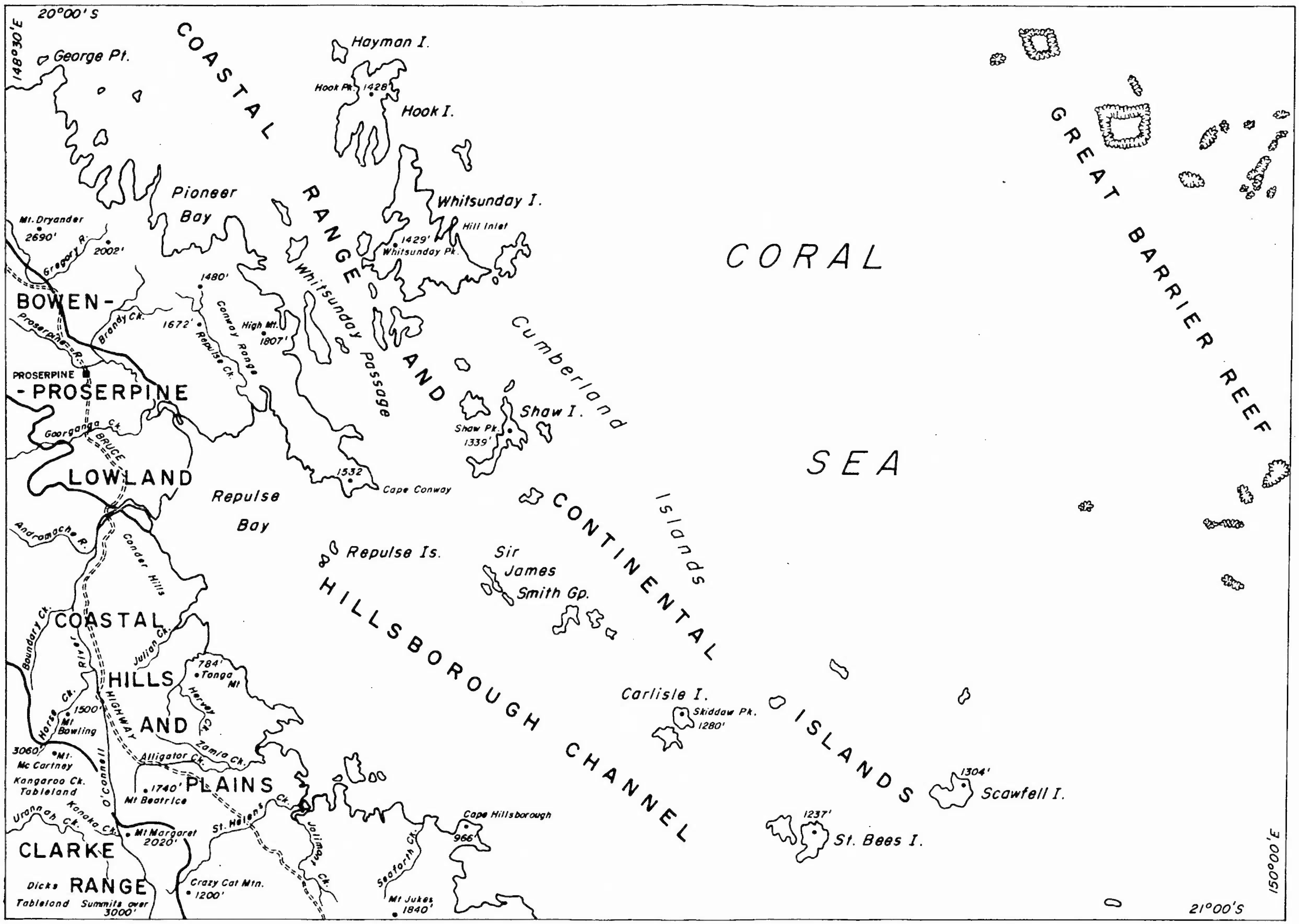
The north-eastern margin of the lowland, although indented by subsidiary valleys, is well defined, and is undoubtedly controlled by major faults. In the south-west the lowland merges with the coastal hills and plains.

The lower reaches of the Proserpine River and its tributaries meander across the lowland. Old channels of the Proserpine River are distinguishable from the air as ox-bow lakes.

PHYSIOGRAPHY - PROSERPINE

Fig. 2.

1 : 250,000 Sheet area



0 10 20 30 40 miles

CLARKE RANGE .... *Physiographic unit*

———— .... *Boundary of physiographic unit*

To accompany Record 1968/22.

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Photo Plate 1: Aerial view of drowned coastline north of Proserpine. Looking south-west across Mount Dryander (2617 feet) to the Bowen-Proserpine Lowland.
Photo by D.H. Blake. BMR Neg. No. GA/313

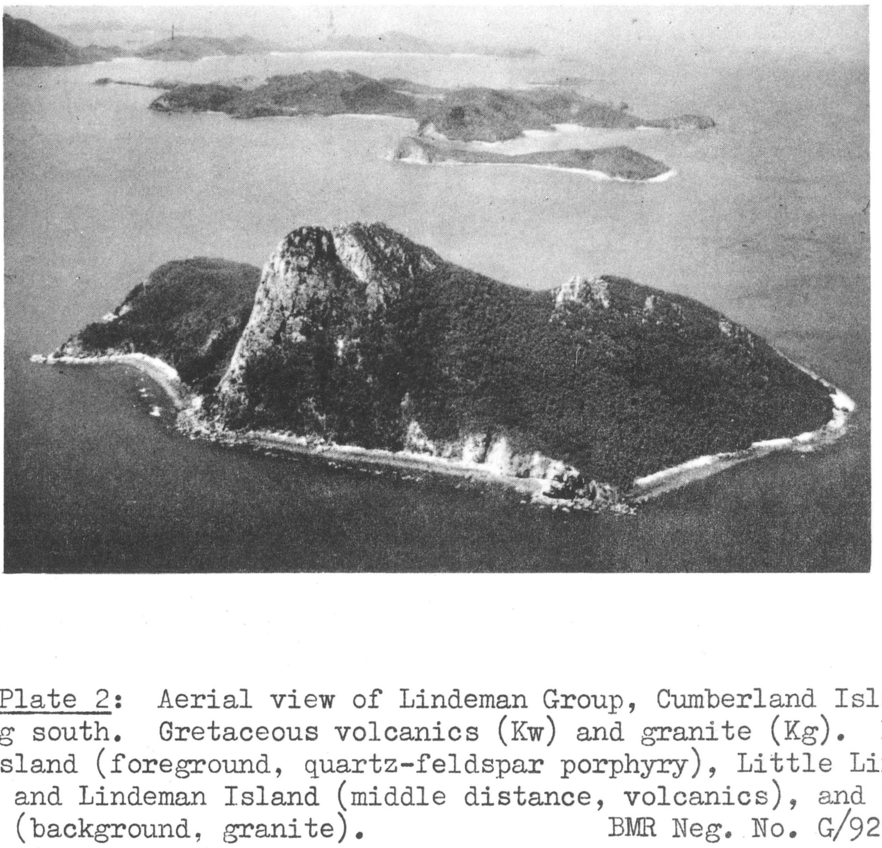


Photo Plate 2: Aerial view of Lindeman Group, Cumberland Islands, looking south. Gretaceous volcanics (Kw) and granite (Kg). Pentecost Island (foreground, quartz-feldspar porphyry), Little Lindeman Island and Lindeman Island (middle distance, volcanics), and Shaw Island (background, granite). BMR Neg. No. G/9254

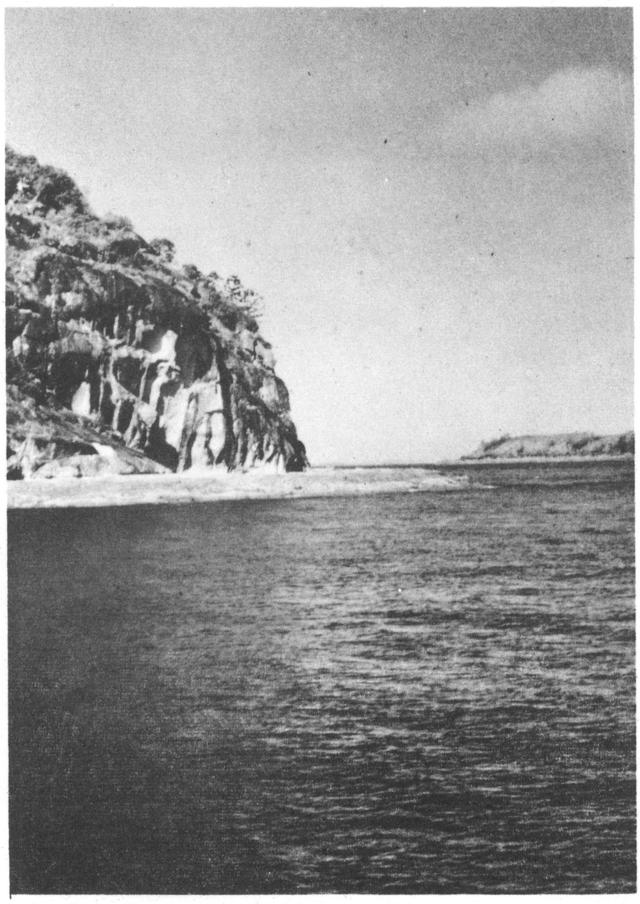
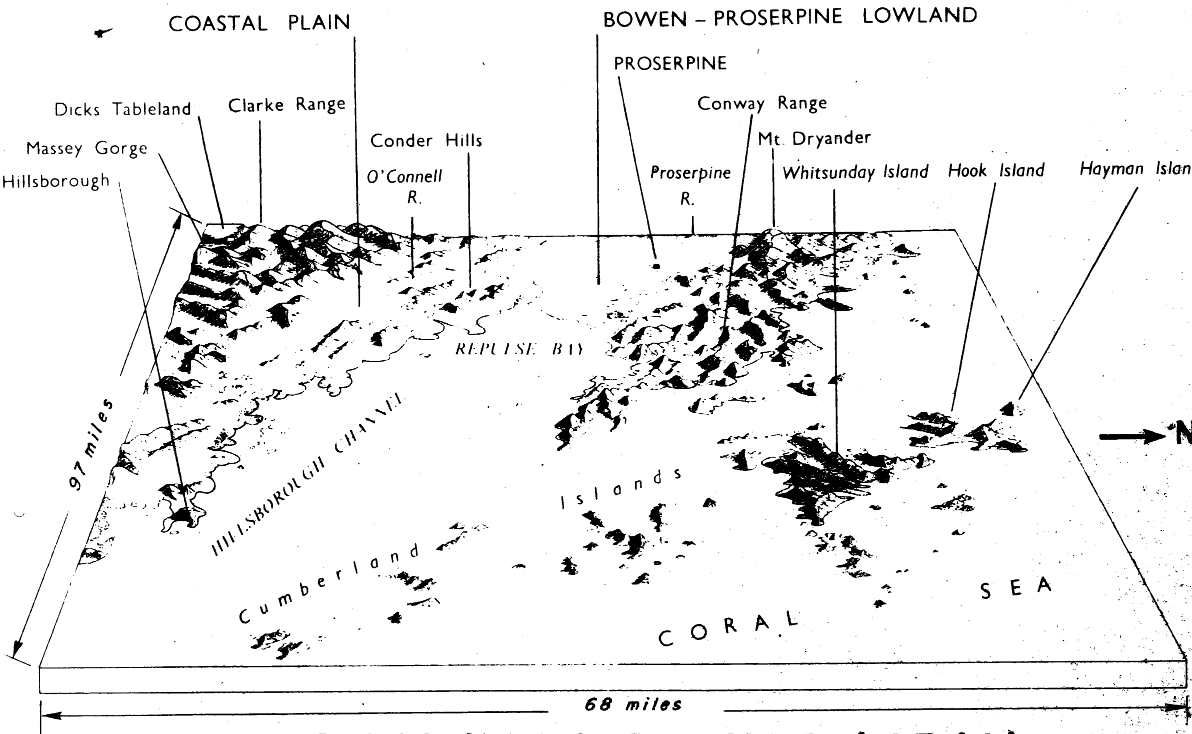


Photo Plate 3: Wave-cut platform in tuff (Whitsunday Volcanics), northern end of Linné Island . BMR Neg. No. GA/315.

FIGURE 3.



PHYSIOGRAPHIC BLOCK DIAGRAM
PROSERPINE 1:250,000 SHEET AREA

F 55/A4/13

To accompany Bureau of Mineral Resources Record 1968/22. *Drawn by C.J.Lucey, Drafting Section, Queensland, Department of Mines.*

The north-west end of the Lowland being higher is not swampy, and much of it is devoted to sugar farming.

The Coastal range and islands are characterized by a pronounced drowned coastline, both in the islands and on the mainland (Photo Plates 1 and 2). The drowned coastline is restricted to north-east of Hillsborough Channel and the Bowen-Proserpine Lowland, and it contrasts with the coastline between Midgeton and Cape Hillsborough. The drowning has been caused by Cainozoic block-faulting, and the scattered islands of the Cumberland Group represent the highest peaks of a drowned landscape.

The Conway Range rises to more than 1,800 feet, and is covered by dense tropical rain forest. Twelve miles north of Proserpine Mt Dryander rises to over 2,600 feet. Here Stanley (1927) noted a high area bounded by steep cliffs, which he suggested might represent the general level of a deeply dissected plateau surface. It is however more probable that this feature has a geological origin (sub-horizontal Proserpine Volcanics).

Hillsborough Channel is about fifteen miles wide and lies between the coast and the chain of Cumberland Islands. Submarine relief is negligible, and the flat sea floor slopes very gently north-east, attaining a maximum depth of ten fathoms along its north-eastern margin. Hillsborough Channel thus represents the submarine continuation of the Bowen-Proserpine Lowland. And it too owes its origin to the Tertiary Hillsborough Basin.

Splendid examples of elevated wave-cut platforms 4 to 5 feet above high tide level, can be seen on various islands from Hook to St Bees (Photo Plate 3), and suggest a recent fall in sea-level or corresponding emergence of the land. G.A.V. Stanley (1927) describes perhaps the best example thus; "Along most of the eastern side of Whitsunday Island a marginal bench is apparent, elevated uniformly about 4 feet above high-tide level. This bench persists also into Hill Inlet, in the south-eastern portion of the island, along the shores of which low cliffs are cut in volcanic agglomerates. The bench usually attains a width of 18-20 feet and is elevated about 4 feet above high-tide mark". Benches seen in the course of the present survey were of similar height and commonly have a small notch at the inner end of the platform. These benches bear witness to only the most recent sea-level fluctuation, but features such as the extensive sand dunes on Whitsunday Island and the drowned topography indicate major fluctuations during the Cainozoic.

REGIONAL GEOLOGY

The stratigraphy of the area is summarised in Table 1 (Enclosure)

The stratified rocks fall into four major groups:

1. Upper Devonian and Lower Carboniferous
   Campwyn Beds, Edgecumbe Beds

2. Upper Carboniferous to Lower Permian
   Lizzie Creek Volcanics, Carmila Beds, Airlie Volcanics, Calen Coal Measures

3. Cretaceous
   Whitsunday Volcanics, Proserpine Volcanics

4. Tertiary
   Cape Hillsborough Beds, Unnamed sediments of the Hillsborough Basin (Ts)

The Campwyn Beds contain Upper Devonian fossils, whereas the exposed part of the Edgecumbe Beds is wholly Carboniferous. The Lizzie Creek Volcanics consists mainly of lavas, but the Carmila Beds contain a large proportion of pyroclastics and sediments. The Airlie Volcanics are structurally isolated from the other Upper Carboniferous to Lower Permian units; they are unfossiliferous, but resemble parts of the Carmila Beds. The Calen Coal Measures are a non-volcanolithic sequence which overlaps the Carmila Beds. The Proserpine Volcanics, which consist mainly of rhyolite flows, are regarded as the terrestrial equivalents of the Whitsunday Volcanics, which are water-lain intermediate to acid pyroclastics. The presence of contemporaneous volcanics and a probably older spore content distinguishes the Cape Hillsborough Beds from the Unnamed sediments of the Hillsborough Basin (Ts).

UPPER DEVONIAN-LOWER CARBONIFEROUS

Campwyn Beds (D-Cc)

Nomenclature

A sequence of Upper Devonian to Lower Carboniferous volcanics and sediments which crop out in the Mackay Sheet area was mapped in 1962 and named Campwyn Beds by Jensen, et al. (1966). The same sequence continues north into the Proserpine Sheet area. Previous references to the rocks have been made by Reid (1924a), who correlated them with the Rockhampton Series, and by Maxwell (in Hill and Denmead, 1960), who regarded them as equivalents of the Rockhampton Group.

Distribution and topography

The Campwyn Beds occupy a belt about five miles wide, which trends north-west along the coast in the southern half of the Sheet area. The rocks which form South and East Repulse Islands are also referred to the Campwyn Beds.

Apart from the Condor Hills, which rise to 1,180 feet above sea-level, topography is generally subdued, and the unit tends to form low strike ridges and gentle rises.

Lithology

The Campwyn Beds comprise acid to intermediate pyroclastics and lavas, mudstone, siltstone, sandstone, conglomerate, and rare limestone.

The most common rocks are red and green rhyolitic tuffs, which consist of fine-grained siliceous lithic fragments, quartz, and feldspar in a groundmass of quartz, feldspar, chlorite, and clay minerals. Variations in the size of the fragments give rise to volcanic breccia, lapilli tuff, and tuff. Rhyolite is also common, being generally dark in colour - red, purple or brown. It is frequently amygdaloidal. Trachytic and andesitic lavas and pyroclastics are rare.

Among the sediments, the mudstone is generally thin bedded, and dark grey to black, weathering deep red. Small-scale graded bedding has been observed. The siltstone is usually white to brown, but in some places it contains dark carbonaceous bands. At Finlaysons Point, siltstones contain marine fossils, and grade from calcareous siltstone to calcilutite. Sandstone in the sequence includes cross-bedded quartz sandstone, grading in places to quartz pebble conglomerate, feldspathic sandstone, and tuffaceous sandstone. Tabular cross-bedding is well developed in sandstone at Halliday Bay (Photo Plate 4). The rare limestone in the sequence is oolitic.

Part of the sequence is well exposed at Midgeton and on the Red Cliff Islands (Photo Plate 5). The northern promontory at Midgeton is composed of about 2,000 feet of thin flows and pyroclastics, well exposed at low tide. A well bedded sequence of tuff, agglomerate, and rare porphyritic andesite flows crops out along the northern coast of the promontory. Fossiliferous sediments and volcanics, metamorphosed by granite (Kg) to the albite-epidote hornfels facies, crop out at Halliday Bay.

Good exposures occur in the O'Connell River, chiefly in the northern bank, over a distance of about 2 miles normal to the regional strike. The following rock types are exposed: argillaceous quartz siltstone, andesitic tuff and agglomerate, arkose, volcanic pebble conglomerate, tuffaceous arkosic conglomerate, and carbonaceous arkosic siltstone with plant fossils. The argillaceous siltstone is brown to red-brown. It is thinly and regularly bedded and contains fine cross-laminations. Most out-crops are intensely jointed. In thin section (B.M.R. TS 66159523) the siltstone consists of well sorted subangular closely packed grains of un-strained quartz (70 per cent; average grain size 0.05mm.) in an argillaceous matrix (20 per cent). Grains of epidote (up to 0.1mm.), which amounts to 5-7 per cent, have irregular outlines. Scattered small sheaves of biotite, sericite, and chlorite amount to 3-5 per cent. The siltstone contains rare grains of plagioclase and zircon, and small fragments of felsitic volcanics. The tuff and agglomerate are blue-green to brown and generally massive, but thin beds of tuff reveal the structure. The pyroclastics grade through tuffaceous arkose to arkose. The tuffaceous arkosic conglomerate contains clasts of quartz, euhedral feldspar, and white biotite granite.

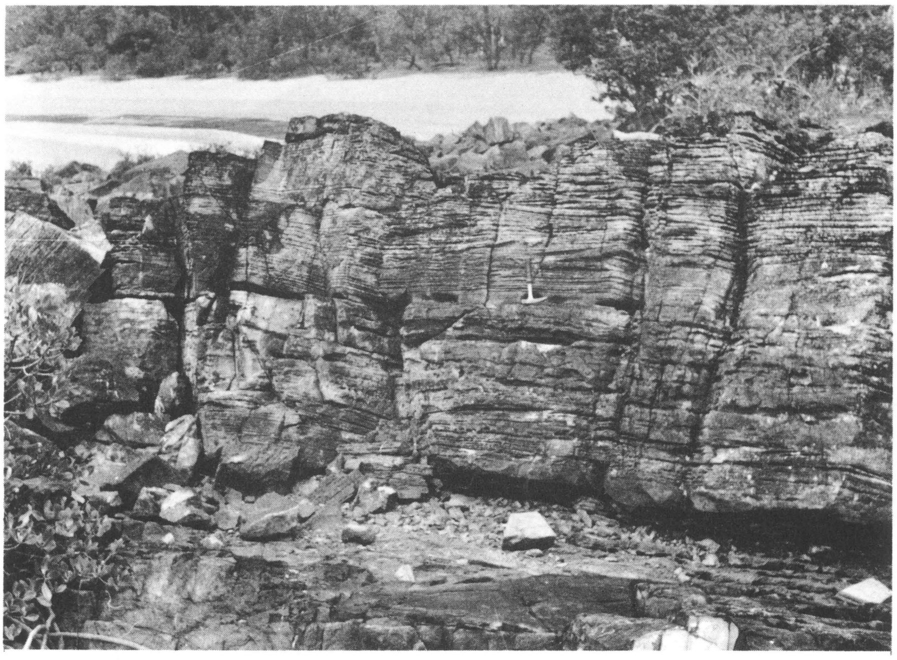


Photo Plate 4: Tabular cross-bedding in indurated arenites of the Campwyn Beds (Upper Devonian to Lower Carboniferous), Halliday Bay.
BMR Neg. No. M/264/2

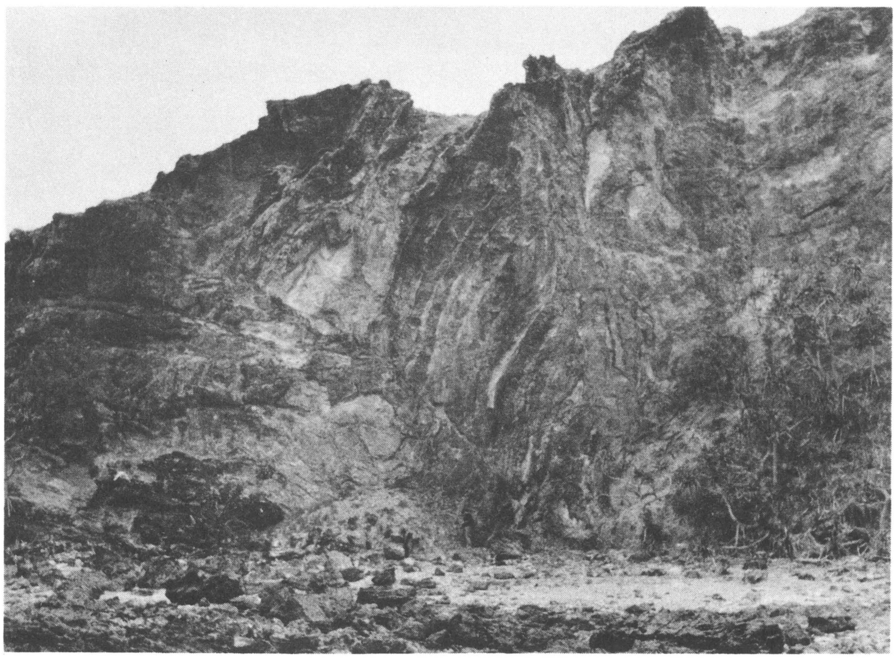


Photo Plate 5: Folding and faulting in Campwyn Beds, Outer Red Cliff Island. Figure at base gives scale. BMR Neg. No. M/267

Fossiliferous carbonaceous arkosic siltstone and fine arkose crop out in the north bank of the river, 400 yards downstream from the bridge. The siltstone and arkose are interbedded with green crystal-lithic tuff, and are overlain by tuffaceous sediments with interbeds of cobble conglomerate. The cobbles are well rounded, and consist mainly of green quartz-feldspar porphyry and minor flow-banded rhyolite. An exceptionally large volcanic clast, 5 feet in diameter, was observed.

At the south-eastern point of East Repulse Island a lens of limestone is in juxtaposition with andesitic pyroclastics and flows. The limestone contains corals of Upper Devonian age (Simmonds and Tucker, 1960). The limestone (B.M.R. TS 65152141) is a moderately recrystallized, rather pure skeletal-pelletal calcarenite, consisting of crystalline calcite, recrystallized mud pellets, and organic remains (M.C. Brown, pers. comm.). The organic remains include probable crinoid ossicles, Girvanella sp. and possible gastropods and ostracods. The presence of Girvanella, combined with the possible presence of gastropods and ostracods, indicates deposition in shallow clear water (J.J. Veevers, pers. comm.).

Although Simmonds and Tucker show the sequence as dipping to the north-east at 30 degrees, the relationship of the limestone to the volcanics is not a simple stratigraphic one. In general, the limestone appears as a tabular body, dipping steeply to the north-east between walls of structureless andesitic agglomerate. The agglomerate which forms the south-western wall includes small blocks of limestone. At the north-westerly limit of outcrop, the limestone appears to overlie strongly jointed volcanics, with a faulted contact which dips north-east at 30 degrees. Green chloritized agglomerate and andesitic tuff containing fresh crystals of pyroxene crop out between tide marks along the south-western shore; they are well bedded and dip regularly at 50 degrees to the east-south-east, and thus strike at a high angle to the limestone body. In the immediate vicinity of the limestone, both it and the agglomerate are faulted and intruded by irregular bodies of coarse tuffisite. The tuffisite intrusions are dyke-like in places. Both they and the agglomerate are strongly epidotized. The structureless agglomerate which encloses the limestone is identical with the Conway Peninsula agglomerates, which are mapped with the Cretaceous Whitsunday Volcanics.

Identical agglomerate also forms North Repulse Island, where it incorporates blocks of marble up to six feet across.

The relationships of the rocks on East Repulse Island are complex, and require detailed study. For the present it is suggested that the Devonian limestone, and possibly also the regularly bedded pyroclastics, represent parts of the Campwyn Beds. The tuffisite intrusions and the massive agglomerate probably represent remnants of a Cretaceous eruption centre in which blocks of Campwyn Beds are now preserved.

Severely sheared quartz porphyry and quartz-feldspar porphyry form the northern headland of South Repulse Island. The headland is parallel to the shear direction. The porphyry is very strongly kaolinized and ironstained, and the exposed surfaces are a patchwork of red and white criss-crossing veins and blotches. The rock is intruded by a network of quartz veins and pods, which have been deformed by the shearing. In view of the strong shearing, it is possible that the alteration is hydrothermal. Mid-way along the northern shore, the shearing decreases in intensity and the quartz veins become less abundant, suggesting the shear may trend out to sea. Further evidence of hydrothermal alteration is present 200 yards farther to the south-east where some of the porphyry is siliceous and pyritic; here the porphyry is intruded by thick dolerite dykes and thin microdiorite dykes. The age and relationships of these rocks are unknown; for the present they are mapped with the Campwyn Beds.

Depositional environment

Marine fossils indicate that at least part of the unit was laid down under marine conditions, and the presence of algae points to relatively shallow water. The oolitic limestone was presumably deposited under similar conditions. Volcanics interbedded with the sequence may be at least partly terrestrial, and the common occurrence of plant fossils indicates that parts of the unit were laid down in, or near, a continental environment.

Structure

Folding is moderate in the Campwyn Beds, and faulting appears to be important only at the margins of the area of outcrop (Photo Plate 5). The rocks generally dip to the west or south-west at low to moderate angles. The sequence exposed in the O'Connell River is strongly jointed, and in places brecciation and networks of calcite veins suggest faulting. The general structure of the O'Connell River section is that of an anticline plunging to the north-west.

Intrusions

A Cretaceous alkali granite stock (Kg) has intruded and metamorphosed the sequence at Halliday Bay. Acid and minor intermediate dykes of unknown age also intrude the Campwyn Beds. Tertiary rhyolitic plugs (Tr) intrude the sequence north of Blackrock Creek and in the Mount Springcliffe district.

Thickness

Insufficient structural information makes it difficult to estimate the thickness. From Outer Red Cliff Island to a point near the western limit of the Campwyn Beds, the thickness is estimated at 10,000 feet. However, there may be some repetition of the sequence by folding.

Stratigraphic relationships and age

The Campwyn Beds are the oldest rocks exposed in the Sheet area. Their relationships with the Permian units are poorly known, but the difference in age suggests an unconformable relationship.

Both Upper Devonian and Lower Carboniferous fossils have been found in the sequence. Upper Devonian marine fossils (see Appendix A, part 1) Cyrtospirifer sp., Stenosia sp., Aviculopecten sp., and Syringopora sp., together with Leptophloeum australe were found on Outer Red Cliff Island by members of a students' excursion from the University of Queensland in 1957. The students also found L. australe on Newry Island. Aleveolites sp. and Macgeea sp., assigned to the lower part of the Upper Devonian, were found in limestone on East Repulse Island by Simmonds and Tucker (1960).

Lower Carboniferous fossils have been found at Victor Point, Finlaysons Point, and near old Saint Helens Homestead (see Appendix A). The Victor Creek locality was discovered on the students' excursion; it contains: Lepidodendron veltheimianum, Stigmaria ficoides, and Sigillaria sp. Collections made at Finlaysons Point include marine fossils of Upper Tournaisian age. Determinations and relevant discussion are given in Appendix A (pt.2).

Reid (1924a) recorded marine fossils in an oolitic limestone near Old Saint Helens Homestead. Fauna identified in this collection, which is housed in the Geological Survey of Queensland Museum, were: Prospira striatoconvoluta (Benson and Dunn), Spirifer sp., an Orthotetid, and Camarotoechia sp.

Professor Dorothy Hill (pers. comm.) reports that a student of the University of Queensland found Ectochoristites near Midge Point. Dr. K.S.W. Campbell (pers.comm.) regards this as indicating a Middle Visean age.

LOWER CARBONIFEROUS

Edgecumbe Beds (Cle) (new name)

A steeply dipping sequence of Lower Carboniferous volcanics and sediments crops out in the north-western part of the Sheet area, and is herein named the Edgecumbe Beds. The beds extend into the Bowen Sheet area, where they consist mainly of sediments (Paine, et al., in prep b).

Nomenclature

Brown (1963), who first described the sequence referred it to the Campwyn Beds. However, we consider that the sequence warrants a separate stratigraphic name, as it represents a distinctive lithological unit which, on present knowledge, can not be directly equated with any particular section of the Campwyn Beds. The Edgecumbe Beds are known to contain only Lower Carboniferous fossils, whereas the Campwyn Beds extend down into the Upper Devonian.

Volcanics and sediments exposed in the Proserpine area represent the upper part of the sequence, of which more is exposed in the Bowen Sheet area.

Limestone within the unit was described from the Ben Lomond district by Saint-Smith (1918) and by Stanley (1927). The most comprehensive description of the unit is by Brown (1963) who measured and described 4,175 feet of section in Ten Mile Creek (Bowen Sheet area) above its junction with the Gregory River. This constitutes the type section. The name is derived from Edgecumbe Bay, in the Bowen Sheet area.

Distribution and Topography

In the north the Edgecumbe Beds occupy low country between the Gregory River and a rugged range which culminates in Mount Dryander (2,690 ft.). Resistant beds form two low hills, known locally as Cork Hills and Double Ridge. In the Lower Gregory-Riordan Vale-Bonavista area, the Edgecumbe Beds form high hills and lower strike ridges, separated by alluviated lowlands.

The Edgecumbe Beds are very poorly exposed. In the lower country, outcrops are generally masked by alluvium and soil; in the hills, dense rain forest, tall grass, and deep soil hide the rocks.

Lithology

Paine et al. (in prep,b) describe the lowermost exposed 4,000 feet of the unit in the Bowen Sheet area as a sequence of shale, greywacke, limestone, feldspathic sandstone, siltstone, argillaceous sandstone and pebble conglomerate, overlain by a prominent oolitic limestone bed, which crops out at the Junction of Ten Mile Creek and the Gregory River, just west of the Proserpine Sheet boundary. Those parts of the Edgecumbe Beds exposed in the Proserpine Sheet area are stratigraphically higher than the oolitic limestone horizon.

Lithic sandstone interbedded with pyroclastics, noted by Brown (1963) immediately east of where the Gregory River crosses the Sheet boundary, conformably overlies the oolitic limestone. It is overlain by andesite, crystal and lithic tuffs, and some rhyolite. Andesite, dacite, rhyolite and crystal tuffs form the Cork Hills and Double Ridge. Near Collingvale Homestead, porphyritic rhyolite, crystal and lithic tuff, and volcanic breccia occupy a similar stratigraphic position. Brown (1963) reports "1,000 feet of poorly exposed limestones, sandstones, and possibly shales" east of Cork Hills. The limestone is thin and unfossiliferous. The sequence further to the east is masked by younger units or replaced by igneous intrusions.

The Edgecumbe Beds in the Lower Gregory-Riordan Vale-Bonavista area consist of interbedded rhyolite, andesite, rhyodacite, fine and coarse tuff, volcanic breccia and thin highly tuffaceous sediments. The sequence is best exposed in the gravel pits at the western end of Mount Julian. Rhyolite, in a few places, is pyritic or auto-brecciated; the andesite is commonly amygdaloidal.

Thickness

Neither the top nor the base of the Edgecumbe Beds is exposed, so that their total thickness is unknown. In the Box Creek area, 4 miles north of Collingvale Homestead, where the sequence is close to vertical, the exposed thickness is estimated at about 20,000 feet, of which 15,000 feet lies within the Proserpine area.

Structure and Relationships

North of Lower Gregory, the Edgecumbe Beds strike north-north-west and dip very steeply to the east. Paine et al. (in prep.b) show that the facing of the sequence in the Bowen Sheet area is to the east. Individual beds can be traced in a straight line for considerable distances, and all the evidence indicates that the unit in this area has not been folded, but has been tilted, as a block, through 90 degrees to the east.

In the Lower Gregory-Riordan Vale-Bonavista area the Edgecumbe Beds are folded and complexly faulted. An easterly plunging syncline is interpreted near Mount Marlow. At Mount Julian the sequence is very close to vertical, and air-photo interpretation further suggests that elsewhere in this area the bedding dips very steeply.

In places, the Edgecumbe Beds are faulted against the Airlie Volcanics (P11). Indirect evidence suggests that the contact, where not faulted, is probably an angular unconformity. The Airlie Volcanics north-west of the Proserpine-Cannonvale road do not closely resemble the Edgecumbe Beds; they are dominantly andesitic, have a lower proportion of fine pyroclastics, and are more massively bedded. Measured attitudes in coastal areas indicate that the Airlie Volcanics have a regional dip of 20^{o}-30^{o} to the south-east in this area. As the Edgecumbe Beds strike north-north-west or west-north-west and dip subvertically, an angular unconformity almost certainly separates the two units. However the contact is obscured by dense rain forest.

North-north-east of Collingvale Homestead, the Edgecumbe Beds are unconformably overlain by the Cretaceous Proserpine Volcanics (Kp). Mount Marlow, five miles north-east of Proserpine, appears to be capped by rhyolite (Kp), which rests unconformably on the Edgecumbe Beds. The Beds are also intruded by diorite (P-Md) and granite (P-Mg).

Fossil evidence shows that the Edgecumbe Beds are probably equivalent to part of the Campwyn Beds, which include rocks ranging in age from Upper Devonian to Lower Carboniferous. However, the structure and stratigraphic succession of the Campwyn Beds are poorly known; Campwyn Beds are only moderately folded, and it is unlikely that more than 10,000 feet of the Upper Devonian-Lower Carboniferous sequence is exposed in any particular area. The Edgecumbe Beds have an unusually consistent subvertical attitude, and they are estimated to be 20,000 feet thick. Detailed mapping might show that parts of the Campwyn Beds can be correlated with the Edgecumbe Beds. The fact that the very thick Edgecumbe Beds contain no exposed Devonian rocks, whereas the Campwyn Beds contain Upper Devonian to Visean fossils, suggests that the Lower Carboniferous succession thickens rapidly to the north.

Age

Four collections of fossils made by Brown (1963) from the Bowen Sheet area were determined by R. G. McKellar, two as Middle or Upper Tournaisian and two as Upper Tournaisian.

Environment of Deposition

The occurrence of marine fossils and oolitic limestone in the lower parts of the Edgecumbe Beds indicates a shallow marine environment. However, flows and pyroclastics predominate in the upper part of the sequence, limestones are absent, and marine fossils are not known to occur. These factors suggest a terrestrial environment.

UPPER CARBONIFEROUS TO LOWER PERMIAN

Carmila Beds (Pla)

Nomenclature

The Carmila Beds are a sequence of Lower Permian and/or Upper Carboniferous terrestrial volcanolithic sediments and volcanics, which crop out along the eastern side of the Urannah Igneous Complex, from Saint Lawrence to Bowen. The unit was defined by Jensen, et al. (1966). No type section was designated, but outcrops around the village of Carmila, 50 miles south of Mackay, were regarded as typical of the unit. Rocks of similar age and lithology are now known to extend as far north as Bowen.

Distribution and topography

In the Proserpine Sheet area, the Carmila Beds extend from the southern margin of the Sheet area north-west to Slater Creek. They crop out in an elongate belt between the Urannah Igneous Complex and the Lizzie Creek Volcanics in the west, and the Campwyn Beds in the east. In the main, the Carmila Beds form steep hilly country, interrupted by flat alluvial plains. Prominent strike ridges occur in places. Near the contact with the Urannah Igneous Complex relief is greatest, some hills rising steeply to more than 1,500 feet above sea-level.

