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REGIONAL GEOLOGY OF THE MACKAY 1:250,000 SHEET AREA QUEENSLAND

by

A.R.Jensen, C.M.Gregory, (B.M.R.)
and V.R.Forbes, (G.S.Q.)

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SUMMARY

The oldest unit in the area, the Upper Devonian-Lower Carboniferous Campwyn Beds, consist of at least 24,000 feet of volcanics and minor fossiliferous marine sediments. It crops out in the coastal areas of the Mackay Sheet area, in a broad south plunging anticline, and is faulted against the Permian in the west.

The Upper Carboniferous-Lower Permian, Lower Bowen Volcanics, possibly 10,000 to 20,000 feet thick, crop out on each side of a large intrusive mass, the Urannah Complex. The Lower Bowen Volcanics are thought to be disconformably younger than the Campwyn Beds, but a faulted contact between the two units obscures the relationship. The Campwyn Beds are also faulted against the Carmila Beds, a Lower Permian freshwater unit about 7,000 feet thick, which forms a south plunging syncline in the south-eastern part of the area. On the eastern side of the Complex, the Volcanics are folded and faulted extensively, but on the western side they dip to the south-west under the Middle Bowen Beds, to form part of the eastern limb of the Bowen Syncline. The Volcanics are disconformably overlain by the Calen Coal Measures, a Permian (possibly Lower Permian) unit, which are about 1,000 feet thick in the northern part of the Sheet area.

The Middle Bowen Beds crop out west of the Urannah Complex, and have a regional dip to the south-west. They consist of about 850 feet of marine fossiliferous siltstone and sandstone, of Lower Permian age. They have been divided into three subunits on fossiliferous and lithological evidence. The unit is conformably overlain by Upper Permian Upper Bowen Coal Measures.

The Palaeozoic sequence is intruded by the Urannah Complex and by smaller intrusions, and unconformably overlain by unfolded Tertiary acid and intermediate volcanics, basalt, and freshwater sediments; it is also overlain by Cainozoic alluvium and soil. Quaternary sand dunes have been formed on the coast in some places.

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INTRODUCTION

In 1960 the Bureau of Mineral Resources and the Geological Survey of Queensland commenced a joint programme of regional geological mapping in the Bowen Basin, to assist in the search for petroleum. The western third of the Mackay 1:250,000 Sheet area was mapped during 1961, and a report (Jensen, Gregory and Forbes 1962) subsequently written. The rest of the sheet was mapped during 1962, and this report summarizes the geology of that part of the Sheet area covered by air-photos at 1:85,000 scale.

The Mackay Sheet area, on the coast of Queensland, and about 500 miles north of Brisbane, is bounded by latitudes 21° and 22° south and longitudes 148° 30' and 150° east. About two thirds of the area are covered by aerial photos at 1:85,000 scale, taken by Adastra in 1960. Transparent overlays of the geology of each photo were made in the field, reduced, and fitted together on a base supplied by the Division of National Mapping, to form the map contained in this report.

The topography of the mainland varies considerably, but it can be generalized as shown in the topographic sketch map, (Fig.1), and divided into four divisions - (a) coastal lowlands, (b) open hilly country, (c) coastal range, (d) south-western plain.

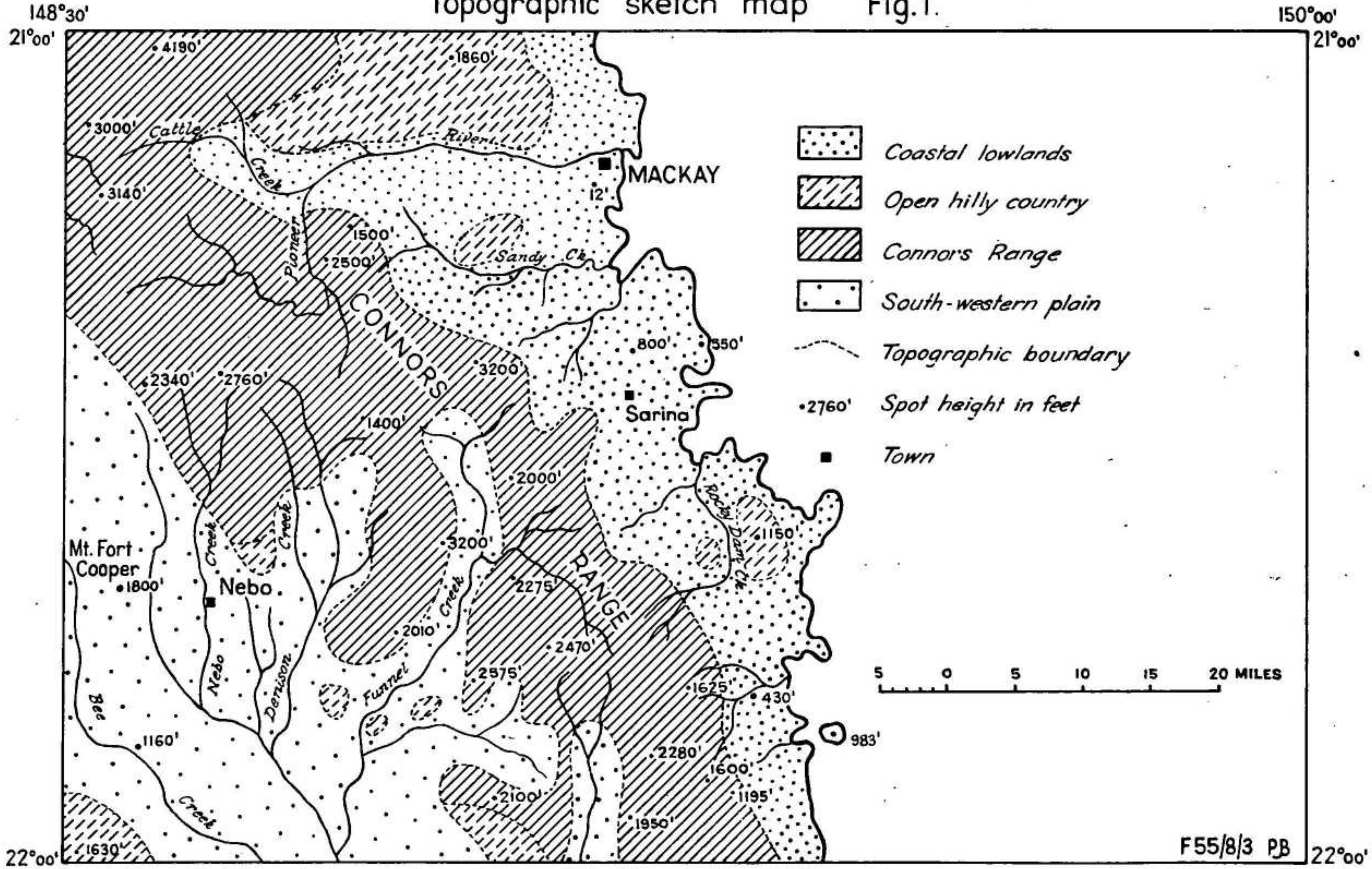
(a) The coastal lowlands vary in altitude from 500 feet to sea level, where mangrove swamp and tidal flats are common.

(b) In some areas the lowlands give way to open hilly country with peaks up to 1,800 feet. Drainage in both the lowlands and the hilly country is eastwards to the sea.

(c) The Connors Range is the main watershed for the area, separating the headwaters of the coastal streams flowing east, the Broken River flowing west, and the Funnel-Bee Creeks system flowing south. The Bee and Funnel Creeks system joins the Isaacs and the Fitzroy Rivers. The Range is very rugged and includes peaks up to 4,200 feet in the northern part of the area. It is covered by tropical rainforest in places.

(d) The south-western plain is not a true plain as small rounded hills and strike ridges are common, but these seldom exceed two hundred feet above the level of the plain. A few volcanic peaks, such as Mount Fort Cooper, which is 1,000 feet above the level of the plain, interrupt this pattern. Hilly country in the south-western corner of the Sheet, around Bundarra Homestead consists of a ring of hills up to 600 feet high.

Topographic sketch map Fig.1.



148°30' *Bureau of Mineral Resources Geology and Geophysics April 1963* *To accompany Record 1963/71* 150°00'.

The area has a hot summer and a cool winter; rainfall occurs mainly in the summer. The south-western plain has an annual average rainfall of 30 inches. The Connors Range receives 90 to 136 inches per year and coastal areas from 55 to 70 inches per year.

Access on the mainland is good; the Bruce Highway, a sealed road running from north to south, joins Mackay with Prosperine and Rockhampton. Roads in the vicinity of Mackay are sealed and the Nebo-Clermont highway is being sealed. Most of the other roads are graded but unsealed, and are often impassable during very wet weather. Even the Bruce Highway is cut occasionally by floods, particularly by Funnel Creek. The coastal railway line from Brisbane passes through Mackay, and a subsidiary line runs west from Mackay to Northerdale, at the foot of the coastal range. Mackay, with a population of 15,000, has an artificial deepwater harbour, and a good aerodrome. Many of the cattle stations have small airstrips.

The main industry of the coastal area and the Pioneer Valley is that of sugarcane, this area producing a quarter of Queensland's sugar. Crushing mills are found throughout the coastal area, and a plant which produces methylated spirits and ethyl alcohol is situated at Sarina. The land west of Connors Range supports cattle, and timber is taken from part of the Range. Dairying and general farming support some of the population. Another important asset to the district is the tourist industry, the Connors Range providing dramatic mountain scenery amidst tropical rain-forest vegetation, and the port of Mackay gives access to various island resorts of the Great Barrier Reef.

PREVIOUS INVESTIGATIONS

Geological investigations

Most previous geological reports have been concerned with small mineral deposits. However there are a few reports which deal with a larger area and a few palaeontological and palaeobotanical reports.

Jack (1893) was the first to write about gold in the district; others reporting on this subject include: Ball (1910a and 1932), Marks (1913), Morton (1925), Denmead (1932), Reid (1935, 1936, 1939), East (1946), and Jensen (1947). Copper mines and prospects have been discussed by Ball (1909, and 1910c), Lees (1907), Marks (1913), Cameron (1915), Reid (1935), Ridgeway (1944), and Shepherd (1953). Other metaliferous deposits discussed were: graphite - Dunstan (1906), molybdenite - Reid (1941), wolfram - Shepherd (1952), and uranium - Brooks (1961). Coal deposits have been the subject of many reports including: Cameron (1905), Ball (1910d and 1927), Reid (1925, 1929b, 1946, 1951), Hawthorne (1961), and Powel Duffryn Technical Services (1949). Quarry sites were investigated by Reid (1931), and Shepherd (1933). Oil shale at Plevna was reported by Ball (1927), Shepherd (1939), Reid (1942), and Austral Mining Pty Ltd, (1958). Beach sands were investigated by Dowsett Engineering Pty Ltd, (1955), and Connah (1961). Water supplies of the Pioneer River valley and the Dalrymple Heights area were examined by Calvert (1959), Abbis (1959) and Baird (1962).

Investigation of larger areas began with Jack (1887), and this was followed by Maitland (1889a), Dunstan (1901), Cameron (1903), and Reid (1924-25, 1929a and 1930). There was a lack of regional geological reports for the next twenty-four years until Isbell's report (1954). This was followed by Lawrence (1956), and Laing (1959).

Palaeontological reports have been written by Whitehouse (1925, 1939), and Dickins (1961), and palaeobotanical reports by M.E. White (1962 and 1963a, b).

The Bureau of Mineral Resources in conjunction with the Geological Survey of Queensland commenced work in the area in 1961 and mapped the western third of the Mackay 1:250,000 Sheet area, (Jensen, Gregory and Forbes, 1962). This present report incorporates all the information presented in the previous report, as well as describing the geology of the remainder of the mainland area. The French Institute of Petroleum produced a photo interpretation map of the area for the Bureau, in 1962.

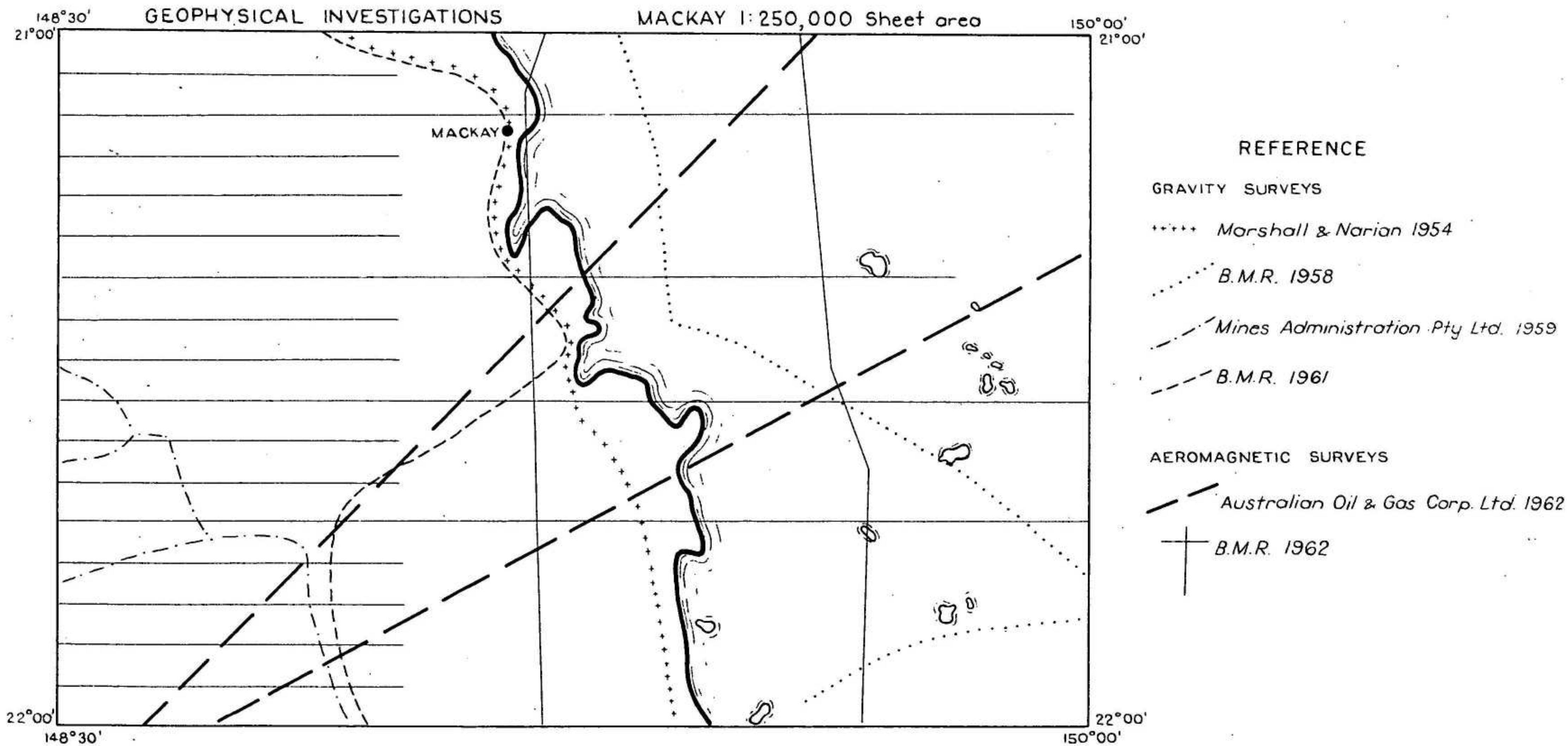
Two geologists, from Ampol Exploration (Qld) Ltd, W.C. White and G.A. Brown visited various islands off the coast during 1962, and their results are presented in an unpublished report (White and Brown, 1963).

Geophysical Investigations

The areas covered by the four gravity surveys and two aeromagnetic surveys made on the Mackay Sheet area are shown in Figure 1a.

The gravity surveys were carried out by: the University of Sydney in 1958, the Bureau of Mineral Resources in 1958 and 1961, and Mines Administration Pty Ltd in 1959. The University of Sydney (Marshall and Narain, 1954) made some measurements along the coast as part of a regional gravity survey of eastern Australia. The Bureau of Mineral Resources made underwater gravity measurements as part of a survey of the Great Barrier Reef (Goodspeed and Williams, 1959), and a gravity traverse was run along the coast in 1961, for calibration purposes. Starkey (1959) made gravity measurements in the south-west portion of the Sheet area for Mines Administration Pty Ltd, in a survey of the northern part of the Bowen Basin.

Both Australian Oil and Gas Corporation Ltd and the Bureau of Mineral Resources have made aeromagnetic surveys in the area. The lines flown by the A.O.G. survey are shown on figure 1a, and the results are given by Hartman (1962). The Bureau made an aeromagnetic survey of the western third of the Mackay Sheet in 1961, and additional lines were flown at a greater spacing in 1962 over the rest of the area. The work was done by G. Young, A.G. Spence, A. Drage, F.E.M. Lilley, B. Dockery, and J. Moo. Permission to include the total magnetic intensity profiles is gratefully acknowledged.


GEOPHYSICAL INVESTIGATIONS
MACKAY 1:250,000 Sheet area
148°30'
21°00'
150°00'
21°00'
MACKAY
22°00'
148°30'
22°00'
150°00'
REFERENCE
GRAVITY SURVEYS
Marshall & Narion 1954
B.M.R. 1958
Mines Administration Pty Ltd. 1959
B.M.R. 1961
AEROMAGNETIC SURVEYS
Australian Oil & Gas Corp. Ltd. 1962
B.M.R. 1962

STRATIGRAPHY

A summary of the stratigraphy is given in Table 1.

(a) Devonian - Carboniferous

The Campwyn Beds

Summary: The Campwyn Beds crop out in a north-west trending coastal belt extending from Notch Point in the south to the Prosperine 1:250,000 Sheet area in the north. The unit is composed mainly of volcanic flow rocks and pyroclastics, interbedded with siltstone, sandstone, conglomerate and limestone. Intrusions are common and low grade metamorphic rocks are developed locally. Marine fossils collected in the unit are Devonian. The unit is folded into a broad south plunging anticline, which is faulted against Permian units in the west. The unit is estimated to be about 24,000 feet in this area.

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"Campwyn Beds" is a new name proposed herein for a sequence of Devonian-Carboniferous volcanics and sediments. The unit crops out in a north-west trending coastal belt extending from Notch Point in the south on to the Prosperine 1:250,000 Sheet area. The name "Campwyn" is derived from Campwyn Beach, near Sarina Beach (longitude 149°19' E, latitude 21° 22' S). Outcrop at Campwyn Beach is of green volcanic breccia which is a common lithology in the unit. No sections have been measured, and no type area has been defined. Very good exposures can be found on every coas coastal headland within the area of outcrop, but probably the greatest number of easily accessible outcrops are to be found between Hay Point and Sarina Beach, especially in the vicinity of Campwyn Beach. Outcrops away from the coast are poor.

The unit forms low rounded hills, with generally thick vegetation. It is not well bedded, but in places trend lines parallel to the strike can be recognized.

Rock types, in order of abundance, include agglomerate, tuff, breccia and flow rocks, siltstone, sandstone, conglomerate and limestone. Intrusives are common and low grade metamorphic rocks are developed locally. Epidotisation is widespread (especially in the andesitic rocks) and dykes, quartz veins, and calcite veins are common.

SUMMARY OF STRATIGRAPHIC UNITS

TABLE 1.

Period	Rock Unit and Letter Symbol	Thickness	Lithology	Fossils	Relationship with other Units
QUATERNARY	Qd		Quartz sand, lithic sand		
	Cz		Soil		
	Cza		Alluvium - fluvial and coastal.	*Crocodilus nathani* west of Homevale (on Mt. Coolon 1:250,000 Sheet area).	
TERTIARY	Ta	Thickest deposit 265 ft.	Mudstone, siltstone, shale, sandstone, and conglomerate.		Interbedded with Tv in places. Unconformable on Urannah Complex
	Tv	About 700 feet maximum	Acid and intermediate flows and pyroclastics.		Unconformable on Palaeozoic units and Urannah Complex. Overlies Tb with probable conformity
	Tb	Less than 200 ft.	Olivine basalt.		Unconformable on Palaeozoic units
UPPER PERMIAN	Pub - Upper Bowen Coal Measures	Unknown - top of unit not present.	Siltstone, lithic sandstone, conglomerate.	Unidentified fossil wood.	Conformably above the Middle Bowen Beds.
LOWER PERMIAN	Plm Middle Bowen Beds. Unit C	5200 ft.	Blue siltstone.	Fauna IV) See Appendix A	Conformably above Lower Bowen Volcanics.
	Plm Middle Bowen Beds. Unit B	1400 ft.	Feldspathic quartz sandstone.	Fauna III (IIIa, IIIb, IIIc)) See Appendix A	
	Plm Middle Bowen Beds. Unit A	1800 ft.	Brown ferruginous subgreywacke and brown calcareous siltstone.	Fauna II) See Appendix A	
	Plc - Calen Coal Measures	1000 ft.	Sandstone, siltstone, claystone, minor coal.		Disconformably overlies Lower Bowen Volcanics.
	Pla - Carmila Beds	7000 ft.	Conglomerate, lithic sandstone, siltstone, lithic and crystal tuff, acid volcanics, shale.	Permian plant fossils including *Noeggerathiopsis hislopi* (Upper Carb. - Lower Perm.)	Possibly unconformable on Lower Bowen Volcanics.
	Plv - Lower Bowen Volcanics	Unknown - could be 10,000 - 20,000 ft.	Mainly intermediate flows and pyroclastics with minor acid and basic volcanics. Shale, sandstone, conglomerate.	Permian plant fossils including *Noeggerathiopsis hislopi* (Upper Carb. - Lower Perm.)	Probably disconformable on Campwyn Beds.
UPPER DEVONIAN TO LOWER CARBONIFEROUS	D/Cc - Campwyn Beds	At least 24,000 ft.	Volcanic flows and pyroclastics, siltstone, sandstone, conglomerate, limestone.	*Alveolites* sp., *Thamnopora* sp., *Phillipsastrea*? sp.) Devonian. Upper Devonian to Lower Carboniferous fossils on the Proserpine 1:250,000 Sheet area.	Oldest unit in the area.

Andesitic agglomerate, lapilli tuff, and tuff are very common, and are represented in almost every exposure. They are generally dark green and purple in colour, and the shoreline outcrops commonly exhibit honeycomb weathering. Coarse agglomerates are common, and fragments up to 8 inches in diameter have been noted. Tuffs are frequently indurated and some are definitely metamorphosed. Andesite volcanics at Slade Point, and others as far south as Sarina Beach show effects of metamorphism to varying degrees. Knight (1939) describes siliceous metamorphosed tuffs from the Grasstree Mine area. Contact metamorphic effects are the most obvious, but the local development of schistose lithic tuff in the Alligator Creek area suggests that metamorphic effects may not be due solely to the numerous intrusions.

The tuffs are generally hard and massive with no recognisable bedding, but a small proportion are fine, ashy, and well bedded. Pebbly and sandy tuff occurs, but is not common.

Andesite and basalt are common flow rocks and rhyolite is not uncommon. Pyrite occurs commonly in the rhyolite and rhyolitic breccia, and also in andesitic and rhyolitic tuff.

Siltstone is probably the most abundant sedimentary rock, and the best single outcrop is at Half Tide. Here a very large, flat, wave cut platform exposes about 300 feet of section comprising approximately 140 feet of basic volcanics, followed by 70 feet of acid and intermediate tuff and breccia, which are overlain by 90 feet of siltstone and lithic sandstone. The siltstone is well bedded with regularly alternating hard and softer beds. The harder beds are 2-6 inches thick and generally calcareous. The softer beds are generally porous, ironstained and up to two feet thick, and frequently contain tiny pyrite crystals. Massive poorly bedded siltstone, fine lithic sandstone, and rare pebble conglomerate are also exposed.

In contrast to the generally unaltered sediments at Half Tide, hardened siltstone is exposed at Eimeo in the north, and near Yarrawonga Homestead in the south. The outcrop to the north-east of Yarrawonga exposes hard, well bedded calcareous rock with fine bands of alternating dark siltstone and lighter fine sandstone. Some specimens show at least forty bands per inch. Very small scale current bedding was noted, but no graded bedding was evident. The sediments exposed at Eimeo include well bedded, hard, non fissile, carbonaceous slates with carbonised plant fragments. Gold in the Alligator Creek district is reported to occur in quartz veins in spotted slate.