Lithology

The Carmila Beds in the Proserpine Sheet area consist mainly of clastic sediments and pyroclastics, interbedded with minor acid lavas. Sedimentary rocks include sandstone, shale, mudstone and conglomerate. Sandstone in the sequence is trough cross-stratified lithic sandstone, but quartz sandstone has been observed in a few localities. The lithic sandstone is commonly calcareous. Conglomerates of acid volcanic pebbles occur in places near the base, for example in the headwaters of Surprise and Hervey Creeks, but is also found higher in the sequence. At Surprise Creek it is interbedded with grey-white cherty tuff which bears plant impressions (locality P4). Coarse crystal tuff, which is characteristic of the Carmila Beds in the Mackay and Saint Lawrence Sheet areas, was seen in only a few places in the Proserpine Sheet area. Rhyolite observed within the area of outcrop of the unit is believed to be intrusive as sills and dykes. However rhyolite flows are known in the unit in the Mackay Sheet area.

Good exposures of the Carmila Beds are found in the hills north and south of the Andromache River, and in the bed of the river itself. Fine to coarse labile arenites with lenses of conglomerate crop out in the river upstream from Bromby Creek. The section appears to consist mainly of sedimentary rocks, but there are outcrops of pyroclastics in the low range east of Bromby Creek, in the bed of the river a few yards above the railway bridge, and at the Fish Creek confluence. Small slumps occur in places, and the coarser arenites tend to form thin lenticular units. This characteristic is exaggerated where the rocks are tightly folded, and this is perhaps due to incipient boudinage. Some of the conglomerates contain clasts of pink granite. In places, the rocks are silicified and extensively jointed. Acid and basic dykes are common. In an outcrop of near-vertical well bedded arenites in the bed of the river one mile upstream from the railway bridge, sedimentary truncation features enable the facing to be established. The finer sediments in this outcrop contain some carbonaceous laminae. A specimen of medium-grained arenite was thin sectioned (B.M.R. Ts 65152180); it is a calcareous arkosic subgreywacke or volcanolithic arkose, consisting of sericitized feldspar grains (30 percent), felsitic volcanic fragments (30 percent), calcite cement (30 percent), volcanic quartz grains (5 percent), and fragments of devitrified glass (5 percent).

The coarser fraction is well sorted and moderately to well rounded: 70 to 80 percent of the grains fall within the size range 0.3 to 1.0 mm. The finer grains are more angular. Packing is rather loose, and the calcite cement prevades the rock very evenly, in places replacing some of the grains.

Andesite or basalt, with agglomerate, forms low hills and rises just south of the headwaters of Baldwins Creek. Dacitic crystal-lithic tuff and agglomerate form the northern end of an outlying spur of the Clarke Range, three miles west-north-west of Mount Millar. A mile to the south-east, boulders of acid crystal tuff and coarse volcanolithic greywacke (or reworked lithic tuff) were found in a small creek which drains the eastern side of the spur; these rocks appear to have been metamorphosed by the intrusion of the Urannah Igneous Complex, because fine-grained biotite is extensively developed in the matrix. Andesitic crystal-lithic tuff crops out in the bed of the O'Connell River, west of Rhino Mount.

Environment of deposition

In the Proserpine and Mackay Sheet areas the only fossils found in the unit are plants, and this, together with the presence of trough cross-stratified lithic sandstone, suggests a continental environment for the unit. However, marine fossils have been found in the Carmila Beds in the Saint Lawrence Sheet area (Malone, et al., in press).

Structure

South of Ellaroo the Carmila Beds dip regionally to the south-west, with a few minor folds. The rocks exposed in the Andromache River are sufficiently well bedded to show that the general structure in this area is broadly synclinal (see cross section on geological map). The syncline is modified by minor tight folds, which are probably related to strike faults. The axis of the main syncline also appears to be strike faulted; it trends north-north-west, passing through the confluence of Fish Creek and the Andromache River. Another north-north-west-trending syncline, whose axis also appears to be faulted, has been photo-interpreted between Dingo and Baldwins Creeks, near the margin of the Sheet area. In the Bowen Sheet area the Carmila Beds dip consistently to the north-east.

In the Proserpine Sheet area the regional structure of the unit is a faulted and intruded synclinorium which strikes north-north-west.

Thickness

The regional outcrop dimensions of the unit near Calen suggest a thickness of at least 8,000 feet. This represents a minimum because the unit is intruded by the Urannah Igneous Complex. A thickness of at least 6,000 feet is estimated for that part of the sequence which occurs within the Proserpine Sheet area along the Andromache River. Regular east-facing dips in the Carmila Beds between the Proserpine and Andromache Rivers (largely Bowen Sheet area) suggest a thickness approaching 20,000 feet for that part of the unit which is preserved above the intrusive granite contact. This estimate of 20,000 feet makes no allowance for repetition or loss of section due to strike faulting, which is a distinct possibility. The possibility that overturned isoclinal folds may be present is very remote.

Age and relationships

The Carmila Beds contain Noeggerathiopsis hislopi and Glossopteris (see Appendix B). The age of these fossils is Upper Carboniferous or Lower Permian. David and Browne (1950) mention that Rhacopteris has been noted near St Helens,in terrestrial beds conformably overlying equivalents of the Rockhampton Series (Campwyn Beds, in this report), but they quote neither the source of their information nor the exact location. Cordaites australis and Cordaicarpus, which together indicate an Upper Carboniferous or Lower Permian age, have been found in the Bowen Sheet area about 12,000 feet above the intruded base of the unit (Paine et al., in prep. b).

Although the structural relationship of the Carmila Beds to the Campwyn Beds is unknown, the difference in age between the two units, and the presence in places of conglomerates near the base of the Carmila Beds, indicate that the relationship is certainly disconformable, and it is likely that detailed mapping would disclose angular unconformities in places. Near Thoopara, the contact is probably a fault.

It is possible that an angular unconformity in places may separate the Carmila Beds from the Calen Coal Measures (q.v.).

The contact between the Carmila Beds and the Urannah Igneous Complex is not known in detail. None of the field observations in the Proserpine Sheet area indicated an unconformity. The "Mixer" mine occurs in granite near the contact, just within the Bowen Sheet area, 3 miles west-north-west of Glencoe Homestead. Mineralization is also associated with the contact at the Cedar Ridge mines farther north. This mineralization, and the proven Lower Cretaceous age of the intruding granite north of Hecate Homestead (Paine, et al., in prep. b), shows that the contact is wholly intrusive at and north of the "Mixer" mine. However, granite sampled due west of Glencoe Homestead, again just within the Bowen Sheet area, has given an isotopic age of 305 ± 15 million years (Rb/Sr, total rock), which is Upper Carboniferous. The extent of this particular body of granite within the Urannah Igneous Complex is not known, nor was its contact with the Carmila Beds found, although volcanics and granite were seen in outcrop within a few hundred feet of each other. Establishment of the nature of this contact would help to indicate the age of the Carmila Beds.

Hornfelsing of pyroclastics 2 miles west of Mount Millar indicates that the granite there is younger than the Carmila Beds. Farther east and south-east, the morphology of the western foot of the Mount Millar range suggests that the contact is faulted. Between Mount Bowling and Mount Beatrice, photo-interpretation indicates an intrusive contact; at least some of the granite there has been dated as Cretaceous.

In conclusion, the contact between the Carmila Beds and the Urannah Igneous Complex is mainly intrusive, but the significant relationship, which could establish a minimum age for part of the Carmila Beds near Glencoe Homestead, must await detailed mapping of the Upper Carboniferous phase of the Urannah Igneous Complex.

Lizzie Creek Volcanics (Plv)

Rugged, thickly vegetated country between Mount Ossa and the upper reaches of Saint Helens Creek consists of intermediate, acid, and minor basic lavas and pyroclastics. The volcanics are a continuation of the Lower Bowen Volcanics in the Mackay Sheet area. The Lower Bowen Volcanics, which crop out widely in the northern half of the Bowen Basin, have been renamed Lizzie Creek Volcanics (Malone, et al, in press). The Lizzie Creek Volcanics in this area are believed to be equivalent to the basal part of the Carmila Beds, from which they are distinguished by their greater content of lavas and scarcity of interbedded sediments.

The unit is not named on the accompanying geological map, being shown simply by the symbol Plv.

Lithology

Green porphyritic andesite predominates over acid and basic rocks between Camerons Gap and Mount Pelion. Minor agglomerate and tuff are associated with the andesite in places. Red and green rhyolitic lapilli tuff, similar to that commonly found in the Campwyn Beds, has also been observed.

Rubbly outcrops of acid lavas occur on the hillside south of the road at Silent Grove. Rock types include rhyolite or trachyte densely porphyritic in feldspar, acid welded tuff, and crystal-lithic tuff. Pale brown, largely structureless acid lavas crop out between Murray Creek and Camerons Gap. A prominent planar feature in the lavas at Camerons Gap, possibly representing original layering, dips west at 10 degrees.

Agglomerate, intruded by microgranite sills, crops out in a road cutting just north of the confluence of Barren Creek and Saint Helens Creek. Massive intermediate pyroclastics, intruded by basic dykes,form the bed of Saint Helens Creek where it flows out of the mountains west of Crazy Cat Mountain.

Sediments occur in Saint Helens Creek south of Barren Mountain. They include shale, siltstone, lithic sandstone, and conglomerate.

The shale is dark and contains fossil plants; it varies in hardness, and possesses a shaley "cleavage" as well as close random jointing, especially in weathered outcrops. Siltstone is rare, and may be tuffaceous. The sandstone contains a high proportion of lithic fragments, mostly of volcanic origin, and in places grades to tuffaceous sandstone. It is moderately well sorted, containing a low proportion of silt or clay matrix, but in places grades to sandstone and poorly sorted pebble conglomerate composed mainly of volcanic fragments. Colour varies from brown to green, and the bedding from thin to thick.

In Barren Creek, one mile east of Mount Lilian, labile volcanic conglomerate and greywacke derived from basaltic or andesitic rocks underlie clean quartz sandstone of the Calen Coal Measures.

Gravel composed of volcanic fragments occurs in the bed of Urannah Creek, 3 miles inside the Bowen Sheet area. The fragments include coarse pyritic lithic tuff, flow-banded rhyolite, dacitic crystal tuff, and thinly bedded tuffaceous sediments. This indicates that some undetected outcrops of volcanics occur, probably within the Proserpine Sheet area, west of the main watershed in country mapped as Urannah Igneous Complex.

Structure, Age and Relationships

Bedding in shale south of Saint Helens Creek is horizontal. Photo-interpretation suggests that the sequence between Camerons Gap and Murray Creek is also near horizontal. Bedding trends have not been observed on air photographs. Fossil plants found in the unit indicate an Upper Carboniferous to Lower Permian age. They include: Vertebraria indica, Noeggerathiopsis hislopi Bunb., Samaropsis dawsoni Shirley, and fragments of Glossopteris.

The relationship between the Lizzie Creek Volcanics and the Carmila Beds is obscured by the overlying Calen Coal Measures. However, the similarity of the fossil assemblages of the two units indicates that they are of similar age. Volcanics are much more abundant than sediments towards the base of the Carmila Beds in the Bowen Sheet area, and for this reason the Lizzie Creek Volcanics are regarded as broadly equivalent to the basal part of the Carmila Beds.

Airlie Volcanics (Pll) (new name)

Intermediate to acid pyroclastics, andesite, and rhyolite in the area north and east of Proserpine, have been mapped as a new stratigraphic unit, the Airlie Volcanics, of probable Upper Carboniferous to Lower Permian age.

Nomenclature

Prior to our mapping, the geology both of the mainland east and north of Proserpine, and of the Cumberland Islands north of Shaw Island, was poorly known. Stanley (1927, p. 6) considered the volcanics in this area to be of "Permo-Carboniferous (Lower Bowen) age". He suggested however that the geology of the area was complex, and required more thorough investigation. The Geological Map of Queensland (1953) shows the volcanics as Undifferentiated Upper Palaeozoic.

Our mapping suggests that the volcanics of this area are divisable into the Lower Carboniferous Edgecumbe Beds (Cle), the probably Upper Carboniferous to Lower Permian Airlie Volcanics (Pll), and two Cretaceous units - the Whitsunday Volcanics (Kw), and the Proserpine Volcanics (Kp).

The new name, Airlie Volcanics, has been proposed for a sequence of pyroclastics and flows which crop out in the ranges north and east of Proserpine and on Rattray, Olden, Grassy, Armit, and Double Cone Islands.

The coastal outcrops from Scrubby Hill (E136600., N2461700) to the Beak (E149000., N2460600), constitute the type area of the Airlie Volcanics. The name is derived from the small seaside resort of Airlie. The best exposures in the type area are on the small promontory at Airlie, and at Mandalay Point.

Distribution and Topography

The Airlie Volcanics, and the overlying Proserpine Volcanics, form rugged ranges, covered by rain forest north and east of Proserpine. Access is very poor except in the lower areas where sugar cane is grown. A few temporary tracks used for timber haulage give some access to the more rugged parts of the ranges. By far the best exposures are to be found along the coast and in the islands.

Lithology

Between Bluff Point and Olden Island the Airlie Volcanics consist of intermediate to basic lavas and pyroclastics, with some dacite and rhyolite. The dark blue-grey or purple lavas range from aphanitic to sparsely porphyritic, and are commonly vesicular or amygdaloidal. Most are severely altered, and in thin section it is not possible to tell andesite from basalt. Phenocrysts, where present, consist of plagioclase and pyroxene. The groundmass of a typical lava is a felted mass of flow-aligned plagioclase laths (identified in one slide as labradorite), accompanied by abundant opaque granules and chlorite. Calcite forms small evenly spaced aggregates, and in one specimen it forms about 30 per cent of the rock. Most amygdules consist of calcite, some are formed from chlorite, or microcrystalline quartz, and others from calcite and chalcedony. Massive green agglomerate containing bombs and fragments of purple lava is the chief pyroclastic rock, but many outcrops contain minor interbeds of well bedded blue-green crystal-lithic tuff. Volcanic breccia at Double Cone Island contains small aggregates of pyrite; the fragments in the breccia are rhyolite, green bedded tuff, and granite.

Dacitic welded lapilli tuff, porphyritic spherulitic dacite (or rhyodacite) and andesite occur at the northern tip of Armit Island. The dacite contains 5 percent amphibole and 5 percent biotite; the amphibole is extensively replaced by calcite and sericite, and the biotite is altered to chlorite and sericite. Flow banded rhyolite or trachyte overlies agglomerate on the eastern islet of Double Cone Island. Rattray Island, on the northern boundary of the Sheet area, consists of massive andesite, more porphyritic than other andesites in the sequence.

The stratigraphically higher parts of the sequence between Bluff Point and Cow Island consist of pyroclastics, with some andesite and rhyolite. Intermediate to basic lavas, so common in the lower part of the sequence, have been observed in only a few places, where they probably occur as solitary flows. The pyroclastics range from fine-bedded tuff to massive volcanic breccia and agglomerate, and the coarse and fine grained rocks are usually interbedded. The tuffaceous rocks are generally dark reddish brown or greenish brown crystal-lithic tuffs, but crystal tuff and devitrified crystal-vitric tuff are common. Typical tuffaceous rocks accompanied by some andesite lavas are well exposed around the small promontory at Airlie. The crystal-lithic tuffs are moderately sorted, regularly bedded, medium to very fine-grained rocks, which are almost certainly waterlain. Clastic material includes angular acid and intermediate volcanic fragments, broken plagioclase crystals, and a small percentage of devitrified glassy fragments. A sparse, very fine-grained matrix is present in some specimens. Bedding units range from a quarter of an inch to a foot in thickness. Some of the tuffs at Airlie are welded. Regularly bedded waterlain tuffs, exposed in road cuttings between Airlie and Shute Harbour, are interbedded with massive dark green welded tuff. Devitrified crystal-vitric tuff is well exposed at Stripe Point; crystal tuff is interbedded with agglomerate and andesitic breccia on the western side of Funnel Bay.

At Bald Head, at the mouth of the Proserpine River, a section of near vertical tuffs is very well exposed. The tuffs contain carbonized wood fragments, and some at least are waterlain. They are composed of fragments of plagioclase, volcanic rocks, devitrified glass and rare pyroxene.

Rhyolite is an abundant rock type between Shute Harbour and Pioneer Point. It is deep reddish brown, strongly flow banded, and microspherulitic. Rhyolite breccia is commonly associated with the flows. The area about Mount Rooper consists entirely of rhyolite and rhyolite breccia, and probably represent an extrusive centre.

Structure

The Airlie Volcanics are folded into a broad syncline which plunges south or south-south-west at a low or moderate angle.

Thickness

Neither the top nor the bottom of the Airlie Volcanics is exposed, and consequently the total thickness of the unit is unknown. A thickness of about 20,000 feet is estimated for that part of the unit which crops out between Olden Island and Airlie, but this makes no allowance for the effects of movement on the Woodwark Fault, and other possible faults.

Relationships

The Edgecumbe Beds and the Airlie Volcanics form the basement on which the Cretaceous volcanic units were deposited.

Overall, the lithology of the Airlie Volcanics is significantly different from that of the Whitsunday and Proserpine Volcanics, but locally the major differences are not apparent. Also parts of the Airlie Volcanics resemble the volcanics and pyroclastics of the upper parts of the Edgecumbe Beds, and, as the contacts between the two units are either faulted or masked by rain forest, it has not been possible to demonstrate conclusively that the two units are unconformable. The main reasons for regarding the Airlie Volcanics as a sequence distinctly younger than the Edgecumbe Beds have been their contrasting structure and the close lithological similarities of the Airlie Volcanics with parts of the Carmila Beds.

The south-eastern boundary of the Airlie Volcanics is interpreted as the east-north-east trending Conway Fault. Although the lithology of the Whitsunday Volcanics between Cape Conway and the fault is not markedly different from that of the Airlie Volcanics exposed in coastal outcrops north of the fault, there is a marked difference between the attitudes of the two sequences north and south of the fault. Also, the existence of the carbonaceous arkosic conglomerate (Kc) at Cape Conway proves that the sequence south-east of the Conway Fault is Mesozoic in age or younger.

The eastern margin of the Airlie Volcanics is a major fault or perhaps fault system (the Molle Fault) extending south-south-east along a marked topographic feature - Long Island Sound.

The boundary between the Airlie Volcanics and the Cretaceous Proserpine Volcanics is for the most part photointerpreted, because it is inaccessible and poorly exposed. Fortunately, the Proserpine Volcanics are mainly subhorizontal, and the boundary can be satisfactorily photointerpreted on the 1:85,000 scale photographs, using the 1:24,000 scale Proserpine photographs for further checking.

Along the northern and north-western margins, the Airlie Volcanics are intruded by granite (P-Mg) and diorite (P-Md).

Age

There is no evidence available for determining a definite age for the Airlie Volcanics. No fossils, excepting rare indeterminate wood fragments at Bald Head, have been found. Rubidium-strontium age-determinations on rhyolites from Shute Harbour have failed to produce an isochron. However, A. Webb (pers. comm.) states that the results indicate an age older than Mesozoic.

The Airlie Volcanics probably unconformably overlie the Lower Carboniferous Edgecumbe Beds. They most closely resemble the Upper Carboniferous to Lower Permian Carmila Beds, particularly that part of the Carmila Beds exposed in the Bowen Sheet area. Regional mapping in the Mackay-Bowen Hinterland has shown Upper Carboniferous to Lower Permian to be the main period of Palaeozoic vulcanicity in this area. It is considered unlikely that the Airlie Volcanics are not of this age; a tentative Upper Carboniferous to Lower Permian age is therefore assigned to the unit, based on analogy with the Carmila Beds and on regional considerations.

The absence of sediments in the Airlie Volcanics makes it unlikely that fossils will be found; isotopic age-determination, probably by using the rubidium-strontium method on rhyolites, at present holds out the best hope for dating the unit.

LOWER PERMIAN

Calen Coal Measures (Ple)

Nomenclature

The name "Calen Coal Measures" was first used by Hill (*in* Hill and Denmead, 1960, p. 222) for a unit described, but not formally named, by Reid (1929a), who recorded about 1,000 feet of coal measures cropping out west of Calen. Reid distinguished this unit from the underlying Lower Bowen Volcanics (Carmila Beds).

Distribution and topography

The Calen Coal Measures crop out in a narrow strip of country extending from Elaroo siding south-east into the Mackay Sheet area. A small outcrop is mapped farther north, at Kamo Siding. Most of the beds in the unit are soft; they crop out poorly to form gently undulating plains. The upper beds, however, are hard quartzose sandstone, and this rock type forms steep ridges near Calen (the Whiptail Range), and caps high hills southwards to the Pioneer River in the Mackay Sheet area.

Lithology

The Calen Coal Measures comprise sandstone, siltstone, carbonaceous shale, mudstone, and coal. The sandstone is coarse to medium grained, quartzose, brown to white, and thick bedded . Large to medium-scale cross stratification in the sandstone makes measurement of dips difficult; small-scale slumps have been observed. The Calen Coal Measures are best exposed in the road cuttings in the Bruce Highway north of Mackay, where thin-bedded siltstone, micaceous quartz sandstone, and carbonaceous shale are intruded by large dykes and sills. The lack of tuffaceous or other volcanic detritus in the rocks distinguishes the Calen Coal Measures from the underlying Carmila Beds. Some sandstone outcrops contain thin pebble conglomerate bands. Imprints of fossil wood and coalified wood fragments occur in many outcrops of the unit.

Petrographic examination of a specimen of sandstone from Barren Creek, north of Barren Mountain shows it to be a very pure quartz sandstone. The grains are well rounded, moderately well sorted, and closely packed; their diameter is generally about 1mm., but ranges down to 0.1mm. Traces of a clay matrix are present. Most of the grains are strained and many have overgrowths of secondary silica. Rare grains of quartzite are present.

Environment of deposition

No marine fossils have been found in the Calen Coal Measures; this and the presence of coal are taken to indicate either continental or near-shore sedimentation.

Thickness and structural relationships

Reid (1929,a) estimated that the unit was 1,000 feet thick in the Blackrock Creek area, assuming no loss or repetition of section by faulting; the quartz sandstone which forms the Whiptail Range is the highest bed exposed. This figure is similar to that obtained by Jensen et al. (1966) at Mount Toby in the Mackay Sheet area. However, in Barren Creek, the Whiptail Range quartz sandstone, where it reappears on the south-western limb of a syncline, is only 200 feet stratigraphically above greywacke and tuffaceous conglomerate of the Lizzie Creek Volcanics. This and similar outcrops in the Mackay Sheet area indicate that the quartz sandstone unit at the top of the succession overlaps older beds of the unit.

The regional strike is north-west, and the regional dip south-west. In the southernmost outcrops the unit is preserved in a south-east plunging syncline in the Buthurra siding area; the limbs of this structure dip at about 30 degrees. In this area an angular unconformity between the Calen Coal Measures and the Lizzie Creek Volcanics can be seen. A similar relationship may exist between the Calen Coal Measures and the Carmila Beds, but this has not been seen. In the Calen area the regional dip is to the south-west, but small folds, such as the Whiptail Range syncline may be due to disturbance by intrusion or faulting. In this area the Calen Coal Measures are intruded by the rhyolite plug of Barren Mountain (P-Mr), by the granite of Mount Catherine (P-Mg), by the Urannah Igneous Complex, and by a body of porphyritic dolerite (P-Mo). Sandstone in Barren Creek is intruded by sills of fine-grained microgranite.

Relationships and age

The possibility that an unconformity may in places separate the Calen Coal Measures from the Carmila Beds is suggested by the overlapping relationship of the sandstone in the Whiptail Range, and by minor divergences of strike and dip between the two sequences east of Mount Ossa.

The fact that the Calen Coal Measures contain no volcanic detritus indicates a change of provenance from that of the Carmila Beds.

The Calen Coal Measures are almost certainly Permian in age. Reid (1929,a) reported Glossopteris and Vertebraria at the Calen colliery (later the Fleetwood colliery), and the unit is underlain by a thick sequence of Upper Carboniferous to Lower Permian rocks, (Plv, Pla). It is unlikely to be Triassic, both on plant fossil evidence, and on overall lithology as compared with the Triassic sequence in the northern part of the Bowen Basin. Reid correlated the unit with the Lower Permian Collinsville Coal Measures, which seems reasonable. Although the Calen Coal Measures do not have the tuffaceous material of the Upper Permian Blackwater Group and its equivalents, there is a possibility that they could be equivalent to the coal of the Blenheim Sub-group (Upper Permian).

UPPER CARBONIFEROUS TO LOWER CRETACEOUS

Urannah Igneous Complex (C-Mr)

The Urannah Igneous Complex forms mountainous country rising to more than 3,000 feet above sea-level in the south-west of the Sheet area. It is part of a belt of granitic rocks 150 miles long. Access is difficult owing to the rugged terrain and rain forest; only the eastern part of the complex was inspected. The lithology is generally granodiorite or adamellite, but quartz diorite and gabbro also occur. Most outcrops are intruded by basic and acid dykes. The plutonic rocks are mostly massive. Strong lineaments, some of which probably represent faults, are visible on air photographs of the eastern part of the complex. Upper Carboniferous, Lower Permian, and Cretaceous isotopic dates have been obtained from the complex in and near the Sheet area. The complex is regionally intrusive into the Upper Carboniferous to Lower Permian volcanics and sediments. Apart from very minor emery and pyrite, no mineralization is known to occur within the Sheet area, but gold-copper mineralization in the adjacent Bowen and Mackay Sheet areas suggests that the complex in the Proserpine area should be regarded as a potentially mineralized area.

Nomenclature and distribution

The name "Urannah Complex" was introduced by Malone, et al. (1964) for plutonic rocks in the north-east corner of the Mount Coolon Sheet area. The name is derived from Urannah Homestead, in the south-east corner of the Bowen Sheet area. The rocks were known to form part of an extensive plutonic complex, which was later mapped over a distance of 150 miles in a north-west trending belt from Broad Sound to the coast west of Bowen (Jensen, et al., 1966, Malone, et al., 1966 and in press, Paine, et al., in prep, a & b). As part of a proposal for confining the name "Urannah" to rocks south-east of Grant Creek (Bowen Sheet area), Paine, et al. (in prep. b) introduced the adjective "Igneous" to the name, because by then metamorphic rocks were known to be of only very minor importance. The complex forms 100 square miles of mountainous country in the south-west corner of the Proserpine Sheet area. The mountains form part of the Clarke Range.

Topography and access

The Urannah Igneous Complex is deeply dissected, and relief in some areas is more than 2,000 feet. Some peaks rise to more than 3,000 feet above sea-level and are the highest in the Sheet area.

Most of the complex is covered by rain forest, but the vegetation is less dense along the headwaters of Horse and Pandanus Creeks east of the Clarke Range, and west of Eungie and Kangaroo Creeks in the Clarke Range itself. Sugar can is grown on cleared land along the O'Connell River and at Taro Creek.

Access within the complex is difficult, but several roads cross the contact from the east. A well graded gravel road, used by logging crews, climbs the escarpment west of the Forestry Station (Cathu State Forest). From the top of the escarpment temporary access tracks lead off into the forest. Well maintained gravel roads afford access in the farmed areas. In general, outcrops must be sought in road-cuttings and creeks. They are extremely rare in the forest.

Lithology

Geological observations were confined to the more easily accessible parts of the Complex. Spot observations were made in Massey Gorge by helicopter, and in Saint Helens Creek.

Rocks of the Complex range widely in lithology, but adamellite and granodiorite are probably the commonest rock types. Medium to coarse biotite adamellite crops out at the foot of the escarpment due west of Glencoe Homestead at the border of the Sheet area. Coarse biotite adamellite forms tors beside the road one mile east of the Forestry Station, and granodiorite crops out 1.5 miles west of the Forestry Station.

The coarse adamellite east of the Forestry Station is inequigranular; it consists of quartz (45 percent), perthite (30 percent), oligoclase (20 percent), biotite (5 percent), muscovite (1 percent), and accessory hematite and zircon.

The granodiorite is leucocratic, and consists of quartz (50 percent), strongly zoned plagioclase (35-40 percent), perthite (5-7 percent), biotite (2 percent), hornblende (2 percent), and accessory hematite, apatite, and zircon. The biotite is universally fresh, but the hornblende may be either completely unaltered or entirely chloritized, even in adjacent crystals. The granodiorite is intruded by abundant dykes; some of the microdiorite dykes contain prominent aggregates of calcic andesine phenocrysts, and pyrite cubes up to 1 mm in diameter. Thin aplitic micro-adamellite dykes dip steeply to the south-west. In places the granodiorite is crowded with xenoliths of biotite-hornblende microdiorite.

Outcrops of medium to coarse spinel-bearing gabbro occur in a deep road cutting just below the lip of the escarpment of the Kangaroo Creek Tableland. The gabbro contains some coarse hornblende-plagioclase segregations in which hornblende crystals attain a length of 8 cm. The gabbro mass is restricted in extent; leucocratic rocks reappear at the top of the escarpment and extend north to beyond the head of Boundary Creek.

Medium-grained diorite containing rare pyrite crystals and granodiorite containing dioritic xenoliths crop out on the western slopes of Mount Macartney.

Hornblende-biotite adamellite or granodiorite, abundantly intruded by acid and basic to intermediate dykes, occurs beside the O'Connell River where it crosses the contact. Blocks of quartz diorite were noted in a small tributary of Saint Helens Creek south-west of Barren Mountain. Boulders and cobbles of leucocratic biotite "granite" are abundant in the bed of Saint Helens Creek, where it debouches from the rugged spurs of the complex west of Crazy Cat Mountain. South of Rise and Shine the contact of the complex has been photo-interpreted; plutonic rocks have not been seen <u>in situ</u>.

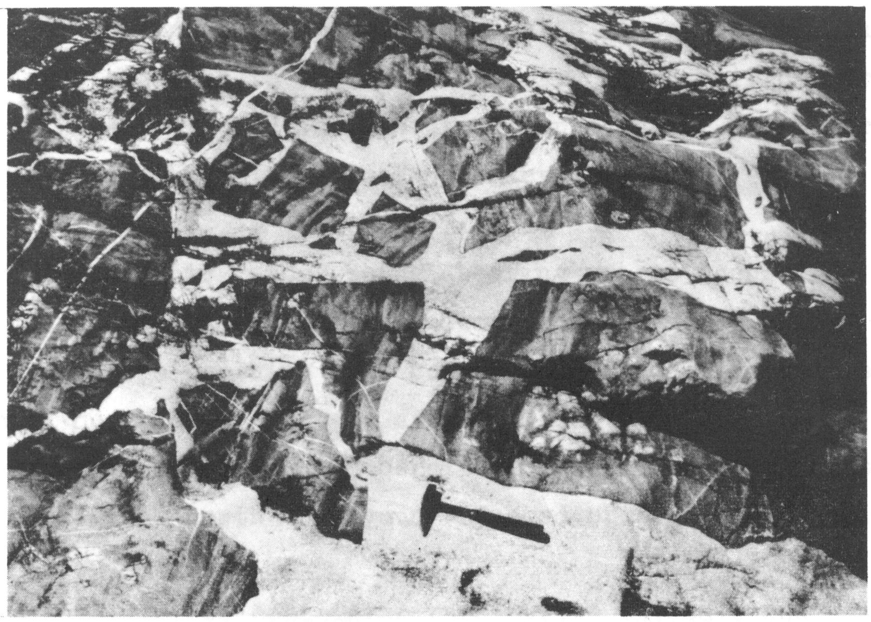


Photo Plate 6: Adamellite intruding foliated diorite in a network of dilational dykes. Urannah Igneous Complex (Upper Carboniferous to Cretaceous), Massey Gorge. BMR Neg. No. GA/314

Weakly foliated, inequigranular, hornblende-biotite "adamellite" of variable colour index and grain size crops out in the bed of Massey Creek, just south of the margin of the Sheet area. It is intruded by dark dykes which strike east. Quite extensive xenolithic areas of foliated fine-grained diorite also occur. The adamellite intrudes the diorite in a network of dilational dykes (Photo Plate 6). Foliation in the diorite strikes east.

Structure

All rocks in these parts of the Complex which were visited are essentially massive; foliation, where observed, is weak and evanescent. Numerous lineaments can be seen on the air photographs, mainly in the eastern half of the area occupied by the Complex; the more persistent are almost certainly faults. The O'Connell River occupies a straight meridional valley which bifurcates south of Kanaka Creek; the valley is on strike with the O'Connell Fault.

Age and relationships

Isotopic dating (mainly within the Bowen Sheet area) has shown that there have been separate intrusive events in the Upper Carboniferous, Lower Permian, and Lower Cretaceous. A limited amount of evidence is available on the distribution of the different intrusions in the Proserpine Sheet area.

A specimen from due west of Glencoe Homestead has been dated as Upper Carboniferous (305 $\pm$ 15 m.y., Rb/Sr, total rock), and adamellite from Massey Gorge yielded a Lower Permian age (268 m.y., $\pm$ 3 percent, K/Ar, biotite). The coarse adamellite east of the Forestry Station is Lower Cretaceous (117 m.y., $\pm$ 3 percent, K/Ar, biotite). Granodiorite 1.5 miles west of the Forestry Station has yielded an Upper Permian age (235 m.y. $\pm$ 3 percent, K/Ar, biotite and hornblende coincident ages; alluded to in error as 245 m.y. in Malone, et al, 1966), but in the absence of other similar ages from the complex, Webb (pers. comm.) interprets this result as being due to loss of argon by an Upper Carboniferous or Lower Permian intrusion, owing to the emplacement of the nearby Lower Cretaceous granite. The Cretaceous intrusive event may correspond to that represented by the Hecate Granite in the Bowen Sheet area (Paine, et al. in prep.). K/Ar dates obtained from the Hecate Granite range from 123 to 127 million years. Alternatively the date of

117 m.y. may reflect the probably distinct later event exemplified by the ages of 110 and 115 m.y. which have been obtained from the granite (Kg) at Halliday Bay. Isotopic dates obtained by the K/Ar method from rocks in the Clarke Range just west of the Sheet area range from 283 to 294 m.y.

Nowhere was the contact of the complex seen in outcrop. Its location could be narrowed down to a few hundred feet in places, and in general it may be said that the contact is regionally intrusive, although the results of isotopic dating have shown that at least one phase of the complex may be older than the neighbouring volcanics and sediments. For further discussion,see Carmila Beds.

Between Rise and Shine and Saint Helens Creek the complex is evidently Lower Permian or younger; it intrudes a plug of rhyolite (P-Mr) which in turn has intruded the Lower Permian Calen Coal Measures.

A small piece of emery (see Appendix F) was picked up from the valley floor 2.5 miles west of Mount Millar at E118000 N2403500. Pieces of hornfelsed volcanics occur in creeks which drain the ridge immediately to the west. These occurrences are evidence for an intrusive relationship west of Mount Millar. Pebbles of volcanic rocks were found in Urannah Creek, just west of the Sheet area, showing that volcanic rocks crop out in the Clarke Range west of the main divide.

<u>Mineralization</u>

Apart from the occurrence of emery and minor disseminated pyrite in diorite and dyke rocks, no mineralization is known to occur in the complex in the Proserpine Sheet area. However, widespread minor gold and copper mineralization and some silver-lead-zinc mineralization are associated with the complex and the Hecate Granite in the neighbouring Mackay and Bowen Sheet areas. The complex and its contact in the Proserpine Sheet area should therefore be regarded as potentially mineralized.

PERMIAN TO MESOZOIC

Masses of diorite, dolerite, rhyolite, and granite which intrude the Palaeozoic rocks but are otherwise of unknown age, are discussed below.

Diorite (P-Md)

Diorite crops out in a narrow belt and as discrete masses to the north-north-west of Proserpine between Nelly Bay and Lower Gregory. The full extent of the diorite is masked by alluvium and Tertiary sediments (Ts) in the low country, and by dense rain forest in the rugged ranges.

North of Box Creek the diorite varies slightly in grain size but shows little compositional variation. A typical specimen, collected from the Gamut Creek-Dingo Beach track crossing, is fine-grained and consists of andesine (55 percent), green hornblende (35 percent), quartz (5-10 percent) and chloritized biotite (1-2 percent). Apatite is an abundant accessory. The diorite mass is intruded along most of its eastern side by red biotite granite (P-Mg). Beside the Dingo Beach track, just north of Miralda Creek, biotite granite and pegmatite dykes intrude the diorite and are cut by microdiorite and felsite dykes. The relationship of this elongate mass of diorite to the Edgecumbe Beds was not observed in the field; it is however almost certainly intrusive.

An irregular mass of leucocratic diorite about 2 miles long intrudes rhyolite and pyroclastics of the Edgecumbe Beds in the headwaters of Vine Creek. A sectioned specimen is medium grained and consists of oligoclase/andesine (80 percent), hornblende (5 percent), clinopyroxene (5 percent), quartz (5-10 percent), chloritized biotite (2 percent), accessory apatite and iron ore. Quartz is interstitial and in places micrographic. The ferromagnesian minerals are highly altered, and the plagioclase is sericitized and cloudy.

Medium-grained diorite, which crops out at the junction of Dryander Creek and the Gregory River, contains microdioritic xenoliths and small volcanic fragments. It intrudes rhyolite, tuff and breccia of the Airlie Volcanics. It closely resembles the diorite in the headwaters of Vine Creek, but quartz is less abundant, and the rock is not so altered.

Dolerite (P-Mo)

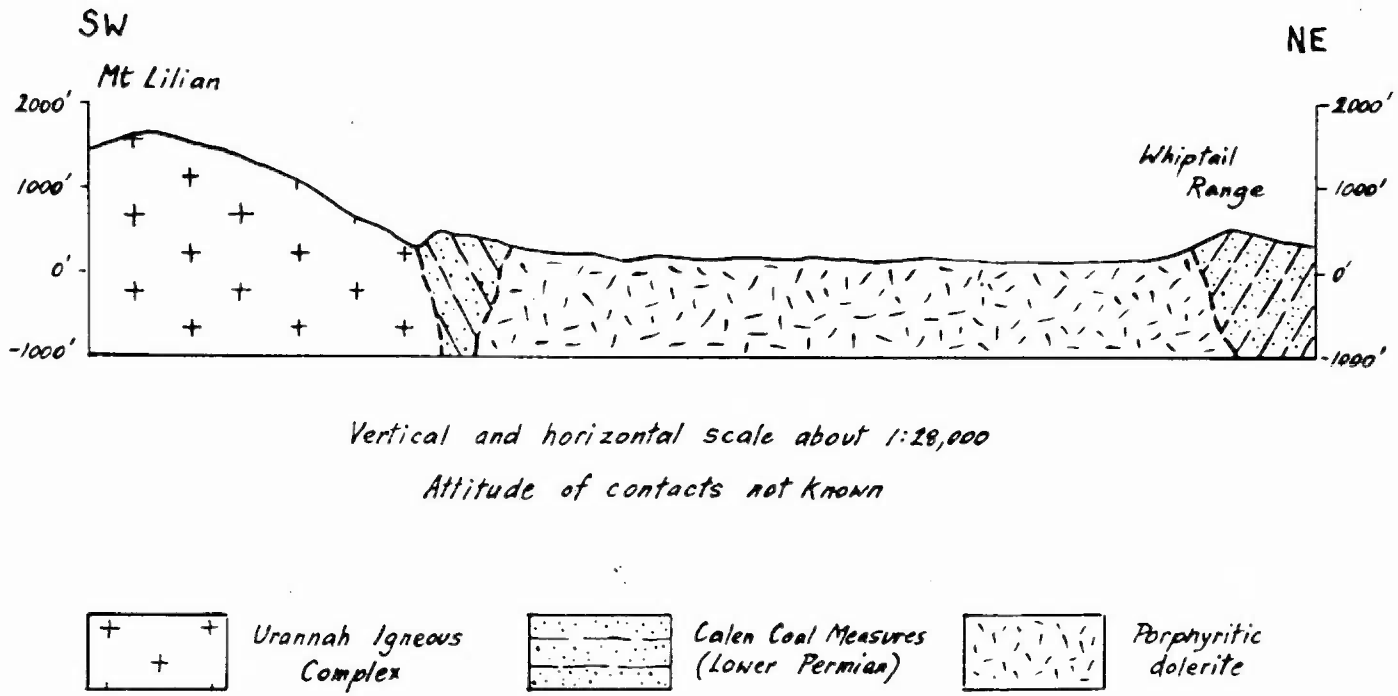
An elongate intrusion of altered, densely porphyritic dolerite, lithologically distinct from other intrusions in the Sheet area, forms dissected lower-lying country between sandstone ridges of the Calen Coal Measures, five miles west of Calen. The dolerite crops out as scattered tors on gentle slopes, and is well exposed in creeks.

A typical specimen (B.M.R. T.S. 65152216) consists of densely packed, euhedral phenocrysts of labradorite averaging 5mm (up to one cm.), in a groundmass of feldspar (15 percent), augite (8 percent), chlorite (8 percent), sericite (3 percent), opaque minerals (3-4 percent), quartz (1-2 percent), and accessory apatite and calcite. The grainsize of the groundmass ranges from 0.5 to 3mm. The labradorite phenocrysts (An_{55}), which constitute 60 percent of the rock, are traversed by a dense network of micro-fractures. The groundmass feldspar is very turbid, and is tentatively identified as albite. Microperthite forms a few euhedral crystals, intermediate in size between the phenocrysts and the groundmass feldspars. Sub-ophitic augite (up to 3 mm.) is generally fresh; it is associated with minor amounts of weakly pleochroic pale brown amphibole. Chlorite forms yellow-green aggregates of very small matted crystals, and also fills abundant fine cracks in the quartz grains. Sericite (?) occurs in sheaves associated with quartz and chlorite.

Loose pieces of drusy, leucocratic microgranite occur in places among outcrops of dolerite. Sills of similar leucocratic microgranite, up to six feet thick, intrude agglomerate (Plv) in a road cutting just north of the confluence of Barren Creek and Saint Helens Creek.

Fig. 4

Sketch section across DOLERITE INTRUSION (P-Mo)
from Mount Lilian to the Whiptail Range



Vertical and horizontal scale about 1:28,000

Attitude of contacts not known

To accompany Bureau of Mineral Resources Record No. 1968/22

AGW 9/8/67

The dolerite has been intruded along the axis of a syncline (Figure 4) whose limbs are exemplified by a quartz sandstone of the Calen Coal Measures (Lower Permian). The relationship with the Urannah Igneous Complex was not established, but the air photographs suggest that the contact is faulted.

Intrusive rhyolite (P-Mr)

Three rhyolite intrusions occur close to each other in a north-west-trending line between Cathu and Saint Helens Creek. They form Mount Beatrice, Barren Mountain, and Rocky Mount.

An almost perfectly elliptical plug of rhyolite, 3 miles long, forms a steep rugged range south-east of Yalboroo, which culminates in Mount Beatrice, 1,740 feet above sea-level. The centre of the intrusion is occupied by an open valley, but the creeks have cut ravines in the more resistant marginal zone.

Flow-banded rhyolite forms bars in Beatrice Creek, at the margin of the plug. The rhyolite (not thin-sectioned) is sparsely porphyritic in quartz and feldspar. The flow-banding dips at 60 degrees to the north-east, and photo-interpretation suggests that it dips steeply outwards around the entire marginal zone of the intrusion. From this it is concluded that the present level of erosion is not far below the original roof of the plug, and that the intrusion widens with depth.

The plug intrudes the Lower Permian Calen Coal Measures and the Carmila Beds. Its elliptical margin is interrupted by the Mount Catherine granite boss (P-Mg), which therefore is presumed to intrude it.

A rhyolite plug, nearly circular in plan and about two miles in diameter, forms Barren Mountain, 5 miles south-west of Calen. On the air photos it is seen as a less densely vegetated area than the adjacent Urannah Igneous Complex. Barren Mountain rises to 1,780 feet above sea-level. The intrusion has been carved into ravines, controlled by joints. Barren Mountain rises steeply from the valley of Saint Helens Creek, but in the west it merges into the higher and more broadly dissected granitic country of the Urannah Igneous Complex.

The intrusion consists of rhyolite or dellenite, but the feldspars are difficult to identify (B.M.R. T.S. 65152138,39,40). Quartz varies between 10 and 45 percent, and some of the rocks approach trachyte in composition. Phenocrysts of quartz and feldspar are rare. Biotite, which amounts to about 7 percent of one specimen, commonly occurs as very fine-grained aggregates. Chlorite and opaques are also present. Crystals of sieve-textured garnet up to 2 mm in diameter comprise about 1% of some specimens. Flow-banding is present in places; it dips steeply towards the centre of the plug.

The margin of the intrusion is sharply defined in the north, east, and south, but in the west it cannot be readily photo-interpreted. The morphology of the western side of the plug indicates that it has been intruded by the Urannah Igneous Complex, and the garnets in the rhyolite are believed to be due to hornfelsing by the complex. The seive texture of the garnet crystals, and the fact that the flow - aligned feldspar crystals in the rhyolite do not swirl around them. suggest they are porphyroblasts.

The Barren Mountain plug has intruded and domed the Calen Coal Measures around its northern and eastern margins.

A sill-like intrusion of rhyolite, 2 miles long by 1/3 mile wide, intrudes the Carmila Beds north of Yalboroo. The sill crops out as an uneven ridge whose northern end rises to form Rocky Mount, 920 feet above sea level.

Granite (P-Mg)

Granite crops out in the north-west of the Sheet area, between Box Creek and George Point, and forms Saddleback, Eshelby and Gumbrell Islands. Very little soil is present and the granite is strongly jointed. Medium-grained siliceous biotite granite is the main rock type, but adamellite has been noted in places. Fine-grained, coarse-grained and leucocratic granites are also present. Biotite, which forms only 1-2% of the granite but is more abundant in the adamellite, is invariably chloritized. The granite is intruded by aplite, felsite and microdiorite dykes.

Cameron (1903) reports that Mount Catherine is granite, and states that the granite intrudes coal-bearing sediments, now mapped as the Calen Coal Measures. Boulders of pink hornblende microgranite intimately intruding diorite occur in Beatrice Creek, which drains Mount Catherine. An extensive quartz-filled breccia, with no obvious trend, occurs at the north-west extremity of the granite. On the air photograph this granite appears to intrude the rhyolite intrusion (P-Mr) of Mount Beatrice.

CRETACEOUS

The Cretaceous Volcanic rocks in the Sheet area have been mapped as two units, the Whitsunday Volcanics, a series of water-lain pyroclastics, and the terrestrially deposited Proserpine Volcanics which consist mainly of rhyolite flows. Both are new stratigraphic names.

Whitsunday Volcanics (Kw)

A history of repeated vulcanism and faulting, considerable similarities in rock type between volcanic units, thick forest cover, and disconnected outcrops all combine to make stratigraphic correlation in the Proserpine region a hazardous exercise, especially in the islands. However, field mapping, isotopic age-determinations, and a lucky find of fossils at Cape Conway have established beyond reasonable doubt that the volcanic rocks which form most of the Cumberland and Whitsunday Islands are Cretaceous in age.

Prior to the mapping of the Proserpine Sheet area, the only extensive development of Cretaceous volcanics known in Queensland was the Lower Cretaceous Graham's Creek Formation of the Maryborough Basin (Ellis 1966). Evidence of the existence of an extensive belt of Cretaceous volcanics off shore between Proserpine and Maryborough has been accumulating over the last few years. Ellis (1966), in discussing the possible northward continuation of the Graham's Creek Formation, as indicated by offshore seismic and aeromagnetic surveys, suggested that a shallow supra-basement anomaly beneath the Bunker Group of islands may represent the Lower Cretaceous Graham's Creek Formation. An aeromagnetic survey of the Swain Reefs area for Australian Gulf Oil (Affleck and Landan, 1965) indicated a discontinuous supra-basement, probably composed of volcanics, beneath the

Swain Reefs. Wreck Island No. 1 bore, drilled by Humber Barrier Reef Oils Pty.Ltd., in the Capricorn Group in 1959, bottomed in lapilli tuff which Ellis (1966) has since suggested may be equivalent to the Lower Cretaceous Graham's Creek Formation. It appears that the volcanics of the Percy Isles (Northumberland Group) are very similar to the Whitsunday Volcanics (A.C. Kirkegaard, pers. comm.) and descriptions by White and Brown (1963) of islands in the Beverley Group correspond closely with the characteristics of the Whitsunday Volcanics. The occurrence of known and possible Cretaceous volcanics in coastal Queensland is outlined in Figure 5.

Nomenclature

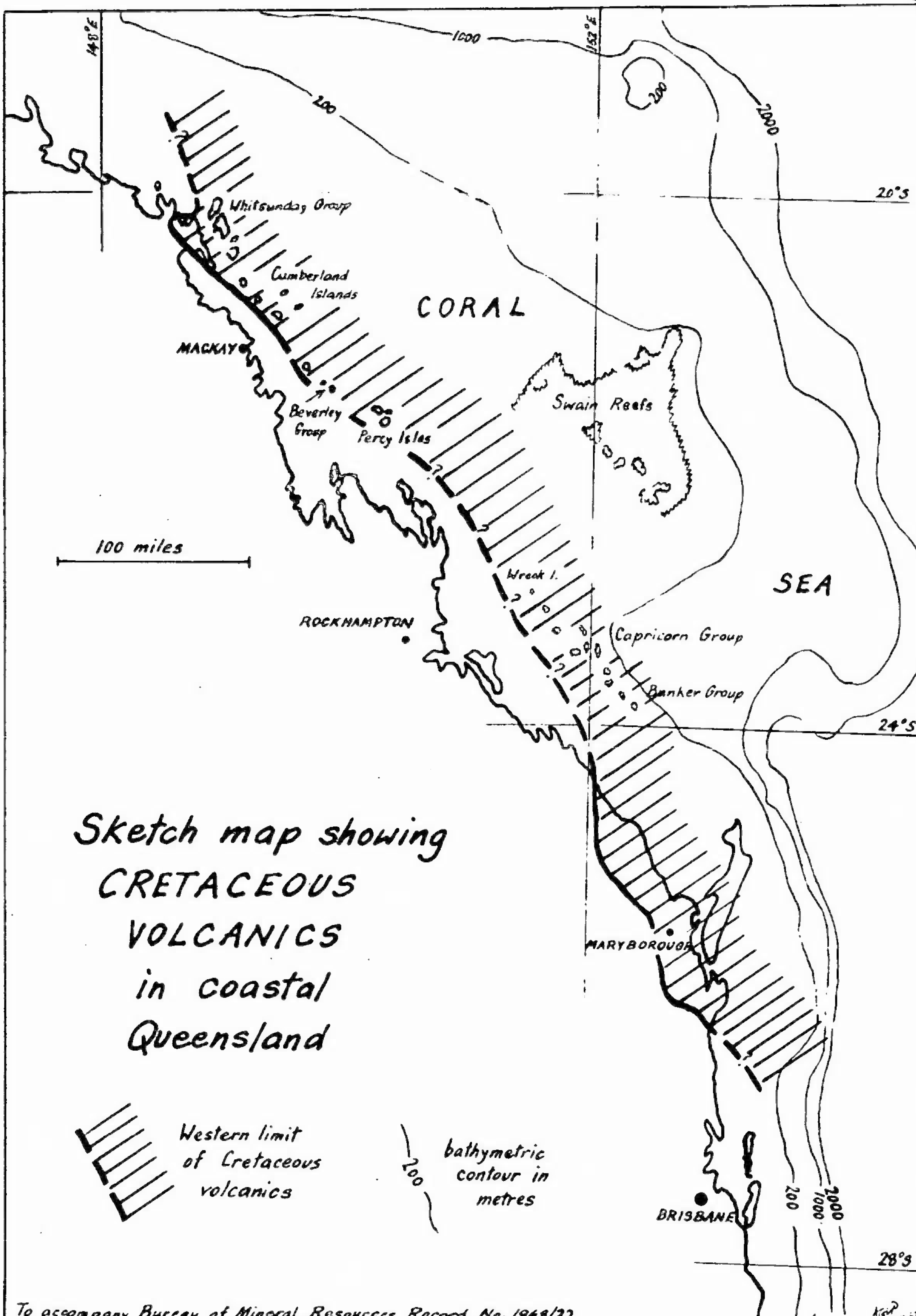
The name, Whitsunday Volcanics, is given to a thick sequence of pyroclastics and minor flows which forms most of the islands in the Proserpine Sheet area east of Long Island Sound and Hillsborough Channel. The name is derived from Whitsunday Island, and coastal outcrops between Reef Point (161700E.,2459300N) and the eastern tip of the island (179000E, 2458900N) constitute the type area.

Distribution and Topography

The Whitsunday Volcanics form most of the Cumberland Islands (of which the Whitsunday Group is generally considered to form part), and the Cape Conway peninsula. They are mapped as far south as the margin of the Sheet area, but in the light of our recent mapping (which has been greatly helped by isotopic age-determinations) it is reasonable to extend the unit south to cover similar volcanics in the Northumberland Islands, which lie within the Mackay and Percy Isles 1:250,000 Sheet areas.

The physiography of many of the islands has been described in some detail by Stanley (1927). Hook, and Whitsunday Islands rise to more than 1,300 feet above sea level. Saint Bees and Carlisle Islands are more than 1,200 feet high,and the remaining larger islands average about 600 feet high. The islands represent the high areas of a drowned mature landscape, and plunge into deep water immediately offshore. Beaches are rarely developed, and most coasts are steep and rocky. A prominent elevated wave cut platform is often present four to five feet above high water level.

Fig. 5



148°E
152°E
1000
200
2000
20°S
24°S
28°S
Whitsunday Group
Cumberland Islands
CORAL
SEA
MACKAY
Beverley Group
Percy Isles
Swain Reefs
Wreck I.
Capricorn Group
Bunker Group
ROCKHAMPTON
MARYBOROUGH
BRISBANE
100 miles
Sketch map showing CRETACEOUS VOLCANICS in coastal Queensland
Western limit of Cretaceous volcanics
bathymetric contour in metres
To accompany Bureau of Mineral Resources Record No. 1968/22

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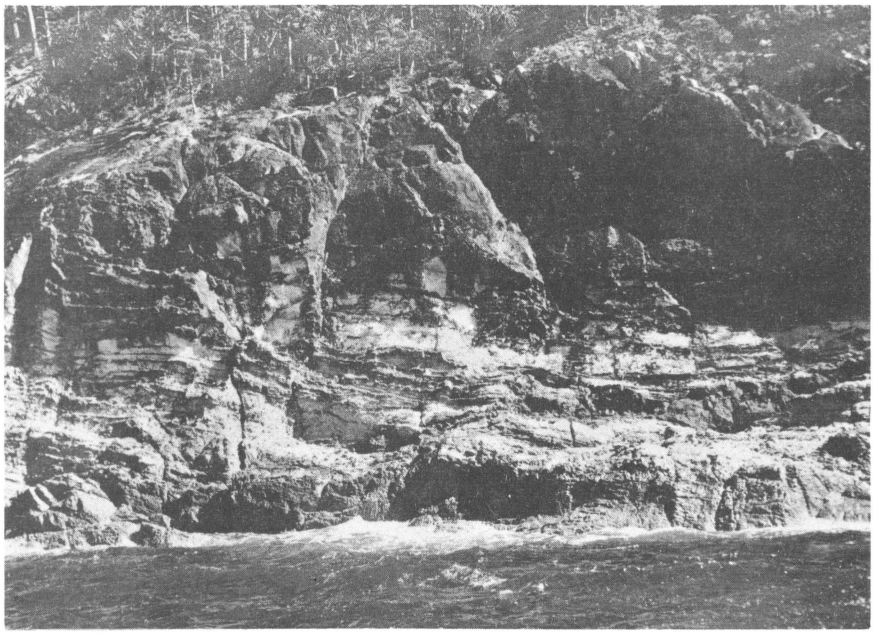


Photo Plate 7: Photo by J. E. Zawartko. BMR Neg. No.G/8403

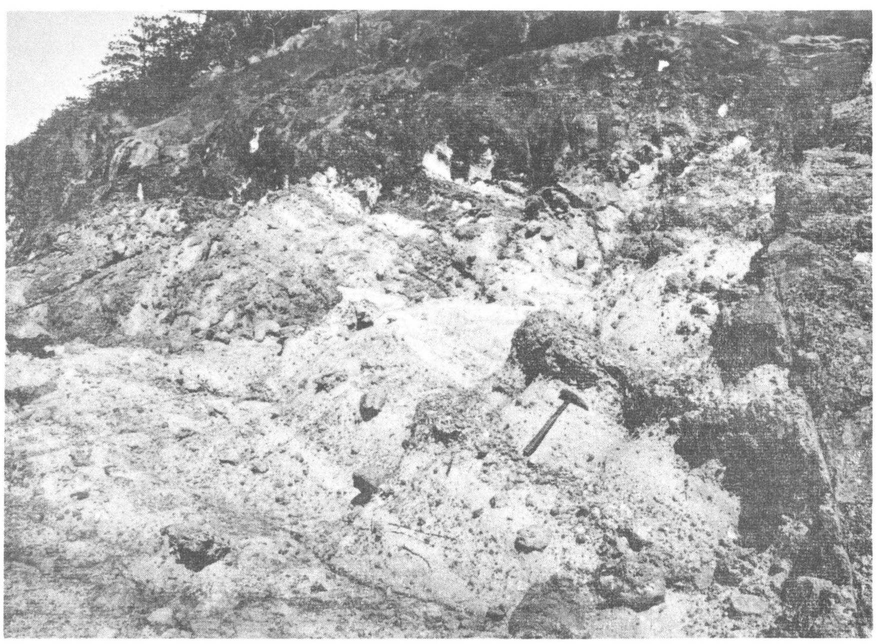


Photo Plate 8: Photo by J.E. Zawartko. BMR Neg. No. G/8400

Photo Plates 7 and 8: Coastal outcrops of pyroclastics of the Whitsunday Volcanics (Cretaceous), Whitsunday Island. Corrosion by sea-water has etched the rocks to reveal the bedding. The outcrops beyond the reach of salt spray appear structureless. Advanced preferential etching of the tuffaceous matrix has made the rocks in the foreground of Photo Plate 8 appear almost unconsolidated in the photograph. However in reality the rocks are extremely hard; they are studded with myriads of sharp projecting lapilli and bombs.

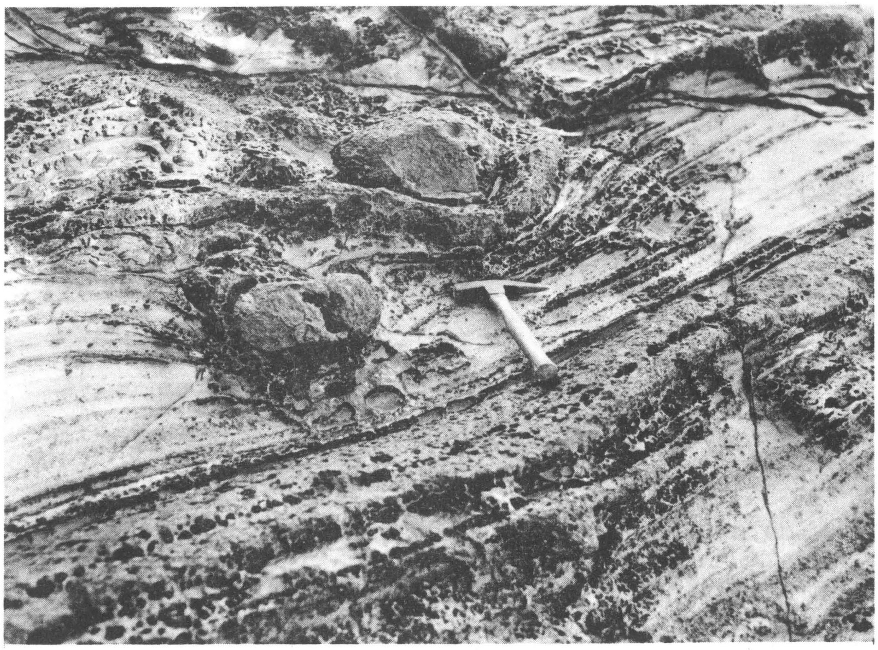


Photo Plate 9: Bedding deformed by settling of volcanic bombs, Whitsunday Volcanics, north-west point of Hamilton Island.
Photo by J. E. Zawartko. BMR Neg. No.G/8401

The larger islands in the north are covered by rain forest but many of the smaller islands are lightly timbered.

Lithology

The Whitsunday Volcanics include two subunits which have not been formally named. These subunits, an arkosic, carbonaceous, conglomeratic sequence near Cape Conway (Kc) and the quartz-feldspar porphyry plug (Ki) of Pentecost Island, are described separately.

(1) Undivided Whitsunday Volcanics (Kw)

The geology of most of the islands is described on pages 54 to 62 and only a general account of the lithology of the unit is given here. Neither the top nor the base of the unit has been recognized, and owing to absence of marker beds, to the complex structure, and to outcrop gaps, no stratigraphic succession has been established. Indeed it is doubtful if one could be established, based on present exposures.

The Whitsunday Volcanics are a sequence of principally acid to intermediate pyroclastics, with subordinate intermediate to basic pyroclastics, relatively minor rhyolite and andesite, and rare basalt. Many outcrops consist of massively weathering green, grey, or brown rocks composed of unsorted ejecta up to boulder size in a very fine tuffaceous matrix. These outcrops have a characteristically ashy aspect, and there is generally a gradation in grain size between matrix and fragments. Only rarely do the rocks show any tendency to part along the bedding planes, and the shapes of most outcrops are independent of bedding. Indeed dip and strike measurements can generally be made only by sighting the intersections of bedding planes with rock surfaces. Inland from the shore-line the rocks weather massively and rèveal no trace of bedding, and it is only in the littoral zone, where selective weathering of the constituents has occurred, that the widespread, although crudely, bedded nature of the sequence is brought to light. Here corrosion by sea-water generally causes the finer material to weather recessively, leaving the coarser ejecta to form sharp projections (Photo Plates 7,8, and 9). The bedding is best displayed by characteristic thin interbeds of fine-grained green or blue-grey tuff, commonly regularly laminated, and displaying graded bedding. The grain size of the tuffs ranges from 0.25 mm down to less than 0.005 mm, and they are composed entirely of fine devitrified ash, although chlorite and calcite occur in some specimens. Many of the tuffs are slightly recrystallized. Cavernous weathering, in places spectacular, is one of the memorable aspects of these rocks (Photo Plate 3). Normal subaerial weathering has evidently given rise to a subtly developed case-hardened skin. In rocks along the shore the skin temporarily protects the outcrops from corrosion by salt spray, but once the skin has been breached, weathering of the interior proceeds rapidly, producing caverns and overhangs.

These massively weathering, unsorted, ashy rocks crop out almost continuously around the coasts of Hook and Whitsunday Islands, and evidently form the major parts of many other islands in the Cumberland Group. Conclusive evidence of subaqueous deposition, such as slumps, small diapiric structures, clastic dykes (Photo Plate 10), scours, and wedge-out structures, can be found in many of the finer tuffs. The volcanic detritus appears to have undergone little if any reworking. With the important exception of a thick lens of sediments in the Cape Conway peninsula (Kc, see below), virtually no epiclastic material has been identified in the sequence.

Beds of lapilli tuff and agglomerate which lack the fine ashy matrix characteristic of the rocks described above have been observed throughout the unit. Such pyroclastics are generally better bedded than the unsorted tuffaceous agglomerates. Welded ash-flow tuff and crystal tuff are commonly interbedded with the lapilli tuff and agglomerate. Volcanic conglomerate, containing rounded volcanic cobbles and pebbles,in an abundant fine ash matrix, has been observed in a few places. Flow-banded rhyolites, possibly intrusive in places, occur on Whitsunday, Hamilton, and Maher Islands, and on Bullion Rocks. Andesite crops out on Linleman and Border Islands and is a prominent rock type in the Cape Conway peninsula. Hornblende dacite, or dacitic welded tuff forms most of Carlisle Island. Rhyolite, autobrecciated rhyolite, rhyolitic agglomerate and breccia, and intrusion breccia are predominant on Hamilton Island. In general, flows are not common in the Whitsunday Volcanics, and are probably restricted to the vicinity of eruption centres.

Photo Plate 10: Sedimentary injection dyke in water-lain tuff, Whitsunday Volcanics, Nara Inlet, Hook Island. The dyke is cut by small slump-faults which parallel the bedding. The margins of the dyke are flow-banded.
Photo by J.E. Zawartko. BMR Neg. No. G/8409

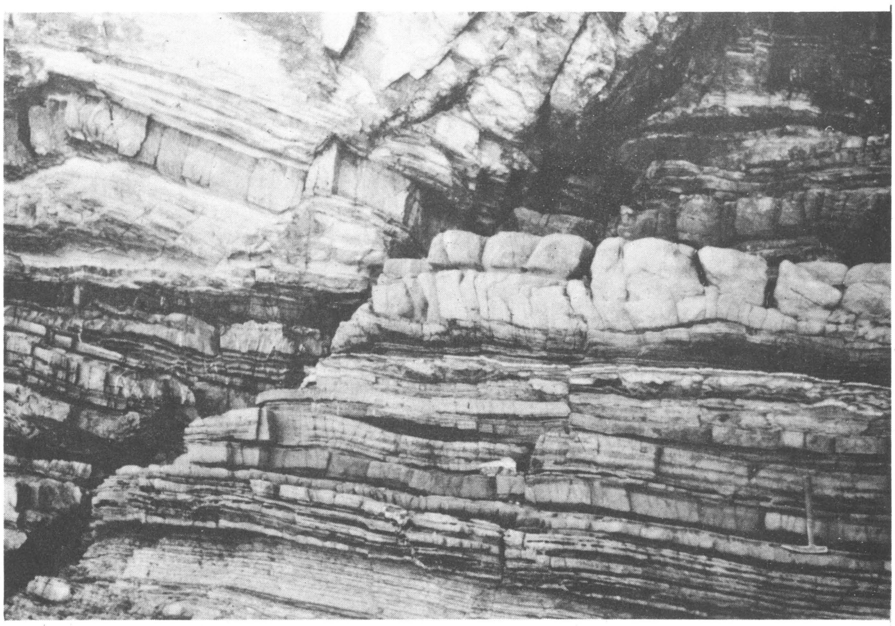


Photo Plate 11: Fault cutting well bedded arkosic carbonaceous subgreywacke (Kc) of the Whitsunday Volcanics, Cape Conway. Small gash veins of quartz are visible on the left. BMR Neg. No. GA/316

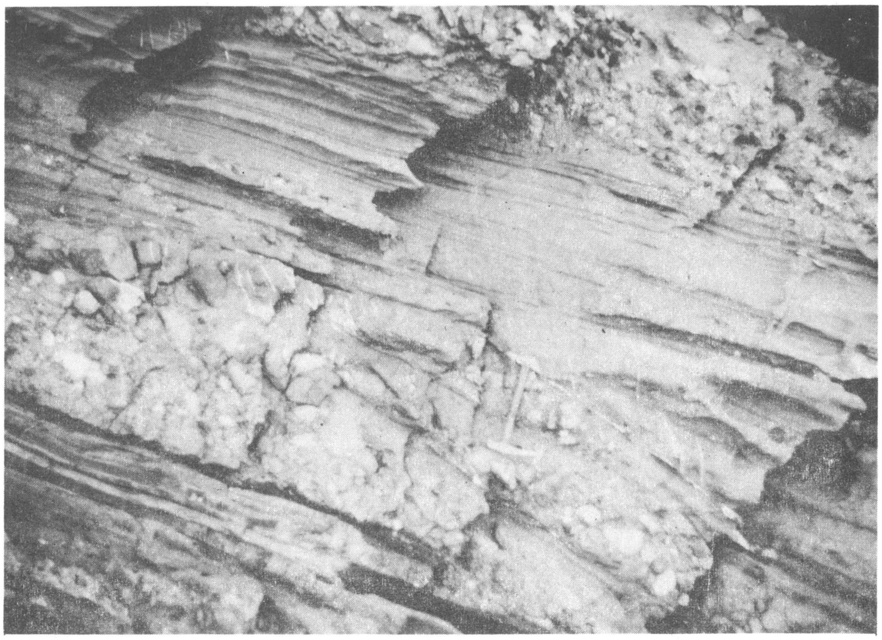


Photo Plate 12: Polymictic conglomerate and subgreywacke (Kc), Whitsunday Volcanics, Cape Conway. Small quartz gash veins are present here also. BMR Neg. No. GA/317

(2) <u>Cape Conway peninsula clastic succession (Kc)</u>

A sequence of unusually immature conglomeratic arkosic and carbonaceous sediments, enclosed between underlying and overlying massive andesitic volcanics (Kw), is very well exposed at many points along the southern coast of the Cape Conway peninsula. It dips regularly to the north-east at about 30 degrees, but near Defiance Island the strike of the rocks swings to the west and the dip steepens to 55 degrees. The thickness of the sequence, based on measured dips and air-photo interpretation, is estimated at 1,800 feet.

The rocks are well bedded, and, in contrast with the pyroclastics of the rest of the Whitsunday Volcanics, minor differential erosion of beds has exposed the actual bedding planes themselves, allowing direct readings of dip and strike to be made (Photo Plate 11). Bedding units in the finer-grained rock types commonly range from 2 to 6 inches in thickness. In general, the bedding is regular to thinly lenticular. Some small intraformational recumbent folds occur in places, suggesting that minor sliding of beds occurred before the rocks were consolidated. The sequence is not cross-bedded. White and Brown (1963) record graded bedding in greywacke and common slumps in siltstone just west of Cape Conway.

Polymictic conglomerate (Photo Plate 12) is the main rock type, and many of the arenite beds contain pebbles and cobbles. The sequence as a whole is volcanolithic, arkosic, and carbonaceous. Widespread replacement by secondary calcite has affected all rocks in the sequence.

The arenites are volcanolithic subgreywackes, grading in places to arkose. Volcanic detritus is the chief clastic component, both as quartz and plagioclase crystals, and as fragments of very fine-grained lavas. Arkosic debris derived from acid granite is abundant; some rocks are true arkoses. Carbonaceous lithic fragments are universally present, and where they are abundant the rocks are dark grey to black. Some beds contain lenticular laminae which appear to consist largely of grains of vitrain.

Carbonaceous material is absent from the sequence at the head of a large bay 4 miles west-north-west of Cape Conway. Some very fine-grained non-carbonaceous beds in the sequence are probably tuffs.

Sorting is generally poor, but in most specimens much of the clastic detritus lies close to the upper grain-size limit of the rock. The degree of rounding is very variable, reflecting the wide range in hardness of the grains. Quartz grains are everywhere angular, showing that the sediments underwent only a brief period of transport.

Subgreywacke also forms the matrix of the conglomerates. The clasts in the conglomerates are generally well rounded, and most are of cobble size, but granite boulders up to 8 feet occur in the more arkosic beds. The clasts: matrix ratio is high. Micaceous, thin bedded, carbonaceous arenite and leucogranite form the majority of the clasts, but clasts of dark grey to black carbonaceous labile siltstone, grading to coal and lignite are abundant. Less common are clasts of: coarse black labile arenite, fine quartzite, porphyritic volcanics, dolerite, and flow-banded rhyolite. There are rare clasts of vein quartz. One clast of spotted andalusite hornfels was recorded. In the coaly clasts there are gradations between dark brown rather soft lignitic material and black, thoroughly coalified rocks which consist partly of vitrain. Some of the coaly clasts contain the Mesozoic plant fossils Cladophlebis australis (Morr.) and Equisetites rotiferum Tennyson Woods. These were identified by Mrs. M. E. White, and are described in Appendix D. Coaly material from the conglomerate clasts was examined for spores by Dr. P.R. Evans, but was found to be too carbonized to contain any identifiable material.

Neither the granitic nor the volcanic clasts in the conglomerate can be identified as having been derived from a particular source. The granitic source area was probably the Urannah Igneous Complex; a large proportion of the volcanic clasts were no doubt derived directly from the products of intermittent contemporaneous vulcanism. The sequence as a whole no doubt originated as a result of active uplift of the basin margin, coinciding with a diminution in the intensity of volcanic activity.

(3) Intrusive quartz-feldspar porphyry (Ki)

Pentecost Island consists mainly of grey, fine to medium-grained pyritic quartz-feldspar porphyry. The porphyry normally contains 4 to 5 percent pyrite, and there is some sporadic minor copper mineralization. In places up to 25 percent of the rock has been replaced by alunite. The occurrence of alunite and other mineralization on Pentecost Island is described in Appendix H.

The quartz-feldspar porphyry is generally massive but in a few places contains angular fragments of quartz porphyry. Although it appears to be a plug intrusive into the Whitsunday Volcanics, it is not considered to be significantly younger, and it probably formed a feeder to the volcanics. Massive, coarse, crystal-lithic tuff and agglomerate, part of the country rock of the plug, crop out along the south-east coast. The tuff contains fragments of bright red leucocratic porphyritic microgranite which in places bears small pyrite pseudomorphs. A small area of grey, well-bedded coarse tuff containing carbonized probable plant fragments occurs within the main body of quartz-feldspar porphyry at point P1 (see sketch map accompanying Appendix H).

Relationships and Structure

The thickness of bedding units in the Whitsunday Volcanics varies from a few millimetres to tens of metres or more, but many outcrops are massive. Horizontal strata are rare, and throughout the unit moderately to steeply dipping beds alternate with expanses of gently undulating strata. Although slumping is obvious in places and some of the more moderate dips may be primary, much of the folding is undoubtedly tectonic. The Hook Syncline is an open fold whose western limb forms most of Hook Island, dipping east at about 15 degrees. The sequence in the Molle Islands may represent part of the western limb of the Hook Syncline, and may thus lie stratigraphically beneath the rocks of Hook Island. However the physiography suggests a fault along Whitsunday Passage (Whitsunday Fault), but the movement and significance of such a fault are unknown. Little of the eastern limb of the Hook Syncline is exposed, but dips near the axis are about 5-10 degrees to the west. In the south the Hook Syncline is truncated by the Cid Fault. It is possible that the Cid Fault is a transcurrent fault, which would help to account for the difference in regional attitude across it, but this is largely conjectural.

The steep easterly dip of the rocks on Long, Pine, Dent and the Molle Islands, as contrasted with the westerly dips along the mainland coast, suggest that a north-north-westerly fault (Molle Fault) can be postulated between these islands and the mainland. A corollary of this is that the Whitsunday Volcanics on these islands form a block which has been down-faulted with respect to the Airlie Volcanics on the mainland. No consistent regional attitude is apparent in the Whitsunday Volcanics in the Lindeman Group and in the scattered islands south of Cumberland Passage. The existence of a fault coinciding with the north-eastern side of Hillsborough Channel (Cumberland Fault) is suggested by the fact that Hammer Island, Bullion Rocks, Allonby Island, and the western points of Brampton, Keswick, and Saint Bees Islands lie roughly in a straight line, and by the steep easterly dips on Hammer Island. The latter imply downthrow to the east.

The intermediate lavas and pyroclastics along the north-east coast of the Cape Conway peninsula proved regionally indistinguishable from the Airlie Volcanics west of Long Island Sound, but they overlie the Cape Conway epiclastic lens (Kc) which contains Mesozoic fossils. The Conway Fault has been postulated to account for this. Its existence is suggested by the marked contrast in regional attitude between the rocks of the Cape Conway peninsula and those west of Long Island Sound, by a low gap in the Conway Range south-west of Cow Island, and by the discordance in attitude between the Conway epiclastic lens and the Proserpine Volcanics.

The Whitsunday Volcanics are intruded by alkali granite stocks (Kg), notably between Shaw Island and the southern margin of the Sheet area, and by abundant basic, intermediate and acid dykes.

Thickness

The thickness of the Whitsunday Volcanics is unknown, but it probably amounts to several thousand feet. If movements on possible faults coinciding with Nara and Macona Inlets (Hook Island) are disregarded, a minimum thickness of 5,000 feet may be present in the western limb of the Hook Syncline.