Arenaceous sediments are not abundant, but tuffaceous sandstone, lithic sandstone and some quartz sandstone have been noted. Well bedded light green and brown lithic and tuffaceous sandstone is common at Cape Palmerston. Beds are generally less than one foot thick, and are interbedded with andesitic agglomerate and tuff, rhyolitic flows, and banded chert. Sediments cropping out about three miles south of Allom Point include fine, non-calcareous, quartz sandstone and hard, quartz-lithic sandstone. The sandstone is in general well and thinly bedded. It varies from porous, unaltered and friable in the Allom Point area to hard metamorphosed sandstone and quartzite in the Grasstree area. Light grey crystalline quartzite also crops out near Slade Point.

Conglomerate is not common in the Campwyn Beds. Beds of pebble conglomerate up to four feet thick are interbedded with tuff, agglomerate, breccia, and sandstone in the area immediately south-west of Sarina Beach. Hard indurated conglomerate also occurs near Grasstree Mine. Conglomerate (probably with a tuffaceous matrix) is interbedded with andesitic breccia, rhyolitic flows, and bedded tuff at Shoal Point and at other localities north and west of Mackay. Some of the outcrops in this area are very hard and metamorphosed.

Limestone, impure limestone, and calcareous siltstone have been noted, but they represent only a small part of the unit. Most limestone seen is fossiliferous and possesses a slightly foetid odour. Marine fossils were collected from a four-inch richly fossiliferous band within fine, very hard, light grey limestone at Allom Point. Another marine fossil collection was made from a bed three feet thick of weathered, fine, grey limestone about two miles east of Notch Point. Limestone and calcareous siltstone occur about two miles south-east of Kelvin Homestead, but no fossils were seen.

Fossil collections containing brachiopods, lamellibranchs, and gastropods have been submitted from localities M608 (Notch Point) and M639 (Allom Point). Whitehouse (1939) describes fossil corals from an andesite agglomerate at Campwyn Beach, and another collection submitted from this locality (M798), yielded Devonian fossils (Hill, 1962) *Alveolites* sp., *Thamnopora* sp., *Phillipsastrea*? sp.

Collections from Notch Point and Allom Point have not yet been identified. On the southern half of the Prosperine area fossils found in the unit range from Upper Devonian to Lower Carboniferous (Jensen, 1963).

There are numerous intrusives into the Campwyn Beds, especially in the north of the area. Mt. Chelona, four miles north of Sarina, rises to over 400 feet above the surrounding country, and is composed of tor-forming, homogeneous, medium-grained granites. At Mt. Basset, near Mackay, quarrying has exposed a non-homogeneous mass of micro-granodiorite-diorite intruded by dark fine-grained dykes. The area to the north and west of Mackay seems to consist of metamorphosed remnants of rocks of the Campwyn Beds, which have been intruded by numerous irregular masses and dykes of microdiorite and other igneous rocks, Reid (1931) describes Flat Top Island, to the south-east of Mackay as consisting entirely of granite and diorite, with intrusive porphyry dykes and masses. Irregular diorite intrusives are common in the Grasstree area, and have been noted at Half Tide and on Freshwater Peninsula. Medium grained granodiorite crops out three miles south of Allom Point, but plutonic intrusives are less common in this area. Andesitic or basaltic dykes can be found in almost every outcrop, but are more numerous in the north. Dykes in the Slade Point - Mt. Basset area are generally andesitic, and trend north-south dipping steeply to the west. Most are 2-6 feet wide, but dykes greater than 20 feet wide are present. Andesitic dykes occur at Dudgeon Point and Hay Point, and a rhyolite (?) dyke 40 feet wide trending north-east cuts siltstone and volcanics at Half Tide. The fine grained basic dykes in the Grasstree - Campwyn Beach area appear to have a general north-east trend, and are less than ten feet in width. Knight (1939) describes dyke rocks in the Grasstree mine area as "hornblende porphyrite" and "felsite". Both basic and rhyolite dykes occur on Freshwater Peninsular. The majority of them strike north-north-east and in places, dykes or porphyritic rhyolite appear to cut the basic dykes. Dykes are less numerous in the south of the area, but have been noted at Armstrong Beach, and at Notch Point near Walter Reid Homestead.

The Campwyn Beds form an upfaulted coastal block separated from younger units to the west by a major fault line. This block, is folded into a relatively simple anticline plunging to the south, whose axis trends north to north-east and passes between Allom Point and Glendower Point. No other major fault lines have been recognised, but small faults are numerous, and frequently displace dykes cutting the Campwyn Beds. Jointing is generally well developed and joints are commonly filled with quartz veins.

Possible Campwyn Beds crop out west of the fault line near Koumala, but the structural relationship between these outcrops and the Campwyn Beds east of the fault line is not known. As the Carmila Beds and the Lower Bowen Volcanics dip away from the Campwyn Beds in the Koumala area, an anticlinal structure may affect the units. Alternatively, the Campwyn Beds may have been faulted into this position.

No sections have been measured in the Campwyn Beds, and neither the top nor the bottom of the unit has been located. However approximately nine miles of outcropping Campwyn Beds would be covered along a line south west from Hay Point. There do not appear to be any reversals of dip in this area and a conservative dip of 30° would indicate almost 24,000 feet of section. However faulting in the area may upset this calculation.

(b) Permian

Nomenclature of the Bowen Basin succession

This subject was discussed in the Geology of the Mount Coolon Area (Malone, Corbett, and Jensen 1961). For that report it was decided to use the established, informal nomenclature, Lower Bowen Volcanics, Middle Bowen Beds, and Upper Bowen Coal Measures. This nomenclature will be retained in this report.

Lower Bowen Volcanics

Summary: The Lower Bowen Volcanics crop out on either side of the Urannah Complex. Topography produced by the unit varies from flat to moderately rugged. The unit consists of volcanics, which predominate, and sediments. The volcanics include both flows and pyroclastics, mainly of intermediate composition, but basic and acid types are present. Interbedded sediments include shale, labile sandstone, tuffaceous sandstone, and conglomerate. West of the Urannah Complex the unit dips to the southwest but the structure is more complicated east of the Complex, where it is faulted and folded. The unit disconformably overlies the Campwyn Beds, and is disconformably overlain by the Calen Coal Measures. Plant fossils contained in the unit have a range from Upper Carboniferous to Lower Permian.

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The term 'Lower Bowen' has been used since 1892, when Jack and Etheridge introduced it as the lowest division of the Bowen Group, in the Bowen River coalfield (Jack and Etheridge, 1892). Reid (1924-25 and 1929a) in his description of the Collinsville area, divided the Lower Bowen

Volcanics into three units, the Mount Devlin Volcanics, the Mount Devlin Coal Measures, and the Mount Toussaint Volcanics, but this subdivision was not accepted by Malone et al (1962).

The unit crops out in two areas, on either side of the Connors Range, which is formed by the Urannah Complex. For the purposes of this report the area south-west of the Complex will be referred to as the Nebo area, and north of the Complex as the Eton area. The Nebo area extends from the headwaters of Moonlight Creek, in the north, to Murray Creek, south of Undercliff homestead, in the southern part of the area. The Eton area extends from the northern boundary of the Sheet, near Silent Grove Creek, to Bolingbroke homestead, in the south.

The topography within this unit is varied. In the Nebo area the volcanics at the top of the sequence produce relatively flat plains, but the lower part of the sequence is marked by moderately high rounded hills, especially near the Urannah Complex, and west of Tertiary volcanics near Homevale. These contrasted types of topography are not seen in the Eton area where, for the most part, the topography is hilly, and almost mountainous where the unit is close to the Urannah Complex. Examples of this are the mountainous terrains near Bolingbroke, and near the Range Hotel. Strike ridges are rare in both the Nebo and Eton areas, and this fact together with the massive nature of the volcanic constituents of the unit, make geological photo interpretation difficult.

There is a great variety of rock types, both of volcanic and sedimentary origin, included in the Lower Bowen Volcanics in the type area at Collinsville, and in the Mackay area. In some places in the Mackay Sheet area, notably near Nebo, volcanics predominate and sediments are almost lacking. In other places, such as near the Range Hotel and also near Sarina, the sedimentary sequence is well developed, and volcanics are of minor importance. Around Bolingbroke homestead, and in neighbouring areas, volcanics and sediments are of equal importance. Mapping was not at a scale which allowed subdivision of the unit into various lithological members, and the following description of lithology, under the headings of Volcanic rocks and Sedimentary rocks, aims at providing a regional picture of the lithology and its variations.

Volcanic rocks:

Within the unit there is a range of lava types from basic to acid, which includes andesite, trachyte, dacite, rhyolite, and basalt. Andesite, the most abundant rock type, ranges in texture from fine to coarse and from massive to strongly porphyritic. Phenocrysts are of plagioclase and commonly hornblende, and rarely of potash feldspar, quartz and biotite. The most common colour is green, produced by chloritization, but white to buff plagioclase rich varieties do occur. Some of the lavas have small xenoliths of shale up to ½ inch in length. Pyrite is a common accessory mineral, and secondary calcite replaces feldspar. Andesite dykes intruding the sequence could be related genetically to the Volcanics or to the Urannah Complex.

Rhyolite, toscanite, and dacite are distributed throughout the unit, although they are more common in some places than in others. Leucocratic, and commonly porphyritic, rhyolite is the second most abundant flow rock in the unit. Toscanite and dacite are generally darker in colour than the rhyolite, and contain euhedral phenocrysts of potash feldspar, quartz and rare hornblende. Some of the flows are strongly porphyritic and flow textures are developed in much of the rhyolite and in some dacite flows. Dykes of dacite intruding the Volcanics are thought to be comparable in age and genesis to one another.

Trachyandesite and trachyte are relatively uncommon in the unit. They range in colour from green to grey and purple, but in places they are creamy white. Textures range from coarse to fine, massive to porphyritic. Flow textures are common in the trachyte. Phenocrysts are of plagioclase, potash feldspar and hornblende, and rarely quartz and biotite.

Basic lavas, although the rarest type in the unit, occur throughout the sequence. Both vesicular and massive types have been observed.

Coarse, pale green, agglomerate is one of the most common rock types throughout the unit. Beds range from a few, to tens of feet thick, containing ejectimenta up to 2 feet in diameter. The composition is generally andesitic. Both lithic and crystal tuff are also common in the sequence. The crystal tuff is generally red, or green, and contains broken crystals of quartz and feldspar; the lithic tuff is generally green. Fine massive tuff of a green or brown colour is also common and its composition ranges from andesitic to dacitic. Epidotization, in rare cases, has converted up to 50% of the rock to epidote, producing a pale green rock with a saccharoidal texture.

Secondary alteration and weathering has affected most of the volcanics in the unit and produced chlorite, epidote, hydrated iron minerals and calcite. The hydrated iron minerals are responsible for the red colouration which occurs in many of the rocks, and epidote and chlorite for the persistent green colouration.

Sedimentary rocks:

The most common sedimentary rocks found in the Lower Bowen Volcanics are shale, labile sandstone, tuffaceous sandstone, and conglomerate. In the Nebo area thin beds of shale, sandstone and conglomerate are interbedded with andesitic and acid volcanics. The shale is dark grey and fissile; it is finely laminated and is probably tuffaceous. Sandstone is rare and where observed is composed of lithic fragments, of volcanic origin. The conglomerate is composed of both angular and rounded constituents and in places grades into a volcanic breccia. Small slump structures are present in the shale but cross stratification has not been observed in the Nebo area.

Sediments, including siltstone, coal, sandstone, and conglomerate, constitute most of the section at the Range Hotel, in the Eton area. The sediments are indurated and well exposed in Blackwaterhole Creek, at the contact with the Urannah Complex. The siltstone is grey, yellow or purple; in places it is either micaceous, carbonaceous, or graphitic, and it commonly contains plant fragments. It may be tuffaceous in part. The sandstone ranges in colour from white to grey-brown and green and the proportion of lithic fragments varies considerably from place to place. It is generally well bedded, commonly laminated, and cross bedding is only poorly developed. Tuffaceous sandstone crops out in places, particularly at the top of the range, on the Eton-Nebo road. The conglomerate ranges from pebble to boulder size and is invariably hard. The constituents are well rounded, many of them being of plutonic origin. Thin seams of coal are reported by Dunstan (1901).

Dumbleton Rocks, on the Pioneer River seven miles west of Mackay, is a magnificent outcrop of Lower Bowen Volcanics. About 500 feet of section is exposed consisting of conglomerate, tuffaceous sandstone, black siliceous shale, and interbedded volcanics. The basal part of the section exposed is a massive pebble to boulder conglomerate. Cross stratification is exhibited by some of the tuffaceous sandstone (Fig.2). Diorite dykes are common.

In the Kungurri district, dark grey carbonaceous shale with plant fragments, is interbedded with massive white rhyolite and green andesite. South of Sarina, sediments, including siltstone, sandstone and conglomerate, predominate in a sequence about 2,000 feet thick.

The two areas of outcrop of the Lower Bowen Volcanics are separated by the Urannah Complex. The unit in the Nebo area dips to the south-west at about 30°, forming part of the east limb of the Bowen Syncline.

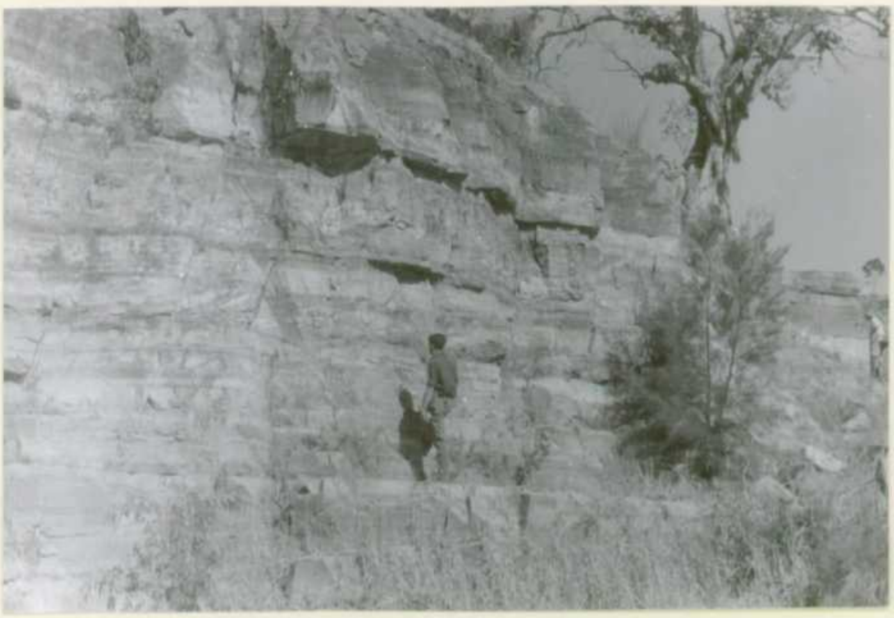

Figure 2: A small part of the outcrop of Lower Bowen Volcanics at Dumbleton Rocks. Current bedded quartzite on a level with geologist's head.
File M266/Neg.3.

Reliable dips are difficult to obtain in this unit because of the abundance and massive nature of the volcanic members. A dip to the south-west is evident in the Homevale area, but near Hamilton Park the dip is to the south. Inconsistent dips further south, near New Yard homestead, and the fact that the Middle Bowen Beds crop out to the south of the Volcanics, may indicate that a fault separates the two units in that locality.

The Urannah Complex intrudes the Volcanics, but in many places the contact is faulted. This relationship is seen at the Range Hotel where indurated sediments are vertical, and in places overturned, at the contact, and dipping at 18° a mile away. The linear contact between the Lower Bowen Volcanics and the Complex west of Kungarri is taken to indicate a fault contact, and the swing to the south of the Pioneer River at Gargett may indicate fault movement.

The broad regional structure of the Volcanics on the eastern side of the Complex is obscured by local folding and faulting, and by the absence of regional marker beds. Photo interpretation indicates a possible north-west dip, south-east of Pinevale, but field measurements indicate tight folding just to the south of this area. A north-east dip is evident near Sarina, but this trend dies out to the north, and at Scrubby Mountain the dip is to the west.

The Volcanics are thought to overlie the Campwyn Beds disconformably because of their age difference. The only mapped contact between the two units, at Sarina, is faulted. The north-west trend of this fault is the same as that of many faults in the Volcanics, but the dip of the fault plane is unknown. The Calen Coal Measures disconformably overlie the unit.

The age of the unit probably ranges from the Upper Carboniferous to the Lower Permian, the evidence being plant fossils found at various places. The following identifications were made by M.E. White (White, 1963a and b).

Locality M572

Mackay Photo run 5, photo 93. Specimens F22266

Glossopteris indica Sch.
Small Samaropsis seeds
Equisetalean stems
Equisetalean leaf sheaths, probably
Phyllotheca australis Bgt.

Locality M754

Mackay Photo run 3, photo 51.

Glossopteris ampla Dana
Glossopteris indica Sch.
Noeggerathiopsis hislopi (Bunb)?
Samaropsis dawsoni Shirley
Equisetalean stems

Locality M140

Mackay Photo run 2, photo 25. Specimen F22268

Equisetalean stems

Locality M423

Mackay Photo run 4, photo 67. Specimens F22034-5-6-7.

Samaropsis dawsoni
Noeggerathiopsis hislopi (Bunb.)
Vertebraria indica Royle

Locality M765

Mackay Photo run 2, photo 25. Specimen F22273

Small equisetalean stems
Indeterminate plant fragments

Locality M446

Mackay Photo run 4, photo 65 Specimen F22038

Glossopteris indica Sch.
Equisetalean stems

Locality M751

Mackay Photo run 4, photo 63 Specimen F22271

Equisetalean stems.

M.E. White (pers.comm.) notes that Noeggerathiopsis hislopi is characteristic of the Lower Bowen Volcanics, and does not occur with forms typical of the Upper Bowen Coal Measures. It is also noted that the age of N. hislopi, from recent work overseas, ranges from Upper Carboniferous to Lower Permian.

The thickness of the unit is unknown but it has been estimated to be from 10,000 to 20,000 (Malone et al 1962).

The Carmila Beds

Summary: The Carmila Beds, a Permian freshwater sequence 7,000 feet thick, crops out in the south-west part of the mainland on the Mackay Sheet area. It consists of conglomerate, lithic sandstone, siltstone, lithic and crystal tuff, acid flow rocks, and shale. The unit is folded into a broad south plunging syncline, the axis of which trends north-north-west. It is possible that it is not intruded by the Urannah Complex. The unit, possibly younger than the Lower Bowen Volcanics, contains fossil plants which range from Upper Carboniferous to Lower Permian.

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Carmila Beds is a new name proposed by the authors for a sequence of Permian fresh water sediments and volcanics cropping out east of the main coast range and south of Koumala. There are no previous regional reports on the area, and no prior names for the unit exist. No sections have been measured, and no type area has been defined. Good exposures can be found in most creeks within the area of outcrop, but most of the common lithologies in the unit are exposed in borrow pits and creeks within a short distance of Carmila.

The unit forms easily recognisable strike ridges and cuestas. The ridges are highest in the west, and disappear under the coastal alluvium to the east. Most of the creeks flow across the regional strike but nowhere was there enough outcrop exposed to make section measuring worth while.

The following description of the lithology of the Carmila Beds is compiled solely from field descriptions of approximately sixty outcrops. Rock types, in order of abundance, include conglomerate, lithic sandstone, siltstone, lithic and crystal tuff, acid flow rocks, and shale. In general the succession of lithologies consists of acid volcanics at the base of the unit, followed by conglomerate and sandstone with some volcanics, and overlain by sandstone, siltstone and shale with some acid flows and fine tuff .

Conglomerate is very abundant in the north of the area of outcrop, and is well exposed in the upper parts of Basin Creek and Marion Creek, and along Funnel Range. Mt. Funnel is capped by approximately 80 feet of conglomerate and coarse sandstone; a 30 foot bed of cobble conglomerate with interbedded tuff, sandstone and siltstone is exposed on Mt. Cutlack; a bed of boulder conglomerate at least 30 feet thick overlain by rhyolite flows caps Mt. Christian. However the largest and most accessible outcrop of conglomerate is in the bed of Rocky Dam Creek about $\frac{3}{4}$ mile east of Mt. Christian siding. Here a thick, uniform bed of hard boulder conglomerate overlain by coarse lithic tuff and dipping gently to the east, forms the wall of a natural "Rocky Dam". The conglomerate has regular bedding, and no obvious torrential structures. Phenoclasts are generally 4-6 inches in diameter, but rare 4 foot boulders are present.

The conglomerate in the unit, in general, is hard and a tough greenish, probably tuffaceous matrix is not uncommon. Coarse lithic sandstone also occurs as matrix, while in some places matrix is nearly absent.

Phenoclasts are mainly of acid volcanic rock, commonly porphyritic and fluidal rhyolite. Except for the occasional boulders of plutonic rock, lithology of the phenoclasts is similar to that of the volcanics in the Carmila Beds, especially in the scarcity of basic rocks.

The beds of conglomerate are generally thick and uniform, and appear to persist without changing character over extensive areas especially in the upper reaches of Basin Creek and Marion Creek. Cross-bedding and lensing of beds are rarely seen, and only occasionally are sandy beds and lenses included. In general, the conglomerate beds are only moderately permeable, and the lithic matrix and relative absence of joints makes them less attractive as aquifers than could normally be expected for unmetamorphosed conglomerates.

Conglomerate apparently forms the base of the sedimentary sequence in the Carmila Beds, overlying acid volcanics. Thick gently dipping beds of conglomerate are common in the north but disappear under the coastal alluvium to the south, until at Flaggy Rock no sediments are exposed and only basal flows and tuffs are represented.

Lithic sandstone and tuffaceous sandstone are the most common arenaceous sediments. Felspathic sandstone and quartz lithic sandstone are present in the sequence but quartz sandstone is rare. Sandstone is generally not well sorted, and contains some pebbly bands. Colour is commonly yellow or brown but in places olive green or khaki.

Lithic sandstone appears to be harder than the more quartzose varieties. In places it appears silicified but only in a few cases was calcareous cement indicated. A low permeability is the general rule.

Coarse sandstone is generally massive and poorly sorted; medium to fine grained sandstone is better sorted, thin bedded, and is commonly interbedded with siltstone and shale. Most beds of sandstone are uniform and strucureless, and few important internal bedding structures were noted.

Some of the well bedded medium-grained quartz lithic sandstone shows ripple marking and contains thin lenses and seams of siltstone.

Coarser sandstone is interbedded with, or lies above the conglomerate, while the finer varieties are generally higher in the sequence, interbedded with siltstone, which is the dominant lithology at the top of the unit. Best exposures are obtained in creeks and gullies along the road between Ilbilbie and Notch Point.

Siltstone and shale are well exposed in road and rail cuttings and creeks between Ilbilbie and West Hill. Probably the best single outcrop is in a railway cutting immediately north of the Gillinbin Creek bridge, where approximately 60 feet of interbedded tuff, tuffaceous and lithic sandstone, siltstone, carbonaceous shale, and a thin seam of soft black carbonaceous pug is exposed.

The siltstone is generally well bedded, uniform in appearance and grain size within each bed, but not well laminated. Sandy lenses within siltstone beds are uncommon. Shale is less abundant than siltstone and is generally very fissile, carbonaceous, and dark grey or purplish in colour. Shale beds sometimes exhibit slight pinch and swell of beds.

The siltstone and shale generally contain plant remain, but the best plant fossil collections have come from light grey, thin bedded, hard, siliceous siltstone. The carbonaceous shale is usually very fissile and so rich in carbonised plant remains that it crumbles on splitting. Khaki and dark grey siltstone with poor fissility and uniform appearance is common, but it usually crumbles on exposure to give angular fragments too small to contain useful plant remains. The less common dark micaceous siltstone and light grey shale do not crumble so readily but have only fragmentary plant remains.