Age and relationships

Although small carbonaceous fragments have been found in tuffs on Hammer and Pentecost Islands, the only identifiable fossils found so far in the Whitsunday Volcanics are the Mesozoic plant fossils *Cladophlebis australis* (Morr.) and *Equisetites rotiferum* Tennyson Woods, which occur in coaly clasts in conglomerate (Kc) at Cape Conway (Appendix E). Fossils therefore provide some evidence that the Whitsunday Volcanics are no older than Mesozoic.

A Cretaceous age is indicated by isotopic age determinations. An isotopic age of 112 m.y. ± 3 percent (K/Ar, hornblende) has been obtained from the dacite which forms most of Carlisle Island. The 111±5 m.y. age (Rb/Sr isochron) obtained from rhyolites in the Proserpine Volcanics confirms that a period of intense volcanic activity occurred in the Proserpine area at this time. These dates suggest the Albian stage of the Cretaceous (Harland, Smith, and Wilcock, 1964). Two specimens from the quartz-feldspar porphyry plug of Pentecost Island have been dated at 96 and 106 m.y. (K/Ar, whole rock). The Whitsunday Volcanics are intruded by alkali granites, no samples of which have proved suitable for age determination. However the alkali granite at Halliday Bay has been dated at 110 and 115 m.y. ± 3 percent (K/Ar, hornblende).

Most rocks of the Whitsunday Volcanics are distinct from the Airlie Volcanics in that they contain a large proportion of fine-grained devitrified ashy material. However,many outcrops of the Whitsunday Volcanics lack this ashy matrix, and therefore some uncertainty exists as to where to map a boundary between the two units. Although Long, Pine, Dent and the Molle Islands are formed from pyroclastics which do not contain fine ashy material we believe that they belong to the Whitsunday Volcanics and that the Molle Fault forms the boundary with the Airlie Volcanics.

The stratigraphic relationship between the Whitsunday Volcanics and the Airlie Volcanics is not known. However the difference in age between the units and the tectonically active nature of the region indicate that it must be an angular unconformity.

Environment of deposition

The non-discovery of marine fossils in the Whitsunday Volcanics indicates an essentially continental environment of deposition. Most of the pyroclastic sequence consists of ashfall deposits. The abundance of coarse debris in most outcrops, combined with the presence of lavas and pyroclastic flows, indicates that vents probably occurred throughout the volcanic belt which is now represented by the Cumberland Island chain. Recognizable vents occur at Pentecost Island (quartz-feldspar porphyry plug), Hamilton Island (rhyolite breccia, etc.), and Brampton Island (thick andesite dykes in intimate association with pyroclastics of similar composition).

The abundance of slump structures, diapiric dykes, and scour features shows that most of the succession was laid down subaqueously on an unstable basement. The lack of evidence of reworking by currents and the thin laminations in fine tuffs indicate a low-energy environment of deposition, unaffected by traction currents. The evidence therefore favours deposition in a land-locked intramontane basin. Apart from the Cape Conway lens (Kc), no epiclastic rocks have been found, and this suggests continuous vulcanism.

Geology of the individual islands

The dominance of pyroclastics in the Whitsunday Volcanics, the complex structure, and the outcrop gaps inherent in island geology make it difficult to compile a regional synthesis of the geology of the unit. However, because of the splendid outcrops which are available around the shores of the islands, many observations were made, and further information on the geology of the individual islands is recorded below.

North Molle Island

Acid to intermediate pyroclastics and subordinate andesite crop out along the shore west of Mount Sharp. Quartz veining is common, generally in a north-north-west direction. Blue-grey and green-grey crystal tuffs, consisting of plagioclase crystals, rare hornblende and lithic fragments, set in a matrix of devitrified shards, crop out just west of Hannah Point.

West Molle Island

Dark grey-black andesitic agglomerate intruded by basic dykes forms the northern end of the island.

Mid Molle Island

Grey-blue tuff and lapilli tuff, which form Mid Molle Island, are strongly jointed. The eastern side of the island is essentially a dip slope.

South Molle Island

Attitudes in the pyroclastics steepen progressively to the west, where the bedding is vertical. The steepening is thought to be associated with an inferred major fault (Molle Fault), trending north-north-west along Long Island Sound.

East of the Tourist Settlement a 200-foot sill of gabbro intrudes a very well bedded sequence of coarse tuff, agglomerate, and black thinly bedded cherty tuff.

Long Island

Blue-grey crystal tuff forms Humpy Point, between Happy Bay and Palm Bay. It consists of abundant broken plagioclase crystals and rare lithic fragments, enclosed in a very fine-grained, completely devitrified matrix. Blue grey lapilli tuff, lithic-crystal tuff, and light coloured, pyritic, fine-grained acid tuff crop out in the small bay a mile south of Long Island Peak. Green, pink, and reddish-brown lithic tuff and lapilli tuff occur at the southern tip of Long Island where they are cut by a north-south fault. Brown (1963) recorded a north-trending fault at the north-east point of Long Island, and reported that the fault is marked by a breccia zone 150 feet wide, veined with quartz. This faulting is probably related to the inferred near-north-south fault just west of Long Island.

The pyroclastics on Long Island dip steeply to the north-east.

Pine Island

Tuff, lapilli tuff, agglomerate, andesite, and trachyte crop out along the western side of Pine Head. They are intruded by numerous amygdaloidal microdiorite dykes; post-dyke faulting is highlighted by epidotization and silicification.

Hook Island

Fine-grained, green-grey, thinly bedded to laminated tuffs crop out on both sides of Nara Inlet. In thin section the laminated tuff consists of very fine devitrified ash accompanied by some secondary calcite. Thickly bedded, poorly sorted lapilli tuff and some agglomerate are associated with the fine-grained tuff. On a small promontory at grid reference E160700, N2477500 an outcrop of grey and yellow-brown tuff and agglomerate shows sedimentary structures reflecting contemporaneous faulting and deposition, tight small-scale chevron folds (slumps?), and clastic dykes up to 6 inches wide and 60 feet long. The sedimentary dykes consist of fine-grained tuffaceous material similar to that of the enclosing rocks; their margins are flow-banded.

Two miles south of Pinnacle Peak, fine tuffs and conglomeratic waterlain tuffs dip gently and uniformly west, but a little further to the south the pyroclastics are contorted into spectacular nearly isoclinal slump-folds, which have amplitudes of 50 feet or more.

Whitsunday Island

Much of the Whitsunday Island sequence is very similar to that of Hook Island, particularly in the prevalence of thinly bedded ash-fall tuffs.

In Gulnare Inlet the pyroclastics generally consist of abundant scoriaceous rock fragments about one centimeter in diameter, set in a very fine matrix.

The coastline between Reef Point and Loriad Point is formed from dip-slopes of pyroclastic rocks.

Midway between Daniel Point and Whitsunday Cairn are excellent exposures of waterlain, thinly laminated, blue-grey tuff showing scour structures. In thin section the rocks consist of very fine grained laminae of quartz, plagioclase, and sericite, alternating with coarser laminae consisting mainly of angular quartz and plagioclase fragments. Fine micaceous material, calcite, and epidote are scattered throughout the rock. Devitrification is complete. The rocks are no doubt ash-fall, crystal-vitric tuffs.

In an outcrop at Tongue Point bedding in pyroclastics has been chaotically disrupted prior to lithification. Rafts, blocks, and slivers of fine tuff occur in zones of coarse tuff, and on occasion vice versa. At one place small (up to 25 cm.) tabular rafts of thin-bedded fine tuff are incorporated haphazardly in a matrix of coarse tuff. The rafts are angular, and the fine bedding in them has not been disturbed.

Cid Island

A major north-east fault transects the island, separating greenish-grey tuff, agglomerate, and breccia in the south from massive agglomerate and rhyolite which crop out along the coast west of Bolton Hill.

Stanley (1927) reported basalt overlying fine-grained laminated tuff.

Dent Island

Dent Island is essentially a long strike ridge rising to more than 500 feet above sea-level. Blue-grey agglomerate, andesite, and siliceous welded tuff, which crop out towards the southern end of the island, are pyritic in places, strongly jointed, and intruded by microdiorite dykes. These rocks dip steeply to the east, whereas dark blue-grey andesitic agglomerate at the northern tip of the island dips very steeply westwards.

Plum Pudding

Massive dark blue-grey andesitic agglomerate. Possibly an old vent.

Hamilton Island

The very complex structure and varied lithology of the rocks on Hamilton Island suggest that they form an eruption centre. Rhyolitic breccia and agglomerate form the southern point of the island. The breccia contains blocks of flow-banded rhyolite and rhyolite breccia measuring up to 20 feet by 15 feet; it may be an auto-brecciated rhyolite flow. Similar breccias occur on a promontory a mile and a half farther east.

Along the east coast irregular pipe-like masses of andesitic intrusion breccia cut across haphazardly-dipping breccia, agglomerate, and rhyolite. Well rounded quartz pebbles were observed in some of the pyroclastics.

Passage Peak consists of coarse rhyolitic breccia and agglomerate. North of Passage Peak flow-banding in rhyolite dips steeply to the south.

Border Island

Basalt or andesite crops out along the western shore, three-quarters of a mile from the southern tip of the island. The rest of the island is composed of ashy pyroclastics.

Lupton Island

Black, welded crystal-lithic tuff, strongly chloritized and epidotized, forms the southern end of the island. The tuff contains scattered irregular aggregates of pyrite.

Haslewood Island

Dacitic ignimbrites accompany ash-fall pyroclastics in Windy Bay, and crop out continuously along the westernmost shore, where they dip steeply seaward. On the southernmost promontory dark andesitic lavas are interbedded with a six-feet thick bed of pale green tuff which dips north at 30 degrees.

Lindeman Island (Photo plate 2)

Blue-grey andesite, pyritic welded crystal tuff, and trachyte are exposed in the small bay north-north-east of Mount Olden. A specimen of the tuff consists of pale green hornblende, plagioclase, fine-grained volcanic fragments, and quartz in a fine granoblastic groundmass. The tuff is completely devitrified, and has been slightly recrystallized, possibly by the granite of Shaw Island.

Tuffaceous cobble conglomerate accompanies pyroxene andesite and pyroclastics along the south coast.

At Boat Point brown welded vitric-lithic tuff dips gently to the north.

Maher Island

A horizontal sequence of trachytic flows and thin tuffs (Simmonds, 1961) forms the southern tip of the island. Light brown fluidal rhyolite crops out along the north-west shore.

Shaw Island

Volcanics north of Neck Bay comprise rhyolite and acid welded tuff, and ash-fall pyroclastics. These rocks are intruded by felsite, microdiorite, and microadamellite dykes.

Anchorsmith Island

Massive pale green grey dacite (?), sparsely porphyritic in feldspar and hornblende, occurs at the western end of the island, and grey flow-banded rhyolite crops out at the eastern end. The rhyolite may be intrusive.

Hammer Island

An excellent exposure of steeply dipping crystal-lithic tuffs occurs on the eastern shore at grid reference E179000 N2416700. The tuffs are grey-green, indurated, and well bedded. They contain lenses of green andesitic agglomerate. Cut-and-fill and slump structures occur in places. Some of the finer beds contain flecks of carbonaceous material now converted to graphite.

Beds of fine crystal-vitric tuff occur in the sequence. Much of this rock is very thinly laminated, some laminae consisting of little other than extremely fine-grained, barely resolvable volcanic dust. Some of the less fine-grained laminae have been severely deformed and disrupted by minor interstratal pre-consolidation movements. Many of the beds are graded. The great regularity of some of the laminae indicates deposition in perfectly calm water. In places laminae are deformed by dropped volcanic fragments up to 2 cm long. Syngenetic microspherular pyrite occurs in some of the fine tuffs (see Appendix G).

Allonby Island

Welded tuff overlies slumped ash-fall pyroclastics. Networks of quartz and calcite veins accompany small faults.

Bullion Rocks

Coarse welded tuff overlies green-grey ash-fall pyroclastics at the eastern end of the rocks. The western rocks consist of contorted flow-banded rhyolite. Quartz veins trend at 160 degrees.

Ingot Islets

A sequence like that on Hammer Island dips steeply north-west. A porphyritic felsite sill 20 feet thick intrudes the sequence.

The rocks of Goldsmith, Locksmith, Farrier, and Linné Islands include much fine-grained pyroclastic material, reminiscent of Hook and Whitsunday Islands. Pyroclastics on the north coast of Linné Island dip at variable angles, due to slump structures. The attitude in undisturbed areas is sub-horizontal, but steep dips and sudden reversals of dip characterize the slumped areas. Regularly bedded tuffs on the southern promontory are metamorphosed by the Tinsmith Island granite.

Maryport Island

Exposures of pyroclastics on Maryport Island are perhaps the most spectacular in all the islands visited. The south-eastern and eastern sides of the small island, which are exposed to the prevailing winds, are cavernously weathered. The pyroclastics are completely unsorted. Volcanic conglomerate (similar to the conglomerate in the Tertiary Cape Hillsborough

Beds, Photo Plate 15), consists of subrounded boulders of rhyolite, tuff, and agglomerate set in a matrix of devitrified volcanic ash. The tuff which forms some of the boulders is identical with the matrix. Some boulders, up to 10 feet in diameter, consist of bedded ash-fall tuff. Very fine-grained clastic dykes are common. The complete lack of sorting suggest the rocks have been formed by an avalanche of consolidated and semi-consolidated pyroclastics and flows.

Finger and Thumb Islet

Sheared, and in places brecciated, quartz-alunite rock forms the western end of the larger islet. In the field the rock was described as a thinly and uniformly bedded quartzite, but in thin section it is seen to consist of 30 to 40 percent alunite/natroalunite occurring in strongly aligned crystals which have imparted a false "bedding" to the rock. The occurrence of alunite in this rock is described in Appendix H.

The eastern end of the islet consists of a highly altered, multi-coloured, structureless, granular rock, in which vague relict feldspar phenocrysts are visible in hand specimen. It is possibly an altered volcanic rock.

Carlisle Island

Massive hornblende dacite or dacite welded tuff forms most of the island. An isotopic age of 112 million years ($\pm$ 3 percent) has been obtained by the potassium-argon method on hornblende from the dacite. Bedded pyroclastics occur on the south-eastern promontory.

Brampton Island

Acid or intermediate coarse crystal-lithic tuff and agglomerate crop out along the northern shore. The tuff is well exposed in cuttings along the tourist railway, about one hundred yards east of the pier. It consists of jumbled plagioclase crystals and grey ,black, white, and green lithic fragments in a grey-green matrix. The tuff is massive and unsorted. Vertically flow-banded dacite, or quartz andesite probably comagmatic with the tuff, forms a network of thick dykes, some of which are at least 500 feet wide and are described in the chapter on granites (Kg). The dykes probably acted as feeders to the tuff.

Cockermouth Island

Andesite or dacite is overlain by pyroclastics at the eastern tip of the island. Pyroclastics form the rest of the island.

Particularly fine outcrops of thinly laminated ash-fall crystal tuffs showing pre-consolidation deformation structures occur on a small islet off the western end of Cockermouth Island at E216500 N2400700. The rocks are pale grey-green, and weather massively. Sedimentary structures include graded bedding, small-scale cross bedding, and wedge-outs. Small faults exhibiting a variety of movements highlighted by the thin laminations are beautifully displayed on water-worn surfaces. They include low and high-angle normal and reverse faults, and some miniature horsts and grabens. Small diapiric injection structures also occur. The outcrops could provide a magnificent graphic introduction to students in the three-dimensional aspects of faulting and in the relationships between contemporaneous faults and stratigraphic variations. A large specimen exhibiting some of these interesting features is held at the Bureau of Mineral Resources, Canberra.

Saint Bees Island

Rhyolite breccia crops out among pyroclastics on the north-western shoulder of the island. Massive dark agglomerate, containing some fragments of hornblende microgranite, crops out on the steep slope which overlooks a wreck at the northernmost point of the island.

Apart from granite in the south-east, the normal pyroclastic suite forms the rest of the island.

Keswick Island

The island was only briefly examined. It consists largely of massive agglomerate.

Tern Island

White and Brown (1963) describe the island as consisting of "porphyritic flow rocks".

Proserpine Volcanics (Kp)

The Proserpine Volcanics, a sequence of rhyolite and minor pyroclastics and andesite, overlie the Airlie Volcanics in the rugged coastal range north and east of Proserpine. A rubidium-strontium isotopic isochron determined from rhyolite flows indicates a Cretaceous age.

The volcanics are regarded as terrestrial equivalents of the Whitsunday Volcanics.

Nomenclature

The new name, Proserpine Volcanics, is derived from Mount Proserpine (E139500, N2441000), eleven miles east-south-east of Proserpine township. The type area is that within a two-mile radius of Cedar Creek Falls (E139200, N2445600) where the rhyolites in the sequence are particularly well exposed.

Distribution and topography

The Proserpine Volcanics crop out in two separate areas, north and east of Proserpine. The volcanics occupy mountainous country covered by rain forest, but a few marginal valleys have been cleared for sugar farming and afford some access to the unit. Long north-westerly hogbacks are developed between Bonavista and Rocky Point. The highest peaks in the Conway Range and most of the hills between the Conway Range and the Bowen-Proserpine Lowland are believed to be formed of Proserpine Volcanics. The specimens from which the Cretaceous rubidium-strontium isochron was determined were collected over an area of about 20 square miles between Bonavista and Repulse Creek, and it is with some confidence that rocks of this age are mapped as occupying a north-west trending belt of country between Brandy Creek and Repulse Bay. North and east of Repulse Creek the unit has been photo-interpreted. Although photo-interpretation is unreliable in rain forest country, small cliffs which are developed at intervals along the north-eastern side of some of the summits of the Conway Range are tentatively interpreted as marking the limits of the Proserpine Volcanics in the north and east of this area. North of Proserpine a persistent line of cliffs which occurs high up along the northern side of the Mount Dryander range is photo-interpreted as being formed from gently dipping Proserpine Volcanics; largely for this reason the highest country in the Mount Dryander range is mapped as Proserpine Volcanics.

The vehicle track which runs from Brandy Creek to the headwaters of Repulse Creek is a disused forestry access road which is rapidly becoming overgrown by rain forest.

Lithology

The Proserpine Volcanics, in contrast with the underlying Airlie Volcanics, consist predominantly of flows, with only minor pyroclastic rocks.

Rhyolite flows, typified by the rhyolites at Cedar Creek Falls, comprise most of the unit. The rhyolite is light reddish brown and usually strongly flow-banded. Flow banding is almost invariably planar, and contorted flow banding is rare, except in the rhyolites of the Mount Dryander area; the attitude of planar flow banding persists over considerable distances, and is commonly parallel to the attitude of interbedded pyroclastic rocks. The rhyolite flows are not microspherulitic, in contrast to rhyolites of the Airlie Volcanics in the Shute Harbour area. However, at one locality, a mile north-east of Cedar Creek Falls, the rhyolite flows are coarsely spherulitic, with spherulites up to two inches in diameter.

Autobrecciated rhyolite flows were observed in a few places, associated with rhyolitic lithic tuff and agglomerate. In Repulse Creek, rhyolite flows and pyroclastics are interbedded with andesite and dacite flows. Andesite may be a more common rock type in the sequence than the frequency of andesite outcrops would suggest, for the andesite weathers much more readily than the rhyolite.

Excellent exposures of rhyolite, interbedded with andesite, crystal-lithic tuff, and welded lithic-crystal tuff, occur along the shore of Repulse Bay, between Rocky Point and the mouth of Repulse Creek.

Cream and reddish brown flow-banded rhyolite and rhyolitic tuff occur in the Mount Dryander area.

Structure

The Proserpine Volcanics have a low to moderate regional dip to the south-west, but in the Foxdale Fault Zone the rocks dip steeply to the north-east, giving rise to long hogbacks. Between Mount Dryander and Charley Creek the volcanics appear to dip very gently to the south-west.

East of Proserpine, major faults related to the development of the Hillsborough Basin (Tertiary) form the western and south-western limits of the unit (Foxdale Fault Zone); the faults are marked by intense brecciation, and in places silicification. The Conway Fault is postulated off Rocky Point to account for a structural discordance which evidently exists between the south-westerly dipping Proserpine Volcanics and the northerly dipping Whitsunday Volcanics in the Cape Conway peninsula.

Thickness

East of Proserpine, extensive faulting complicates the structure, but the sequence is estimated to be roughly 3,000 feet thick. In the little known Mount Dryander area a thickness of 2,000 feet is estimated from air photographs and the 2-inches-to-one-mile contoured maps.

Age and relationships

In view of the active tectonic history of the area and the difference in age between the units, there can be no doubt that the Proserpine Volcanics unconformably overlie the Edgecumbe Beds and the Airlie Volcanics. However, owing to poor outcrop and considerable lithological similarities, no contacts between the units were sighted in the field. An angular unconformity is evident on air photographs in the Mount Dryander area, where the gently dipping Proserpine Volcanics appear to overlie the more steeply dipping Airlie Volcanics. South-east of the Proserpine-Cannonvale road a prominent cliff-forming rhyolite is taken as the basal member of the unit.

Rhyolite flows from the Cedar Creek Falls area have yielded an isochron of 111$\pm$5 million years (Cretaceous) by means of the rubidium-strontium method, and are thus the same age as the Whitsunday Volcanics(q.v.).

The relationship between the two units is unknown because, as presently recognized, they occupy separate areas. The Airlie Block on which the Proserpine Volcanics rest (see Structural Geology), has been up-faulted with respect to the Whitsunday Block, and it is theoretically possible that the Proserpine Volcanics represent a lower stratigraphic level than the Whitsunday Volcanics and that erosion may have entirely removed the Whitsunday Volcanics from the Airlie Block. However it seems more likely that the depositional areas of the two units were distinct, for the Proserpine Volcanics appear to have been deposited terrestrially on a relatively stable block of Airlie Volcanics, whereas the Whitsunday Volcanics were deposited in an unstable subaqueous environment.

A prominent swarm of felsite dykes intrudes the volcanics east of Repulse Creek, and can be seen on air photographs to extend from The Inlet to about 2 miles west of Mount Conway. Many of the rhyolite dykes which intrude the Airlie Volcanics are probably related to the Proserpine Volcanics. The best examples are the large north-east trending dyke-like intrusion 2 miles south-east of Riordan Vale, and a sill exposed in a road cutting one mile west of Shute Harbour.

Mineralization

Some of the more siliceous rhyolites, especially those in the area about Little Conway Mountain, contain disseminated pyrite. Very minor gold mineralization, associated with the intrusion of a dyke into the Proserpine Volcanics, was reported from the Brandy Creek area by Saint-Smith (1918).

Granite (Kg)

Several masses of alkali granite intrude the Cretaceous Whitsunday Volcanics. Although rocks collected so far from these granites have proved too altered for isotopic dating, the intimate and probably comagmatic relationship between the granites and the volcanics, and the Cretaceous isotopic dates obtained from the alkali granite at Halliday Bay, strongly suggest that the granites as a group are Cretaceous also.

The physiography of the Cretaceous granites is similar to that of the Whitsunday Volcanics. The coastlines of many of these steep rugged islands are obviously controlled by joints, and some are probably fault-controlled.

The granites form a well defined group of sub-volcanic alkalic intrusives. Shaw Island and its neighbours are evidently part of a single mass. A larger mass, embracing Wigton, Calder, Derwent, Scawfell, Aspatria (and a small part of Brampton?) Islands can be inferred in the south. However, it is possible that here the various granite islands represent small discrete intrusions.

It is conceivable that Tinsmith Island is part of a granite mass formerly exposed in the centre of a ring of islands consisting of Linné, Goldsmith, Ingot, Bullion Rocks, Allenby, Finger and Thumb, and Coffin Islands. Such a granite would provide a possible origin for the alunitization at Finger and Thumb.

No mineralization has been recorded from the Cretaceous granites. However, they are not easily accessible and probably have been little prospected. The granites and their contacts may be regarded as potential exploration targets for tin, wolfram, molybdenum and bismuth mineralization, and to a lesser extent copper, lead, and zinc.

A small intrusion of syenite near Mount Dryander is also considered to be of Cretaceous age, partly by analogy with the Cretaceous Mount Abbot Igneous Complex in the Bowen Sheet area (Paine et al. in prep,b), and partly because it is possible that it intrudes the Proserpine Volcanics.

<u>Hayman Island</u>

Micrographic adamellite, intruded by numerous microdiorite dykes, forms almost all of Hayman Island. Volcanics occur only on the south eastern tip of the island. Arkhurst Island, off the south-west coast of Hayman Island, is formed of identical adamellite.

At a small promontory midway along the west coast of the island the adamellite is colour banded, and this property has been highlighted in the zone of corrosive littoral weathering, which extends to about 15 to 20 feet above sea level. The origin of the banding is problematical. It is expressed by alternations in colour between light brown and orange brown and by differential weathering of the bands, to give slight relative relief. The bands are regular; they average nine inches in thickness, and dip gently south-east. Specimens from two adjacent bands reveal only marginal variation in composition. Both specimens are medium-grained porphyritic micrographic adamellites. Sodic andesine occurs both as phenocrysts with average length of 5mm., and as more abundant smaller crystals 1-2mm. long set in a micrographic intergrowth of quartz and alkali feldspar. The groundmass comprises about 40-45 percent of each rock. Quartz, as irregular interstitial grains up to 1 mm. diameter, forms about 5 percent of each rock. Minor green amphibole and biotite are almost completely chloritized. Accessory minerals are zircon and tourmaline, while calcite, epidote and opaque minerals are common secondary alteration products. Comparison of the two specimens shows that the one taken from the band which is more resistant to weathering has slightly more and somewhat larger plagioclase crystals. However overall compositional variation is so slight that it is unlikely that the banding reflects simple composition variation. A complicating factor is that in places rock of the more resistant type appears to transgress upwards and downwards as lobate "skins" on the surface of the differently coloured, negatively weathering bands; the bands would thus seem to be connected in some way with weathering. However it is possible that closer study might show that these "skins" are in fact simply the surfaces of lobes which have a third dimension and which therefore would be an original feature of the rock. Banding is also readily visible at Dolphin Point and at a few points along the northern coast. The bands dip regularly and shallowly to the south-south-east. The banding is parallel to a weakly developed set of joints, and it is possible that the combination of incipient jointing and littoral weathering may have brought it about.

In a few places immediately below the visibly banded portion, the adamellite is crowded with dark microdioritic xenoliths. Some xenoliths are tabular but most are rounded. The xenolithic zones and the parallel banding appear to be closely associated, and together they suggest that the adamellite may be a gently dipping sheet. The Whitsunday Volcanics on nearby Hook Island also have a gentle regional dip to the south-east.

The adamellite is intruded by numerous microdiorite dykes along a prominent set of vertical meridional joints.

Epidotized pyroclastics at the north-western tip of Longford Island are intruded by a 40-foot wide dyke of microgranite which is almost certainly related to the Hayman Island adamellite. The microgranite is sparsely porphyritic; rare phenocrysts of quartz and plagioclase (0.2mm to 1mm) occur in a groundmass of very fine flow-aligned alkali feldspar laths. The microgranite is cut by microdiorite and felsite dykes. The pyroclastics contain fragments of aplitic granite of unknown origin.

Halliday Bay

Medium to coarse aphyric, leucocratic, hornblende alkali granite crops out on the coast at Halliday Bay and forms hills south of Ball Bay. Two-thirds of the specimen examined in thin section consists of unaltered perthite, the balance being quartz (30 percent) in large irregular mosaics and small equant grains; strongly pleochroic unaltered green hornblende (2-3 percent); and hematite (1-2 percent). Two specimens of this granite have yielded isotopic ages of 110 and 115 million years (Cretaceous), by the potassium-argon method on hornblende.

Shaw and nearby islands

Coarse-grained granite forms Shaw, Mansell, Thomas, Seaforth, Keyser, Comston, Triangle, Silversmith and Volskow Islands, and Long, Dorsal, and Coppersmith Rocks. These represent the highest points of a submerged granitic mass of possibly stock-like shape.

One specimen examined is a coarse-grained, equigranular, alkali granite composed of quartz (50 percent), microperthite (45 percent), and minor andesine (An_{35}) and biotite. The quartz grains are strained and fractured. Andesine occurs as small laths. The biotite is extensively chloritized.

Another specimen collected from the east coast of Shaw Island, due north of Volskow Island, is a medium to coarse leucocratic biotite alkali granite. It consists of quartz (45 percent); microperthite (40 percent); albite (10 percent) as rims around perthite, as small aggregates, and as rare large crystals; patchily chloritized biotite (2 percent); and accessory sphene, iron opaques, and zircon.

One and a half miles south-south-west of Shaw Peak the rock is a porphyritic granite in which microperthite, quartz, and more rarely andesine form phenocrysts up to 4 mm. diameter in a fine even-grained groundmass of quartz, perthite and minor plagioclase. Biotite (1-2 percent) forms flakes of intermediate size some of which are unaltered, although most flakes are partly chloritized.

The granite is prominently jointed; the dominant joint sets strike nearly north and nearly west. The coastal outline in many places, particularly on Mansell Island, is obviously joint controlled. Where the jointing is most intense, the granite resembles a breccia. Numerous dykes, chiefly microdiorite or dolerite, but rarely felsite, intrude the granite along the two most prominent joint sets. Aplite dykes are rare.

The contact of the granite with the Cretaceous Whitsunday Volcanics is nowhere exposed. Shaw Island consists mainly of granite but north of Neck Bay it is formed of volcanics. The contact is unfortunately hidden beneath the narrow sand-covered neck which joins the two parts of the island. There are several reasons for believing that the granite intrudes the nearby Whitsunday Volcanics: (1) no granitic fragments have been found in the nearest outcrops of volcanics.

(2) similar granites are known to definitely intrude the Whitsunday Volcanics in the Cumberland Islands further to the south.

(3) large acid dykes intrude the volcanics on Shaw Island north of Neck Bay.

Baynham Island is formed from pink quartz-feldspar porphyry which is probably related to the granite. The porphyry consists of corroded quartz and plagioclase phenocrysts averaging 1 mm. diameter, enclosed in a very fine groundmass of quartz and alkali feldspar. The most prominent joints dip at 40 degrees to the south-west, which is parallel to flow banding in the porphyry. One intermediate dyke was observed to intrude the porphyry.

A prominent pinnacle on the north-east coast of Shaw Island is formed by two vertically dipping dykes which intrude gently dipping crystal tuffs. One dyke is a 25-foot wide quartz-feldspar porphyry similar to the Baynham Island porphyry. The other dyke, also 25 feet wide, is a porphyritic fine-grained adamellite. The adamellite dyke is probably an off-shoot of the granite which forms the southern part of Shaw Island.

Coarse inequigranular graphic alaskite occurs as boulders in the arkosic conglomerate of Blackcombe Island (K/Tb). Some of the boulders are large, and must have been derived from a nearby source, such as the granites of Shaw and adjacent islands. In the alaskite, perthite amounts to 55 percent, and quartz to 45 percent. The only mafic mineral is hematite. There is a trace of muscovite.

<u>Tinsmith Island</u>

Tinsmith Island consists of a pink, fine-grained granite which contains numerous small (1 inch) highly digested mafic-rich xenoliths. In one specimen biotite (5 percent) is universally chloritized, and secondary epidote is spread throughout the rock. Another specimen is a leucocratic, fine-grained perthitic alkali granite in which the mafics have been entirely altered to chlorite, epidote, and iron opaques. The perthite (45 percent) is strongly sericitized, and albite (5 percent),which is commonly enveloped by perthite, is also severely altered. The quartz is neither strained nor fractured; its texture varies between allotriomorphic, poikilitic, and graphic.

Tuffs on the southern tip of Linné Island are hornfelsed by the granite. They are intruded by microgranite dykes which closely resemble parts of the Tinsmith Island granite.

Brampton Island

Granophyre forms the south-eastern point of Brampton Island, where it has intruded the volcanics along a joint plane which dips north at 80 degrees. The granophyre is flow-banded parallel to the contact over a width of 20 feet. The rock contains strongly saussuritized plagioclase phenocrysts (20 percent, probably albite). The groundmass is made up of two components: (1) Sub-spherulitic, partly granophyric aggregates whose nuclei consist of laths of potash feldspar and granophyric to poikilitic quartz; the nuclei are rimmed by micrographic intergrowths which become progressively finer grained towards the margins of the aggregates. (2) An equigranular but generally very fine-grained quartzofeldspathic mesostasis. Chlorite, epidote, and iron opaques amount to about 5 percent of the rock. The different textures developed in the groundmass suggest a complex cooling history.

On the south-western promontory of Brampton Island, the volcanics are intruded by a 500-foot wide dyke of flow-banded grey porphyritic granitic rock similar to the granophyre described above. The flow banding is tightly plicated in places. Intrusion breccias,composed of blocks of granophyre in similar granophyre, form zones up to 15 feet wide, suggesting multiple intrusion and autobrecciation. The great thickness of the dyke suggests that it is a marginal offshoot of the granophyre which occurs on the south-east point of the island.

Silloth Rocks

The northernmost rock is a complex of hornfelsed pyroclastics, intrusive feldspar porphyry, granite, and microdiorite dykes. Grey contaminated granite forms the smaller rock to the south, and the southernmost and largest islet consists of red alkali granite intruded by a dense swarm of dark dykes.

The grey contaminated granite is crowded with dark rounded xenoliths. It is densely porphyritic in plagioclase, and is named an altered granophyric augite-hornblende-quartz micromangerite. Phenocrysts amount to 65 percent, and consist of labradorite (50 percent), hornblende (10 percent), augite (2-3 percent), magnetite (1 percent), and accessory epidote, sphene, and apatite. The hornblende is almost completely chloritized.

Augite is generally fresh, but some crystals are partly uralitized. The groundmass (35 percent) consists of a very fine-grained somewhat granophyric aggregate of intersertal quartz and euhedral alkali feldspar, with minor epidote, chlorite, iron opaques and ferromagnesian minerals. The slide contains a small xenolith of quartz-hornblende-augite micro-diorite.

The alkali granite consists of quartz (40 percent), perthite (40 percent), albite (17 percent), biotite (3 percent), and accessory epidote and opaques. The quartz is largely unstrained, and has a somewhat runic texture in parts of the slide. In places the perthite approaches antiperthite in composition. Albite is moderately saussuritized. Biotite is entirely chloritized.

Thick dykes of granophyric alkali microgranite, no doubt connected with the Silloth Rocks granite, intrude volcanics along the south-east coast of Cockermouth Island.

Saint Bees and Aspatria Islands

Pink to red porphyritic granophyre (hand-specimen description only) forms Aspatria Island, and the intrusive contact between this granite and the Whitsunday Volcanics is excellently exposed along the east coast of Saint Bees Island as alternating sheets of granite and volcanics. On Aspatria Island, a well developed set of joints dips shallowly to the west.

Lupton Island

A 500-foot thick dyke of deuterically altered quartz micro-monzonite or microdiorite intrudes volcanics on the long southern promontory of Lupton Island in the Whitsunday Group. The dyke does not form the promontory, but strikes south-east across it. The great width of the dyke suggests that it may be a marginal (possibly contaminated?) offshoot of a plutonic body. The narrow chilled margin of the dyke is dark grey and distinctly porphyritic, but the rock which forms the central part of the intrusion is brown to pink overall, but speckled with seriate porphyritic crystals of cream feldspar and green aggregates of chlorite and epidote. The main body of the dyke is very severely deuterically altered: the feldspars are completely saussuritized and unidentifiable, and the ferromagnesian phenocrysts are entirely pseudomorphed by epidote and chlorite;

there is a very sparse skeletal mesostasis. The chilled marginal phase has escaped much of the alteration: albite twinning is detectable in the feldspars, and the ferromagnesian minerals consist of chloritized and epidotized hornblende (7-8 percent), fairly fresh augite (3-5 percent), and opaques (2-3 percent).

Hook Island

A 35-foot wide dyke of porphyritic granophyric microgranite intrudes the Whitsunday Volcanics a mile west of Pinnacle Peak at the northern end of Hook Island. The dyke forms a small promontory as the enclosing tuff and agglomerate have been more readily eroded by the sea. Columnar jointing is very well developed, and the feature is known locally as the "Woodpile".

The pinkish-brown microgranite is porphyritic in plagioclase and quartz. Andesine (An_{35}), as laths up to 4mm. long, comprises about 10 percent of the rock. Quartz (5 percent) and chloritized biotite (1-2 percent) form smaller phenocrysts. The groundmass is an extremely fine intergrowth of quartz and feldspar. Staining techniques indicate that the feldspar is potash feldspar. Calcite (5 percent) and chlorite are alteration products scattered throughout the microgranite.

Islands not visited in the course of the survey

Wigton, Calder, Scawfell, Derwent, and Redbill Islands, and Three Rocks were not visited in the course of this survey, but were briefly examined by Ampol Exploration (Qld) Pty.Ltd. The following notes are extracted from Ampol's unpublished report (White and Brown, 1963).

Wigton Island

Medium-grained grey granite, crowded with irregular, angular basic xenoliths up to 3 feet long, and intruded by basic dykes.

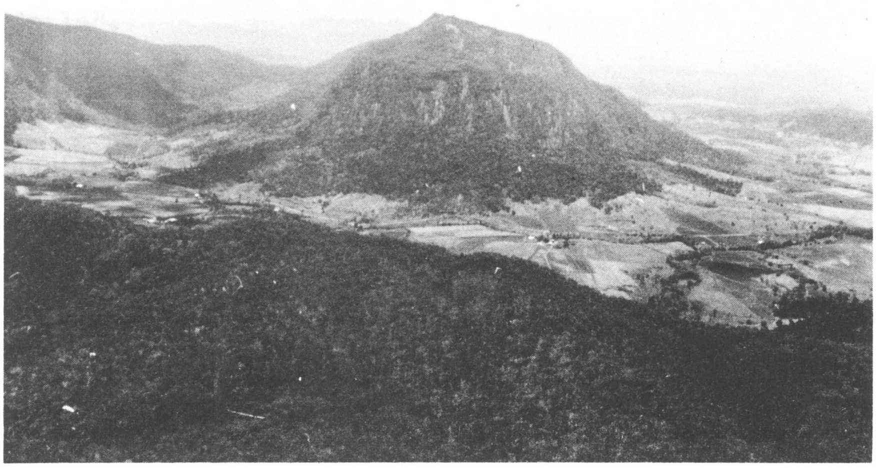


Photo Plate 13: View looking north to Mount Jukes (1870 feet) from the summit of Mount Blackwood. The annular valley of Neilson Creek surrounds Mount Jukes. Hills formed by Cretaceous granite (Kg) are visible in the distance, just to the left of the summit. The Cape Hillsborough headland and Andrews Point are faintly visible on the right. BMR Neg. No. M/257

Calder Island

Strongly jointed pink leucosyenite, intruded by basic dykes and sheets. The syenite is composed almost entirely of feldspar, with rare quartz, and accessory topaz, spinel, chlorite and magnetite. At the western end of the island the syenite contains numerous hornblendic xenoliths.

Scawfell Island

Composed entirely of granite with a very strong set of north-south joints. Much of the granite, particularly on the east side of the island, is crowded with large hornblendic xenoliths. Some of these are thin slabs and gently dipping sheets, but many are detached pods and angular blocks.

Derwent Island

Pink granite.

Three Rocks

Medium-grained pink granite cut by a few thin basic dykes. Flat sheet joints are developed in the granite.

Redbill Island

Composed of grey micaceous granite, visibly different from the granites of the rest of the Cumberland Islands, none of which contain any appreciable percentage of mica.

Mount Jukes Syenite Complex (Kj_1 and Kj_2)

Distribution and topography

The Mount Jukes Syenite Complex (new name) is named after Mount Jukes, a steep conical mountain which forms a prominent landmark 7 miles south-west of Cape Hillsborough (Photo Plate 13).

The complex measures 4½ miles from north to south by 2¼ miles from east to west (Fig. 6). The southern boundary of the Proserpine Sheet area passes through Mount Jukes and most of the complex lies within the Mackay Sheet area.

Since the Mackay Sheet was mapped (Jensen, et al., 1966), a new road has been built to a television transmitter at the top of Mount Blackwood, 1,700 feet above sea level, thereby affording good access and fresh exposures of part of the complex. This road was traversed in 1966, in the course of a reconnaissance of the area. A small outcrop of granodioritic rock in the annular valley of Neilson Creek was also found in the course of this reconnaissance, and is regarded as representative of a separate intrusion underlying the Neilson Creek valley, which is shown on the Mackay geological map as soil with minor alluvium. Much of the valley is devoted to sugar cane farms; the valley is traversed by a sealed road which connects the Bruce Highway at Kuttabul with the coastal village of Seaforth.

The complex consists of three separate intrusions, referred to here informally as intrusion "A" (Neilson Creek valley), intrusion "B" (Mount Blackwood), and intrusion "C" (Mount Jukes). Intrusion B crops out wholly within the Mackay Sheet area. N.C.Stevens (in Hill and Denmead, 1960) alluded briefly to Mount Jukes as a ring complex, composed largely of granophyre and dolerite, with some rhyolite dykes.

Intrusion A is in contact with the northern margin of intrusion B; it surrounds Mount Jukes (intrusion C), which rises to 1,850 feet above sea-level. The northern limit of intrusion C is masked by scree and scrub, but the intrusion appears to be oval in plan. The valley underlain by intrusion A is surrounded in the west, north and east by a concentric ridge of hornfelsed Lower Permian sediments and volcanics. To the south, this ridge passes into the steep northern slopes of Mount Blackwood (intrusion B).

Nomenclature

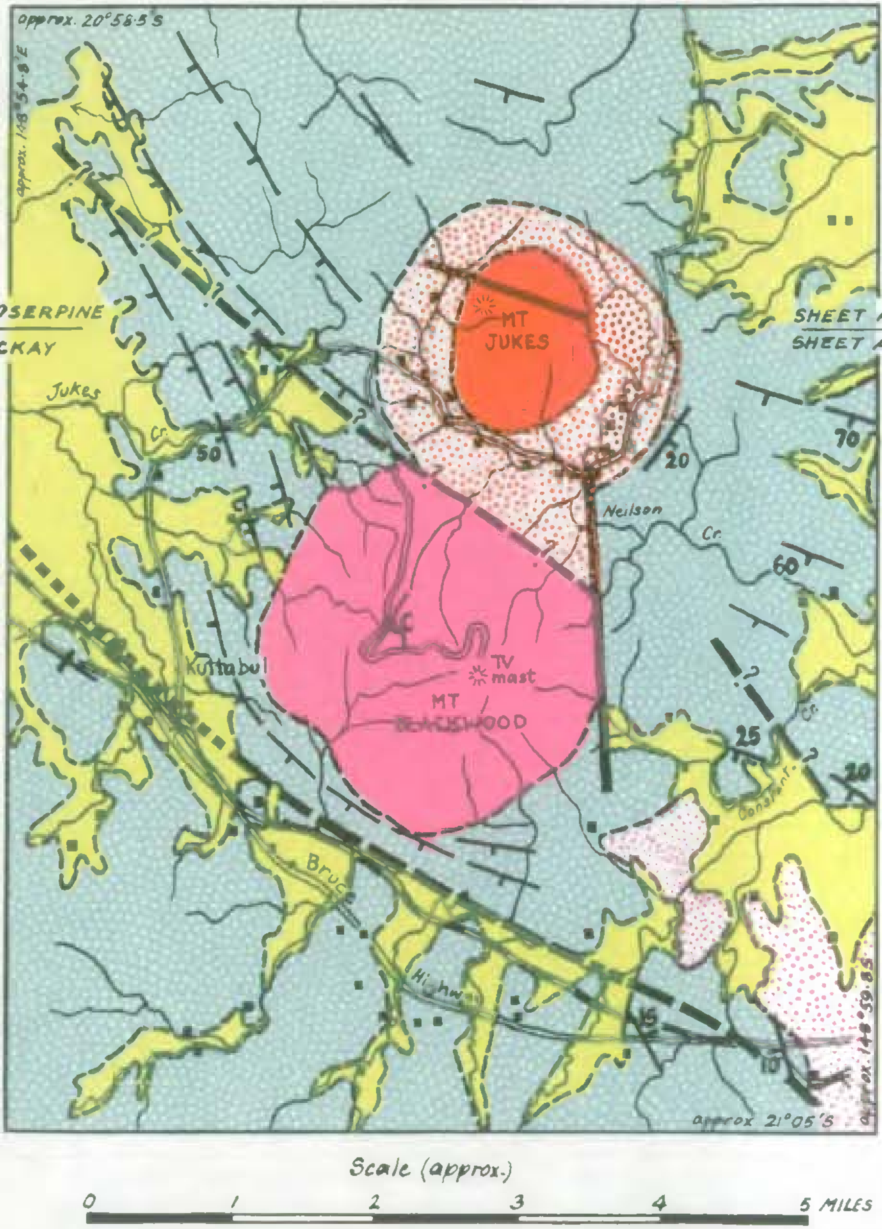
The type area of intrusion A is the road cutting at E166500, N2372500,and that of intrusion B is the road cutting at E164800, N2370300. Mount Jukes itself forms the type area of intrusion C.

To accompany Bureau of Mineral Resources Record No. 1968/22

Fig 6

Sketch map of MOUNT JUKES SYENITE COMPLEX

Drawn from air-photo overlay (uncontrolled)
Largely air-photo interpretation



REFERENCE

CAINOZOIC — Alluvium, colluvium, residual soil

CRETACEOUS? — Mount Jukes Igneous Complex
- Kj_2 C — Leucocratic granophyric quartz syenite and alkali granite
- B — Granophyric augite-biotite-hornblende-quartz syenite
- Kj_1 A — Weathered granodiorite, concealed by soil and colluvium
- Microdiorite; minor hornfelsed sediments

LOWER PERMIAN — Calen Coal Measures, Carmila Beds — Sediments and pyroclastics

- Geological boundary, approximate
- Fault (line broken where position approximate or concealed)
- Inclined strata (20)
- Vertical strata
- Felsite dyke (f)
- Sealed road
- Great Northern Railway
- Building

MG
4/8/67

Lithology

Intrusion A

The outcrop was noted in the field as deeply weathered, medium-grained granodiorite; the outcrop was very crumbly, and no hand specimen was collected. Intrusion A is evidently much more susceptible to chemical weathering than the strongly positively weathering rocks of intrusions B and C. Pieces of gabbro and trachyte (Jensen, 1963) have been found in small tributaries of Neilson Creek.

Intrusion B

A specimen collected at E 165500, N 2371600 is a fine-grained granophyric alkali syenite with an allotriomorphic texture. It consists of perthite (50 percent), albite (30 percent), hornblende (6 percent), quartz (5 percent), biotite (3 percent), augite (2 percent), and minor epidote, opaque minerals, and zircon. Quartz is interstitial, and merges in places with a granophyric mesostasis which amount to 2-3 percent. The colour index, texture, and grain-size vary considerably, even within a single outcrop. Small joints filled with a blue-green chloritic mineral are abundant, and in the field all rock types looked deuterically altered. However in thin section, the amphiboles are only patchily chloritized, and many of the larger crystals (up to 2mm.) are almost entirely fresh. Small aggregates of pyrite were seen in the syenite at a sharp bend in the road three quarters of a mile west-north-west of the summit of Mount Blackwood. A 15-foot dyke of severely kaolinized "felsite", porphyritic in feldspar, intrudes the syenite beside the road, three quarters of a mile north-west of the summit.

Intrusion C

A specimen taken from the margin at E167300 N2373200 is an inequigranular, fine to medium-grained, leucocratic, granophyric quartz syenite or alkali granite. It consists of perthitic alkali feldspar enclosing rare plagioclase remnants (85 percent), granophyric to interstitial quartz (10 percent), hornblende (3 percent) and accessory chlorite, biotite, allanite, apatite, opaque minerals, and zircon. The perthite occurs as equant, subidiomorphic crystals which average 0.5 to 1 mm, but range up to 5 mm. Many crystals have micrographic margins. Hornblende is only slightly altered; it occurs as scattered individual crystals averaging 0.25 mm. Biotite occurs in rare knots of very fine crystals which average 0.05 mm.

Order of emplacement and structure.

The order of emplacement of intrusions A and B is not known. Intrusion C is younger than intrusion A because it is situated centrally within it. A felsite dyke, noted above as cutting intrusion B, strikes towards Mount Jukes and is therefore believed to be related to intrusion C. For this reason, intrusion C is believed to be younger than intrusion B.

The small size and subcircular outcrop of the intrusions suggests they are epizonal stocks. Intrusion B has domed or pushed aside the bedded country rocks along its south-western contact which suggests forceful emplacement. In contrast, intrusion A has not noticeably disturbed the country rocks and was perhaps emplaced by passive stoping, associated with ring fracturing.

Stratigraphic relationships and age

The Mount Jukes Syenite Complex intrudes the Lower Permian Carmila Beds and Calen Coal Measures. It is regarded as Cretaceous in age, by analogy with the alkali granite at Halliday Bay (Kg).

CRETACEOUS OR TERTIARY

Unnamed arkosic conglomerate (K/Tb), Blackcombe Island

Blackcombe Island is a rocky islet measuring 1,100 feet by 500 feet,and rising to 164 feet above sea-level. It is situated north-east of the Sir James Smith Group, on the ocean side of the Cumberland Islands chain.

The islet consists entirely of coarse arkosic boulder conglomerate, (Photo plate 14),with minor beds of arkosic cobble conglomerate. Sub-rounded clasts of pink leucocratic granite are set in a poorly sorted purple arkosic matrix. In spite of excellent exposure, only very rare clasts of other rock types (quartzite and possible altered volcanics) were found. The conglomerate is crudely bedded, and a dip slope about five acres in extent and readily visible on air photos forms the western end of the islet. There are some poorly developed and widely spaced joints. Rare, thin quartz veins strike south-east. White and Brown (1963) record a thick meridional dolerite dyke intruding the conglomerate.

Photo Plate 14: Crudely bedded arkosic conglomerate (late Cretaceous or Tertiary), Blackcombe Island. BMR Neg. No. GA/311

The conglomerate dips regularly west-north-west at 23 degrees. The thickness exposed is estimated at 425 feet.

A clast from the conglomerate was described in thin section as a graphic alaskite, and is therefore typical of the Cretaceous alkali granite suite (Kg). Such a coarse conglomerate must have been derived from a source nearby, and the obvious provenance is the granite of Shaw and adjacent islands, of which the nearest outcrop is Dorsal Rock, 1.3 miles north-west of Blackcombe Island. Although the field relationships of this granite are unknown, it seems reasonable at present to regard it as Cretaceous. The Blackcombe Island conglomerate was probably laid down in an intra-montane basin in late Cretaceous or Tertiary times. The fact that the conglomerate dips towards its apparent source area is probably due to tilting induced by Cainozoic faulting.

TERTIARY

Tertiary rocks in the Sheet area have been mapped as three units: (1) Cape Hillsborough Beds (new name), (2) Intrusive rhyolite or trachyte (Tr) and (3) Unnamed sediments of the Hillsborough Basin (Ts).

Cape Hillsborough Beds (Th) (new name)

Distribution and Topography

The Cape Hillsborough Beds are 1,600 feet of Tertiary sediments and volcanics forming the rugged headland at Cape Hillsborough, which rises to almost 1,000 feet above sea-level. Two areas of rhyolite unconformably overlying the Carmila Beds 5 miles north-northwest of Calen are also mapped with the unit. At Cape Hillsborough several benches are formed by the more resistant rocks. The sequence dips gently to the south.

The rhyolite near Calen forms rises and small hills.

Nomenclature

The volcanic and sedimentary sequence in the Cape Hillsborough area was described by A.R. Jensen (1963), but was not formally named. The cliffs between Cape Hillsborough (E178000, N2385200) and Andrews Point, (E179400, N2382500), constitute the type area of the Cape Hillsborough Beds.

Lithology

The strata consist of rhyolite, rhyolitic agglomerate, conglomerate, shale, sandstone, and basalt. The following succession (deduced from isolated observations) forms the northern part of the Cape Hillsborough promontory:

top.........rhyolite and rhyolitic agglomerate
conglomerate containing large
boulders of pyroclastics
volcanic pebble conglomerate
shale..............................base not seen

The rhyolite and agglomerate overlie and interfinger with the volcanic conglomerate; together they are about 1,000 feet thick and form the bulk of the headland. The conglomerates contain boulders of tuff and agglomerate up to 10 feet long, and are probably scree deposits (Photo Plate 15). The pebble conglomerate is only a few feet thick, and only a few feet of shale is exposed above sea-level. The shale, which crops out on the north coast of Cape Hillsborough, is soft, brown, and carbonaceous, and contains plant debris. Cross-bedded sandstone (possibly beach rock) is associated with the shale. Oil shale is reported to occur nearby (Reid, 1939). The Mackay Oil Prospecting Syndicate (MOPS) hole No. 4, located south of the main hill, passed through 303 feet of soft shale and mudstone, and finished in hard silicified sandstone. The location of MOPS No. 5 is not known precisely, the only description of its location being 'Cape Hillsborough, approximately two chains from high water mark forming the south boundary of Reserve R60, Parish of Ossa - 30 feet above sea level'.

Photo Plate 15: Cape Hillsborough Beds, Cape Hillsborough (Tertiary). Conglomerate consisting largely of agglomerate boulders, with a bed of finer conglomerate at the base. BMR Neg. No. M/267

The section penetrated in MOPS No. 5 is:

Thickness of interval in feet	Depth to base of interval in feet	Lithology	Rock Unit
30	30	not recorded	) Cape
195	225	shale	) Hillsborough) Beds
500	725	sandstone, tuffaceous in part	)
1145	1870	andesitic tuff	) Probably
60	1930	tuffaceous sandstone	) Campwyn) Beds
475	2405	andesitic tuff	)

Outcrop geology indicates that the andesitic sequence is probably part of the Campwyn Beds.

At Andrews Point, south of Cape Hillsborough, basalt is overlain by a friable, grey-white, fine, argillaceous sandstone, which bears impressions of dicotyledonous leaves.

The pyroclastic rocks in the Cape Hillsborough Beds are characterized by the presence of glassy fragments. This contrasts strongly with the Whitsunday Volcanics which are universally devitrified.

Newry, Outer Newry, and Mausoleum Islands are composed of sandstone resting unconformably on Campwyn Beds. Fossil wood, thought at that time to be Mesozoic, was discovered by the Queensland University Students Excursion in 1957. However, it is more probable that the sandstone is Tertiary, assuming correlation with the sandstone near the base of the Cape Hillsborough Beds. In 1912, two bores drilled on Newry Island in search of coal encountered 85 feet of soft sandstone, pebbly conglomerate, and shale, before entering Campwyn Beds. The logs, recorded in a notebook of W.E.Cameron, and held at the Queensland Geological Survey (see also Cameron, 1915), are:

Bore No. 1

Top Measures	Hard white sandstone, ironstone, hard and pebbly conglomerate - horizontal
20 - 50 ft.	Hard sandstone, coarse and fine - horizontal
50 - 85 ft.	Coarse sandstone with 13 ft. blue shale from 65-78 ft.
	UNCONFORMITY
85 - 200 ft.	Volcanic tuff and coarser breccias, dip 20° distinct in places.
200 - 335 ft.	Volcanic breccia with calcite vein, dip steep, somewhat indistinct.

Bore No. 2

Top Measures	Horizontal sandstone (10ft.)
42 - 68 ft.	Mostly shales, horizontal
68 - 75 ft.	Rough carbonaceous sandstone (horizontal)
	UNCONFORMITY
75 - 150 ft.	Sandy volcanic breccias with one thin mudstone, dip 35° distinct.
150 - 281 ft.	Coarse volcanic breccia, dip 35° indistinct.

White porphyritic rhyolite which lies unconformably on the Carmila Beds 5 miles north-north-west of Calen is also thought to be Tertiary.

Thickness

Assuming that the strata above the andesitic volcanics in MOPS No. 5 are Tertiary, the thickness of the unit at Cape Hillsborough is about 1,600 feet.

Structure and Stratigraphic Relationships

The strata at Cape Hillsborough dip gently to the south at about 10°. In places dips are higher, but these are either primary or related to faulting. The south-western contact with the Campwyn Beds is probably faulted, as none of the thick Tertiary sequence exists west of the supposed fault. The Cape Hillsborough Beds east of this fault were possibly originally deposited in the Hillsborough Basin. The sequence at Cape Hillsborough may correlate with the lower part of the sequence in the Hillsborough Basin which, at least in Proserpine No.1 Well, consists of sediments with an abundance of vitric volcanic fragments.

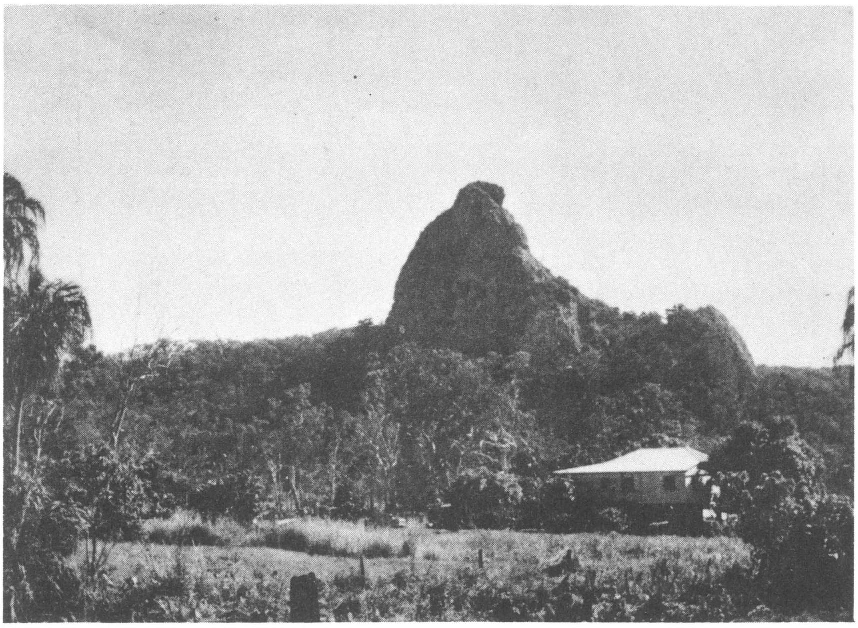


Photo Plate 16: Looking north towards Pinnacle Rock, a trachytic plug (Tr) near Cape Hillsborough.   BMR Neg. No. M/265/13

Age

Whitehouse (1939) described small gastropods similar to Sigaretus in shales from the north side of Cape Hillsborough. He suggested a tentative Tertiary age. Dear described indeterminate gastropod remains from the same locality (Appendix A, part 3). Cuttings from MOPS No. 4 between 235 and 303 feet yielded Tertiary (probably lower Tertiary) spores (Appendix C). Dicotyledonous leaves occur in sandstone at Andrews Point (Appendix D).

Environment of deposition

The gastropod remains have provided no evidence in favour of either a marine or fresh-water environment. However the absence of undoubted marine fossils, the presence of leaves and spores, and the abundance of coarse pyroclastics in the succession together suggest continental conditions.

Intrusive rhyolite or trachyte (Tr)

Pinnacle Rock, which rises precipitously to 700 feet above sea-level 1.5 miles south of Halliday Bay, is a plug of fine-grained rhyolite or trachyte (Photo Plate 16). The plug intrudes granite of Cretaceous age (Kg). Fragments of this granite were found in the rhyolite at the southern margin of the plug.

Mount Springcliffe, near Seaforth, is a similar trachytic plug which intrudes the Campwyn Beds.

Both plugs are probably related to the Tertiary vulcanism which contributed to the Cape Hillsborough Beds.

Unnamed sediments of the Hillsborough Basin (Ts)

Except for horizontal sandstone which crops out in the Bowen-Proserpine Lowland north of Collingvale Homestead, the unnamed sediments (Ts) are known only in the subsurface, They occur in a narrow north-west-trending fault-bounded basin which underlies the Bowen-Proserpine Lowland and Hillsborough Channel. The basin is an asymmetrical graben, and is deepest close to its north-eastern margin; it is named the Hillsborough Basin in this report and on the accompanying geological map. The graben has a maximum width of nine miles. Onshore and offshore seismic surveys carried out on behalf of the tenement holder (Ampol Exploration (Qld) Pty.Ltd) have indicated up to 7,000 feet of sediments 3 miles south-south-east of Proserpine, and up to 10,000 feet in Hillsborough Channel, 7 miles north-east of Cape Hillsborough. The onshore seismic results were later confirmed by the drilling of a stratigraphic test well, Proserpine No. 1, by Ampol in 1965.

The name "Hillsborough Basin" is considered more appropriate than "Mackay Basin", which has been used in the unpublished reports of Ampol and its contractors, because the greatest thickness of sediments is indicated in Hillsborough Channel, north-east of Cape Hillsborough, whereas offshore from Mackay the basin appears to be ill defined and the sediments thin.

Topography

The Bowen-Proserpine Lowland rises to only 80 feet above sea-level, and the Tertiary sediments of the Hillsborough Basin are masked by Cainozoic alluvium and mud-flats. The Hillsborough Channel has a flat floor which slopes gently eastwards, reaching a maximum depth of ten fathoms next to the Cumberland Islands.

Lithology

Thin outwash deposits of coarse argillaceous sandstone and sandy siltstone form a veneer on bedrock north of Collingvale Homestead.

Shallow seismic drilling (up to 200 feet) in the Bowen-Proserpine Lowland showed the uppermost sediments in this area to be clay with coarse river-sand stringers, overlying brown carbonaceous shale (Brown 1963). Some of this unconsolidated material is probably of Quaternary age.

Proserpine No. 1 Well, drilled as a stratigraphic test 7.5 miles south-east of Proserpine, penetrated 4,208 feet of sediment. A detailed stratigraphic table is presented in the well completion report (Ampol Exploration (Qld) Pty.Ltd., 1965), and is summarized here as follows:

Thickness of interval in feet	Depth to base of interval in feet	Lithology
1370	1370	Shale, sandstone, sand, clay, and minor siltstone.
		Bed of slightly glauconitic sand 190-205 feet
1136	2506	Mostly shale; minor sandstone, clay, and siltstone
270	2776	Interbedded shale and sandstone, conglomeratic towards base
594	3370	Shale and minor lithic sandstone, in places conglomeratic
630	4000	Mostly shale, some lithic sandstone
208	4208	Volcanic pebble conglomerate and minor shale
		Bottomed in volcanic breccia.

The shale in the interval 0-1370 feet is dark grey to black and brown, moderately hard, fissile to blocky, and commonly has carbonaceous laminations. Sandstone is more abundant from 1170 feet to 1370 feet; the sandstone is generally fine-grained, and consists of quartz, lithic grains and weathered feldspar with an argillaceous, in part calcareous, matrix. The bed of glauconitic sand is very slightly calcareous and argillaceous.

In the section 1370 feet to 2506 feet the sandstone is fine-grained and has a calcareous clay matrix. A little very fine-grained limestone is also present.

Between 2506 and 2776 feet the sandstone is somewhat different from that in the overlying units. It is more lithic and in places conglomeratic, particularly towards the base of this section.

From 2776 to 4208 feet, the sediments are increasingly labile as the proportion of lithic and vitric fragments increases. This section is quite distinctive from that overlying it.

The sandstone is lithic and commonly conglomeratic. It is light to medium grey and green-grey, very fine to coarse-grained, poorly sorted, and consists of subangular green, grey, orange, brown, buff and red lithic grains, white quartz, feldspar, traces of mafic minerals, mica and carbonaceous specks, set in an argillaceous matrix. The matrix in some specimens is calcareous.

In the interval 4000 - 4208 feet the conglomerate consists of rounded to subrounded pebbles of fine-grained or vitric volcanic rocks, tuffaceous shale and tuffaceous sandstone, cemented by light brown tuffaceous clay.

The well bottomed in volcanic breccia of unknown age. It is possibly part of the Campwyn Beds.

The section below 2,776 feet is described by Ampol as quite distinctive from that overlying it, in that the sediments are more labile. However, we have examined a thin section of a typical arenite from the interval 1,644 feet to 1,648 feet (Core No. 4), and found that it too consists largely of labile constituents. The arenite is friable, and required impregnation, so that little trace of a matrix or cement is present. The rock is a volcanolithic subgreywacke, consisting principally of volcanic rock fragments (mainly devitrified glass), with subordinate feldspar, quartz, and chlorite. Between 10 and 15 percent of the thin section consists of angular clastic grains of coaly material.

Specimens from Core 8 (2783 feet to 2798 feet) and Core 12 (4027-4037 feet) were examined for Ampol Exploration (Qld) Pty.Ltd.,by the Core and Cuttings Laboratory of the Bureau of Mineral Resources (Ampol Exploration (Qld) Pty.Ltd., 1965). A specimen from Core 8, was described as a labile sandstone, whose principal constituents are grains of slightly devitrified volcanic glass (40 percent), grains of trachyte or trachy-andesite (15%), and some other highly altered finely porphyritic fragments. The only interstitial material is minor chlorite. The specimen from Core 12 was described as a conglomerate made up of pebbles of highly altered ?andesite (70 percent), and partly devitrified volcanic glass (20 percent); a pale brown clay makes up the remainder of the rock.

Thickness

The onshore reflection-refraction seismic survey indicated up to 7,000 feet of sediments three miles south-south-east of Proserpine (Namco International, Inc., 1964). Proserpine No. 1 proved 4,208 feet 7.5 miles south-east of Proserpine, at a point where the seismic results suggested 4,500 feet.

A maximum thickness of almost 10,000 feet of sediments was recorded north-east of Cape Hillsborough by the marine seismic survey (Western Geophysical Company of America, 1964). The sediments are thickest on the north-eastern side of the Hillsborough Basin.

Structural Relationships

A preliminary aeromagnetic survey (Hartman 1963) suggested that the Hillsborough Basin is divided into a series of smaller basins by east-west faults and cross structures. The marine seismic survey defined the limits of the trough, and gave more precise information on sedimentary thicknesses and structure.

A sketch map of reflection horizon "B" of average reflection time 1.0 second, contoured at .050-second intervals (Figure 8) illustrates some of the information obtained. Regional dip within the Hillsborough Basin is to the north-east. The sediments terminate sharply against a steep basement wall, which runs the entire length of the north-east side of the basin. The wall probably represents a fault scarp which remained active during deposition; it is named the Repulse Fault on the geological map. Up-dip thinning of the sediments is evident on all but the north-east side of the basin. South from Mackay, which is a few miles south of the Proserpine Sheet area, very little or no sedimentary section is present.

Onshore, both reflection and refraction information (Namco International, Inc., 1964) established the presence of an asymmetrical sediment-filled trough immediately south of Proserpine, with a maximum sedimentary thickness of 7,000 feet. The trough strikes north-west. Figure 7 is a structure contour map based on a deep horizon "B" with an average reflection time of 0.700 seconds. The map, is contoured with an interval of 0.1 seconds, or approximately 500 feet.

The north-eastern flank of the trough is steep, and includes a major fault (Proserpine Fault) which has a minimum throw of about 1,500 feet to the south-west, although the exact throw is difficult to estimate. The south-western flank slopes much more gently, and terminates in a shallow plateau. Although the physiography suggests otherwise, the trough terminates no less abruptly to the north-west. It does not extend north of Proserpine beneath the Bowen-Proserpine Lowland, for the sediments at Proserpine and immediately north-west of the town are only about 100 feet thick. The report by Namco International Inc. (1964) suggests the sediments have onlapped onto the basement thus accounting for the rapid thinning. The axial zone of the trough shallows gradually towards Repulse Bay, where the trough becomes broken up by cross-faults. The isochron study suggests that the sedimentary units thicken seawards.

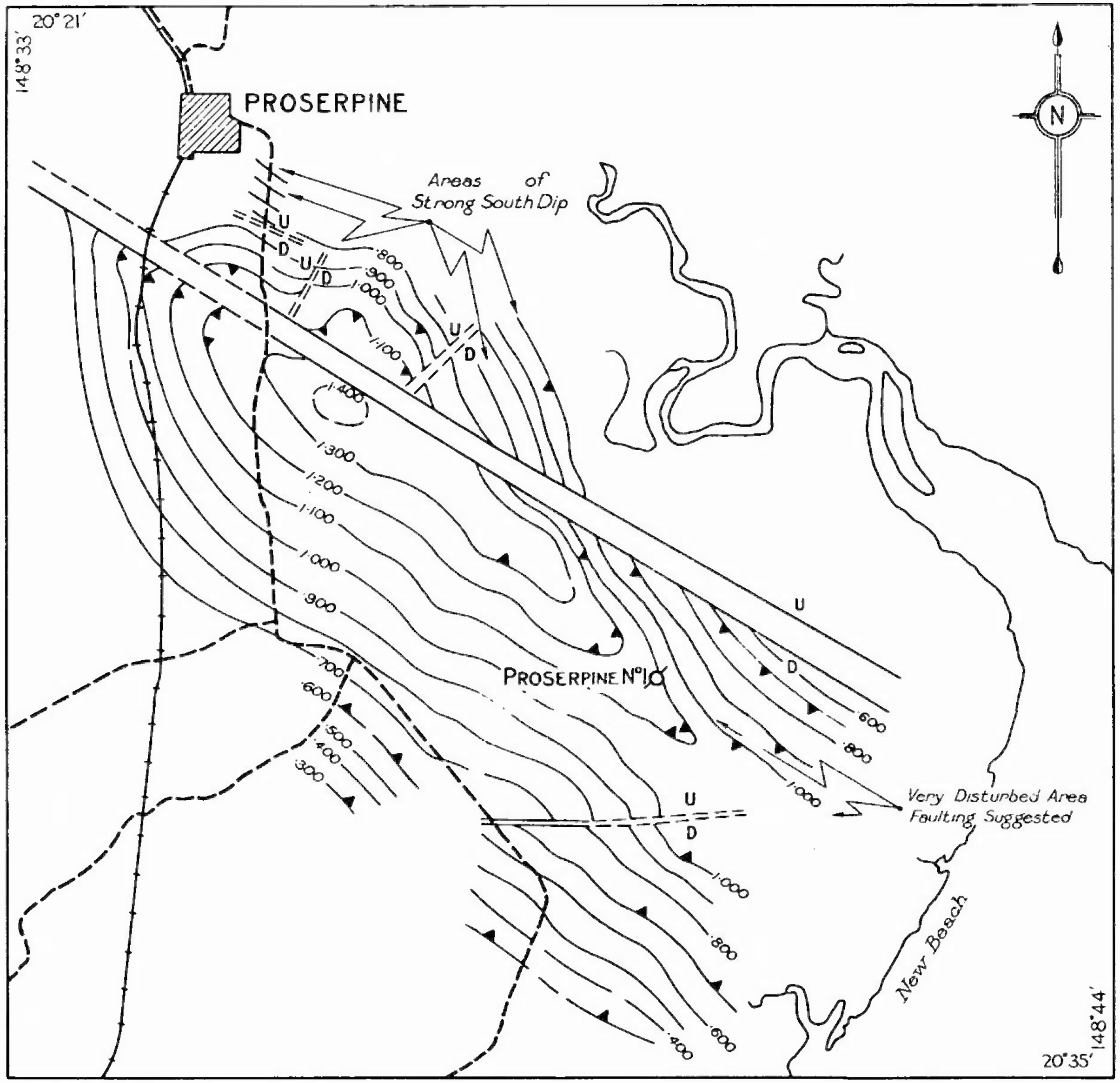
Proserpine No. 1 was drilled on the south-eastern flank of the trough. The attitudes of the sediments determined in the well are variable. From 0-2462 feet the dip varies from 5^{o} to 30^{o}, but is mainly between 12^{o} and 19^{o}. The attitudes in cores 8,10 and 11 between 2783 feet and 3710 feet are much flatter, and the dips range from 0 to 4 degrees. This difference in attitude occurs at roughly the same depth as does the change in lithological aspect noted in the lithological log. The higher dips in the upper section are probably partly due to cross-bedding.

Age

Samples from the first 8 cores cut from Proserpine No. 1 Well (down to 2,800 feet) were submitted by the company to the Bureau of Mineral Resources for palynological examination. They were examined by Dr. P.R. Evans, whose report is included as Appendix E.

A significant feature of the cores is the rarity of pollens of Nothofagidites type, which are characteristic of the Australian early Tertiary, but rare in the late Cretaceous and late Tertiary. Evans considers three possibilities:

Fig. 7



Drafting Section, Queensland Department of Mines.

STRUCTURAL CONTOUR MAP OF REFLECTION "B"

ONSHORE HILLSBOROUGH BASIN

Reference

— — — ....Road

—+—+— .....Railway

Contour Interval : 0·1 second (500ft. approx.)

Based on report by Namco International Inc. to Ampol Exploration (Qld) Pty. Ltd.

SCALE IN MILES

1 ½ 0 1 2 3

To accompany Bureau of Mineral Resources Record No.1968/22.

F55-A4 8

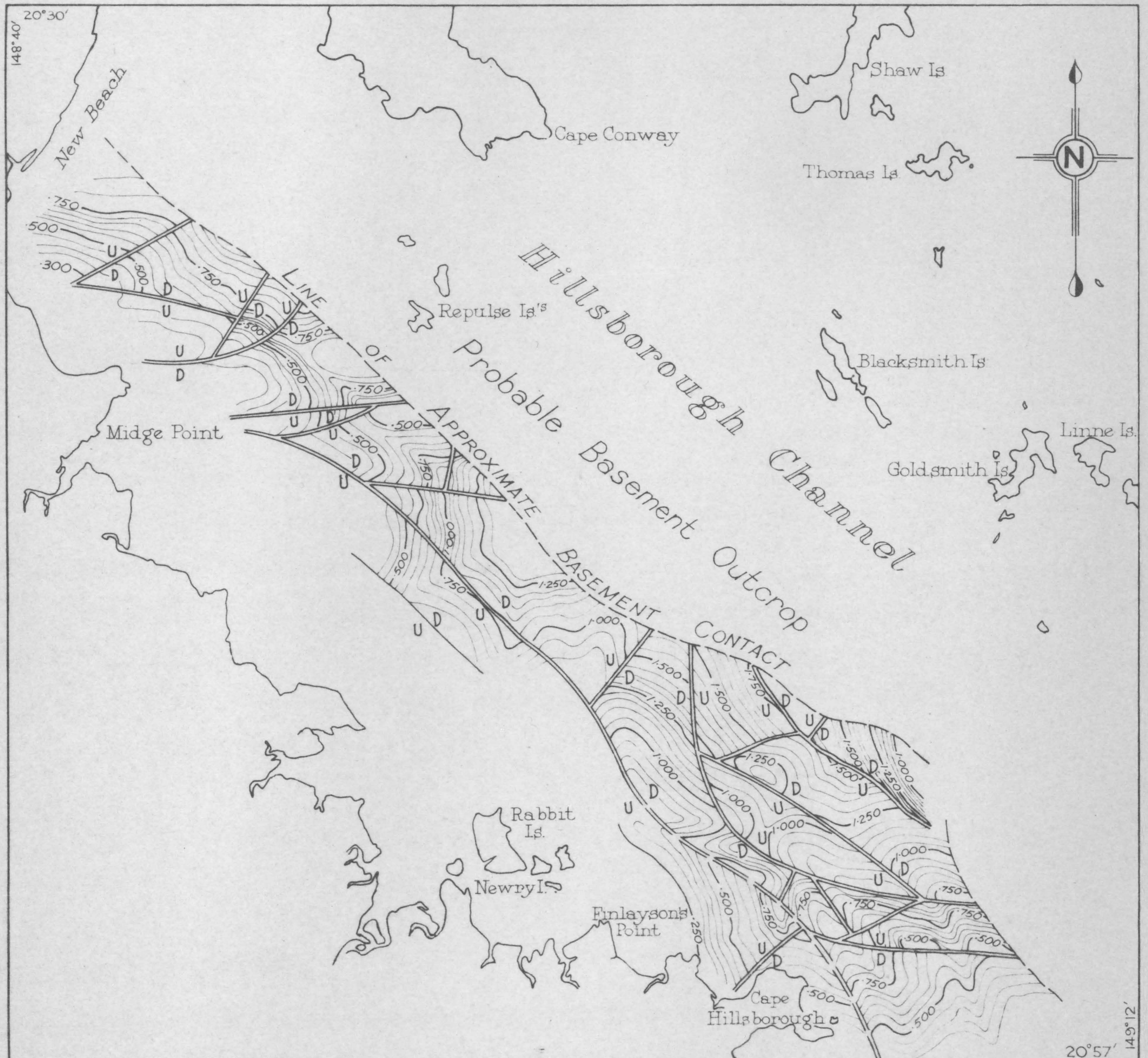


Fig. 8

STRUCTURAL CONTOUR MAP OF REFLECTION "B"

OFFSHORE HILLSBOROUGH BASIN

Reference

U/D .... Fault

Contour Interval : 0·05 second (500 ft. approx)

Based on report by Western Geophysical Comp. of America to Ampol Exploration (Qld) Pty. Ltd.