Siltstone and subordinate shale, interbedded with fine tuff and sandstone, form the upper part of the Carmila Beds as exposed in the Ilbilbie-West Hill area. There are local reports of the occurrences of coal in the vicinity of Koota, but no coal was seen.

Rhyolite and dacite are the most abundant flow rocks in the Carmila Beds. Trachyte has been noted in the field, but no andesitic or basaltic flow rocks have been seen.

Several thick rhyolitic flows crop out strongly in the area. Bull's Head Bluff and other well developed cuestas at the heads of Basin Creek and Gillinbin Creek represent the outcrop of thick rhyolitic flows and tuffs near the base of the Carmila Beds in this area. These are overlain by interbedded conglomerate, coarse sandstone, and other acid volcanics. Another rhyolite flow(s) up to 50 feet thick overlies conglomerate capping Mt. Christian. Most flows, however, are of the order of 10 feet and less in thickness.

The rhyolite and dacite are generally light grey or green in colour, in places porphyritic or less commonly fluidal. Thin flows of porphyritic rhyolite-dacite with phenocrysts of biotite in a fine light grey groundmass are not uncommon, and trachyte flows and flow breccias have been identified near the base of the Carmila beds in the Flaggy Rock area.

Lithic tuff, rhyolitic tuff, and rhyolitic and dacitic crystal tuff are the common pyroclastics of the Carmila Beds. Acid volcanic breccias and lapilli tuffs are less common, and agglomerates and basic pyroclastics are very rare.

The pyroclasticsalso crop out strongly, forming cuestas, especially in the vicinity of Flaggy Rock. The Bluff, south-west of Flaggy Rock, is capped by approximately 300 feet of coarse-grained, light green, bedded tuff of intermediate composition.

The lithic tuff is generally well bedded and light green, grey or brown in colour. The coarse-grained variety is tough and volcanic fragments containing quartz, felspar and mica are not uncommon. The finer grained lithic tuff is generally weathered, porous, and darker in colour. Acid crystal tuff is frequently hard and siliceous with grains of felspar and clear quartz in a reddish-purple or light green fine-grained matrix.

Intrusives into the Carmila Beds are rare. A weathered basic dyke four feet wide cuts shale and siltstone south of Ilbilbie. Another outcrop exposes quartz veined hornblende diorite in a creek about three miles south of West Hill. Epidotisation is absent and quartz veins are extremely rare - one narrow vein cutting conglomerate was noted in upper Marion Creek. Many of the conglomerates near the base of the unit are very hard, but the absence of any other definite intrusives, and their relatively undisturbed attitude suggests they have suffered only minor intrusions.

The unit is folded into a shallow, relatively simple syncline plunging gently to the south, whose axis trends north-north-west and passes through a point two miles east of West Hill. Most of the eastern limb has been eroded down, and is now covered by coastal alluvium. Dips in the western limb are consistent in direction, and become steeper towards the south. However, none exceeds 30°, and few exceed 20°. The existence of minor tighter folding in the centre of the syncline is indicated by closely spaced opposing dips as high as 45° along the Ilbilbie-Notch Point road.

Faulting has not been severe in the area. One north-east trending fault appears to follow Marion Creek, and another follows Carmila Creek near Carmila, displacing the southern block to the east. Other faults occur, but their displacement is small, and most outcrops are relatively free of joints.

The junction between the Carmila Beds and the Campwyn Beds to the north-east is thought to be a faulted one, along a line east of and parallel to Funnel Range. Field evidence for this fault includes severely contorted and jointed outcrops along the beach from north of Green Hill to Walter Reid homestead.

To the south and west of the Carmila Beds, are the rocks of the Lower Bowen Volcanics and the intrusives of the Urannah Complex. It is thought that the Carmila Beds lie unconformably on the Lower Bowen Volcanics, and also that they were deposited after the bulk of the Urannah Complex Intrusives were in place.

Andesitic dykes, basaltic dykes, and quartz veins cut Campwyn Beds to the east of the Carmila Beds near Walter Reid homestead, and to the north of them at coastal outcrops east of Oonooie. Basic dykes are also common cutting Urannah Complex intrusives and Lower Bowen Volcanics to the north and west. Epidotisation and calcite veining are common in both Campwyn Beds and Lower Bowen Volcanics. Moreover, both of these units show numerous small faults, and jointing is generally well developed. The lack of intrusives into the Carmila Beds, suggests that they were deposited after the main phase of igneous activity in the area. The paucity of faults, joints, and quartz veins, and the absence of other secondary mineralisation supports this conclusion. Moreover, the Carmila Beds form a distinct photogeological, lithological and structural unit, apparently resting upon the Urannah Complex. No exposure illustrating unconformity between Carmila Beds and Urannah Complex has been seen, but in view of the evidence, an unconformity is thought possible.

Collections of plant fossils have been made from various localities in the unit. Most of the plants have a Permian range; they include Nooggerathiopsis hislopi which is also found in the Lower Bowen Volcanics and which ranges from the Upper Carboniferous to the Lower Permian. As the Carmila Beds are thought to be equivalent to beds at the top of the Lower Bowen Volcanics in the St. Lawrence area (Malone et al, 1963). They are regarded as Lower Permian in age.

The following identifications were made by M.E. White (1963a, b).

Locality M506

Mackay Photo run 7, photo 55. Specimens F22269

Indeterminate.

Locality M654

Mackay Photo run 7, photo 53. Specimens F22267

Glossopteris communis Feist

Phyllotheca australis Bgt., stems and sheaths

Glossopteris indica Sch.

Nummulospermum bowenensis Walk.

Locality M675

Mackay Photo run 7, photo 53. Specimens F22270

Noeggerathiopsis hislopi (Bunb.)

Equisetalean stems

Nummulospermum bowenensis Walk.

Glossopteris venation fragment

Locality M604

Mackay Photo run 7, photo 604.

Equisetalean fragments

Seeds (? *Samaropsis*)

? *Glossopteris* type venation fragments

The following sample was examined by P.R. Evans:

Locality M508

Mackay Photo run 7, photo 53.

Very rare, fragmentary, unidentifiable spores.

No sections have been measured in the Carmila Beds, but assuming a constant dip of 10° over eight miles in the Basin Creek area, a thickness of at least 7,000 feet is indicated.

It is thought that the Carmila Beds were deposited in a large fresh water basin formed to the east of the present position of Connors Range, and partly separated from the Bowen Basin by a high, formed of uplifted Lower Bowen Volcanics and Urannah Complex intrusives. The extrusion of the acid volcanics at the base of the Carmila Beds probably represents the later phases of igneous activity in the Urannah Complex. The predominance of acid volcanic phenoclasts in the Carmila conglomerates suggests that these volcanics also covered much of the surface surrounding the basin. The decreasing abundance of volcanics, and the appearance of fine sediments with plant fossils indicates a return to more quiescent conditions. Later geologic history includes uplift, and gentle folding, slight faulting, and very minor intrusions. The Carmila Beds are unconformably overlain by Tertiary sediments.

The Calen Coal Measures

Summary: The Calen Coal Measures crop out over a small area in the northern part of the area. They are composed of at least 1,000 feet of sandstone, siltstone, claystone, and minor coal. The structure of the unit is broadly synclinal, but the unit is severely faulted. The unit disconformably overlies the Lower Bowen Volcanics, and is thought to be Lower Permian. In the type area it contains Permian plants. Petroleum found in a water well at Walkerston possibly comes from this unit.

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The term 'Calen Coal Measures' was first used by Hill and Denmead (1960), the unit having been described, but not formally named, by Reid in 1929b. Reid's description applies to about 1,000 feet of coal measures cropping out west of Calen, on the Prosperine 1:250,000 Sheet area. Occurring exclusively north of the Pioneer River, the Coal Measures (Plc) on the Mackay Sheet form continuous outcrop with the type area, about ten miles to the north. Topography produced by the unit near Mt. Toby consists of high hills with steep sides. Further to the north and east the topography is more subdued, consisting of some low strike ridges in relatively flat terrain.

The unit comprises sandstone, siltstone, claystone, and coal. The sandstone is coarse,quartz rich, brown to white and thick bedded. Large scale cross-stratification is common, making the measurement of dips difficult; small scale slumps have been observed. Although well sorted, pebble bands are common, the pebbles being mainly of quartz and quartzite. Thin beds of siltstone in the unit grade laterally into soft brown claystone. Local residents report small bands of coal near Mt. Toby. Road cuttings five miles west of Yakapari, on the Bruce Highway, show excellent exposures of the thinner beds in the unit. (Figs. 3, 4, 5, 6.)

The structure of the unit is possibly synclinal with a plunge to the north. Beds on the extreme western margin dip gently off the Lower bowen Volcanics at about 20°. On the southern margin, just north of the Pioneer River the regional dip is to the north, but this is interrupted by faulting and minor folding. Intrusion of sills and dykes, in the central part of the area of outcrop is associated with folding and faulting, and this is well displayed in Bruce Highway road cuttings. It is evident that intrusion has caused some folding, but as some of the dykes and sills are themselves faulted it has to be assumed that at least some of the faults are caused by regional stresses. (Figs. 3, 4, 5, 6.) The intrusion of Mt. Jukes has also caused folding, as the beds on its western margin are vertical.

Figure 3: Faulting, folding, and intrusion in the Calen Coal Measures, in a road cutting on the Bruce Highway. File M266/Negs.31,32,33

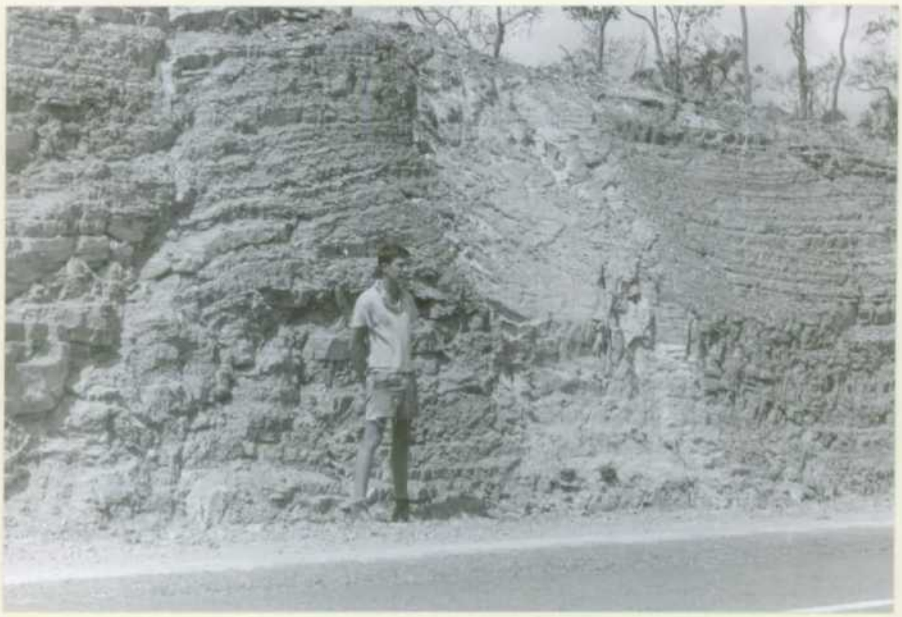

Figure 4: A dyke in the Calen Coal Measures, causing some displacement of the bedding.
File M266/Neg.36.

Digure 5: A dyke in the Calen Colen Coal Measures, causing considerable disruption of the bedding.
File 265/Neg.25.

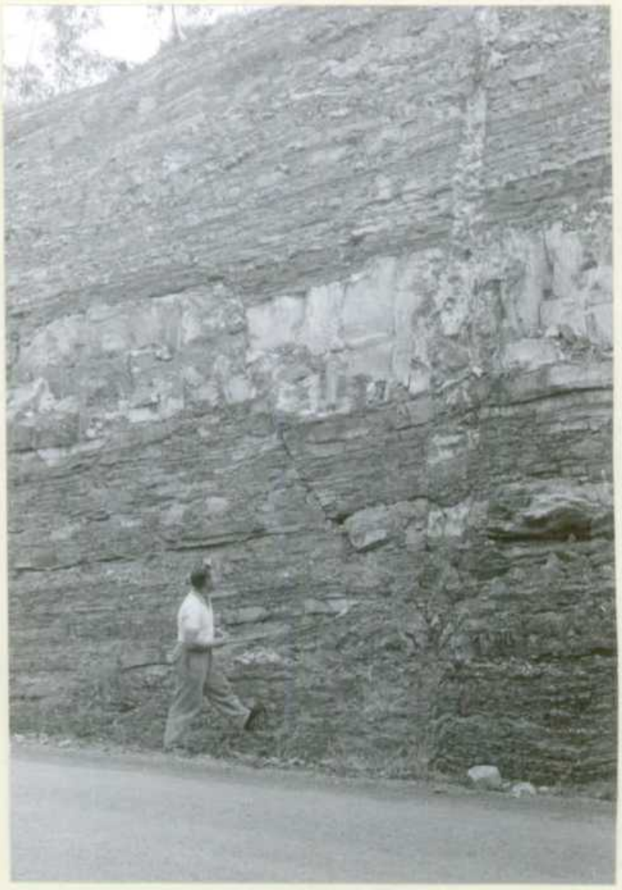

Figure 6: A normal fault displacing a sill in the Calen Coal Measures. A vertical dyke cuts thesequence.

File 265/Neg.27.

Larger faults affecting the unit trend north-west, but their hade and direction of movement is unknown. This is a common fault direction in this area, and similar faults on the Proserpine Sheet, and at Sarina, have strong vertical displacement.

Although there is no evidence of an angular unconformity between the Lower Bowen Volcanics and the Coal Measures, it is thought that a disconformity exists. Evidence for this is the sudden change of lithology at the boundary of the two units. The large mass of intermediate and basic intrusives south-east of Mount Blackwood is thought to intrude the Measures, but where observed the boundary was faulted. The acid intrusions of Mounts Blackwood and Jukes intrude the unit and cause some hornfelsing of the beds close to the contact.

At Calen the unit contains Vertebraria indica so it is certainly Permian. Beds underneath the unit yield Upper Carboniferous to Lower Permian plant fossils (based on the age of Noeggerathiopsis hislopi), and deposition appears to be continuous from these undivided freshwater beds into the Calen Coal Measures. Marine fossils were reported to the authors occurring near Mt. Toby, but none could be found. However, it is possible that the unit is in part marine, and that Reid's (1929b) correlation of the unit with the Lower Permian Middle Bowen Beds is correct. Petroleum found in a water well at Walkerston possibly comes from this unit.

It is thought, from air photo interpretation, that much of the unit is present at Mt. Toby, which is about 1,000 feet high. The dip at this locality is low and it is therefore estimated that about 1,000 feet of section is exposed in this area. However, neither the top nor the base of the unit is exposed at Mt. Toby and therefore the thickness is estimated to be more than 1,000 feet (probably less than 2,000 feet).

The Middle Bowen Beds

Summary: The marine Middle Bowen Beds crop out in three areas on the Mackay Sheet area; the Homevale area, the Mount Flora area, and the Funnel Creek area. They are divided into three units, A, B, and C, on the basis of faunal content and lithology. Unit A, where seen, consists of siltstone and subgreywacke, and is characterized by Fauna II (Dickins, Malone, and Jensen 1962). Unit B is sandy, and contains Fauna III. It is overlain by Unit C, which has a basal conglomerate but is mainly a siltstone unit with Fauna IV. These units cannot be recognized in the Mount Flora area, where the lithology includes conglomerate, sandstone and siltstone. Siltstone and sandstone of Unit A crop out in the Funnel Creek area.

The unit dips regionally to the south-west in the Homevale area, but in the Mount Flora area it is domed by the Bundarra intrusion, and consequently dips north near the northern contact. Small scale tight folding near Homevale Homestead dies out southward. The unit is estimated to be 8,500 feet thick north of Mount Landsborough. Marine macrofossils in the unit indicate a Lower Permian age, possibly extending into the lowermost Upper Permian.

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The Middle Bowen Beds crop out in three localities on the Mackay Sheet; the Homevale area, the Mount Flora area, and the Funnel Creek area. In the Homevale area the beds form gently undulating topography with low strike ridges in some places, and in the Funnel Creek area, flat plains. The unit produces rough broken topography in the Mount Flora area, between high cuestas of sandstone at the top of the unit, and the ring of hills surrounding the intrusion.

Three subdivisions of the Middle Bowen Beds, designated A, B, and C, have been recognised in the northern part of the Bowen Basin, (Dickins et al, 1962). Each of the three units has a characteristic macrofossil assemblage (Faunas II, III, and IV, in A, B, and C respectively), and locally distinctive lithological characteristics. The Middle Bowen Beds in the Mackay area can be subdivided by faunal assemblages II, III, and IV, and the corresponding lithologies fit reasonably well with the section as it is known in the northern part of the Basin. No subdivision can be attempted in the Mount Flora area, and only a few feet of section crop out in the Funnel Creek area.

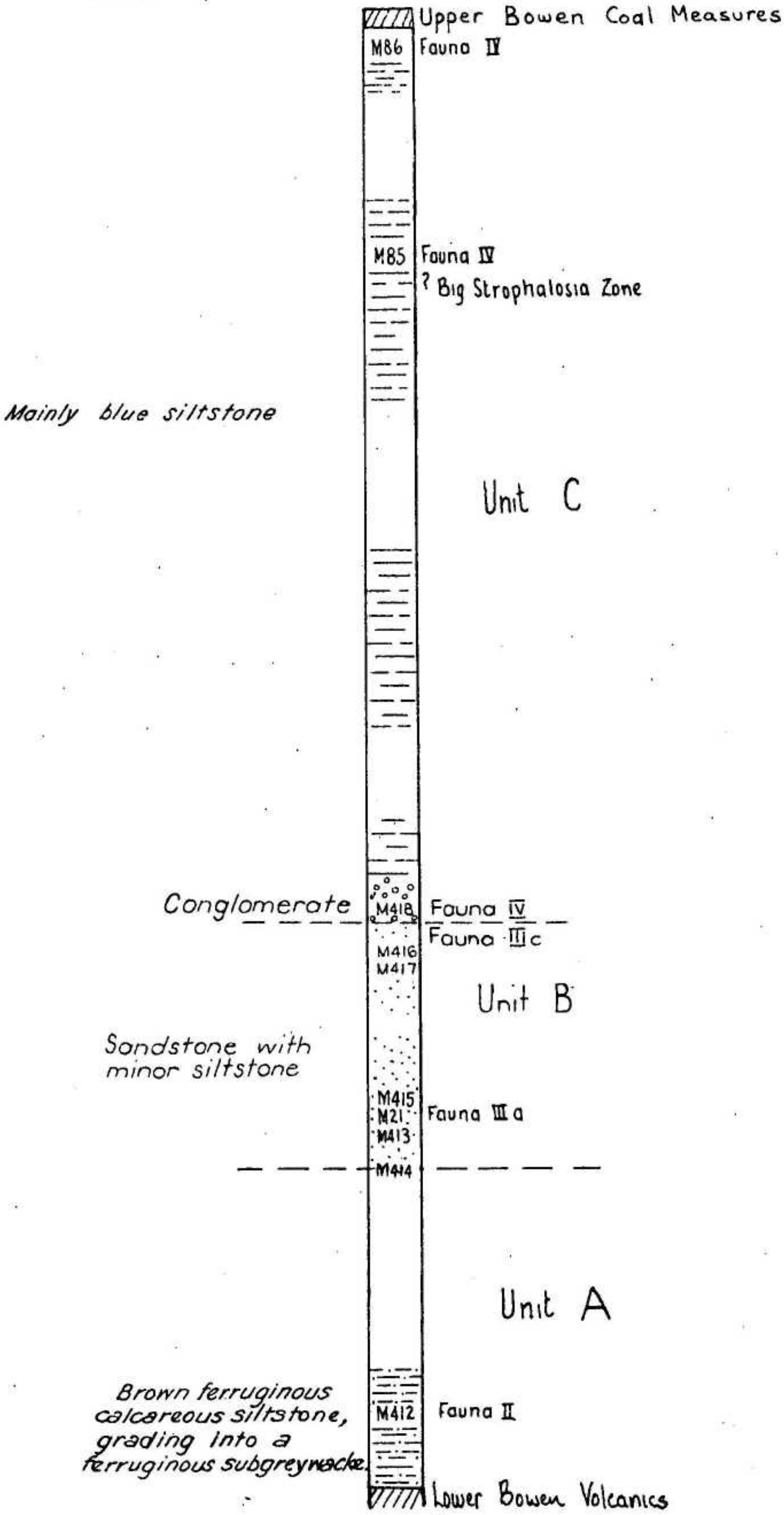
The Homevale area:

The geology is structurally complicated in the Homevale to Carrinyah area where many fossil collections have been made. Three collections, M21, M85, and M86, were made just north of Mount Landsborough, where the structure is relatively simple, and where the stratigraphic section in figure 7 was computed. The positions of other fossil collections shown on the section are approximate, as they have been extrapolated along strike from the north.

The basal unit, A, crops out very poorly not only in the Homevale area but also in areas to the north, on the Mount Coolon and Bowen Sheet areas. The only outcrop of the unit in this area consists of a brown, ferruginous, subgreywacke, which grades into a brown, calcareous, siltstone. It is packed with well preserved marine fossils of Fauna II.

Fig. 7.

Relationship Between Fossil Collections at Mount Landsborough and Homevale



Scale 1 inch = 1,000 feet.

To accompany Record No 1963/71
Bureau of Mineral Resources, Geology and Geophysics. May 1962

F55/8/2

Unit B, north of the Mackay area near Collinsville, is divided into three subunits, B1, B2, and B3, containing Faunas IIIa, IIIb, and IIIc, respectively; IIIa being the oldest. In the Homevale area, Unit B is composed of sandstone and minor siltstone. The sandstone is medium grained, yellow to grey or buff in colour, hard and calcareous, slightly feldspathic, quartz rich (up to 60%), and cross-bedded in places. Fauna IIIa is found at the base of Unit B, and IIIc at the top. The boundary between Units B and C lies between fossil collection points M417 and M418, the latter containing Fauna IV. Fossil collection M416 from a point intermediate between M417 and M418 contains elements of both faunas. The boundary is also marked at two localities by a pebbly quartz lithic sandstone.

Above the basal pebbly sandstone, Unit C, where seen, consists of light blue, micaceous siltstone, with crinoid stems in places. A richly fossiliferous bed about 20 feet thick, cropping out about 1,300 feet below the top of Unit C, and containing *Strophalosia* cf. *clarkei* and *S.* cf. *ovalis*, is regarded as the Big Strophalosia Zone (Dickins et al, 1962).

The Mount Flora Area:

No macrofossils, apart from crinoid stems, have been found in the Middle Bowen Beds in the Mount Flora area. The strata are metamorphosed and sheared by the Bundarra Granodiorite, and outcrop is poor and discontinuous. An examination of outcrop in two creeks north of the intrusion has yielded some information regarding the sequence.

The lowest bed, about 8,000 feet from the top of the sequence, has been metamorphosed by the intrusion to andalusite hornfels. The following 2,500 feet consists mainly of sheared blue siltstone, and fine sandstone, friable in places. This is overlain by an indurated, thick bedded, quartz sandstone, and then by 3,000 feet of poorly outcropping blue and white siltstone, purple siltstone, and brown micaceous sandstone. Overlying these beds is a distinctive sequence of about 800 feet of purple siltstone which weathers to a light green colour, and contains crinoid stems. This is overlain by a pebble conglomerate, 2,500 below the top of the unit. A bed of cross-bedded quartz sandstone crops out 1,500 feet below the top, forming large cuestas, and this is overlain by interbedded blue and white siltstone to the top of the unit.

An idea of the reliability of the composite section can be given by stating that it is the result of the examination of only 14 outcrops. It would be unwise, on such meagre evidence, to attempt subdivision of the section in terms of the units A, B, and C. The presence of quartz sandstone 1,500 feet from the top of the sequence is interesting as it shows that porous beds do occur near the top of the unit.

Funnel Creek area:

Light blue micaceous siltstone is interbedded with calcareous sandstone in the Funnel Creek area. Fossiliferous ferruginous rubble is common.