SCALE IN MILES

2·5 2 1·5 1 ·5 0 2·5 5 7·5

To accompany Bureau of Mineral Resources Record No. 1968/22

F55 - A4 - 9

(1) that the microfloral assemblage may be strongly facies-controlled, and that the abundance of pteridophytes and the rarity of Nothofagidites are due to local factors;

(2) that the rarity of Nothofagidites indicates a late Tertiary age;

(3) that the rarity of Nothofagidites and the abundance of pteridophytes indicates a late Cretaceous age.

For reasons stated in his report, Evans considers that no choice can yet be made between these three alternatives.

The development of the Hillsborough Basin post-dates the Proserpine Volcanics, which have been dated at 111±5 m.y. (about the middle of the Cretaceous).

The gross composition of the sediments below about 2,500 feet does not appear to differ from that of the sediments in the higher part of the section, but the abundance of vitric fragments, some of which are only slightly devitrified (Ampol Exploration (Qld) Pty Ltd, 1965, pp 23 and 24), may be an indication of contemporaneous volcanic activity. As the Cretaceous Whitsunday and Proserpine Volcanics are universally devitrified, the presence of vitric fragments suggestsa correlation with the volcanics of the Tertiary Cape Hillsborough Beds which contain abundant perlitic and pumiceous material.

We consider that the balance of evidence favours a Tertiary age for the Hillsborough Basin sediments.

Environment of deposition

The palynological results are not diagnostic so far as the environment is concerned, but Evans (Appendix E) suggests that the sediments from 0-1,060 feet could have been deposited in a near-shore marine or estuarine environment, and that the abundance of pteridophyte spores between 1,370 and 1,983 feet may indicate swampy conditions. Evans considers that the fungal remains between 2,245 and 2,798 feet strongly indicate fresh-water conditions.

No palynological information is available for the section below 2800 feet, but there is nothing to suggest a significantly different environment, beyond the possibility that there may have been some contemporaneous volcanic activity.

UNDIVIDED CAINOZOIC

Alluvium, etc (Cza)

Much of the land surface of the Sheet area is underlain by superficial alluvial deposits, some of which may extend down into the top of the Pliocene. Colluvial and outwash deposits which form gentle slopes close to the hills and ranges, merge in places with the alluvium. Alluvium bordering streams is the main source of groundwater in the Sheet area. The alluvium consists of sand, silt, mud, and gravel. It is on alluvial deposits that most of the sugar cane is grown.

It is not known at what depth the boundary between the Pleistocene and Tertiary lies.

QUATERNARY

Coastal sand dunes (Qr)

Extensive sand dunes occur at many places along the coast, and some, for example those between Proserpine and New Beach and south of Sand Bay, occur several miles inland, representing old strand lines or offshore bars. The dunes are seldom more than a few feet high. The dunes between Proserpine and New Beach have been largely obliterated by mud brought down by the Proserpine River during floods.

A large complex of thickly vegetated dunes occurs in the south-east of Whitsunday Island. The configuration of these dunes is not related to the present coast-line, and their origin was probably not connected with coastal processes. The crests of some of the dunes are estimated from air photographs to be up to 200 feet above sea-level, but this does not necessarily indicate sand thickness, because the dunes rest upon a buried landscape of Whitsunday Volcanics. Away from the beach the dunes are stabilized, but waves and tides are redistributing some sand along the shore towards the north-west, to form a large spit at the mouth of Hill Inlet. The sand in the dunes is brilliantly white and consists almost entirely of quartz, representing a potential source of silica sand (see Economic Geology). The purity of the sand can only have been brought about by a prolonged period of subaerial chemical weathering and reworking on a land surface which lay to the south-east. A low stand of sea-level during an ice age would have provided suitable conditions for this.

Similar sand fills hollows on Haslewood Island and probably underlies most of Whitehaven Bay.

Coastal mud flats (Qm)

Much of the low-lying country fringing the coast, especially near estuaries, consists of mud flats which are periodically inundated by high tides and floods. Generally, thin salt layers are interbedded with the mud. The development of mud flats along the mainland coast between New Beach and the southern border of the Sheet area has probably been accelerated by a slight relative emergence, in Recent times.

A study of Recent marine and littoral sedimentation in the Whitsunday Islands and adjacent mainland was carried out by Thomas (1966).

DYKES

The strike directions and attitudes of dykes recorded in the course of the survey are plotted in Figure 9.

The excellent exposures around the coastlines show that dyke-emplacement has been an important rock-forming process in the region. In areas other than the coastlines exposures of dyke rocks are scarce; even on the coastline, it is much easier to recognize, say, basic dykes in granite (e.g. Shaw Island), than in intermediate or basic volcanics (e.g. Double Bay, and the eastern shore of the Cape Conway Peninsula). Therefore the quantity and distribution of dykes plotted on the map probably convey no indication of their real abundance and distribution. However, the number of dykes recorded around the drowned coasts is enough to present a statistically meaningful picture of the directions and attitudes of emplacement north-east of Proserpine and Hillsborough Channel.

Basic and intermediate dykes

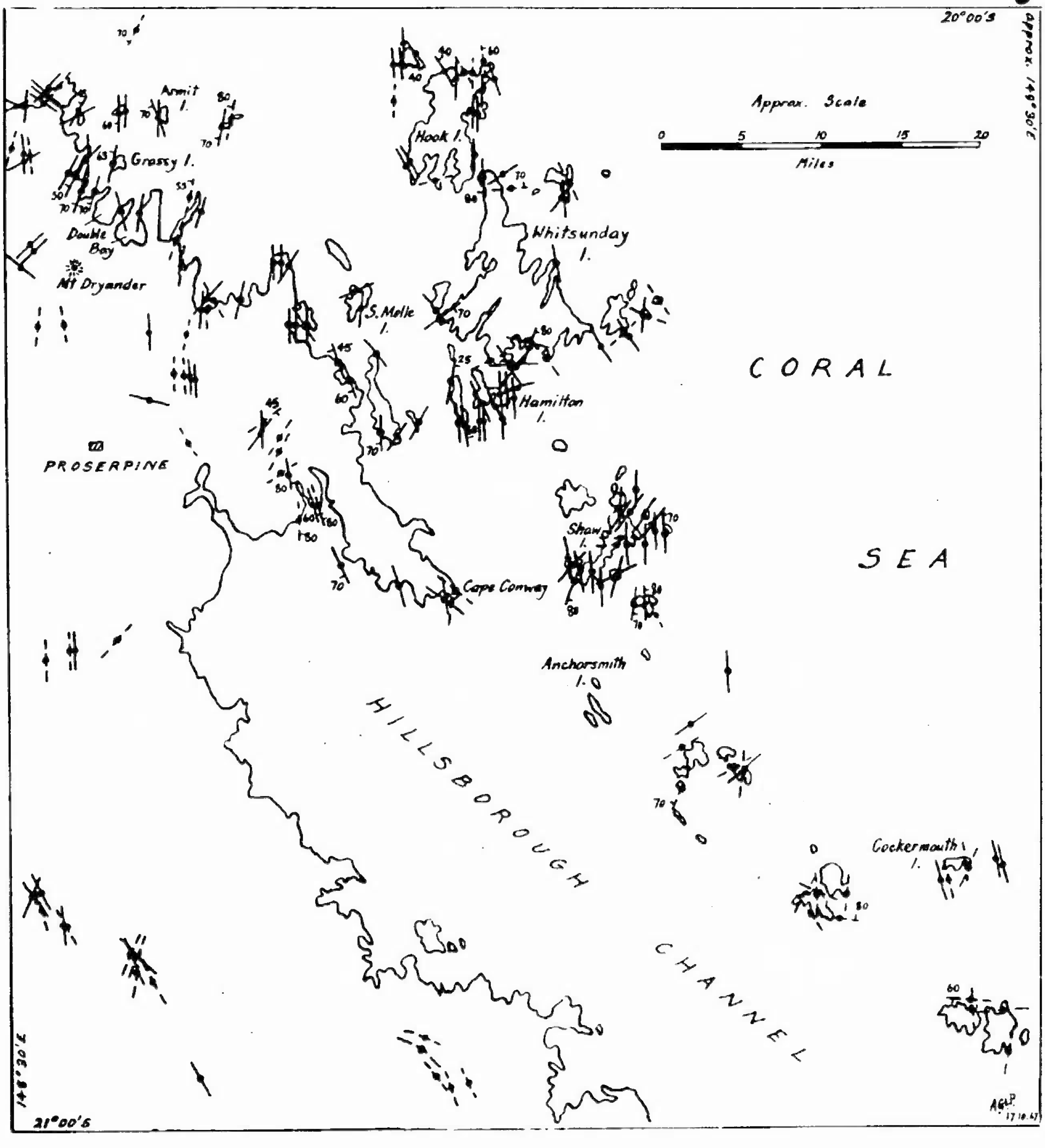
Basic and intermediate dykes are more common than acid dykes. They range widely in thickness, composition, texture and grain-size. Most dykes are between 2 and 5 feet thick, but dykes up to 50 feet thick occur in places, notably in the Airlie Volcanics on the western shores of Armit and Grassy Islands. Multiple dykes have been observed at several localities. Six miles north of Mount Dryander porphyritic acid dykes up to 60 feet thick are intruded by parallel microdiorite dykes. Many basic and intermediate dykes are epidotized, and many contain small disseminated cubes of pyrite. The strike of almost all of them falls within the NNW-NNE octant, and many of the dykes strike meridionally. Their attitude is generally controlled by the joint pattern of the country rocks.

The largest basic hypabyssal intrusion discovered in the field was a sill of altered gabbro, 200 feet thick, which intrudes the Whitsunday Volcanics on South Molle Island. The sill dips steeply to the east. The gabbro consists essentially of plagioclase and clinopyroxene, but epidote, prehnite, and chlorite are developed throughout the rock. The intrusion is slightly discordant in places, and has a narrow chilled margin. The sill is intruded by at least four sub-parallel microdiorite dykes which trend about north. A six-foot-thick sill of fine-grained porphyritic gabbro, which contains a few specks of chalcopyrite, occurs farther to the east, towards Deedes Point.

Acid dykes

Acid dykes are generally thicker than basic or intermediate ones; thicknesses of up to 500 feet have been observed. The close association between acid dykes and outcropping granite in the islands south of latitude 20°40'S suggests that elsewhere such dykes are indicators of near-surface granitic bodies. Again there is a wide range in thickness, texture, composition, and grain-size. Many of the finer grained dykes are flow-banded, and columnar jointing is commonly developed. A spectacular example of columnar jointing may be seen in a thick dyke of granophyric microgranite (locally known as "the Woodpile") near the north-eastern tip of Hook Island.

Fig. 9



Sketch map showing DYKES in the Proserpine 1:250,000 Sheet area

Basic or intermediate dyke } showing dip where not vertical

Acid dyke

To accompany B.M.R. Record No. 1968/22

F 55-A4-10

Other dykes

A thin discontinuous dyke of black porphyritic hyaloandesite intrudes dacite at the southern end of Anchorsmith Island.

Dykes composed of fragmental material (tuffisites) intrude the Whitsunday Volcanics along the east coast of Hamilton Island and on an islet off the south-western end of Cockermouth Island, where they range up to 35 feet in thickness. Irregular dykes of similar texture intrude volcanics of probable Cretaceous age on East Repulse Island (see Campwyn Beds).

Age of the dykes

Most of the dykes probably belong to the Lower Permian and Cretaceous cycles of igneous activity. However White and Brown (1963) record a thick dolerite dyke which intrudes the arkosic conglomerate of Blackcombe Island (K/Tb). The conglomerate appears to be derived from the presumably Cretaceous granite of Shaw and nearby islands, and the occurrence indicates that some dykes may be distinctly later than the Cretaceous igneous activity, and are possibly related to the Cainozoic vulcanism (Cape Hillsborough Beds).

On the north coast of Dumbell Island bedded tuffs have been plastically deformed at their contacts with thick intermediate or acid dykes, indicating that the dykes in this case were intruded before the tuffs were consolidated.

On the north coast of Tinsmith Island the sequence is: (1) granite, (2) basic dykes, (3) acid dykes. This suggests either that some of the acid dykes are not magmatically related to the granites, or that two distinct magmas were available for intrusion within a short period of time.

STRUCTURAL GEOLOGY

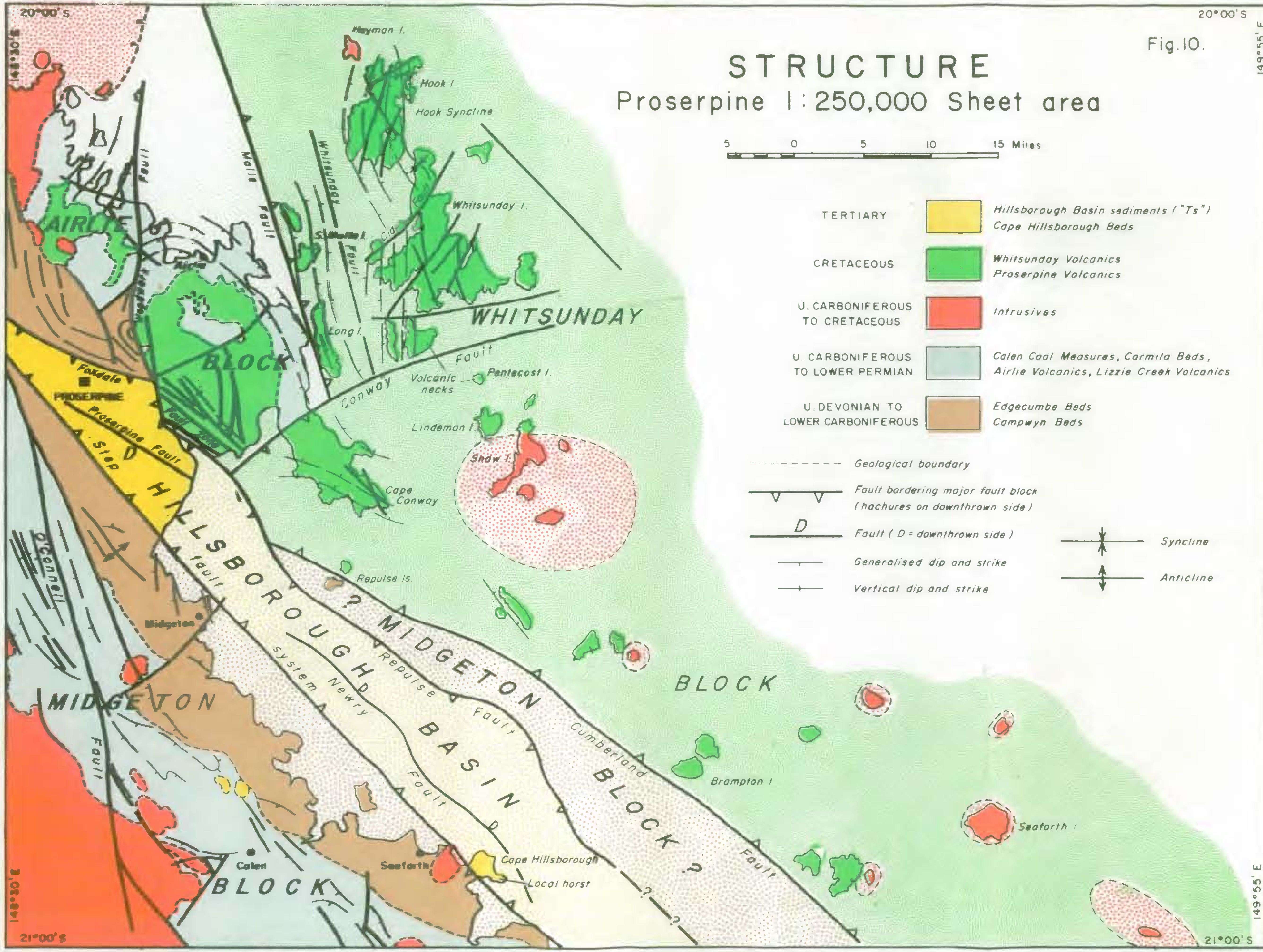
An interpretation of the regional structure of the Sheet area is shown in Figure 10.

Block faulting, which characterizes the structure of coastal Queensland is the most prominent structural feature. Three major fault directions can be recognized. South-east faults, on which the major component of movement has been vertical, divide the area into four structural blocks, namely the Midgeton, Airlie, and Whitsunday Blocks, and the Hillsborough Basin. North-east faults, which may have a significant horizontal component of displacement, have modified the shape and distribution of the structural blocks. Several meridional faults have influenced the distribution of the stratigraphic units within the blocks.

Midgeton Block

The Midgeton Block, which consists principally of the Campwyn Beds, the Carmila Beds,the Calen Coal Measures and the Urannah Igneous Complex, is a remnant of a basin whose depositional history extended from the Upper Devonian to the Lower Permian. Its history of sedimentation is similar to that of the Yarrol Basin, a major intracratonic basin best developed in the Monto-Mundubbera area about 300 miles south-east of Proserpine. As a discontinuous, narrow belt of Devonian, Carboniferous, and Permian sediments can be traced from Proserpine to the Monto area, it is possible that the sediments in the Proserpine area represent a northern continuation of the Yarrol Basin. However it is possible that the structural high north of Rockhampton may have separated the depositional area preserved in the Proserpine area from the Yarrol Basin proper.

Regional dip throughout the block is moderate to the south-west, but in detail the structural attitudes are variable. Near their northern limit of outcrop the Campwyn Beds form an anticline which plunges gently north-west. The contact between the Campwyn Beds and the overlying Carmila Beds has not been seen in outcrop, but the age difference between the units suggests an unconformity. Jensen (1966) shows this contact in the Mackay Sheet area as a high-angle reverse fault, and it is quite possible that the contact in the Proserpine Sheet area is also faulted in places.



To accompany Record 1968/22

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The regional structure of the Carmila Beds, including that part in the Bowen Sheet area, is a north-north-west-trending synclinorium, which has been modified by major faults and by the intrusion of the Urannah Igneous Complex. Dips in the Proserpine Sheet area are mainly to the south-west, and those in the Bowen Sheet area appear to be consistent to the north-east. The axis roughly coincides with the O'Connell Fault. The Calen Coal Measures similarly have a regional dip to the south-west, modified by intrusions and faults. The measures are downthrown and tilted to vertical along the O'Connell Fault; they are not preserved west of it.

The Urannah Igneous Complex occupies the south-western part of the Midgeton Block. The Complex as a whole forms the Connors Arch (Malone, et al., 1966), which separates the Bowen Basin sequence in the west from the structurally more complex Lower Permian sequences to the east. The arch probably originated in the Middle or Upper Carboniferous, as a result of batholithic emplacement, and is thus wholly younger than the Campwyn Beds. Intrusion was renewed in the Lower Permian and Cretaceous, and the Urannah Igneous Complex probably had an important influence on the distribution and deformation of the stratified rocks in the Midgeton Block. The part of the Complex which lies within the Proserpine Sheet area, although generally younger than the stratified rocks to the east, intruded and reinforced a pre-existing granitic belt which formed a structurally high area. Faulting within the block is most prominent in north-north-west and north-east directions. The Calen Coal Measures have been tilted to vertical along the O'Connell Fault, and are not preserved west of it, but no offset of the contact of the Urannah Igneous Complex is apparent across the fault, although a strong lineament traverses the complex on strike with the fault. This suggests that the main movement on the O'Connell Fault preceded the emplacement of this part of the complex, and that subsequent movements were only minor.

In late Cretaceous or Tertiary times, block faulting of the Midgeton Block gave rise to the Hillsborough Basin.

Small granite stocks (P-mg and Kg) and other intrusions (P-Mr, P-Mo) were emplaced in the Midgeton Block in Permian to Mesozoic times.

Airlie Block

The Airlie Block contains the Airlie Volcanics, the Edgecumbe Beds, and the Proserpine Volcanics, and intrusive rocks (P-Md, P-Mg). It is a horst, formed as a result of Cretaceous or Tertiary earth movements.

North and north-west of Proserpine the Edgecumbe Beds have been tilted en bloc, and now dip vertically or very steeply to the east-north-east and north-east. North-east of Proserpine their structure is complicated by faulting and probably also by folding, but their regional dip is still steep and north-easterly.

The Airlie Volcanics have been folded into a large open syncline which plunges south or south-south-west at a low or moderate angle. Dips are moderate to low in the western limb, and somewhat steeper in the eastern limb. The Proserpine Volcanics unconformably overlie the Airlie Volcanics, and dip regionally to the south-west at low to moderate angles. The south-west margin of the block is marked by the Foxdale Fault Zone, on which downthrow has been to the south-west. The Molle Fault (downthrow to the north-east) forms the eastern margin of the Airlie Block, and the Conway Fault (downthrow to the south-east) forms the southern boundary. The Woodwark Fault, which merges with the Foxdale Fault Zone, has downthrown the Airlie Volcanics against the Edgecumbe Beds.

Whitsunday Block

The Whitsunday Block consists mainly of the Cretaceous Whitsunday Volcanics and related granites (Kg). The block has been down-faulted against the Midgeton and Airlie Blocks, thus destroying the original configuration of the Cretaceous depositional area. The base of the Cretaceous sequence is nowhere exposed, because all contacts are either faulted or covered by the sea.

The Hook Syncline is an open fold with gently dipping limbs. South of the Cid Fault several other large faults complicate the structure, and the Hook Syncline loses its identity. The overall pattern of folding in the Whitsunday Block is not clear; dip facings and strike directions are variable, and no structural trends are recognizable.

The granite which forms Shaw and adjacent islands can be readily interpreted as a stock about 12 miles in diameter. It is not known whether the granite islands in the south-east form part of a large mass, or represent separate intrusions, but the common occurrence of xenoliths suggests that they represent separate intrusions.

Hillsborough Basin

The Hillsborough Basin is a narrow asymmetrical graben which trends north-west from near the southern border of the Sheet area to Proserpine. Detailed descriptions of the structure of the Hillsborough Basin may be found in the reports submitted to Ampol Exploration (Qld) Pty Ltd, by its geophysical contractors (Namco International, Inc. 1964, Western Geophysical Company of America, 1964).

The north-east margin of the basin is a fault system which comprises the Foxdale Fault Zone, the Proserpine Fault, and the Repulse Fault. This fault system remained active during deposition. Its presence offshore has been proved by a marine seismic survey (Western Geophysical Company of America, 1964). Brecciation and silicification have been observed in places along faults within the Foxdale Fault Zone. A small horst of vertically dipping Airlie Volcanics at Bald Head, 12 miles south-east of Proserpine, has been preserved within the zone. A south-east-trending shear zone on South Repulse Island may be related to the development of the graben.

The greatest amount of subsidence in the Hillsborough Basin occurred along its steep north-eastern flank, where, in one area (north-east of Cape Hillsborough), up to 10,000 feet of sediments were deposited.

The south-western flank of the graben is interpreted as a series of small step-faults (Namco International Inc., 1964), and here the overall slope of the basin floor is relatively gentle. The sediments thicken towards the north-east, and it is clear that the boundary faults along the north-east margin were the major influence controlling subsidence and sedimentation within the basin.

Sediment thickness decreases markedly towards the southern boundary of the Sheet area, where the basin loses its identity. In the north-west, the basin ends abruptly in an asymmetrical synclinal structure, as depicted in Figure 6. It is possible that the positive basement feature which is interpreted to lie immediately north of this structure is related to movements along the O'Connell Fault.

Geophysical surveys suggest that the Tertiary sediments of the Hillsborough Basin are cut by many faults (Figure 7). One of these, the Proserpine Fault, has a displacement of at least 1,500 feet (south block down). These post-sediment faults trend predominantly either south-east, or north-east to east. The rugged headland formed from the Cape Hillsborough Beds is probably a horst in which the beds have been upthrown from where they were deposited in the Hillsborough Basin.

The drowned coastline in the Airlie and Whitsunday Blocks was probably caused by tilting and block-faulting in the late Tertiary or Quaternary, or in both.

GEOLOGICAL HISTORY

During the Upper Devonian and Lower Carboniferous, sediments, pyroclastics, and minor flows (Campwyn Beds and Edgecumbe Beds) were deposited in environments ranging from shallow marine to fresh water. The basement of these rocks is not exposed, and nothing is known of the geological history before the Upper Devonian. Deposition of these sequences probably ceased at the end of the Lower Carboniferous. A break in sedimentation between the Lower and Upper Carboniferous, accompanied by earth movements, appears to have occurred throughout Queensland (except at the southern end of the Yarrol Basin). One hundred miles west of the Proserpine area two unconformities are recognized in this part of the geological record: one between the Lower Carboniferous Drummond Group (Malone, et al. 1966, Wyatt, et al. 1967, Olgers, in prep.) and the Upper Carboniferous Bulgonunna Volcanics (Malone, et al. 1964 and 1966) and the other between the Bulgonunna Volcanics and the Lower Permian Lizzie Creek Volcanics (which may extend down into the Upper Carboniferous). These events were probably represented at least in part in the Proserpine Sheet area, because no Upper Carboniferous fossils have been found in either the Campwyn Beds or the Edgecumbe Beds. Isotopic dating indicates that the earliest phase of the Urannah Igneous Complex was emplaced in the Middle to Upper Carboniferous (A.W.Webb, pers.comm.), and this would almost inevitably have been accompanied by some diastrophism.

In Upper Carboniferous to Lower Permian times, acid to intermediate volcanics and associated sediments (Carmila Beds, Lizzie Creek Volcanics and Airlie Volcanics) were deposited in fresh water. The volcanic activity died away in the Lower Permian, and, after minor tilting of the rocks, the Calen Coal Measures were laid down, probably in coastal swamps. The tilting may have been connected with further granite emplacement, which is known to have taken place at about that time, 30 miles to the west (Paine, et al., in prep, b).

There is a gap in the geological record between the Lower Permian and the Cretaceous. It is conceivable that some of the intrusions grouped as "Permian to Mesozoic" (P-Md, P-Mg, P-Mr, and P-Mo) were emplaced after the Lower Permian and before the Cretaceous, but no Triassic or Jurassic intrusions have been discovered so far in the region, and it is more likely that they are either Permian or Cretaceous.

The Cretaceous was an important rock-forming period in the region. Several plutonic intrusions in the Bowen Sheet area, one of which, the Hecate Granite (Paine, et al. in prep, b), measures at least 500 square miles, and a granite at Eungella just south-west of the Sheet area (Webb and McDougall, 1964), have yielded isotopic ages which fall within a group averaging about 125 m.y. (Lower Cretaceous). It is possible that part of the Urannah Igneous Complex was intruded at about this time. Younger isotopic ages obtained from the region (110 and 115 m.y. from granites (Kg), and 112, 111, 106, and 96 m.y. from the Proserpine and Whitsunday Volcanics) appear to form a distinctly younger group, indicating that a plutonic phase was followed about 10 million years later by a phase of volcanic and sub-volcanic activity. It is believed that the Proserpine Volcanics (mainly rhyolite) were erupted terrestrially upon a stable block, while a thicker sequence of ash-fall pyroclastics and minor flows, the Whitsunday Volcanics, were being laid down in an unstable fresh-water trough a short distance to the east. As volcanic activity waned, the depleted and differentiated magma cooled as high-level alkaline granite stocks (Kg). Similar magma rose in places to intrude the stable block to the west, forming the granite at Halliday Bay (Kg) and the Mount Jukes Syenite Complex.

These events were followed by uplift and erosion, and the late Cretaceous or Tertiary arkosic conglomerate (K/Tb) of Blackcombe Island was laid down in a small intramontane basin among hills formed from Cretaceous granite.

The block-faulting which established the present general layout of the rock units began in the late Cretaceous or early Tertiary, and allowed up to 10,000 feet of sediments (Ts) to accumulate in a narrow graben, the Hillsborough Basin. At present the evidence from onshore exposures of the sediments indicates fresh-water deposition; the chance of marine sediments occurring elsewhere in the graben is considered remote, because the seismic results show that the basin was bounded on the north-east by a continuous steep fault scarp, and that the sediments thin markedly south-east of Cape Hillsborough. But the possibility of a narrow connection with the sea cannot be entirely ruled out. Vulcanism contributed to the supply of detritus in the lower part of the section, and the acid plugs of Mount Springcliffe and Pinnacle Rock (Tr) represent two of the volcanic centres.

The faulting continued, possibly into the Quaternary, and fragmented the Hillsborough Basin into subsidiary fault blocks. It was probably these movements which caused the drowning of the coastline north-east of Hillsborough Channel and the uplifting of the Cape Hillsborough horst.

The sand deposits on Whitsunday and Haslewood Islands were formed by wind from sand exposed during lower sea-levels in the Quaternary. More recently, the development of low sand dunes along the coast west of Hillsborough Channel has probably been facilitated by slight relative emergence. Further evidence of this Recent emergence is provided by the wave-cut benches in several of the Cumberland Islands.

ECONOMIC GEOLOGY

Coal near Calen and clay at Pindi Pindi are the only mineral deposits which have been worked in the district.

Coal

The coal, which occurs near the top of the Calen Coal Measures, was noted by R.L. Jack in 1887. Later A.G. Maitland (1889b), L.C. Ball (1910) and J.H. Reid (1924,b, 1929,a) inspected the coalfield. Reid (1929a) referred to an "ill-starred attempt to open up the coal seams". In 1927-28 about 500 tons were produced at the Calen Colliery, which consisted of several small shafts at the foot of the Whiptail Range, four miles west of Calen. Later the Fleetwood Colliery was established in the same area, and between 1932 and 1939 produced 8,964 tons of high rank, bituminous, non-coking coal. The coal measures are extensively faulted and dykes have destroyed much of the coal. Production from both collieries was:

Colliery	Year	Tons	Value (£)
Calen	1927	300	445
"	1928	214	261
Total			706
Fleetwood	1932	151	106
"	33	376	300
"	34	1545	1155
"	35	956	740
"	36	801	652
"	37	3238	2593
"	38	1543	1172
"	39	254	199
Total		8864	6917

Two coal shafts were sunk near the junction of Macquarie and Jolimont Creeks, in 1920. Saint-Smith (1920) reports that only minor coaly bands were encountered, both the shafts going to about 90 feet. The coal was altered to graphite and was of no commercial value.

Limestone

Connah (1958) records several small occurrences of limestone near Cape Hillsborough, Seaforth and old Saint Helens Homestead. On the south-east side of the peninsula at Cape Hillsborough, he records a small lens of dark grey oolitic fossiliferous limestone interbedded with andesitic tuff. Thin lenticular beds of impure limestone, which are interbedded with calcareous sandstone, crop out above high water mark on the beach one mile north of Seaforth. Connah noted a 10 foot thick bed of fossiliferous oolitic limestone interbedded with andesitic tuffs east of old Saint Helens Homestead, but the exact location of old Saint Helens Homestead is now unknown. Simmonds and Tucker (1960) examined a limestone deposit of excellent quality on East Repulse Island and estimated reserves at 87,000 tons. All limestone occurrences are found in the Upper Devonian - Lower Carboniferous Campwyn Beds. None of the occurrences offers prospects of large reserves.

Clay

Clay has been mined at Pindi Pindi since 1934 for the production of house bricks and fire bricks. Houston (in press) reports that steeply dipping shale and mudstone are mined in two pits, one at the works at Pindi Pindi and the other about six miles away. The sediments are part of the Lower Permian Carmila Beds. Between 1934 and 1938, 15,300 tons of brick clay was mined. During the period 1952-1957, 8,040 tons of brick clay were produced. Houston (in press) states that recorded production from the two pits for the period 1959-1965 is approximately 18,240 tons. Production in 1965 was 3,805 tons.

Petroleum

Igneous intrusions and an abundance of volcanics and probable continental sediments, rule out any possibility of discovering commercial quantities of petroleum in the Palaeozoic and Mesozoic rocks.

During the last decade oil exploration companies have become interested in the petroleum prospects of the Tertiary sediments in the Hillsborough Basin. The Mackay Oil Prospecting Syndicate (MOPS) drilled two wells during 1956-7 near Cape Hillsborough, one to 303 feet (MOPS No 4) and the other to 2,405 feet (MOPS No 5), but neither oil nor gas was encountered. MOPS No 5 well penetrated about 700 feet of Tertiary strata. In a report on the wells, Lawrence (1956) recorded a greasy laminated shale which, when analysed, gave:

Solids and non-combustibles..................	82 percent
Volatiles (incl. sulphur and higher hydrocarbons)......................	8 percent
Water...	10 percent

In 1962 and 1963 Ampol Exploration (Qld) Pty Ltd, carried out reconnaissance geological mapping of Authorities to Prospect 93P and 94P, which took in the coastal and offshore area between Broad Sound and Bowen. The existence of a deep graben (the Hillsborough Basin) was first demonstrated by an aeromagnetic survey (Hartman, 1963), and was later confirmed by onshore and offshore seismic surveys (Namco International Inc, 1964, Western Geophysical Company of America, 1964).

These surveys indicated up to 7,000 feet of sediments a few miles south of Proserpine, and up to 10,000 feet offshore in the deepest part of the graben, north-east of Cape Hillsborough.

In 1965 Ampol drilled Proserpine No 1 Well 7.5 miles south-east of Proserpine, as a stratigraphic test of the northern part of the basin. The well was drilled on the eastern flank of a faulted synclinal trough, and proved 4,208 feet of Tertiary, or possibly late Upper Cretaceous sediments where the seismic results had indicated 4,500 feet of sediments. No significant shows of hydrocarbons were encountered in the well, and no effective porosity or permeability was evident in the sediments drilled.

No evidence of marine sedimentation in the Hillsborough Basin has come to light from the section encountered in Proserpine No 1, nor from either of the MOPS wells at Cape Hillsborough. The lack of such evidence, when considered in conjunction with the impermeable nature of the section in Proserpine No 1, downgrades the petroleum potential of the basin. A further unfavourable feature, shown by the geophysical work, is the fact that the basin appears to have been enclosed on all sides, suggesting that it developed in an intramontane environment, and had no well established connexion with the sea. At present the petroleum prospects depend on discovery, by drilling, of a significant thickness of clean sandstones in the offshore part of the basin, in conjunction with evidence for a marine origin for at least part of the section.

Groundwater

Because of the abundant rainfall (up to 70 inches), groundwater supplies are not used extensively. Rainfall is sufficient for the growing of sugar without irrigation. Alluvial deposits bordering rivers and major creeks give a satisfactory supply; several bores in the alluvium of the Proserpine River supply the town of Proserpine. The Bowen-Proserpine Lowland is the largest storage area, but its groundwater potential has not been fully investigated. The Queensland Irrigation and Water Supply Commission has carried out some drilling in the course of investigations into the Proserpine water supply. Seismic shot holes, drilled in the area surrounding Proserpine No. 1, by (Namco International Inc. in 1964), struck water in sandy beds at depths ranging from 5 to 65 feet. Over half the holes struck water within the first twenty feet. The quality of the water was not recorded. A small amount of irrigation is carried on near Proserpine.

The supply of fresh water from natural run off on Hayman Island is barely sufficient to support the tourist resort. Laycock (1966) carried out a survey of the water resources of the island, and indicated that the water supply would continue to be a problem, especially after a succession of dry seasons. Most of the Cumberland Islands have steeply plunging coastlines; beaches, potentially the most favourable storage areas for groundwater, occur only sporadically.

Gold

No gold has been produced from the Proserpine Sheet area. Gold and silver were reported to be associated with a basic dyke in the Brandy Creek area. However samples collected by Saint-Smith (1918) during an inspection of the prospect contained neither gold nor silver. Morton (1926) reported that a supposed gold discovery at Conway Beach consisted of strongly pyritic siliceous rhyolite which contained only traces of gold and silver.

On present knowledge the most favourable area in which to look for gold is the contact of the Urannah Igneous Complex. Many small gold deposits are associated with the Cretaceous Hecate Granite, a few miles west of the Sheet area (Paine, et al., in prep, b). The Hecate Granite was formerly mapped as part of the complex (Malone, et al, 1966), and it occupies a similar structural position, on the eastern margin of the batholith, as that part of the Urannah Igneous Complex which lies within the Proserpine Sheet area. Isotopic dating has shown that granite of Cretaceous age occurs near the contact in the Proserpine Sheet area (just east of the Forestry Station), and it is possible that the granite throughout the whole length of the intrusive contact south of the Forestry Station is Cretaceous too. The area is thickly vegetated, and probably has not been thoroughly prospected.

Base metals

A local prospector, Mr A. Blair, reported to the field party that small quantities of wolfram had been found in the headwaters of Gamut Creek, north of Collingvale Homestead, but the locality was not inspected by the field party.

Minor copper mineralization was noted in the field in alunitized and pyritized porphyry on Pentecost Island (Appendix H). Values of up to 525 ppm copper, 300 ppm lead, and 1,570 ppm zinc were determined by atomic absorption spectrophotometry on samples collected from the island in the course of the survey. The mineralization is erratic, but it suggests that further investigation could be worth while.

Another occurrence of alunitized rock, on Finger and Thumb Islets, is described in Appendix H, and a minor occurrence of syngenetic microspherular pyrite, on Hammer Island, is described in Appendix G.

As with gold, it is considered that the best area to search for base metal deposits is the contact of the Urannah Igneous Complex. A small zinc-lead-silver-copper deposit, the "Mixer" or "Godkin" Mine, occurs in microgranite at the contact just west of the Sheet area, due west of Mowo Siding. The mine contained some rich pockets of ore, but the mineralization was too erratic to be worked at a profit (Cribb, 1954).

No mineralization has been reported from the Cretaceous alkaline granites (Kg), or the Mount Jukes Igneous Complex, but these rock units should be regarded, prima facie, as potential source areas for molybdenum, wolfram, and tin mineralization, and possibly also copper, lead, and zinc.

Emery

A small piece of corundum-maghemite rock was found lying on the surface in a valley 2.5 miles west of Mount Millar, during a helicopter traverse. A description of the specimen is given in Appendix F.

Silica sand

The brilliant white beaches which fringe Whitehaven Bay and Hill Inlet (Whitsunday Island) were noted in 1927 by G.A.V. Stanley, and in recent years they have been recognized as the site of potential silica sand deposits. Most of the reserves occur in a series of south-east-trending, thickly vegetated dunes which rise to more than 200 feet above sea-level in the south-east of Whitsunday Island. The dunes cover about 4 square miles. Some similar wind-blown sand occurs on Haslewood Island. The Bowen Mineral Company has prospected the deposits, but no development has taken place, and little information is available on reserves and grades.

An analysis of 99.89 percent S_1O_2 and minimum reserves of 800 million tons have been reported by W. Hickmott of the Bowen Mineral Company (pers. comm.).

Opal and banded agate

Maitland (1889,b) reports that opal and banded agate occur commonly in the debris at the base of the steep cliffs at Cape Hillsborough.

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APPENDIX A

by

J.F. Dear (Geological Survey of Queensland)

Part 1,

Faunal and floral lists from sites discovered prior to 1962 in the Proserpine Sheet area.

Locality: Victor Creek; Grid ref. 658823, St. Helens 1-mile sheet.

Determinations: *Lepidodendron veltheimianum*
Stigmaria ficoides
? *Sigillaria* sp.

Age: Probably Lower Carboniferous

Locality: Grid reference 658825, St. Helens 1 -mile sheet.

Determinations: Fragmentary plant stems and leaves.

Age: ? Lower Carboniferous

Locality: Outer Red Cliff Island; Reference 682900, St. Helens 1-mile sheet.

Determinations: *Cyrtospirifer* sp.
? *Sentosia* sp.
? *Aviculopecten* sp.
? *Syringopora* sp.
Leptophloeum australe

Age: Upper Devonian

Locality: Newry Island; Reference 640917, St. Helens 1-mile sheet.

Determinations: *Leptophloeum australe*

Age: Upper Devonian

Locality: Outer Newry Island; Reference 649917, St. Helens 1-mile sheet.

Determinations: Fossil wood

Age: Mesozoic

Locality: Reference 577807, St. Helens 1-mile sheet.

Determinations: ?Noeggerathiopsis sp.

Age: ? Permian

Locality: Reference 573802, St. Helens 1-mile sheet.

Determinations: Fragmentary plant remains

Age: ? Permian

Locality: Reference 574801, St. Helens 1-mile sheet.

Determinations: Fragmentary leaves showing anastomosing venation,

Age: Permian

Locality: Andrews Pt.; Reference 795825, Hillsborough 1-mile sheet.

Determinations: Dicotyledonous leaves

Age: Tertiary

Locality: Approximately 1¾ miles east of old St. Helens Homestead

Determinations: Prospira striatoconvoluta (Benson and Dun)
Spirifer sp. with high area on pedicle valve.
Orthotetid
Camarotoechia sp.

Age: Lower Carboniferous

Remarks: All collections except the last mentioned were made by students of the University of Queensland in 1957, and are housed at the University of Queensland. The last mentioned collection was made by J.H. Reid (1924a), and is housed in the collections of the Geological Survey of Queensland.

Part 2,

Palaeontological report on fossils from Seaforth.

by

J.F. Dear

Locality: P. 28F Finlayson's Point, Seaforth; map reference 388167, Proserpine, 1:250,000 sheet.

Collector: Combined B.M.R. - G.S.Q. party, 1962.

Determinations:

Rugosochonetes kennedyensis var. *magnus* Maxwell
Schellwienella sp.
Schuchertella sp.
Rhipidomella australis (McCoy)
Spirifer sp.
Prospira tellebangensis Maxwell
Tylothyris sp.
Brachythyris productoides (Eth.fil.)
Cleiothyridina sp.
Straparollus sp.
Baylea sp.
Indet. aviculopectenid
Indet. trilobite fragments.

Age: Upper Tournaisian

Remarks: The assemblage compares closely with the Upper Tournaisian faunas of the Yarrol Basin, in particular with that described by Maxwell (1961a) from the Tellebang Formation at Old Cannindah. The specimen figured by Maxwell as *Ectochoristites wattsi* Campbell compares closely with *Spirifer* sp., and in addition *Rugosochonetes kennedyensis* var. *magnus*, *Rhipidomella australis*, and *Prospira tellebangensis* occur in both faunas. *Straparollus australis*, which was described by Maxwell (1961b) from the same locality in the Tellebang Formation, closely resembles *Straparollus* sp. Maxwell considered the fauna at Old Cannindah to be Upper Tournaisian in age.

In Three Moon Creek, Cania, 26 miles to the north-west of Old Cannindah, a fauna strikingly similar to that from Finlayson's Point occurs in mudstones immediately overlying an oolitic limestone. It includes *Rugosochonetes kennedyensis* var. magnus, *Rhipidomella australis*, *Prospira tellebangensis*, *Brachythyris productoides*, and species that closely resemble *Schellwienella* sp., *Schuchertella* sp., *Cleiothyridina* sp., and *Straparollus* sp., respectively. A form identical to *Spirifer* sp. occurs in mudstones approximately 150 feet below the oolitic limestone. The fauna at Cania is thought to be slightly younger than that from Old Cannindah, but is of Upper Tournaisian age.

Spirifer sp. also compares closely with the species figured by Maxwell (1954) as *Spirifer* cf. *liangchowensis* Chao from the *Spirifer* Zone of the Mt. Morgan district. *Rugosochonetes kennedyensis* var. *magnus* is also present in the *Spirifer* Zone, which was considered by Maxwell to be Visean in age. The latest evidence available suggests however, that the fauna of this Zone may be approximately correlated with the Upper Tournaisian faunas at Old Cannindah and at Cania.

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Part 3.

Palaeontological report on fossils from Cape Hillsborough

by

J.F. Dear

(Unpublished report on files of Geological Survey of Queensland, 3/1/64)

Collector: Ampol Exploration (Q'land) Pty. Limited.

Locality: Sample P51; north side of Cape Hillsborough, north of Mackay.

Determination: indet. gastropod remains

Age: Tertiary

Remarks: The sample contains several crushed specimens of a small indeterminate naticoid gastropod of little value in age determination and correlation. In the absence of any associated marine organisms, there is no reason to suppose that the deposit is not of freshwater origin, as gastropods are known from several localities in the Tertiary freshwater deposits of Queensland.

The exposed sequence at Cape Hillsborough consists essentially of a lower sandstone and shale unit, overlain by a thickness of rhyolitic volcanics and derived sediments. Gastropods have been collected previously from the lower unit outcropping on the northern side of Cape Hillsborough.

Several specimens collected by J.H. Reid in 1939 were the subject of an unpublished report by Whitehouse (1939) who suggested tentatively that they were of Tertiary age, and referred them to the genus *Sigaretus* Lamarck. The present whereabouts of this collection is not known.

In 1957, another collection was made by geology students from the University of Queensland. This collection, which was not available for comparison, proved of little value in age determination, but Dr. Endean of the Zoology Department of the University of Queensland was of the opinion that the gastropods present were of probable freshwater origin. The students also collected dicotyledonous leaves from a sequence of interbedded sandstones and rhyolitic volcanics outcropping on the causeway between Wedge Island and Andrews Point, approximately 1½ miles south-east of Cape Hillsborough. Subsequently, Jensen (1963) recorded dicotyledonous leaves from the lower sandstone/shale unit on the northern side of Cape Hillsborough, confirming a Tertiary age for the entire exposed sequence at Cape Hillsborough.

Hodgson (1963) reported Tertiary (probably Lower Tertiary) spores from the probable equivalents of the sandstone/shale unit in the Mackay Oil Prospecting Syndicate No. 4 Oil Exploration Bore at Cape Hillsborough, from cuttings between 235 feet and 303 feet.

References:

HODGSON, E.A., 1963 : Appendix C in JENSEN, A.R.,: The geology of the southern half of the Proserpine 1:250,000 sheet area. Bur.Min. Resour. Aust. Rec. 1963/65 (Unpubl.)

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APPENDIX B

SUMMARY OF UPPER CARBONIFEROUS-PERMIAN FOSSIL PLANTS IN THE AREA

(based on identifications by Mary E. White in 1963)

Unit	Locality+	Species
Carmila Beds	P2	*Noeggerathiopsis hislopi* (Bunb.)
		?*Glossopteris* fragments
" "	P4	*N. hislopi* (Bunb.)
" "	P17	*N. hislopi* (Bunb.)
		Equisetalean fragments
		Glossopteris fragments
" "	P52	*N. hislopi* (Bunb.)
		Glossopteris venation fragments
		Equisetalean stems
" "	P140	*N. hislopi* (Bunb.)
" "	P150	*N. hislopi* (Bunb.)
		Samaropsis dawsoni Shirley
		Equisetalean stems
" "	P153	*Glossopteris indica*
		Equisetalean stem
" "	P174	Equisetalean stems
Lizzie Creek Volcanics	P22	*Glossopteris* fragments
		Vertebraria indica
Calen Coal Measures	P93	*Glossopteris* fragments
		Equisetalean fragments

+ Localities shown on accompanying 1:250,000 scale geological map.

APPENDIX C

Palynological determination, Mackay Oil Prospecting Syndicate Wells Nos. 4 and 5

by

E.A. Hodgson

Three samples, submitted by A.R. Jensen, from Cape Hillsborough Bores Nos. 4 and 5, have been examined for spores.

The sample from Bore No. 4 (235-300 feet) produced a good yield of well preserved pollen, among which triporate species including Triorites harrisii were relatively abundant. Rare specimens of Nothofagus cf. deminuta were recorded. The remainder of the assemblage was made up of Inaperturopollenites sp. podocarpaceous species and unidentified pollens including an inter-semiangular form. This sample is of Tertiary (probably Lower Tertiary) age.

Two samples from Bore No. 5, from 40 feet and from 660-665 feet, failed to produce a microflora.

APPENDIX D

Report on collections of plant fossils from the Proserpine district, Queensland.

by

Mary E. White

Part 1 - 1965 collections

Collector: A.W. Webb 10 miles S.W. of Proserpine. Carmila Beds.

Specimens F22719 - F22721 Military Grid Ref. E681400 N 2432500

In specimen F22719 impressions of stems and broad ribbon leaves with fine parallel venation occur. The stems are similarly veined. There is no noding visible. These specimens are referable to *Cordaites australis* (M'Coy), a Cordaitean of Upper Devonian and Carboniferous distribution which was also found in Lower Bowen rocks in the 1961 collection (White, 1962).

In specimen F22720 large seeds are present associated with *Cordaites australis*. These seeds are up to 2cm long, pear-shaped, with greatest width up to 1.5cm. and with a narrow wing-like border. They are referable to *Cordaicarpus* and are assumed to be the seeds of *Cordaites australis*. They are, however, indistinguishable from the *Samaropsis dawsoni* seeds which are so characteristic of the Lower Bowen.

In specimen F22721 there are some ribbed stems which have definite nodes and are equisetalean.

The presence of *Cordaites australis* and *Cordaicarpus* seeds (which would be called *Samaropsis dawsoni* if present in a Lower Permian flora without *Cordaites*) indicates that the age of the fossil horizon is Lower Permian at youngest, or more probably Upper Carboniferous. There is an increasing volume of evidence that the early *Gangamopteris* floras of the Lower Bowen, which contain the characteristic Lower Bowen type of *Noeggerathiopsis* (close relative of *Cordaites australis*) are Upper Carboniferous at least in part.

Age: Upper Carboniferous or Lower Permian.

Reference:

WHITE, MARY E., 1962 - Report on 1961 plant fossil collections. *Bur. Min. Resour. Aust. Rec.* 1962/114 (unpubl.)

Part 2 - 1966 collections

Summary:

Three collections of plant fossils were submitted from the Proserpine District of Queensland in 1966 by A.G.L. Paine.

Collection 1, from the Campwyn Beds, contains Lepidodendroid stem impressions cf. Lepidodendron veltheimianum or L. aculeatum and Equisetalean fragments. A Carboniferous age is suggested, but Upper Devonian is not precluded.

Collection 2, from clasts in conglomerate of the Whitsunday Volcanics consists of slate with plant impressions, and coaly specimens with no identifiable plant remains. Cladophlebis australis and Equisetites rotiferum are identified, indicating Lower Mesozoic age.

Collection 3, from the Cape Hillsborough Beds consists of specimens of fine white sandstone with numerous impressions of dicotyledonous leaves of Tertiary age.

Collection 1 (Campwyn Beds)

North bank of O'Connell River, 400 yards downstream from the Bruce Highway Bridge. Military Grid Ref.: E 128600 N 2426500 From a sequence of tuffaceous sediments interbedded with volcanics. Specimens F 22865, F 22866, and F 22867.

The plant fragments in the specimens are largely indeterminate. There are two impressions of immature Lepidodendroid stems, with crowded leaf bases. They are of Lepidodendron veltheimianum general type and are tentatively referred to that species or to L. aculeatum which has similar young forms (Specimen No. F 22865).

Some fragments of ribbed Equisetalean stems are present in specimen F 22867. No specific determination can be made. The presence of a Lepidodendron of the veltheimianum type suggests a Carboniferous age for the specimens. The Calamite does not assist in dating. On the available evidence no closer age-determinations can be made than Upper Devonian or Carboniferous.

Collection 2 (Whitsunday Volcanics, Kc)

Cape Conway, East of Proserpine. Military Grid Ref. E163900 N2430400. Clasts from a thick (2000') conglomerate lens interbedded in volcanics.

Specimens F22868 - F22874

This collection consists of specimens of a slaty nature containing visible plant remains, and an additional sample of coaly specimens. As the collection is of importance in elucidating stratigraphical problems, it has been examined in great detail and the coaly specimens have been broken up and fragments examined in the hopes of finding additional evidence.

The following plants are identified in the specimens:-

Cladophlebis australis (morr.)

Equisetites rotiferum Ten. Woods

Small spherical seed.

The age of the plant horizon is Lower Mesozoic.

Cladophlebis australis is very common in the Jurassic and Lower Cretaceous, but occurs also in the Triassic. It is a form genus of sterile fronds, showing considerable variation in form.

Equisetites rotiferum is Jurassic, but very similar to E. rajmahalensis from the Lower Cretaceous of India.

Details of specimens follow:-

F 22868: Specimens with indeterminate plant remains.

F 22869: Specimens with fragmentary Cladophlebis australis (Morr.)

F 22870: Specimens with clearly determinate Cladophlebis australis.

F 22871: Terminal part of frond and impression of larger frond of Cladophlebis australis.

F 22872: Specimens with stem impressions and leaf sheaths of Equisetites rotiferum.

F 22873: Specimen with cast of small round seed.

F 22874: Three small specimens of Equisetites rotiferum.

Collection 3 (Cape Hillsborough Beds)

Cape Hillsborough. Military Grid Ref. E178800 N 2432900.

Fine grained white sandstone interbedded in a Cainozoic volcanic sequence.

Specimens F22875, F22876.

Dicotyledonous leaves are present in these specimens. In view of the great diversity of dicotyledonous leaves during this epoch no identification should be made on gross morphology alone. Only when cuticles are present, or fruits associated, or where there is some very characteristic feature showing relationships with modern plant families or genera, can identifications safely be made.

Age: Tertiary

APPENDIX E

Palynological examination of cores from Ampol Proserpine No. 1 Well, Queensland

by

P.R. Evans

Samples from the first eight cores cut in Ampol Proserpine No. 1 Well, Queensland have been submitted for palynological examination by the company. The samples were received either by A. Lloyd, while he was visiting the well site, or by direct despatch. The samples came from the following depth:

Core 1, 771 ft
Core 2, 1070 ft
Core 3, 1375 ft
Core 4, 1652 ft
Core 5, 1978 ft
Core 6, 2251 ft
Core 7, 2632 ft
Core 8, 2783 ft

A preliminary examination of these samples has produced the following results.

Cores 1 and 2 yielded relatively common angiosperm pollens and a moderate proportion of dinoflagellate microplankton. The samples were taken from dark grey bituminous shale and fine siltstones showing some small-scale cross bedding. They could represent a near-shore marine or perhaps estuarine environment.

Cores 3, 4, and 5 yielded an abundance of pteridophytic spores including varieties of Cyathidites, Osmundacidites, and Gleicheniidites. The few specimens of Contignisporites sp. cf. C. cooksonii were found in core 3, and rare specimens of Cicatricosisporites sp. cf. C. australiensis were found in cores 4 and 5. Rare triporate pollens and multiporate pollens assignable to Nothofagidites were found in core 5. Cores 6, 7, and 8 yielded relatively few microfossils, among which fungal thyrothecia and multicelled phragmospores were relatively common. Triporate and multiporate pollens were observed in core 8.

None of the samples examined from cores 3 to 8 gives a clear idea of the section being penetrated. The continued presence of angiosperm pollens indicates that the Tertiary is represented.

The abundant content of pteridophyte spores in cores 3 to 5 and the relatively high fungal content in cores 6 to 8 indicate that local environmental factors as well as the rocks' age influence the content of the assemblages.

The following alternatives should be considered:

1. The microfloral assemblages of cores 3 to 8 represent localized facies. The abundant pteridophyte content of cores 3 to 5 may indicate a localized pteridophyte floral province, developed away from the normal areas of angiosperm provenance, such as in a swampy district. The fungal remains in cores 3 to 8 strongly indicate a freshwater environment of deposition.

2. The section penetrated by Proserpine No. 1 is of relatively late Tertiary age. Throughout this project I expected, but did not find, the abundant _Nothofagidites_ microflora of the early Tertiary. This microflora is known to occur in Lower Miocene sediments in the Wreck Island bore, and in early Tertiary sediments in the Duaringa area, south of Proserpine. If sediments of Eocene to Miocene age are present in the Proserpine region, the _Nothofagidites_ microflora may well be expected to occur there. If the assemblages found in Proserpine No. 1 are not strongly facies controlled, then probably a late Tertiary section is being drilled.

3. _Nothofagidites_-type pollens are known to make their first appearance in New Zealand and in the Otway Basin of Victoria in late Upper Cretaceous times. The rarity of _Nothofagidites_ and the dominance, at least from about 1300 to 2000 feet in the well, of pteridophyte spores might indicate that late Upper Cretaceous sediments are present. However none of the typical Upper Cretaceous pollens known to the writer has yet been found in the Proserpine samples.

As there is a general lack of knowledge of Australian late Tertiary palynology and of the means by which different floral provinces in the Tertiary may be expressed in their microfloral counterparts, no choice can yet be made between the three alternatives listed above.

APPENDIX F

(From B.M.R. Laboratory Report No. 92, 1965)

MINERALOGICAL EXAMINATION OF AN IRON OXIDE - CORUNDUM-RICH ROCK FROM NEAR PROSERPINE, QUEENSLAND

by

I.R. Pontifex.

Registered Number : 65152221

Location: 5 miles south-west of Bloomsbury.
Military grid reference: E118000 N2403500

Description: The hand specimen is unusually heavy and very weakly magnetic. Individual opaque grains in the rock are moderately magnetic.

An examination of a thin-section and a polished section of the rock indicates that it consists of:

corundum	approximately	50 percent
maghemite	"	40 percent
hematite	"	5 percent
sericite	"	5 percent
ilmenite	"	1-2 percent

The rock has an equigranular texture; euhedral corundum grains occur within an allotriomorphic granular aggregate of iron oxides.

Corundum occurs as individual lath-shaped crystals of generally uniform grain-size which average 0.75 mm x 0.25 mm. Most of the corundum crystals are surrounded by a narrow alteration corona of sericite. This is probably a primary alteration product.

APPENDIX G

SYNGENETIC MICROSPHERULAR PYRITE AT HAMMER ISLAND

(WHITSUNDAY VOLCANICS) (A.G.L.P.)

Microspherular, or "framboidal" pyrite, similar to that described by Baker (1960) from Branch Creek (northern Tasmania), Cobar, and Mount Isa, occurs in tuffs of the Whitsunday Volcanics (Cretaceous) on the eastern shore of Hammer Island (Lat. 20°39'S., Long. 149°03'5"E.) in the Sir James Smith Group. The Military Grid Reference of specimens is E179200 N2417200.

Microspherules consisting of granules of probable hematite and limonite were discovered in the course of systematic petrographic work (thin section 66159530), and were suspected of being pseudomorphs after pyrite. Later, in another thin section (66159532) sulphide microspherules (probably pyrite) were found; in places these were partly altered to hematite and limonite. The identification of pyrite has been confirmed by mineragraphic work by Dr. J.A. Macdonald of C.S.I.R.O.

The host rocks are grey, thinly laminated but indurated, fine crystal and vitric intermediate tuffs, deposited under water.

TS. 66159530

The microspherules occur:

(1) In a "bed" 1 cm. thick which consists of convoluted injection structures of coarser poorly sorted tuff (average maximum grain size 0.1mm.) in a host bed of finer, well sorted tuff whose grain size ranges from 0.01mm. down to the resolution threshold. The microspherules form thin arcuate tenuous trails in the lobes of coarser material, to which they appear to be restricted.

(2) Scattered throughout a composite lamina which is of uniform thickness (1.5mm.) but which has suffered advanced disruption and mixing of grain sizes due to interstratal mobilization under load. The microspherules form about 1 to 2 percent of the lamina.

The microspherules are of remarkably uniform size and are commonly perfect spheres. They average 0.02 to 0.025 mm. in diameter, the largest being 0.03 mm. and the smallest 0.015 mm. Each is composed of an aggregate of several hundred closely packed polygonal, sub-spherical, and ovoid granules which are also of uniform size, ranging from 0.003mm. down to 0.001 mm. The granules are translucent, and their relief is considerably higher than that of the mounting medium (Lakeside 70). In colour they range from pale amber to deep red. Some spherules have been partly or completely disintegrated, and in places trails of granules are all that remain. The fact that most spherules are intact suggests that disintegration took place during manufacture of the slide.

TS. 66159532

The bedding in much of this thin section has not been deformed by differential load phenomena. The rock laminae are generally distinct. They are more uniform and finer than in TS. 66159530.

Pyrite occurs:

(1) In an attenuated "saddle-reef" up to 0.2mm. thick in fine tuff laminae enwrapping a 3mm. void in the slide which was presumably occupied by a rock fragment. The "saddle-reef" is centred above the void, as deduced from the orientation of graded bedding. The "saddle-reef" conforms to the bedding and thins in both directions away from the crest of the compaction fold developed above the rock fragment. The pyrite in this feature occurs as fairly densely packed anhedral grains 0.002 to 0.015mm. in diameter, and as rare cubes. Limonite granules resembling those in TS. 66159530, and presumably liberated from oxidized pyrite microspherules, occur in the "saddle-reef" where it is cut by a narrow joint. An even more attenuated lenticle of graphite (J.A. Macdonald, pers. comm.) 0.05 mm. thick, conforms to the bedding 0.1mm. above the pyrite "saddle-reef".

(2) As a pinching and swelling lamina, up to 0.2mm. thick, composed of densely packed anhedral grains, and bordered by a thin selvedge of limonite granules. The lamina is parallel with the bedding.

(3) As rare small aggregates and trails of grains and microspherules (now oxides) around which a suggestion of differential compaction is detectable in places. The aggregates and trails appear to be the disrupted remnants of continuous lenticles.

Origin

The conformability between the pyritic lenticles and the bedding planes of the rocks is notable. This feature can still be recognized in those parts of the rocks which have been severely deformed by differential compaction, for the trails of microspherules faithfully follow the sinuous injection and disruption structures. This shows that the pyrite was introduced "syngenetically", before the rocks were lithified.

Reference:

BAKER, G., 1960 - Some Australian occurrences of microspherular pyrite. N. Jb. Miner., Abh., 94 (Festband Ramdohr). 564-83.

26th July, 1967.

APPENDIX H

ALUNITIZATION AND OTHER MINERALIZATION AT PENTECOST ISLAND AND FINGER AND THUMB ISLET

(A.G.L.P.)

Pentecost Island

Pentecost Island (Photo Plate 2 and Fig. 11) lies ten miles offshore from Cape Conway and thirty miles due east of Proserpine. It is a rugged, thickly wooded island, just under a mile from east to west, by two-thirds of a mile across. Continuous outcrops, in places cliffs, generally bordered by a narrow boulder beach, occur around 70 percent of the shore. Large bare outcrops project to form a discontinuous south-west-trending central ridge which culminates at its north-eastern end in a precipitous crag 941 feet above sea level. There are no sheltered bays or sandy beaches on the island, and it is only possible to land in fairly calm weather.

The island is the eroded remnant of a plug of grey quartz-feldspar porphyry. Remnants of the pyroclastic country rock are preserved along the south-eastern shore.

The quartz-feldspar porphyry contains disseminated pyrite, and weathering of the pyrite has coloured the outcrops an arresting deep orange. Rare small green copper stains occur on joint surfaces at widely separated points around the shore.

During routine petrological examinations D.E. Clarke and W.B. Dallwitz discovered 25 percent alunite/natroalunite in a specimen collected in 1965 from the northern shore (specimen 65152421). This was confirmed by A.D. Haldane (B.M.R. Lab. Report No. 30, 1966) who by calcining and leaching the specimen, determined the following results:-

	$\%K_2O$	$\%Na_2O$
Acid soluble	2.0	0.4
Water soluble	1.9	0.5

A part of the same specimen was submitted to I.R. Pontifex for mineragraphic examination. He estimated the pyrite content at 3 percent, and the content of copper sulphides (as digenite replacing chalcopyrite, and minor covellite) at a maximum of 0.5 percent. C.D. Branch determined a copper content of 0.13 percent by X-ray spectrograph.

These results were considered to be of sufficient interest to justify a second visit to Pentecost Island, to determine the extent of the alunitization and sulphide mineralization. During the course of regional mapping in 1966, the opportunity was taken to collect a further 22 specimens from the island, seven from within 150 yards of specimen 65152421, and 15 from around the shore at intervals as regular as practicable (see fig. 11). They were analysed by J.R. Beevers and T. Ford for Cu, Pb, Zn, Cd, Au, Ag by atomic absorption spectrophotometry; for Mo by colorimetry; and for available K and Na (i.e. as alunite/natroalunite) by calcining and leaching (see attached table).

The results indicate that the alunitization is sporadic. All but one specimen contain less than 1250 ppm extractable K (averaging 250ppm), and less than 500 ppm extractable Na (averaging 200 ppm). The exception is a specimen (P4) which contained 16000 ppm available K and 3400 ppm available Na (rougly equivalent to 2 percent K_2O and 0.5 percent Na_2O). This specimen, although containing remarkably similar K_2O and Na_2O percentages to those obtained for specimen 65152421, was collected from the shore a quarter of a mile east of 65152421. Two intervening specimens (P5 and P6) and the seven collected from the immediate vicinity of 65152421 (P7 to P13) all contain low values of available K_2O and Na_2O. The rocks which contain alunite are not distinguishable, either in their field setting or in hand specimen, from those that do not. However, with further work it might be possible to develop some crude criteria, such as hardness or lustre of the rock.

Specimen P1 contained 525 ppm copper, P3A contained 300 ppm lead and 1570 ppm zinc, P4 180 ppm lead, P15 210 ppm copper and P16 280 ppm lead and 180 ppm zinc. The other specimens averaged 15 ppm or less copper, 50 ppm lead, and 20 ppm zinc. Gold and silver were less than 0.1 ppm in all specimens; molybdenum was less than 0.2 ppm; 10 ppm cadmium was detected in one specimen (P3A).

The zeolite laumontite forms thin veins up to 1cm. wide in the porphyry at P8-13. The laumontite was identified by C.D. Branch by X-ray diffractometry. Analysis by spectrophotometer (J. Puchel) indicates that it is the sodium-rich end member.

Finger and Thumb Islet

Finger and Thumb is a small, isolated rocky islet situated midway between Brampton Island and the Sir James Smith Group. It is 15 miles from Cape Hillsborough on the mainland, and 50 miles south-east of Proserpine. Its exposed parts measure about 250 feet from east to west, by 70 feet across.

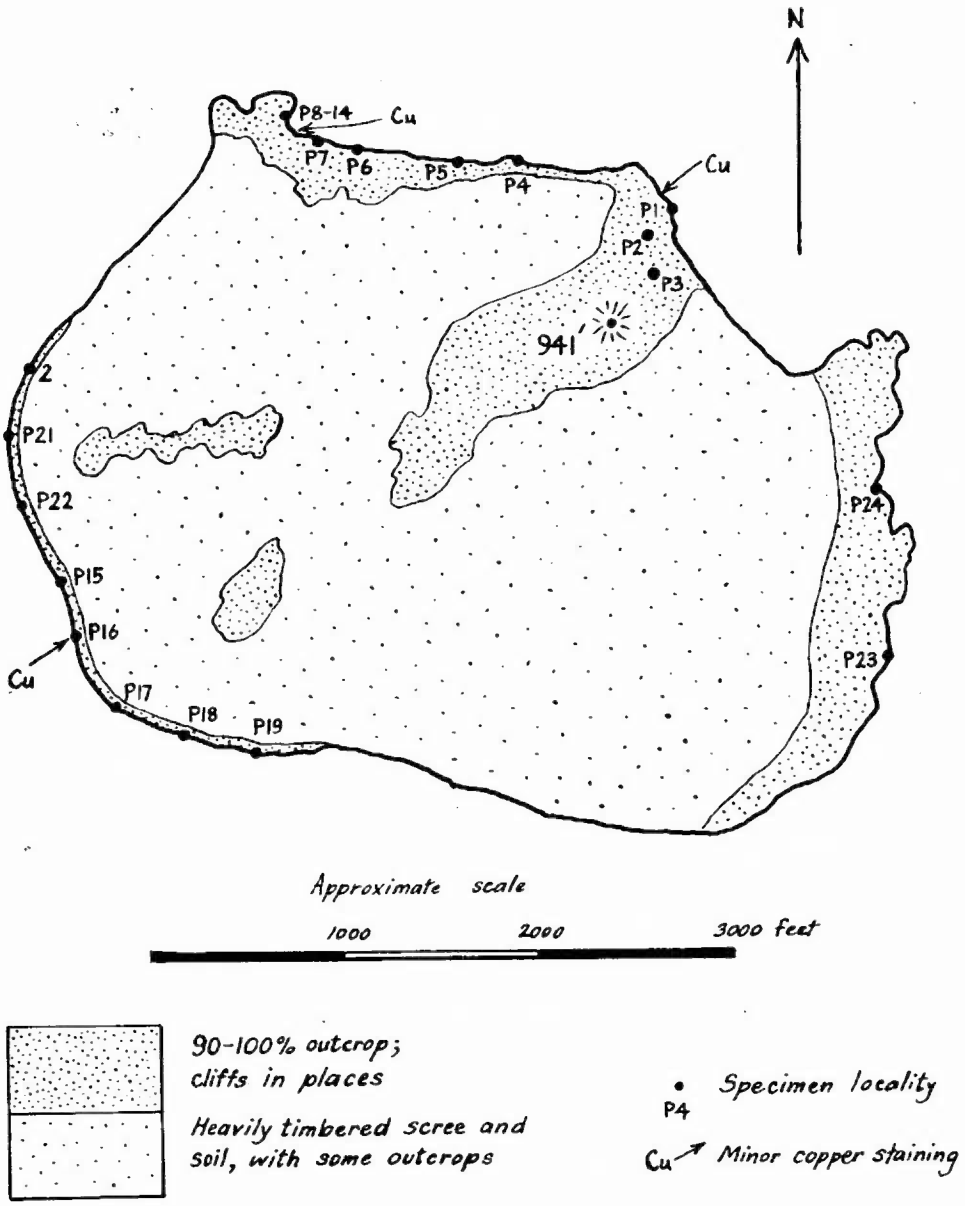
The islet was briefly examined at both ends. The rocks at the western end were described in the field as thinly and uniformly bedded, white to pale buff, fine-grained quartzitic rocks, brecciated in places and dipping north-north-west at 45 degrees. These rocks were puzzling at the time, and seemed out of context with the volcanics and granite which form the rest of the island chain. A highly altered and structureless granular rock, with vague relict feldspar phenocrysts and presumably of igneous (no doubt volcanic) origin, was found at the eastern end of the islet.

Fig. 11

PENTECOST ISLAND

Locality sketch plan showing specimens collected for analysis, 1966

(uncontrolled – enlarged from air photograph overlay)



To accompany Appendix H, B.M.R. Record 1968/22

A specimen of the quartzitic rock from the western end was found, during routine petrological work, to contain 30 to 40 percent alunite-natroalunite, occurring as very small evenly distributed tabular laths averaging 0.03 mm. in length. The alunite laths are strongly aligned, both physically and optically, and give the rock a definite "grain", which was mistaken in the field for bedding. The rest of the rock consists of 50 percent equigranular quartz (0.01 to 0.15 mm), with a somewhat granoblastic texture; 3 to 10 percent oval voids (averaging 0.3 mm) aligned parallel to the alunite and rimmed by thin, discontinuous remnants of hematite; and 1 percent hematite in strings of small grains, also parallel to the alunite foliation. It is suggested that the voids may represent former pyrite crystals.

This rock is thought to have originated as follows: the original rock (from the context, no doubt volcanic, although there is no longer any textural evidence to support this) was mineralized by pyrite, and strongly sheared. Sulphuric acid solutions or vapours, introduced during shearing, reacted with feldspar to form alunite-natroalunite, which grew in a stress field.

A.D. Haldane determined the available Na_2O and K_2O content of this rock, by calcining and leaching, at 2.3 percent and 2.1 percent respectively (B.M.R. Lab. Report No. 4, 1967).

16th March, 1967

Analysis of samples

by

J.R. Beevers

(B.M.R. Lab. Report No. 38, 1966)

22 samples were submitted.

Analyses of Cu, Pb, Zn and Cd were carried out by atomic absorption spectrophotometry. Analyses of K and Na were performed by cold-leaching ignited material. All results are expressed in parts per million.

Analyses by T. Ford showed that Au and Ag were less than 0.1ppm in all samples, and Mo (by colorimetry) was less than 0.2 ppm.

Sample No.	Cu	Pb	Zn	Cd	K	Na
P1	525	70	15	-	< 100	100
P2A	< 10	80	6	-	400	200
P3A	15	300	1570	10	800	170
P4	55	180	8	-	16,000	3,400
P5	< 10	20	8	-	300	300
P6	< 10	25	11	-	240	240
P7	< 10	25	40	-	120	170
P8	< 10	25	75	-	< 100	150
P9	< 10	20	45	-	200	200
P10	< 10	30	37	-	200	210
P11	30	40	7	-	1,200	350
P12	< 10	50	45	-	120	220
P13	< 10	60	30	-	200	270
P15	210	60	7	-	< 100	160
P16	20	280	180	-	< 100	100
P17	< 10	70	4	-	< 100	100
P18	15	80	19	-	200	480
P20	10	80	12	-	200	260
P21	30	50	4	-	300	260
P22	75	50	4	-	200	200
P23	< 10	40	28	-	120	160
P24	10	60	18	-	120	140

APPENDIX J

Isotopic age-determinations from the Proserpine 1:250,000 Sheet area, by A.W. Webb

Note: the analytical error in individual K/Ar determinations is ±3 percent)

Sheet area reference No.	A.N.U. Accession number	Military grid reference Eastings	Northings	Rock Type	Mineral analysed	Method	Age (x10^6 years)
2	GA 1142	170600	2384000	Granite	Hornblende	K/Ar	110
3	GA 1154	170600	2385300	"	"	"	115
4	GA 1135	119700	2397500	Granodiorite	Biotite Hornblende	" "	235 235
5	GA 1170	121800	2397500	"	Biotite	"	117, 117
9	GA 5394	175100	2447100	Quartz-feldspar porphyry	Total rock	"	96, 106
20	GA 5508	143800	2447900	Acid volcanic	Total rock	Rb/Sr	111±5*
21	GA 5512	137800	2445200	" "	" "	"	111±5*
22	GA 5511	138900	2445100	" "	" "	"	111±5*
23	GA 5507	139500	2447800	" "	" "	"	111±5*
25	GA 5553	205700	2399700	Dacite	Hornblende	K/Ar	112
26	GA 5546	137400	2445500	Acid Volcanic	Total rock	Rb/Sr	111±5*
27	GA 5547	139200	2445200	" "	" "	"	111±5*
32	GA 5552	136400	2442200	" "	" "	"	111±5*
33	GA 5539	136600	2444100	" "	" "	"	111±5*

* Isochron

APPENDIX K

Supplementary petrographic notes (A.G.L.P.)

WHITSUNDAY VOLCANICS

Undivided

Nara Inlet. Hook Island

65152159 Green, fine-grained, ash-fall crystal tuff.
General grain size 0.005 - 0.05 mm.
Quantity of chloritic debris suggests intermediate composition. Slightly recrystallized.

Dumbell Island (N. coast)

65152148 Similar to 65152159, but not recrystallized. Graded bedding.

65152160 Similar to 65152148, but contains sub-spherical concretions of optically continuous calcite.
Margins of concretions irregular. Calcite confined to the concretions.

Lupton Island (southern promontory)

65152175 Black andesitic crystal-lithic tuff.
Chloritized, epidotized. Welded. Contains aggregates of pyrite. Next to contact with thick intermediate dyke (65152173-4).

Haslewood Island (N. and W. coasts)

65152143 Red-brown dacitic ignimbrite.
Contains strongly chloritized and epidotized fragments of fine porphyritic dacite (grading to andesite).
Fragments flattened, lenticular.

65152144 Dark grey dacitic ignimbrite.
Contains coarsely devitrified lenticles, in which perlitic structures are well-preserved.