The structure of the unit is different in the three areas of outcrop. In the Homevale area, the regional dip of about 40° is to the south-west, but the beds are folded, in places, into small, tight folds with limbs dipping up to 70°. These die out southwards, and are absent just north of Mount Landsborough. This type of folding is not found in the Mount Flora area, where the beds are domed by the intrusion; dips north of the intrusion range from 30° to 60° to the north.

Little is known of the structure of the Funnel Creek area, the only dip measurement in the unit being 70° to the north. The Lower Bowen Volcanics crop out directly to the north of this locality, so the regional strike must be east-west in this area as the two units are conformable. Thus the regional dip is to the south, and not to the north as the dip measurement suggests; this anomaly may indicate faulting.

The unit was deposited in a marine shelf environment, but the depth of water was probably less in Unit B than in A or C, as indicated by the sandier nature of B and by the presence in it of cross-bedding. Unit B in the Collinsville area contains a considerable deposit of coal, possibly indicating a widespread regression of the sea at this time. The conglomerate at the base of C probably indicates elevation of the source area, and a deepening of the basin, with the subsequent deposition of finer sediments to form the bulk of the unit.

Just north of Mount Landsborough, assuming a dip of 45° and measuring the distance on air photos, the thickness of the unit is estimated to be 8,500 feet. The figure for the dip is derived from six measurements in the field. Unit A is about 1,800 feet, B about 1,400 feet, and C about 5,200 feet. Calculations based on rather inconsistent dips in the Mount Flora area, result in an estimate of 8,000 feet for the thickness of the unit in that area. This may not represent the total thickness of the Middle Bowen Beds in that area, as the base may not be exposed.

The Middle Bowen Beds range in age from lower Artinakian, or possibly uppermost Sakmarian (Dickins 1961), to Kungurian. A list of macrofossils found in the unit on the Mackay Sheet is given in Appendix A.

The Upper Bowen Coal Measures

Summary: The Upper Permian, Upper Bowen Coal Measures, conformably overlying the Middle Bowen Beds, crop out in three small areas in the south-western part of the Mackay Sheet. They consist of siltstone, lithic sandstone and conglomerate, and dip broadly to the west-south-west, except in areas of minor tight folding, and where they are domed by the Bundarra Granodiorite. The unit is 10,000 feet thick elsewhere, but the entire sequence does not crop out in this area.

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The Upper Bowen Coal Measures crop out in three areas, west of the Urannah Complex, on the Mackay Sheet area: the Homevale area, the Mount Travers area, and the Mount Flora area. The Coal Measures are a continuation of those cropping out on the Mount Coolon and Bowen Sheet areas, forming part of the eastern limb of the 'Bowen Syncline'.

Topography produced by the unit in the Homevale area, like that of the Middle Bowen Beds, consists of long, low, rounded strike ridges. Trees are sparse, except in a patch south of the Peak where dense brigalow scrub grows. A distinctive pattern, produced on air photos by trees growing along bedding trends, shows the structure of the unit, even though outcrop is poor. Hills in the Mount Travers area are low and rounded, but not strike ridges. Again, bedding trends are picked out by the vegetation. Topography produced by the unit in the Mount Flora area is flat, and outcrop is extremely poor.

The unit consists of siltstone, lithic sandstone and conglomerate. The pressnce of volcanic lithic fragments in the sandstone and conglomerate, and an abundance of fossil wood and leaves, distinguish the unit from the Middle Bowen Beds.

The base of the unit was seen in three places: near Harrybrandt homestead; three miles to the east-south-east of Harrybrandt Homestead; and near the Peak. The change from Middle Bowen Beds is transitional, near Harrybrandt, quartz rich pebble conglomerate grading into conglomeratic lithic sandstone, with bands of white, micaceous, quartz siltstone. East of Harrybrandt the change is sharp, from thin bedded blue micaceous siltstone to cross-bedded lithic sandstone, with abundant fossil wood, interbedded with thin beds of brown carbonate rock, probably dolomite. The same lithologies are present at the boundary between the two units near the Peak, except the thin dolomite beds.

In the Mount Travers area the unit consists of thin bedded claystone and siltstone with fossil plant debris, sandstone and conglomerate. The sandstone contains varying proportions of feldspar and quartz, but always a high proportion of volcanic fragments; it is commonly festoon bedded. Volcanic pebble conglomerate is common.

The unit has a regional dip of about 30° to the south-west, in the Homevale area, but it is folded into small tight folds, in places, the axes of which trend north-north-west. This type of folding is also present in the Mount Travers area, and minor faulting affects the beds in both areas. The unit is domed by the Bundarra Granodiorite, and consequently dips are away from the intrusion. For example, near Harrybrandt homestead the dip is to the north. The unit conformably overlies the Middle Bowen Beds, and is unconformably overlain by Tertiary basalt.

The top of the sequence does not crop out on the Mackay Sheet, and hence the thickness of the unit cannot be determined. On the adjacent Mount Coolon Sheet area, it is 10,500 feet.

The abundance of plant debris, the absence of marine fossils, and the presence of moderately large scale festoon bedding, are taken to indicate a lacustrine environment. Contemporaneous vulcanism is indicated by devitrified glass, and volcanic rock fragments.

No identifiable plant remains were found in the unit, on the Mackay Sheet. Elsewhere in the Bowen Basin the unit is regarded as Upper Permian.

(c) <u>Tertiary</u>.

<u>Basalt</u>

<u>Summary</u>: Tertiary olivine basalt crops out mainly in the west and south-west part of the area, but there is a small outcrop north of Mirani. The basalt exhibits various textures including vesicular, amygdaloidal, porphyritic, and non-porphyritic. It is unconformable on the Permian Bowen Basin sequence and is similar in part to Tertiary basalt on the Mount Coolon Sheet area. It is less than 200 feet thick, and is possibly Tertiary.

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Tertiary basalt flows cover about 40 square miles, west of Nebo, where they form black soil plains. The basalt is covered by black soil except at Mount Fort Cooper, and in a few creeks and on small rubble covered rises. Mount Fort Cooper is a steep sided, flat topped hill, standing about 1,000 feet above the level of the plain. It is almost circular in plan view.

Basalt also crops out south-east of Waitara, north of Plevna and north of Mirani. South-east of Waitara it forms low rubble covered rises and small hills. North of Plevna, in the Eungella district, it is found capping hills and as boulders in deep soil profiles, exposed in road cuttings. North of Mirani it crops out in the flood plain of the Pioneer River. Outcrop is poor and the basalt is covered by red soil and alluvium.

The basalt west of Nebo varies in texture from vesicular or amygdaloidal to even-grained or porphyritic. It consists of olivine, titanaugite, and labradorite. The amygdules when present range up to one foot in diameter, but the average size is one to two inches. The basalt north of Plevna and also Mirani is lithologically similar to the olivine basalt west of Nebo, having as its constituent minerals olivine, titanaugite and labradorite, with phenocrysts of bytownite rounded by resorption.

The thickness of basalt in the Nebo area is less than 200 feet. Reid (1925) estimated it to be 1,000 feet, on the basis of the height of Mount Fort Cooper, which is 1,000 feet above the level of the plain. However, Mount Fort Cooper is now thought to be a volcanic plug, for the following reasons: (i) it is an isolated hill of basalt very much higher than the surrounding country, (ii) it has a conical shape, apart from the flat top, (iii) basic plugs are known on the Clermont Sheet area south-west of Nebo (Veevers, Randall, Mollan, and Kirkegaard, 1961), (iv) air photos show it to be surrounded, at its base, by a slightly raised bench which could mark part of the old crater rim.

The basalt unconformably overlies the Middle Bowen Beds west of Homevale and of Nebo, as well as the Upper Bowen Coal Measures west of Nebo. It unconformably overlies the Lower Bowen Volcanics south-east of Waitara and north of Mirani, and the Urannah Complex north of Plevna. At Mount Landsborough and south-east of Waitara it is overlain by acid volcanics.

The basalt west of Homevale is a continuation of basalt thought to be Tertiary (Malone et al, 1961), covering large areas on the Mount Coolon Sheet area. Amygdaloidal basalt west of Nebo is overlain by a more massive type which is commonly found on the Mount Coolon Sheet.

Acid and intermediate volcanic rocks

Summary: Volcanic rocks of possible Tertiary age crop out in a number of places on the Mackay Sheet area. Three types of topography are produced by the volcanics: plateaux bounded by vertical cliffs, high mountainous country, and small rounded or conical hills. The unit includes flows and pyroclastics of acid and intermediate composition. It overlies unconformably units folded by the Triassic orogeny. It is about 700 feet thick west of Homevale but elsewhere the thickness, where known, is less.

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Acid and intermediate volcanics crop out in a discontinuous line from Plevna, on the north-west edge of the Sheet area, to Murray Creek, in the southern part of the area. They also crop out at the Leap, near Koumala, at Glendower Peninsular, West Hill Island, and Mount Hector.

The unit produces three types of topography: plateau areas, high mountainous country, and small isolated hills or hilly country. North of Homevale the unit has produced a high plateau with vertical sides about 500 feet high. The plateau surface is rough and broken. Small remnants of the once larger plateau area, such as the Marling Spikes, now stand isolated from the main plateau area. The same type of topography has been produced north of Burrenbring, but the plateau is more dissected.

Mountainous country is formed by the unit north of Waitara homestead, and west of Koumala. The area north of Waitara changes from hilly country, directly north of the homestead, to mountainous country at Pine Mountain. The area west of Koumala and Pine Mountain, are not only high and mountainous but also covered by thick scrub.

Small hills are formed by the unit in the area including and north of Mount Landsborough, in the Murray Creek valley, at West Hill Island, Mount Hector and Glendower Peninsular. The Peak, north-west of Mount Landsborough, Mount Hector, and West Hill Island are conical shaped hills, circular in basal plan and pointed at the top.

The unit is composed of acid and intermediate volcanic rocks, flows and pyroclastic. Rock types, in order of abundance, are: rhyolite, flows and pyroclastics, trachyte, trachytic tuff, dacite, andesite, and ignimbrite. Brown or white rhyolite, the most common rock type in the sequence, displays various textures: fine grained and non porphyritic, porphyritic, and flow laminated. The porphyritic rhyolite has phenocrysts up to $\frac{1}{4}$ inch in diameter of quartz and potash feldspar. Pyrite phenocrysts, cubes and pyritohedrons, up to an inch in diameter, are common in the Boothill Creek area. The laminae of flow laminated rhyolite are commonly contorted, plicated or undulose.

Rhyolitic breccia and agglomerate are both commonly interbedded with flow rocks. They crop out over most of the area, but are most extensive in the Marling Spikes, Mount Britton and Mount Landsborough areas. Jack (1887) reported that a near horizontal deposit of volcanic ash, containing rare large fragments, capped hills to the east of Homevale Station. Maitland (1889a) examined outcrop in about the same area which he described as about a mile to the south of Mount Britton township,* and considered that it was made up of lava and flows containing subangular fragments of itself, broken by movement of successive flows over the rapidly cooling mass. Probably both views are correct, as both tuffaceous and autobrecciated lavas are present.

Rhyolitic agglomerate, brecciated rhyolite, and poorly bedded rhyolite tuff crop out near Diamond Cliffs. The rugged Diamond Cliffs proved inaccessible for close study, but from a distance large fragments up to two feet in diameter could be seen. Boulders, presumably from the cliff, were of rhyolitic agglomerate and they contained fragments of fluidal rhyolite and glassy black pitchstone, which ranged from very small to two feet in diameter. Rare outcrops of vesicular basalt were noted in this area, but their relationship to the agglomerate and rhyolite flows could not be determined because of heavy vegetation. However, all the rugged peaks and plateaux in the Marling Spikes - Mount Britton area are capped by rhyolitic flows, breccia or agglomerate.

The Marling Spikes are a series of spectacular peaks generally regarded as volcanic plugs (Hill and Denmead, 1960). However, the plug-like shapes are probably the result of the dissection and erosion of a plateau, their general height being about the same as other flat top remnants. One of the smaller peaks consists of fine grained, flow banded rhyolite or trachyte. The rocks exhibit nearly horizontal large scale flow banding, suggesting that they are a flow remnant rather than a plug. No slickensiding or obvious disturbance of the underlying rocks near the peaks is evident.

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* Mount Britton, an old gold mining town, has since disappeared. It was about $1\frac{1}{2}$ miles north of the Marling Spikes.

Two hills on the Mackay Sheet area are regarded as acid volcanic plugs - Mount Hector and The Peak. Mount Hector is a small coastal hill north or Sarina, and about two miles south-east of Dudgeon Point. It is approximately circular in plan, and has the general appearance of a volcanic plug. However, the outcrops are not simple in detail. In places the rock is fragmental and bedded, and contains fragments of light grey fine-grained rhyolite. Elsewhere, light grey apparently intrusive rhyolite is exposed. The rocks are weathered and leached, and are commonly stained by limonite and haematite to form attractive intricate patterns with bands developed parallel to the joints. The Peak, an isolated conical hill about 600 feet high, is composed of flow banded porphyritic rhyolite, and surrounded by a low ring of rhyolitic breccia.

Mount Britton, east of Carrinyah homestead and south of the Marling Spikes, is capped by rhyolite or trachyte and is probably a remnant of the same sheet which covered the Marling Spikes area. At Mount Landsborough, further to the south, a thick sheet of brecciated rhyolite overlying vesicular basalt is capped by a thin bed of siltstone.

Possible Tertiary rhyolite flows and tuff overlie Campwyn Beds in the Glendower Point area. Most of the rock is weathered, but fresh rock seen was light grey and porphyritic, with large well rounded grains of quartz and white feldspar in a very fine grey groundmass. The quartz grains are up to 5 mm. in diameter and the feldspar generally smaller. On weathering the quartz is left standing up on the surface. The tuffaceous rocks are generally clayey, weathered, and mottled red and white, with rare veins of pure white magnesite up to four inches thick.

Trachytic volcanics are next in abundance to those of rhyolitic composition. Trachyte is generally flow laminated, porphyritic or even grained. Phenocrysts in the porphyritic variety are commonly potash feldspar, and in some cases quartz, hornblende, or plagioclase. Iron oxide, generally titaniferous, is a common accessory mineral. Mafic minerals are commonly altered to penninite. Quartz is generally absent from the groundmass. Malachite staining is associated with some of the trachyte near Twelve-Mile Creek, and west of Waitara homestead.

Tertiary trachytic flows and sills are common in the area around Yakapari and The Leap, north-west of Mackay. Reid (1931) examined exposures in this area and concluded that near Yakapari, the trachyte occurred as immense sills intruding shale. The Leap consists of thick flows of columnar trachyte capping extremely altered sedimentary rocks, which are intruded by thick trachyte sills. Some dykes of olivine green, glassy, semi-perlitic pitchstone were noted.

West Hill Island is possibly a trachytic volcanic plug. It is a conical island 980 feet high and about 1½ miles in diameter, lying ½ mile off shore. It is a dominant topographic feature as the nearby mainland is flat, low lying, coastal alluvium, except for one rocky headland south-west of the island. The island was not visited, but the outcrop on the mainland exposed green trachyte, which is apparently the edge of the West Hill Island plug. At one place near the edge of the outcrop (furthest from the island) the rock shows well developed columnar jointing with horizontal columns which appear to radiate from the centre of the island.

Dacite in the unit is generally grey or brown, fine to coarse grained, and from weakly to strongly porphyritic. Phenocrysts are commonly plagioclase or quartz and, in some cases, potash feldspar. Porphyritic varieties are more common in the outcrops north of Burrenbring than in those to the south, when considering the main line of volcanics. Dacite is the chief rock forming the horizontal cappings of mountains north-west of Koumala. The dacite flows show columnar jointing with vertical columns. Porphyritic dacite is common, with phenocrysts of plagioclase up to ¼ inch long, and some blebs of dark green femics, in a fine, buff brown, siliceous groundmass.

Andesite, uncommon in the north-western part of the Sheet, becomes more abundant in southern outcrops of the unit, especially around Tierawoomba and Undercliff homesteads. It is generally green, but it varies from non-porphyritic to porphyritic, and coarse to fine-grained. Phenocrysts are commonly plagioclase and in some cases hornblende and potash feldspar; they are usually small and make up no more than 10% of the rock.

Ignimbrite crops out at Pine Mountain, eleven miles east-south-east of Nebo. The Mountain, nine hundred feet above the level of the plain, is covered in dense scrub, making approach difficult, and although few cliffs are developed very steep slopes are common, especially near the top. The Mountain is a pile of basaltic and andesitic rocks, capped by about seven hundred feet of ignimbrite. The ignimbrite is composed of large flattened lapilli of pumice, minor andesite rock fragments and corroded phenocrysts of quartz and feldspar, in a welded mass of glass shards, volcanic ash and glass. Much of the glass has devitrified and pumice fragments have altered to a mass of spherulites.

The unit unconformably overlies the Campwyn Beds at Glendower Point and intrudes them at Mount Hector. It unconformably overlies the Lower Bowen Volcanics west of Koumala, at Pine Mountain north of Waitara homestead, north of Burrenbring, and west of Homevale homestead. It is unconformable on the Urannah Complex at Plevna and near Tierawoomba, and the Calen Coal

Measures at The Leap. The Upper Bowen Coal Measures and the Middle Bowen Beds are overlain by the unit near The Peak. The unit overlies Tertiary basalt at Mount Landsborough.

The thickest sequence of Tertiary acid and intermediate volcanics is west of Homevale, where it is estimated that about 700 feet of section crop out. Maximum thickness of the volcanics near Glendower Point is 180 feet. Elsewhere in the unit the thickness is unknown.

The acid volcanics at Mount Landsborough are thought to be Tertiary because they overlie Tertiary basalt. The volcanics elsewhere overlie units folded by the Triassic orogeny and so they are certainly post-Triassic. A Tertiary age is tentatively assigned to them because of the Mount Landsborough Tertiary vulcanism, and because vulcanism of this type was common in eastern Queensland during the Tertiary.

Sedimentary rocks

Summary: Sedimentary rocks of possible Tertiary age crop out at Plevna, Rocky Dam Creek, Alligator Creek, Lake Epsom, Boothill Creek, Mount Landsborough, and in coastal creeks. None of the outcrops is extensive. Lithologies encountered in these deposits include mudstone, siltstone, shale, sandstone and conglomerate. The thickest deposit is at Plevna where at least 265 feet has been indicated by drilling for oil shale. In all cases the sediments are flat lying; they overlie folded Palaeozoic units and in some cases are interbedded with Tertiary volcanics.

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Plevna:

Tertiary sediments are not very extensive in the Mackay 1:250,000 Sheet. Probably the thickest sequence occurs at Plevna, south-east of Eungella. The sequence is known from bores and shafts put down to test the oil shale occurring within it. It consists essentially of shale at the base, overlain by a thin section (less than 40 feet) of clay and tuff. Lithologies logged (Reid, 1942) include carbonaceous shale, tuffaceous shale, oil shale, siltstone, mudstone, fine sandstone, and tuff. The sedimentary sequence has been covered by later flows, generally acid, which leave only a very small area of outcrop (approximately 60 acres, according to Reid, 1942). Hence the Plevna Tertiary sediments have not been separated on the map, and are included within the Tertiary Volcanics.

These sediments are younger than the Late Palaeozoic or Mesozoic orogeny which folded the Bowen Basin succession, and the overlying volcanics are believed to be Tertiary from mapping on Mount Coolon Sheet area (Malone et al 1961). Moreover Ball (1927) reported what he thought were Tertiary fossil leaves.

A thickness of at least 265 feet is indicated by an exploration bore which bottomed at this depth, still within the Tertiary sedimentary sequence.

Rocky Dam Creek basin:

Other consolidated Cainozoic sediments in the area crop out as thin and discontinuous sequences which are probably younger than those at Plevna. Several outcrops within the basin of Rocky Dam Creek expose horizontal, easily broken, lacustrine sediments. The best outcrop is in Waterfall Creek, a tributary of Rocky Dam Creek, eight miles east of Koumala. Here 25 feet of coarse unsorted light brown or white sandstone, pebbly sandstone, and some conglomerate is exposed. Bedding is horizontal and slightly undulating, with beds 2-4 feet thick. Another outcrop in Bull Creek, also a tributary of Rocky Dam Creek, two miles south of Mount Christian siding, exposes ten feet of coarse porous clayey sandstone and unsorted cobble conglomerate. The sandstone is slightly calcareous and has numerous open spaces lined with hard light grey clay.

Light brown, soft, unaltered, Cainozoic siltstone overlies granite of the Urannah Complex at an outcrop seven miles south of Koumala, near another small tributary of Rocky Dam Creek. The siltstone is very porous with a high clay content, but sandy bands and rare rounded pebbles occur. At least four feet of horizontal sediments are exposed but probably do not extend over a very large area.

Alligator Creek basin:

Scattered outcrops of thin Cainozoic sediments occur throughout the Alligator Creek basin and probably underlie much of the soil and alluvium in this area. The best outcrop in a tributary of Alligator Creek five miles west of Sarina, exposes about six feet of poorly sorted pebbly sandstone and breccia. The breccia consists of coarse very angular boulders, chiefly of greenish Permian siltstone, in a coarse sandy matrix with limonitic cement. Another outcrop at "The Rocks" near the mouth of Alligator Creek exposes four feet of porous easily broken coarse quartz sandstone.

Lake Epsom:

Isbell (1955) mentions "coarse unbedded sandstones and gravels that are sometimes lateritised", which crop out along the Eton-Nebo road, near Lake Epsom. These sediments are semi-friable and generally contain abundant quartz and mica. It is possible that Lake Epsom is a shallow remnant of the once much larger Tertiary or Recent lake, in which these sediments were deposited.

Although they occur discontinuously over a moderately large area, these beds are very thin and igneous basement of Urannah Complex is exposed in many places, even close to Lake Epsom.

Boothill Creek and Mount Landsborough:

There are some outcrops of poorly bedded, semi-friable, coarse, quartz sandstone in the Boothill Creek area which are interbedded with the Tertiary acid volcanics. They are both thin and discontinuous.

On top of the acid flows and agglomerate at Mount Landsborough there is a thin bed of siltstone, whose outcrop is too small to show on the map.

Other deposits:

Many of the coastal creeks in the area are partially blocked by beds of horizontal, shelly, pebble conglomerate or calcareous sandstone. Probably the best example is at Carmila Creek, where a two foot bed of well consolidated, sandy, pebble conglomerate with shell fragments, almost blocks the mouth, just above high water mark.

(d) Undifferentiated Cainozoic

Undifferentiated Cainozoic deposits are shown on the Mackay 1:250,000 Sheet under two symbols - Cz, and Cza. The Cz symbol is incorrectly explained on the map as 'undifferentiated unconsolidated sediment'; it represents soil cover. A symbol is added to the Cza to denote mangrove swamp; it also represents tidal flats.

There are five main areas of alluvial cover (Cza) on the Mackay Sheet area: (i) in the Bee and Funnel Creek flood plain, (ii) in the Cattle Creek valley, (iii) in the Pioneer River valley, (iv) in the upper Funnel Creek valley, and (v) in coastal areas.

The alluvium of the Bee Funnel Creek flood plain, in the south-west part of the Sheet area, is known from water bores to be at least 80 feet thick in places. Alluvium five miles west of Homevale homestead contained fragments of an extinct freshwater crocodile, Crocodilus nathani, found in the banks of a creek (Woods, 1960). This species is known only from jaw fragments from two localities in North Queensland. The age is believed to be Tertiary. Another large bone fragment from the same locality could not be identified, but Woods suggests it may be a fragment from the skull of a giant extinct marsupial related to Diprotodon. Smaller fragments of portion of a fossil femur of a kangaroo were also recovered.

Alluvium of the Pioneer River valley has been studied in connection with water supplies for Mackay. Abbiss (1959) described the stratigraphic section in the alluvium in a depression known as The Lagoons, near Mackay. It consists of clay loam top soil, grading to silt, fine sand, coarse sand with silt and clay, and a few bands of clean sand and water-worn pebbles. Depth to bedrock varies from 70 feet to 100 feet from the surface.

(c) Quaternary

The coastline is characterized by numerous rocky headlands and extensive swamps in the sheltered portions, and some sandy beaches. Numerous small areas of vegetated coastal sand dunes have been separated on the Mackay 1:250,000 Sheet (Qd), but they have not been studied in any detail. The areas of sand accumulation are usually long and narrow, parallel to the coast, and they seldom extend more than half a mile from it. They are commonly backed by swamps. The dunes are generally less than 30 feet high and tend to form ridges with a south-east trend, parallel to the prevailing wind. This is well illustrated north of Mackay, where extensive areas of dune sand are found. The sand around Mackay is white, well sorted, and quartz rich, but some of the sands near West Hill Island and Carmila Beach appear to contain more lithic fragments and other minerals, (epidote for example), and are generally darker in colour.

INTRUSIVE ROCKS

The Urannah Complex

Summary: The Urannah Complex is a diorite-granite-granodiorite mass with minor basic and intermediate plutons, and abundant acid and intermediate dykes. It occupies a strip of country about twenty miles wide, extending from the north-west corner of the Sheet to the southern edge; it also extends to the Mount Coolon, Bowen, Proserpine, and St. Lawrence Sheet areas. It is believed to be the product of several intrusive epochs, starting in the Carboniferous and ending sometime in the Mesozoic.

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The name 'Urannah Complex' was introduced (Malone, et al.) in 1962, in a description of the geology of the Bowen Sheet area. Although it occupies a large part of the area mapped, it was not examined in detail. It is thought to include the products of several major intrusive episodes.

The main area of outcrop on the Mackay Sheet extends from the north-east corner of the Sheet, where it is about 20 miles wide, to the southern edge, where it is much narrower. Stocks cropping out on either side of the main area of outcrop, contain the same type of intrusive rocks, and are included in the unit. The Complex crops out from Bowen in the north to St. Lawrence in the south, a distance of over 150 miles.

Topography produced by the Complex generally consists of high and rugged mountains, with steep ravines. Mount Dalrymple, at the headwaters of Finch Hatton Creek is just under 4,100 feet above sea level, and Finch Hatton, eight miles to the south, is only 300 feet above sea level. The sides of Cattle Creek Valley rise steeply to 1,500 feet above Cattle Creek. Massey Gorge, just off the north-west corner of the Sheet, is reported to have an almost sheer drop of 1,000 feet. Topography is more subdued, however, south of the Cattle Creek, in the vicinity of Mount Spencer, and in the Funnel Creek Valley, near Wandoo homestead. Owing to the rugged terrain, access in the area of outcrop of the unit is not easy. A good forestry road runs from Pinnacle homestead to Endeavour Creek, giving access to good exposures in the nearby creeks. Outcrop of the Complex near the Bruce Highway and on the road from Strathdee homestead to the Range Hotel is not good.

The Urannah Complex was not mapped in detail in the Mackay area. Mapping consisted in outlining the area of outcrop of the unit, and noting the variation in lithology. Separate intrusions were not split from the main mass. Comparison with the rocks of the Complex on the southern half of the Bowen Sheet, showed them to be almost identical, and a more complete report of lithological variations within the unit is contained in the description of the geology of the Bowen area (Malone et al. 1962).

The most abundant plutonic rocks in the Complex are diorite and granite. Diorite is most common in the north-western portion of the area, and granite in the south-eastern. Other coarse grained plutonics include pegmatite, gabbro, granodiorite, and hornblendite. Dyke rocks consist of basalt, andesite, microdiorite, and aplite.

Diorite of the Complex ranges in grainsize from fine to very coarse, and the fabric ranges from massive to foliated. The mineral assemblage is normal, with plagioclase, hornblende, minor quartz, and accessory iron oxide. Xenoliths are common in places.

The granite varies from massive to foliated, the latter type being more abundant near Eungella (off the Sheet - west of Netherdale). Grainsize is generally even, but in the porphyritic types the phenocrysts are up to three times the size of the main mass of crystals. Phenocrysts are of potash feldspar, usually quite rounded. Pegmatite dykes consist of coarse crystals of potash feldspar and quartz, up to two inches long, with minor smaller crystals of biotite and muscovite.

Granodiorite fabric, like that of the granite, varies from massive to foliated and even to gneissic in places. However, the foliated type was seen only in the Eungella district. Granodiorite commonly contains xenoliths of fine grained melanocratic amphibolite. It is commonly found associated with pegmatitic dykes.

Sub-round stocks of gabbro and hornblendite intrude the Complex, occupying areas of low relief up to a square mile in surface area. The gabbro is hornblende rich and grades into hornblendite, containing large phenocrysts of green brown hornblende enclosing anhedral crystals of labradorite (An 60). No inclusions were seen in these poorly exposed basic intrusions.

Basalt and dolerite dykes are common throughout the Complex and appear to be of at least two different ages. All the primary minerals in the dykes are at least partially altered to calcite, epidote, chlorite, saussurite and hydrated iron minerals; some are extensively epidotized. The fabric of these intrusions varies from intergranular to porphyritic. The dykes range in size from an inch to 20 feet wide, and bifurcations are common.

Micro-diorite and andesite form the majority of dyke rocks in the Complex. In outcrop they are dark to light green, depending on the degree of epidotization and chloritization. The dykes range greatly in width as do the basaltic dykes, and in texture they range from fine grained to medium grained, and porphyritic. Chilled margins against the diorite and the granite are usual. There are at least two ages of intrusion of the micro-diorite. The most frequent direction of intrusion is north-west; other directions are random. Sub-round masses of micro-diorite, probably related to the dykes, intrude the Complex.

Amphibolite generally occurs as xenoliths in diorite and granodiorite, but it was also noted as a separate mass or roof pendant, near a coarse grained intrusion of hornblendite. As xenoliths, the amphibolite consists of a medium grained, equigranular mass of green hornblende, plagioclase, and quartz. The xenoliths range from an inch up to twenty yards in length. They are generally elongate and narrow, and show a random distribution with concentrations in certain areas.

The Urannah Complex intrudes the Lower Bowen Volcanics, causing some metamorphism at the contact. On the eastern margin it is commonly faulted against the Volcanics, this feature being observed in Blackwaterhole Creek, near the Range Hotel. Tertiary basalt, acid and intermediate volcanics and sediments overlie the Complex unconformably in many places.

A sample of granodiorite from the Complex, on the Bowen Sheet area, was approximately 270 million years old, as determined by K-A age determination methods. This places the intrusion at that place at the end of Carboniferous time. However, in the Mackay area, the Complex is known to intrude the Lower Bowen Volcanics, and hence the age of part of the Complex must be post Lower Permian. It is therefore thought that the Complex has had a long history of separate intrusions, from the Upper Carboniferous to the Mesozoic.

<u>The Bundarra Granodiorite</u>

The Bundarra Granodiorite crops out over an area of about 80 square miles on the Mackay, Mount Coolon, Clermont, and St. Lawrence 1:250,000 Sheet areas. The name was first used by Malone et al. (1961) in place of the old name 'Mount Flora granite'; Mount Flora itself is composed of metamorphosed sediments. The granodiorite crops out poorly to form an area of low relief, surrounded by a ring of hills of metamorphosed Middle Bowen Beds.

The only outcrops found within the boundary of the mass, in the Mackay area, consisted of small patches of andalusite hornfels and, near the base of Mount Flora, grey gneissic granodiorite. From previous work

(Malone et al, 1961) the intrusion is known to range from a leucocratic granodiorite to an alkali granite. Biotite is the main ferromagnesian, but in places hornblende is abundant and the rock approaches a syenite. Intensive prospecting and some small scale mining for copper and gold have been concentrated around the intrusion. Most of the mineralization is within the metamorphosed sediments, but a few veins continue into the igneous rock. A description of the geology and mineralization is given by Ball (1910a).

The intrusion domes the Middle Bowen Beds and the Upper Bowen Coal Measures, and the strike of the beds on the northern flank is consistently north-east. However, the dip does not show a regular decrease away from the intrusion and it is possible that the beds were gently folded before the intrusion.

Intrusion post dates the deposition of the Upper Bowen Coal Measures, and was probably during the Mesozoic Hunter-Bowen orogeny.

Miscellaneous intrusions

Mount Chelona:

Mount Chelona is a small hill about 500 feet high, three miles north of Sarina. It consists of a medium to coarse grained granite, with pink potash feldspar and a greenish mica. Large tors of the granite are found on the side of the hill. The granite intrudes the Campwyn Beds and is therefore post Lower Carboniferous. A Mesozoic age is tentatively assigned to the intrusion, that being the time of the orogeny in this area.

Intrusive complex north-west of Mackay:

A small igneous complex intrudes Upper Palaeozoic rocks, north-west of Mackay near Farleigh. It crops out very poorly and the scale of mapping did not allow intrusive rocks to be separated from those of volcanic and sedimentary origin. The unit forms hilly country with small valleys separated by short ridges, relief being in the order of 300 feet. The ridges commonly run north-west/south-east. Small rounded hills are common north of Reliance Creek.

The main rock type is a medium grained, equigranular, green, hornblende microdiorite, which in places forms large tors. Within the mass, and intruded by it, there are patches of andesite, acid flows and pyroclastics, very weathered granite, and conglomerate. The conglomerate, found two miles west of North Mackay, consists of well rounded granite pebbles up to three inches in diameter. It is possibly part of the Lower Bowen Volcanics. The microdiorite is intruded by acid and basic dykes.

Mount Bassett, although separated from the main igneous mass by alluvium, is thought to be part of the same complex. A large quarry exposes microdiorite intruded by many dykes. A granite xenolith was observed in the microdiorite.

The microdiorite intrudes the Campwyn Beds, the Lower Bowen Volcanics and the Calen Coal Measures. It was probably intruded during the folding of these Palaeozoic units in the Mesozoic.

The granodiorite at Mount Travers:

A small elongate stock intrudes the Upper Bowen Coal Measures, at Mount Travers in the south-western corner of the Mackay Sheet area. It forms two parallel ridges, one longer than the other, with a maximum height above the level of the plain of 150 feet. This is in contrast with the Bundarra Granodiorite which forms an area of low relief.

The intrusive is a grey microgranodiorite with altered sodic plagioclase, accessory muscovite and secondary calcite, at Mount Travers itself. However, it grades southwards into a fine grained grey-brown acid porphyry, with phenocrysts of plagioclase and hornblende. The weathered surface of this rock exhibits banding, and small cavities which in places are filled with quartz.

In this area the Upper Bowen Coal Measures, into which the granodiorite is intruded, are folded tightly, the fold axes striking north-north-west. Although the intrusion is elongated parallel to this direction, dips observed indicate that it is discordant to the bedding. It was therefore intruded after the folding of the Coal Measures. However, both intrusion and sediments are effected by a fault, west of Mount Travers.

The intrusion may be an exposed dyke from the Bundarra Granodiorite which crops out four miles to the south. However, the Bundarra intrusion was emplaced into beds which were gently folded, as explained in the section on that intrusion.

Tertiary intrusions:

Small acid to intermediate intrusions form Mount Jukes, Mount Blackwood and Mount Vince, which are all in the northern part of the Mackay Sheet area, Mount Vince being nearly west of Mackay, and Mounts Jukes and Blackwood north of Mount Vince.

Mount Jukes, with an altitude of 1,850 feet, is a spectacular topographic feature; it is surrounded by a narrow valley, which in turn is ringed by a low circular ridge. The intrusion is reported to be 'an eruptive centre ..... a ring complex intrusive' (Hill and Denmead, 1960), and it is correlated with Tertiary trachyte plugs cropping out nearby on the Proserpine Sheet area. It is also reported (Hill and Denmead, 1960) to consist of a high core of granophyre with dolerite and rhyolite dykes. There is no outcrop in the valley but trachyte and gabbro boulders have been found in small creeks. The surrounding ridge is composed of metamorphosed Permian rocks, and in part by the granite of Mount Blackwood.

Little is known of the geology of Mount Blackwood other than it is a coarse granite intrusion. It has steep sides and is covered by thick vegetation. It forms part of the rim around Mount Jukes and a Tertiary age is tentatively suggested.

Mount Vince is an isolated high hill about 15 miles west of Mackay. It forms the northern wall of a crater-like valley which is almost surrounded by a high ridge. The intrusion consists of a grey monzonite in the one locality visited. It is assumed to intrude the Lower Bowen Volcanics but the contact is obscured by alluvium.

STRUCTURAL GEOLOGY

The generalized structure of the mainland area, as shown on the structural sketch map (Fig.8), comprises four structural units: (a) Permian units west of the Urannah Complex, (b) the Urannah Complex, (c) the Permian units east of the Complex, and (d) the Devonian-Carboniferous block. The only distinct structural break between these blocks is the fault separating (c) and (d).

(a) The Permian units west of the Urannah Complex

The structural block west of the Urannah Complex is part of the eastern limb of the Bowen Syncline. The regional dip of Permian units of this block is between 30° and 50° to the south-west, but this pattern is broken by (i) small tight folds in the Middle Bowen Beds and Upper Bowen Coal Measures and (ii) the northerly dip produced by the intrusion of the Bundarra Granodiorite. The Permian units are overlain unconformably by flat-lying Tertiary volcanic rocks.

(b) The Urannah Complex

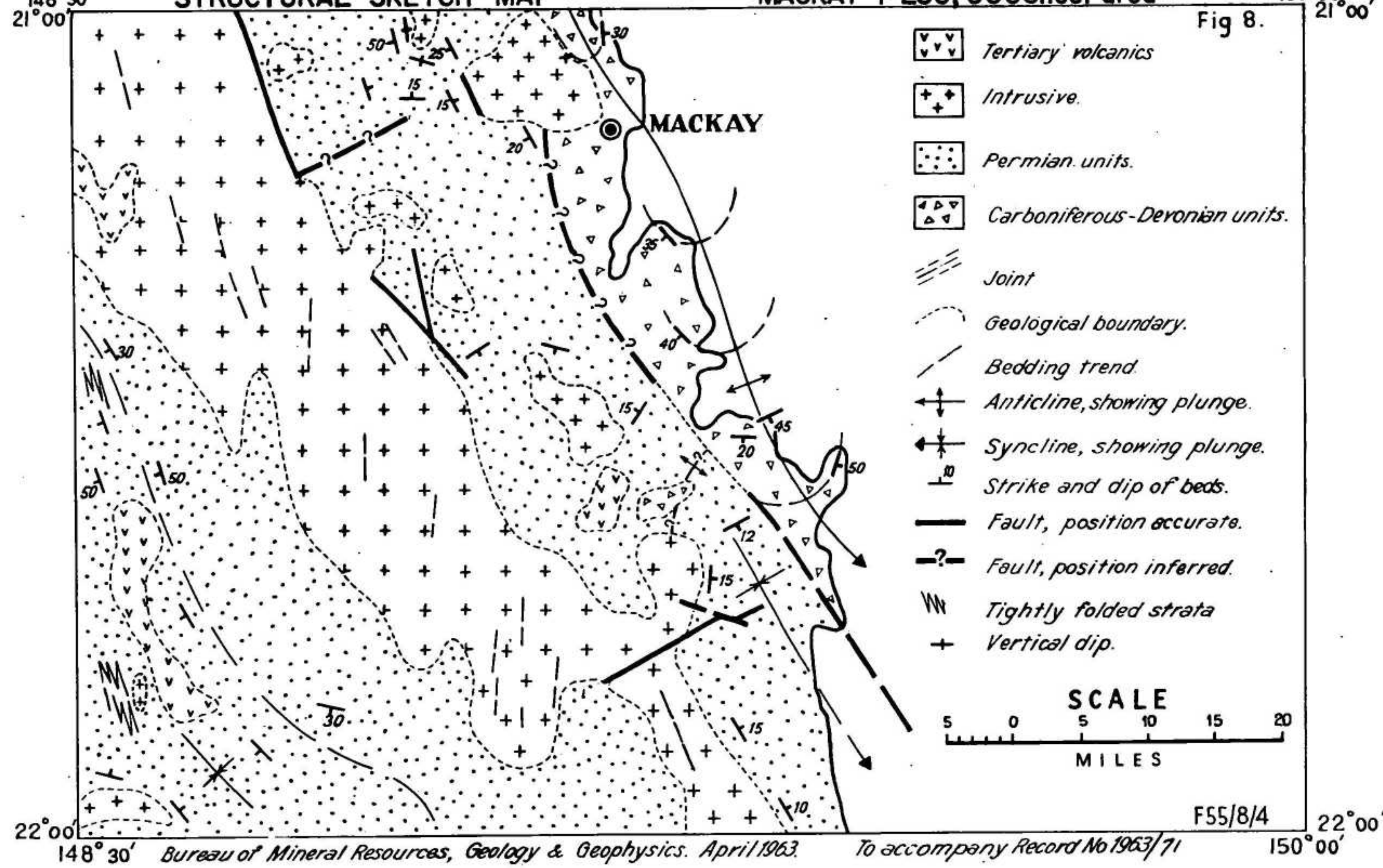
The outcrop of the Urannah Complex trends north-north-west, parallel to many of the structural trends in the Bowen Basin. Jointing, from air photo interpretation, is commonly in a north to north-north-west direction. The eastern margin of the Complex is faulted in at least two areas. Tertiary volcanics and sediments overlying the Complex are horizontal.

(c) The Permian units east of the Complex

The oldest Permian unit cropping out east of the Complex, the Lower Bowen Volcanics, has not been mapped in sufficient detail to interpret its regional structure. Dip measurements and photo interpretation show it to be both folded and faulted. It is faulted on its eastern margin against the Campwyn Beds by a north-north-west trending fault. A common fault direction is east-north-east; these two fault directions, east-north-east and north-north-west are the major fault directions on the southern half of the Proserpine Sheet area (Jensen 1963). In that area the east-north-east faults have a dominant lateral displacement in contrast to the north-north-west trending faults, which have a dominant vertical displacement.

The Lower Bowen Volcanics are unconformably overlain by the Tertiary volcanics, and disconformably overlain by the Calen Coal Measures. The Carmila Beds are folded into a south plunging syncline with an axis trending north-north-west. The western limb of the syncline dips about 15° to the

STRUCTURAL SKETCH MAP MACKAY 1:250,000 Sheet area



Bureau of Mineral Resources, Geology & Geophysics. April 1963. To accompany Record No 1963/71 east-north-east, and the eastern limb is probably cut off by a fault; the plunge of the syncline is about 10° to the south-south-east. The regional structure of the Calen Coal Measures is possibly that of a syncline plunging to the north-west, but the pattern is broken by faulting, and folding caused by intrusions.

An anticlinal structure is possibly present near Koumala, where the Campwyn Beds crop out west of the main fault line. The Lower Bowen Volcanics appear to dip north off the structure, and the Carmila Beds dip south. An alternative explanation for Campwyn Beds being west of the main fault line is the presence of a concealed east-north-east lateral fault.

Tertiary volcanic rocks in this block are flat lying.

A discussion of the structure of the area is not complete without some mention of the Cattle-Creek - Pioneer River lineation. Cattle Creek rises in the hills near Netherdale and runs due west to Owens Creek where it turns abruptly south-south-east to flow south of Gorgett. It bends around a strong north-north-west trending fault on the edge of the Urannah Complex and joins the Pioneer River. West of Mirani, the Pioneer River takes up roughly the same direction as the original Cattle Creek course, and flows for about 20 miles due west, out to sea. This striking lineation, set off by the steep sided Cattle Creek valley, is particularly well seen on a photo mosaic. Its significance is unknown.

(d) The Devonian-Carboniferous block

The Devonian-Carboniferous block consists of a north-plunging anticline, the limbs of which dip about 30°. It is faulted in the west against the Permian block, and is on the upthrown side of the fault. The type of fault separating the two blocks is unknown; if it was initiated during the folding of the Campwyn Beds it is possibly high angle reverse.

The structure of those parts of the Sheet covered by sea is unknown. Profiles from the Bureau of Mineral Resources aeromagnetic survey, which are characterized by steep slopes over the mainland and the islands, appear flatter east of Mackay. This may indicate that depth to magnetic basement is greater in that area than elsewhere on the Sheet area. Recent work on the Proserpine 1:250,000 Sheet area (White and Brown, 1963, and Jonson, 1963) indicates the possibility of a Tertiary graben structure off the coast, north of Mackay, on the Proserpine Sheet area. The structure of the area east of Mackay, where the magnetic basement is deeper than on the rest of the Sheet, could be a continuation of this graben.

GEOLOGICAL HISTORY

Vulcanism was widespread when the Upper Devonian and Lower Carboniferous shallow sea covered part or all of the Mackay area. Most of the deposits formed at the time were of volcanic origin, but in a few places terrigenous sand and silt, and limestone were deposited. Uplift, some time in the Carboniferous, resulted in the withdrawal of the sea, and possibly a cessation of volcanic activity.

The area was again the site of deposition, mainly of volcanic material, in the Upper Carboniferous and Lower Permian, when a thickness of conglomerate, volcanic flows and pyroclastics was built up on the land and in freshwater lakes, forming the Lower Bowen Volcanics. Intrusion of the Urannah Complex into the basal Lower Bowen Volcanics, in the late Upper Carboniferous, produced a structural high. This high was probably the source of part of the conglomerate and sediment deposited in the south-eastern part of the area in the Lower Permian forming the Carmila Beds. At about the same time, in the northern part of the area, the Calen Coal Measures were formed in a fluvial, and in part paludal environment.

During the Lower Permian the sea covered the basin formed on the north-western side of the high, and marine sediments were deposited in a shelf environment. The sea shallowed considerably during the deposition of part of the Middle Bowen Beds (Unit B), with the subsequent deposition of sandy sediment. This time corresponds to a period of coal formation further to the north (Collinsville Coal Measures). A return to deeper water conditions when Unit C was deposited, was followed by withdrawal of the sea. The Upper Permian saw the formation of extensive freshwater lakes and swamps in which the Upper Bowen Coal Measures were deposited.

The Palaeozoic sequence of the area was folded and the Carpwyn Beds were faulted against the Lower Bowen Volcanics as a result of compression, probably in the Triassic. Parts of the sequence were intruded by the Urannah Complex.

The Tertiary was marked by volcanic activity, first basaltic and then more acidic. Volcanic sequences were built up in many parts of the area and subsequently eroded. In some places freshwater lakes received thin sedimentary deposits.

ECONOMIC GEOLOGY MACKAY 4 - MILE

Summary: The area has not been an important producer of minerals, but small production of copper, silver, and gold has come from numerous small workings in four main fields - Mt. Britton, Mt. Spencer (Pinevale), Mt. Flora, and Grasstree. Deposits of coal, graphite, oil shale, heavy mineral sand, molybdenite, and wolfram have been tested, but have not been exploited. The occurrence of a complex uranium-rare earth mineral has been reported, and clay has been mined.

At present some mining is being done at Mt. Britton (gold), Mt. Orange (copper) and Glenella (clay). Enterprise Exploration Pty Ltd have carried out an intensive prospecting campaign in the Mt. Flora area, and small scale prospecting is in progress around Pinevale, Grasstree, and Bolingbroke. Ampol Exploration (Qld.) Pty Ltd hold Authority to Prospect for Petroleum 93P, embracing most of the land east of the coast range, and extending out to sea.

Surface water is relatively abundant throughout the area, and underground water has not been extensively exploited except in the Lower Pioneer Valley.

It appears unlikely that large quantities of petroleum will be found on the mainland. Crude bitumen has been found on coastal outcrops and in one case crude petroleum was found on top of fresh water in a water well.

. . . . .

Copper:

Copper ores are widespread throughout the area and are associated with many of the various intrusive rocks. They generally occur close to the contact of the intrusive rocks with the bedded rocks. The chief areas of copper mineralization are the Mt. Flora - Mt. Orange area, and the Pinevale area. Areas of minor mineralization include Netherdale, Freshwater Point and Sarina Beach.

Mt. Flora and Mt. Orange area:

The Mt. Flora and Mt. Orange fields lie about twenty miles south-west of Nebo. In this area, the Bundarra Granodiorite intrudes sediments of the Middle Bowen Beds. Contact metamorphic effects are considerable, and copper mineralization was associated with the intrusion. Malachite, azurite, chrysocolla, chalcocite, and chalcopyrite occur in joints which run at right angles to the contact. The richest ore bodies were found in

SUMMARY OF PRODUCTION FROM MINES IN MACKAY 1:250,000 SHEET AREA

TABLE 2.

Producer	Chief Production	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (tons)	Wolfram (lbs)	Clay (tons)	Recorded Value (£)
Mt. Britton	1881-1890	282	14,519	23				53,900
Pinevale	1940-1957	2,433	24	8,759	248			43,500
Mt. Flora and Mt. Orange	1900-1918	1,755	22	9,244	290			27,600
Grasstree	1892-1901 1936-1940	10,595	4,560	284				24,900
Ben Mohr	1916	680	42		71			7,740
Mackay District (Chiefly alluvial)	1926-1961	232	843	27				5,430
Bong Bong (Lone Wolf)	1942-1952	100	14	2,457	12			2,400
Sunnyside	1932-1958	181	264	11				2,260
Blue Mt.	1944-1947	148	4	439	15			1,700
Mirani	1951-1953						2,000	1,200
Netherdale	1907; 1912	143		135	14			730
Mt. Mosquito	1935; 1952	126	14					450
Glenella	1961						2,100	210
Golden Valley	1940	22	13					120
Alligator Creek	1893	50	27					90
Bolingbroke	1942; 1952					360 (63-69%)		90
Tally Ho	1908	26	10					40
Freshwater Point	1940	4						20
Total.	1881-1961	16,777	20,356	21,379	650	360	4,100	172,400

in the meta-sediments but a few are continuous into the granodiorite. Numerous porphyry dykes are associated with the granodiorite, and in several cases, the deposition of the copper ore was found to be directly connected with these dykes, both in the granodiorite and in the meta-sediments (Ball, 1910 a).

Copper ore was first discovered in the area in the late 1870's, and a smelter was erected in 1879. Copper matte was produced spasmodically until 1912, when this smelter blew up. A new smelter was erected in 1913, worked in 1914, and was shut down in 1915. Production since 1918 has been small and spasmodic. During 1957, the old workings at Mt. Orange were reopened, and the deepest shaft is accessible to 30 feet. The production between 1900 and 1918 was recorded as 1,624 tons of ore yielding 260 tons of copper, 8,384 oz. of silver, and 20 oz. of gold, valued at £26,000. Latest production recorded is 15 tons of copper ore in 1960.

Enterprise Exploration Pty Ltd, carried out a geochemical survey of the Bundarra Granodiorite in 1962.

A copper prospect near Mt. Travers, north of Mount Flora, was described by Ball (1910a). The mineralization was probably associated with the intrusion of the microdiorite at Mt. Travers, and the copper occurs as malachite, in joints in Upper Bowen sediments. No production is recorded.

Pinevale area:

Pinevale Copper Mine is situated on Pinevale Creek, a tributary of the Pioneer River, ten miles south of Mirani. Pinevale lies within the Urannah Complex, close to the contact with Lower Bowen Volcanics. Granitic and dioritic rocks occupy the whole of the area in the vicinity of the mine. These are cut by vertical basic dykes which are cut in turn by quartz veins, which appear to be confined to north-east trending joints. The ore body is reported to occupy a vertical tension joint within a curved fault zone some 140 feet wide. The lode consists of quarts veining of variable width, and containing mainly chalcopyrite and bornite with traces of galena and sphalerite and occasionally hematite. Gold and silver are also present.

Copper was first discovered on Pinevale Creek before 1890, but there was little production until 1942, except for 43 tons of copper produced in 1907-8. During the period 1942-1953, the mine was developed almost to its present state and produced over 1,600 tons of ore yielding 184 tons of copper. Since 1953, production has been negligible, except for 565 tons of ore produced during 1956-57. The mine consists of three levels, and three winzes, one of which is used as a shaft, one is filled in, and the other is closed off. Much work has been done in recent years on overhauling the plant, retimbering, development work, testing, and prospecting, but the mine was closed in 1959, and little work of any kind has been done since then.

Bong Bong lies about two miles north-west of Pinevale on the same side of the Pioneer River. Mineralized veins in granitic rocks were worked here around 1900 to yield lead, copper, silver, and traces of manganese. Spasmodic work between 1942 and 1952 yielded small quantities of gold, silver and copper. A little prospecting and development work has been done in recent years, and at present (1961) a shaft and a drive are being constructed in the hope of producing copper ore.

Copper ores, very similar in occurrence to those at Pinevale, occur at Mt. Ben Mohr, in well jointed syenitic rock. The Twin Mine was the chief producer. The nearby Blue Mountain copper mine was worked during the early years of World War II for galena, sphalerite, chalcopyrite, and little bornite.

The Tally Ho deposit, five miles south of Pinevale, consists of pipe-like quartz sulphide lodes in brecciated granite. The sulphides, in order of abundance, include sphalerite, galena (probably argentiferous), tetrahedrite, and a small amount of pyrite and chalcopyrite. Some gold is present. The deposit was discovered in 1908, and Cameron reported a 62 foot shaft in 1915. However total recorded production is only about 26 tons of ore, mostly hand picked. An assay of Tally Ho ore, quoted by Cameron (1915) gave -

4.2%	lead
8.0%	zinc
12.4 oz.	silver
trace	gold

The complex ore is reported to be amenable to flotation treatment, but apparently the owners could not overcome the twin difficulties of transport and treatment, and there has been little work done since 1915. Cameron (1915) noted that ore at greater depth may be richer in lead and zinc sulphide, and thus Tally Ho may repay deeper prospecting.

Several small copper prospects have been worked in the Netherdale district. Chalcopyrite and some malachite occur in fissures and quartz veins in gabbro, biotite granite, and other intrusives of the Urannah Complex. Mines worked include Royal Victory, Victory, Silver King and King Copper. Production has been small but actual grade and tonnages are not recorded, except for 134 tons of 10% copper ore from King Copper Mine in 1912, and 135 oz. of silver from Silver King on Cattle Creek, in 1907.

Copper ores are sometimes associated with intrusives into volcanics of the Campwyn Beds. An old shaft on Freshwater Peninsula was reopened in 1940 to produce 4 tons of copper ore, consisting of malachite and azurite in andesitic tuff. Assays showed 13-19% copper, 2 oz. silver and a little gold. Samples submitted from Sarina Beach in 1940 assayed 4.5% copper.

Gold:

Gold has been found at Mt. Britton, Sunnyside and Eton, Kungurri, Grasstree, Alligator Creek, Golden Valley, and Mount Mosquito.

The occurrences appear to be confined to the Lower Bowen Volcanics and the Campwyn Beds, and associated with intrusives into these units. Most of the gold occurs in quartz veins and lenses cutting volcanics, but some quartz veins cutting intrusives of the Urannah Complex carry low gold values. However in the Grasstree area, the gold is generally not associated with quartz veins, while the occurrences at Mt. Mosquito suggest an alluvial deposit.

The Mt. Britton area has been the chief producer of gold in the area, and some gold is still being mined. The present Mt. Britton mine lies about four miles north of Homevale homestead, north-west of Nebo. The gold occurs in quartz veins and lenses in a generally andesitic country rock of the Lower Bowen Volcanics, not far from its contact with the Urannah Complex. However most of the gold won was obtained from the bed and banks of Oakey Creek for a distance of three miles in the vicinity of the mine. A feature of the field was the scarcity of fine gold, and the sporadic distribution of large nuggets (up to 69 oz.).

Payable gold was first reported from Mt. Britton in March 1881, and in a few weeks about 300 men were on the field. Early in May a large number of nuggets were found, causing a gold rush to the area; by June, 1,500 men were on the field, and by the end of the year 4,808 oz. of gold had been won. Various reefs were subsequently opened up, notably the Little Wanderer, and Lady Mary, but were abandoned after intensive and costly prospecting. In the ten years 1881-1890, records show production of 14,000 oz. of gold valued at £48,700. By 1893, only a few alluvial miners remained. Since 1890, production from the field has been small and spasmodic. A floater containing 15 oz. of gold was discovered in 1931. Some prospecting and small scale reef and alluvial mining is still taking place. Present production is from a quartz lode, six inches wide reported to yield 5-6 oz. gold per ton.

A three head stamp battery was erected in 1933 at Sunnyside, eight miles north-west of Sarina. This battery crushed gold ores from prospectors working small gold leaders in the Lower Bowen Volcanics in the area. Many leases were worked, but the chief producer was the Merry Widow. Sporadic gold with quartz and pyrite occurs in gossanous vugs in silicified conglomerate at Lucky Hit Lease, four miles south-west of Eton. Samples from the Follow On Lease in the same area, showed traces of arsenic. Exaggerated reports of a find near Blackwaterhole Creek, south of Eton, caused a rush to the area in 1896, but recorded production from all prospects in this area is negligible.

Reid (1936) describes a gold prospect near Kungurri, close to the contact between silicified sediments of the Lower Bowen Volcanics and quartz diorite of the Urannah Complex. Veins of quartz carrying galena occur apparently crossing the contact. No production is recorded and the best assay was 25 dwt. per ton.

The most important gold occurrences in the Campwyn Beds are found in the Grasstree area. The Grasstree Mine, formerly known as The Zelma, is situated on the coast, 1½ miles north of Sarina Inlet. The geology of the mine area is complex. The workings are in kaolinised, intruded, metamorphosed volcanics and sediments of the Campwyn Beds. Lithologies include andesitic tuff and breccia, andesitic and rare rhyolitic flows, coralline andesitic agglomerate, and some indurated conglomerate, intruded by masses of diorite, and associated dykes. The important gold occurrences appear to be confined to metamorphosed tuff, and most evidence indicates that the gold is pre-diorite (Reid 1939). However one small vein of quartz and chalcopyrite in diorite showed low gold values. Reid (1939) mentions "felsites" which are older than the diorite, and suggests the gold may be hydrothermally associated with these. Brecciated zones are also important in determining localisation of ore. The richest ore in the mine has been a siliceous kaolin breccia with lightly disseminated pyrite.

The Zelma Mine was opened in 1886 and a 20-head battery was completed by the end of 1891. From 1892 to 1901, records indicate crushings of over 9,000 tons of ore which yielded over 2,000 oz. of gold. Jack (1893) recorded small trial crushings which yielded 2-9 dwt. per ton. The field was practically idle from 1897 till 1935, when the Grasstree Gold Mining Syndicate commenced operations. In the period 1936-1940, over 10,000 tons of ore yielded 4,560 oz. gold and 284 oz. silver. Since 1940, activity has been limited to prospecting and testing. Two gold mining leases were applied for in 1961.

Gold was discovered to the east of the mouth of Alligator Creek in 1886. There was a five stamp battery at the site, together with two shafts of 25 feet and 30 feet deep, but the only crushing recorded is of 50 tons of ore yielding 27 oz. of gold in 1893. The gold occurs in ironstained quartz veins up to four inches thick in spotted slate of the Campwyn Beds. High gold values were reported, but the mine petered out quickly. Since then there has been spasmodic prospecting in the area, and later assays of quartz reefs gave values of 10-15 dwt./ton gold.

A number of small shows have been tested around 1940 in the Golden Valley area, 1½ miles south of Grasstree. These deposits, like those at Grasstree, occur within the Campwyn Beds. East (1946) mentions intrusives cut by "hornblende porphyrite dykes" which both he and Jensen (1947) thought could be related to the intrusives at Grasstree. Only production recorded is 12.5 oz. of gold in 1940.

Since 1933, prospecting around Mt. Mosquito, east of Ilbilbie, has revealed what Reid (1935) thought was probably a bedded deposit, of unusual type, containing very fine gold in folded and hardened sandstone and mudstone. Numerous shallow shafts and trenches were dug, but only small production is recorded. Prospecting also revealed traces of copper mineralization in fine hard lithic sandstone of the Campwyn Beds on Green Hill, two miles to the north.

Wolfram:

A wolfram occurrence on Bolingbroke Station, 21 miles south-west of Sarina, is described by Shepherd (1952). Magnetite veins have also been reported in this area. The wolfram occurs as small disseminated crystals in numerous white quartz veins in granite of the Urannah Complex. The quartz veins vary in thickness up to four feet, but are usually lens shaped and less than 50 feet in length. Numerous shallow shafts and trenches were sunk in the early 1950's, but recorded production is small. The wolfram crystals are so small and so sparsely disseminated through the quartz that laborious hand picking is necessary. This area may repay further prospecting.

Molybdenite:

Reid (1941) reports the occurrence of molybdenite on Knight Island, 33 miles east of Sarina. The island consists entirely of granite, with a zone of heavily quartz-veined greisen. Molybdenite occurs both in the greisen, and in quartz veins cutting the greisen, but Reid considered the occurrence as having no likely commercial development beyond small scale gouging operations.

Uranium:

Brooks (1961) reports on a uranium prospect south of Pinnacle homestead on Teemburra Creek, a tributary of the Pioneer River. The report describes the occurrence of a niobate-titanate-rare earth-uranium oxide mineral in an orthoclase quartz segregation, in granite within the Urannah Complex. Andesitic dykes are common in the area but rhyolitic and some aplitic dykes also occur. The uranium mineral occurs as small, rounded, brown, semi-translucent, vitreous grains, closely associated with black chloritic material, and in places, with fine-grained pyrite. The prospect is not considered to be of economic significance, but indicates that other deposits could occur in the area around the margins of this granite.

Beach sand heavy minerals:

The beach sands of the area were investigated by Dowsett Engineering (Aust.) Pty Ltd in 1955, and by Tweed Rutile and Minerals Ltd, 1956. Dowsett reported no evidence of appreciable heavy mineral concentration except in the Shoal Point-Bucasia area ten miles north of Mackay.

Connah (1961) examined the Shoal Point area, and reported indicated reserves of 10,000 tons of heavy mineral of approximate composition -

Magnetite	52%
Ilmenite	40%
Zircon	7%
Rutile	trace
Others	1%

However, Connah observed that beach resources alone do not appear to be sufficient as a basis for a local industry.

Dowsett Engineering reported a small quantity of beach washings containing 5% zircon at Bucasia, and a green sand containing epidote from Carmila Beach.

An auriferous sand claim was worked at Grasstree in 1936 for a yield of 8 oz. gold from 800 tons of sand.

Coal:

Minor coal bands have been found in the Lower Bowen Volcanics, the Calen Beds, the Carmila Beds and in the Upper Bowen Coal Measures. Carbonaceous and graphitic shales are common in the Lower Bowen Volcanics, but the only coal seams reported are exposed in Blackwaterhole Creek, near the Range Hotel. These were first reported by Dunstan (1901), but no seams greater than three feet thick have been found, and the coal has not been exploited.

Coal has been mined from the Calen Beds at Calen, on the Proserpine 1:250,000 Sheet, and has been reported by Ball (1910d) from Mt. Toby and Mt. McGregor on the Mackay Sheet. However none of these occurrences has been exploited, as the seams are generally thin, disturbed, and intruded.

There are local reports of coal occurrences in the Carmila Beds between Ilbilbie and West Hill. Carbonaceous shale occurs in this area, but no coal was seen. However thin coal seams do occur in the Carmila Beds, in Oakey Creek, on the St. Lawrence 1:250,000 Sheet area.

Minor coal has been observed at several localities within the Upper Bowen Coal Measures in the south-west corner of the area mapped. Cameron (1905) mapped the lower beds of the coal measures, and reported coal occurrences from a point four miles west of Mt. Britton, to one three miles east of Oxford Downs. However, none of these occurrences has been exploited, and the most promising Upper Bowen Coal deposits occur further to the west in the Lake Elphinstone and Kemmis Creek areas, on the Mt. Coolon 1:250,000 Sheet.

Oil Shale:

Plevna is eleven miles south of Netherdale, on Hazlewood Creek. Oil shale in the area was first reported on by Ball in 1927. The Plevna basin is an outlier of Tertiary sediments and tuff, lying on the irregular surface of Urannah Complex and Lower Bowen Volcanic rocks. The oil shales themselves are overlain by about 40 feet of clay and tuff. The whole Tertiary sequence is covered by later acid flows, except for a narrow central basin of about 60 acres. This basin is immediately surrounded by hills of younger volcanic rocks, beneath which the sediments may extend in several directions. Reid (1942) gives the width of the basin as under one mile, but because of the heavy overburden of younger volcanics, the length and shape of the basin are unknown.

Work in the area has been confined to exploration and determination of reserves. Seven bores and a shaft were put down during 1939-40, and three bores in 1958. One of these bores bottomed at 265 feet, in what are thought to be Tertiary sediments.

The oil shale is uniformly fissile, greenish grey in colour, and of a low grade type, with an indicated crude oil yield of slightly over twenty gallons per ton. It has not been mined.

Graphite:

Deposits of graphite near Homebush (Por. 776 and 777, Par. Eton) were examined by Maitland and reported by ~~Ball~~ Dunstan (1906). ~~Ball~~ Dunstan noted that the graphite is associated with shale and quartzite and both interbedded and intrusive igneous rocks and reported an 80 foot prospecting tunnel which revealed a seam of graphite with maximum width of four feet and average width of eighteen inches.

Several other small occurrences of graphite containing 15-70% graphitic carbon are known in the Lower Bowen Volcanics in this area, and at the time of his examination, Maitland considered the deposits to be worth further attention.

Clay:

Bricks were made from Mirani clay as early as 1907, and a brickworks built on the site later used clay from Mirani and Pindi-Pindi (on the Proserpine Sheet area). However, production has been spasmodic, and the latest recorded production from the Mirani pit was in 1953.

The North Queensland Potteries Pty Ltd commenced operations at Glenella, four miles north-east of Mackay, in 1961, and produced over 2,000 tons of clay, chiefly from alluvial clays at Glenella. This company also obtains clay from Palmara, Kuttabul, Hampden (fire clay) and the old Mirani Pit.

Quarries:

Mt. Bassett quarry, near Mackay, is the largest in the area supplying stone to the Mackay Harbour Board, and the Mackay City Council. Rock for the harbour wall and breakwater is taken as it is blasted down. Gravel for road metal and concrete aggregate is delivered from the crushing plant.

A number of smaller quarries throughout the area supply road dressing from a great variety of rocks. Reid (1931) examined and described in detail some fifteen potential sites within twenty miles of Mackay, for a quarry to supply stone to the Harbour Board. Mt. Bassett was the site eventually chosen.

Petroleum:

Traces of bituminous material have been reported from several points along the coast, and during the 1962 field season patches of bitumen were observed at almost every coastal outcrop north of Cape Palmerston. Mott (1958) reported sub-round pellets, $\frac{1}{4}$ inch to 2 inches in diameter, at high water mark on the southern side of Deadman's Island, an extension of Cape Palmerston. Mott notes that the occurrence of this material seems to be confined to a section of the coast between Repulse Bay and Broad Sound. However, he suggests that the material is probably furnace oil, concentrated by the prevailing currents, which are towards the coast in this area and not parallel to it as is the case along most of the Queensland coast. Bituminous material from Half Tide near Grasstree has been submitted for analysis to the Bureau of Mineral Resources Petroleum Technology Section, and the results are given in Appendix B. It is crude petroleum.

Three scout bores were drilled in 1955-56 by the Mackay Oil Prospecting Syndicate (MOPS Nos. 1,2 and 3), to test the significance of reported petroleum seepages. Two of the bores, numbered 1 and 2, were situated on the coastline ten miles north-north-east of Sarina in portion 1, 296, parish of Hector, county of Carlisle, near Grasstree, in Campwyn Beds. They both encountered silicified sandstone and tuff, and No.1 was abandoned at a depth of 55 feet, and No.2 at 150 feet. Bore No.3 was drilled at Hay Point, 12 miles north-north-east of Sarina, also in Campwyn Beds, and the same lithology was encountered. It was abandoned at 150 feet. None of the holes encountered oil or gas.

In October 1962 a grey-brown oily liquid several inches thick was observed on top of fresh water in a well at Walkerston. The depth to water from the surface was 28 feet. A sample of the liquid submitted to the Petroleum Technology Section for analysis, was determined to be crude petroleum, similar in composition to the bituminous material found at Half Tide. It is not known in what rocks or alluvium the well is dug. It is possible that the oil has come from the Lower Bowen Volcanics or the Calen Coal Measures. The Calen Coal Measures are the most likely reservoir, as they contain many porous beds.

The prospect of an accumulation of petroleum on the mainland is given in "Conclusions".

Water:

(1) Lower Pioneer Valley and City of Mackay

The average annual rainfall in this area is 60-65 inches. The rainfall is seasonal with a pronounced wet season from December to April. Most streams are permanent and surface water is plentiful. However the increasing demand for water by sugar mills and for city water supply and irrigation, has led to increased interest in the conservation of surface water, and in the search for good supplies of underground water.

The Pioneer Valley below Mirani consists of an extensive area of alluvial flats with a few hills, crossed by surface drainage channels running roughly parallel to the Pioneer River. Calvert (1959) observes that near Mirani are found the remains of an old anabranch which consists of swamps in the upper reaches, but later forms a channel known as Sandy Creek, near Eton. He also notes a second anabranch near Walkerston, which becomes Baker's Creek, and a third south of the river below Dumbleton Rocks which is referred to as "The Lagoons".

Underground water may be obtained from the alluvial sediments at practically any point in the lower valley and flood plain, the quantity able to be pumped depending mainly on the permeability of the aquifer. The water is of good quality, and is struck at depths from 5 feet to 60 feet (in some places more). The underground water supplies in the area east of Walkerston, between Baker's Creek and the Pioneer River, have been extensively developed for irrigation and domestic purposes. The present Mackay supply is drawn from the Lagoons area, on the south-west boundary of the city.

The City of Mackay has depended on this source for its water supply since 1896. From 1921 onwards, a gradual lowering of the water levels at the pumps at the end of each dry season was noted, until at the end of the 1953 drought, the level at the city's waterworks fell below mean sea level with slight infiltration of salt water. Since 1935 the Council, with the advice and assistance of the Irrigation and Water Supply Commission, has carried out an almost continuous investigation of the underground water supply.

The area between the Pioneer River and Baker's Creek has been the site of several systematic investigations, the most recent and extensive by the Irrigation and Water Supply Commission during 1947-51. In this survey, nineteen lines of bores were put down along and across the valley, and a total of 4,500 feet drilled, using earth auger and percussion plant. Where good waterbeds were obtained, observation pipes were inserted, and many readings of standing water level were taken. In 1947, the Pioneer Basin was constituted a declared area under the Water Acts, and systematic records of water levels in observation bores throughout the area have been kept since then. A direct result of this investigation was the sinking, development, and equipping of three Council bores in Alexander Street, with a combined capacity of 100,000 gal/hour.

The depression known as The Lagoons at one time formed part of the Pioneer River, and could now be described as an anabranch which has become silted by deposition from river flooding and surface runoff. Bores on the line of the Lagoons depressions in general show the greatest thickness of coarse sediments. Depth to bedrock varies from 70 feet to 100 feet from the surface.

Abbiss (1959) considered that during periods of high rainfall and good recharge, the supply available for pumping from underground sources would meet the liberal demands of the city for at least twenty years. However because of the danger of salt infiltration, and to prevent restriction upon usage during drought years, the city water supply is augmented by taking surface water from the Pioneer River at Dumbleton Rocks. The demand for water for mill and irrigation supplies in the Marian area led to the construction of the Marian Weir, commenced in 1950.

(2) <u>Dalrymple Heights - Eungella - Crediton Areas</u>

Dalrymple Heights, Eungella, and Crediton lie respectively north, west, and south of Netherdale, on a plateau at the head of the Pioneer Valley, about 50 miles west of Mackay. Most of the area is closely settled, and devoted to dairying. Rainfall averages vary from 90 inches to 136 inches per year, but because of fast runoff, and the comparatively long dry season, the local interest in water conservation schemes is high.

The majority of rocks in the area are highly weathered, and soil depth is considerable. Throughout the area the water table is fairly high, appearing as springs near the heads of gullies, but because of the abundance of igneous rocks, there seems little likelihood of obtaining sufficient supplies of underground water for irrigation. In the Urannah Complex, water is held only in the joints and fractures, and consequently the springs give only small flows, and the yield from bores would be similarly low.

The basalt allows water to percolate through it more rapidly, but as it is mainly at a higher elevation, bores into it would have poor local storage, and consequently a lower yield. Baird (1962) suggests that the contact between the basalt and the granite appears to offer the best chance of higher yield. He also suggests that earth dams for surface storage on the Urannah Complex may in many cases offer a better economic return than bores that may give only a limited supply.

Apart from a few shallow wells, little attempt has been made to tap underground water in the area. Thus no figures are available as a guide to estimating flows that could be expected. In isolated instances, wells into patches of alluvium along some of the creeks may give flows sufficient for stock water or small scale irrigation.

Analyses are available of water samples taken by Baird (1962) from springs and wells in the area. All samples analysed were declared suitable for watering stock, but one was considered unsuitable for domestic purposes, because of its hardness and high chloride content. Most samples were acidic with pH generally between 6 and 6.5 and thus untreated water could be corrosive to metals.

As a result of a proposal for the development of the Upper Broken River for hydroelectric power generation, Wyatt (1958) reported on the geology of the area, and his map shows two possible dam sites - one at Granite Bend, on the Mt. Coolon 1:250,000 Sheet, and the other south-west of Netherdale on the Mackay 1:250,000 Sheet. This scheme has been shelved, at least for the present, because of insufficient rainfall data.

(3) <u>Eton - Sarina - Koumala - Carmila district, east of the coast ranges</u>

Average annual rainfall in this area is generally between 55 and 70 inches. Surface water is relatively abundant, and streams are generally permanent, so that few bores have been put down. Moreover, records are largely incomplete, so that it is hard to obtain a useful picture of the occurrence of groundwater from them.

The area is occupied by rocks of the Urannah Complex, Lower Bowen Volcanics, Campwyn Beds and Carmila Beds, none of which appear to contain extensive aquifers. Bores into the Urannah Complex are rare. Water is sometimes obtained where the bore intersects a major joint, but otherwise chances of obtaining good supplies are poor. Quality too, is unpredictable, but is generally more or less acid and corrosive.

The Lower Bowen Volcanics have little potential as underground water producers, and bores into them are rare. However a bore near Eton, 68 feet deep in "slate" is reported to yield 8,000 gal./hour. Bores near Koumala put down for town water supply penetrated ashy tuff and yielded water at the rate of 24,000 gal./hour and 30,000 gal./hour from bores 71 feet and 75 feet deep. This water was hard and considered unsuitable for cordial making. The abundance of andesitic volcanics and the occurrence of calcite veins in both the Lower Bowen Volcanics and the Campwyn Beds suggests that hard, lime-rich water may be the general rule for underground supplies in these units.

No bore records are available for bores into the Carmila Beds, but the rocks are generally impermeable. However it is possible that underground water (possibly sub-artesian) may be available from sandstones at the top of the Carmila Beds, which are covered by alluvium, in the area east of the railway line between Ilbilbie and Carmila.

Sarina water supply is obtained from a dam on Middle Creek, a tributary of Plane Creek, eight miles south-west of the town. Domestic water supplies for some of the small coastal settlements (e.g. Grasstree) are supplemented by water obtained from shallow spears and wells into sand dunes close to the beach, which apparently tap a thin layer of fresh water floating on the salt sea water. The supply remains fresh providing the well is not deepened, and pumping rate is not excessive.

(4) Nebo district, south and west of the coast ranges

Average rainfall in this area is about 30 inches per year. Most creeks are non-perennial, but generally have large permanent waterholes, and water can usually be obtained from spears in the sandy beds of many of the larger streams.

Permanent water is usually obtained at shallow depth in the alluvium close to the creeks, and most of the bores in the area are in the alluvium south and west of Nebo, and along Cooper creek and Moonlight Creek. Bores in the Nebo area vary from 50 feet to 350 feet in depth. One bore four miles south of Nebo passed through 115 feet of alluvium. The town supply is obtained from a bore 61 feet deep yielding good water.

In contrast to the generally good underground water around Nebo, all twelve bores along Moonlight Creek and Cooper Creek produced permanent water described as "hard" or "very hard". These bores are all around 70 feet deep, and produced at a rate of about 700 gal./hour.

In general, the Urannah Complex and Lower Bowen Volcanics have little potential as underground water producers. Both the Middle Bowen Beds and the Upper Bowen Coal Measures contain aquifers for sub-artesian water. Further west on the Mt. Coolon 1:250,000 Sheet area, good underground water production is commonly obtained near coal seams in the Upper Bowen Coal Measures.

CONCLUSIONS

(a) Regional geology

About 50,000 feet of marine and freshwater units crop out in the area. The Yarrol and Bowen Basins at one time extended into part of the area. The Campwyn Beds are thought to be a possible extension of the Yarrol Basin sequence, and the Permian units on the western side of the Urannah Complex are part of the Bowen Basin sequence. Lower Permian marine beds of the Bowen Basin were deposited west of the present position of the Urannah Complex, but not on the eastern side, where the only possible coeval units are freshwater.

(b) The Middle Bowen Beds

The Middle Bowen Beds are about the same thickness (8,500 feet) at the nearest estimated section, on the Mount Coolon 1:250,000 Sheet area. But Unit C has increased considerably and Units A and B are thinner.

(c) Regional geolocical problems still remaining

The following problems are still unsolved:

(1) A knowledge of the type of fault separating the Campwyn Beds from the Permian units would throw some light on the regional tectonics.

(2) The relationship between the Urannah Complex and the Carmila Beds is uncertain. Deductions concerning the palaeogeography of the area can be made if it is known whether this is an intrusive or unconformable contact.

(3) The thickness of the Lower Bowen Volcanics is unknown, but it is unlikely that regional mapping will solve this problem.

(4) The age of possible Tertiary intrusions is uncertain. If they are Tertiary it might reduce the chances of finding accumulations of petroleum in possible Tertiary off-shore sequences.

(5) The relationship between the Lower Bowen Volcanics and the Carmila Beds is unknown. Work on the St. Lawrence Sheet area (Malone et al. 1963) indicates that the Carmila Beds may be equivalent to beds at the top of the Lower Bowen Volcanics and at the base of the Middle Bowen Beds.

(d) Petroleum prospects

It appears unlikely that petroleum will be found on the mainland in the Mackay area in economic quantities. Palaeozoic units either lack reservoir rocks or suitable structure, or they are intruded. Tertiary sediments are thin and in general lack porosity, but oil shale is present at Plevna.

Fine grained marine sediments in the Campwyn Beds could be possible source rocks, but the unit is intruded, eroded, and contains few reservoir rocks, certainly none of any thickness. The Lower Bowen Volcanics include no likely source or reservoir rocks and the unit is intruded by the Urannah Complex, and many dykes and sills. Although intrusions are rare in the Carmila Beds, the synclinal structure, and the lack of reservoir rocks make it a poor petroleum prospect. The Calen Coal Measures have good porosity and possible interbedded cap rocks, but intrusions are common. The unit could be the reservoir for the petroleum at Walkerston.

The Middle Bowen Beds contain possible source rocks in Units A and C, and Unit B contains some porous beds, but the regional dip to the south-west would not favour accumulation in this area unless stratigraphic traps are present. Unit C offers some reservoir potential in the Mount Flora area, but it is intruded by the Bundarra Granodiorite. The Upper Bowen Coal Measures, like the Middle Bowen Beds, contain possible reservoir rocks, and a similar structure; they possibly contain stratigraphic traps.

The widespread occurrence of bitumen on the coast might indicate submarine seeps. Possible sources are the Campwyn Beds, and Tertiary marine sediments which do not crop out on the mainland. It is possible that a thick Tertiary sequence in a graben east and north of Mackay, is covered by the sea.

(e) Metaliferous prospects

Although the area has not been an important producer of minerals, mineralization is widespread, generally associated with intrusions. The area is therefore worthy of more detailed prospecting and geological investigation, especially for copper. Attention should be focused on the Urannah Complex and the Lower Bowen Volcanics.

BIBLIOGRAPHY

ABBIS, T.J., 1959 - Water supply augmentation, amended scheme. Mackay City Council Report by City Engineer.

AUSTRAL MINING (QLD) PTY LTD, 1958 - Plevna oil shale basin - Eungella, Queensland. Geol.Surv.Qld Auth.Rep. 191 (unpubl.).

BAIRD, J., 1962 - Hydrogeology of the Dalrymple Heights area. Geol.Surv.Qld Rep. E45 (unpubl.).

BALL, L.C., 1909 - Annual Report 1909 - Tally Ho. Ann.Rep.Dep.Min.Qld, 1909, 174.

BALL, L.C., 1910a- The Mount Flora gold and mineral field. Publ.geol.Surv.Qld, 228.

BALL, L.C., 1910b- Some mineral fields in the hinterland of Mackay. Ibid., 229.

BALL, L.C., 1910c- Mount Spencer gold and mineral fields with special reference to its copper mines. Qld Govt.Min.J., 11, 226.

BALL, L.C., 1910d- Coal at Black Rock Creek, near Mackay. Ibid., 11, 283.

BALL, L.C., 1927 - Oil shale in the Eungella district. Ibid., 28, 306.

BALL, L.C., 1932 - The Grasstree goldfield. Ibid., 33, 328.

BROOKS, J.H., 1961 - Mannings uranium prospect, Teemburra Creek, Mackay. Ibid., 62, 147.

BRUNNSCHWEILER, R.O., 1957 - Final report on the Bowen Basin. Santos Ltd Auth. to Prospect 16P. Geol.Surv.Qld Auth.Rep. 680, (unpubl.).

CALVERT, F.J., 1959 - Groundwater investigations, Pioneer River Basin. Rep.Irrig.and Water Sup.Comm. (Qld) (unpubl.).

CAMERON, W.E., 1903 - Additions to the geology of the Mackay and Bowen Districts. Publ.geol.Surv.Qld, 181.

CAMERON, W.E., 1905 - Central District coal measures - their continuation towards the Mackay and Nebo Districts. Qld Govt Min.J., 6, 180, 227.

CAMERON, W.E., 1915 - The Tally Ho mine, Mackay District. Ibid., 16 (Oct.), 505.

CONNAH, T.H., 1961 - Beach sand heavy mineral deposits of Queensland. Publ.geol.Surv.Qld, 302, 26.

DENMEAD, A.K., 1932 - Alluvial gold mining in Queensland, Part II. Qld Govt Min.J., 33, 142.

DICKINS, J.M., 1961 - Appendix in Malone, E.J., Corbett, D.W.P., and Jensen, A.R., Geology of the Mount Coolon 4-mile area. Bur.Min.Resour.Aust.Rec. 1961/69 (unpubl.).

DICKINS, J.M., MALONE, E.J., and JENSEN, A.R., 1962 - Subdivision and correlation of the Middle Bowen Beds. Bur.Min.Resour.Aust.Rec.1962/87 (unpubl.).

DOWSETT ENGINEERING (AUST.) PTY LTD, 1955 - Final report, beach sands prospecting, North Queensland. Geol.Surv.Qld Auth.Rep., 274 (unpubl.).

DUNSTAN, B., 1901 - Geological features of Hazledean, West of Mackay. Publ.geol.Surv.Qld, 164.

DUNSTAN, B., 1906 - Other Queensland graphite deposits. Qld Govt Min.J., 7, 73.

EAST, J.D., 1946 - Golden Valley mine, Parish of Hector, Mackay District. Qld Govt Min.J., 47,375.

GOODSPEED, M.W., WILLIAMS, L.W., 1959 - Preliminary report on underwater gravity survey, Great Barrier Reef area; Thursday Island to Rockhampton. Bur.Min.Resour.Aust.Rec., 1959/70 (unpubl.)

GOUGH, K., 1961 - Final report on Queensland Authority to Prospect No, 77P. for Reef Oil Co. Ltd, Geol.Surv.Qld Auth.Rep. 680 (unpubl.).

HARTMAN, R., 1962 - Aeromagnetic survey of Great Barrier Reef for Australian Oil and Gas Corp. Ltd. B.M.R. File No. 62/1714 (unpubl.).

HAWTHORNE, W.L., 1961 - Coal resources, Nebo coalfield. Publ.geol.Surv.Qld, 303.

HILL, D., and DENMEAD, A.K., 1960 - The Geology of Queensland. J.geol.Soc.Aust. 7.

HILL, D., 1962 - Palaeontological Report on Collections made by the Bowen Basin Party. Memo to Chief Govt.Geologist Geol.Surv.Qld, 27/9/62.

ISBELL, R.F., 1954 - Survey of the Nebo-Collinsville region. Bur.Invest.Qld Tech.Bull., No.4.

ISBELL, R.F., 1955 - The geology of the northern section of the Bowen Basin. Pap.Univ.Qld Dep.Geol. 4(11).

JACK, R.L., 1879 - The Bowen River coalfield. Publ.geol.Surv.Qld 4.

JACK, R.L., 1887 - On the geological features of the Mackay district. Ibid., 39.

JACK, R.L., 1888 - The mineral wealth of Queensland. Ibid., 48.

JACK, R.L., 1893 - Grasstree goldfield near Mackay. Ibid., 93.

JENSEN, A.R., GREGORY, C.M., and FORBES, V.R., 1962 - Geology of the western part of the Mackay 1:250,000 Sheet area. Bur.Min.Resour.Aust.Rec. 1962/71.

JENSEN, A.R., 1963 - The geology of the southern half of the Proserpine 1:250,000 Sheet area. Ibid, 1963/65.

JENSEN, H.I., 1947 - Report on the 'Golden Valley' G.M. Lease Application No. 53, Mackay District. Geol.Surv.Qld (files).

KNIGHT, C.L., 1939 - Petrological notes on Grasstree rock specimens. Appendix in Reid (1939). Qld Govt Min.J., 40, 47.

LAING, A.C.M., 1959 - Reconnaissance geology of the northern section of the Bowen Basin and Styx Basin. Mines Administration Pty Ltd Rep. Q/56P/63 (unpubl.).

LAWRENCE, J.L., 1956 - Geological report on Mackay Oil Prospecting Syndicate Holdings. Geol.Surv.Qld Auth.Rep. 174 (unpubl.).

LEES, W., 1907 - The copper mines and mineral fields of Queensland. Qld Country Life, Brisbane.

MAITLAND, A.G., 1889a - Geological features and mineral resources of the Mackay District. Publ.geol.Surv.Qld, 53.

MAITLAND, A.G., 1889b - Geological Observations at the heads of the Isaacs, Sutton and Bowen Rivers. Publ.geol.Surv.Qld, 54.

MALONE, E.J., CORBETT, D.W.P., and JENSEN, A.R., 1961 - Geology of the Mount Coolon 4-mile area. Bur.Min.Resour.Aust.Rec. 1961/69 (unpubl.).

MALONE, E.J., MOLLAN, R.G., OLGERS, F., JENSEN, A.R., GREGORY, C.M., KIRKEGAARD, A.G., FORBES, V.R., 1963 - The Geology of the Duaringa-St. Lawrence 1:250,000 Sheet areas, Queensland. Bur.Min.Resour.Aust.Rec. 1963/60 (unpubl.).

MALONE, E.J., JENSEN, A.R., GREGORY, C.M., FORBES, V.R., 1962 - Geology of the Bowen South area. Bur.Min.Resour.Aust.Rec. 1962/72 (unpubl.).

MARKS, E.O., 1913 - Notes on Tally Ho Mine, Mackay District, Qld Govt Min.J. 14 (May), 241.

MARSHALL, C.E., NARAIN, N., 1954 - Regional gravity investigations in eastern and central Commonwealth. Univ.Sydney, Dep.Geol.& Geoph.Mem. 1954/2.

MORTON, C.C., 1925 - Mount Britton goldfield. Geol.Surv.Qld Rep. (unpubl.).

POWELL DUFFRYN TECHNICAL SERVICES, 1949 - First report on the coal industry of Queensland, 3 vols. Qld Parl.Pap.A., 16-1949.

MOTT, W.D., 1958 - Note to Consolidated Zinc Pty Ltd. Geol.Surv.Qld files (unpubl.)

REID, J.H., 1924-25 - Geology of the Bowen River Coalfield. Qld Govt Min.J., 25, 399-411, 447-466; 26, 4-11.

REID, J.H., 1925 - The Permo-carboniferous Coal Measures of the Nebo District. Ibid., 26, 465.

REID, J.H., 1929a - Geology of the Bowen River coalfield. Publ.geol.Surv.Qld, 276.

REID, J.H., 1929b - Coal prospects, Mackay District. Qld Govt Min.J., 30, 156

REID, J.H., 1930 - The Queensland Upper Palaeozoic succession. Publ.geol.Surv.Qld, 278.

REID, J.H., 1931 - Quarry sites for the Outer Harbour Scheme, Mackay District. Qld Govt Min.J., 32, 315.

REID, J.H., 1935 - Gold prospecting, Mosquito Mountain, Koumala District. Memo to Chief Govt Geologist, 21/5/1935 Geol.Surv.Qld (unpubl.).

REID, J.H., 1936 - Gold prospect, Kungurri, Mackay District. Ibid., 6/11/1936, (unpubl.).

REID, J.H., 1937 - Grasstree mine, Sarina. Qld Govt Min.J., 38, 424.

REID, J.H., 1938 - Grasstree mine, Sarina. Interim Report. Ibid., 39, 296.

REID, J.H., 1939 - Grasstree mine and goldfield, Sarina. Ibid., 40, 42.

REID, J.H., 1941 - Occurrence of molybdenite, Knight Island, Sarina. Ibid., 42, 115.

REID, J.H., 1942 - The Tertiary oil shales of Plevna-Eungella District. Ibid., 43, 2.

REID, J.H., 1943 - Pine-vale copper mine, Mirani. Ibid., 44, 97.

REID, J.H., 1945 - Idem, Ibid., 46, 364.

REID, J.H., 1946 - Geological reconnaissance of the Nebo District coal areas. Ibid., 47, 11.

REID, J.H. 1951 - Test drilling on the Nebo coalfield. Ibid., 92, 51.

RIDGWAY, J.E., 1935 - Lucky Hit, P.A., Eton. Memo to Chief Govt Geologist, Geol.Surv.Qld, (unpubl.).

RIDGWAY, J.E., 1944 - Nethordale mines. (Royal Victory, Victory, and King Copper Lode) Qld Govt Min.J., 45, 181-182.

SHEPHERD, S.R.L., 1933 - Proposed quarry site at Mount Bassett. Qld Govt Min.J., 24, 8.

SHEPHERD, S.R.L., 1935 - Note on prospecting work near Mosquito Mountain, S.E. of Mackay. Memo to Chief Govt Geologist, 15.4.1935. Geol.Surv.Qld, (unpubl.).

SHEPHERD, S.R.L., 1939 - Oil shale at Eungella. Qld Govt Min.J. 40, 91.

SHEPHERD, S.R.L., 1952 - Wolfram at Bolingbroke Station, Sarina District. Memo to Chief Govt Geologist, 10/11/52. Geol.Surv.Qld, (unpubl.).

SHEPHERD, S.R.L., 1953 - Pinevale copper mine, Mackay District. Qld Govt Min.J., 54, 492.

SHEPHERD, S.R.L., 1955 - Report on Middle Creek Dam Site, Sarina. Rep. to Chief Govt Geologist, 22/11/55. Geol.Surv.Qld, (unpubl).

STARKEY, L.J., 1959 - Report on regional gravity investigations in Authority to Prospect 56P. Mines Administration Pty Ltd, Rep.(unpubl.).

VEEVERS, J.J., RANDAL, M.A., MOLLAN, R.G., and PATEN, R.J., 1961 - Geology of the Clermont 4-mile Sheet area. Bur.Min.Resour.Aust.Rec. 1961/75 (unpubl.).

WHITE, M.E., 1962 - Report on 1961 fossil plant collections. Ibid., 1962/114 (unpubl.).

WHITE, M.E., 1963a - Report on 1962 plant fossil collections. Ibid., 1963/1 (unpubl.).

WHITE, M.E., 1963b - Report on East Bowen plant fossil collection. Ibid., 1963/33 (unpubl.).

WHITE, W.C., and BROWN, G.A., 1963 - Preliminary report on the geology of the Mackay Region, Area 93P and the southern part of 94P. Rept.Ampol Exploration (Qld) Ltd (unpubl.).

WHITEHOUSE, F.W., 1925 - List of fossil fauna, Nebo District. Qld Govt Min.J., 26, 474.

WHITEHOUSE, F.W., 1939 - Some corals from Grasstree. Appendix in Reid (1939). Ibid., 40, 48.

WOODS, J., 1960 - Vertebrate fossils from Homevale Station. Rept in Geol.Surv.Qld files 19/12/60, on fossils submitted by Dept. of Geol., Univ. of Qld.

WYATT, D.H., 1958 - Geological reconnaissance - Broken River area. Qld Govt Min.J. 59, 121.

APPENDIX A

IDENTIFICATION OF THE PERMIAN MARINE MACROFOSSILS FROM THE MACKAY 1:250,000 SHEET AREA

by

J.M. DICKINS

. . . .

INTRODUCTION

A discussion of the identifications, faunal subdivisions and correlations is given by J.M. Dickins (1962).

. . . .

The following macrofossils were found on the Mackay Sheet area:

FAUNA II

M 411 - Lat. 21°29'15" S., Long. 148°32'00" E.

Pelecypods

Merismopteria sp.

Brachiopods

Ingelarella profunda Campbell 1961
Dielasmatid

M 412a - Lat. 21°29'30" S., Long. 148°32'45" E.

Pelecypods

Astartila cf. *gryphoides* (de Koninck) 1877
Deltopecten limaeformis (Morris) 1845
Aviculopecten cf. *fittoni* (Morris) 1845 (Outline of shell wavy)
Schizodus sp. nov. A.

Brachiopods

Terrakea pollex Hill 1950
Cancrinella sp. (rather flat pedicle valve and ornament not well developed)
Cancrinella farleyensis (Etheridge & Dun) 1909
Anidanthus springsurensis (Booker) 1932
Strophalosia preovalis Maxwell 1954
Taeniothaerus sp.
Lissochonetes sp.
Neospirifer sp. ind.
Trigonotreta sp. A (close to *T. stokesii* of Brown, 1953)

Ingelarella ovata Campbell 1961

Ingelarella profunda Campbell 1961

Notospirifer sp. ind.

Pseudosyrinx sp. nov.

Gilledia cf. cymbaeformis (Morris) 1845

Gilledia sp. nov.

M 412b - Latitude and Longitude as for M 412a, but slightly higher stratigraphically.

Pelecypods

Astartila cf. gryphoides

Pachymyonia sp. ind. (one specimen similar to but may not be identical with P. cf. etheridgei Dun from MC 479 of Dickins, 1961a)

Modiolus sp.

Deltopecten squamuliferus (Morris) 1845

Aviculopecten tenuicollis (Dana) 1847

Streblopteria sp.

Cypricardinia ? sp. ind.

Brachiopods

Cancrinella farleyensis (Etheridge & Dun) 1909

Anidanthus springsurensis (Booker) 1932

Strophalosia preovalis Maxwell 1954

Strophalosia brittoni Maxwell 1954

Taeniothaerus sp.

Neospirifer (Grantonia) cf. hobartensis (Brown) 1953

Trigonotreta sp. A.

Ingelarella ovata Campbell 1961

Ingelarella profunda Campbell 1961

Notospirifer hillae Campbell 1961

FAUNA II ?

M 414 - Lat. 21°28'15" S., Long. 148°31'30" E. (lies stratigraphically between definite Fauna II and Fauna III)

Brachiopods

Terrakea sp. (a large form but seems wider at the umbo than T. solida and apparently lacks well developed umbonal thickening).

FAUNA IIIa

M 413 - Lat. 21°28'15" S., Long. 148°31'15" E.

Pelecypods

Glyptoleda cf. reidi Fletcher 1945

Glyptoleda sp. nov. ? (squat form upturned at the back, also found in MC 420, Dickins 1961a)

Astartila cf. gryphoides (de Koninck) 1877

Chaenomya sp. nov. B?

Stutchburia cf. costata (Morris) 1845

Schizodus sp. (possibly similar to that from Glendoo Member)

Gastropods

Mourlonia (*Platyteichum*) cf. *costatum* Campbell 1953

Glossopteris leaf.

M 415 - Lat. 21°28'00" S., Long. 148°31'15" E.

Pelecypods

Glyptoleda sp.?

Megadesmus sp. nov.?

Astartila cf. *gryphoides* (de Koninck) 1877

Pachymyonia sp. nov.

Chaenomya sp. nov. B

Wilkingia ? sp. nov.

Gastropods

Warthia sp.

Mourlonia (*Platyteichum*) cf. *costatum* Campbell 1953

Brachiopods

Ingelarella cf. *ingelarensis* Campbell 1960

Wood.

PROBABLE FAUNA IIIa.

M 21 - Lat. 21°31'00" S., Long. 148°33'30" E.

Pelecypods

Wilkingia? sp. nov.?

Atomodesma cf. *mytiloides* Beyrich 1864

Pseudomonotis? sp. nov. (Gryphoid spiny shell)

Gastropods

Mourlonia (*Platyteichum*) cf. *costatum* Campbell 1953

Brachiopods

Cancrinella sp.

Ingelarella cf. *ingelarensis* Campbell 1960

Crinoids

Separate plates.

FAUNA IIIc.

M 416 - Lat. 21°27'45" S., Long. 148°30'00" E.

Pelecypods

Megadesmus? sp. (appears to be same as at Collinsville 3 - Dickins 1961b)

Astartila? cf. *gryphoides* (de Koninck) 1877? (one incomplete specimen)

Notomya? sp. nov. (may be same as species of CL 122 - Dickins 1961b)

Gen. et sp. nov.?

Streblopteria sp.

Stutchburia cf. *compressa* (Morris) 1845

Schizodus ? sp. nov. B?

Gastropods

Warthia sp.

Mourlonia (_Mourlonia_) cf. _strzeleckiana_ (Morris) 1845

Mourlonia (_Platyteichum_) cf. _costatum_ Campbell 1953

Peruvispira sp. nov. (as at B 270b and CL 122 - Dickins 1961b)

Brachiopods

Notospirifer sp. B (like a large _N_. cf. _extensus_. Appears less cut back from umbo than N. _minutus_ Campbell. However, has a fold in sulcus and therefore differs from _N_. cf. _extensus_)

M 417 - Lat. 21°27'00" S., Long. 148°30'45" E.

Pelecypods

Aviculopecten cf. _subquinquelineatus_ (McCoy) 1847

Stutchburia cf. _costata_ (Morris) 1845

Stutchburia cf. _compressa_ (Morris) 1845

Stutchburia _cuneata_ (Dana) 1847

Cypricardinia? sp.

Astartidae gen. et nov. A (seems more transversely elongated than species in Fauna IV)

Brachiopods

Ingelarella cf. _ingelarensis_ Campbell 1960

Ingelarella _undulosa_ Campbell 1961

Notospirifer sp.? (may be _N_. _minutus_ or _N_. cf. _extensus_)

Flattish dielasmatid

Wood.

FAUNA IV Below Big _Strophalosia_ Zone.

M 418 - Lat. 21°27'00" S., Long. 148°30'30" E.

Pelecypods

Megadesmus _grandis_ (Dana) 1847

Megadesmus? sp.

Schizodus sp. nov. C.

Big _Strophalosia_ Zone

M 85 - Lat. 21°34'45" S., Long. 148°34'00" E.

Pelecypods

Myonia cf. _carinata_ (Morris) 1845

Myonia cf. _corrugata_ Fletcher 1932

"_Solemya_" _edelfeldti_ (Etheridge Jnr.) 1892

"_Modiolus_" cf. _mytiliformis_ (Etheridge Jnr.) 1892

Stutchburia cf. _costata_ (Morris) 1845

Astartidae gen., sp. ind.

Brachiopods

Strophalosia cf. *clarkei* (very numerous as in Big *Strophalosia* Zone)

Strophalosia cf. *ovalis*

Ingelarella cf. *ingelarensis*

Notospirifer cf. *minutus*

Streptorynchus cf. *pelicanensis* Fletcher 1952

Bryozoans.

Probably above Big *Strophalozia* Zone

M 86 - Lat. 21°34'45" S., Long. 148°33'15" E.

Pelecypods

"*Modiolus*" cf. *mytiliformis* (Etheridge Jnr.) 1892

Astartidae gen., sp. ind.

Brachiopods

Cancrinella or *Terrakea* sp.

Strophalosia cf. *ovalis*

Neospirifer sp.

Fenestellid bryozoans

Corals

Cladochonus sp.

Single Corals

Crinoid step ossicles

REFERENCES

DICKINS, J.M., 1961a - Appendix *in* Malone, E.J., Corbett, D.W.P., and Jensen, A.R., Geology of the Mount Coolon 4-mile area. *Bur.Min.Resour.Aust.Rec.* 1961/69 (unpubl.).

DICKINS, J.M., 1961b - Appendix *in* Veevers, J.J., Randal, M.A., Mollan, R.G., and Paten, R.J., The Geology of the Clermont 4-mile Sheet area, Queensland. *Ibid* 1961/75.

DICKINS, J.M., 1962 - Appendix *in* Malone, E.J., Jensen, A.R., Gregory, C.M., and Forbes, V.R., Geology of the Bowen South area. *Bur.Min.Resour.Aust.Rec.* 1962/72 (unpubl.).

APPENDIX B

ANALYSIS OF BITUMEN AND OIL SAMPLES FROM THE MACKAY AREA

by

J. Puchel
(Petroleum Technology Section,
Bureau of Mineral Resources)

Three seepage samples submitted on the 6th November 1962 have been tested. Characterization of these samples is based on paper chromatography techniques. Distillation characteristics could be obtained only in the case of the oily phase of the water well samples.

Results of quantitative tests and observations are given in Table 1.

Each sample contained asphaltenes and resins, but oil from the water well sample contained only traces of these compounds. Practically no polycyclic hydrocarbons were noticed in the oil from the water well sample, but they were more evident in the bitumen sample from Half Tide.

The sample from Finlayson Point appears to be derived from a crude base different to that of the other two samples.

Table 1.

Results and observations on bitumen and oil samples from the Mackay area

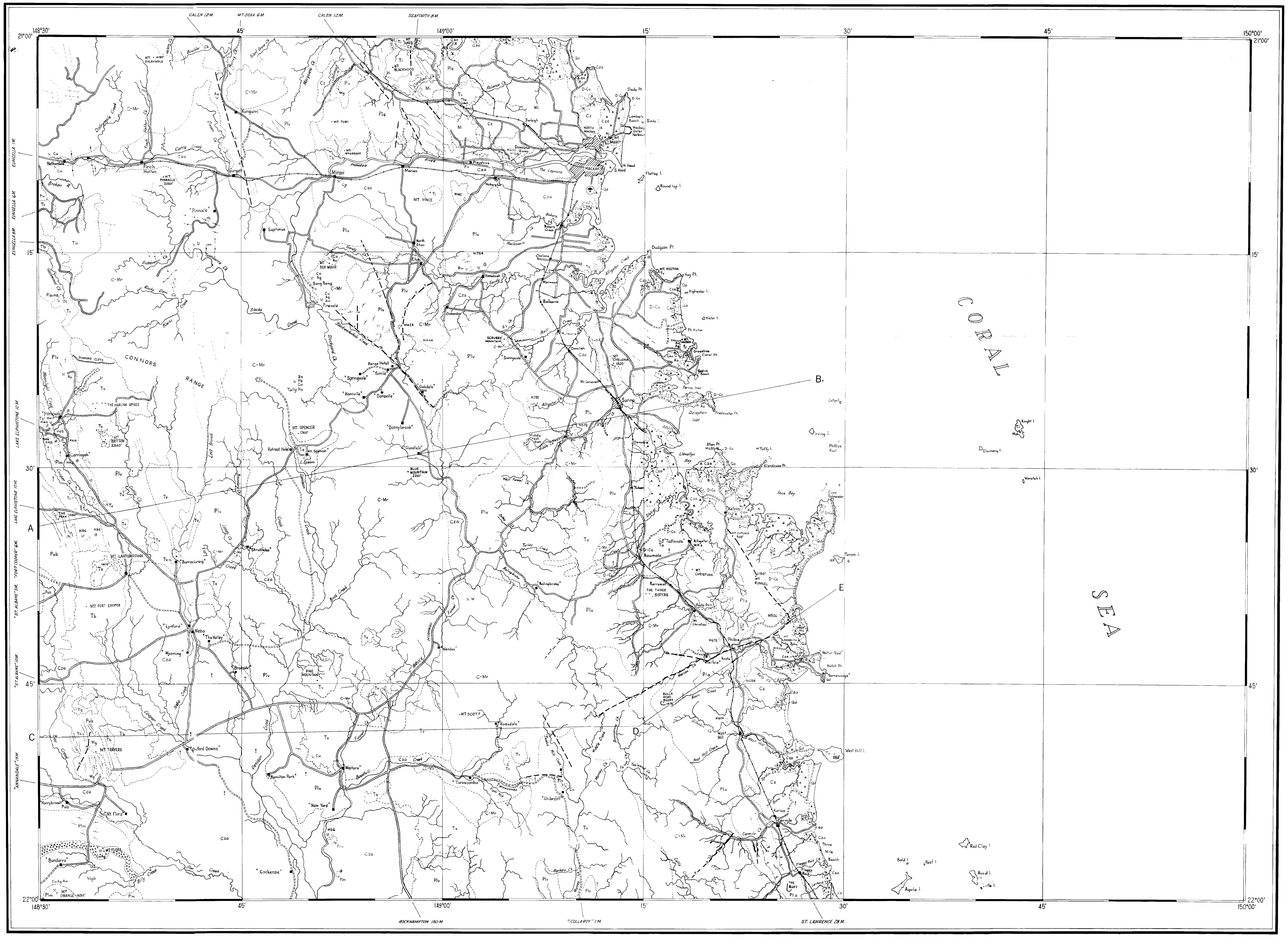
Sample description	Composition			Distillation C°			Observations
	water	hydrocarbons	solids	70-110	110-280	280-360	
Bitumen from Finlayson Point Proserpine Sheet area. Coll. A.R.Jensen	1%	3.7%	95.2%	--- not tested ---			Viscous, black, odourless
Oily phase in water from well of Mr. R. Taylor, Fadden St. Walkeston. Mackay Sheet area.	98.5%	1%	0.5%	12%	8%	21%	Non-viscous green oil. Distillation residue - slightly viscous liquid, strong naphtenic odour.
Bitumen from Half Tide, near Sarina Beach, Mackay Sheet area. Coll. V.Forbes.	6.8%	74%	20%	--- not tested ---			Waxy, black, odourless.

PRELIMINARY EDITION, 1962
SUBJECT TO AMENDMENT

AUSTRALIA 1:250,000

MACKAY
QUEENSLAND

1:250,000 GEOLOGICAL SERIES SHEET SF55-8

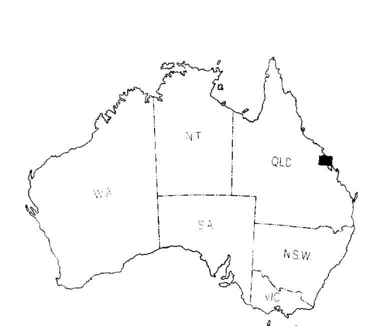


Reference

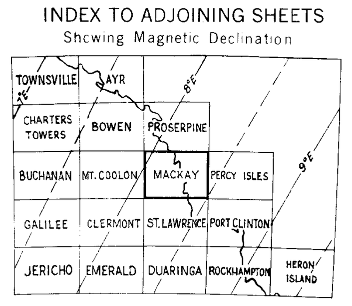
CAINOZOIC			Qd	Coastal dune sand
			Cza	Soil, sand, alluvium, coastal sediments, flood plain desposits Mangrove swamp
			Cz	Undifferentiated unconsolidated sediment
	TERTIARY		Ta	Semi-friable sandstone
			Tv	Rhyolite, trachyte, andesite, rhyolitic agglomerate and breccia, minor basalt, ignimbrite.
			Tb	Mainly basalt flows, some minor porphyritic rhyolite
			Ti	Undifferentiated intrusive rocks
MESOZOIC			Mi	Undifferentiated basic and intermediate intrusive rocks
			Mg	Acid intrusive rocks
		Bundarra Granodiorite	Mgb	Leuco-granodiorite
	CARBONIFEROUS TO MESOZOIC	Urannah Complex	C-Mr	Granite-diorite-granodiorite complex with abundant acid, intermediate, and basic dykes
PALAEOZOIC	PERMIAN	Upper Bowen Coal Measures	Pub	Lithic sandstone, siltstone, carbonaceous shale, coal, conglomerate bands
		Middle Bowen Beds	Plm	Quartz sandstone, lithic sandstone, blue micaceous fossiliferous siltstone
		Calen Coal Measures	Ple	Lithic sandstone, quartz sandstone, chert, carbonaceous shale, siltstone, coal, rhyolite.
		Carmila Beds	Pla	Conglomerate, siltstone, carbonaceous shale, lithic sandstone, rhyolite, dacite, tuff.
		Lower Bowen Volcanics	Plv	Andesitic flows, agglomerate and tuff, minor rhyolite and dacite, tuff, siltstone, feldspathic sandstone.
	UPPER DEVONIAN TO LOWER CARBONIFEROUS	Campwyn Beds	D-Cc	Andesite and rhyolite flows and pyroclastics, siltstone, fossiliferous limestone (includes minor intermediate and basic intrusives).

Geological boundary
Fault
Where location of boundaries and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries are dotted, faults are shown by short dashes.
Strike and dip of strata
Prevailing dip of strata
Vertical strata
Overturned strata
Strike and dip of foliation
Bedding trend lines
Joint pattern
Dykes:- an = andesite rh = rhyolite
M412 Macrofossil locality
M751 Plant fossil locality
Fossil wood
Mine
Prospect
Ag Silver
Au Gold
Cu Copper
Cy Clay
G Graphite
M Molybdenite
Ol Oilshale
Pb Lead
Rm Road metal
U Uranium Niobium Titanium Rare earths
W Wolfram
Z Zirconium Beach sands
Zn Zinc
Windpump
Homestead
Airfield
Road
Vehicle track
Cliff
Metamorphic aureole

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Queensland. Slotted template control supplied by the Division of National Mapping, Department of National Development, 1962. Spot heights taken from Lands Department Queensland Four Mile Series. Transverse Mercator Projection.

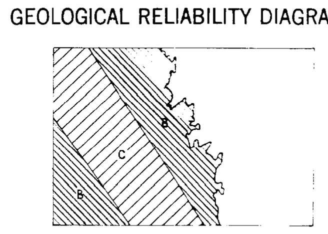


INDEX TO ADJOINING SHEETS
Showing Magnetic Declination



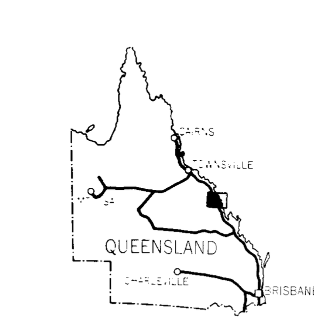
Scale 1 : 250,000
5 0 5 10 15 MILES
5 0 5 10 15 20 25 KILOMETRES

GEOLOGICAL RELIABILITY DIAGRAM

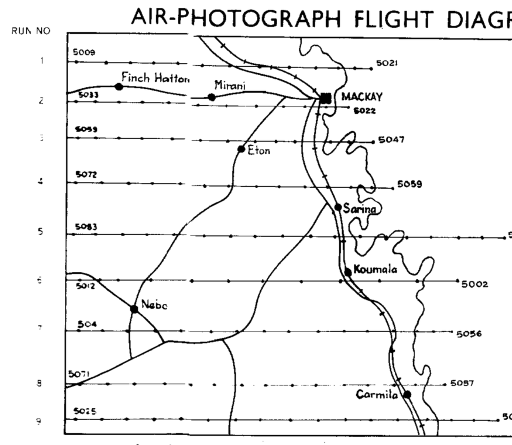


B – *Detailed reconnaissance - numerous traverses*
C – *Air-photo interpretation - few traverses*

Geology by: A.R. Jensen, C.M. Gregory (B.M.R.) and V.R. Forbes (G.S.Q.), 1961, 1962
Compiled by: A.R. Jensen, C.M. Gregory (B.M.R.) and V.R. Forbes (G.S.Q.), 1962
Drawn by P.J. Brown

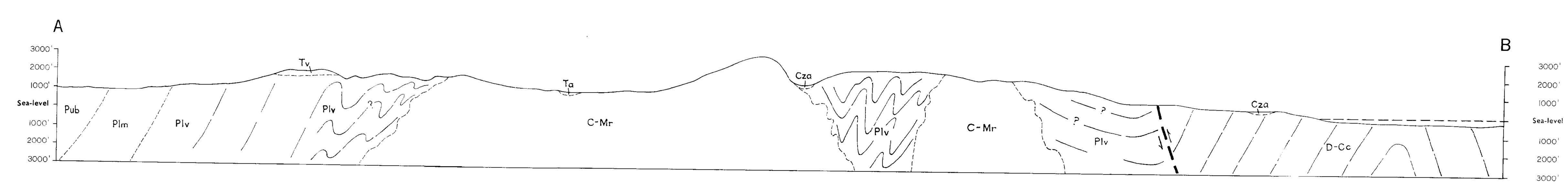


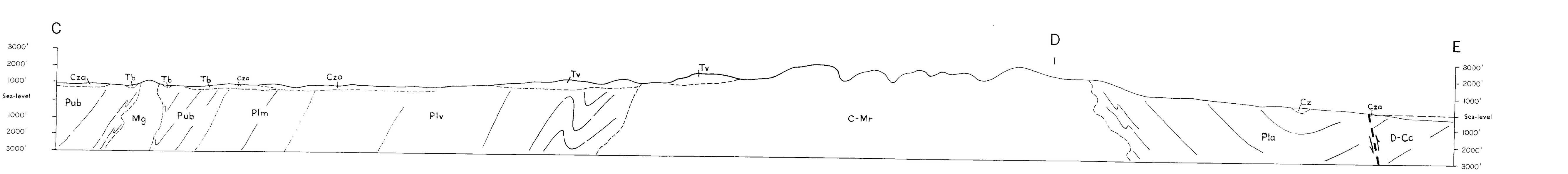
AIR-PHOTOGRAPH FLIGHT DIAGRAM



Air photography by Adastra Airways Pty Ltd complete vertical coverage at 1:85,000 scale.

Sections





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MACKAY

QUEENSLAND

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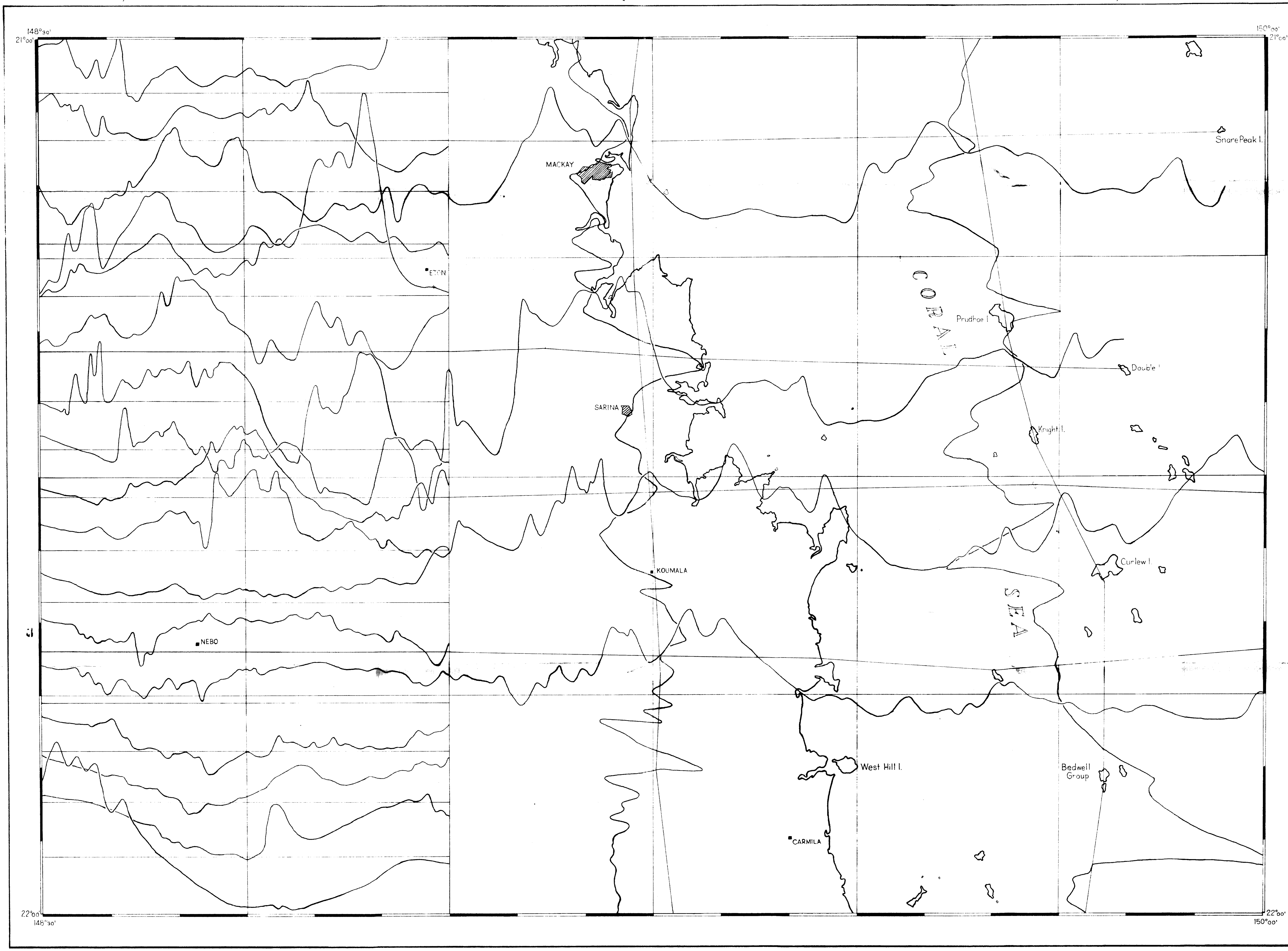
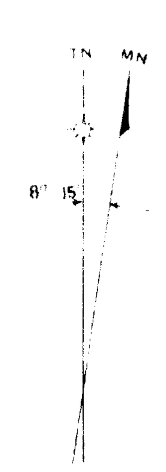
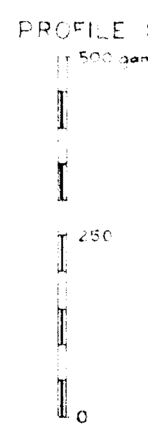
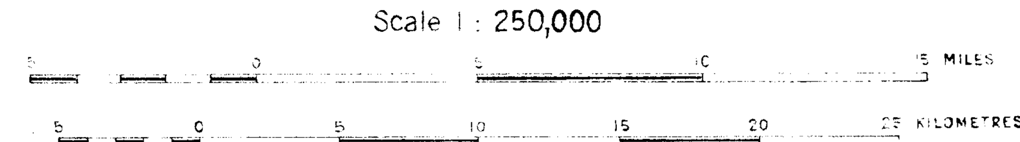






TOTAL MAGNETIC INTENSITY PROFILES

AIRBORNE SURVEY BOWEN BASIN 1962



Bureau of Mineral Resources Geology and Geophysics May 1963

EXPLANATORY NOTES

The traverses were flown by a DC-3 aircraft at an altitude of 2000 feet above sea level.

The total magnetic profiles were recorded by a rectilinear recorder and have been corrected for the South component of a regional gradient in total intensity of 7 gammas per mile in a direction S 6°W (Western part of sheet) and 8 gammas per mile in a direction S 5°W (Eastern part of sheet).

The profiles recorded at intervals of 4 miles are shown on the map.

The flight lines which also serve as base lines to the profiles have been positioned on the map with a probable error of ± ¼ mile (Western part of map) and of ± ½ mile (Eastern part of map).

To accompany Record 1963/71

F55/8/5