65152146 Purple-brown dacitic ignimbrite.
Groundmass consists mainly of flattened, devitrified glass shards.

Hammer Island (E. shore)

66159530 Grey-green, laminated, fine ash-fall crystal tuff.
Slightly recrystallized. Small-scale load and injection phenomena. Microspherular iron oxides after pyrite. Slide described in Appendix G.

66159531 Grey, fine-grained, ash fall crystal tuff.
Slightly recrystallized. Poorly sorted-crystals range up to 0.05 mm. Abundant carbonaceous wisps.

66159532 Grey-green, laminated, fine ash-fall crystal tuff.
Some interstratal contortions and injections. Rare, minute carbonaceous wisps. Rare lapilli up to 3 cm. Slide described more fully in Appendix G.

Finger and Thumb Islets

66159528 Alunitized, sheared, fine-grained igneous rock.
Superficially resembles quartzite in hand specimen. Slide described in Appendix H.

66159533 Highly altered, fine-grained quartz-chlorite-sericite-hematite rock. Brown chlorite occurs essentially as monomineralic aggregates. Sericite occurs in aligned sheaves and veins. Abundant small scattered granules of hematite.

Brampton Island (N. coast)

66159524 Grey-green, coarse, intermediate crystal-lithic tuff.
Completely unsorted. Abundant epidote and chlorite. Oligoclase crystals and fragments up to 2mm., lithic fragments up to 3 cm.

Carlisle Island

66159541 Dacite or dacite welded tuff.
Phenocrysts of calcic andesine (25 percent), quartz (7 percent), hornblende (7 percent), potash feldspar (1-2 percent), and Fe-opaques (1-2 percent).
Plagioclase ranges up to 4 mm. Zoning and alteration both very variable. Most crystals severely fractured.
Quartz ranges up to 3 mm. Deeply embayed, but bipyramidal form recognizable. Severely fractured.
Hornblende ranges up to 3 mm. Olive green. Chloritization minor.

Islet S.W. of Cockermouth Island

66159536 Pale grey-green, laminated, fine ash-fall crystal tuff.
Similar to Hammer Island specimens (66159530-2). Graded bedding well developed in some laminae.

Kc, Conway peninsula

Cape Conway

65152149 Black, carbonaceous subgreywacke.
In general not well sorted, but 50 percent of the clasts fall within the size range 0.2 to 1.0 mm.
Rare grains up to 2.0 mm. Packing tight-virtually no matrix. Rock fragments 60 percent; mineral grains 40 percent.

Rock fragments:

(a) Volcanics (50 percent). Sub-rounded to rounded. Mostly very fine-grained lavas (andesitic to dacitic). Some felsite fragments.
(b) Coaly material (10 percent). Sub-angular, suggesting brittleness. Minutely granular to silvery in reflected light-graphitic? Some of the grains contain thin layers of anisotropic material (silica?).

Mineral grains:

In decreasing order of abundance: quartz, feldspar (mostly sodic plagioclase, some perthite), muscovite, and biotite. Predominantly angular to sub-angular. Some of the quartz is strained and fractured (granitic).

65152150 Grey fine-grained "tuff", or "tuffaceous claystone"
Almost completely altered to calcite (65 percent) and chlorite (20 percent). Remainder of rock consists of lithic fragments (many of which are coaly), quartz, and feldspar.

65152154 Black, fine-grained, micaceous, calcareous, carbonaceous subgreywacke.
Not well sorted, but upper grain size limit well defined at about 0.1 mm. Calcite cement 25 percent, clay matrix 5-10 percent.

Clasts:

Quartz 20 percent. Rarely up to 0.2 mm. Angular.
Some grains have undulose extinction.
Felsitic volcanics, 10 percent; subangular.
Altered feldspar, 10 percent.
Coaly fragments, 10 percent.
Calcite fragments, 10 percent.
Muscovite, 5 percent.
Sericitic and calcitic aggregates occur both as clasts and as matrix/cement.

Headland 1 mile W. of Cape Conway

65152155 Calcareous carbonaceous sub-greywacke
Completely unsorted. Grains range up to 2 mm. (rarely 3 mm.); angular. Calcite, replacing grains and as cement, amounts to 15 percent.

Mineral grains:

Quartz (granitic) 25 percent
Altered feldspar (plagioclase and perthite) 20 percent
Muscovite 2-3 percent

Rock fragments

"Andesite" and "felsite" 25 percent.
Coarse micaceous kaolinitic quartzose siltstone 3 percent.
Coaly material 7 percent; contains thin layers of anisotropic material; partly replaced by calcite.

65152156 Arkose. Completely unsorted.
Mostly angular grains of feldspar and granitic quartz, up to 5 mm. Sub-rounded clasts of fine-grained volcanics amount to 5 percent (up to 1 cm.).
Feldspar mostly perthite. Calcite has replaced some grains.

65152157 Pale grey, calcified, volcanolithic subgreywacke.
Calcite has replaced many grains, and now forms 40 percent of the rock. Grains sub-angular to sub-rounded. General maximum grain size about 0.3 mm. Packing tight. Grains mostly very fine-grained "felsite". Some plagioclase and rare perthite.
Angular volcanic quartz grains 1 percent.
Carbonaceous fragments up to 3 mm. in hand specimen.

The following rocks occur as clasts in conglomerate which crops out at Cape Conway:

65152151 White medium to coarse alkali alaskite
Grain-size 1-3 mm.
Quartz, 45 percent; strained and fractured.
Perthite (with some antiperthite), 45-50 percent.
Albite, 5-7 percent
Minor carbonate, chlorite, iron-opaques.
Much of the feldspar is patchily calcified.

65152153 Grey, fine-grained, calcareous, sericitic orthoquartzite.
Grain-size 0.1 to 0.2 mm.
Well sorted and fairly well rounded.

Clasts: Quartz, 80 percent; mostly unstrained. Now somewhat annealed by overgrowths.
Rare plagioclase, biotite, muscovite, zircon.

Matrix: Sericitic, 10 percent.

Cement: Calcite, 8 percent; also replacing grains. In separate areas, discrete from the matrix.

66159542 Black, calcified, volcanolithic greywacke
Bimodal. 85 percent of the grains range between 2 and 4 mm. Packing tight. The remaining 15 percent (matrix) are poorly sorted and range from 0.05 to 0.5 mm.

Coarser grains;
Quartz, 10 percent. Sub-rounded.
Unstrained, glassy in hand specimen.
Deep embayments contain devitrified glass.
Volcanic fragments, 75 percent. Sub-rounded to rounded. Mainly very fine-grained altered andesite, some devitrified glass.

Matrix: Chloritic, probably tuffaceous.
Rock very extensively replaced pari passu by calcite, which now amounts to 50 percent.

66159543 Black, andesitic lithic tuff
Slide contains an eared vesicular lapillus, 4 mm. long.

66159544 Black, calcified, volcanolithic greywacke
A re-worked lithic-crystal tuff. Poorly sorted, but many of the grains lie close to a general maximum size of 2-3 mm.

Clasts:
Quartz, 40 percent. Sub-angular to sub-rounded.
Unstrained. Embayed.
Volcanic fragments, 25 percent. Fine-grained, andesite, porphyritic rhyolite, and felsite.
Sub-angular to rounded.
Plagioclase, 20 percent. Strongly sericitized, and calcified. Sub-angular to rounded.

Matrix:
Patchy, but averages 15 percent. Tuffaceous; very fine-grained.
Clasts and matrix replaced by calcite (10 percent).

66159545 Black, carbonaceous, tuffaceous siltstone
Grains sub-angular to angular.
Most grains near the maximum grain-size (0.1 mm).
Some sericite grains.
5-10 percent sub-angular fragments of black opaque material, probably carbonaceous.

66159546 Black volcanolithic subgreywacke
Bimodal. Various volcanic rock types, chiefly andesitic, occur as tightly packed sub-angular to well-rounded clasts between 1 and 4 mm. Smaller grains, chiefly feldspar but some quartz and lithic fragments, partly fill the interstices. Chief pore-filler is a chalcedonic cement (10 percent). Small patches of calcite are growing from scattered nuclei in the less acidic clasts.

66159547 Calcified, chloritized, albitized "basalt"
One 2 mm. crystal of pyrite.
An unidentified opaque mineral (5 percent) forms irregular laths 1-2 mm x 0.2 mm. It has the following properties:

(1) Pale buff to cream in hand specimen

(2) Opaque to transmitted light

(3) Pinkish-cream in reflected light

Military grid references

65152149	E164000	N2430400
65152150	"	"
65152154	E163500	"
65152155-7	E161900	N2430300
65152151	E163900	N2430400
65152153	"	"
66159542-7	"	"

Ki, Pentecost Island

66159503 Grey, alunitized, pyritic, fine-grained quartz-feldspar porphyry

Phenocrysts:
Alunite, 25 percent. Common size 0.5 x 0.1 mm. Mutually interfering sheaves and clusters; in places radiating, in places in aggregates which are bounded by parallel faces and no doubt pseudomorphing feldspar. Locally poikilitic, including fine granular crystals of quartz.

Quartz, 10 percent. Range from 0.07 to 0.4 mm; common size 0.25 mm. Many crystals have faces; many are evidently fragments of larger crystals. Not embayed, but some crystals have secondary overgrowths.

Opaques, 5 percent. Commonly 0.1 mm, up to 1 mm. In trains of grains (and rims) around quartz and alunite. Provisionally identified as pyrite.

Groundmass: 60 percent. Quartzofeldspathic - very fine grained. Discrete patches of different grain size; mostly about 0.005 to 0.01 mm., but vein-like and equant areas of grain size 0.04 mm. May contain some alunite.

66159508 Grey, sericitized, devitrified, pyritic quartz-feldspar porphyry
Seriate porphyritic.

Phenocrysts:
Feldspar, 40-50 percent. 0.2 to 2mm. Commonly 1 mm. Severely sericitized. Vaguely defined albite and carlsbad twinning.

Quartz, 10 percent. 0.2 to 2mm. Commonly 1 mm. Euhedral, embayed, fragmental.

Chlorite and zoisite, 2-3 percent.

Opaques, 5 percent. Provisionally identified as pyrite.

Groundmass:

Quartzofeldspathic. Inequigranular, and of heterogeneous texture. Microspherulites, averaging 0.05 mm in diameter, form extensive areas. General grain size of groundmass 0.02 mm.

66159513 Dark grey, sericitized and epidotized, pyritized fine-grained feldspar porphyry
Rock now consists of a fine mosaic of quartz and feldspar grains, within which are distributed aggregates of sericite and epidote and small scattered aggregates and trains of opaques.

Quartzofeldspathic groundmass: mostly between 0.01 and 0.05 mm. Grains in places interlocking (recrystallized?). Grades in places to coarser grain-size (0.5mm). In places there appear to be vaguely defined bands of contrasting grain size.

Sericite: In irregular aggregates forming about 20 percent of the rock. Aggregates may contain some quartz and feldspar. Some aggregates bounded by straight faces, probably ex-feldspar. The diffuse and ragged nature of most aggregates may indicate the breaking up of feldspar phenocrysts under stress. Also as extremely fine grains in the groundmass.

Epidote: 15 percent. Mostly 0.05-0.2mm. Commonly associated with sericite. Diffuse and ragged aggregates, but in places bounded by straight lines.

Opaques: 3-5 percent. Wide range in size - 0.002-0.3mm. Generally scattered, but with a tendency to occur in aggregates and trails along cracks and around feldspar pseudomorphs. Euhedral. Provisionally identified as pyrite. However, one large (0.2mm) grain is whitish-blue to silvery-granular in reflected light.

Military grid references

66159503	E175500	N2446900
66159508	E175100	N2447000
66159513	E174700	N2446100

CAPE HILLSBOROUGH BEDS

North side of Andrews Point

66159556 Andesitic basalt (Military grid reference E179000 N2382450)
Equigranular.

Plagioclase: 70 percent. Laths average 1 mm long. Prominently flow-aligned. An_{52}. Generally fresh, but some crystals slightly altered to sericite and chlorite along cleavages.

Chlorite: 15 percent. After hornblende. Allotriomorphic to interstitial.

Titanaugite: 12 percent. Anhedral to interstitial. Fresh.

Iron opaques: 3 percent. 0.05 to 0.15 mm.

The slide contains a small circular area 2 mm in diameter in which the augite is green (grading to pink), and only carlsbad twinning is developed in the plagioclase.

The two rocks described below occur as fragments in volcanic breccia on the shore 1 mile south of Cape Hillsborough

(Military grid reference E177600 N2383800)

65152219 Altered porphyritic basalt

Phenocrysts:

Plagioclase: 40 percent. Up to 20 mm. Fresh, corroded, fractured. Seriate porphyritic. An_{60}.

Olivine (?): 1 percent. Up to 2 mm. Entirely pseudomorphed by "serpentine" or hydrous silicates.

Iron opaques: 1 percent. Up to 2 mm.

Amygdales (?): 2-3 percent. Up to 2 mm. Spherular aggregates of a probably hydrous silicate (moderate to high birefringence, relief lower than the plagioclase, parallel extinction. The crystals have finely granular surfaces).

Groundmass:

Plagioclase: 40 percent. 0.05 to 0.1 mm. Fresh laths.

Hydrous silicate (?) 10 percent. Irregular aggregates. Same properties as mineral filling amygdales. Also occurs in thin veins which in places transect the phenocrysts.

Pyroxene: 2-3 percent. Up to 0.2 mm. Small colourless laths.

Iron opaques: 2-3 percent. Average 0.02 mm.

65152220 Porphyritic trachyte

Phenocrysts:

Potash feldspar: 20 percent. Up to 6 mm. Clear, unaltered. Carlsbad twinning. Presumably sanidine, but R.I. = that of Lakeside 70.

Voids: 1-2 percent. Up to 0.7 mm. In places have shapes typical of amphibole cross-sections.

Hematite: trace. Up to 0.7 mm.

Groundmass:

Feldspar: 60 percent. A continuous felt of predominantly equidimensional laths. Average 0.05 mm.

Dark grey isotropic material: 10 percent. Fills groundmass interstices.

Iron opaques: 4 percent. Very fine grained.

Chlorite: 5 percent. Fine grained.

Zircon: Trace. Up to 0.02 mm. Associated with the amphibole (?) voids.

DYKES

Islet in Nelly Bay

65152162 Altered dolerite (Military grid reference E115500 N2484900)

Plagioclase: 50 percent. Laths, average grain size 2x0.4mm. Strongly zoned. Cores An_{55}.

Augite: 20 percent. Ophitic. 1 to 3 mm. Marginally altered to uralite.

Hornblende: 7 percent, rimming many of the augite crystals. Patchily pleochroic.

Chlorite: 20 percent. Pleochroic, colourless to pale green. Fibrous.

Iron opaques: 3 percent.

Apatite: Trace. Acicular, fine grained.

Mainland south-west of Grassy Island

65152170 Leucocratic dolerite (Military grid reference E123800 N2474500)

Inequigranular to densely porphyritic

Plagioclase: 75 percent. Up to 7 mm. An_{65}. Fresh. Euhedral.

Augite: 10 percent. Up to 2 mm. Fresh. Subophitic.

Chlorite: 10 percent. Infilling. Ex-hornblende?

Iron opaques: 3-4 percent. Average 0.2 to 0.4 mm. Euhedral.

Anchorsmith Island

66159534 Hyaloandesite (Military grid reference E179600 N2420900)

Phenocrysts:

Plagioclase: 10 percent. Somewhat fragmentary. Great range in grain size, up to 2 mm. Twinning not well developed, but composition probably about An_{50}. Strongly flow-aligned. Corroded in places.

Chlorite: 4 percent. Pseudomorphing amphibole or clinopyroxene. Pale brown. Smaller size range than plagioclase.

Augite: 1 percent. Fresh. Small.

Glassy groundmass:

Devitrified along fine cracks. R.I. less than that of Lakeside 70. Well developed perlitic structures. Abundant microlites, flow-aligned, and commonly disposed in "eddies".

TABLE 1 STRATIGRAPHIC TABLE OF ROCK UNITS

ERA	PERIOD OR EPOCH	ROCK UNIT	LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
CAINOZOIC	QUATERNARY	Qm	Mud, silt, minor salt	Littoral flats and pans	Superficial	Estuarine and littoral deposits	Best developed along coastline of emergence N.W. and S.W. of Hillsborough Channel.
		Qr	Sand; silica sand.	On mainland low linear ridges up to 5 feet high. Extensive vegetated dunes up to 100 ft above sea-level on Whitsunday Island and Haslewood Island.	Superficial	Ancient and present strand-line dunes. Ancient blowout dunes on Whitsunday Island. Wind blown veneer on Haslewood Island.	Grade of silica sand on Whitsunday Island up to 99.87% SiO_2.
	UNDIVIDED	Cza	Sand, gravel, silt, mud	Flat to gently undulating	Superficial. Merges with Ts and Qm.	Mainly alluvium; some colluvial and residual deposits.	Underground water.
	TERTIARY	Ts	Coarse argillaceous sandstone, sandy siltstone.	Plain	Thin veneer on Edgecumbe Beds, granite (P-Mg) and diorite (P-Md).	Superficial, outwash deposits.	Ferricrete capping preserved in places just west of Sheet area.
		Ts (subsurface only, Proserpine No.1)	Shale, labile arenite, minor conglomerate.	Forms the Bowen-Proserpine Lowland and underlies Hillsborough Channel.	Inferred to unconformably overlie pre-Tertiary units.	Deposited in an asymmetrical graben, the Hillsborough Basin. No definite evidence of marine deposition.	Palynology of upper 2800 feet of Proserpine No. 1 section suggests a late Tertiary age (Appendix E) Maximum thickness of 10,000 feet in offshore area determined by marine seismic survey.
		Cape Hillsborough Beds Th	Acid volcanics, conglomerate, shale, argillaceous sandstone, basalt.	Rugged bluffs at Cape Hillsborough; hills and rises near Zamia Creek; flat-topped islands	Unconformably overlies and is faulted against Campwyn Beds. Unconformably overlies Carmila Beds. Possibly equivalent to the lower part of the Hillsborough Basin succession (Ts).	Terrestrial; no definite evidence of marine deposition.	Palynology of M.O.P.S. No. 4 well suggests a Lower Tertiary age. (Appendix C). 1600 ft thick.
		Tr	Rhyolite or trachyte.	Small steep hills, in places precipitous, e.g. Pinnacle Rock (700 feet).	Intrude Campwyn Beds, and granite (Kg) at Halliday Bay.	Plugs	Probably related to the volcanics of the Cape Hillsborough Beds.
	TERTIARY OR CRETACEOUS	K/Tb	Coarse arkosic conglomerate	Blackcombe Island. Cliffs and dip-slopes.	Probably non-conformable on Kg.	Local intramontane basin?	Derived from Kg. Exposed thickness 425 feet. Intruded by dolerite dykes.

TABLE 1 STRATIGRAPHIC TABLE OF ROCK UNITS

ERA	PERIOD OR EPOCH	ROCK UNIT		LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
MESOZOIC	CRETACEOUS	Mount Jukes Syenite Complex	Kj_2	Fine to medium-grained leucocratic granophyric quartz syenite, alkali granite.	Forms Mount Jukes, a steep truncated cone1,850 feet high.	Intruded centrally into Kj_1.	Epizonal	Regarded as Cretaceous by analogy with the Cretaceous granite at Halliday Bay. A third intrusion of the complex occurs just south of the Proserpine Sheet area.
		Mount Jukes Syenite Complex	Kj_1	Granodiorite	Annular valley surrounding Kj_2. Very poor outcrop.	Intrudes Carmila Beds.	Epizonal?Prominent ridge formed by metamorphic aureole.	
			Kg	Leucocratic alkali granite, granophyre and syenite.	Steep, rugged islands. Steep valley S.E. of Mt. Dryander. Hills south of Halliday Bay.	Most stocks intrude the Whitsunday Volcanics. One stock intrudes Campwyn Beds and is intruded by Tr. Another intrudes the Airlie Volcanics and the Proserpine Volcanics.	Epizonal stocks probably co-magmatic with the Whitsunday Volcanics and the Proserpine Volcanics.	Granite at Halliday Bay isotopically dated at 110 and 115 m.y. (K/Ar, hornblende).
		Whitsunday Volcanics	Kw	Intermediate and acid pyroclastics, minor flows.	Steep rugged islands and Cape Conway Peninsula.	Probably faulted against Airlie Volcanics Intruded by alkali granite stocks (Kg).	Varied. Deposited subaqueously in fresh water. Extensively faulted.	Dacite from Carlisle Island isotopically dated at 112 m.y. (K/Ar method, hornblende). Stratigraphic succession and thickness unknown, but certainly thousands of feet thick. Unfossiliferous.
		Whitsunday Volcanics	Ki	Pyritic quartz-feldspar porphyry.	Steep, rugged. Pentecost Island.	Intrudes the Whitsunday volcanics, but probably part of same volcanic episode.	Volcanic plug.	Sporadically alunitized (Appendix H). Isotopically dated at 96 and 106 m.y. (K/Ar, total rock).
		Whitsunday Volcanics	Kc	Well bedded carbonaceous arkosic conglomerate, calcareous carbonaceous subgreywacke, greywacke and arkose.	Part of the rugged Cape Conway peninsula.	A lens about 1800 feet thick enclosed between andesitic volcanics.	Margin of depositional basin.	Coaly clasts in the conglomerates contain Mesozoic plant fossils. (Appendix D). About 1,800 ft thick.
		Proserpine Volcanics	Kp	Rhyolite, andesite, minor pyroclastics.	Rugged mountainous terrain rising to more than 2600 feet at Mount Dryander.	Unconformable on the Edgecumbe Beds and the Airlie Volcanics. Probably equivalent to the Whitsunday Volcanics. Intruded by syenite (Kg).	Probably terrestrial. Local steep attitudes attributed to faulting.	Isotopic isochron, defined by Rb/Sr method on rhyolite flows, 111 ± 5 m.y. Up to 3,000 ft thick. Unfossiliferous.

TABLE 1 STRATIGRAPHIC TABLE OF ROCK UNITS

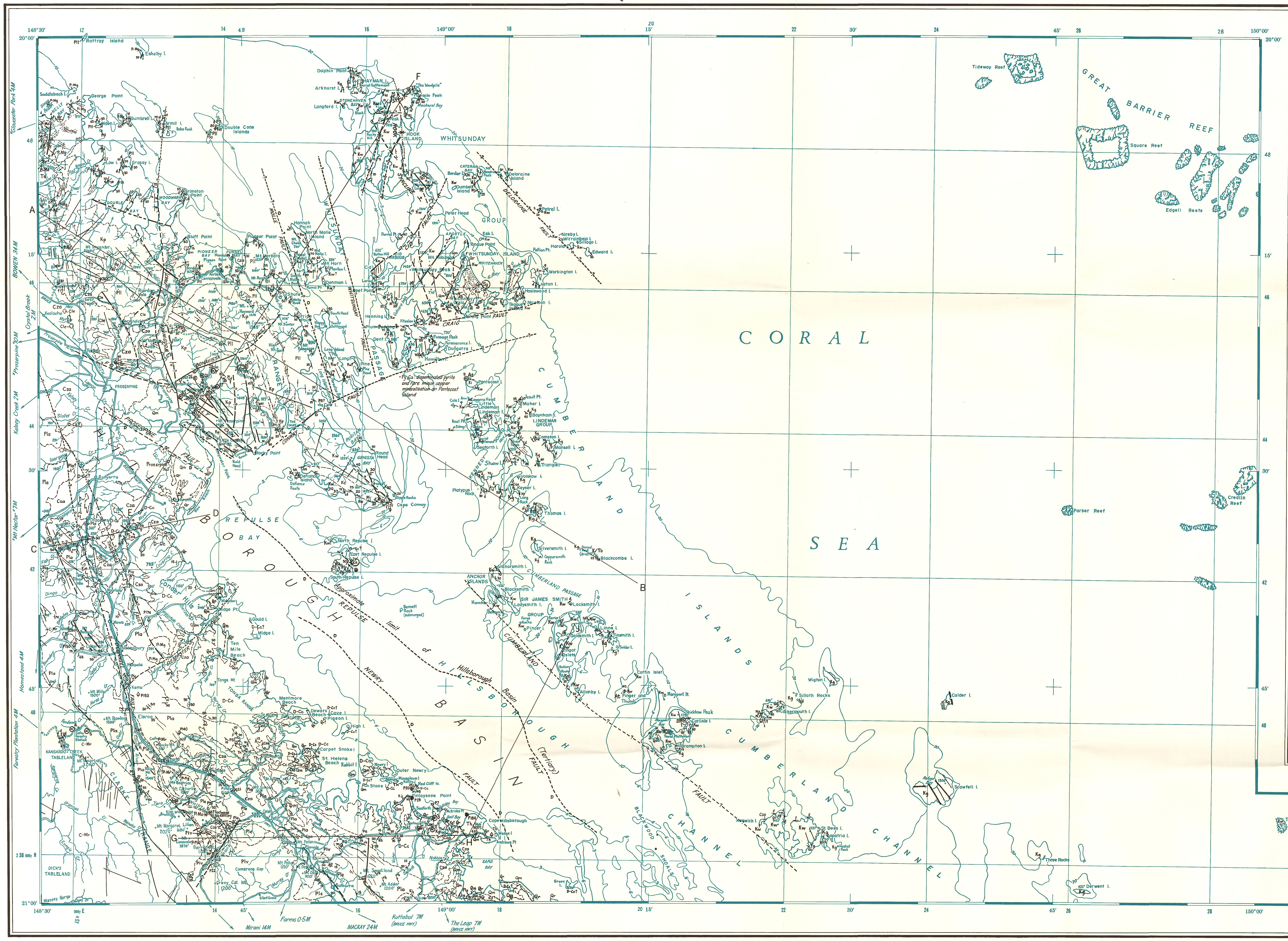
ERA	PERIOD OR EPOCH	ROCK UNIT	LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
PALAEOZOIC TO MESOZOIC	PERMIAN TO MESOZOIC	P-Mg	Granite	Hills, mostly steep and rugged.	George Point mass intrudes Edgecumbe Beds, Airlie Volcanics and diorite (P-Md), and is intruded by numerous dykes. Bloomsbury stock intrudes Carmila Beds. Mt. Catherine stock intrudes Calen Coal Measures and rhyolite plug (P-Mr).		Younger age-limits unknown.
		P-Mr	Rhyolite. Possibly some dellenite and trachyte.	Rugged mountains up to 1780 feet. Deeply dissected in places.	Beatrice body intrudes Calen Coal Measures and is intruded by P-Mg. Barren Mtn mass intrudes Calen Coal Measures and Lizzie Creek Volcanics, and is intruded by Urannah Igneous Complex. Rocky Mtn mass intrudes the Carmila Beds.	Oval bosses (Mt. Beatrice & Barren Mtn.), and elongate concordant mass (Rocky Mtn).	
		P-Mo	Altered porphyritic dolerite.	Undulating valley between sandstone ridges.	Intrudes Calen Coal Measures. Probably faulted against Urannah Igneous Complex.		Younger age- limits unknown.
		P-Md	Diorite	Mainly low plains and hills. Some rugged terrain in the south.	Intrudes Edgecumbe Beds and Airlie Volcanics. Intruded by granite (P-Mg) and numerous dykes.		
	UPPER CARBONIFEROUS TO LOWER CRETACEOUS	Urannah Igneous Complex C-Mr	Acid, intermediate and basic plutonic rocks. Numerous dykes.	Steep mountains rising to more than 3,000 feet above sea level.	Generally intrusive into neighbouring Upper Carboniferous to Permian Volcanics and sediments. (Plv, Pla, Ple).	Part of a large composite batholith.	Upper Carboniferous, Lower Permian, and Cretaceous isotopic dates have been obtained (see text).
PALAEOZOIC	LOWER PERMIAN	Calen Coal Measures Ple	Quartzose sandstone, siltstone, carbonaceous shale, mudstone, coal.	Mainly gently undulating plains. Some steep ridges, e.g. Whiptail Range.	Overlies the Carmila Beds and Lizzie Creek Volcanics, possibly unconformably. Possibly equivalent to the Collinsville Coal Measures (Bowen Sheet area). Intruded by Urannah Igneous Complex, P-Mo, P-Mr, and P-Mg.	Probably fresh water. Distribution of the quartzose sandstone at the top of the unit (e.g. Whiptail Range) is wider than that of the rest of the unit, suggesting an overlapping relationship.	Plant fossils. Thickness about 1,000 feet.

TABLE 1 STRATIGRAPHIC TABLE OF ROCK UNITS

ERA	PERIOD OR EPOCH	ROCK UNIT	LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
PALAEOZOIC	UPPER CARBONIFEROUS - LOWER PERMIAN	Airlie Volcanics P11	Acid and intermediate pyroclastics and flows.	Densely vegetated ranges rising to about 1400 feet. Steep islands.	Possible time equivalent of the Carmila Beds. Probably unconformable on Edgecumbe Beds. Overlain unconformably by the Proserpine Volcanics. Faulted against the Whitsunday Volcanics. Intruded by P-Md, P-Mg, and Kg.	Continental.	Unfossiliferous. Isotopic dating results unsatisfactory, but suggest a late Palaeozoic age (see text). Resemble parts of the Carmila Beds. About 20,000 ft thick
		Carmila Beds Pla	Lithic sandstone, siltstone, mudstone, conglomerate, acid and intermediate flows and pyroclastics.	Steep hilly terrain up to 1500 feet high, interrupted by flat alluvial plains. Some undulating low-lying country.	Probably unconformably overlies the Campwyn Beds. Intruded by younger phases of the Urannah Igneous Complex; possibly younger than oldest phases of the complex. Intruded by Mount Jukes Syenite Complex, P-Mg, P-Mr, and Kg. Overlain by Calen Coal Measures, possibly unconformably.	Continental.	Plant fossils. May be as much as 20,000 feet thick.
		Lizzie Creek Volcanics Plv	Acid to intermediate flows and pyroclastics; shale, lithic sandstone.	Rugged hills and ranges up to 1500 feet high.	Probably equivalent to the basal part ofthe Carmila Beds. Overlain by Calen Coal Measures, possibly unconformably. Intruded by Urannah Igneous Complex and P-Mr.	Continental.	Rare plant fossils. Thickness unknown.
	LOWER CARBONIFEROUS	Edgecumbe Beds Cle	Acid and intermediate flows and pyroclastics, minor lithic sandstone and limestone.	Strike ridges and hills with maximum relief about 500 feet; some plains.	Probably equivalent to part of the Campwyn Beds. Probably unconformably overlain by Airlie Volcanics, although contact is mostly faulted. Unconformably overlain by Proserpine Volcanics. Intruded by P-Md and P-Mg.	In the Bowen 1:250,000 Sheet area lowermost preserved part of unit consists of siltstone, shale, and oolitic limestone, indicating a shallow marine environment. Dominance of volcanics in the upper part in the Proserpine Sheet area may indicate terrestrial conditions.	Better exposed in the Bowen 1:250,000 Sheet area (Paine et al., in prep. b), where the beds contain abundant marine fossils. About 20,000 ft thick.
	UPPER DEVONIAN-LOWER CARBONIFEROUS	Campwyn Beds D-Cc	Acid and intermediate flows and pyroclastics; mudstone, siltstone, quartzose sandstone, oolitic limestone, conglomerate.	Varies from low coastal plains, interrupted by low strike ridges, to high country such as the Tonga Range (650 feet) and the Conder Hills (1180 feet).	Overlain, probably unconformably by Carmila Beds. Intruded by P-Mg, Kg, and Tr.	Marine fossils indicate a shallow marine environment for at least part of the sequence. Volcanics suggest that part of the sequence may be terrestrial.	About 10,000 ft thick. Marine and plant fossils.

PRELIMINARY EDITION, 1968
SUBJECT TO AMENDMENT

PROSERPINE
QUEENSLAND

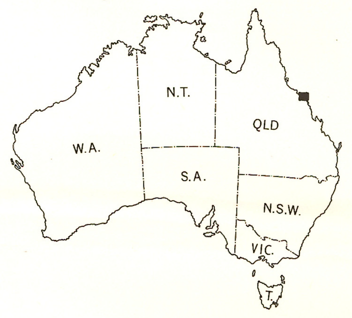


Reference

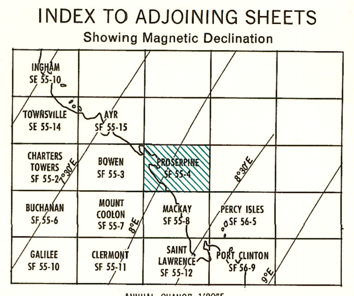
CAINOZOIC	QUATERNARY		Qm	Coastal mud, silt and minor evaporites
			Qr	Coastal dune sand (showing trend of dunes)
			Cza	Mainly alluvium; some colluvium and residual soil
	TERTIARY	Cape Hillsborough Beds	Ts	Coarse argillaceous sandstone, sandy siltstone. Shale, labile arenite, conglomerate in Proserpine No.1 Well
			Th	Acid volcanics, conglomerate, shale, argillaceous sandstone, basalt
			Tr	Rhyolitic intrusives
	TERTIARY OR CRETACEOUS		K/Tb	Coarse arkosic conglomerate (Blackcombe Island)
MESOZOIC	CRETACEOUS	Mount Jukes Syenite Complex	Kj_2	Granophyric quartz syenite and alkali granite
			Kj_1	Granodiorite
			Kg	Leucocratic alkali granite, granophyre and syenite
		Whitsunday Volcanics	Kw	Acid and intermediate pyroclastics; minor flows
			Ki	Pyritic quartz-feldspar porphyry
			Kc	Well bedded carbonaceous arkosic conglomerate, calcareous carbonaceous sub-greywacke, greywacke and arkose
		Proserpine Volcanics	Kp	Rhyolite, andesite, minor pyroclastics
	PERMIAN - MESOZOIC		P-Mg	Granite
			P-Mr	Rhyolitic intrusives
			P-Mo	Altered porphyritic dolerite
			P-Md	Diorite
PALAEOZOIC	U. CARBONIFEROUS TO L. CRETACEOUS	Urannah Igneous Complex	C-Mr	Acid, intermediate and basic plutonic rocks
	LOWER PERMIAN	Calen Coal Measures	Ple	Quartzose sandstone, siltstone, carbonaceous shale, mudstone, coal
	UPPER CARBONIFEROUS TO LOWER PERMIAN	Airlie Volcanics	Pll	Acid and intermediate pyroclastics and flows
		Carmila Beds	Pla	Lithic sandstone, siltstone, mudstone, conglomerate acid and intermediate pyroclastics and flows
			Plv	Acid and intermediate flows and pyroclastics, shale, lithic sandstone
	LOWER CARBONIFEROUS	Edgecumbe Beds	Cle	Acid and intermediate flows and pyroclastics, minor lithic sandstone and limestone
	U. DEVONIAN TO L. CARBONIFEROUS	Campwyn Beds	D-Cc	Acid and intermediate flows and pyroclastics; mudstone, siltstone, quartzose sandstone, oolitic limestone, conglomerate

- Geological boundary
- Syncline
- Fault 'D' indicates downthrown side
- 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
- Prevailing dip of strata
- Vertical strata
- Dip <15° (air-photo interpretation)
- Dip 15°-45° (air-photo interpretation)
- Dip >45° (air-photo interpretation)
- Joint pattern (air-photo interpretation)
- Anticline showing plunge (air-photo interpretation)
- Lineament (air-photo interpretation)
- Strike and dip of cataclastic foliation
- Strike and dip of flow banding
- Vertical flow banding
- Strike and dip of jointing
- Marine macrofossil locality — Number refers to collection described in Appendix, BMR Record 1968/22
- Plant fossil locality — Number refers to collection described in Appendix, BMR Record 1968/22
- Isotopic dating specimen, with locality number
- Dyke, showing dip where inclined
  d - dolerite, microdiorite; da - dacite; f - felsite, rhyolite, microgranite, quartz-feldspar-porphyry, granophyre; g - granite; gb - gabbro
  t - tuffisite
  Absence of rock type symbol denotes photo interpretation only
- Abandoned mine
- Quarry
- Unexploited deposit
- Minor mineral occurrence
  At - Alunite, C - Coal, Cl - Clay, Cu - Copper, Gr - Gravel
  E - Emery, Ls - Limestone, Py - Pyrite, Sg - Sand (glass)
- Dry hole - abandoned (MOPS - Mackay Oil Prospecting Syndicate)
- Coral Reef
- Bathymetric contour (fathoms)
- Road
- Vehicle track
- Railway with station
- Aerodrome
- Landing ground
- "Collingvale" Homestead
- Building
- Town
- 1150' Spot elevation

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development in conjunction with the Geological Survey of Queensland. Base map compiled by the Bureau of Mineral Resources from 1:93,000 scale controlled planimetric compilation supplied by the Division of National Mapping, Department of National Development. Aerial photography in 1960 by Adastra Airways Pty. Ltd.; complete vertical coverage at 1:85,000 scale.
Transverse Mercator Projection



INDEX TO ADJOINING SHEETS
Showing Magnetic Declination



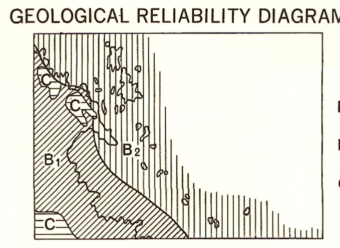
Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

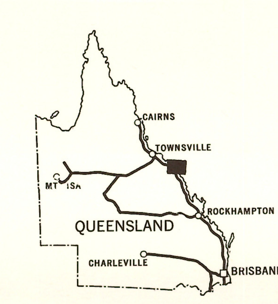
Sections
Folding schematic Attitude of faults not known
Scale: $\frac{V}{H} = 2$

GEOLOGICAL RELIABILITY DIAGRAM



B_1 Detailed land reconnaissance with air-photo interpretation
B_2 Detailed coastal reconnaissance by launch
C Mainly air-photo interpretation

Geology and compilation 1962 and 1965-67 by: D.E. Clarke (G.S.Q.)
A.G.L. Paine (B.M.R.) and A.R. Jensen (B.M.R.)
Drawn by: P.J. Brown and A. Tatarow (B.M.R.)



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS